US010897077B2

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

(10) **Patent No.: US 10,897,077 B2**
(45) **Date of Patent: Jan. 19, 2021**

(54) **INVISIBLE ANTENNAS**

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

(72) Inventors: **David Chi**, Taipei (TW); **Leo Joseph Gerten**, Taipei (TW); **Hung-Wen Cheng**, Taipei (TW); **Po Chao Chen**, Taipei (TW); **Shih Huang Wu**, Taipei (TW); **Sean Hung**, Taipei (TW)

(73) Assignee: **Hewlett-Packard Development Company, L.P.**, Spring, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 224 days.

(21) Appl. No.: **16/081,132**

(22) PCT Filed: **Oct. 24, 2016**

(86) PCT No.: **PCT/US2016/058397**
§ 371 (c)(1),
(2) Date: **Aug. 30, 2018**

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(65) **Prior Publication Data**

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(51) **Int. Cl.**
H01Q 1/38 (2006.01)
G06F 1/16 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 1/38*** (2013.01); ***G06F 1/1616*** (2013.01); ***G06F 1/1698*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC .. H01Q 1/38; H01Q 5/38; H01Q 1/22; H01Q 1/24; H01Q 1/48; H01Q 9/30
(Continued)

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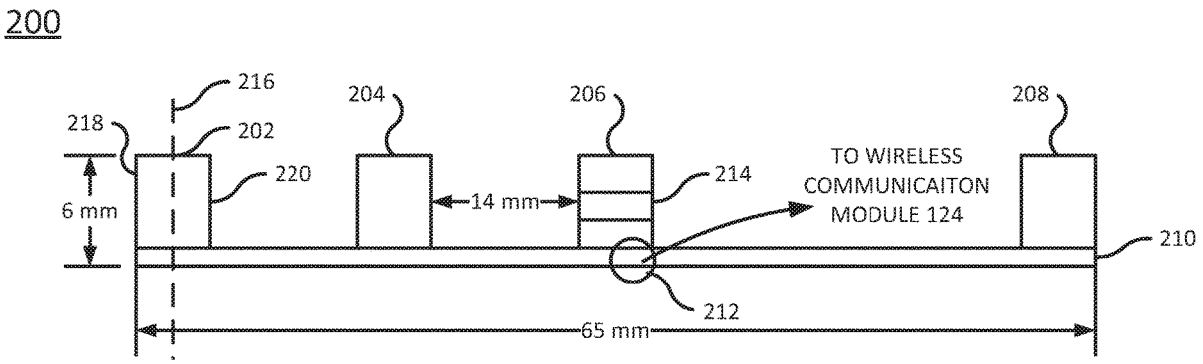
Primary Examiner — Andrea Lindgren Baltzell
(74) *Attorney, Agent, or Firm* — Tong, Rea, Bentley & Kim LLC

(57) **ABSTRACT**

In example implementations, an antenna for a mobile device is provided. The antenna includes a printed circuit board and a plurality of metal members coupled to the printed circuit board. The printed circuit board is devoid of metal traces. The plurality of metal members is positioned along a length of the printed circuit board to operate at a desired frequency band when inserted into an opening along an outer edge perimeter of a metallic housing of the mobile device.

12 Claims, 4 Drawing Sheets



US010897085B2

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

(10) **Patent No.: US 10,897,085 B2**
(45) **Date of Patent: Jan. 19, 2021**

(54) **ANTENNA AND ANTENNA SYSTEM**

(71) Applicant: **Smarteq Wireless Aktiebolag**, Kista (SE)

(72) Inventors: **Erika Hansson**, Stockholm (SE); **Mattias Hellgren**, Åkersberga (SE); **Johan Sjöberg**, Sollentuna (SE); **Yuan Xu**, Sollentuna (SE)

(73) Assignee: **SMARTEQ WIRELESS AKTIEBOLAG**, Kista (SE)

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

(21) Appl. No.: **16/583,961**

(22) Filed: **Sep. 26, 2019**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Oct. 15, 2018 (SE) 1851260

(51) **Int. Cl.**
H01Q 1/32 (2006.01)
H01Q 9/04 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 9/0414*** (2013.01); ***H01Q 1/3233*** (2013.01); ***H01Q 1/3283*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/32; H01Q 1/3233; H01Q 1/3283; H01Q 9/0407; H01Q 9/0414; H01Q 19/10; H01Q 21/205; H01Q 21/29; H01Q 25/005
See application file for complete search history.

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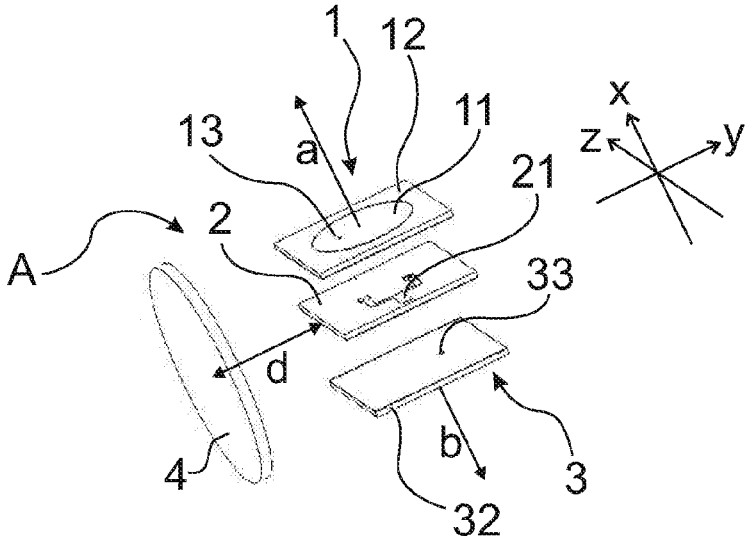
Primary Examiner — Hoang V Nguyen
(74) *Attorney, Agent, or Firm* — Christopher & Weisberg, P.A.

(57) **ABSTRACT**

An antenna for a vehicle. The antenna has an omni-directional radiation pattern and is configured for V2X communication. An x-y plane is defined as the horizontal plane in relation to the vehicle, an x-z plane is defined as a plane that is parallel to a side of the vehicle to which the antenna is positioned, and a y-z plane is defined as an elevation plane in relation to the vehicle. The antenna includes a first patch antenna and a second patch antenna and a reflector, and a feed network and power divider. The first patch antenna is aimed in a first direction along the x-axis. The second patch antenna is aimed in a second and opposite direction along the x-axis, and the reflector is positioned in a plane that is parallel to the x-z plane.

23 Claims, 3 Drawing Sheets



US010897087B2

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

(10) **Patent No.: US 10,897,087 B2**
(45) **Date of Patent: Jan. 19, 2021**

(54) **INTEGRATED SLOT ANTENNA**

(71) Applicant: **Hewlett-Packard Development Company, L.P.**, Spring, TX (US)

(72) Inventors: **Juhung Chen**, Taipei (TW); **Leo Gerten**, Austin, TX (US); **Po Chao Chen**, Taipei (TW); **Hung-Wen Cheng**, Taipei (TW)

(73) Assignee: **Hewlett-Packard Development Company, L.P.**, Spring, 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.: **16/608,821**

(22) PCT Filed: **Apr. 18, 2017**

(86) PCT No.: **PCT/US2017/028028**

§ 371 (c)(1),
(2) Date: **Oct. 26, 2019**

(87) PCT Pub. No.: **WO2018/194555**

PCT Pub. Date: **Oct. 25, 2018**

(65) **Prior Publication Data**

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

(52) **U.S. Cl.**
CPC ***H01Q 13/10*** (2013.01); ***H01Q 1/241*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 13/10; H01Q 1/24
USPC 343/770
See application file for complete search history.

(56) **References Cited**

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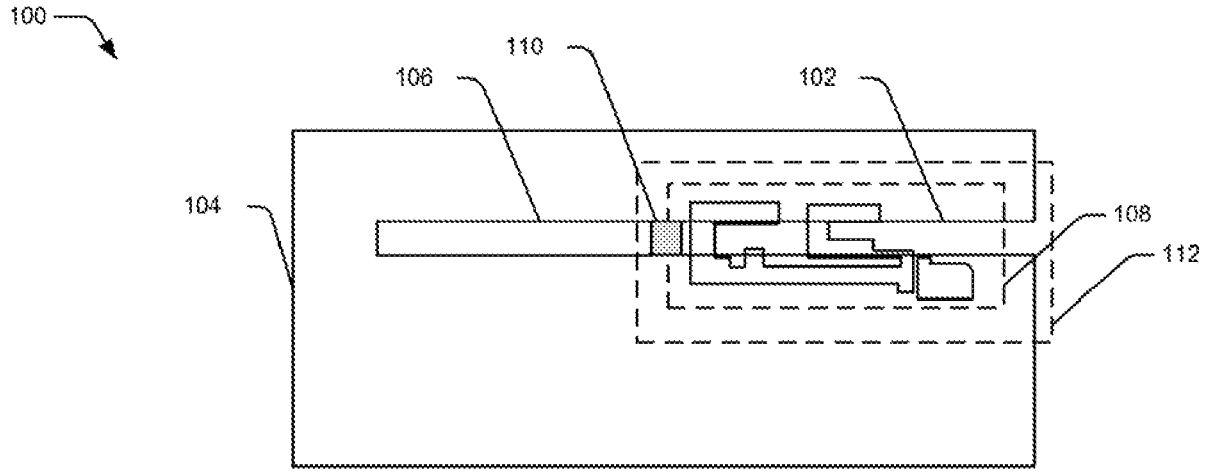
Primary Examiner — Andrea Lindgren Baltzell
(74) *Attorney, Agent, or Firm* — HPI Patent Department

(57) **ABSTRACT**

Examples of an integrated slot antenna are described. The integrated slot antenna comprises a first slot, a second slot and a separating member. The first slot is an open-ended slot and is coupled to a first antenna member to form a first slot antenna. The first slot antenna operates in a first predetermined range of frequencies. The second slot is a close-ended slot and is separated from the first slot by the separating member.

