



(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**

(56) **References Cited**

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

U.S. PATENT DOCUMENTS

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

7,969,382 B2 * 6/2011 Kim G06F 1/1632 345/1.1
10,326,866 B2 6/2019 Lee et al.
(Continued)

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

FOREIGN PATENT DOCUMENTS

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

CA 2 974 416 1/2019
CN 105552526 5/2016
(Continued)

OTHER PUBLICATIONS

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

Extended Search Report and Written Opinion dated Oct. 8, 2020 in counterpart European Patent Application No. EP20159335.7.

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

(Continued)

(65) **Prior Publication Data**

US 2020/0272198 A1 Aug. 27, 2020

Primary Examiner — Tan H Trinh

(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye P.C.

(30) **Foreign Application Priority Data**

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

(57) **ABSTRACT**

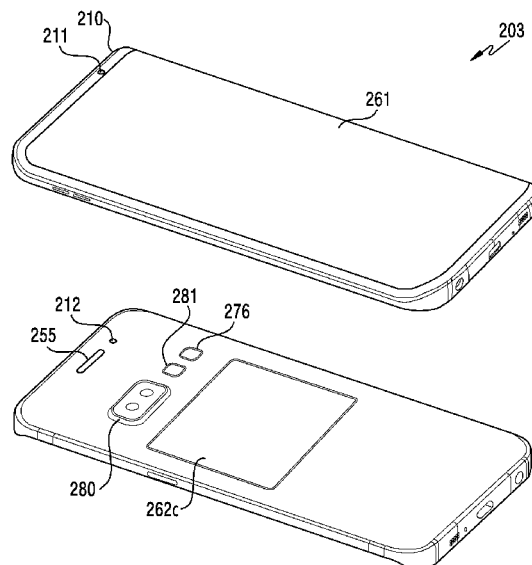
(51) **Int. Cl.**
G06F 1/16 (2006.01)
G06F 1/18 (2006.01)
(Continued)

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.

(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)

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)

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(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.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,257,751 B2 * 2/2016 Felic H01Q 9/045
10,483,618 B2 * 11/2019 Park H01L 21/6835

(Continued)

FOREIGN PATENT DOCUMENTS

JP 2000-232315 A 8/2000
JP 4240953 B2 3/2009
KR 10-0962574 B1 6/2010

Primary Examiner — Tho G Phan

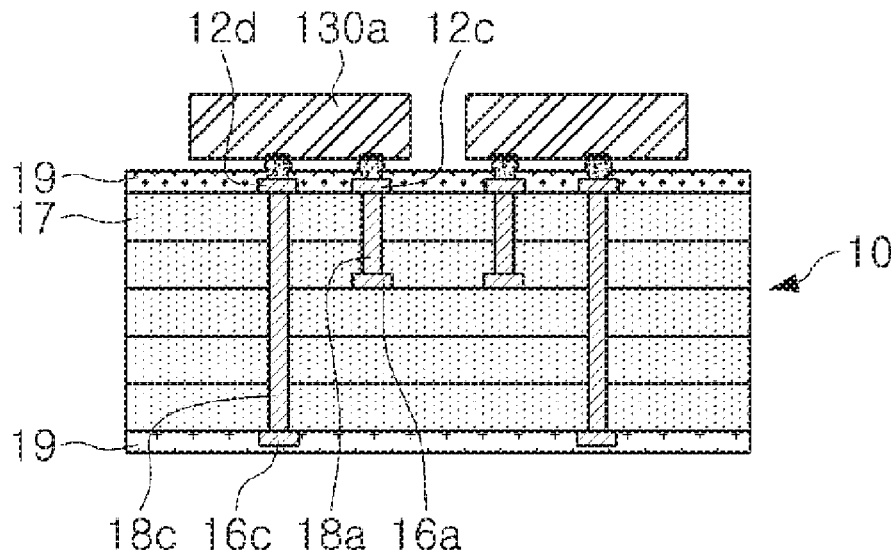
(74) *Attorney, Agent, or Firm* — NSIP Law

(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
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(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

2005/0079903 A1* 4/2005 Taketomi H01Q 1/243
455/575.5
2014/0361934 A1* 12/2014 Ely H01Q 1/24
343/702
2015/0125636 A1* 5/2015 Chan C25D 11/022
428/34.1
2016/0201178 A1* 7/2016 Oota C23C 18/12
428/472.2
2016/0204502 A1* 7/2016 Misra H01Q 1/243
343/702
2017/0346162 A1* 11/2017 Han H01Q 1/243

