US011137798B2

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

(10) **Patent No.: US 11,137,798 B2**
(45) **Date of Patent: Oct. 5, 2021**

(54) **ELECTRONIC DEVICE**

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

(72) Inventors: **Wanjae Ju**, Suwon-si (KR); **Seunghak Lee**, Suwon-si (KR); **Chanho Park**, Suwon-si (KR)

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

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

(21) Appl. No.: **16/800,157**

(22) Filed: **Feb. 25, 2020**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Feb. 25, 2019 (KR) 10-2019-0021873

(51) **Int. Cl.**
G06F 1/16 (2006.01)
G06F 1/18 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***G06F 1/165*** (2013.01); ***G06F 1/182*** (2013.01); ***G09G 3/3208*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC G06F 1/1626; G06F 1/165; G06F 1/1698; G06F 1/182; G09G 3/3208; H01Q 1/243;
(Continued)

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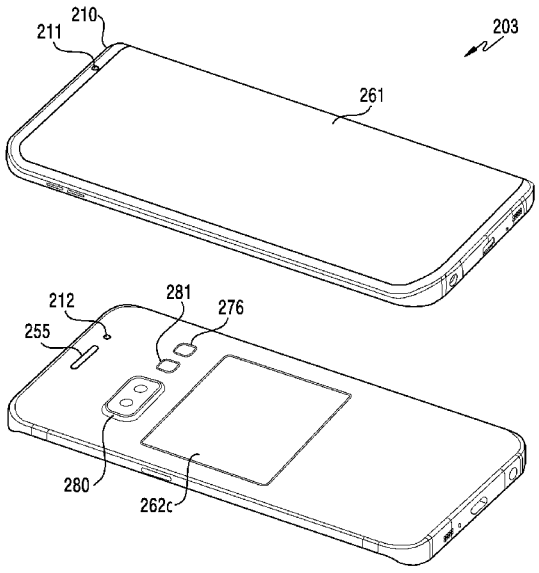
Primary Examiner — Tan H Trinh
(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye P.C.

(57) **ABSTRACT**

Various embodiments relate to an electronic device. The electronic device may include: a housing including a first surface facing a first direction and a second surface facing a second direction opposite the first direction; a first display viewable through the first surface; a battery disposed between the first display and the second surface; a second display having a size smaller than a size of the first display and viewable through a partial area of the second surface; a short-distance wireless communication antenna disposed at a lower end of the second display and configured to transmit/receive a short-distance wireless communication signal through the partial area of the second surface and the second display; and a shield disposed at a lower end of the short-distance wireless communication antenna and configured to block transmission/reception of the short-distance wireless communication signal through the first surface.

19 Claims, 24 Drawing Sheets



US011139551B2

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

(10) **Patent No.: US 11,139,551 B2**
(45) **Date of Patent: Oct. 5, 2021**

(54) **CHIP ANTENNA MODULE**

(71) Applicant: **SAMSUNG ELECTRO-MECHANICS CO., LTD.**, Suwon-si (KR)

(72) Inventors: **Seong Hee Choi**, Suwon-si (KR); **Sang Jong Lee**, Suwon-si (KR)

(73) Assignee: **SAMSUNG ELECTRO-MECHANICS 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 162 days.

(21) Appl. No.: **16/506,289**

(22) Filed: **Jul. 9, 2019**

(65) **Prior Publication Data**

US 2020/0091583 A1 Mar. 19, 2020

(30) **Foreign Application Priority Data**

Sep. 18, 2018 (KR) 10-2018-0111749
Nov. 7, 2018 (KR) 10-2018-0136072

(51) **Int. Cl.**

H01Q 1/22 (2006.01)
H01Q 9/04 (2006.01)
H01Q 1/24 (2006.01)
H01Q 1/38 (2006.01)
H01Q 9/40 (2006.01)
(Continued)

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

CPC ***H01Q 1/2283*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 5/10*** (2015.01); ***H01Q 9/045*** (2013.01); ***H01Q 9/0421*** (2013.01); ***H01Q 9/40*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/2283; H01Q 1/2291; H01Q 1/22; H01Q 1/38; H01Q 1/24; H01Q 1/243; H01Q 1/48; H01Q 5/10; H01Q 9/04; H01Q 9/0407; H01Q 9/0457; H01Q 9/0421; H01Q 9/045; H01Q 9/40; H01Q 21/00; H01Q 21/0025; H01Q 21/0093; H01Q 21/06; H01Q 21/065; H01Q 21/28; H01Q 5/36; H01Q 5/364; H01Q 5/378; H01Q 9/0414; H01Q 9/42; H01Q 19/10

See application file for complete search history.

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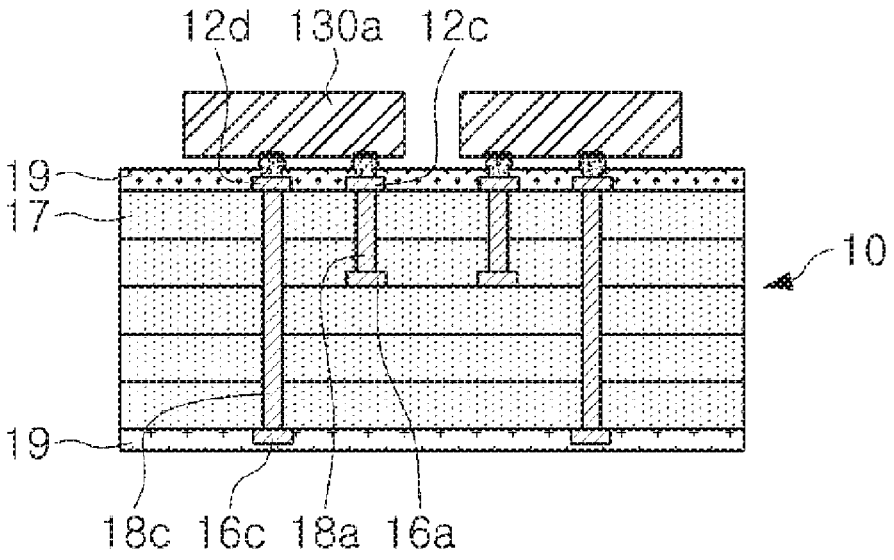
Primary Examiner — Tho G Phan
(74) *Attorney, Agent, or Firm* — NSIP Law

(57) **ABSTRACT**

A chip antenna module includes: a substrate including a feed wiring layer to provide a feed signal, a feeding via connected to the feed wiring layer, and a dummy via separated from the feed wiring layer; and a chip antenna disposed on a first surface of the substrate and including a body portion formed of a dielectric substance, a radiating portion that extends from a first surface of the body portion and is connected to the feeding via and the dummy via, and a grounding portion that extends from a second surface of the body portion opposite the first surface of the body portion.

9 Claims, 7 Drawing Sheets



US011139553B2

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

(10) **Patent No.: US 11,139,553 B2**
(45) **Date of Patent: Oct. 5, 2021**

(54) **TECHNOLOGIES FOR A METAL CHASSIS FOR AN ELECTRONIC DEVICE**

(71) Applicant: **Intel Corporation**, Santa Clara, CA (US)

(72) Inventors: **Jayprakash Thakur**, Bangalore (IN); **Prakash Kurma Raju**, Bangalore (IN); **Prasanna Pichumani**, Bangalore (IN); **Akarsha Kadadevaramath**, Karnataka (IN)

(73) Assignee: **Intel Corporation**, Santa Clara, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 152 days.

(21) Appl. No.: **16/233,791**

(22) Filed: **Dec. 27, 2018**

(65) **Prior Publication Data**

US 2019/0131692 A1 May 2, 2019

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 1/38	(2006.01)
H05K 5/04	(2006.01)
C25D 11/00	(2006.01)
C25D 11/12	(2006.01)
C25D 11/18	(2006.01)

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

CPC ***H01Q 1/24*** (2013.01); ***C25D 11/00*** (2013.01); ***C25D 11/12*** (2013.01); ***C25D 11/18*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/38*** (2013.01); ***H05K 5/04*** (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

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2016/0204502	A1*	7/2016	Misra	H01Q 1/243 343/702
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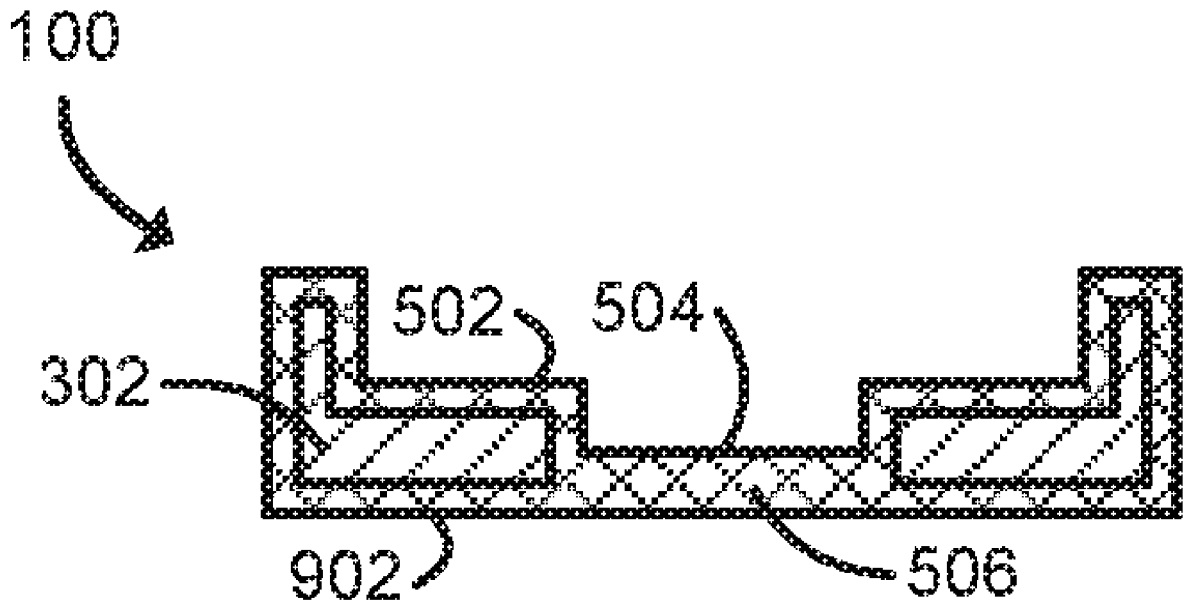
Primary Examiner — Louis J Rufo

(74) *Attorney, Agent, or Firm* — Hanley, Flight & Zimmerman, LLC

(57) **ABSTRACT**

Technologies for a metal chassis for an electronic device are disclosed. A manufacturer may manufacture a chassis of an electronic device by machining a recess into a chassis preform and perform an anodization of the chassis. The manufacturer may machine the side of the chassis preform opposite the recess to a predefined thickness, and then perform a subsequent anodization. The predefined thickness is selected so that, after the subsequent anodization, there is a single anodized layer between the surface of the recess and the chassis surface on the opposite side. The single anodized layer is non-conductive, allowing electromagnetic signals of an antenna to pass through.

19 Claims, 7 Drawing Sheets



US011139554B2

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

(10) **Patent No.: US 11,139,554 B2**
(45) **Date of Patent: Oct. 5, 2021**

(54) **ELECTRONIC DEVICE INCLUDING ANTENNA DEVICE**

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

(72) Inventors: **Shinho Yoon**, Suwon-si (KR); **Dongjun Oh**, Suwon-si (KR); **Jonghyuck Lee**, Suwon-si (KR); **Soonho Hwang**, Suwon-si (KR)

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

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

(21) Appl. No.: **16/794,859**

(22) Filed: **Feb. 19, 2020**

(65) **Prior Publication Data**

US 2020/0266524 A1 Aug. 20, 2020

(30) **Foreign Application Priority Data**

Feb. 19, 2019 (KR) 10-2019-0019551
Jul. 1, 2019 (KR) 10-2019-0078718

(51) **Int. Cl.**
H04B 1/38 (2015.01)
H01Q 1/24 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***G06F 1/1681*** (2013.01); ***H01Q 1/42*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 13/16*** (2013.01); ***H04M 1/0216*** (2013.01)

(58) **Field of Classification Search**
CPC H04M 1/0216; H04M 1/0214; H04M 1/0225; H01Q 1/243; H01Q 1/42; H01Q 1/48; H01Q 13/16; G06F 1/1681
See application file for complete search history.

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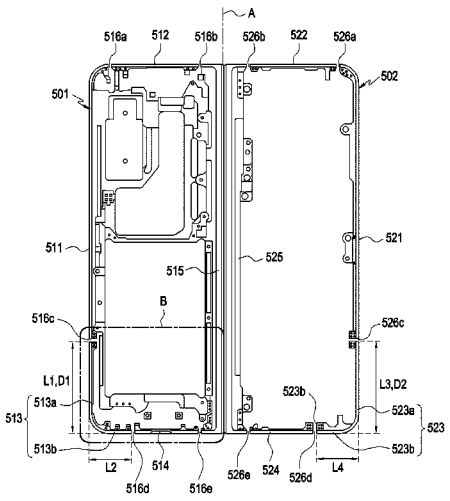
Primary Examiner — Tuan Pham
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

An electronic device is provided. The electronic device includes a first housing structure including a first side surface member, a second housing structure including a second side surface member, a hinge structure configured to rotatably connect the first housing structure and the second housing structure and configured to provide a folding axis on which the first housing structure and the second housing structure rotate, and at least one printed circuit board, wherein the first side surface member or the second side surface member includes a first side surface portion a second side surface portion, a third side surface portion, a fourth side surface portion, a fifth side surface portion, a first slit a second slit a third slit, and a fourth slit, and a fifth slit, and wherein at least part of at least one of the second side surface portion, the third side surface portion, and the fourth side surface portion is formed of a radiation conductor and is electrically connected to the at least one printed circuit board.

18 Claims, 23 Drawing Sheets



US011139556B2

(12) **United States Patent**
Huang

(10) **Patent No.: US 11,139,556 B2**
(45) **Date of Patent: Oct. 5, 2021**

(54) **ANTENNA STRUCTURE**

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

(72) Inventor: **Chun-Lin Huang**, 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 3 days.

(21) Appl. No.: **16/867,946**

(22) Filed: **May 6, 2020**

(65) **Prior Publication Data**

US 2021/0159586 A1 May 27, 2021

(30) **Foreign Application Priority Data**

Nov. 22, 2019 (TW) 108142489

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 13/10	(2006.01)
H01Q 1/48	(2006.01)
H01Q 9/42	(2006.01)
H01Q 9/06	(2006.01)

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

CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 9/06*** (2013.01); ***H01Q 9/42*** (2013.01); ***H01Q 13/10*** (2013.01)

(58) **Field of Classification Search**

CPC H01G 1/243; H01G 1/48; H01G 9/06; H01G 13/10; H01G 1/38

See application file for complete search history.

(56) **References Cited**

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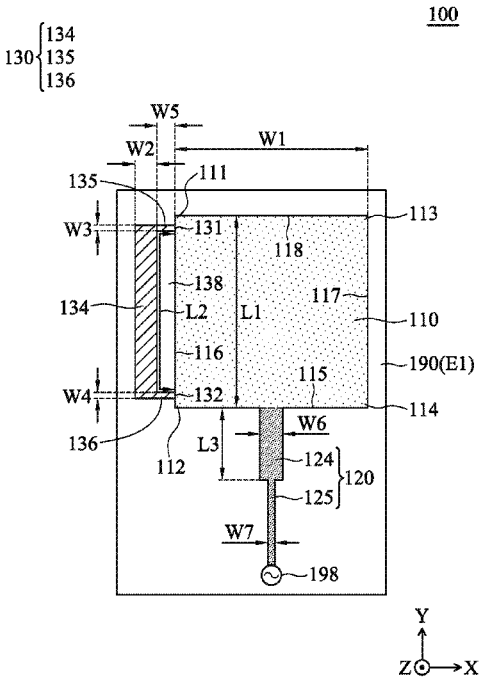
Primary Examiner — Graham P Smith

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

(57) **ABSTRACT**

An antenna structure includes a main radiation element, a first feeding element, a first additional radiation element, a dielectric substrate, and a ground plane. A first signal source is coupled through the first feeding element to a first side of the main radiation element. The first additional radiation element is coupled to a second side of the main radiation element. A first slot is formed between the first additional radiation element and the main radiation element. The second side is different from the first side. The dielectric substrate has a first surface and a second surface which are opposite to each other. The main radiation element, the first feeding element, and the first additional radiation element are disposed on the first surface of the dielectric substrate. The ground plane is adjacent to the second surface of the dielectric substrate.

19 Claims, 9 Drawing Sheets



US011139557B2

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

(10) **Patent No.: US 11,139,557 B2**
(45) **Date of Patent: Oct. 5, 2021**

(54) **ANTENNA ASSEMBLY FOR TERMINAL WITH FOLDABLE SCREEN AND TERMINAL**

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

(72) Inventors: **Yufei Zhu**, Shenzhen (CN); **Kai Dong**, Shenzhen (CN); **Shengjun Liu**, 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 0 days.

(21) Appl. No.: **16/994,645**

(22) Filed: **Aug. 16, 2020**

(65) **Prior Publication Data**

US 2020/0411957 A1 Dec. 31, 2020

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2019/094096, filed on Jun. 30, 2019.

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 5/307	(2015.01)
H04B 7/0413	(2017.01)
H04M 1/02	(2006.01)

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

CPC ***H01Q 1/243*** (2013.01); ***H01Q 5/307*** (2015.01); ***H04B 7/0413*** (2013.01); ***H04M 1/0268*** (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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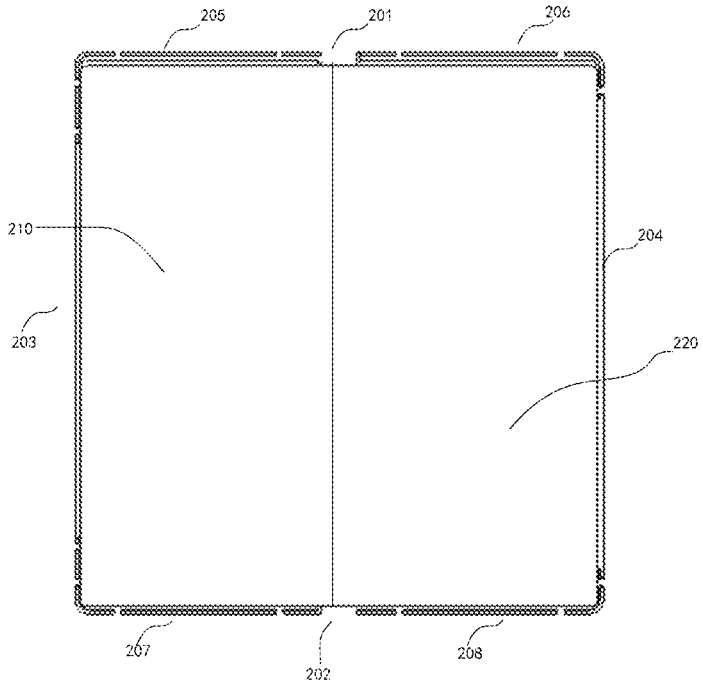
Primary Examiner — Hsinchun Liao

(74) *Attorney, Agent, or Firm* — W&G Law Group

(57) **ABSTRACT**

A terminal with a foldable screen and an antenna assembly thereof are disclosed. The antenna assembly includes a foldable frame and seven antenna modules. The frame includes a first side frame; a second side frame opposite to the first side frame, a third side frame, and a fourth side frame. A first antenna portion is disposed at a corner connecting the first side frame to the third side frame. A second antenna portion is disposed at a corner connecting the second side frame and the third side frame. A third antenna portion is disposed on the second sub-frame. Fourth, fifth, and sixth antenna portions are sequentially arranged on the fourth side frame. A seventh antenna portion is disposed on the fourth sub-frame. At least 2*2 MIMO configuration of WIFI frequency band and 4*4 MIMO configuration of 5G NR frequency band below Sub-6G frequency band are formed by the antenna modules.

20 Claims, 12 Drawing Sheets



US011139559B2

(12) **United States Patent**
Wei

(10) **Patent No.: US 11,139,559 B2**
(45) **Date of Patent: Oct. 5, 2021**

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

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

(72) Inventor: **Shih-Chiang Wei**, 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 195 days.

(21) Appl. No.: **16/669,719**

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

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Feb. 26, 2019 (TW) 108106433

(51) **Int. Cl.**
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 1/243; H01Q 1/244; H01Q 1/48; H01Q 5/357; H01Q 5/385; H01Q 5/364; H01Q 13/10
See application file for complete search history.

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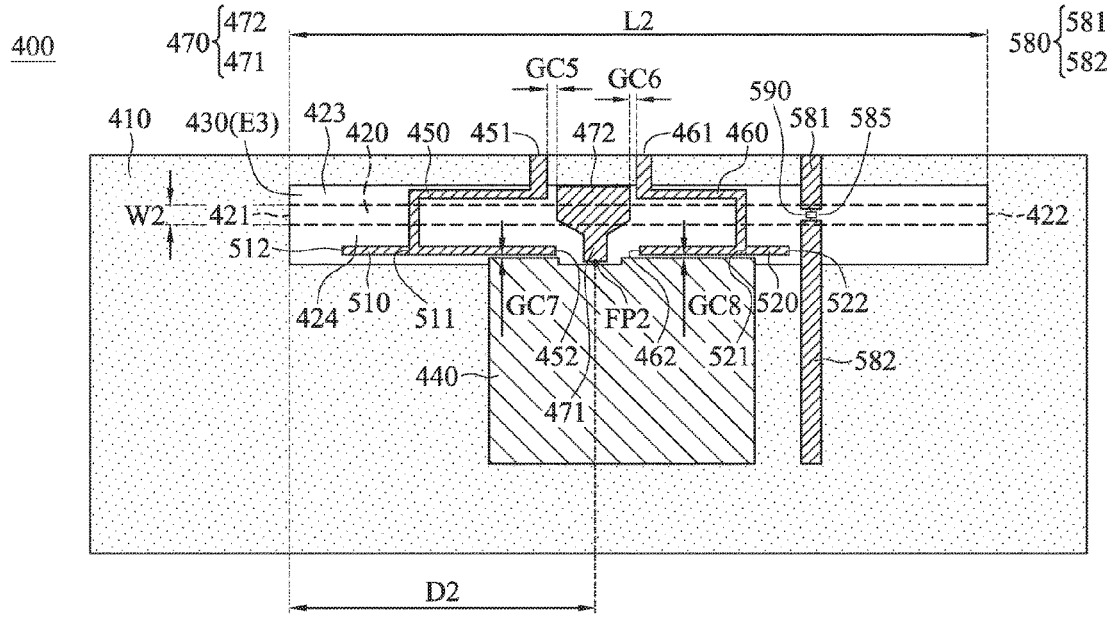
Primary Examiner — Awat M Salih
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

A mobile device includes a metal mechanism element, a ground plane, a first parasitic radiation element, a second parasitic radiation element, a feeding radiation element, and a dielectric substrate. The metal mechanism element has a slot. The first parasitic radiation element and the second parasitic radiation element are both coupled to the metal mechanism element. The first parasitic radiation element and the second parasitic radiation element both extend across the slot. The feeding radiation element is disposed between the first parasitic radiation element and the second parasitic radiation element. An antenna structure is formed by the feeding radiation element, the first parasitic radiation element, the second parasitic radiation element, and the slot of the metal mechanism element. The antenna structure covers at least a first frequency band. The length of the slot is shorter than 0.48 wavelength of the first frequency band.