15 Claims, 5 Drawing Sheets



US010903549B2

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

(10) **Patent No.: US 10,903,549 B2**
(45) **Date of Patent: Jan. 26, 2021**

(54) **RECONFIGURABLE ANTENNA DEVICE SUITABLE FOR THREE-SEGMENT TYPE METAL BACK COVER**

(71) Applicant: **JRD Communication (Shenzhen) LTD.**, Shenzhen (CN)

(72) Inventors: **Wei Hu**, Shenzhen (CN); **Chaoyu Tian**, Shenzhen (CN)

(73) Assignee: **JRD Communication (Shenzhen) 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 13 days.

(21) Appl. No.: **16/344,775**

(22) PCT Filed: **Sep. 1, 2017**

(86) PCT No.: **PCT/CN2017/100265**
§ 371 (c)(1),
(2) Date: **Apr. 24, 2019**

(87) PCT Pub. No.: **WO2018/076928**
PCT Pub. Date: **May 3, 2018**

(65) **Prior Publication Data**

US 2019/0237853 A1 Aug. 1, 2019

(30) **Foreign Application Priority Data**

Oct. 26, 2016 (CN) 2016 1 0942722

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/50 (2006.01)
H01Q 5/307 (2015.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/242*** (2013.01); ***H01Q 1/50*** (2013.01); ***H01Q 5/307*** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/242; H01Q 1/50; H01Q 5/307; H01Q 1/48; H01Q 5/335; H01Q 5/328
See application file for complete search history.

(56) **References Cited**

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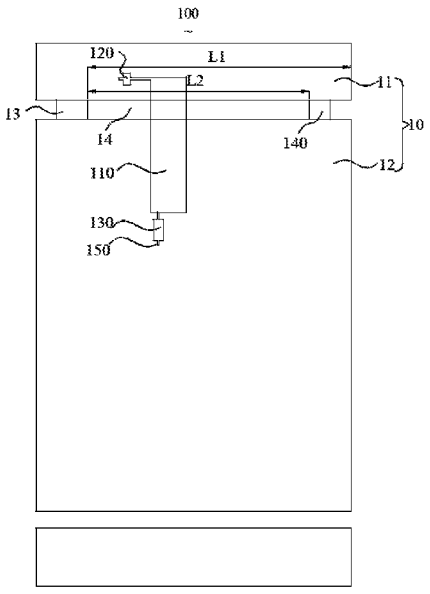
Primary Examiner — Daniel D Chang

(57) **ABSTRACT**

A reconfigurable antenna device suitable for a three-segment metal back cover is provided. The antenna device may include an antenna radiation body, a first matching module, a second matching module, a switch module and a feeding end. The antenna radiation body cab be parallel to and above a first metal body and a second metal body of the metal back cover. The antenna radiation body can be grounded after being connected to the first matching module. The antenna radiation body is further connected to the second matching module, and the second matching module is connected to the feeding end and a switch module, respectively. A multi-band reconfigurable antenna can be achieved by adjusting the position of the switch module.

20 Claims, 1 Drawing Sheet



US010910692B2

(12) **United States Patent**
Furlan

(10) **Patent No.: US 10,910,692 B2**
(45) **Date of Patent: Feb. 2, 2021**

(54) **IN-GLASS HIGH PERFORMANCE ANTENNA**

(71) Applicant: **TAOGLAS GROUP HOLDINGS LIMITED**, Enniscorthy (IE)

(72) Inventor: **Vladimir Furlan**, Munich (DE)

(73) Assignee: **TAOGLAS GROUP HOLDINGS LIMITED**, Enniscorthy (IE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 68 days.

(21) Appl. No.: **16/192,191**

(22) Filed: **Nov. 15, 2018**

(65) **Prior Publication Data**

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Related U.S. Application Data

(60) Provisional application No. 62/591,221, filed on Nov. 28, 2017.

(51) **Int. Cl.**
H01Q 1/52 (2006.01)
H01Q 1/12 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 1/1271*** (2013.01); ***H01P 3/085*** (2013.01); ***H01P 5/1007*** (2013.01); ***H01Q 1/12*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC .. H01Q 1/52; H01Q 1/12; H01Q 1/48; H01Q 13/085; H01Q 1/2283; H01Q 1/526;
(Continued)

(56) **References Cited**

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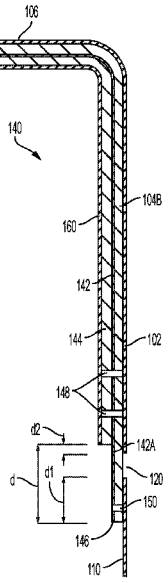
Primary Examiner — Hai V Tran
(74) *Attorney, Agent, or Firm* — Garson & Gutierrez, PC

(57) **ABSTRACT**

Disclosed is an antenna including a radiating element, a co-planar ground plane element and a transmission line extending across at least a portion of the radiating element and the ground plane element. The transmission line includes a dielectric layer. The dielectric layer has a portion of a first major surface adjacent to the ground plane and a second major surface opposite and separated from the first surface. A shield is formed on the second major surface. At least one via extends through the dielectric layer to connect the shield to the ground plane. A feed line extends longitudinally through the dielectric layer from a feed point at a proximal end of the transmission line towards a distal end of the transmission line, the feed line being shielded along a portion of its length extending across the ground plane element by the shield with the distal end of the transmission line lying in register with the radiating element and coupling the feed line to the radiating element.

21 Claims, 10 Drawing Sheets



US010910696B2

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

(10) **Patent No.: US 10,910,696 B2**
(45) **Date of Patent: Feb. 2, 2021**

(54) **MOBILE DEVICE**

(71) Applicant: **Acer Incorporated**, New Taipei (TW)

(72) Inventors: **Kun-Sheng Chang**, New Taipei (TW); **Ching-Chi Lin**, New Taipei (TW)

(73) Assignee: **ACER INCORPORATED**, New Taipei (TW)

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

(21) Appl. No.: **16/550,681**

(22) Filed: **Aug. 26, 2019**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Jul. 5, 2019 (TW) ..... 108123737 A

(51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01Q 9/42 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/2291*** (2013.01); ***H01Q 9/42*** (2013.01)

(58) **Field of Classification Search**
CPC .. H01Q 1/16; H01Q 1/38; H01Q 1/48; H01Q 1/243; H01Q 1/2291; H01Q 5/385; H01Q 9/42; H04M 1/26
See application file for complete search history.

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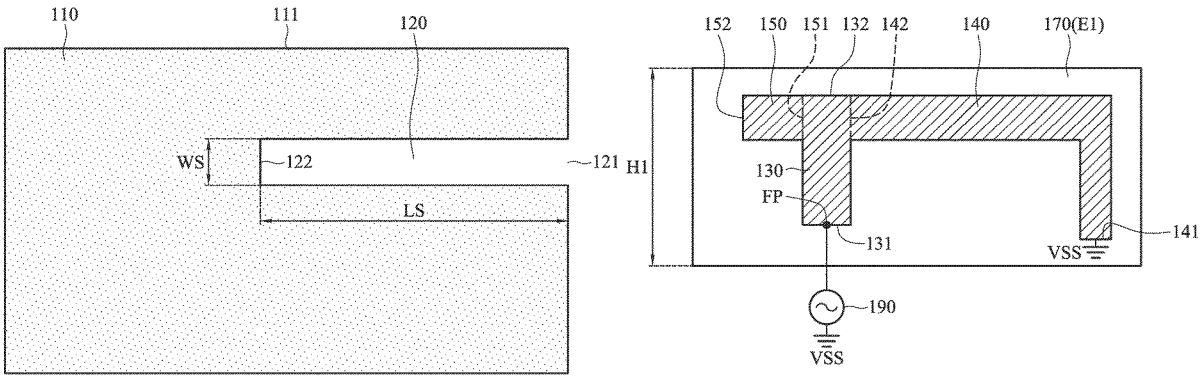
Primary Examiner — Ganiyu A Hanidu
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

A mobile device includes a metal mechanism element, a feeding radiation element, a first radiation element, a second radiation element, and a dielectric substrate. The metal mechanism element has a slot. The slot has an open end and a closed end. The feeding radiation element has a feeding point. The first radiation element extends across the slot of the metal mechanism element. The feeding radiation element is coupled through the first radiation element to a ground voltage. The second radiation element is coupled to the feeding radiation element. The dielectric substrate is adjacent to the metal mechanism element. The feeding radiation element, the first radiation element, and the second radiation element are disposed on the dielectric substrate. An antenna structure is formed by the feeding radiation element, the first radiation element, the second radiation element, and the slot of the metal mechanism element.

15 Claims, 6 Drawing Sheets



US010910697B2

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

(10) **Patent No.: US 10,910,697 B2**
(45) **Date of Patent: Feb. 2, 2021**

(54) **MOBILE TERMINAL**

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

(72) Inventors: **Dongjin Kim**, Seoul (KR); **Kangjae Jung**, Seoul (KR); **Duckyun Kim**, Seoul (KR); **Changwon Yun**, Seoul (KR); **Soyeon Lee**, Seoul (KR); **Songyi Lee**, Seoul (KR)

(73) Assignee: **LG ELECTRONICS INC.**, Seoul (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.: **16/479,072**

(22) PCT Filed: **Jan. 26, 2017**

(86) PCT No.: **PCT/KR2017/000942**
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(2) Date: **Jul. 18, 2019**

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PCT Pub. Date: **Aug. 2, 2018**

(65) **Prior Publication Data**

US 2020/0014093 A1 Jan. 9, 2020

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H01Q 1/24 (2006.01)
H01Q 1/52 (2006.01)
H01Q 1/48 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/521*** (2013.01); *H01Q 1/48* (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/48; H01Q 1/521; H01Q 9/40; H01Q 5/30; H01Q 1/52; H01Q 3/00; H01Q 1/02
See application file for complete search history.