* cited by examiner

Primary Examiner — Louis J Rufo

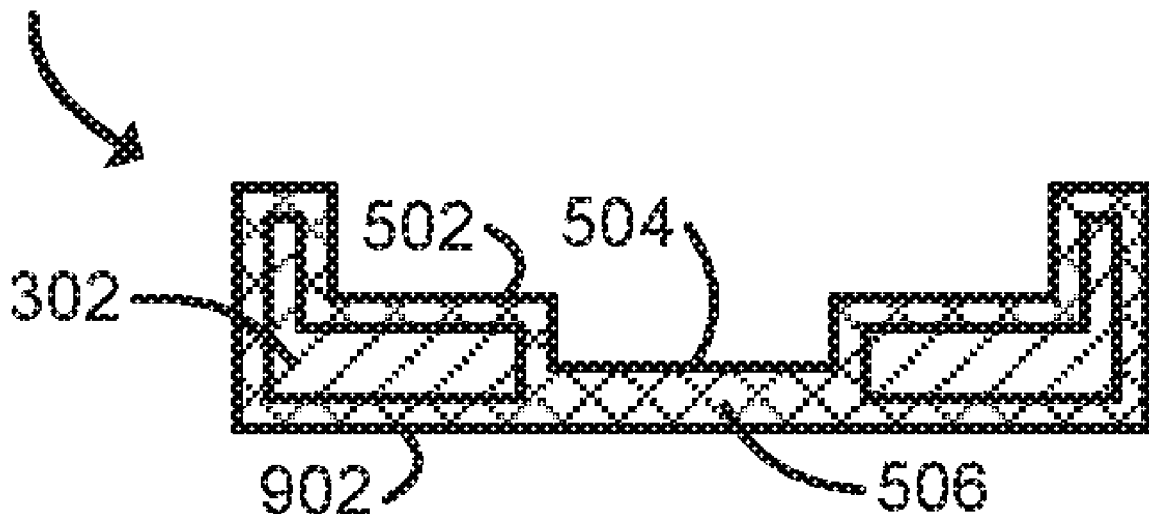
(74) *Attorney, Agent, or Firm* — Hanley, Flight &
Zimmerman, LLC

(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

100





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.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,725,213 B2 5/2014 Nakamura
2007/0037619 A1 2/2007 Matsunaga et al.
(Continued)

FOREIGN PATENT DOCUMENTS

CN 105789827 A 7/2016
JP 2002-190752 A 7/2002
(Continued)

OTHER PUBLICATIONS

Korean Office Action dated May 14, 2020, issued in Korean Application No. 10-2019-0078718.

(Continued)

Primary Examiner — Tuan Pham

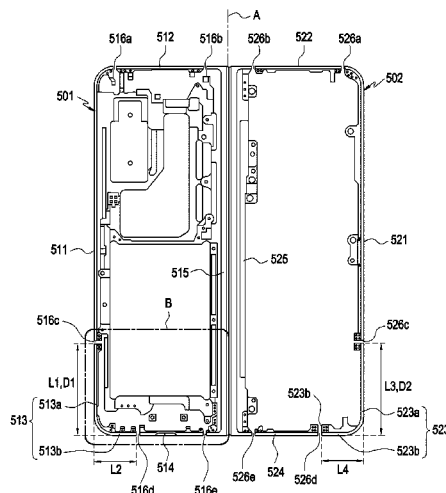
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(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 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



(12) **United States Patent**
Huang

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

(54) **ANTENNA STRUCTURE**

(56) **References Cited**

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

U.S. PATENT DOCUMENTS

(72) Inventor: **Chun-Lin Huang**, Hsinchu (TW)

2013/0169503 A1* 7/2013 Fakharzadeh Jahromi
H01Q 19/005
343/833

(73) Assignee: **WISTRON NEWEB CORP.**, Hsinchu (TW)

FOREIGN PATENT DOCUMENTS

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 3 days.