20 Claims, 9 Drawing Sheets



US011139562B2

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

(10) **Patent No.: US 11,139,562 B2**
(45) **Date of Patent: Oct. 5, 2021**

(54) **ANTENNA DEVICE**

(71) Applicant: **InnoLux Corporation**, Miao-Li County (TW)

(72) Inventors: **Yi-Hung Lin**, Miao-Li County (TW); **Tang-Chin Hung**, Miao-Li County (TW); **Chia-Chi Ho**, Miao-Li County (TW); **I-Yin Li**, Miao-Li County (TW)

(73) Assignee: **INNOLUX CORPORATION**, Miao-Li County (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 77 days.

(21) Appl. No.: **16/546,504**

(22) Filed: **Aug. 21, 2019**

(65) **Prior Publication Data**

US 2020/0091594 A1 Mar. 19, 2020

Related U.S. Application Data

(60) Provisional application No. 62/731,141, filed on Sep. 14, 2018.

(30) **Foreign Application Priority Data**

Apr. 15, 2019 (CN) 201910300447.3

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

(52) **U.S. Cl.**
CPC ***H01Q 1/36*** (2013.01); ***H01Q 9/0407*** (2013.01); *G09G 2300/0876* (2013.01); *H01Q 3/44* (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/35; H01Q 9/0407
(Continued)

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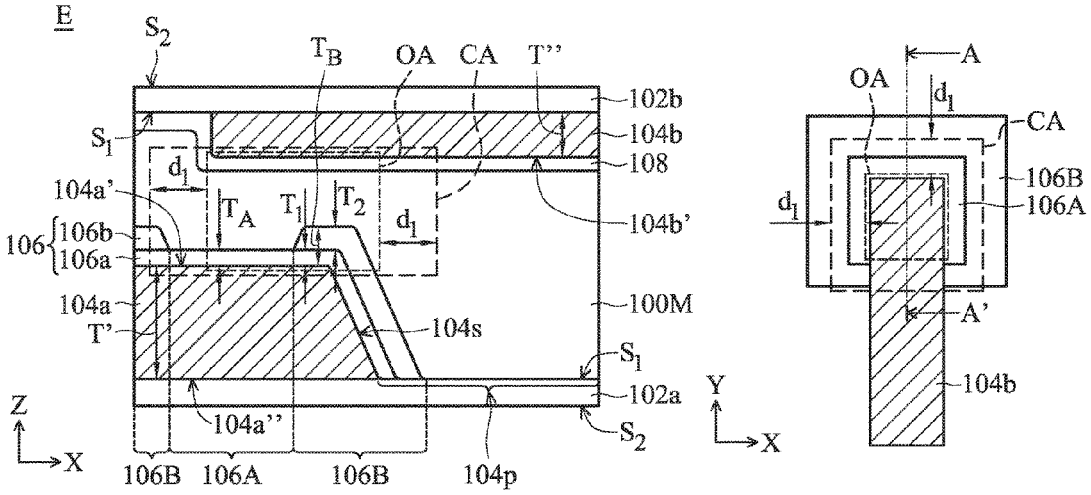
Primary Examiner — Kaveh C Kianni
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

An antenna device is provided. The antenna device includes a first substrate, a first conductive layer, a first insulating structure, a second substrate, a second conductive layer and a liquid-crystal layer. The first conductive layer is disposed on the first substrate. The first insulating structure is disposed on the first conductive layer, and the first insulating structure includes a first region and a second region. The second substrate is disposed opposite to the first substrate. The second conductive layer is disposed on the second substrate. The liquid-crystal layer is disposed between the first conductive layer and the second conductive layer. The thickness of the first region is less than the thickness of the second region, and at least a portion of the first region is disposed in an overlapping region of the first conductive layer and the second conductive layer.

18 Claims, 5 Drawing Sheets



US011139563B2

(12) **United States Patent**
Hamabe

(10) **Patent No.: US 11,139,563 B2**
(45) **Date of Patent: Oct. 5, 2021**

(54) **ANTENNA DEVICE**

(71) Applicant: **Panasonic Intellectual Property Management Co., Ltd.**, Osaka (JP)

(72) Inventor: **Taichi Hamabe**, Kanagawa (JP)

(73) Assignee: **PANASONIC INTELLECTUAL PROPERTY MANAGEMENT CO., LTD.**, Osaka (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 77 days.

(21) Appl. No.: **16/709,018**

(22) Filed: **Dec. 10, 2019**

(65) **Prior Publication Data**

US 2020/0112088 A1 Apr. 9, 2020

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2018/021635, filed on Jun. 6, 2018.

(30) **Foreign Application Priority Data**

Jun. 28, 2017 (JP) JP2017-125965

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

(52) **U.S. Cl.**
CPC ***H01Q 1/38*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 7/06*** (2013.01); ***H01Q 9/30*** (2013.01); ***H01Q 15/008*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 15/006; H01Q 15/008; H01Q 1/38; H01Q 1/48; H01Q 7/06; H01Q 9/285; H01Q 9/30
See application file for complete search history.

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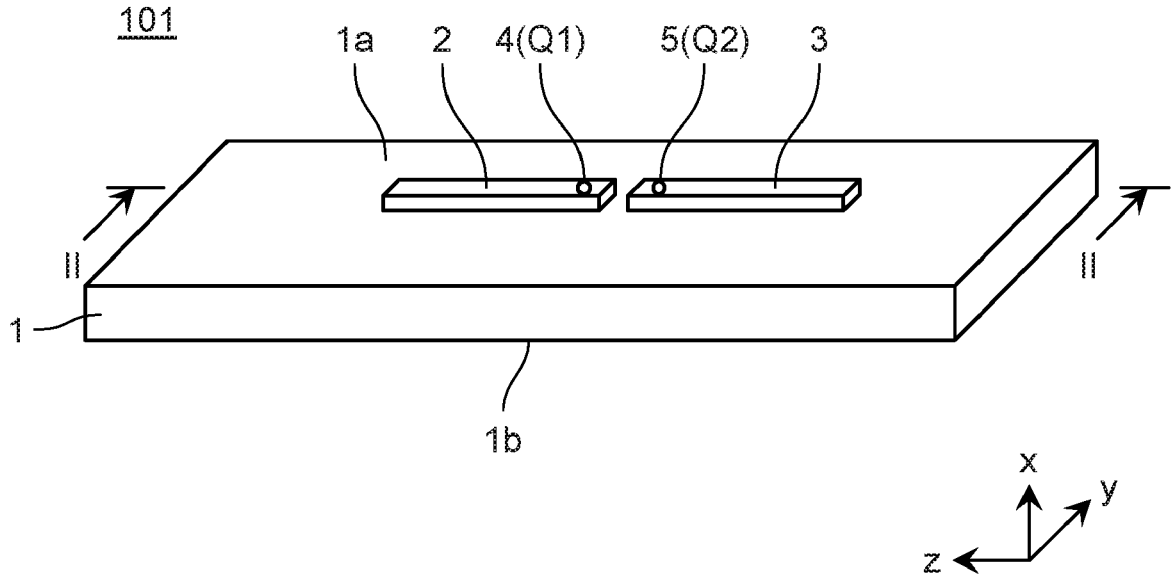
Primary Examiner — Thien M Le
(74) *Attorney, Agent, or Firm* — Wenderoth, Lind & Ponack, L.L.P.

(57) **ABSTRACT**

An antenna device includes at least one antenna conductor, at least one ground conductor, and an artificial magnetic conductor that is located between the at least one antenna conductor and the at least one ground conductor and is disposed separately from the at least one antenna conductor and the at least one ground conductor. At least one of the artificial magnetic conductor and the at least one ground conductor includes at least one opening formed at a place substantially facing a distal-side end of the at least one antenna conductor, the distal-side end of the at least one antenna conductor being opposite a feeder-side end of the at least one antenna conductor.

12 Claims, 16 Drawing Sheets



US011139564B2

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

(10) **Patent No.: US 11,139,564 B2**
(45) **Date of Patent: Oct. 5, 2021**

(54) **ELECTRONIC DEVICE INCLUDING ANTENNA**

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

(72) Inventors: **Sung Chul Park**, Suwon-si (KR); **Hyung Wook Kim**, Suwon-si (KR)

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

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

(21) Appl. No.: **15/733,054**

(22) PCT Filed: **Nov. 2, 2018**

(86) PCT No.: **PCT/KR2018/013249**
§ 371 (c)(1),
(2) Date: **May 1, 2020**

(87) PCT Pub. No.: **WO2019/088756**
PCT Pub. Date: **May 9, 2019**

(65) **Prior Publication Data**

US 2020/0295450 A1 Sep. 17, 2020

(30) **Foreign Application Priority Data**

Nov. 2, 2017 (KR) 10-2017-0145365

(51) **Int. Cl.**
H04B 1/401 (2015.01)
H01Q 1/42 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 1/42*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 1/50*** (2013.01); ***H04B 1/401*** (2013.01)

(58) **Field of Classification Search**
CPC ... H01Q 1/42; H01Q 1/38; H01Q 1/50; H04B 1/401
(Continued)

(56) **References Cited**

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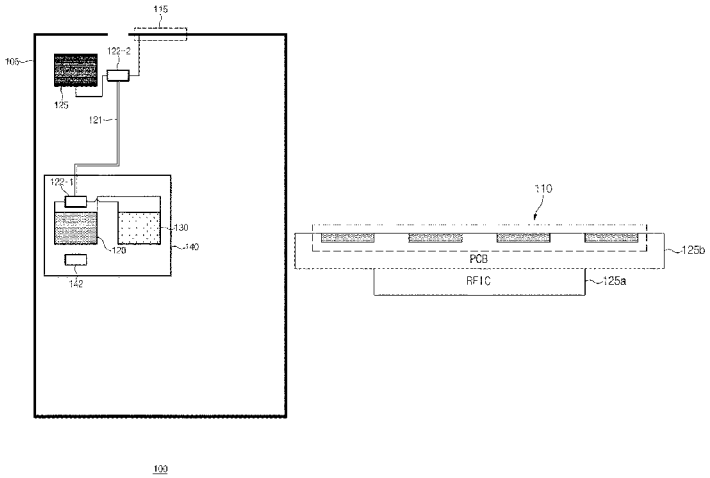
Primary Examiner — Peguy Jean Pierre

(57) **ABSTRACT**

An electronic device according to an embodiment disclosed in the present document comprises: a housing; a first antenna element placed on the housing, or at a first position inside the housing; a second antenna element placed on the housing, or at a second position inside the housing; a communication processor; and at least one communication circuit electrically connected to the first antenna element and the second antenna element, wherein the at least one communication circuit can comprise: a first RF circuit, which generates an IF signal having a first frequency, a local oscillation (LO) signal of a second frequency lower than the first frequency, and a control signal of a third frequency lower than the second frequency; a second RF circuit, which provides, to the second antenna element, an RF signal of a fourth frequency higher than the third frequency and lower than the second frequency; and a third RF circuit, which receives the IF signal from the first RF circuit, up-converts the IF signal, and provides the up-converted signal to the first antenna
(Continued)



US011139565B2

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

(10) **Patent No.: US 11,139,565 B2**
(45) **Date of Patent: Oct. 5, 2021**

(54) **ELECTRONIC DEVICE INCLUDING STRUCTURE FOR SECURING COVERAGE OF ANTENNA**

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

(72) Inventors: **Seunggil Jeon**, Suwon-si (KR); **Namwoo Kim**, Suwon-si (KR); **Seongbeom Hong**, Suwon-si (KR); **Sunghoon Moon**, Suwon-si (KR); **Kyungwoo Lee**, Suwon-si (KR)

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

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

(21) Appl. No.: **16/913,110**

(22) Filed: **Jun. 26, 2020**

(65) **Prior Publication Data**

US 2020/0411978 A1 Dec. 31, 2020

(30) **Foreign Application Priority Data**

Jun. 28, 2019 (KR) 10-2019-0078183

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

(52) **U.S. Cl.**
CPC ***H01Q 1/421*** (2013.01); ***H01Q 1/241*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/24; H01Q 1/241; H01Q 1/243; H01Q 1/421; H01Q 9/0407; H01Q 15/08;
(Continued)

(56) **References Cited**

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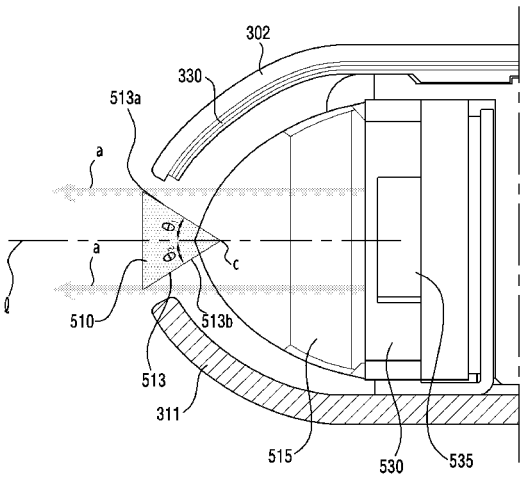
Primary Examiner — Hoang V Nguyen
(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye, P.C.

(57) **ABSTRACT**

An electronic device is disclosed. An electronic device according to various embodiments includes: a housing having a front plate facing a first direction, a rear plate facing a second direction opposite the first direction, and a side housing surrounding a space between the front plate and the rear plate; a conductive member comprising a conductive material disposed between the front plate and the rear plate; a display viewable through the front plate; at least one antenna module including a plurality of antenna elements configured to form a beam in a third direction facing the conductive member, and disposed to be spaced apart from the conductive member in the space; and a wireless communication circuit electrically coupled to the antenna module and configured to transmit and/or receive at least one signal having a frequency in a range of 3 GHz to 100 GHz, wherein the conductive member has a first surface forming a first acute angle with a virtual line crossing centers of the antenna elements and facing in the third direction, and a second surface forming a second acute angle with the virtual line, wherein a joint of the first surface and the second surface is positioned on the virtual line.

20 Claims, 20 Drawing Sheets



US011139566B2

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

(10) **Patent No.: US 11,139,566 B2**
(45) **Date of Patent: Oct. 5, 2021**

(54) **ELECTRONIC 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 24 days.

(21) Appl. No.: **16/826,446**

(22) Filed: **Mar. 23, 2020**

(65) **Prior Publication Data**

US 2021/0167491 A1 Jun. 3, 2021

(30) **Foreign Application Priority Data**

Dec. 2, 2019 (TW) 108143909

(51) **Int. Cl.**

H01Q 1/52	(2006.01)
H01Q 9/04	(2006.01)
H01Q 5/335	(2015.01)
H01Q 1/24	(2006.01)

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

CPC ***H01Q 1/52*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 5/335*** (2015.01); ***H01Q 9/0485*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/52; H01Q 9/0485; H01Q 5/335; H01Q 1/243

See application file for complete search history.

(56) **References Cited**

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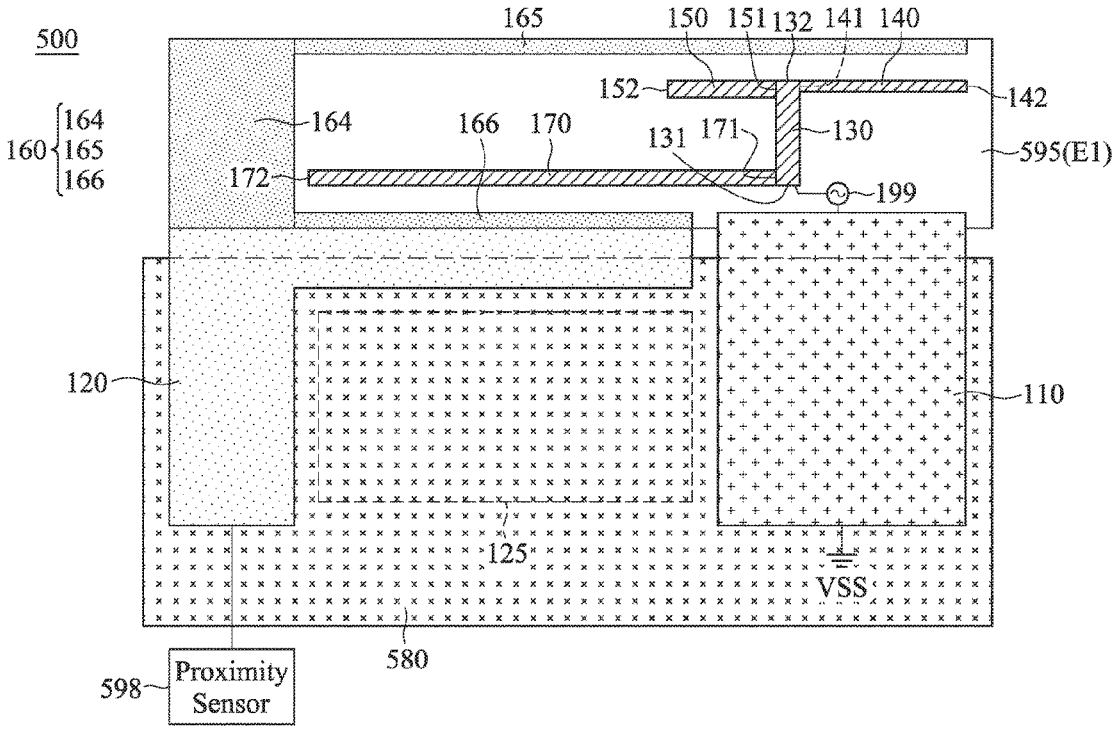
Primary Examiner — Daniel D Chang

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

(57) **ABSTRACT**

An electronic device includes a first metal element, a second metal element, a feeding radiation element, a first radiation element, a second radiation element, a third radiation element, and a matching radiation element. The first metal element is coupled to a ground voltage. The second metal element is separated from the first metal element. The first radiation element and the second radiation element are coupled to the feeding radiation element. The third radiation element is coupled to the second metal element, and is adjacent to the first radiation element and the second radiation element. An antenna structure is formed by the feeding radiation element, the first radiation element, the second radiation element, the third radiation element, and the matching radiation element. A sensing pad is formed by the second metal element and the third radiation element.

15 Claims, 5 Drawing Sheets



US011139567B2

(12) **United States Patent**
Wu

(10) **Patent No.: US 11,139,567 B2**
(45) **Date of Patent: Oct. 5, 2021**

(54) **COMPACT DUAL-BAND MIMO ANTENNA AND MOBILE TERMINAL**

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

(72) Inventor: **Jing Wu**, 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 49 days.

(21) Appl. No.: **16/709,952**

(22) Filed: **Dec. 11, 2019**

(65) **Prior Publication Data**

US 2020/0212561 A1 Jul. 2, 2020

(30) **Foreign Application Priority Data**

Dec. 31, 2018 (CN) 201811650609.8

(51) **Int. Cl.**

H01Q 21/28	(2006.01)
H01Q 1/52	(2006.01)
H01Q 9/04	(2006.01)
H04B 7/0413	(2017.01)
H01Q 5/392	(2015.01)

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

CPC ***H01Q 1/523*** (2013.01); ***H01Q 5/392*** (2015.01); ***H01Q 9/0421*** (2013.01); ***H01Q 21/28*** (2013.01); ***H04B 7/0413*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/523; H01Q 5/392; H01Q 9/0421; H01Q 21/28

See application file for complete search history.

(56) **References Cited**

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1st Office Action dated Mar. 16, 2020 by SIPO in related Chinese Patent Application No. 201811650609.8 (6 Pages).

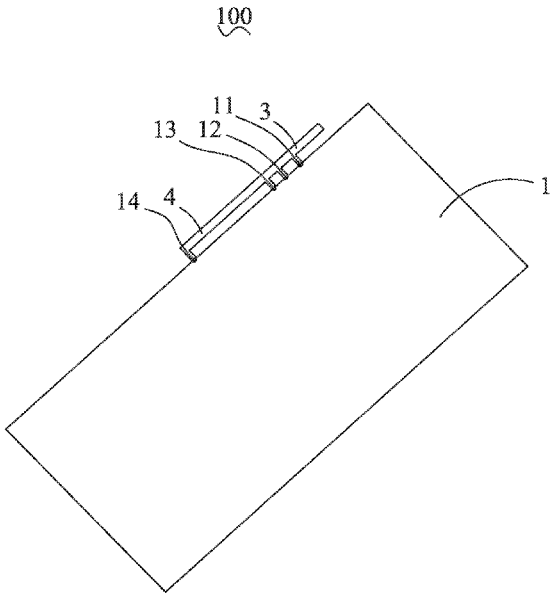
Primary Examiner — Graham P Smith

(74) *Attorney, Agent, or Firm* — W&G Law Group

(57) **ABSTRACT**

A compact dual-band MIMO antenna and a mobile terminal are provided, and the antenna includes a system ground unit, a radiation arm having an open-circuit end and a short-circuit end, a first antenna formed at the open-circuit end and a second antenna formed at the short-circuit end. The first antenna includes a grounding arm connecting the radiation arm with the system ground unit, and a first feeding arm located between the grounding arm and the open-circuit end. The second antenna includes a second feeding arm located between the short-circuit end and the grounding arm. Compared with the related art, the present invention has following beneficial effects: the antenna has compact structure and high isolation; it has dual-band, and it has excellent performance in the dual bands; it has a simple structure, a small volume and a light weight, and it is convenient to manufacture and thus for mass production.