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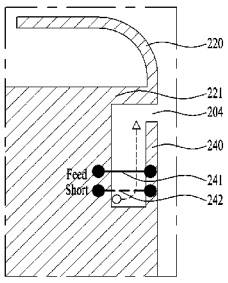
Primary Examiner — Jimmy T Vu
(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

A mobile terminal, which comprises: a case including an electric component mounting part therein; a middle frame mounted on the case; a main board mounted on the case; a first antenna spaced apart from and arranged in parallel to the middle frame, and having a first end that is open and a second end connected to the middle frame; a first feed line connected to a first part of the first antenna so as to transmit a signal; a ground line connected to a second part of the first antenna and performing grounding; a second antenna connected to the ground line; and a second feed line connected to the second antenna, increases the number of Wi-Fi antennas, thereby enabling data transmission speed to become faster.

10 Claims, 8 Drawing Sheets



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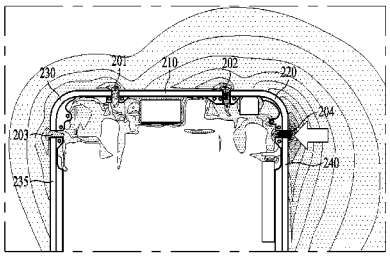

(b)

US010910698B2

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

(10) **Patent No.: US 10,910,698 B2**
(45) **Date of Patent: Feb. 2, 2021**

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

(71) Applicant: **Wistron NeWeb Corp.**, Hsinchu (TW)

(72) Inventors: **Shih-Chiang Wei**, Hsinchu (TW); **Cheng-Da Yang**, Hsinchu (TW); **Kuan-Hung Li**, Hsinchu (TW); **Shu-Yun Yeh**, Hsinchu (TW)

(73) Assignee: **WISTRON NEWEB CORP.**, Hsinchu (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.: **16/669,732**

(22) Filed: **Oct. 31, 2019**

(65) **Prior Publication Data**

US 2020/0274231 A1 Aug. 27, 2020

(30) **Foreign Application Priority Data**

Feb. 22, 2019 (TW) ..... 108105956 A

(51) **Int. Cl.**

H01Q 5/30	(2015.01)
H01Q 1/24	(2006.01)
H01Q 5/357	(2015.01)
H01Q 5/385	(2015.01)

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

CPC ***H01Q 1/244*** (2013.01); ***H01Q 5/357*** (2015.01); ***H01Q 5/385*** (2015.01)

(58) **Field of Classification Search**

CPC H01Q 1/24; H01Q 1/38; H01Q 5/378–5/385; H01Q 13/10

See application file for complete search history.

(56) **References Cited**

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TW	I646729 B	1/2019

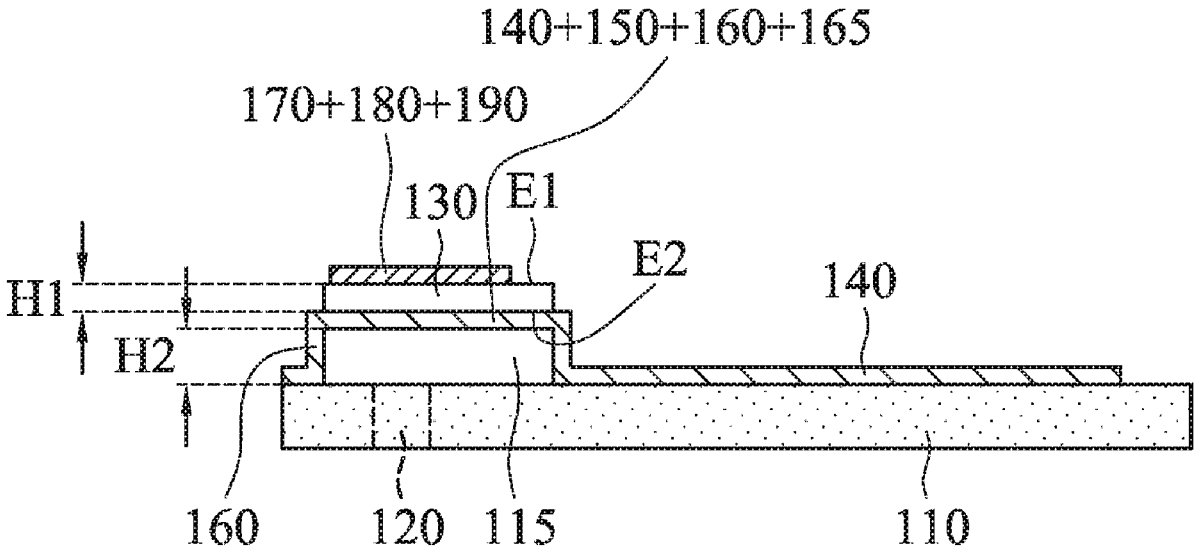
Primary Examiner — Hasan Z Islam

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

(57) **ABSTRACT**

A mobile device includes a metal mechanism element, a dielectric substrate, a holder, a feeding radiation element, a ground plane, a shorting element, a circuit element, a first parasitic radiation element, a second parasitic radiation element, and an additional radiation element. The metal mechanism element has a slot. The ground plane and the shorting element are respectively coupled to the metal mechanism element. The circuit element is coupled between the shorting element and the ground plane. The first parasitic radiation element and the second parasitic radiation element are respectively coupled to the ground plane. The additional radiation element is adjacent to the feeding radiation element or is coupled to the feeding radiation element. An antenna structure is formed by the feeding radiation element, the circuit element, the first parasitic radiation element, the second parasitic radiation element, the additional radiation element, and the slot of the metal mechanism element.

20 Claims, 12 Drawing Sheets



US010910708B2

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

(10) **Patent No.: US 10,910,708 B2**
(45) **Date of Patent: Feb. 2, 2021**

(54) **ANTENNA DEVICE AND ELECTRONIC DEVICE COMPRISING ANTENNA**

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

(72) Inventors: **Kuo Cheng Chen**, Gyeonggi-do (KR); **Se Hyun Park**, Gyeonggi-do (KR); **Tae Young Kim**, Gyeonggi-do (KR); **Ahmed Hussain**, Gyeonggi-do (KR); **Igor Shcherbatko**, Gyeonggi-do (KR); **Je Hun Jong**, Seoul (KR); **Jin Woo Jung**, Seoul (KR); **Jae Hoon Jo**, Gyeonggi-do (KR)

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

(*) 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.: **16/833,964**

(22) Filed: **Mar. 30, 2020**

(65) **Prior Publication Data**

US 2020/0227823 A1 Jul. 16, 2020

Related U.S. Application Data

(63) Continuation of application No. 16/022,023, filed on Jun. 28, 2018, now Pat. No. 10,608,336.

(30) **Foreign Application Priority Data**

Jun. 28, 2017 (KR) 10-2017-0081751

(51) **Int. Cl.**
H01Q 3/24 (2006.01)
H01Q 3/36 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 3/247*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/246*** (2013.01); ***H01Q 1/48*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 3/247; H01Q 1/48; H01Q 1/243; H01Q 21/065; H01Q 21/005
(Continued)

(56) **References Cited**

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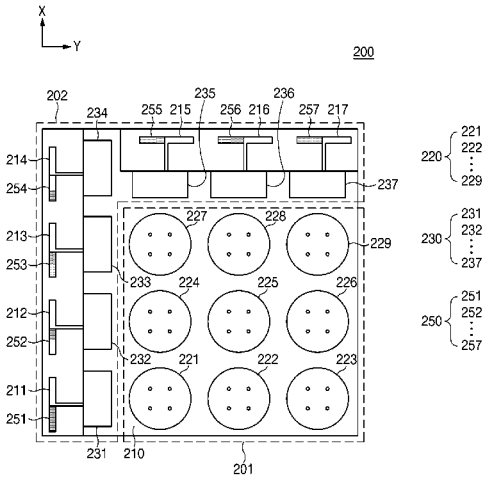
(Continued)

Primary Examiner — Brian K Young
(74) *Attorney, Agent, or Firm* — The Farrell Law Firm, P.C.

(57) **ABSTRACT**

An antenna device includes a ground member including a plane part and a plurality of extension parts extending from one end of the plane part in a first direction and arranged along a second direction, a plurality of patch-type radiators arranged on the plane part along the second direction and configured to radiate vertical polarization, and a plurality of straight radiators spaced apart from the ground member, respectively arranged to be adjacent to the plurality of extension parts, extending in the first direction, and configured to radiate horizontal polarization.

20 Claims, 18 Drawing Sheets



US010910715B2

(12) **United States Patent**
Rutfors

(10) **Patent No.: US 10,910,715 B2**
(45) **Date of Patent: Feb. 2, 2021**

(54) **ANTENNA ARRANGEMENT AND A DEVICE COMPRISING SUCH AN ANTENNA ARRANGEMENT**

(71) Applicant: **PROANT AB**, Umea (SE)

(72) Inventor: **Tomas Rutfors**, Holmsund (SE)

(73) Assignee: **Proant AB**, Umea (SE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 12 days.