CN 104993225 B 10/2017
CN 209461638 U 10/2019
TW M560708 U 5/2018

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

* cited by examiner

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

Primary Examiner — Graham P Smith

(65) **Prior Publication Data**

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

US 2021/0159586 A1 May 27, 2021

(30) **Foreign Application Priority Data**

(57) **ABSTRACT**

Nov. 22, 2019 (TW) 108142489

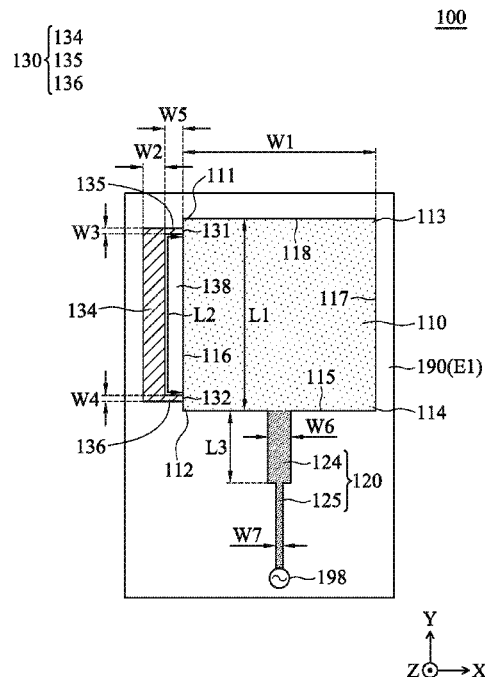
An antenna structure includes a main radiation element, a first feeding element, a first additional radiation element, a dielectric substrate, and a ground plane. A first signal source is coupled through the first feeding element to a first side of the main radiation element. The first additional radiation 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.

(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.

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**

U.S. PATENT DOCUMENTS

10,353,426 B2 * 7/2019 Pantel H04M 1/0264
2019/0189042 A1 * 6/2019 Aurongzeb G06F 1/1637
2019/0305403 A1 * 10/2019 Wang H01Q 1/244
2019/0342542 A1 * 11/2019 Bai H04N 7/147
2019/0350465 A1 * 11/2019 Sahin A61B 5/1102

* cited by examiner

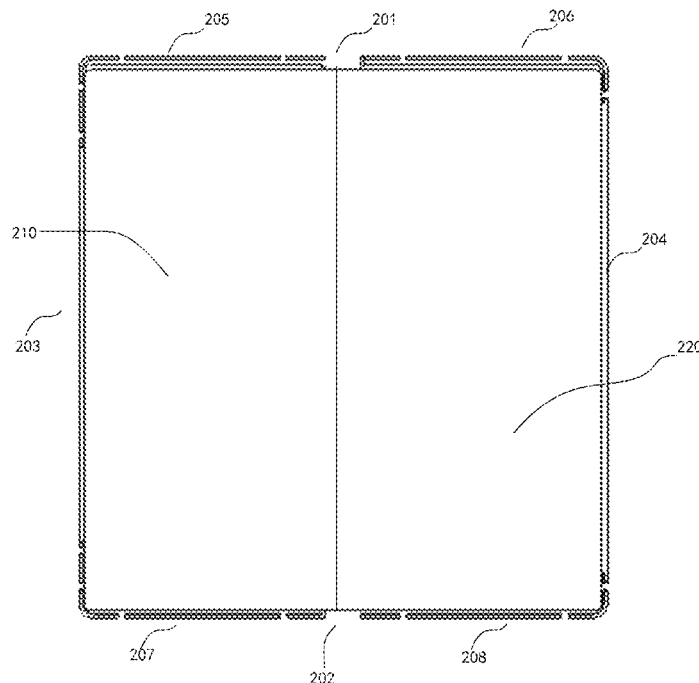
Primary Examiner — Hsinchun Liao

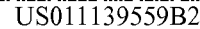
(74) *Attorney, Agent, or Firm* — W&G Law Group

(57) **ABSTRACT**

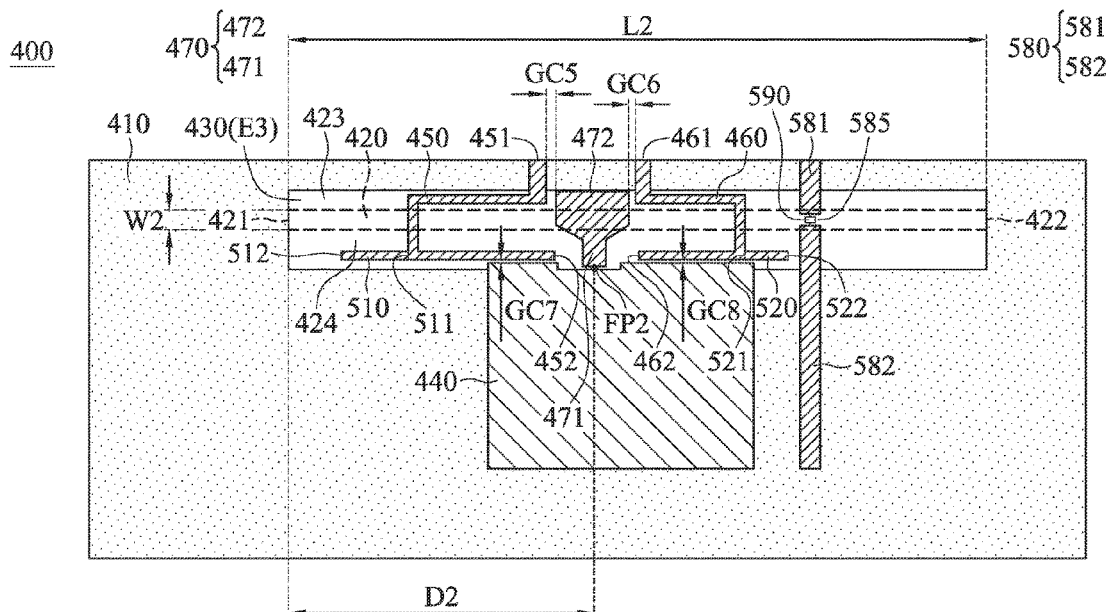
A terminal with a foldable screen and an antenna assembly thereof are disclosed. The antenna assembly includes a foldable frame and seven antenna modules. The frame includes a first side frame; a second side frame opposite to the first side frame; a third side frame; and a fourth side frame. A first 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