4 Claims, 3 Drawing Sheets



US011139568B2

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

(10) **Patent No.: US 11,139,568 B2**
(45) **Date of Patent: Oct. 5, 2021**

(54) **ANTENNA ISOLATION ENHANCEMENT**

(71) Applicant: **Intel Corporation**, Santa Clara, CA (US)

(72) Inventors: **Poul Olesen**, Stoevring (DK); **Simon Svendsen**, Aalborg (DK); **Ole Jagielski**, Viborg (DK); **Farooq Shaikh**, Aalborg (DK); **Daniel B. Schwartz**, Scottsdale, AZ (US)

(73) Assignee: **Intel Corporation**, Santa Clara, 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.: **16/618,580**

(22) PCT Filed: **Jun. 30, 2017**

(86) PCT No.: **PCT/US2017/040471**
§ 371 (c)(1),
(2) Date: **Dec. 2, 2019**

(87) PCT Pub. No.: **WO2019/005145**
PCT Pub. Date: **Jan. 3, 2019**

(65) **Prior Publication Data**

US 2020/0161755 A1 May 21, 2020

(51) **Int. Cl.**
H01Q 1/52 (2006.01)
H01Q 21/24 (2006.01)
H04B 1/525 (2015.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/525*** (2013.01); ***H01Q 21/24*** (2013.01); ***H04B 1/525*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/525; H01Q 21/24; H01Q 5/40; H01Q 5/378; H01Q 9/42; H04B 1/525; H04B 1/00; H04B 1/123
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(56) **References Cited**

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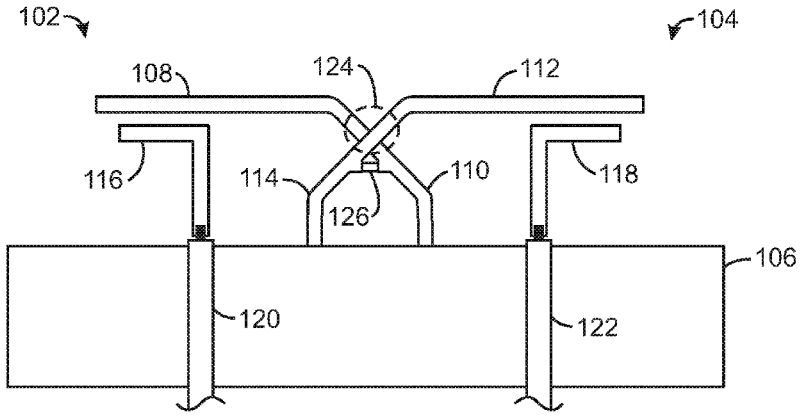
Primary Examiner — Eugene Yun
(74) *Attorney, Agent, or Firm* — Schiff Hardin LLP

(57) **ABSTRACT**

Techniques are disclosed for providing isolation between a pair of partially overlapping antennas. An example electronic device includes a first antenna coupled to a first transceiver through a first signal path comprising a first feed, and a second antenna coupled to a second transceiver through a second signal path comprising a second feed. The first antenna and second antenna partially overlap. The example electronic device also includes compensation circuitry coupled to the first signal path and the second signal path and configured to generate a compensation signal that provides analog cancellation of an interference signal received at the second antenna from the first antenna.

22 Claims, 14 Drawing Sheets



US011139571B2

(12) **United States Patent**
Wu

(10) **Patent No.: US 11,139,571 B2**
(45) **Date of Patent: Oct. 5, 2021**

(54) **COMPACT DUAL-BAND MIMO ANTENNA**

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

(72) Inventor: **Jing Wu**, 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 41 days.

(21) Appl. No.: **16/706,834**

(22) Filed: **Dec. 9, 2019**

(65) **Prior Publication Data**

US 2020/0212568 A1 Jul. 2, 2020

(30) **Foreign Application Priority Data**

Dec. 31, 2018 (CN) 201811650610.0

(51) **Int. Cl.**

H01Q 5/30	(2015.01)
H01Q 5/307	(2015.01)
H01Q 9/42	(2006.01)
H01Q 1/48	(2006.01)
H04B 7/0413	(2017.01)

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

CPC ***H01Q 5/307*** (2015.01); ***H01Q 1/48*** (2013.01); ***H01Q 9/42*** (2013.01); *H04B 7/0413* (2013.01)

(58) **Field of Classification Search**

CPC H01Q 5/30–5/35; H01Q 1/24–1/48

See application file for complete search history.

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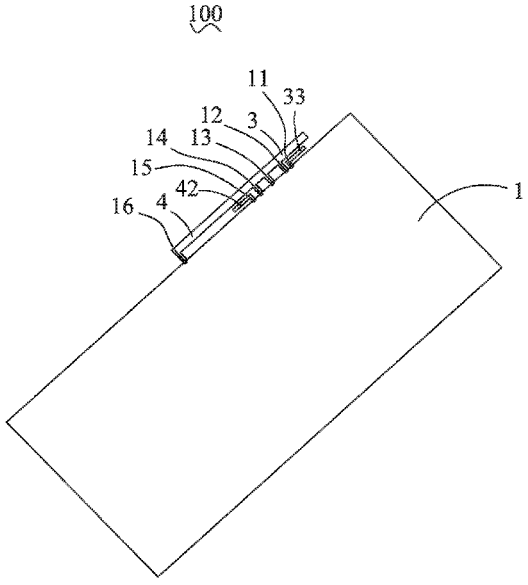
Primary Examiner — Hasan Islam

(74) *Attorney, Agent, or Firm* — W&G Law Group

(57) **ABSTRACT**

A compact dual-band MIMO antenna is provided, including: a system ground unit, a radiation arm having an open-circuit end and a short-circuit end, a first antenna formed at the open-circuit end and a second antenna formed at the short-circuit end. The first antenna includes a grounding arm connecting the radiation arm with the system ground unit, a first feeding arm located between the grounding arm and the open-circuit end, and a first parasitic arm connected to the system ground unit. The second antenna includes a second feeding arm located between the short-circuit end and the grounding arm, and a second parasitic arm connected to the system ground unit. Compared with the related art, the present invention has following beneficial effects: the antenna has compact and simple structure, high isolation, excellent performance in dual bands, a small volume and a light weight, and it is convenient for mass production.

5 Claims, 3 Drawing Sheets



US011139577B2

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

(10) **Patent No.: US 11,139,577 B2**
(45) **Date of Patent: Oct. 5, 2021**

(54) **WIRELESS ELECTRONIC DEVICE**

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

(72) Inventors: **Yung-Sheng Tseng**, New Taipei (TW); **Huei-Chun Yang**, New Taipei (TW); **Chung-Hsuan Tsai**, 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 399 days.

(21) Appl. No.: **16/203,630**

(22) Filed: **Nov. 29, 2018**

(65) **Prior Publication Data**

US 2019/0173188 A1 Jun. 6, 2019

(30) **Foreign Application Priority Data**

Dec. 6, 2017 (TW) 106142766

(51) **Int. Cl.**

H01Q 11/14	(2006.01)
H01Q 9/30	(2006.01)
H01Q 5/335	(2015.01)
H01Q 1/50	(2006.01)
H01Q 21/28	(2006.01)
H01Q 9/42	(2006.01)

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

CPC ***H01Q 11/14*** (2013.01); ***H01Q 1/50*** (2013.01); ***H01Q 5/335*** (2015.01); ***H01Q 9/30*** (2013.01); ***H01Q 9/42*** (2013.01); ***H01Q 21/28*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 11/14; H01Q 5/335; H01Q 5/342; H01Q 5/378; H01Q 5/385; H01Q 5/392; H01Q 5/50; H01Q 1/48; H01Q 1/50; H01Q 9/30; H01Q 21/28

See application file for complete search history.

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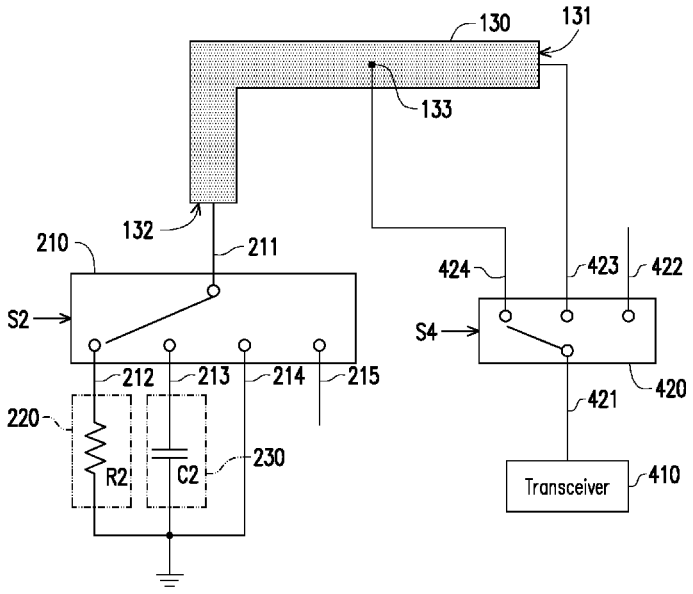
Primary Examiner — Dameon E Levi
Assistant Examiner — Jennifer F Hu
(74) *Attorney, Agent, or Firm* — JCIPRNET

(57) **ABSTRACT**

A wireless electronic device includes a ground plane, a first antenna element, a first extension element, a first switching element and a plurality of impedance elements. The ground plane includes a first edge and a second edge opposite to each other. The first antenna element is adjacent to the first edge. The first extension element is adjacent to the second edge. The first switching element is electrically connected to the first extension element. The plurality of impedance elements are electrically connected between the first switching element and a ground. The first switching element connects the first extension element to one of the plurality of impedance elements in response to an operation frequency band of the first antenna element.

7 Claims, 3 Drawing Sheets



US011139588B2

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

(10) **Patent No.: US 11,139,588 B2**
(45) **Date of Patent: *Oct. 5, 2021**

(54) **ELECTRONIC DEVICE ANTENNA ARRAYS MOUNTED AGAINST A DIELECTRIC LAYER**

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

(72) Inventors: **Jennifer M. Edwards**, San Francisco, CA (US); **Harish Rajagopalan**, San Jose, CA (US); **Simone Paulotto**, Redwood City, CA (US); **Bilgehan Avser**, Mountain View, CA (US); **Hao Xu**, Cupertino, CA (US); **Rodney A. Gomez Angulo**, Santa Clara, CA (US); **Siwen Yong**, San Francisco, CA (US); **Matthew A. Mow**, Los Altos, 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 336 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **15/950,677**

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

(65) **Prior Publication Data**

US 2019/0319367 A1 Oct. 17, 2019

(51) **Int. Cl.**
H01Q 21/22 (2006.01)
H01Q 3/26 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 21/22*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 3/26*** (2013.01);
(Continued)

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

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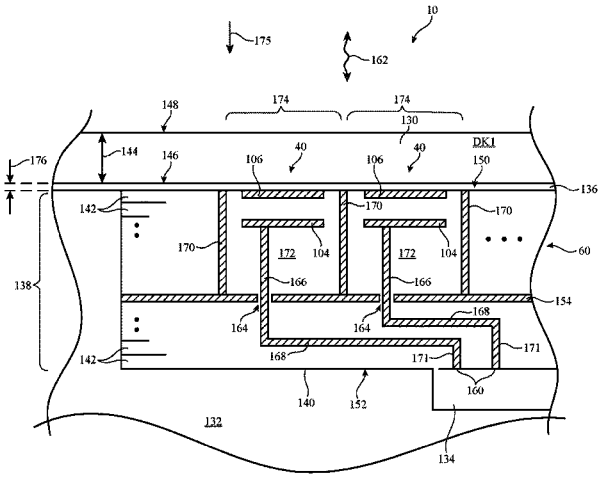
Primary Examiner — Ab Salam Alkassim, Jr.
(74) *Attorney, Agent, or Firm* — Treyz Law Group, P.C.; Michael H. Lyons; Tianyi He

(57) **ABSTRACT**

An electronic device may be provided with a dielectric cover layer, a dielectric substrate, and a phased antenna array on the dielectric substrate for conveying millimeter wave signals through the dielectric cover layer. The array may include conductive traces mounted against the dielectric layer. The conductive traces may form patch elements or parasitic elements for the phased antenna array. The dielectric layer may have a dielectric constant and a thickness selected to form a quarter wave impedance transformer for the array at a wavelength of operation of the array. The substrate may include fences of conductive vias that laterally surround each of the antennas within the array. When configured in this way, signal attenuation, destructive interference, and surface wave generation associated with the presence of the dielectric layer over the phased antenna array may be minimized.

20 Claims, 13 Drawing Sheets



US011145953B2

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

(10) **Patent No.: US 11,145,953 B2**
(45) **Date of Patent: Oct. 12, 2021**

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

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

(72) Inventors: **Jeong-Sik Kim**, Gyeongsangbuk-do (KR); **Ho-Yeon Kim**, Gyeongsangbuk-do (KR); **Hyeontae Cho**, Gyeongsangbuk-do (KR); **Ji-Woo Lee**, Gyeongsangbuk-do (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 649 days.

(21) Appl. No.: **16/003,342**

(22) Filed: **Jun. 8, 2018**

(65) **Prior Publication Data**

US 2019/0058244 A1 Feb. 21, 2019

(30) **Foreign Application Priority Data**

Aug. 21, 2017 (KR) 10-2017-0105164

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

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 5/364*** (2015.01); ***H01Q 13/10*** (2013.01);
(Continued)

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

(56) **References Cited**

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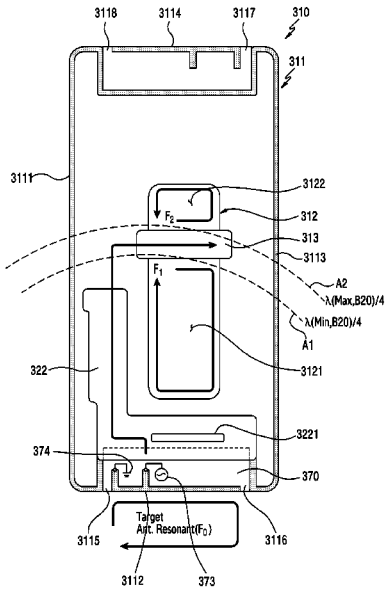
European Search Report dated Jul. 3, 2020.
Korean Search Report dated Aug. 12, 2021.

Primary Examiner — Graham P Smith
Assistant Examiner — Amal Patel
(74) *Attorney, Agent, or Firm* — Cha & Reiter, LLC.

(57) **ABSTRACT**

According to various embodiments, an electronic device comprises a housing comprising: a front surface plate; a rear surface plate spaced apart from the front surface plate opposite thereto; and a side surface member surrounding a space between the front surface plate and the rear surface plate, wherein at least a portion of the side surface member comprises at least one conductive portion disposed between a first nonconductive portion and a second nonconductive portion; at least one wireless communication circuit electrically connected to the conductive portion; a conductive plate disposed in the space, and comprising a slot having a longitudinal direction perpendicular to the conductive portion; a conductor disposed on the conductive plate; and at least one conductive member dividing the slot into a plurality of portions.

20 Claims, 19 Drawing Sheets



US011145954B2

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

(10) **Patent No.: US 11,145,954 B2**
(45) **Date of Patent: Oct. 12, 2021**

(54) **ANTENNA FOR A COMMUNICATION DEVICE**

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

(72) Inventors: **Ming-Shien Tsai**, Taipei (TW); **Leo Joseph Gerten**, Austin, TX (US)

(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 313 days.

(21) Appl. No.: **16/092,090**

(22) PCT Filed: **Jul. 29, 2016**

(86) PCT No.: **PCT/US2016/044794**
§ 371 (c)(1),
(2) Date: **Oct. 8, 2018**

(87) PCT Pub. No.: **WO2018/022100**
PCT Pub. Date: **Feb. 1, 2018**

(65) **Prior Publication Data**

US 2019/0165451 A1 May 30, 2019

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

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 9/42*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/24; H01Q 1/38; H01Q 9/42
USPC ..... 343/700 MS
See application file for complete search history.

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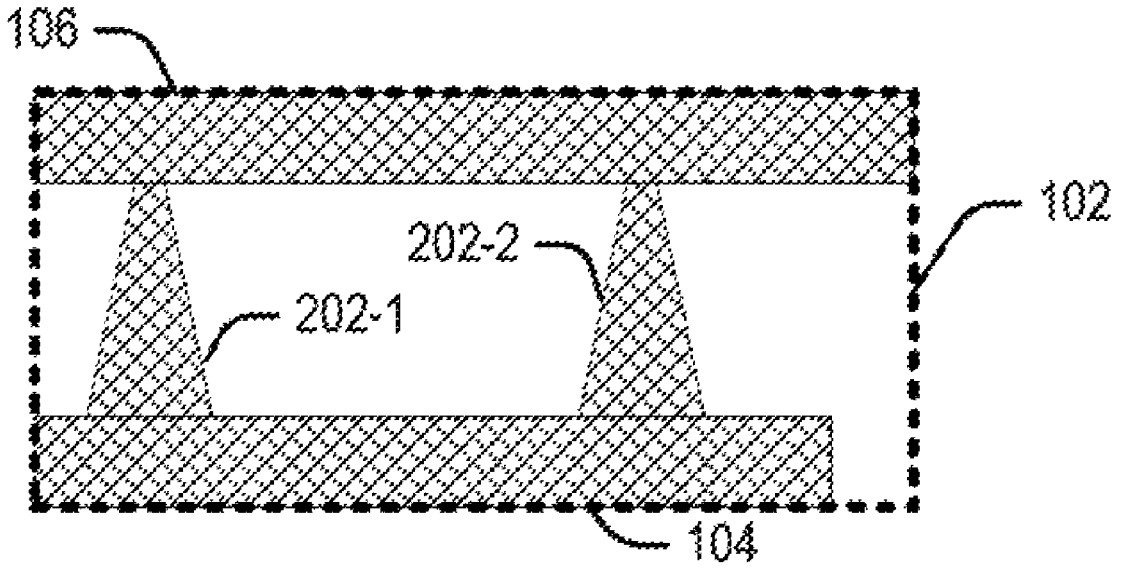
Primary Examiner — Andrea Lindgren Baltzell
(74) *Attorney, Agent, or Firm* — HPI Patent Department

(57) **ABSTRACT**

Examples relating to an antenna for a communication device are described. In one example, the antenna may include a longitudinally extending base strip, and a radiating strip. The radiating strip extends longitudinally with respect to the base strip. The antenna may further include a coupling strip which provides a conducting path between the base strip and the radiating strip. The radiating strip is such that its length is greater than length of the base strip.

14 Claims, 6 Drawing Sheets



US011145955B2

(12) **United States Patent**
Anguera Pros et al.

(10) **Patent No.: US 11,145,955 B2**
(45) **Date of Patent: Oct. 12, 2021**

(54) **WIRELESS DEVICE INCLUDING A MULTIBAND ANTENNA SYSTEM**

(71) Applicant: **Fractus Antennas, S.L.**, Barcelona (ES)

(72) Inventors: **Jaume Anguera Pros**, Castellon (ES); **Ivan Sanz**, Barcelona (ES); **Carles Puente Baliarda**, Barcelona (ES); **Josep Mumbru**, Asnières-sur-Seine (FR)

(73) Assignee: **Ignion, S.L.**, Barcelona (ES)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 87 days.

(21) Appl. No.: **16/597,531**

(22) Filed: **Oct. 9, 2019**

(65) **Prior Publication Data**

US 2020/0044317 A1 Feb. 6, 2020

Related U.S. Application Data

(63) Continuation of application No. 15/331,390, filed on Oct. 21, 2016, now Pat. No. 10,476,134, which is a (Continued)

(30) **Foreign Application Priority Data**

Mar. 30, 2007 (EP) 07105364

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

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/36*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 5/00*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/36; H01Q 1/48; H01Q 5/00; H01Q 5/335; H01Q 5/50; H01Q 21/30
See application file for complete search history.

(56) **References Cited**

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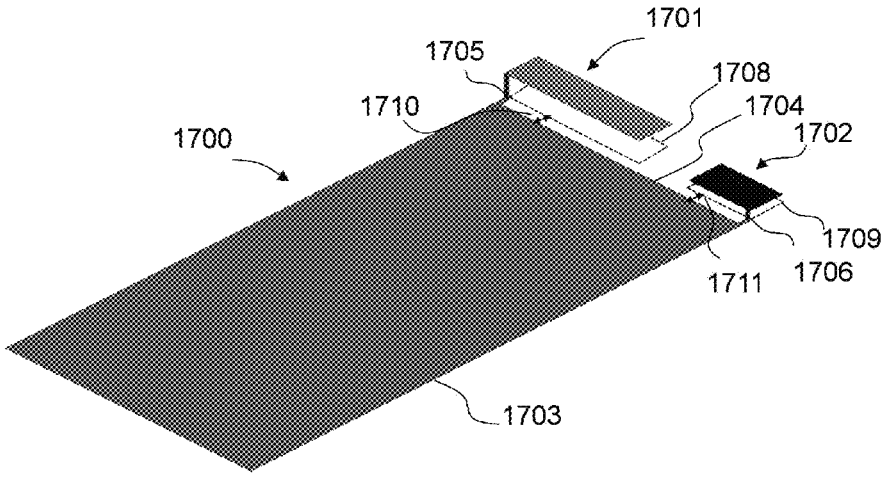
Primary Examiner — Andrea Lindgren Baltzell
Assistant Examiner — Amal Patel
(74) *Attorney, Agent, or Firm* — Edell, Shapiro & Finnan, LLC

(57) **ABSTRACT**

A wireless handheld or portable device includes an antenna system operable in a first frequency region and a higher, second frequency region. The antenna system comprises an antenna structure, a matching and tuning system, and an external input/output (I/O) port. The antenna structure comprises at least one radiating element including a connection point, a ground plane layer including at least one connection point, and at least one internal I/O port. At least one radiating element of the antenna structure protrudes beyond the ground plane layer. The antenna structure features at any of its internal I/O ports when disconnected from the matching
(Continued)



US011145956B2

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

(10) **Patent No.: US 11,145,956 B2**
(45) **Date of Patent: Oct. 12, 2021**

(54) **DUAL-POLARIZED MILLIMETER WAVE ANTENNA UNIT, ANTENNA SYSTEM, AND MOBILE TERMINAL**

(71) Applicant: **SHENZHEN SUNWAY COMMUNICATION CO., LTD.**, Shenzhen (CN)

(72) Inventors: **Shengjie Wu**, Shenzhen (CN); **Anping Zhao**, Shenzhen (CN)

(73) Assignee: **SHENZHEN SUNWAY COMMUNICATION 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 197 days.