(21) Appl. No.: **16/487,465**

(22) PCT Filed: **Feb. 27, 2018**

(86) PCT No.: **PCT/EP2018/054758**
§ 371 (c)(1),
(2) Date: **Aug. 21, 2019**

(87) PCT Pub. No.: **WO2018/154132**
PCT Pub. Date: **Aug. 30, 2018**

(65) **Prior Publication Data**

US 2019/0393603 A1 Dec. 26, 2019

(30) **Foreign Application Priority Data**

Feb. 27, 2017 (EP) 17158217

(51) **Int. Cl.**
H01Q 5/335 (2015.01)
H01Q 9/04 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 5/335*** (2015.01); ***H01Q 1/38*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 9/045*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/36; H01Q 1/38; H01Q 13/08; H01Q 13/085; H01Q 13/10; H01Q 13/103;
(Continued)

(56) **References Cited**

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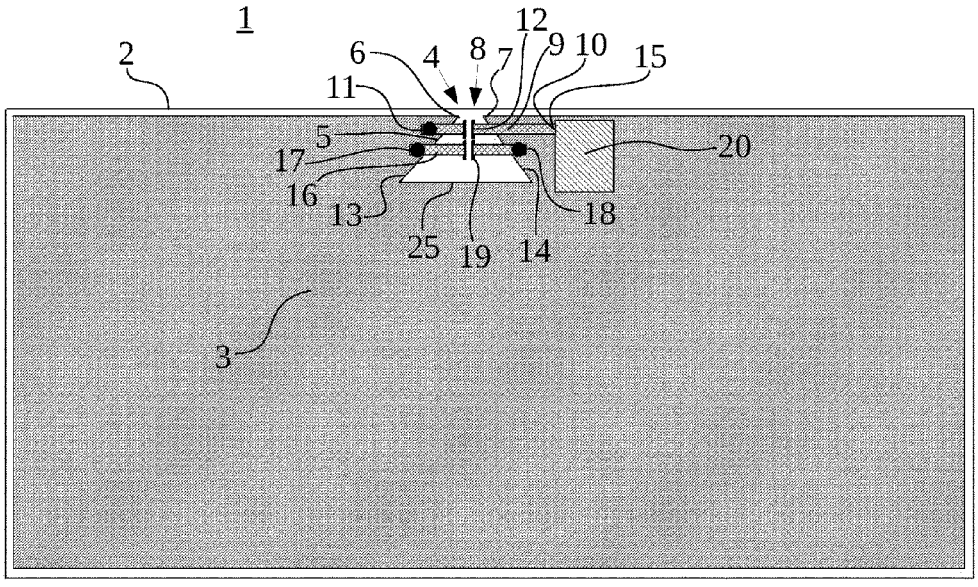
Primary Examiner — Jason Crawford
(74) *Attorney, Agent, or Firm* — Mark P. Stone

(57) **ABSTRACT**

The invention concerns an antenna arrangement (**1**) comprising: —a printed circuit board (**2**) having a metallised area (**3**) acting as a ground plane (**3**) in use, —a recess portion (**4**) in an edge portion of the ground plane (**3**), —a first electrically reactive network (**9**) bridging the recess portion (**4**)—a second electrically reactive network (**16**) bridging the recess portion (**4**), separately from the first electrically reactive network (**9**), wherein an electrical length of the recess portion (**4**) is 1/10th of a wavelength of the resonance frequency of the antenna arrangement (**1**) or less, and wherein a physical distance between the first (**9**) and second (**16**) electrically reactive networks (**9**, **16**) is less than 1/12 of a wavelength of the resonance frequency of the antenna arrangement (**1**). The invention also concerns a device comprising an antenna arrangement (**1**).

20 Claims, 8 Drawing Sheets



US010910720B2

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

(10) **Patent No.: US 10,910,720 B2**
(45) **Date of Patent: Feb. 2, 2021**

(54) **ANTENNA**

(71) Applicant: **TDK CORPORATION**, Tokyo (JP)

(72) Inventors: **Tatsuya Fukunaga**, Tokyo (JP); **Yuichi Kimura**, Saitama (JP)

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

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

(21) Appl. No.: **16/551,169**

(22) Filed: **Aug. 26, 2019**

(65) **Prior Publication Data**

US 2020/0076083 A1 Mar. 5, 2020

(30) **Foreign Application Priority Data**

Aug. 30, 2018 (JP) 2018-161911

(51) **Int. Cl.**

H01Q 1/38	(2006.01)
H01Q 9/04	(2006.01)
H01Q 5/30	(2015.01)
H01Q 13/10	(2006.01)
H01Q 21/30	(2006.01)

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

CPC ***H01Q 9/0464*** (2013.01); ***H01Q 1/38*** (2013.01); *H01Q 5/30* (2015.01); *H01Q 9/045* (2013.01); *H01Q 9/0414* (2013.01); *H01Q 13/106* (2013.01); *H01Q 21/30* (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/38; H01Q 9/0414; H01Q 9/045; H01Q 9/0464; H01Q 13/106; H01Q 21/30

See application file for complete search history.

(56) **References Cited**

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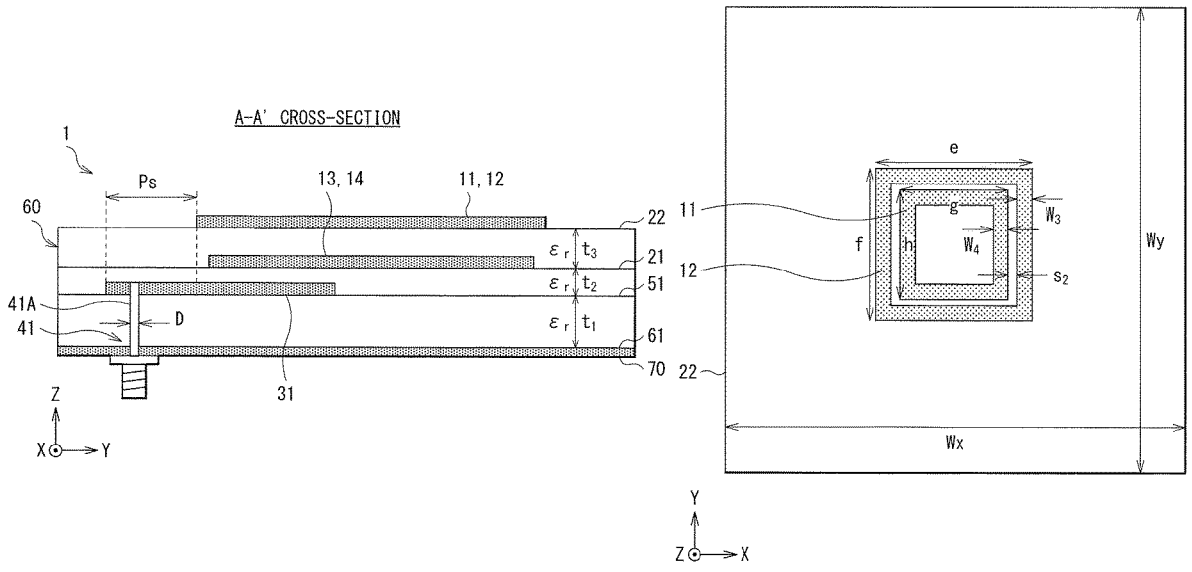
Primary Examiner — Thuy Vinh Tran
(74) *Attorney, Agent, or Firm* — Oliff PLC

(57) **ABSTRACT**

An antenna includes a dielectric, first to fourth antenna electrodes, and at least one probe electrode. The dielectric has first to fifth planes stacked parallel to each other in a stacking direction. The first to the fourth antenna electrodes each have an annular shape. The first antenna electrode is disposed on the first plane. The second antenna electrode is different in size from the first antenna electrode and disposed on the second plane. The third antenna electrode is disposed on the third plane. The fourth antenna electrode is different in size from the third antenna electrode and disposed on the fourth plane. The probe electrode is disposed on the fifth plane and overlaps one or both of the first and third antenna electrodes and one or both of the second and fourth antenna electrodes when seen in plan view along the stacking direction.

7 Claims, 32 Drawing Sheets



US010910726B2

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

(10) **Patent No.: US 10,910,726 B2**
(45) **Date of Patent: Feb. 2, 2021**

(54) **SLOT ANTENNA AND TERMINAL**

(71) Applicant: **HUAWEI TECHNOLOGIES CO., LTD.**, Shenzhen (CN)

(72) Inventors: **Chih-Hua Chang**, Taipei (TW); **Chien-Ming Lee**, Shanghai (CN); **Hanyang Wang**, Reading (GB); **Yen-Cheng Lai**, Taipei (TW); **Yu Chan Yang**, Taipei (TW)

(73) Assignee: **HUAWEI TECHNOLOGIES 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 0 days.

(21) Appl. No.: **16/065,813**

(22) PCT Filed: **Dec. 24, 2015**

(86) PCT No.: **PCT/CN2015/098689**
§ 371 (c)(1),
(2) Date: **Jun. 24, 2018**

(87) PCT Pub. No.: **WO2017/107137**
PCT Pub. Date: **Jun. 29, 2017**

(65) **Prior Publication Data**

US 2019/0013588 A1 Jan. 10, 2019

(51) **Int. Cl.**

H01Q 13/10	(2006.01)
H01Q 13/08	(2006.01)
H01Q 1/48	(2006.01)
H01Q 5/35	(2015.01)
H01Q 21/28	(2006.01)
H01Q 5/335	(2015.01)

(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 13/08*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 5/328*** (2015.01); ***H01Q 5/335*** (2015.01); ***H01Q 5/35*** (2015.01); ***H01Q 13/103*** (2013.01); ***H01Q 13/106*** (2013.01); ***H01Q 21/28*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 13/10; H01Q 1/243; H01Q 1/48; H01Q 5/328; H01Q 5/335
See application file for complete search history.