(45) **Date of Patent:** **Oct. 5, 2021**





(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**

(56) **References Cited**

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

U.S. PATENT DOCUMENTS

(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)

9,536,903 B2 * 1/2017 Umezaki H01L 27/1225
10,756,118 B2 * 8/2020 Yamazaki G02F 1/1368
(Continued)

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

FOREIGN PATENT DOCUMENTS

CN 107658547 A 2/2018
WO 2018/016398 A1 1/2018

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

OTHER PUBLICATIONS

European Search Report dated Feb. 13, 2020, issued in application No. EP 19195749.7.

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

(Continued)

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

(65) **Prior Publication Data**

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Primary Examiner — Kaveh C Kianni

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

Related U.S. Application Data

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

Foreign Application Priority Data

Apr. 15, 2019 (CN) 201910300447.3

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

(Continued)

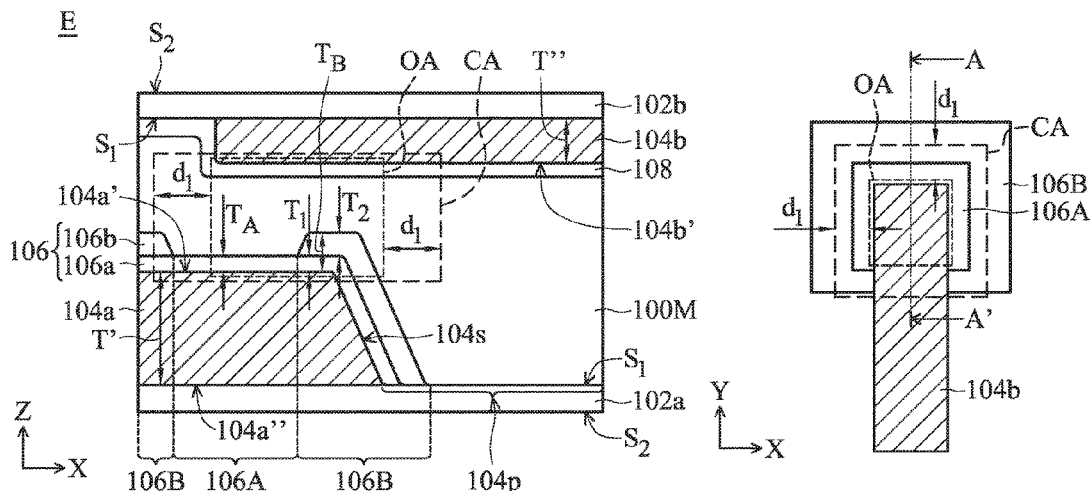
(52) **U.S. Cl.**
CPC **H01Q 1/36** (2013.01); **H01Q 9/0407** (2013.01); **G09G 2300/0876** (2013.01); **H01Q 3/44** (2013.01)

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

(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.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,976,078 B2 * 3/2015 De Rosny H01Q 3/44 343/909

9,531,077 B1 * 12/2016 Weller H01Q 9/065 (Continued)

FOREIGN PATENT DOCUMENTS

JP 2015-70542 4/2015

OTHER PUBLICATIONS

International Search Report dated Sep. 4, 2018 in International (PCT) Application No. PCT/JP2018/021635.