(21) Appl. No.: **16/606,132**

(22) PCT Filed: **Sep. 11, 2019**

(86) PCT No.: **PCT/CN2019/105247**
§ 371 (c)(1),
(2) Date: **Oct. 17, 2019**

(87) PCT Pub. No.: **WO2021/012363**
PCT Pub. Date: **Jan. 28, 2021**

(65) **Prior Publication Data**

US 2021/0028535 A1 Jan. 28, 2021

(30) **Foreign Application Priority Data**

Jul. 23, 2019 (CN) 201910664228.3

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 15/24 (2006.01)
H01Q 21/00 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 15/24*** (2013.01); ***H01Q 21/0006*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 15/24; H01Q 21/0006; H01Q 21/24; H01Q 21/0075; H01Q 9/0478
See application file for complete search history.

(56) **References Cited**

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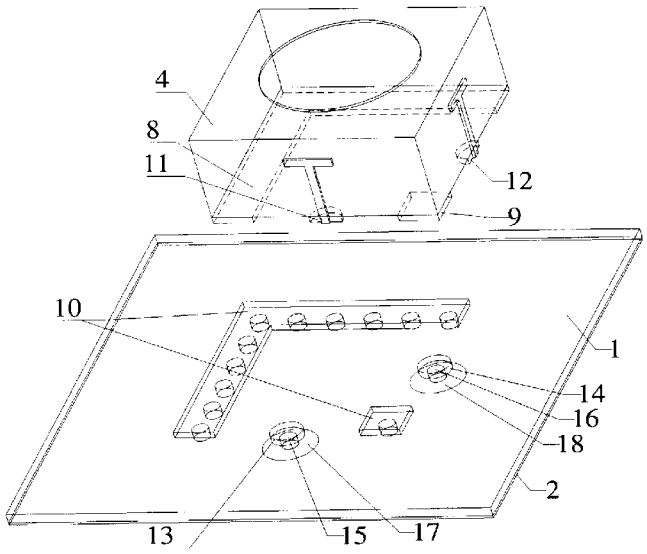
* cited by examiner

Primary Examiner — Awat M Salih
(74) *Attorney, Agent, or Firm* — Oliff PLC

(57) **ABSTRACT**

A dual-polarized millimeter wave antenna unit, an antenna system, and a mobile terminal are disclosed. The dual-polarized millimeter wave antenna unit comprises a main part, a first feed branch, a second feed branch, and a radiator, wherein the radiator is arranged on the top face of the main part, the first feed branch is arranged on a first side face of the main part, the second feed branch is arranged on a second side face of the main body, the first feed branch and the second feed branch are communicated with the bottom face of the main part, the first side face is perpendicular to the second side face, and a weld region is arranged on the bottom face of the main part. The dual-polarized millimeter wave antenna unit provided by the invention has the advantages of wideband, dual polarization, and low sidelobe, thus being especially suitable for 5G communication.

19 Claims, 9 Drawing Sheets



US011145957B2

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

(10) **Patent No.: US 11,145,957 B2**
(45) **Date of Patent: Oct. 12, 2021**

(54) **ANTENNA, ANTENNA CONTROL METHOD, AND TERMINAL**

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

(72) Inventors: **Chongfeng Zhao**, Xi'an (CN); **Bao Lu**, Shenzhen (CN); **Kun Li**, Xi'an (CN)

(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 3 days.

(21) Appl. No.: **16/765,743**

(22) PCT Filed: **Nov. 21, 2017**

(86) PCT No.: **PCT/CN2017/112108**
§ 371 (c)(1),
(2) Date: **May 20, 2020**

(87) PCT Pub. No.: **WO2019/100202**
PCT Pub. Date: **May 31, 2019**

(65) **Prior Publication Data**

US 2020/0313281 A1 Oct. 1, 2020

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/48 (2006.01)
H04M 1/02 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/48*** (2013.01); ***H04M 1/0202*** (2013.01)

(58) **Field of Classification Search**
CPC combination set(s) only.
See application file for complete search history.

(56) **References Cited**

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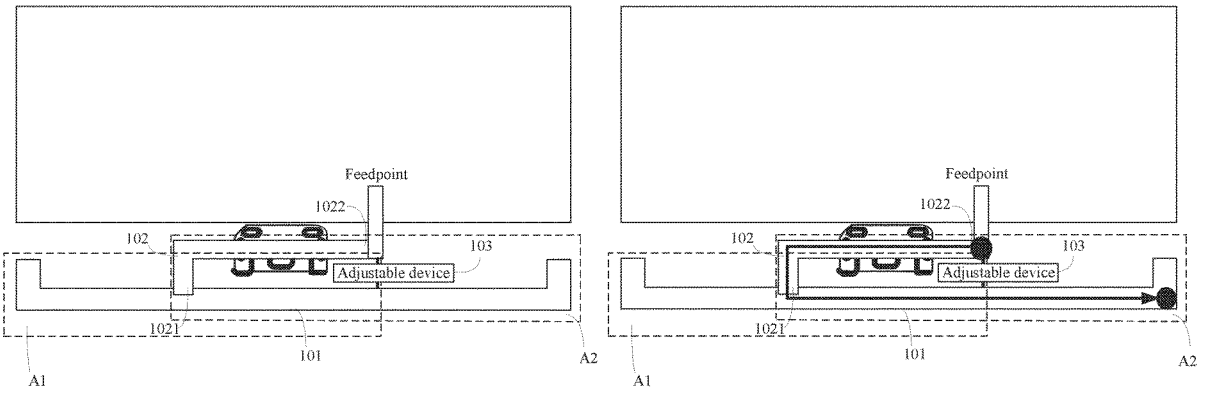
(Continued)

Primary Examiner — Junpeng Chen
(74) *Attorney, Agent, or Firm* — Conley Rose, P.C.

(57) **ABSTRACT**

An antenna, an antenna control method, and a terminal, where the antenna includes an antenna body and an antenna branch, where one end of the antenna branch is coupled to the antenna body, the other end is coupled to a feedpoint of a primary radio frequency channel, and the end of the antenna branch that is coupled to the feedpoint of the primary radio frequency channel is further coupled to the antenna body through a first adjustable device, where the first adjustable device is in an on state or an off state. An antenna branch is coupled between the feedpoint of the primary radio frequency channel and the antenna body, and the antenna branch is capable of coupling or decoupling by switching on or off the first adjustable device.

20 Claims, 9 Drawing Sheets



US011145958B2

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

(10) **Patent No.: US 11,145,958 B2**
(45) **Date of Patent: *Oct. 12, 2021**

(54) **MOBILE DEVICE AND MANUFACTURING METHOD THEREOF**

(71) Applicant: **HTC Corporation**, Taoyuan (TW)

(72) Inventors: **Tiao-Hsing Tsai**, Taoyuan (TW); **Chien-Pin Chiu**, Taoyuan (TW); **Hsiao-Wei Wu**, Taoyuan (TW); **Shen-Fu Tzeng**, Taoyuan (TW); **Yi-Hsiang Kung**, Taoyuan (TW); **Li-Yuan Fang**, Taoyuan (TW)

(73) Assignee: **HTC CORPORATION**, Taoyuan (TW)

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

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **16/895,028**

(22) Filed: **Jun. 8, 2020**

(65) **Prior Publication Data**

US 2020/0303810 A1 Sep. 24, 2020

Related U.S. Application Data

(63) Continuation of application No. 15/723,336, filed on Oct. 3, 2017, now Pat. No. 10,727,569.
(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 1/38*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 5/35*** (2015.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 7/005; H01Q 5/364; H01Q 1/48; H01Q 9/0421; H01Q 1/38;
(Continued)

(56) **References Cited**

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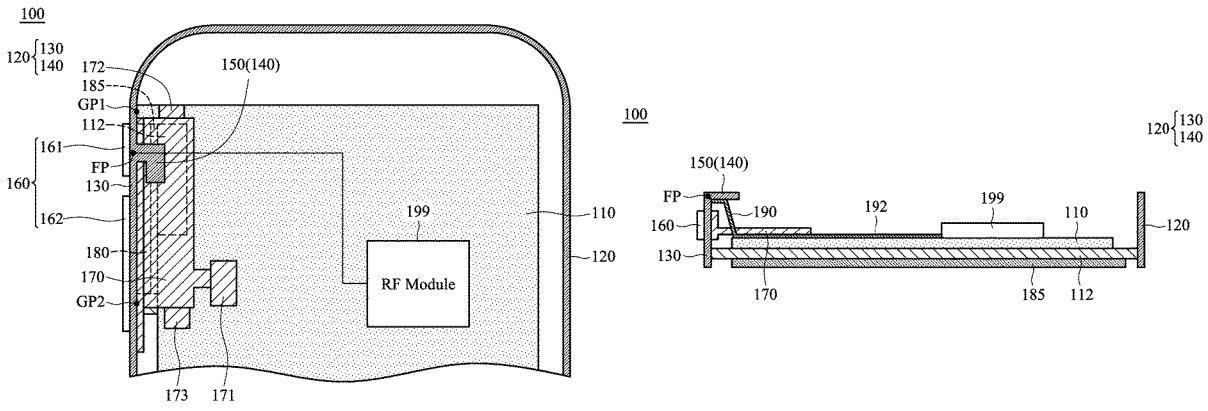
Primary Examiner — Andrea Lindgren Baltzell
Assistant Examiner — Michael M Bouizza
(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

A mobile device at least includes a first circuit board, a metal frame, an electronic component, a second circuit board, and an RF (Radio Frequency) module. The first circuit board includes a system ground plane. The metal frame at least includes a first portion. The first portion is electrically coupled to the system ground plane and a feeding point. An antenna structure is formed by the first portion and the feeding point. The second circuit board is electrically coupled to the electronic component. The electronic component and the second circuit board are adjacent to the first portion of the metal frame. The RF module is electrically coupled to the feeding point, so as to excite the antenna structure.

25 Claims, 11 Drawing Sheets



US011145967B2

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

(10) **Patent No.: US 11,145,967 B2**
(45) **Date of Patent: Oct. 12, 2021**

(54) **ANTENNA SYSTEM**

(71) Applicant: **Wistron Corp.**, New Taipei (TW)

(72) Inventors: **Ying-Sheng Fang**, New Taipei (TW); **Nien-Chao Chuang**, New Taipei (TW); **Po-Tsang Lin**, New Taipei (TW); **Chia-Wei Su**, New Taipei (TW)

(73) Assignee: **WISTRON CORP.**, New Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 112 days.

(21) Appl. No.: **16/710,586**

(22) Filed: **Dec. 11, 2019**

(65) **Prior Publication Data**

US 2021/0126356 A1 Apr. 29, 2021

(30) **Foreign Application Priority Data**

Oct. 29, 2019 (TW) 108138963

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/52 (2006.01)
H01Q 5/307 (2015.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/521*** (2013.01); ***H01Q 5/307*** (2015.01); *H01Q 1/242* (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/521; H01Q 5/307; H01Q 1/242
See application file for complete search history.

(56) **References Cited**

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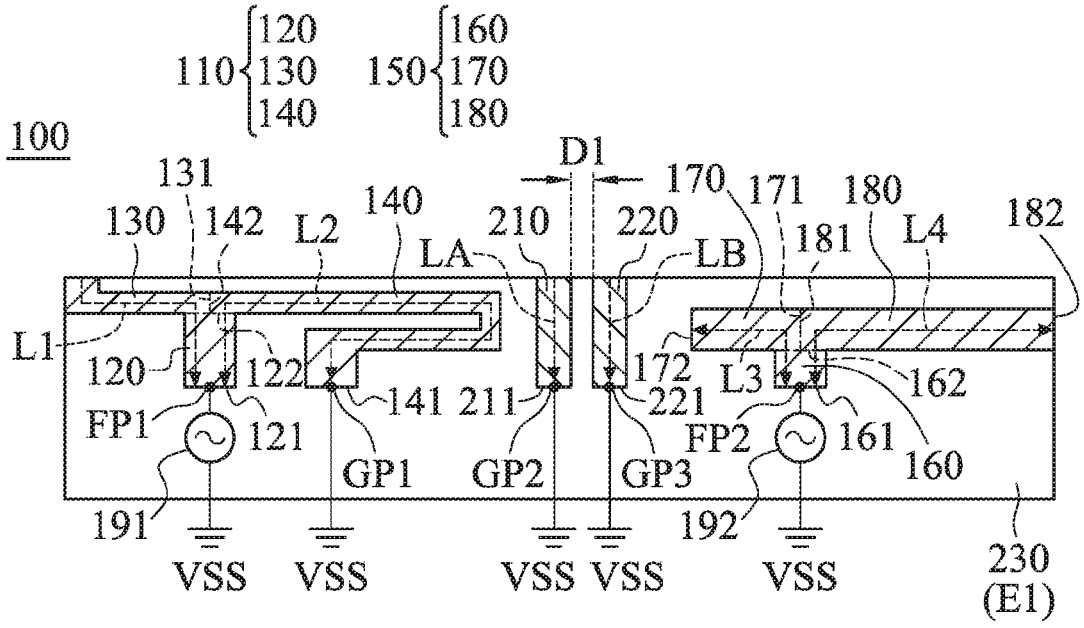
Primary Examiner — Dieu Hien T Duong
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

An antenna system includes a first antenna, a second antenna, a first parasitic element, and a second parasitic element. The first antenna includes a first feeding element, a first radiation element, and a shorting element. The first radiation element is coupled to the first feeding element. The first feeding element is coupled through the shorting element to a first grounding point. The second antenna includes a second feeding element, a second radiation element, and a third radiation element. The second radiation element and the third radiation element are coupled to the second feeding element. The first parasitic element is coupled to a second grounding point. The second parasitic element is coupled to

(Continued)



US011145969B2

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

(10) **Patent No.: US 11,145,969 B2**
(45) **Date of Patent: Oct. 12, 2021**

(54) **STRUCTURE, ANTENNA STRUCTURE, AND RADIO WAVE SHIELDING STRUCTURE INCLUDING TRANSPARENT CONDUCTOR**

(71) Applicant: **NIHON DENGYO KOSAKU CO., LTD.**, Tokyo (JP)

(72) Inventors: **Akira Maruyama**, Tokyo (JP); **Yukio Sato**, Tokyo (JP); **Hiroki Hagiwara**, Tokyo (JP)

(73) Assignee: **NIHON DENGYO KOSAKU CO., LTD.**, Tokyo (JP)

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

(21) Appl. No.: **16/642,376**

(22) PCT Filed: **Aug. 28, 2017**

(86) PCT No.: **PCT/JP2017/030726**
§ 371 (c)(1),
(2) Date: **Feb. 27, 2020**

(87) PCT Pub. No.: **WO2019/043756**
PCT Pub. Date: **Mar. 7, 2019**

(65) **Prior Publication Data**

US 2020/0194883 A1 Jun. 18, 2020

(51) **Int. Cl.**
H01Q 1/52 (2006.01)
H01Q 1/12 (2006.01)
G02B 3/08 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/526*** (2013.01); ***G02B 3/08*** (2013.01); ***H01Q 1/12*** (2013.01)

(58) **Field of Classification Search**
CPC G02B 3/08; G02B 5/045; G02B 5/1876; G02B 19/0076; G02B 25/002;
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(56) **References Cited**

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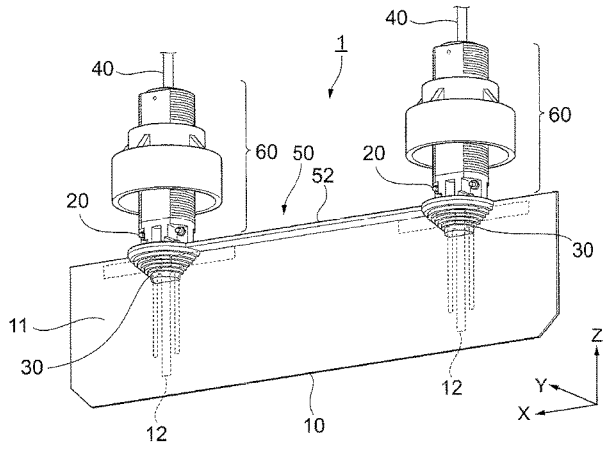
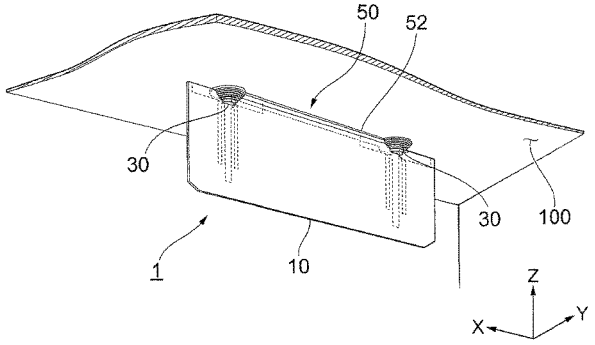
Primary Examiner — Collin X Beatty
Assistant Examiner — Grant A Gagnon
(74) *Attorney, Agent, or Firm* — JCIPRNET

(57) **ABSTRACT**

An antenna structure as an example of a structure including a transparent conductor includes: an antenna as an example of the transparent conductor; a film transmitting a visible light; a positioning structure configured to position the film from an invisible side of a ceiling as an example of a facility; and a flange transmitting the visible light and configured to position the film from a visible side of the ceiling and including a lens part at a position facing the positioning structure.

10 Claims, 11 Drawing Sheets





US011145970B2

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

(10) **Patent No.: US 11,145,970 B2**
(45) **Date of Patent: Oct. 12, 2021**

(54) **ANTENNA DEVICE**

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

(72) Inventors: **Kwang-Hyun Baek**, Gyeonggi-do (KR); **Seung-Tae Ko**, Gyeonggi-do (KR); **Yoon-Geon Kim**, Busan (KR); **Won-Bin Hong**, Seoul (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.: **16/786,449**

(22) Filed: **Feb. 10, 2020**

(65) **Prior Publication Data**

US 2020/0176864 A1 Jun. 4, 2020

Related U.S. Application Data

(62) Division of application No. 15/038,334, filed as application No. PCT/KR2015/001989 on Mar. 2, 2015, now abandoned.

(30) **Foreign Application Priority Data**

May 13, 2014 (KR) 10-2014-0057077

(51) **Int. Cl.**
H01Q 3/01 (2006.01)
H01Q 3/46 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 3/01*** (2013.01); ***H01Q 3/46*** (2013.01); ***H01Q 9/0442*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/2291; H01Q 1/24; H01Q 1/241; H01Q 1/242; H01Q 1/243; H01Q 1/38;
(Continued)

(56) **References Cited**

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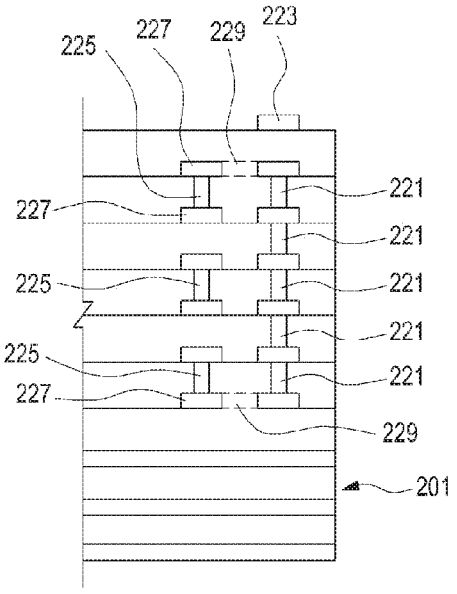
(Continued)

Primary Examiner — Dimary S Lopez Cruz
Assistant Examiner — Patrick R Holecek
(74) *Attorney, Agent, or Firm* — The Farrell Law Firm, P.C.

(57) **ABSTRACT**

Various embodiments of the present disclosure provide an antenna device, which comprises: a radiator for receiving a power supply signal; multiple tuning units disposed adjacently to or on the radiator, wherein the tuning units are short-circuited to the radiator or adjacent tuning units are selectively short-circuited to each other. The antenna device as described above can be variously implemented according to embodiments.

6 Claims, 11 Drawing Sheets



US011145972B2

(12) **United States Patent**
Yang

(10) **Patent No.: US 11,145,972 B2**
(45) **Date of Patent: Oct. 12, 2021**

(54) **ANTENNA OSCILLATOR AND ANTENNA**

(71) Applicant: **SHENZHEN ANTOP TECHNOLOGY CO., LTD.**, Shenzhen (CN)

(72) Inventor: **Ruidian Yang**, Shenzhen (CN)

(73) Assignee: **Shenzhen Antop Technology 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 111 days.

(21) Appl. No.: **16/679,103**

(22) Filed: **Nov. 8, 2019**

(65) **Prior Publication Data**

US 2021/0098871 A1 Apr. 1, 2021

(30) **Foreign Application Priority Data**

Sep. 30, 2019 (CN) 201921673261.4

(51) **Int. Cl.**
H01Q 1/36 (2006.01)
H01Q 3/06 (2006.01)
H01Q 13/10 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 3/06*** (2013.01); ***H01Q 1/36*** (2013.01); ***H01Q 13/106*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 3/06; H01Q 1/36; H01Q 13/10; H01Q 13/103; H01Q 13/106
See application file for complete search history.