(56) **References Cited**

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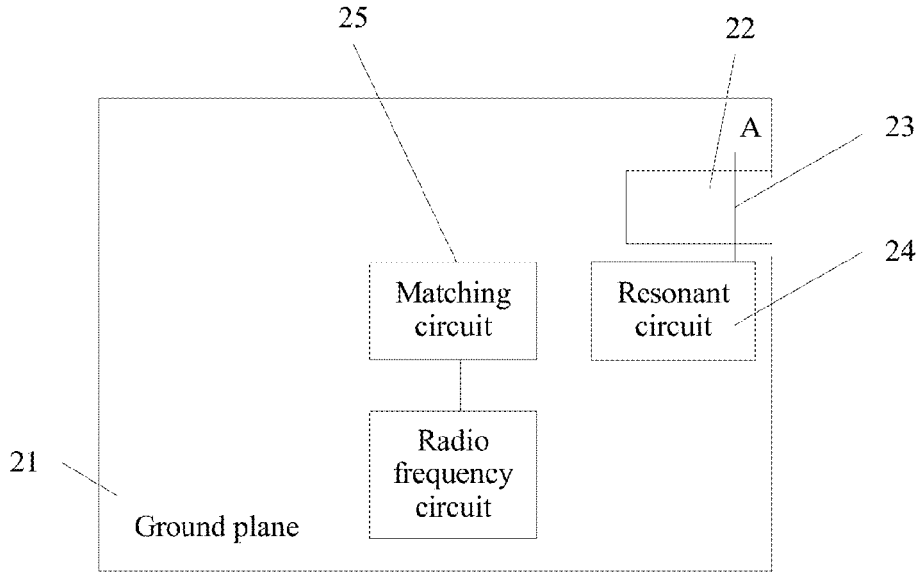
Primary Examiner — Hasan Z Islam
(74) *Attorney, Agent, or Firm* — Kilpatrick Townsend & Stockton LLP

(57) **ABSTRACT**

This application discloses a slot antenna and a terminal. The slot antenna includes a ground plane, an open slot disposed on the ground plane, a slot feeder, and a resonant circuit. The resonant circuit effectively excites a current on a surface of the ground plane, so that the ground plane becomes a primary radiator, and the antenna is a secondary radiator. Therefore, a volume of the antenna can be reduced without affecting radiation efficiency of the antenna.

5 Claims, 10 Drawing Sheets



US010910732B2

(12) **United States Patent**
Samadi Taheri et al.

(10) **Patent No.: US 10,910,732 B2**
(45) **Date of Patent: Feb. 2, 2021**

(54) **COLLOCATED END-FIRE ANTENNA AND LOW-FREQUENCY ANTENNA SYSTEMS, DEVICES, AND METHODS**

(71) Applicant: **wiSpry, Inc.**, Irvine, CA (US)

(72) Inventors: **Mohammad Mehdi Samadi Taheri**, Tehran (IR); **Shuai Zhang**, Aalborg SV (DK); **Gert Frølund Pedersen**, Storvorde (DK)

(73) Assignee: **WISPRY, INC.**, Irvine, CA (US)

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

(21) Appl. No.: **16/157,683**

(22) Filed: **Oct. 11, 2018**

(65) **Prior Publication Data**

US 2019/0109387 A1 Apr. 11, 2019

Related U.S. Application Data

(60) Provisional application No. 62/570,930, filed on Oct. 11, 2017.

(51) **Int. Cl.**
H01Q 21/30 (2006.01)
H01Q 21/28 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 21/28*** (2013.01); ***H01Q 1/521*** (2013.01); ***H01Q 5/15*** (2015.01); ***H01Q 5/307*** (2015.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/521; H01Q 5/307; H01Q 9/0414; H01Q 21/29
See application file for complete search history.

(56) **References Cited**

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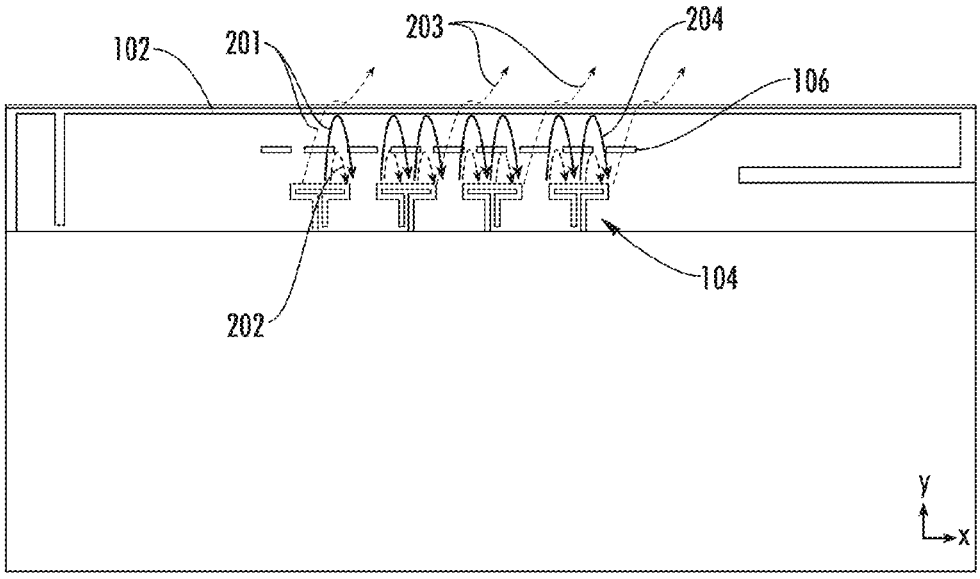
Primary Examiner — Ab Salam Alkassim, Jr.
(74) *Attorney, Agent, or Firm* — Jenkins, Wilson, Taylor & Hunt, P.A.

(57) **ABSTRACT**

Antenna systems, devices, and methods for providing both end-fire mm-wave high-frequency signals and low-frequency RF signals from a collocated antenna array in which at least one high-frequency antenna element and a low-frequency antenna element are spaced apart from one another. Grating strips are positioned between the high-frequency antenna elements and the low-frequency antenna element, the grating strips being spaced apart from one another by a defined spacing. The grating strips are configured such that a signal wave from the high-frequency antenna element propagates through the low-frequency antenna element.

14 Claims, 11 Drawing Sheets



US010916832B2

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

(10) **Patent No.: US 10,916,832 B2**
(45) **Date of Patent: Feb. 9, 2021**

(54) **ELECTRONIC DEVICE SLOT ANTENNAS**

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

(72) Inventors: **Umar Azad**, Santa Clara, CA (US); **Harish Rajagopalan**, San Jose, CA (US); **David Garrido Lopez**, Campbell, CA (US); **Rodney A. Gomez Angulo**, Santa Clara, CA (US); **Mattia Pascolini**, San Francisco, 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 345 days.

(21) Appl. No.: **15/900,610**

(22) Filed: **Feb. 20, 2018**

(65) **Prior Publication Data**

US 2019/0260112 A1 Aug. 22, 2019

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/52 (2006.01)
H01Q 21/06 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/523*** (2013.01); ***H01Q 21/064*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 21/064
See application file for complete search history.

(56) **References Cited**

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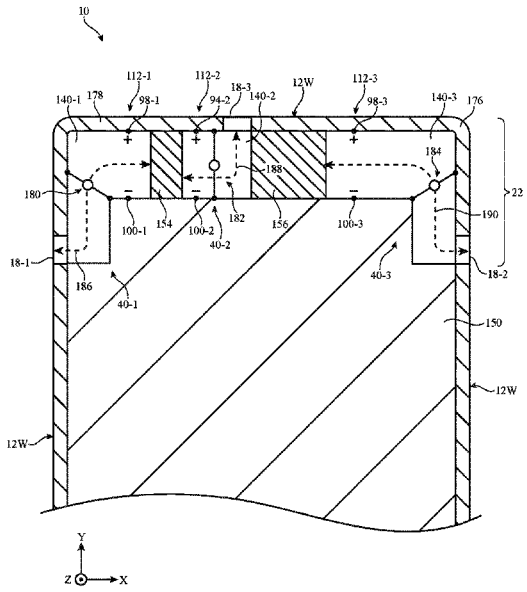
Primary Examiner — Ricardo I Magallanes
(74) *Attorney, Agent, or Firm* — Treyz Law Group, P.C.; Michael H. Lyons; Matthew R. Williams

(57) **ABSTRACT**

An electronic device may include first, second, and third antennas and conductive housing structures. The first, second, and third antennas may each include slots having open ends defined by gaps in the conductive housing structures. The second antenna may be interposed between the first and third antennas. The first and second antennas may convey signals at the same frequencies. The third antenna may convey signals at a lower frequency than the first and second antennas. A switch may be coupled across the third slot and may have a first state at which the switch forms a closed end of the third slot and a second state at which the third slot has two opposing open ends. Control circuitry may selectively activate one of two feeds for the third antenna and may adjust the switch so that the third antenna exhibits satisfactory antenna efficiency regardless of environmental conditions for the device.

19 Claims, 10 Drawing Sheets



US010916833B2

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

(10) **Patent No.: US 10,916,833 B2**
(45) **Date of Patent: *Feb. 9, 2021**

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

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

(72) Inventors: **Dong Ryul Shin**, Daegu (KR); **Min Sakong**, Gyeongsangbuk-do (KR); **Chae Up Yoo**, Seoul (KR); **Jin Woo Jung**, Seoul (KR); **Ho Saeng Kim**, Gyeonggi-do (KR); **Byung Chan Jang**, Gyeongsangbuk-do (KR)

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

(*) 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.: **16/291,567**

(22) Filed: **Mar. 4, 2019**

(65) **Prior Publication Data**

US 2019/0198978 A1 Jun. 27, 2019

Related U.S. Application Data

(63) Continuation of application No. 14/922,967, filed on Oct. 26, 2015, now Pat. No. 10,224,603.