(Continued)

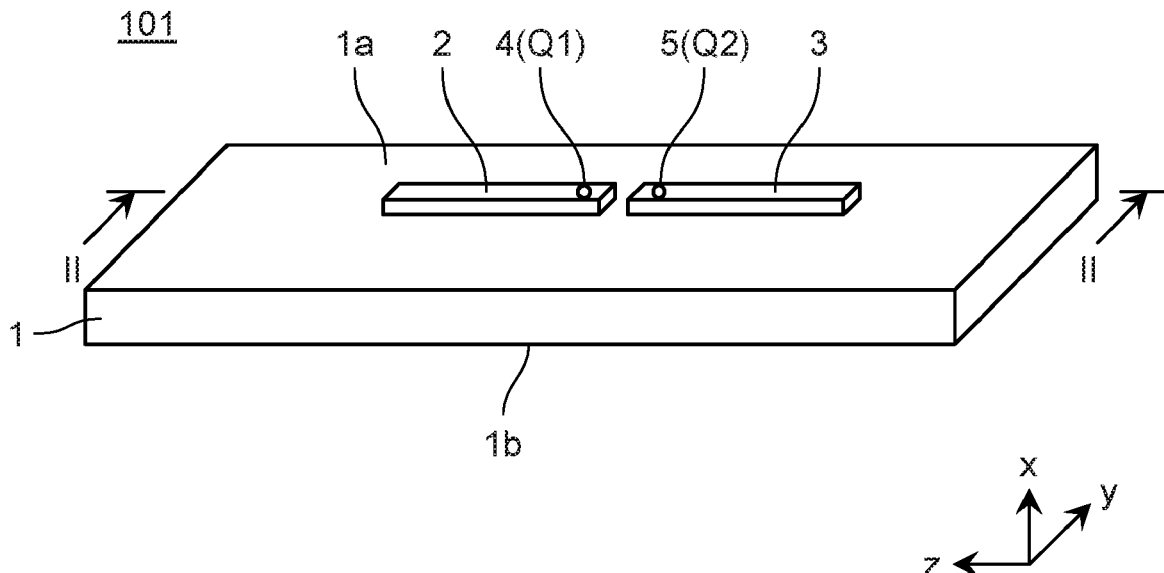
Primary Examiner — Thien M Le

(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**

(58) **Field of Classification Search**

CPC ... H01Q 1/42; H01Q 1/38; H01Q 1/50; H04B 1/401

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

(Continued)

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

(56)

References Cited

U.S. PATENT DOCUMENTS

8,049,506 B2 11/2011 Lazarev
8,644,197 B2 2/2014 Lee et al.

(Continued)

(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.

FOREIGN PATENT DOCUMENTS

KR 10-2011-0130389 A 12/2011
KR 10-2016-0031234 A 3/2016

(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**

OTHER PUBLICATIONS

International Search Report and Written Opinion of the International Searching Authority in connection with International Application No. PCT/2018/013249 dated Jan. 25, 2019, 11 pages.

Primary Examiner — Peguy Jean Pierre

(87) PCT Pub. No.: **WO2019/088756**

PCT Pub. Date: **May 9, 2019**

(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)

(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.**

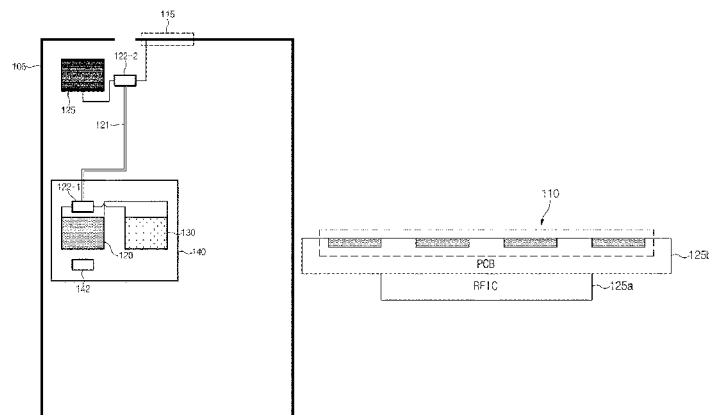
H04B 1/401 (2015.01)

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)





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**

(56) **References Cited**

U.S. PATENT DOCUMENTS

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

9,237,211 B2 1/2016 Tabé
2017/0373376 A1 12/2017 Jo et al.
(Continued)

(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)

FOREIGN PATENT DOCUMENTS

CN 209017097 6/2019

OTHER PUBLICATIONS

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

International Search Report and Written Opinion dated Oct. 16,
2020 in corresponding International Application No. PCT/KR2020/
008352.

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

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

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

(57) **ABSTRACT**

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

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.