(56) **References Cited**

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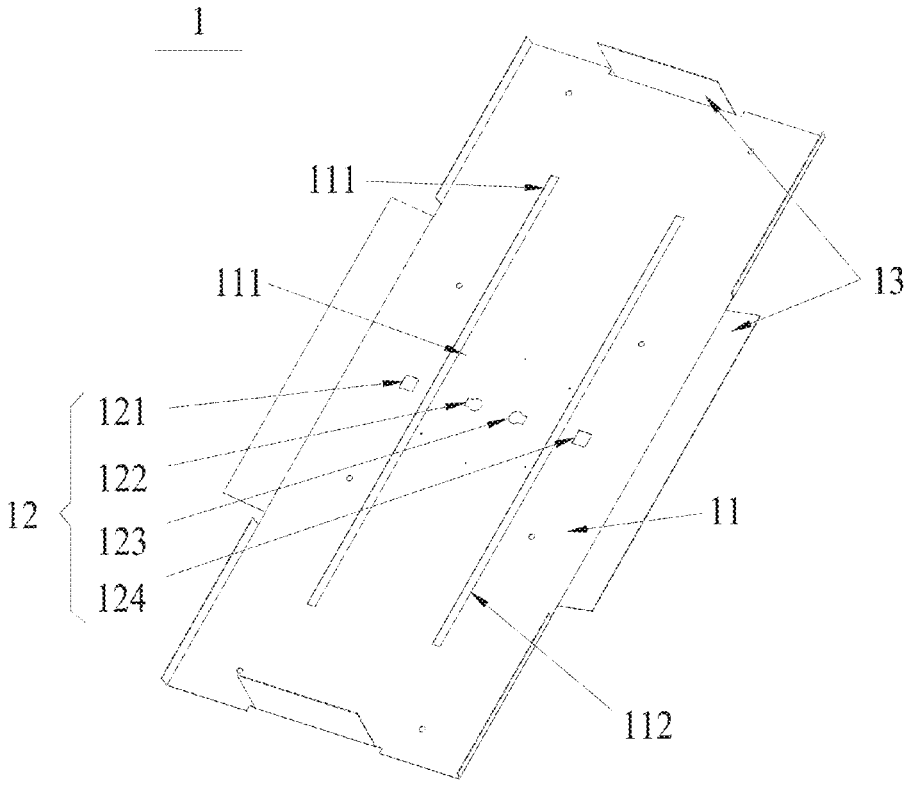
Primary Examiner — Seokjin Kim
(74) *Attorney, Agent, or Firm* — Robert L. Stearns; Dickinson Wright, PLLC

(57) **ABSTRACT**

The disclosure applies to the field of antenna technology, which provides an antenna oscillator and an antenna. The antenna oscillator includes an antenna oscillator body, the antenna oscillator body has a rectangular planar plate-like structure. The first slit and the second slit have strip-shaped structures without branches and are configured on the antenna oscillator body. The first slit and the second slit extend in the direction of the long side of the rectangle and the antenna oscillator body is configured with a pore structure. It can receive and transmit electromagnetic wave signals of a larger bandwidth, expand the effective bandwidth of the antenna oscillator and obtain better signal intensity for each frequency within the effective bandwidth.

13 Claims, 10 Drawing Sheets



US011145973B2

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

(10) **Patent No.: US 11,145,973 B2**
(45) **Date of Patent: Oct. 12, 2021**

(54) **PLANAR END-FIRE PATTERN RECONFIGURABLE ANTENNA**

(71) Applicant: **SOUTH CHINA UNIVERSITY OF TECHNOLOGY**, Guangdong (CN)

(72) Inventors: **Yongmei Pan**, Guangdong (CN); **Yun Ouyang**, Guangdong (CN); **Shaoyong Zheng**, Guangdong (CN)

(73) Assignee: **SOUTH CHINA UNIVERSITY OF TECHNOLOGY**, Guangzhou (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.: **17/260,561**

(22) PCT Filed: **Feb. 25, 2019**

(86) PCT No.: **PCT/CN2019/076009**
§ 371 (c)(1),
(2) Date: **Jan. 15, 2021**

(87) PCT Pub. No.: **WO2020/015359**
PCT Pub. Date: **Jan. 23, 2020**

(65) **Prior Publication Data**

US 2021/0273328 A1 Sep. 2, 2021

(30) **Foreign Application Priority Data**

Jul. 18, 2018 (CN) 201810791251.4

(51) **Int. Cl.**
H01Q 9/28 (2006.01)
H01Q 3/24 (2006.01)
H01Q 1/48 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 3/242*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 9/285*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 3/24; H01Q 9/04; H01Q 9/285; H01Q 1/38–1/48
See application file for complete search history.

(56) **References Cited**

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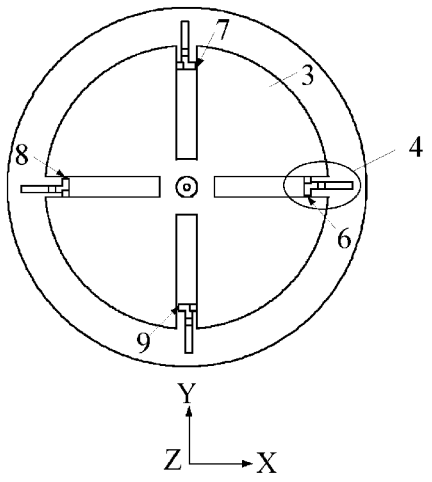
Primary Examiner — Hasan Islam
(74) *Attorney, Agent, or Firm* — JCIPRNET

(57) **ABSTRACT**

The invention discloses a planar end-fire pattern reconfigurable antenna, including a dielectric substrate, a radiation patch, a ground plane, a switch and bias circuit, and a coaxial cable, wherein the dielectric substrate includes a first surface and a second surface in opposite, the radiation patch is attached to the first surface of the dielectric substrate, the ground plane is attached to the second surface of the dielectric substrate, the switch and bias circuit is arranged in a slot of the ground plane, the coaxial cable includes an outer conductor and an inner conductor, the outer conductor is connected to the ground plane, the inner conductor penetrates through the dielectric substrate and is connected to the radiation patch, and the coaxial cable is arranged at a geometric center of the planar end-fire pattern reconfigurable antenna.

9 Claims, 5 Drawing Sheets



US011145979B2

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

(10) **Patent No.: US 11,145,979 B2**
(45) **Date of Patent: Oct. 12, 2021**

(54) **HIGH GAIN AND LARGE BANDWIDTH ANTENNA INCORPORATING A BUILT-IN DIFFERENTIAL FEEDING SCHEME**

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

(72) Inventors: **Hamid Reza Memar Zadeh Tehran**, Richardson, TX (US); **Gary Xu**, Allen, TX (US); **Won Suk Choi**, Plano, TX (US); **Jianzhong Zhang**, Plano, TX (US)

(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.: **17/195,401**

(22) Filed: **Mar. 8, 2021**

(65) **Prior Publication Data**

US 2021/0194127 A1 Jun. 24, 2021

Related U.S. Application Data

(63) Continuation of application No. 16/949,878, filed on Nov. 18, 2020, now Pat. No. 10,944,172, which is a (Continued)

(51) **Int. Cl.**
H01Q 21/06 (2006.01)
H01Q 5/35 (2015.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 5/35*** (2015.01); ***H01Q 5/50*** (2015.01); ***H01Q 9/045*** (2013.01); ***H01Q 21/065*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/523; H01Q 5/35; H01Q 5/50; H01Q 9/045; H01Q 21/065; H01Q 21/24
(Continued)

(56) **References Cited**

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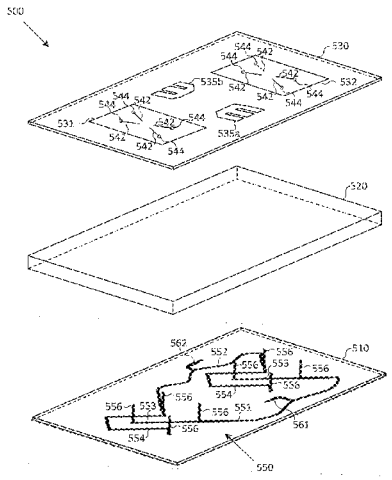
Primary Examiner — Tung X Le

(57) **ABSTRACT**

An antenna and a base station including the antenna. The antenna includes a sub-array that includes first and second unit cells and a feed network. The first and second unit cells comprise first and second patches, respectively, having quadrilateral shapes. The feed network comprises a first transmission line terminating below first corners of the first and second patches, respectively; a second transmission line terminating below third corners of the first and second patches, respectively; a third transmission line terminating below a second corner of the first patch and a fourth corner of the second patch; and a fourth transmission line terminating below a fourth corner of the first patch and a second corner of the second patch. The first corners are opposite the third corners on the respective first and second patches and the second corners are opposite the fourth corners on the respective first and second patches.

20 Claims, 8 Drawing Sheets



US011145983B1

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

(10) **Patent No.: US 11,145,983 B1**
(45) **Date of Patent: Oct. 12, 2021**

(54) **SUBSTRATE-INTEGRATED-WAVEGUIDE-FED CAVITY-BACKED DUAL-POLARIZED PATCH ANTENNA**

(71) Applicant: **NATIONAL CHIAO TUNG UNIVERSITY**, Hsinchu (TW)

(72) Inventors: **Jenn-Hwan Tarng**, Hsinchu (TW); **Chih-Wei Chiu**, Zhubei (TW); **Nai-Chen Liu**, Taichung (TW)

(73) Assignee: **National Chiao Tung University**, 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.: **17/036,107**

(22) Filed: **Sep. 29, 2020**

(30) **Foreign Application Priority Data**

Jun. 23, 2020 (TW) 109121297

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 13/18 (2006.01)
H01Q 1/22 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 9/0457*** (2013.01); ***H01Q 1/2283*** (2013.01); ***H01Q 9/0492*** (2013.01); ***H01Q 13/18*** (2013.01)

(58) **Field of Classification Search**
CPC .. H01Q 1/2283; H01Q 9/0407; H01Q 9/0428; H01Q 9/0435; H01Q 9/0442; H01Q 9/045; H01Q 9/0457; H01Q 9/0478; H01Q 9/0492; H01Q 21/0006; H01Q 21/0031; H01Q 21/0037; H01Q 21/0043;
(Continued)

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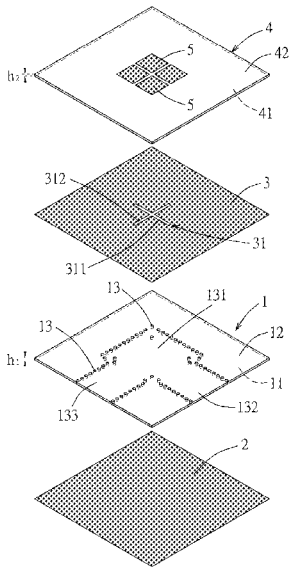
(Continued)

Primary Examiner — Robert Karacsony
(74) *Attorney, Agent, or Firm* — Michael Best & Friedrich LLP

(57) **ABSTRACT**

A dual-polarized patch antenna includes a first insulating substrate; conductive connections, each of which passes through the first insulating substrate, and which are arranged to form a resonant cavity and two feeding ports; first and second metal layers respectively disposed on two opposite surfaces of the first insulating substrate, the second metal layer being formed with a cross-shaped slot that corresponds in position to the resonant cavity; a second insulating substrate disposed on the second metal layer; and four radiation patch units disposed on the second insulating substrate, and corresponding in position to four regions that are on the second metal layer and that are spaced apart by the cross-shaped slot.

9 Claims, 10 Drawing Sheets



US011145985B2

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

(10) **Patent No.: US 11,145,985 B2**
(45) **Date of Patent: Oct. 12, 2021**

(54) **ELECTRONIC DEVICE**

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

(72) Inventors: **Chien-Yi Wu**, Taipei (TW); **Ching-Hsiang Ko**, Taipei (TW); **Chao-Hsu Wu**, Taipei (TW); **Shih-Keng Huang**, Taipei (TW); **Cheng-Hsiung Wu**, Taipei (TW); **Ya-Jyun Li**, Taipei (TW)

(73) Assignee: **PEGATRON CORPORATION**, Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 749 days.

(21) Appl. No.: **16/006,735**

(22) Filed: **Jun. 12, 2018**

(65) **Prior Publication Data**

US 2019/0036223 A1 Jan. 31, 2019

(30) **Foreign Application Priority Data**

Jul. 25, 2017 (TW) 106124894

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

(52) **U.S. Cl.**
CPC ***H01Q 13/10*** (2013.01); ***G06F 1/1656*** (2013.01); ***G06F 1/1658*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 13/10–18
See application file for complete search history.

(56) **References Cited**

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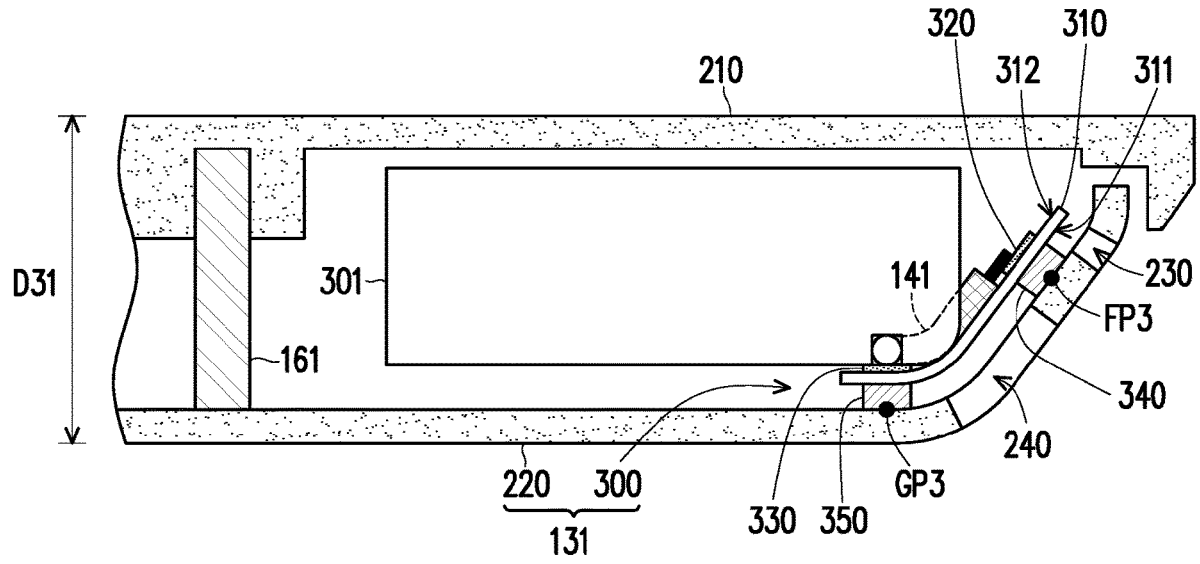
Primary Examiner — Andrea Lindgren Baltzell
Assistant Examiner — Amal Patel
(74) *Attorney, Agent, or Firm* — J.C. Patents

(57) **ABSTRACT**

An electronic device includes a first body and a feed device. A conductive housing of the first body includes a first closed slot, a second closed slot, a feed point and a ground point. The feed device includes a circuit substrate, a feed portion, a ground portion, a first connection portion and a second connection portion. The circuit substrate includes a first surface, a second surface, first conductive holes and second conductive holes, and the first surface faces the conductive housing. The feed portion and the ground portion are disposed on the second surface. The feed portion is electrically connected to the feed point, and the ground portion is electrically connected to the ground point. The feed device and the conductive housing form an antenna. The antenna operates in first and second bands through first and second paths formed by the first and the second closed slots.

17 Claims, 7 Drawing Sheets



US011145990B2

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

(10) **Patent No.: US 11,145,990 B2**
(45) **Date of Patent: Oct. 12, 2021**

(54) **ANTENNA STRUCTURE HAVING MULTIPLE OPERATING FREQUENCY BANDS**

(71) Applicant: **WISTRON NEWEB CORPORATION**, Hsinchu (TW)

(72) Inventors: **Shih-Hsien Tseng**, Hsinchu (TW); **Cheng-Pang Chang**, Hsinchu (TW)

(73) Assignee: **WISTRON NEWEB CORPORATION**, Hsinchu (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 444 days.

(21) Appl. No.: **16/208,604**

(22) Filed: **Dec. 4, 2018**

(65) **Prior Publication Data**

US 2019/0296446 A1 Sep. 26, 2019

(30) **Foreign Application Priority Data**

Mar. 21, 2018 (TW) 107109659

(51) **Int. Cl.**

H01Q 5/335	(2015.01)
H01Q 9/04	(2006.01)
H01Q 9/16	(2006.01)
H01Q 1/24	(2006.01)
H01Q 1/48	(2006.01)
H01Q 19/00	(2006.01)
H01Q 7/00	(2006.01)

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

CPC ***H01Q 19/005*** (2013.01); ***H01Q 1/242*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 5/335*** (2015.01); ***H01Q 7/00*** (2013.01); ***H01Q 9/0421*** (2013.01); ***H01Q 9/16*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 5/321; H01Q 7/00; H01Q 5/378; H01Q 1/38; H01Q 1/521; H01Q 5/10; H01Q 5/328; H01Q 19/005; H01Q 5/335; H01Q 9/065; H01Q 5/392; H01Q 9/04; H01Q 5/357; H01Q 5/385; H01Q 9/42; H01Q 5/371

See application file for complete search history.

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TW	M257522	2/2005

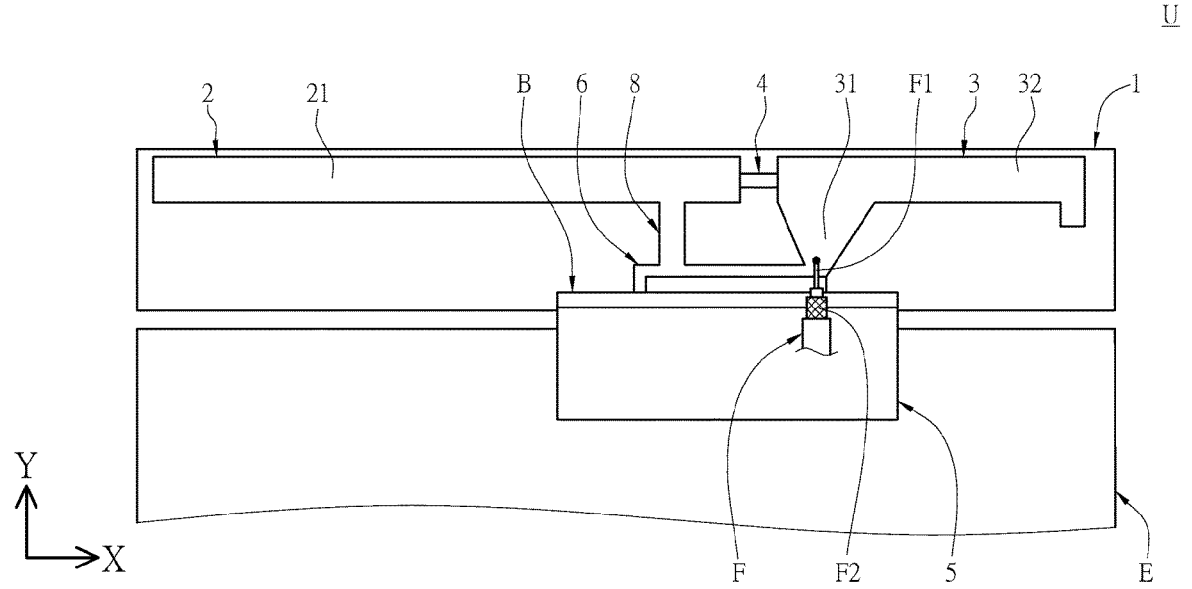
Primary Examiner — Vibol Tan

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

(57) **ABSTRACT**

An antenna structure includes a substrate, a first radiating element, a second radiating element, a first inductor, a ground element, a first conducting element and a feeding element. The first radiating element is disposed on the substrate. The second radiating element is disposed on the substrate. The second radiating element includes a feed receiving portion. The first inductor is coupled between the first radiating element and the second radiating element. The first conducting element is coupled between the feed receiving portion and the ground element. The feeding element is coupled between the feed receiving portion and the ground element and for feeding in a signal.

19 Claims, 11 Drawing Sheets



US011145991B1

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

(10) **Patent No.: US 11,145,991 B1**
(45) **Date of Patent: Oct. 12, 2021**

(54) **SYSTEMS AND METHODS FOR PHASE-COINCIDENTIAL DUAL-POLARIZED WIDEBAND ANTENNA ARRAYS**

(71) Applicant: **Rockwell Collins, Inc.**, Cedar Rapids, IA (US)

(72) Inventors: **Matilda G. Livadaru**, Marion, IA (US); **Jeremiah D. Wolf**, Atkins, IA (US)

(73) Assignee: **Rockwell Collins, Inc.**, Cedar Rapids, IA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 514 days.

(21) Appl. No.: **15/955,030**

(22) Filed: **Apr. 17, 2018**

(51) **Int. Cl.**
H01Q 21/06 (2006.01)
H01Q 21/22 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 21/062*** (2013.01); ***H01Q 21/22*** (2013.01)

(58) **Field of Classification Search**
CPC .. H01Q 21/0006; H01Q 21/062; H01Q 21/22; H01Q 21/24; H01Q 21/26; H01Q 21/29; H01Q 21/293; H01Q 1/246; H01Q 1/521; H01Q 1/523; H01Q 1/525; H01Q 21/245
See application file for complete search history.