(30) **Foreign Application Priority Data**

Oct. 24, 2014 (KR) 10-2014-0145540

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 9/42	(2006.01)
H01Q 5/378	(2015.01)

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

CPC ***H01Q 1/243*** (2013.01); ***H01Q 5/378*** (2015.01); ***H01Q 9/42*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243

See application file for complete search history.

(56) **References Cited**

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(Continued)

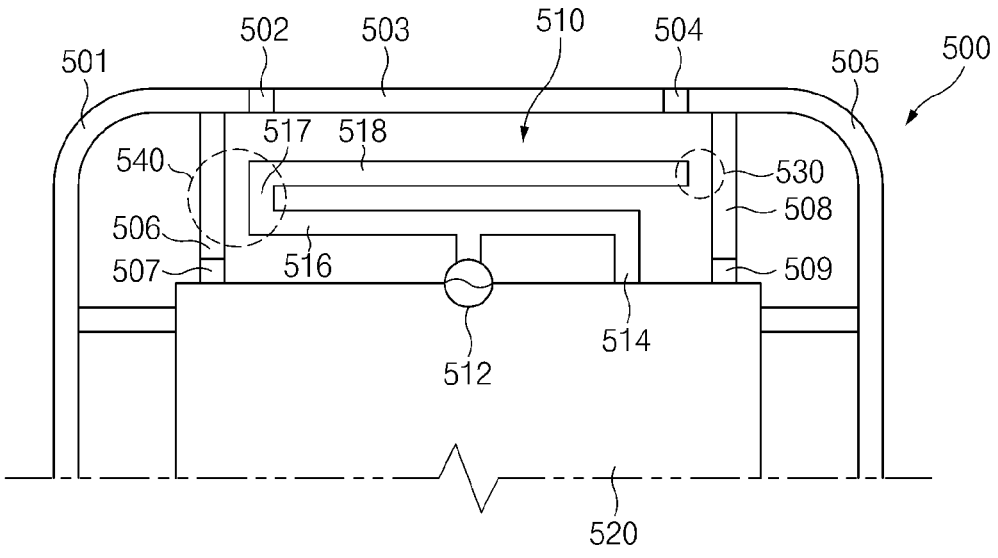
Primary Examiner — Robert Karacsony

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

(57) **ABSTRACT**

An electronic device is provided. The electronic device includes a housing including a segment part used to insulate a portion of the housing and an antenna disposed at a position corresponding to the segment part.

11 Claims, 13 Drawing Sheets



US010916840B2

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

(10) **Patent No.: US 10,916,840 B2**
(45) **Date of Patent: Feb. 9, 2021**

(54) **ELECTRONIC DEVICE WITH MULTI-PIECE ANTENNA STRUCTURE FOR INCREASED STRENGTH AND CONNECTION STABILITY**

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

(72) Inventors: **Liao-Yuan Hsu**, New Taipei (TW); **Kuo-Heng Sun**, New Taipei (TW); **Pao-Ching Mao**, New Taipei (TW); **Yen-Wei 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 0 days.

(21) Appl. No.: **16/424,859**

(22) Filed: **May 29, 2019**

(65) **Prior Publication Data**

US 2019/0372211 A1 Dec. 5, 2019

(30) **Foreign Application Priority Data**

May 29, 2018 (CN) 2018 1 0534171

(51) **Int. Cl.**
H01Q 1/50 (2006.01)
H01Q 1/24 (2006.01)
H01Q 1/36 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/50*** (2013.01); ***H01Q 1/242*** (2013.01); ***H01Q 1/36*** (2013.01)

(58) **Field of Classification Search**
CPC .. H01Q 1/22; H01Q 1/48; H01Q 1/50; H01Q 1/242; H01Q 1/233; H01Q 1/243; H01Q 1/36; H01Q 9/0421
See application file for complete search history.

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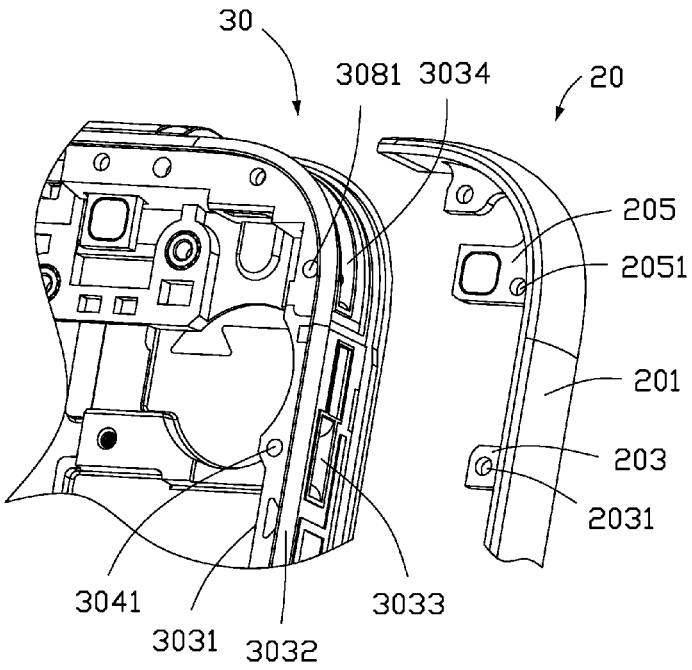
Primary Examiner — Seokjin Kim
(74) *Attorney, Agent, or Firm* — ScienBiziP, P.C.

(57) **ABSTRACT**

An electronic device which is simple to manufacture includes a carrier frame and an outer frame. The carrier frame and the outer frame are both made of metal. The carrier frame serves as a ground terminal. A portion of the outer frame serves as an antenna of the electronic device. The antenna includes a feeding portion and a grounding portion. The feeding portion connects to a feed source. The grounding portion is attached to the carrier frame, and it is fixed to the carrier frame by welding process.

10 Claims, 5 Drawing Sheets



US010916846B2

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

(10) **Patent No.: US 10,916,846 B2**
(45) **Date of Patent: Feb. 9, 2021**

(54) **ANTENNA WITH MULTIPLE COUPLED REGIONS**

(71) Applicant: **Ethertronics, Inc.**, San Diego, CA (US)

(72) Inventors: **Laurent Desclos**, San Diego (CA); **Chew Chwee Heng**, Singapore (SG); **Sebastian Rowson**, San Diego, CA (US); **Jeffrey Shamblin**, San Diego, CA (US)

(73) Assignee: **Ethertronics, Inc.**, San Diego, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 58 days.

(21) Appl. No.: **15/948,203**

(22) Filed: **Apr. 9, 2018**

(65) **Prior Publication Data**

US 2018/0226717 A1 Aug. 9, 2018

Related U.S. Application Data

(63) Continuation of application No. 14/885,981, filed on Oct. 16, 2015, now Pat. No. 9,941,588, which is a (Continued)

(51) **Int. Cl.**

H01Q 1/22	(2006.01)
H01Q 5/328	(2015.01)
H01Q 5/385	(2015.01)
H01Q 7/00	(2006.01)
H01Q 9/06	(2006.01)
H01Q 9/42	(2006.01)

(Continued)

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

CPC ***H01Q 5/328*** (2015.01); ***H01Q 5/321*** (2015.01); ***H01Q 5/378*** (2015.01); ***H01Q 5/385*** (2015.01); ***H01Q 7/005*** (2013.01); ***H01Q 9/06*** (2013.01); ***H01Q 9/42*** (2013.01); ***H01Q 19/005*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 5/30–5/342; H01Q 5/378–5/385; H01Q 9/42; H01Q 1/22–1/24

See application file for complete search history.

(56) **References Cited**

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(Continued)

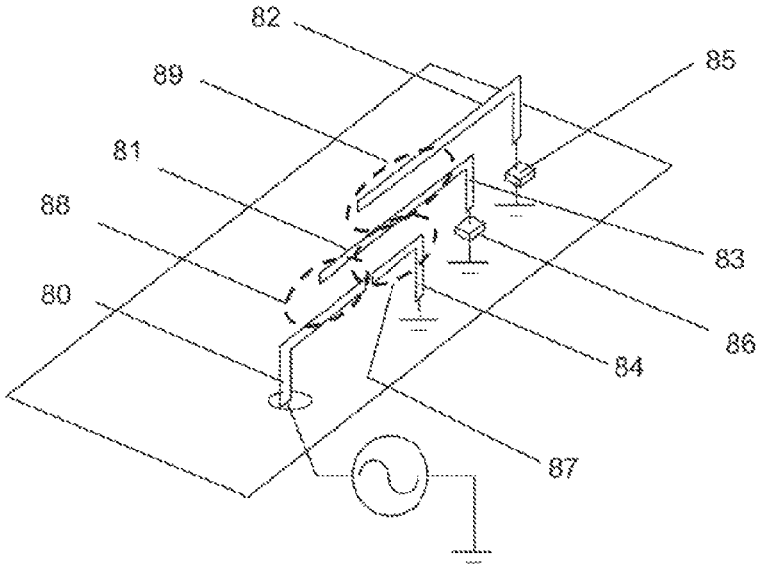
Primary Examiner — Hasan Z Islam

(74) *Attorney, Agent, or Firm* — Dority & Manning, P.A.

(57) **ABSTRACT**

A device includes a plurality of antennas, including one or more active antennas, the antennas being configured in one of a plurality of possible configurations to achieve operation in WAN, LTE, WiFi, or WiMax bands, or a combination thereof. In some embodiments, a passive antenna is utilized with lumped loading to fix the antenna tuning state. A primary and auxiliary radiator can be included in the device and configured for WAN/LTE bands, while additional antennas can be incorporated for WiFi and WiMax bands. Various antenna configurations incorporate the antenna having multiple coupled regions.