(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.**

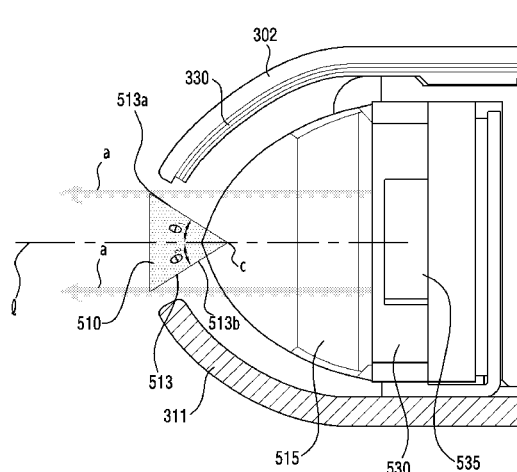
CPC **H01Q 1/421** (2013.01); **H01Q 1/241**
(2013.01)

(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)

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**

U.S. PATENT DOCUMENTS

2016/0028157 A1* 1/2016 Kim H01Q 21/28
343/852

2017/0264002 A1* 9/2017 Yen H01Q 9/42

2018/0288203 A1* 10/2018 Jeon H01Q 5/321

* cited by examiner

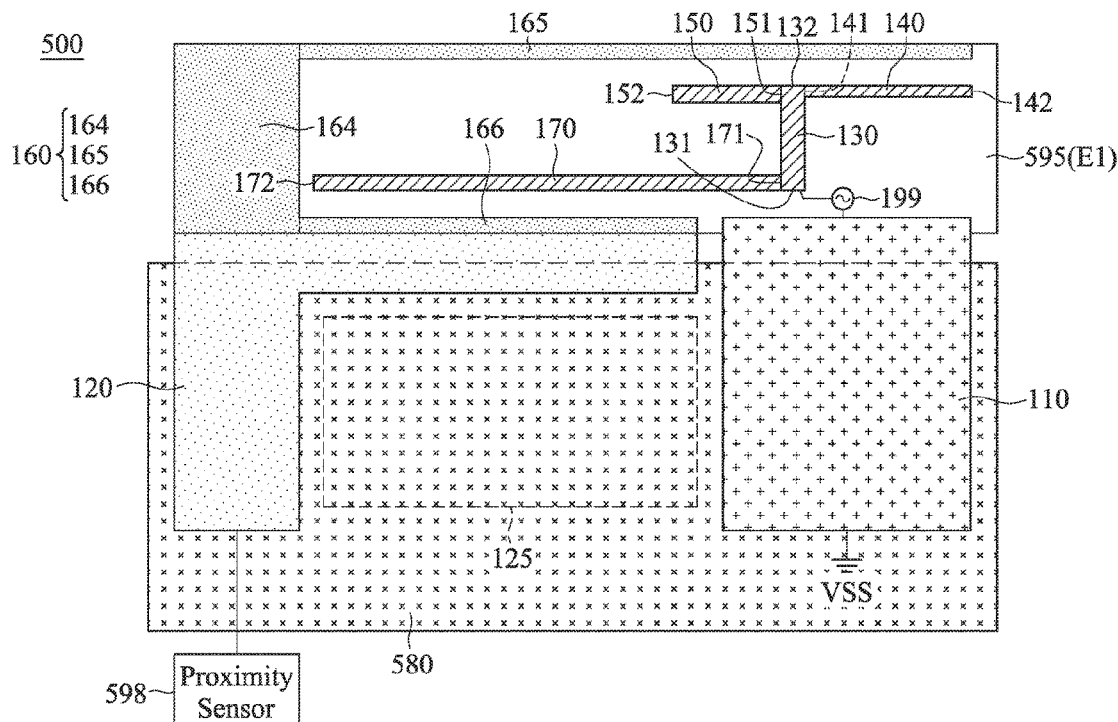
Primary Examiner — Daniel D Chang

(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





(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**

(56) **References Cited**

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

FOREIGN PATENT DOCUMENTS

CN 206236793 B1 6/2017
CN 109742526 A1 5/2019

(72) Inventor: **Jing Wu**, Shenzhen (CN)

(73) Assignee: **AAC Technologies Pte. Ltd.**,
Singapore (SG)

OTHER PUBLICATIONS

PCT search report dated Jan. 23, 2020 by SIPO in related PCT
Patent Application No. PCT/CN2019/113363(4 Pages).
1st Office Action dated Mar. 16, 2020 by SIPO in related Chinese
Patent Application No. 201811650609.8 (6 Pages).

(*) 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**

Primary Examiner — Graham P Smith

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

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

(65) **Prior Publication Data**

US 2020/0212561 A1 Jul. 2, 2020

(30) **Foreign Application Priority Data**

Dec. 31, 2018 (CN) 201811650609.8

(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. Com-
pared with the related art, the present invention has follow-
ing beneficial effects: the antenna has compact structure and
high isolation; it has dual-band, and it has excellent perfor-
mance in the dual bands; it has a simple structure, a small
volume and a light weight, and it is convenient to manu-
facture and thus for mass production.