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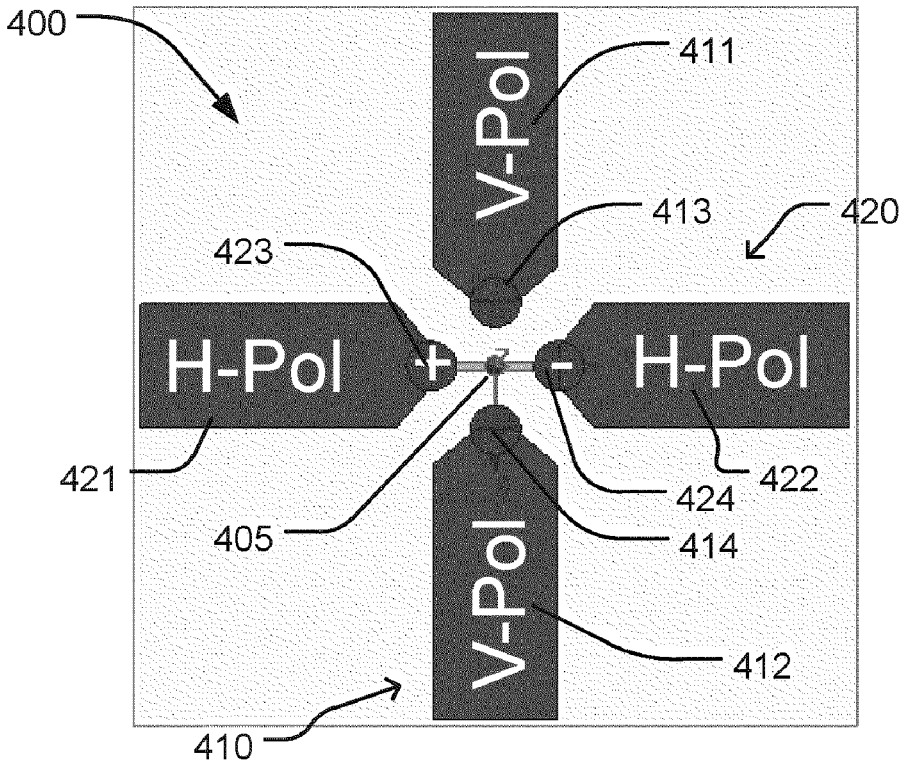
* cited by examiner

Primary Examiner — Andrea Lindgren Baltzell
Assistant Examiner — Patrick R Holecek
(74) *Attorney, Agent, or Firm* — Suiter Swantz pc llo

(57) **ABSTRACT**

The antenna includes a substrate and a plurality of unit cells coupled to the substrate. Each unit cell includes a dipole feed extending from the substrate, a first antenna dipole coupled to the dipole feed, and a second antenna dipole coupled to the dipole feed. The first antenna dipole includes a first arm on a first side of the dipole feed and a second arm on a second side of the dipole feed opposite the first side. The second antenna dipole includes a third arm on a third side of the dipole feed and a fourth arm on a fourth side of the dipole feed opposite the third side.

11 Claims, 5 Drawing Sheets



US011145993B2

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

(10) **Patent No.: US 11,145,993 B2**
(45) **Date of Patent: Oct. 12, 2021**

(54) **ANTENNA MODULE AND TERMINAL THEREOF**

(71) Applicants: **Electric Connector Technology Co., Ltd.**, Shenzhen (CN); **Shanghai University**, Shanghai (CN)

(72) Inventors: **Guangli Yang**, Shenzhen (CN); **Yuanqing Chen**, Shanghai (CN); **Yong Luo**, Shanghai (CN); **Jiayou Xu**, Shanghai (CN); **Zefeng Jiang**, Shanghai (CN); **Xiang Zhang**, Shenzhen (CN); **Yingjie Zhang**, Shenzhen (CN); **Eugene Yu-Jiun Ren**, Shenzhen (CN)

(73) Assignees: **ELECTRIC CONNECTOR TECHNOLOGY CO., LTD.**, Guangming Newdistrict (CN); **SHANGHAI UNIVERSITY**, Shanghai (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.: **16/832,723**

(22) Filed: **Mar. 27, 2020**

(65) **Prior Publication Data**

US 2020/0313305 A1 Oct. 1, 2020

(30) **Foreign Application Priority Data**

Mar. 28, 2019 (CN) 201910242556.4

(51) **Int. Cl.**
H01Q 21/06 (2006.01)
H01Q 1/48 (2006.01)
H01Q 21/00 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 21/065*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 21/0025*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 21/0006; H01Q 21/0025; H01Q 21/065; H01Q 1/38; H01Q 5/10
See application file for complete search history.

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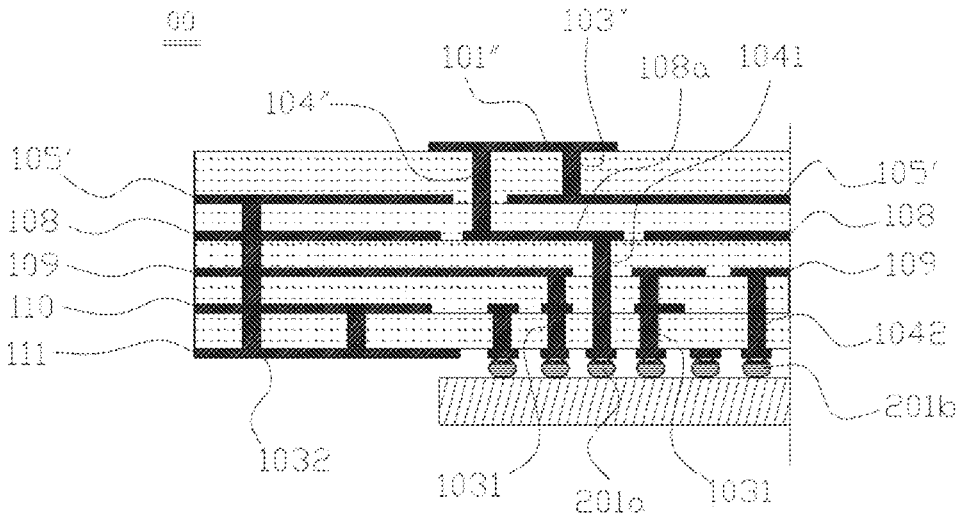
Primary Examiner — Jason Crawford

(57) **ABSTRACT**

An antenna module and a terminal applying the antenna module are disclosed. The antenna module includes an antenna array configured with a plurality of antenna units and a radio-frequency phase shifting system. The antenna array and the radio-frequency phase shifting system are integrated on a circuit substrate to form an independent module. Further, the antenna unit of the antenna module may adopt a solution of a microstrip patch antenna structure loading a short-circuit pillar to generate multiple resonances, thereby expanding the bandwidth of the antenna unit. After the antenna array is formed, the antenna modules may be further arranged perpendicular to each other to expand and achieve large-angle scanning and polarization diversity functions. The disclosed antenna module has a simplified structure and may be applied to 5G communication. It has the advantages of easy system integration, low-profile miniaturization, wide radiation bandwidth, and large-angle scanning.

19 Claims, 5 Drawing Sheets



US011145994B2

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

(10) **Patent No.: US 11,145,994 B2**
(45) **Date of Patent: Oct. 12, 2021**

(54) **LOW COST HIGH PERFORMANCE MULTIBAND CELLULAR ANTENNA WITH CLOAKED MONOLITHIC METAL DIPOLE**

(71) Applicant: **JOHN MEZZALINGUA ASSOCIATES, LLC**, Liverpool, NY (US)

(72) Inventors: **Niranjan Sundararajan**, Liverpool, NY (US); **Charles Buondelmonte**, Baldwinsville, NY (US); **Andrew Litteer**, Clay, NY (US); **Wengang Chen**, Liverpool, NY (US)

(73) Assignee: **JOHN MEZZALINGUA ASSOCIATES, LLC**, Liverpool, NY (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.: **16/758,094**

(22) PCT Filed: **Oct. 25, 2018**

(86) PCT No.: **PCT/US2018/057453**
§ 371 (c)(1),
(2) Date: **Apr. 22, 2020**

(87) PCT Pub. No.: **WO2019/084232**
PCT Pub. Date: **May 2, 2019**

(65) **Prior Publication Data**

US 2020/0328533 A1 Oct. 15, 2020

Related U.S. Application Data

(60) Provisional application No. 62/577,407, filed on Oct. 26, 2017.

(51) **Int. Cl.**
H01Q 21/26 (2006.01)
H01Q 9/28 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 21/26*** (2013.01); ***H01Q 9/28*** (2013.01); ***H01Q 19/10*** (2013.01); ***H01Q 19/108*** (2013.01); ***H01Q 21/062*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 21/26; H01Q 9/28; H01Q 19/108; H01Q 15/14; H01Q 21/062; H01Q 9/285; H01Q 25/001; H01Q 5/48; H01Q 19/10
See application file for complete search history.

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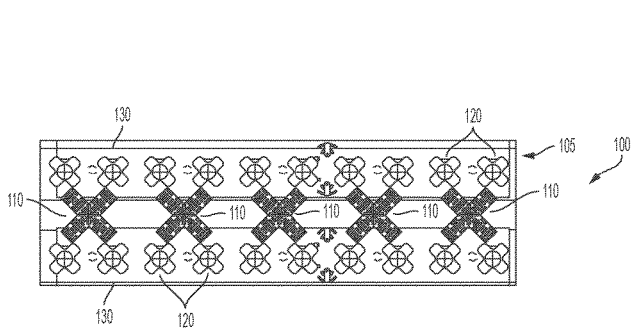
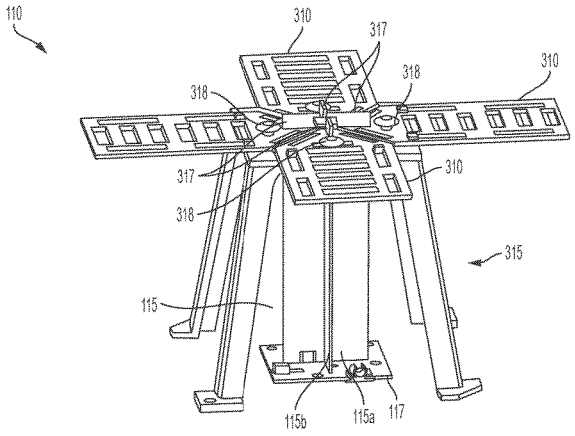
(Continued)

Primary Examiner — Vibol Tan
(74) *Attorney, Agent, or Firm* — Meunier Carlin & Curfman LLC

(57) **ABSTRACT**

Disclosed is a high performance low cost multiband antenna configuration that has a low band dipole having dipole arms formed of stamped sheet metal that has a plurality of slots. Some of the slots are oriented along a longitudinal axis of the low band dipole arm, and others are oriented orthogonal to the longitudinal axis. The presence of the slots creates a plurality of inductor structures, which act has cloaking structures that make the low band dipole substantially trans-
(Continued)





US011146303B2

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

(10) **Patent No.: US 11,146,303 B2**
(45) **Date of Patent: Oct. 12, 2021**

(54) **ANTENNA MODULE**

(71) Applicant: **Murata Manufacturing Co., Ltd.**, Kyoto (JP)

(72) Inventors: **Kengo Onaka**, Kyoto (JP); **Yoshiki Yamada**, Kyoto (JP); **Keisei Takayama**, Kyoto (JP); **Hirotsugu Mori**, Kyoto (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 0 days.

(21) Appl. No.: **16/732,758**

(22) Filed: **Jan. 2, 2020**

(65) **Prior Publication Data**

US 2020/0145038 A1 May 7, 2020

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2018/018898, filed on May 16, 2018.

(30) **Foreign Application Priority Data**

Jul. 6, 2017 (JP) JP2017-132788

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/48 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04B 1/40*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 9/045*** (2013.01);
(Continued)

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

(56) **References Cited**

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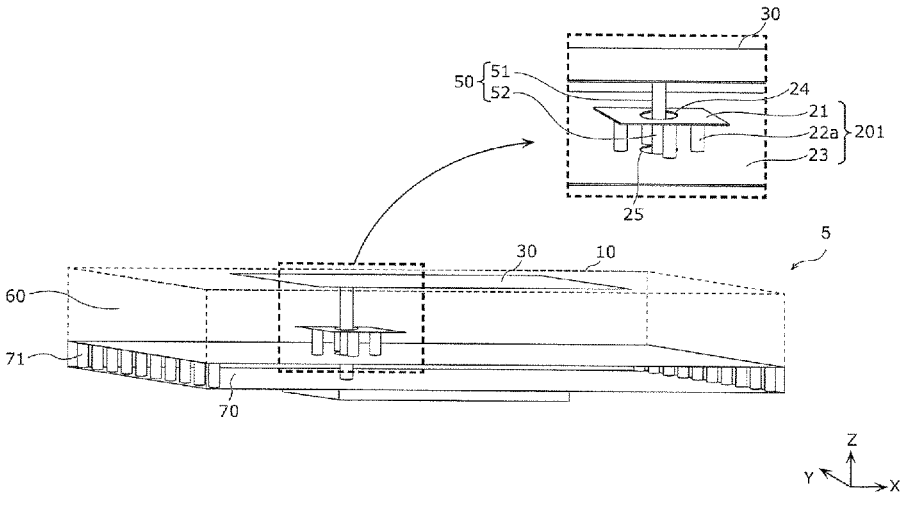
Primary Examiner — Tuan A Tran
(74) *Attorney, Agent, or Firm* — Pearne & Gordon LLP

(57) **ABSTRACT**

An antenna module includes a substrate, a RF signal processing circuit provided on the substrate, a ground electrode provided on the substrate above the RF signal processing circuit, a radiation electrode provided on the substrate above the ground electrode, and a feed line provided in an overlapping area where the radiation electrode and the RF signal processing circuit overlap, the feed line connecting the radiation electrode and the RF signal processing circuit, wherein the ground electrode includes a first ground pattern, a second ground pattern, and a peripheral wall connecting the first ground pattern and the second ground pattern, the peripheral wall surrounds part of the feed line, and the second ground pattern has a through hole through which the feed line penetrates.

19 Claims, 12 Drawing Sheets



US011152716B2

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

(10) **Patent No.: US 11,152,716 B2**
(45) **Date of Patent: Oct. 19, 2021**

(54) **ANTENNA INCLUDING CONDUCTIVE PATTERN AND ELECTRONIC DEVICE INCLUDING ANTENNA**

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

(72) Inventors: **Donghun Shin**, Suwon-si (KR); **Mincheol Seo**, Suwon-si (KR); **Hosaeng Kim**, Suwon-si (KR); **Yoonjae Lee**, Suwon-si (KR); **Byungman Lim**, Suwon-si (KR); **Jaebong Chun**, Suwon-si (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 6 days.

(21) Appl. No.: **16/794,883**

(22) Filed: **Feb. 19, 2020**

(65) **Prior Publication Data**

US 2020/0266551 A1 Aug. 20, 2020

(30) **Foreign Application Priority Data**

Feb. 19, 2019 (KR) 10-2019-0019113

(51) **Int. Cl.**
H01Q 21/00 (2006.01)
H01Q 21/06 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 21/062*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 21/065*** (2013.01); *H01Q 1/24* (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 21/062; H01Q 1/38; H01Q 21/064; H01Q 13/18; H01Q 1/24; H01Q 21/065; H01Q 1/243; H01Q 21/00
See application file for complete search history.

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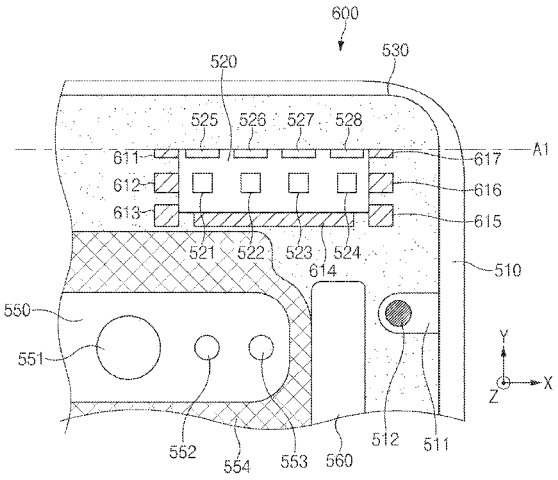
Primary Examiner — Joseph J Lauture
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

An electronic device including an antenna and a conductive pattern formed around the antenna is provided. The electronic device includes a housing including a first plate, a second plate facing away from the first plate, and a side member surrounding a space between the first plate and the second plate, connected to the second plate or integrally formed with the second plate, and including a conductive material, an injection-molding material disposed in the space between the first plate and the second plate in the housing and formed of a non-conductive material, an antenna module including conductive radiators and supported by the injection-molding material, and a conductive pattern disposed on a first surface adjacent to the second plate of the injection-molding material or disposed inside the injection-molding material and disposed adjacent to a part of
(Continued)



US011158932B2

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

(10) **Patent No.: US 11,158,932 B2**
(45) **Date of Patent: Oct. 26, 2021**

(54) **FULL SCREEN ELECTRONIC DEVICE AND ANTENNA THEREOF**

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

(72) Inventors: **Yongsheng Peng**, Shenzhen (CN); **Lei Zheng**, 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 0 days.

(21) Appl. No.: **16/936,449**

(22) Filed: **Jul. 23, 2020**

(65) **Prior Publication Data**

US 2020/0411956 A1 Dec. 31, 2020

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2019/094070, filed on Jun. 30, 2019.

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H04M 1/02 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H04M 1/0266*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H04M 1/0266
See application file for complete search history.

(56) **References Cited**

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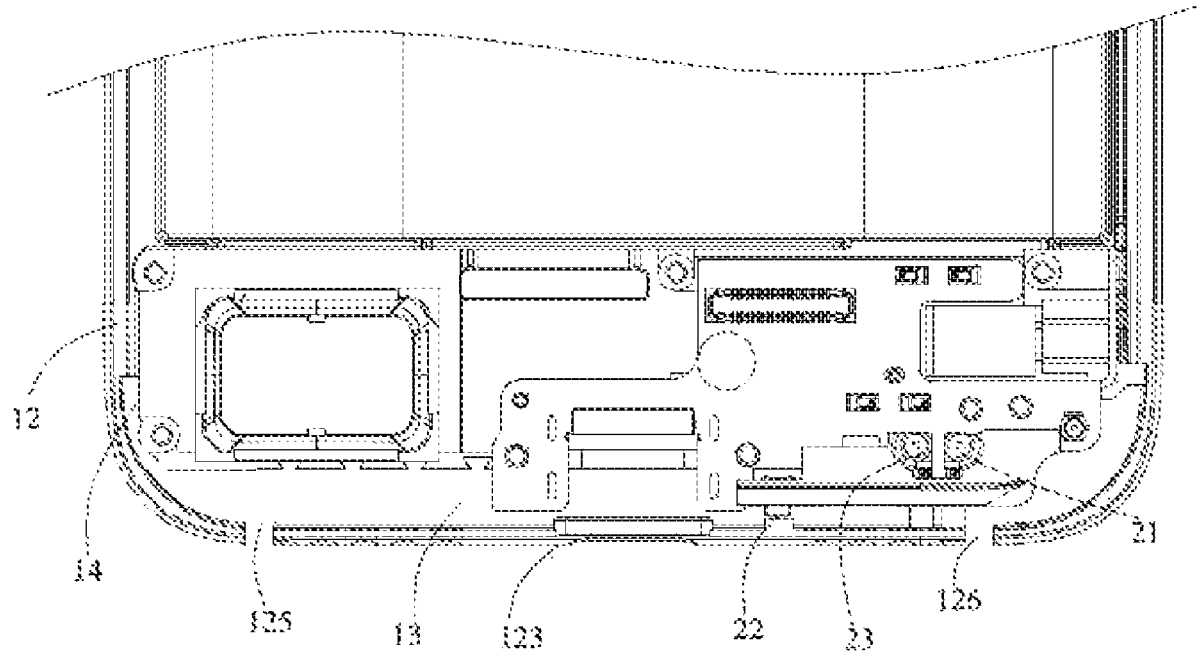
Primary Examiner — Lewis G West
(74) *Attorney, Agent, or Firm* — W&G Law Group

(57) **ABSTRACT**

The present invention discloses an antenna including a frame body and a circuit board arranged in the frame body. The frame body includes a middle frame and an outer metal frame surrounding the edge of the middle frame and connected to the middle frame. The outer metal frame includes a first side frame, a second side frame, a third side frame and a fourth side frame. The circuit board is provided with a feeding part and a switch circuit which are electrically connected with the third side frame. The third side frame and the middle frame are arranged at an interval to form a first gap; a second gap is arranged between one end of the second side frame near the third side frame and the middle frame. BY virtue of this configuration the radiation efficiency of the antenna is accordingly improved.

7 Claims, 3 Drawing Sheets



US011158957B1

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

(10) **Patent No.: US 11,158,957 B1**
(45) **Date of Patent: Oct. 26, 2021**

(54) **CO-LOCATED ANTENNAS WITH COUPLED ARMS**

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

(72) Inventors: **Chris Kruger**, San Diego, CA (US); **Sung Oh**, Palo Alto, CA (US)

(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.: **16/481,279**

(22) PCT Filed: **Mar. 7, 2018**

(86) PCT No.: **PCT/US2018/021328**
§ 371 (c)(1),
(2) Date: **Jul. 26, 2019**

(87) PCT Pub. No.: **WO2019/172904**
PCT Pub. Date: **Sep. 12, 2019**

(51) **Int. Cl.**
H01Q 21/28 (2006.01)
H01Q 1/24 (2006.01)
H01Q 3/34 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 21/28*** (2013.01); ***H01Q 1/241*** (2013.01); ***H01Q 3/34*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 21/28; H01Q 1/241; H01Q 3/34
See application file for complete search history.

(56) **References Cited**

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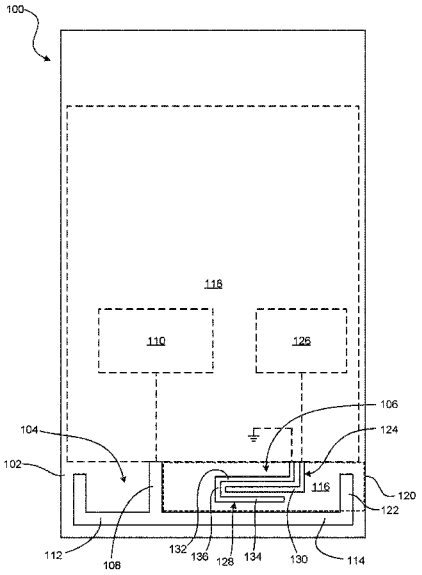
Primary Examiner — Hoang V Nguyen
(74) *Attorney, Agent, or Firm* — Perry + Currier Inc.

(57) **ABSTRACT**

An example device includes a substrate and first and second antennas disposed on the substrate. The first antenna includes a first feed arm to connect to a circuit and a pair of extended arms extending in opposite directions from the first feed arm. The first antenna is co-located with a secondary antenna area. The secondary antenna area is bounded by the first feed arm and by a first extended arm of the pair of extended arms. The secondary antenna area is further to be bounded by a display and by an outer edge of the substrate. The second antenna is disposed within the secondary antenna area and includes a second feed arm to connect to the circuit. The second antenna further includes a coupled arm distant from the second feed arm, the coupled arm positioned between the second feed arm and the first feed arm of the first antenna.