4 Claims, 15 Drawing Sheets



US010916847B2

(12) **United States Patent**
Chang

(10) **Patent No.: US 10,916,847 B2**
(45) **Date of Patent: Feb. 9, 2021**

(54) **MULTI-BAND ANTENNA**

(71) Applicant: **Acer Incorporated**, New Taipei (TW)

(72) Inventor: **Kun-Sheng Chang**, New Taipei (TW)

(73) Assignee: **Acer Incorporated**, New Taipei (TW)

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

(21) Appl. No.: **16/396,743**

(22) Filed: **Apr. 28, 2019**

(65) **Prior Publication Data**

US 2020/0168991 A1 May 28, 2020

(30) **Foreign Application Priority Data**

Nov. 23, 2018 (TW) ..... 107141762 A

(51) **Int. Cl.**
H01Q 5/50 (2015.01)
H01Q 5/328 (2015.01)
H01Q 1/36 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 5/328*** (2015.01); ***H01Q 1/36*** (2013.01); ***H01Q 5/50*** (2015.01)

(58) **Field of Classification Search**
CPC .. H01Q 5/00; H01Q 5/10; H01Q 5/50; H01Q 5/328; H01Q 5/378; H01Q 5/371; H01Q 5/357; H01Q 1/48; H01Q 1/50; H01Q 1/243; H01Q 9/045; H01Q 9/0442; H01Q 9/0435; H01Q 9/0421
See application file for complete search history.

(56) **References Cited**

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TW	201008025	2/2010

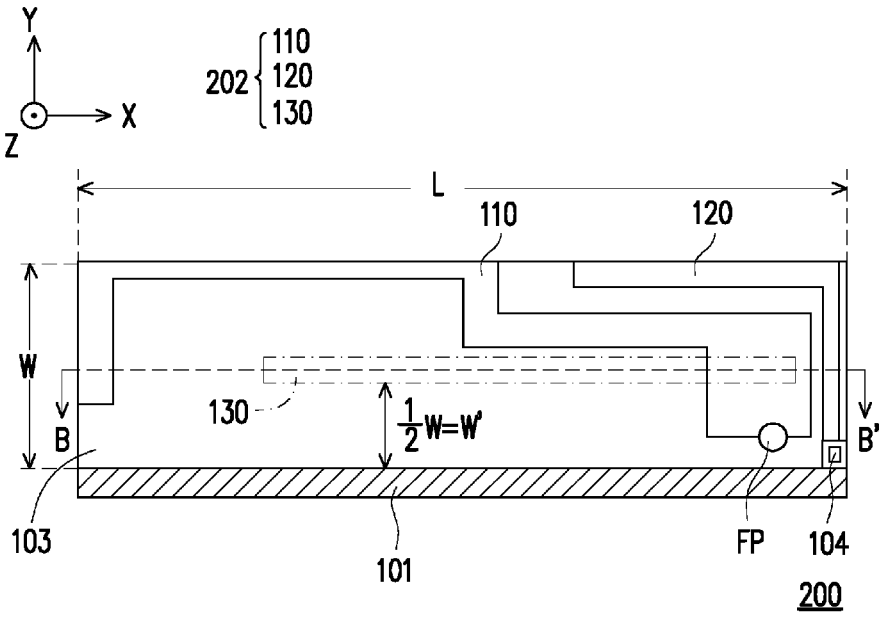
(Continued)

Primary Examiner — Haissa Philogene
(74) *Attorney, Agent, or Firm* — JCIPRNET

(57) **ABSTRACT**

A multi-band antenna includes a ground plane and an antenna element. The antenna element includes a first radiation portion and a second radiation portion. A first end of the first radiation portion is coupled to a feeding point, and a second end of the first radiation portion is a first open end. A first end of the second radiation portion is coupled to a ground plane, and a second end of the second radiation portion is a second open end. The second radiation portion is not electrically connected to the first radiation portion, and a coupling distance exists between the second radiation portion and the first radiation portion. The antenna element operates in a first band through the first radiation portion and operates in a second band through the second radiation portion. The frequency in the first band is lower than the frequency in the second band.

11 Claims, 3 Drawing Sheets



US010916848B2

(12) **United States Patent**
Shinkawa

(10) **Patent No.: US 10,916,848 B2**
(45) **Date of Patent: Feb. 9, 2021**

(54) **ANTENNA**

(71) Applicant: **YAMAHA CORPORATION**, Hamamatsu (JP)

(72) Inventor: **Tomohiro Shinkawa**, Hamamatsu (JP)

(73) Assignee: **YAMAHA CORPORATION**, Hamamatsu (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.: **16/135,518**

(22) Filed: **Sep. 19, 2018**

(65) **Prior Publication Data**

US 2019/0044233 A1 Feb. 7, 2019

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2017/010646, filed on Mar. 16, 2017.

(30) **Foreign Application Priority Data**

Mar. 22, 2016 (JP) 2016-057137

(51) **Int. Cl.**
H01Q 5/378 (2015.01)
H01Q 5/321 (2015.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 5/378*** (2015.01); ***H01Q 5/321*** (2015.01); ***H01Q 5/385*** (2015.01); ***H01Q 7/00*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC .. H01Q 1/38; H01Q 1/48; H01Q 5/30–5/385; H01Q 9/42
See application file for complete search history.

(56) **References Cited**

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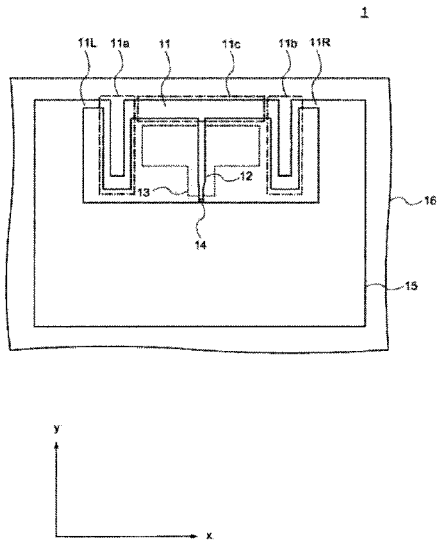
Primary Examiner — Hasan Z Islam
(74) *Attorney, Agent, or Firm* — Rossi, Kimms & McDowell LLP

(57) **ABSTRACT**

Provided is a lower-profile multi-band antenna. According to one embodiment of the present invention, there is provided an antenna including a linear first antenna portion, a conductive portion that connects the first antenna portion with a power feeding point, grounding regions where opposite ends of the first antenna portion are short-circuited and grounded, and a second antenna portion, at least a part of which overlaps with the conductive portion with a dielectric substance interposed between the conductive portion and the second antenna portion. The second antenna portion is disposed in a region surrounded by the grounding regions and the first antenna portion. The conductive portion may be connected to the first antenna portion at a middle point between the opposite ends of the first antenna portion.

5 Claims, 10 Drawing Sheets



US010916851B2

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

(10) **Patent No.: US 10,916,851 B2**
(45) **Date of Patent: Feb. 9, 2021**

(54) **MOBILE ELECTRONIC DEVICE**

(71) Applicant: **Acer Incorporated**, New Taipei (TW)

(72) Inventors: **Wan-Chu Wei**, New Taipei (TW); **Hsieh-Chih Lin**, New Taipei (TW); **Hsin-Wu Chiang**, New Taipei (TW); **Pei-Chi Ma**, New Taipei (TW); **Yu-Chia Chang**, New Taipei (TW); **Pang-Chun Tsai**, New Taipei (TW); **Chung-hao Huang**, New Taipei (TW)

(73) Assignee: **Acer Incorporated**, New Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 223 days.

(21) Appl. No.: **15/943,722**

(22) Filed: **Apr. 3, 2018**

(65) **Prior Publication Data**

US 2019/0074590 A1 Mar. 7, 2019

(30) **Foreign Application Priority Data**

Sep. 4, 2017 (TW) ..... 106130165 A

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 21/28 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 9/0407*** (2013.01); ***H01Q 1/2275*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/521*** (2013.01); ***H01Q 21/28*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/2275; H01Q 1/24; H01Q 1/241; H01Q 1/242; H01Q 1/243; H01Q 1/521; H01Q 9/0407; H01Q 21/28; H01Q 5/30; H01Q 5/307; H01Q 5/314; H01Q 5/328; H01Q 5/50; H01Q 1/523; H01Q 1/525
See application file for complete search history.

(56) **References Cited**

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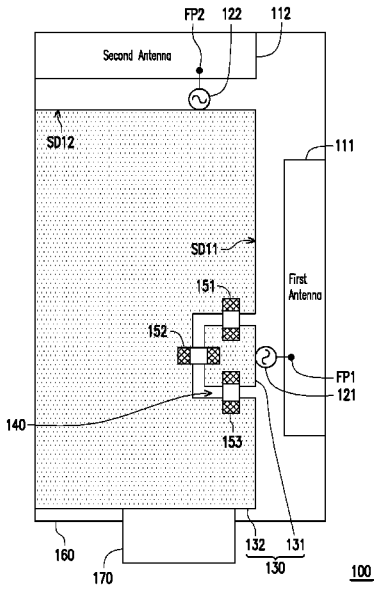
Primary Examiner — Dimary S Lopez Cruz
Assistant Examiner — Patrick R Holecek
(74) *Attorney, Agent, or Firm* — JCIPRNET

(57) **ABSTRACT**

A mobile electronic device includes a ground plane, a first slot, a plurality of first inductive elements, a first antenna, a second antenna, a first signal source, and a second signal source. The first slot is disposed in the ground plane to form a first ground portion and a second ground portion separated from each other. The first inductive elements are respectively connected to the first ground portion and the second ground portion. The first antenna and the second antenna respectively receive a radio-frequency signal in a predetermined band. The first signal source is electrically connected between the first antenna and the first ground portion and receives the radio-frequency signal from the first antenna. The second signal source is electrically connected between the second antenna and the second ground portion and receives the radio-frequency signal from the second antenna.