(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.**

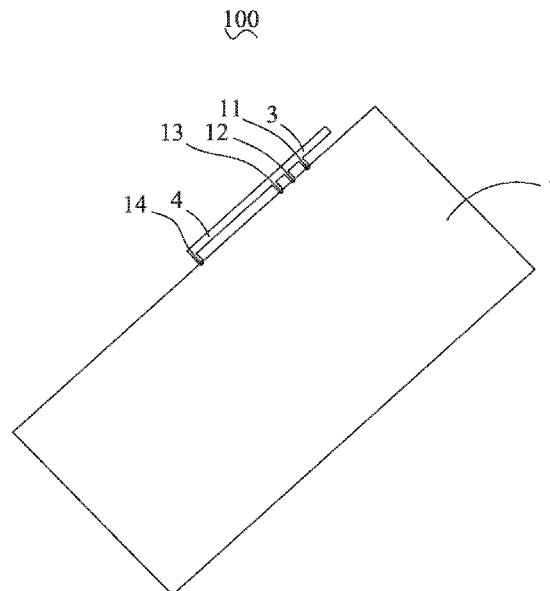
CPC **H01Q 1/523** (2013.01); **H01Q 5/392**
(2015.01); **H01Q 9/0421** (2013.01); **H01Q**
21/28 (2013.01); **H04B 7/0413** (2013.01)

(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.

4 Claims, 3 Drawing Sheets



(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

(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,310,802 A * 3/1967 Coleman G01S 13/78
342/44

5,543,721 A * 8/1996 Knuuti G01R 27/06
324/647

(Continued)

FOREIGN PATENT DOCUMENTS

EP 3185358 A1 6/2017
JP 2015226313 A 12/2015

OTHER PUBLICATIONS

International Search Report for related PCT Application Serial No. PCT/US2017/040471, dated Mar. 29, 2018, 2 pages.

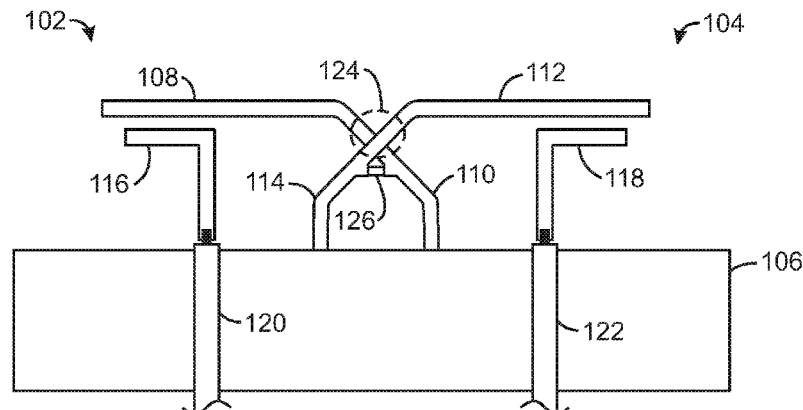
Primary Examiner — Eugene Yun

(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



(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**

(56) **References Cited**

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

U.S. PATENT DOCUMENTS

(72) Inventor: **Jing Wu**, Shenzhen (CN)

6,662,028 B1 * 12/2003 Hayes H01Q 1/243
343/908

(73) Assignee: **AAC Technologies Pte. Ltd.**,
Singapore (SG)

9,484,631 B1 * 11/2016 Napoles H01Q 5/371
9,711,858 B1 * 7/2017 Lee H01Q 9/06

(Continued)

FOREIGN PATENT DOCUMENTS

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 41 days.

CN 104953290 B2 9/2015
CN 206236793 B1 6/2017
CN 109742527 A1 5/2019

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

OTHER PUBLICATIONS

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

PCT search report dated Jan. 15, 2020 by SIPO in related PCT
Patent Application No. PCT/CN2019/111288 (4 Pages).

(Continued)

(65) **Prior Publication Data**

US 2020/0212568 A1 Jul. 2, 2020

Primary Examiner — Hasan Islam

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

(30) **Foreign Application Priority Data**

Dec. 31, 2018 (CN) 201811650610.0

(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.