15 Claims, 6 Drawing Sheets



US011158958B2

(12) **United States Patent**
Kenkel

(10) **Patent No.: US 11,158,958 B2**
(45) **Date of Patent: Oct. 26, 2021**

(54) **DUAL BAND ANTENNA**

(71) Applicant: **Shure Acquisition Holdings, Inc.**, Niles, IL (US)

(72) Inventor: **Mark Allen Kenkel**, Schaumburg, IL (US)

(73) Assignee: **Shure Acquisition Holdings, Inc.**, Niles, IL (US)

(*) 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.: **16/727,631**

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

(65) **Prior Publication Data**

US 2021/0203084 A1 Jul. 1, 2021

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

(52) **U.S. Cl.**
CPC ***H01Q 21/30*** (2013.01); ***H01Q 21/28*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 21/30; H01Q 21/28; H01Q 13/10; H01Q 21/065; H01Q 5/49; H01Q 1/38; H01Q 1/2291; H01Q 19/30; H01Q 21/064; H01Q 1/48; H01Q 21/24; H01Q 3/16; H01Q 3/18; H01Q 3/20
USPC ..... 343/700 MS, 700, 751, 797, 798, 800, 343/809, 810, 811, 824, 826, 827, 812, 343/813, 852, 770
See application file for complete search history.

(56) **References Cited**

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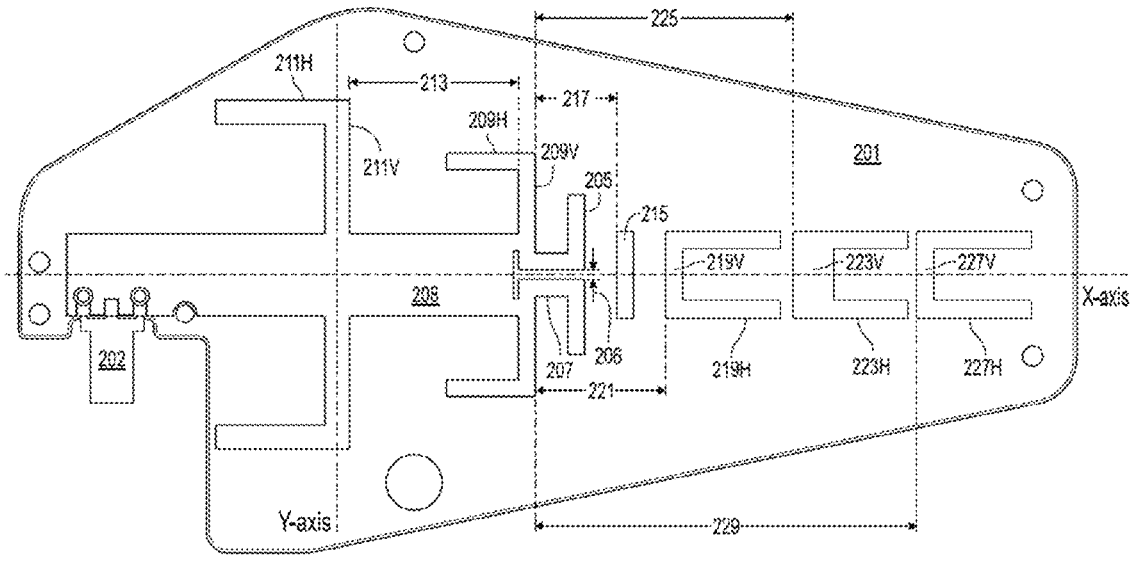
Primary Examiner — Thien T Mai
(74) *Attorney, Agent, or Firm* — Banner & Witcoff, Ltd.

(57) **ABSTRACT**

A dual band antenna that allows the independent optimization of each frequency band by adjusting the sizes of the antenna elements. For example, an antenna may have two different drivers, one for the high-frequency and one for the low frequency. By using elements orthogonally connected to the low frequency driver, the low frequency driver can function as both a reflector to the high frequency drivers and the low frequency driver without affecting the antenna's performance in the high frequency. The antenna may also have parasitic elements. For example, parasitic directors parallel to the high frequency band driver can be configured to improve performance in the high frequency band. Pairs of additional parasitic directors can be orthogonally connected these directors. These pairs can be adjusted in size to improve performance in the low frequency band with minimal impact on performance in the high frequency band.

18 Claims, 7 Drawing Sheets



US011164485B2

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

(10) **Patent No.: US 11,164,485 B2**
(45) **Date of Patent: Nov. 2, 2021**

(54) **ENERGY HARVESTING DEVICE AND DISPLAY DEVICE**

(71) Applicant: **E Ink Holdings Inc.**, Hsinchu (TW)

(72) Inventors: **Yu-Ming Lee**, Hsinchu (TW); **Chuen-Jen Liu**, Hsinchu (TW)

(73) Assignee: **E Ink Holdings Inc.**, 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.: **16/903,387**

(22) Filed: **Jun. 17, 2020**

(65) **Prior Publication Data**

US 2020/0312200 A1 Oct. 1, 2020

Related U.S. Application Data

(63) Continuation of application No. 15/896,093, filed on Feb. 14, 2018, now Pat. No. 10,733,916.

(30) **Foreign Application Priority Data**

Aug. 16, 2017 (CN) 201710700410.0

(51) **Int. Cl.**
G09F 3/20 (2006.01)
G06F 3/147 (2006.01)
G09F 9/37 (2006.01)

(52) **U.S. Cl.**
CPC ***G09F 3/208*** (2013.01); ***G06F 3/147*** (2013.01); ***G09F 9/372*** (2013.01); *G09G 2330/023* (2013.01); *G09G 2380/04* (2013.01)

(58) **Field of Classification Search**
CPC G09F 3/208; G09G 2330/023
USPC 235/487
See application file for complete search history.

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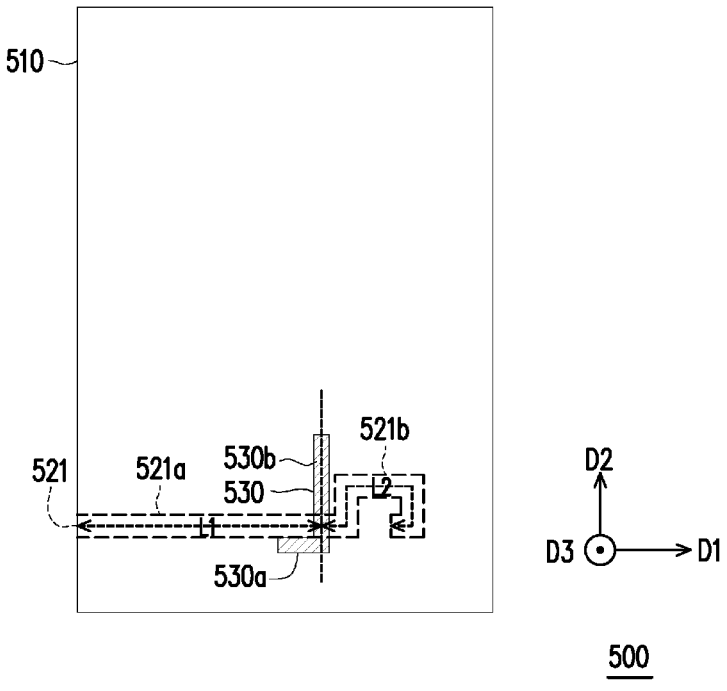
Primary Examiner — Toan C Ly
(74) *Attorney, Agent, or Firm* — JCIPRNET

(57) **ABSTRACT**

An energy harvesting device and a display device are provided. The energy harvesting device is configured to generate a power signal and the energy harvesting device includes a slot antenna. The slot antenna comprises a first section and a second section. The first section of the slot antenna is a linear shape and comprises an opening end, and the second section of the slot antenna is a bending shape and comprises a plurality of continuously bending corners.

19 Claims, 7 Drawing Sheets



US011165157B2

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

(10) **Patent No.: US 11,165,157 B2**
(45) **Date of Patent: Nov. 2, 2021**

(54) **ANTENNA DEVICE**

(71) Applicants: **DENSO CORPORATION**, Kariya (JP); **SOKEN, INC.**, Nisshin (JP); **NATIONAL UNIVERSITY CORPORATION KYOTO INSTITUTE OF TECHNOLOGY**, Kyoto (JP)

(72) Inventors: **Masakazu Ikeda**, Nisshin (JP); **Yuji Sugimoto**, Nisshin (JP); **Hiroaki Kuraoka**, Kariya (JP); **Shiro Koide**, Kariya (JP); **Tetsuya Ueda**, Kyoto (JP); **Kohei Enomoto**, Kyoto (JP)

(73) Assignees: **DENSO CORPORATION**, Kariya (JP); **SOKEN, INC.**, Nisshin (JP); **National University Corporation Kyoto Institute of Technology**, Kyoto (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 610 days.

(21) Appl. No.: **16/079,948**

(22) PCT Filed: **Feb. 13, 2017**

(86) PCT No.: **PCT/JP2017/005055**
§ 371 (c)(1),
(2) Date: **Aug. 24, 2018**

(87) PCT Pub. No.: **WO2017/145831**
PCT Pub. Date: **Aug. 31, 2017**

(65) **Prior Publication Data**

US 2021/0184356 A1 Jun. 17, 2021

(30) **Foreign Application Priority Data**

Feb. 26, 2016 (JP) JP2016-035988

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

(52) **U.S. Cl.**
CPC ***H01Q 9/0421*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 9/0457*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 9/04; H01Q 9/0421; H01Q 9/0457; H01Q 1/48; H01Q 9/28; H01Q 13/08
See application file for complete search history.

(56) **References Cited**

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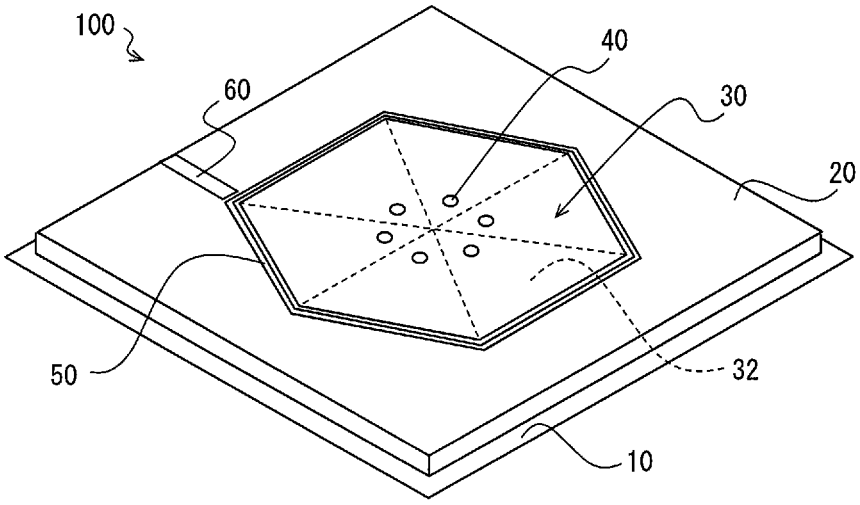
Primary Examiner — Hoang V Nguyen
(74) *Attorney, Agent, or Firm* — Harness, Dickey & Pierce, P.L.C.

(57) **ABSTRACT**

An antenna device includes a ground plate, a patch portion disposed parallel to the ground plate with a particular spacing, a plurality of short circuit portions that electrically connect the patch portion to the ground plate, and a loop portion which is a loop shaped conductor member at a particular spacing from an outer edge portion of the patch portion. The patch portion has an area which forms an electrostatic capacitance that causes parallel resonance with an inductance provided by the short circuit portions at a particular target frequency. The loop portion is formed with a perimeter length which is an integral multiple of the wavelength of radio waves at the target frequency. A feed point is disposed on the loop portion, and current is supplied to the patch portion through the loop portion.

13 Claims, 12 Drawing Sheets



US011165158B2

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

(10) **Patent No.: US 11,165,158 B2**
(45) **Date of Patent: Nov. 2, 2021**

(54) **INTEGRATED ANTENNA ELEMENT, ANTENNA UNIT, MULTI-ARRAY ANTENNA, TRANSMISSION METHOD AND RECEIVING METHOD OF SAME**

(71) Applicant: **TONGYU COMMUNICATION INC.**, Zhongshan (CN)

(72) Inventors: **Zhonglin Wu**, Zhongshan (CN); **Samb Doudou**, Zhongshan (CN); **Ari Isola**, Zhongshan (CN); **Can Ding**, Zhongshan (CN); **Haihan Sun**, Zhongshan (CN); **Yingjie Guo**, Zhongshan (CN); **Shuguang Shao**, Zhongshan (CN)

(73) Assignee: **TONGYU COMMUNICATION INC.**, Zhongshan (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.: **16/484,198**

(22) PCT Filed: **May 12, 2017**

(86) PCT No.: **PCT/CN2017/084202**
§ 371 (c)(1),
(2) Date: **Aug. 7, 2019**

(87) PCT Pub. No.: **WO2018/205278**
PCT Pub. Date: **Nov. 15, 2018**

(65) **Prior Publication Data**

US 2020/0006858 A1 Jan. 2, 2020

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

(52) **U.S. Cl.**
CPC ***H01Q 9/285*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 15/14*** (2013.01); ***H01Q 21/29*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/246; H01Q 1/36; H01Q 1/38; H01Q 9/26; H01Q 9/285; H01Q 15/14; H01Q 25/001
(Continued)

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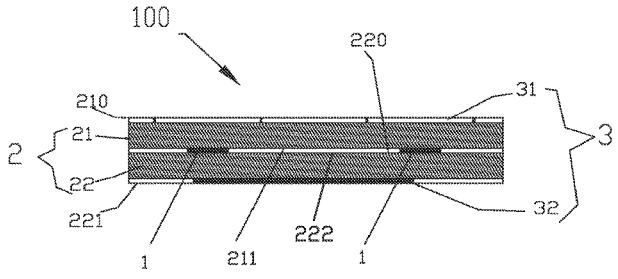
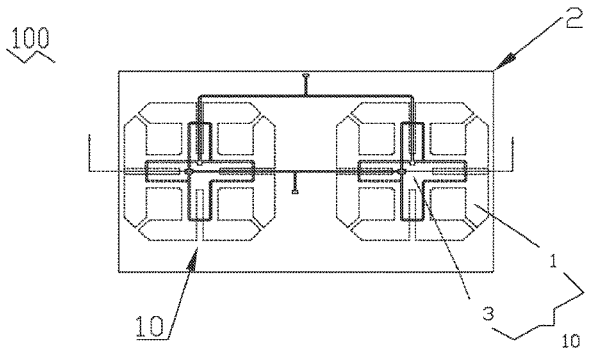
Primary Examiner — Tung X Le
(74) *Attorney, Agent, or Firm* — Oliff PLC

(57) **ABSTRACT**

An integrated antenna element includes a top PCB and a bottom PCB arranged in a laminate structure. Radiating surface units are arranged between the top PCB and the bottom PCB. A first balun and a second balun set separately set on the top and bottom PCBs respectively, each for different polarization. The integrated antenna element is capable of transmitting signals to a base station and receiving signals from a base station.

22 Claims, 6 Drawing Sheets





US011165159B2

(12) **United States Patent**
Hung

(10) **Patent No.: US 11,165,159 B2**
(45) **Date of Patent: Nov. 2, 2021**

(54) **ANTENNAS IN FRAMES FOR DISPLAY PANELS**

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

(72) Inventor: **Kuan-Jung Hung**, Taipei (CN)

(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 659 days.

(21) Appl. No.: **16/080,227**

(22) PCT Filed: **Apr. 24, 2017**

(86) PCT No.: **PCT/US2017/029121**
§ 371 (c)(1),
(2) Date: **Aug. 27, 2018**

(87) PCT Pub. No.: **WO2018/199889**
PCT Pub. Date: **Nov. 1, 2018**

(65) **Prior Publication Data**

US 2021/0194138 A1 Jun. 24, 2021

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

(52) **U.S. Cl.**
CPC ***H01Q 9/42*** (2013.01); ***H01Q 1/2258*** (2013.01)

(58) **Field of Classification Search**
CPC H01G 9/42; H01G 1/2258
See application file for complete search history.

(56) **References Cited**

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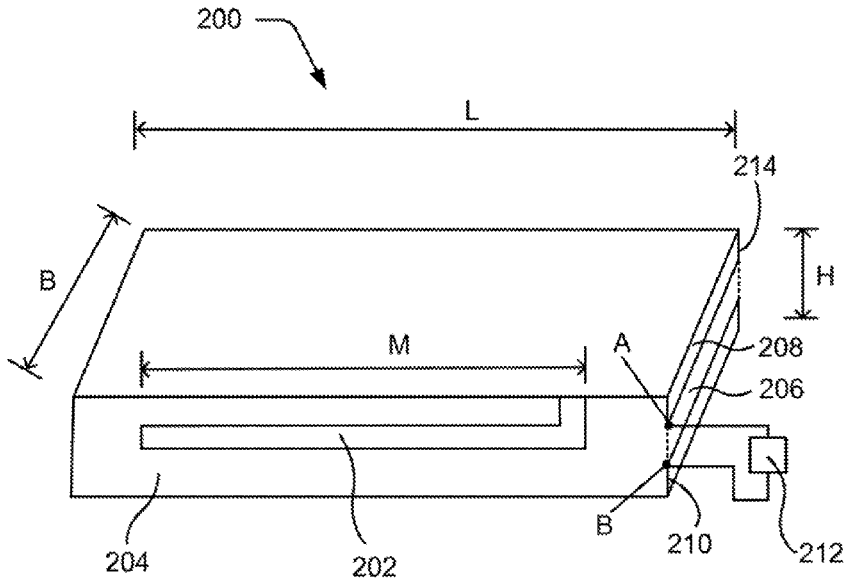
Primary Examiner — Graham P Smith
(74) *Attorney, Agent, or Firm* — HPI Patent Department

(57) **ABSTRACT**

The present subject matter describes an antenna positioned inside a frame for a display panel of an electronic device. In an example implementation, the antenna comprises a cuboidal antenna holder having a first excitation surface and a second excitation surface perpendicular to the first excitation surface.

14 Claims, 10 Drawing Sheets



US011165168B2

(12) **United States Patent**
Kim

(10) **Patent No.: US 11,165,168 B2**
(45) **Date of Patent: Nov. 2, 2021**

(54) **ANTENNA APPARATUS**

(71) Applicant: **Samsung Electro-Mechanics Co., Ltd.**, Suwon-si (KR)

(72) Inventor: **Sang Hyun Kim**, Suwon-si (KR)

(73) Assignee: **Samsung Electro-Mechanics 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 38 days.

(21) Appl. No.: **16/737,129**

(22) Filed: **Jan. 8, 2020**

(65) **Prior Publication Data**

US 2021/0036433 A1 Feb. 4, 2021

(30) **Foreign Application Priority Data**

Jul. 31, 2019 (KR) 10-2019-0093172

(51) **Int. Cl.**
H01Q 1/48 (2006.01)
H01Q 21/06 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 21/065*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 5/35*** (2015.01); ***H01Q 21/0025*** (2013.01); *H01Q 1/241* (2013.01)

(58) **Field of Classification Search**
CPC H01Q 21/065; H01Q 21/0025; H01Q 5/35; H01Q 1/48; H01Q 1/241; H01Q 21/0075;
(Continued)

(56) **References Cited**

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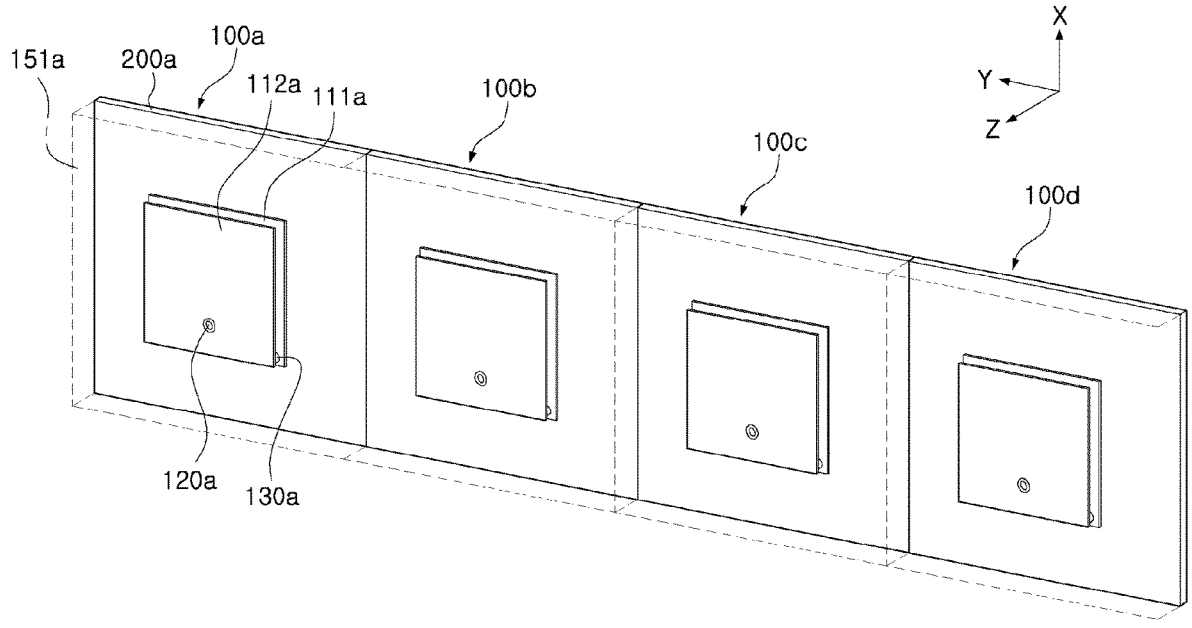
(Continued)

Primary Examiner — Jean B Jeanglaude
(74) *Attorney, Agent, or Firm* — NSIP Law

(57) **ABSTRACT**

An antenna apparatus includes a ground plane; a first patch antenna pattern having a first bandwidth and spaced apart from the ground plane; a second patch antenna pattern spaced apart from the ground plane and the first patch antenna and overlapping at least a portion of the first patch antenna pattern; and guide vias disposed between the first patch antenna pattern and the ground plane and electrically connecting the first patch antenna pattern to the ground plane. The second patch antenna pattern has a second bandwidth corresponding a frequency higher than a frequency of the first bandwidth. The guide vias are disposed along a first side of the first patch antenna pattern.