8 Claims, 4 Drawing Sheets



US010916860B2

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

(10) **Patent No.: US 10,916,860 B2**
(45) **Date of Patent: Feb. 9, 2021**

(54) **COMPACT HIGH-GAIN PATTERN RECONFIGURABLE ANTENNA**

(71) Applicants: **NATIONAL CHIAO TUNG UNIVERSITY**, Hsinchu (TW); **QUANTA COMPUTER INC.**, Tao Yuan (TW)

(72) Inventors: **Jenn-Hwan Tarng**, Hsinchu (TW); **Yu-Chen Lo**, New Taipei (TW); **Sung-Jung Wu**, Taipei (TW); **Nai-Chen Liu**, Taichung (TW)

(73) Assignee: **National Chaio Tung University** **Quanta Computer Inc.**, Tao Yuan (TW)

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

(21) Appl. No.: **16/422,412**

(22) Filed: **May 24, 2019**

(65) **Prior Publication Data**

US 2020/0203848 A1 Jun. 25, 2020

(30) **Foreign Application Priority Data**

Dec. 19, 2018 (TW) ..... 107145882 A

(51) **Int. Cl.**
H01Q 19/28 (2006.01)
H01Q 1/36 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 19/28*** (2013.01); ***H01Q 1/36*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 9/045*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 19/28; H01Q 1/36; H01Q 1/48; H01Q 9/045; H01Q 9/30; H01Q 19/32
See application file for complete search history.

(56) **References Cited**

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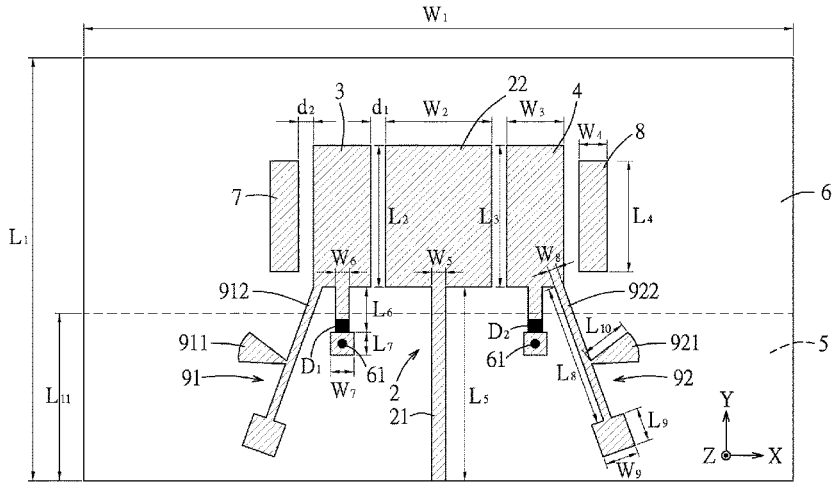
Primary Examiner — Daniel D Chang
(74) *Attorney, Agent, or Firm* — Lewis Roca Rothgerber Christie LLP

(57) **ABSTRACT**

A pattern reconfigurable antenna includes a radiator, a first parasitic element, a second parasitic element, a ground plane, a first switch and a second switch. The radiator includes a feed portion and a radiating portion that are interconnected. The first and second parasitic elements are symmetrically located at two opposite sides of the radiating portion, and are closely adjacent to and spaced apart from the radiating portion. The ground plane is located at another side of the radiating portion, and is spaced apart from the first and second parasitic elements. Each of the first and second switches is connected between the ground plane and a respective one of the first and second parasitic elements, and is operable to establish connection between the same.

8 Claims, 14 Drawing Sheets



US010923816B2

(12) **United States Patent**
Shen

(10) **Patent No.: US 10,923,816 B2**
(45) **Date of Patent: Feb. 16, 2021**

(54) **ANTENNA SYSTEM OF MOBILE TERMINAL AND MOBILE TERMINAL**

(71) Applicant: **AAC Technologies Pte. Ltd.**, Singapore (SG)

(72) Inventor: **Yachuan Shen**, 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 38 days.

(21) Appl. No.: **16/524,215**

(22) Filed: **Jul. 29, 2019**

(65) **Prior Publication Data**

US 2020/0044341 A1 Feb. 6, 2020

(30) **Foreign Application Priority Data**

Aug. 3, 2018 (CN) 201821245508.8

(51) **Int. Cl.**
H01Q 5/335 (2015.01)
H01Q 9/04 (2006.01)
H01Q 1/24 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 5/335*** (2015.01); ***H01Q 1/242*** (2013.01); ***H01Q 9/0414*** (2013.01)

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

2018/0115054 A1* 4/2018 Wu H01Q 5/35
2018/0375196 A1* 12/2018 Han H01Q 5/328

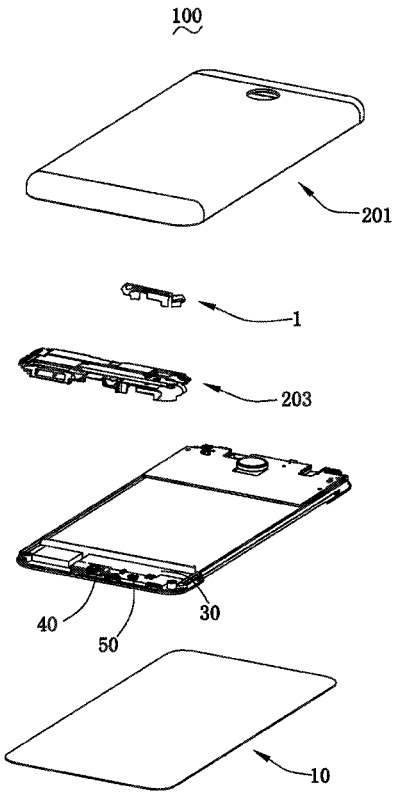
* cited by examiner

Primary Examiner — Jany Richardson
(74) *Attorney, Agent, or Firm* — W&G Law Group LLP

(57) **ABSTRACT**

The present disclosure provides an antenna system of a mobile terminal. The mobile terminal includes a housing, a mainboard accommodated in the housing, a plastic holder covering the mainboard, and a USB interface installed on the mainboard. The antenna system includes a radiator formed on a surface of the plastic holder facing the housing, and a feed end, a first ground point and a second ground point that are disposed on the mainboard. The radiator includes a feed end and a ground feed end spaced apart from each other, a connection end connecting the feed end and the ground feed end, a first stub connected to the ground feed end, and a second stub and a third stub connected to the feed end. The antenna system provided by the present disclosure is more space-saving, and reduces the impact of the USB interface on the antenna.

18 Claims, 7 Drawing Sheets



US010923823B2

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

(10) **Patent No.: US 10,923,823 B2**
(45) **Date of Patent: Feb. 16, 2021**

(54) **PATCH ANTENNA**

(71) Applicants: **AMOTECH CO., LTD.**, Incheon (KR); **WINNERCOM CO., LTD.**, Gyeongsangnam-do (KR)

(72) Inventors: **Chui Hwang**, Incheon (KR); **In-Jo Jeong**, Incheon (KR); **Sang-O Kim**, Incheon (KR); **Hyun-Woo Oh**, Seongnam-si (KR); **Dong-Hwan Koh**, Seoul (KR); **Won-Hee Lee**, Incheon (KR); **Tae-Byung Park**, Anyang-si (KR); **Gi-Cho Kang**, Anyang-si (KR); **Keun-Ho Baek**, Hanam-si (KR)

(73) Assignees: **AMOTECH CO., LTD.**, Incheon (KR); **WINNERCOM CO., LTD.**, Gimhae-si (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 159 days.

(21) Appl. No.: **16/311,092**

(22) PCT Filed: **Jun. 2, 2017**

(86) PCT No.: **PCT/KR2017/005760**
§ 371 (c)(1),
(2) Date: **Dec. 18, 2018**

(87) PCT Pub. No.: **WO2018/004136**
PCT Pub. Date: **Jan. 4, 2018**

(65) **Prior Publication Data**

US 2020/0313298 A1 Oct. 1, 2020

(30) **Foreign Application Priority Data**

Jun. 29, 2016 (KR) 10-2016-0081829

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

(52) **U.S. Cl.**
CPC ***H01Q 9/0407*** (2013.01); ***H01Q 9/0414*** (2013.01)

(58) **Field of Classification Search**
CPC .. H01Q 9/0407; H01Q 9/0414; H01Q 9/0471; H01Q 9/0464; H01Q 9/0428;
(Continued)

(56) **References Cited**

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Primary Examiner — Awat M Salih
(74) *Attorney, Agent, or Firm* — CL Intellectual LLC

(57) **ABSTRACT**

Disclosed is a patch antenna, which is formed so that the upper surface of a dielectric layer has a wider area than the lower surface thereof and is mounted on a printed circuit board to form an air gap, thus maximizing antenna performance while implementing lightweight. The disclosed patch antenna includes a dielectric layer, a radiation patch formed on the upper surface of the dielectric layer, and a lower patch formed on the lower surface of the dielectric layer; and the dielectric layer is formed so that an area of the upper surface is wider than an area of the lower surface to form an air gap between the printed circuit board and the dielectric layer.

10 Claims, 8 Drawing Sheets