16 Claims, 14 Drawing Sheets



US011165169B2

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

(10) **Patent No.: US 11,165,169 B2**
(45) **Date of Patent: Nov. 2, 2021**

(54) **ANTENNA STRUCTURE AND DISPLAY DEVICE INCLUDING THE SAME**

(71) Applicants: **DONGWOO FINE-CHEM CO., LTD.**, Jeollabuk-do (KR); **POSTECH RESEARCH AND BUSINESS DEVELOPMENT FOUNDATION**, Gyeongsangbuk-do (KR)

(72) Inventors: **Jong Min Kim**, Gyeonggi-do (KR); **Dong Pil Park**, Incheon (KR); **Yun Seok Oh**, Gyeonggi-do (KR); **Won Bin Hong**, Seoul (KR)

(73) Assignees: **DONGWOO FINE-CHEM CO., LTD.**, Jeollabuk-Do (KR); **POSTECH RESEARCH AND BUSINESS DEVELOPMENT FOUNDATION**, Gyeongsangbuk-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.: **16/827,967**

(22) Filed: **Mar. 24, 2020**

(65) **Prior Publication Data**

US 2020/0227835 A1 Jul. 16, 2020

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2019/012456, filed on Sep. 25, 2019.

(30) **Foreign Application Priority Data**

Oct. 5, 2018 (KR) 10-2018-0119072

(51) **Int. Cl.**
H01Q 21/06 (2006.01)
H01Q 9/04 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 21/065*** (2013.01); ***H01Q 1/22*** (2013.01); ***H01Q 9/0407*** (2013.01); ***H01Q 21/0075*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 21/0006; H01Q 21/0075; H01Q 21/06; H01Q 21/061; H01Q 21/065;
(Continued)

(56) **References Cited**

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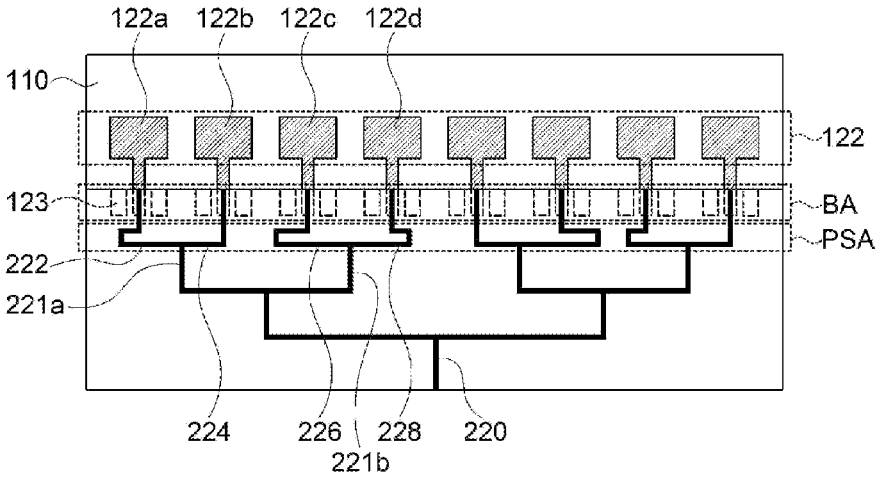
Primary Examiner — Jason Crawford
(74) *Attorney, Agent, or Firm* — The PL Law Group, PLLC

(57) **ABSTRACT**

An antenna structure includes an antenna device including a dielectric layer and a plurality of radiation patterns on an upper surface of the dielectric layer, and a flexible circuit board including a feeding wiring electrically connected to the radiation patterns. The feeding wiring includes a plurality of individual wirings, each of which electrically connected to each of the radiation patterns, and lengths of
(Continued)



US011171398B2

(12) **United States Patent**
Odagiri

(10) **Patent No.: US 11,171,398 B2**
(45) **Date of Patent: Nov. 9, 2021**

(54) **ELECTRONIC DEVICE**

(71) Applicant: **Sony Interactive Entertainment Inc.**, Tokyo (JP)

(72) Inventor: **Kazuya Odagiri**, Kanagawa (JP)

(73) Assignee: **Sony Interactive Entertainment Inc.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 183 days.

(21) Appl. No.: **16/482,183**

(22) PCT Filed: **Feb. 14, 2017**

(86) PCT No.: **PCT/JP2017/005337**
§ 371 (c)(1),
(2) Date: **Jul. 30, 2019**

(87) PCT Pub. No.: **WO2018/150468**
PCT Pub. Date: **Aug. 23, 2018**

(65) **Prior Publication Data**

US 2020/0044302 A1 Feb. 6, 2020

(51) **Int. Cl.**
H01P 3/06 (2006.01)
H01Q 1/50 (2006.01)

(52) **U.S. Cl.**
CPC ***H01P 3/06*** (2013.01); ***H01Q 1/50*** (2013.01); *H01R 2201/02* (2013.01)

(58) **Field of Classification Search**
CPC H01P 3/06; H01P 3/10; H01Q 1/50; H01R 2201/02
See application file for complete search history.

(56) **References Cited**

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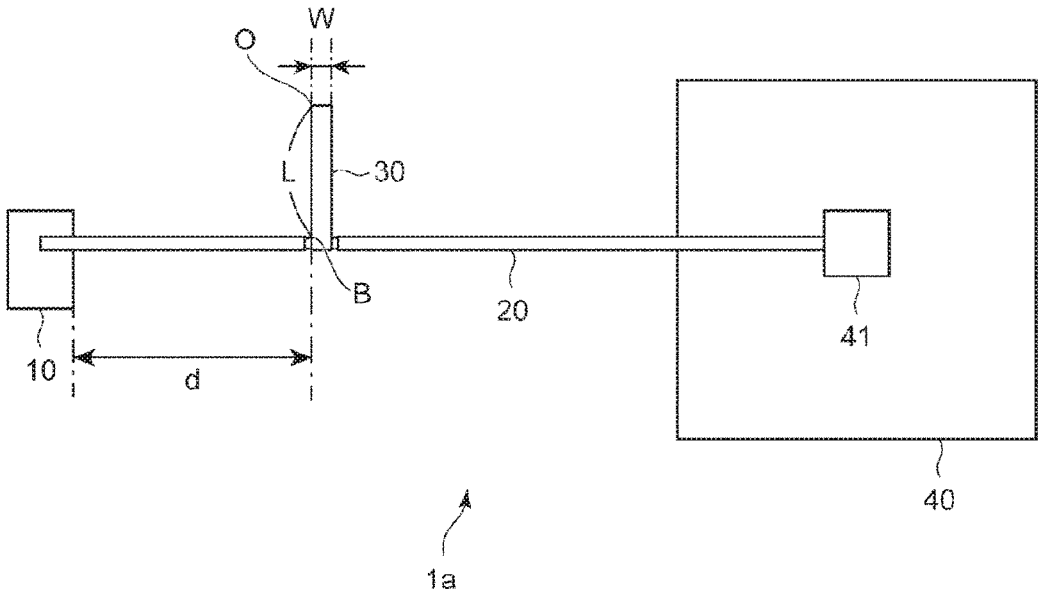
(Continued)

Primary Examiner — Jimmy T Vu
(74) *Attorney, Agent, or Firm* — Matthew B. Dernier, Esq.

(57) **ABSTRACT**

Disclosed herein is an electronic device including a coaxial cable connected to an antenna and a conductive body having a strip-like shape and being electrically coupled to an external conductor of the coaxial cable, an end of the conductive body not being electrically connected other conductive members.

11 Claims, 15 Drawing Sheets



US011171406B2

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

(10) **Patent No.: US 11,171,406 B2**
(45) **Date of Patent: Nov. 9, 2021**

(54) **ANTENNA STRUCTURE INCLUDING CONDUCTIVE PATCH FED USING MULTIPLE ELECTRICAL PATHS AND ELECTRONIC DEVICE INCLUDING THE ANTENNA STRUCTURE**

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

(72) Inventors: **Sumin Yun**, Suwon-si (KR); **Dongyeon Kim**, Suwon-si (KR); **Seongjin Park**, Suwon-si (KR); **Sehyun Park**, Suwon-si (KR); **Myunghun Jeong**, Suwon-si (KR); **Jehun Jong**, Suwon-si (KR); **Jaehoon Jo**, Suwon-si (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 25 days.

(21) Appl. No.: **16/727,484**

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

(65) **Prior Publication Data**

US 2020/0212539 A1 Jul. 2, 2020

(30) **Foreign Application Priority Data**

Dec. 26, 2018 (KR) 10-2018-0169434

(51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01Q 1/38 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 1/2283*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 9/0414*** (2013.01); ***H01Q 9/0435*** (2013.01); ***H01Q 21/065*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/2283; H01Q 1/38; H01Q 21/065; H01Q 9/0414; H01Q 9/0435; H01Q 21/08; H01Q 9/045; H01Q 1/243
See application file for complete search history.

(56) **References Cited**

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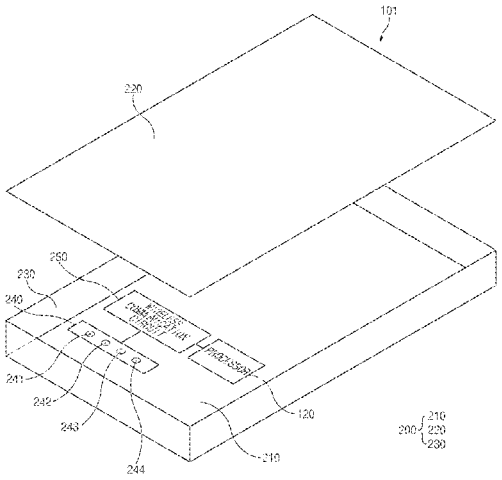
(Continued)

Primary Examiner — Daniel D Chang
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

An electronic device is provided that includes, an antenna structure including a printed circuit board including first and second surfaces, at least one conductive patch interposed between the first second surfaces or is disposed on the first surface, the conductive patch including first to fourth areas placed in a clockwise direction with respect to a first imaginary axis extended in a first direction on the conductive patch and a second imaginary axis intersecting the first imaginary axis and perpendicular to the first imaginary axis, and at least one wireless communication circuit that transmits and/or receives a first signal having a frequency between 3 and 100 GHz. The wireless communication circuit includes a first port electrically connected to a first position of the first area, and a second port electrically
(Continued)



US011171419B2

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

(10) **Patent No.: US 11,171,419 B2**
(45) **Date of Patent: Nov. 9, 2021**

(54) **ANTENNA STRUCTURE**

(71) Applicant: **Quanta Computer Inc.**, Taoyuan (TW)

(72) Inventors: **Chin-Lung Tsai**, Taoyuan (TW); **Ying-Cong Deng**, Taoyuan (TW); **Chung-Hung Lo**, Taoyuan (TW); **Kuan-Hsien Lee**, Taoyuan (TW); **Yi-Ling Tseng**, Taoyuan (TW); **Chung-Ting Hung**, Taoyuan (TW)

(73) Assignee: **QUANTA COMPUTER INC**, Taoyuan (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 96 days.

(21) Appl. No.: **16/747,124**

(22) Filed: **Jan. 20, 2020**

(65) **Prior Publication Data**

US 2021/0066801 A1 Mar. 4, 2021

(30) **Foreign Application Priority Data**

Aug. 30, 2019 (TW) 108131157

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/385 (2015.01)
H01Q 9/30 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 5/385*** (2015.01); ***H01Q 1/243*** (2013.01); ***H01Q 9/30*** (2013.01)

(58) **Field of Classification Search**
CPC H01G 1/38; H01G 5/385; H01G 9/30
See application file for complete search history.

(56) **References Cited**

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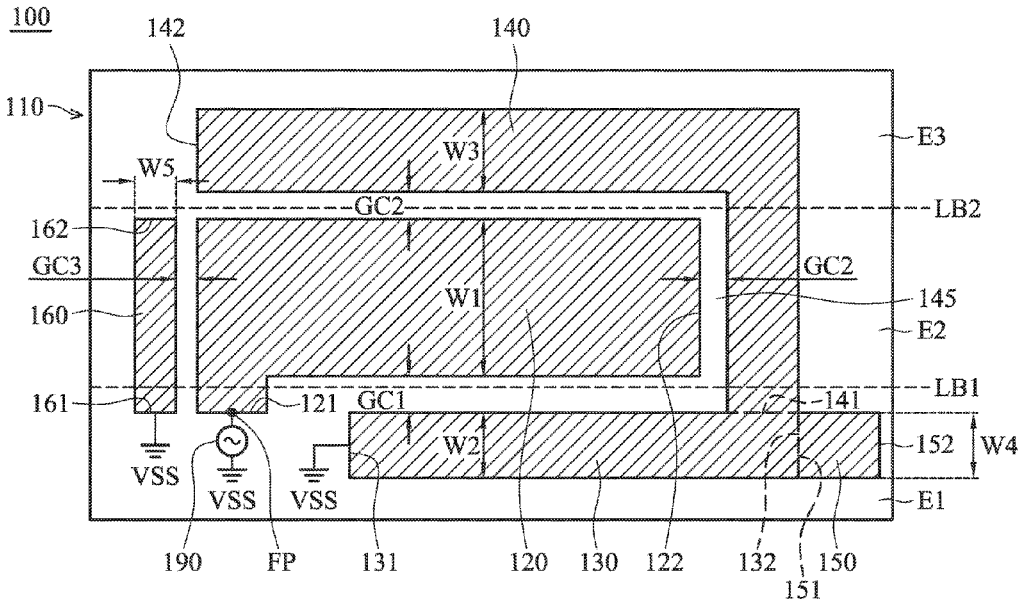
Primary Examiner — Graham P Smith
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

An antenna structure includes a nonconductive supporting element, a feeding radiation element, a first radiation element, a second radiation element, a third radiation element, and a fourth radiation element. The first radiation element is coupled to a ground voltage. A first coupling gap is formed between the first radiation element and the feeding radiation element. The second radiation element is coupled to the first radiation element. A second coupling gap is formed between the second radiation element and the feeding radiation element. The third radiation element is coupled to the first radiation element. The fourth radiation element is coupled to the ground voltage. A third coupling gap is formed between the fourth radiation element and the feeding radiation element. The feeding radiation element, the first radiation element, the second radiation element, the third radiation element, and the fourth radiation element are all disposed on the nonconductive supporting element.

9 Claims, 3 Drawing Sheets



US011171421B2

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

(10) **Patent No.: US 11,171,421 B2**
(45) **Date of Patent: Nov. 9, 2021**

(54) **ANTENNA MODULE AND COMMUNICATION DEVICE EQUIPPED WITH THE SAME**

(71) Applicant: **Murata Manufacturing Co., Ltd.**, Kyoto (JP)

(72) Inventors: **Yoshiki Yamada**, Kyoto (JP); **Keisei Takayama**, Kyoto (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 0 days.

(21) Appl. No.: **17/150,308**

(22) Filed: **Jan. 15, 2021**

(65) **Prior Publication Data**

US 2021/0135364 A1 May 6, 2021

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2020/019609, filed on May 18, 2020.

(30) **Foreign Application Priority Data**

Jun. 28, 2019 (JP) JP2019-120911

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

(52) **U.S. Cl.**
CPC ***H01Q 9/0414*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 5/35*** (2015.01); ***H01Q 9/045*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 9/0414; H01Q 5/35; H01Q 9/045; H01Q 1/243
See application file for complete search history.

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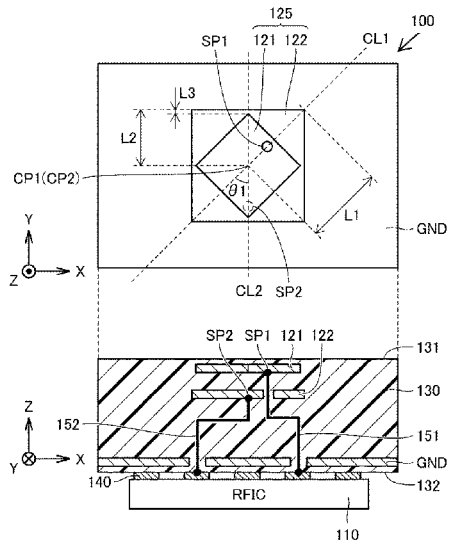
Primary Examiner — Dieu Hien T Duong
(74) *Attorney, Agent, or Firm* — Pearne & Gordon LLP

(57) **ABSTRACT**

An antenna module includes a first power feed element and a second power feed element each having a flat plate shape, and a ground electrode (GND) arranged so as to face the first power feed element and the second power feed element. The first power feed element is configured to radiate a radio wave having a first direction as a polarization direction. The second power feed element is arranged between the first power feed element and the ground electrode (GND), and is configured to radiate a radio wave having a second direction as a polarization direction. A frequency of the radio wave radiated from the first power feed element is higher than a frequency of the radio wave radiated from the second power feed element. An angle formed by the first direction and the second direction is greater than 0° and less than 90°.

13 Claims, 10 Drawing Sheets



US011171422B2

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

(10) **Patent No.: US 11,171,422 B2**
(45) **Date of Patent: Nov. 9, 2021**

(54) **ANTENNA-LIKE MATCHING COMPONENT**

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

(72) Inventors: **Olivier Pajona**, Nice (FR); **Sebastian Rowson**, San Diego, CA (US); **Laurent Desclos**, 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 0 days.

(21) Appl. No.: **16/437,531**

(22) Filed: **Jun. 11, 2019**

(65) **Prior Publication Data**

US 2019/0334245 A1 Oct. 31, 2019

Related U.S. Application Data

(63) Continuation of application No. 15/862,553, filed on Jan. 4, 2018, now Pat. No. 10,355,363, which is a continuation of application No. 14/213,959, filed on Mar. 14, 2014, now Pat. No. 9,893,427.

(60) Provisional application No. 61/838,555, filed on Jun. 24, 2013, provisional application No. 61/785,405, filed on Mar. 14, 2013.

(51) **Int. Cl.**
H01Q 5/50 (2015.01)
H01Q 9/36 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 9/36*** (2013.01); ***H01Q 5/50*** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/38; H01Q 5/50; H01Q 19/005; H01Q 9/0407
See application file for complete search history.

(56) **References Cited**

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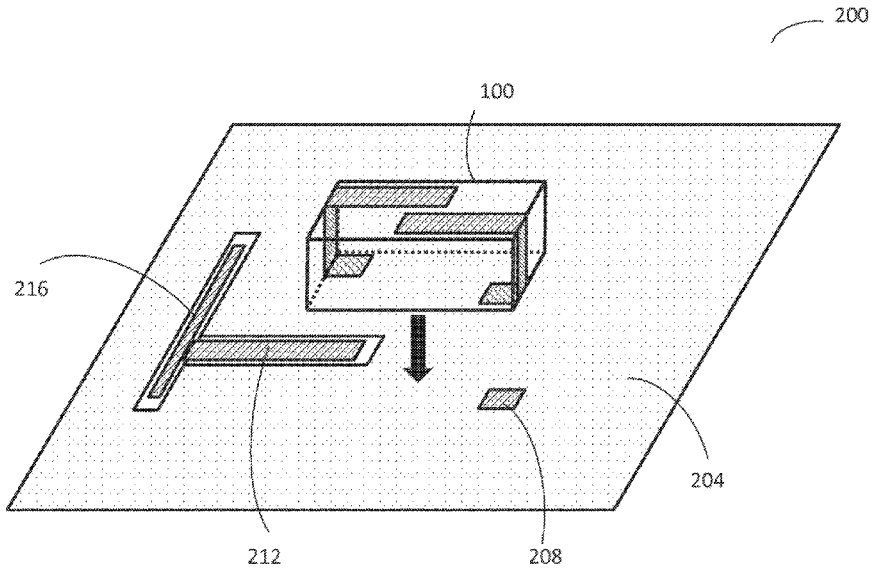
Primary Examiner — Hasan Islam

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

(57) **ABSTRACT**

An antenna-like matching component is provided, comprising one or more conductive portions formed on a substrate. Shapes and dimensions of the one or more conductive portions are determined to provide impedance matching for one or more antennas coupled to the matching component.

6 Claims, 14 Drawing Sheets



US011177583B2

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

(10) **Patent No.: US 11,177,583 B2**
(45) **Date of Patent: Nov. 16, 2021**

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

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

(72) Inventors: **Hui-An Yang**, Taipei (TW); **Jung-Yi Huang**, Taipei (TW); **Kuan-Chuan Huang**, Taipei (TW)

(73) Assignee: **PEGATRON CORPORATION**, Taipei (TW)

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

(21) Appl. No.: **16/699,467**

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

(65) **Prior Publication Data**

US 2020/0235495 A1 Jul. 23, 2020

(30) **Foreign Application Priority Data**

Jan. 21, 2019 (TW) 108201011

(51) **Int. Cl.**
H01Q 1/42 (2006.01)
H01Q 21/30 (2006.01)
H01Q 21/24 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 21/30*** (2013.01); ***H01Q 21/24*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 21/30; H01Q 21/24; H01Q 21/28; H01Q 9/26; H01Q 1/241; H01Q 5/20;
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(56) **References Cited**

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Primary Examiner — Jean B Jeanglaude
(74) *Attorney, Agent, or Firm* — J.C. Patents

(57) **ABSTRACT**

An antenna structure includes a first antenna, a second antenna, a third antenna, and a first grounding portion. The first antenna and the second antenna operate at a first frequency. The first antenna is disposed side by side with the second antenna, and the first antenna and the second antenna are orthogonally polarized. The third antenna operates at a second frequency, and the second frequency is lower than the first frequency. The first grounding portion includes a first side edge and a second side edge opposite to each other. The first antenna and the second antenna are connected to the first side edge and the third antenna is connected to the second side edge. An electronic device includes the said antenna structure.

13 Claims, 11 Drawing Sheets