(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)

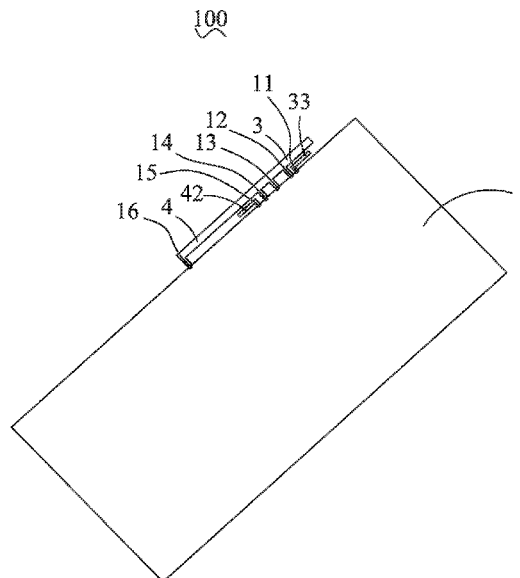
(52) **U.S. Cl.**

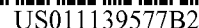
CPC **H01Q 5/307** (2015.01); **H01Q 1/48**
(2013.01); **H01Q 9/42** (2013.01); **H04B**
7/0413 (2013.01)

(58) **Field of Classification Search**

CPC H01Q 5/30–5/35; H01Q 1/24–1/48
See application file for complete search history.

5 Claims, 3 Drawing Sheets





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

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.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,765,536	B2	7/2004	Phillips et al.	
9,698,470	B2 *	7/2017	Zhao	H01Q 1/48
2004/0248523	A1	12/2004	Nishimura et al.	
2008/0007468	A1 *	1/2008	Sato	H01Q 1/243
				343/702
2010/0214175	A1 *	8/2010	Hui	H01Q 1/521
				343/700 MS

(Continued)

FOREIGN PATENT DOCUMENTS

CN	202206437	4/2012
CN	104332706	2/2015

(Continued)

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.

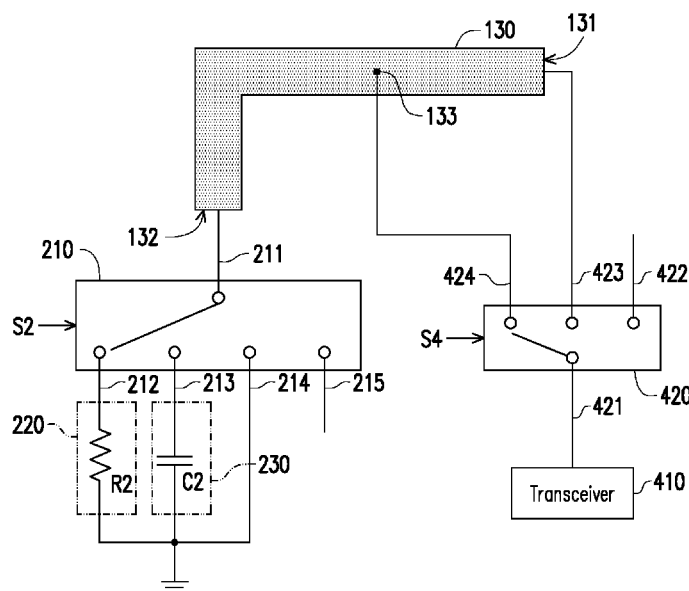
7 Claims, 3 Drawing Sheets

H01O 1/50 (2006.01)

H01Q 9/42 (2006.01)

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)

CPC H01Q 11/14; H01Q 5/335; H01Q 5/342;





(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**

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

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

(56) **References Cited**

(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)

U.S. PATENT DOCUMENTS

7,595,759 B2 9/2009 Schlub et al.
8,102,330 B1 1/2012 Albers
(Continued)

FOREIGN PATENT DOCUMENTS

CN 102377021 A 3/2012
CN 102437405 A 5/2012
(Continued)

OTHER PUBLICATIONS

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

Baiqiang You et al., Modern Antenna Practical Technique, Sep. 30, 2016, pp. 24-27.

(*) 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.

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.

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

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

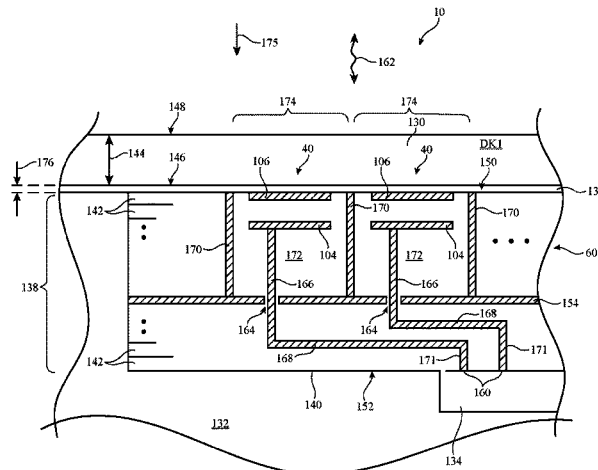
(65) **Prior Publication Data**

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)

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**

(56) **References Cited**

U.S. PATENT DOCUMENTS

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

2006/0284778 A1 12/2006 Sanford et al.
2010/0073247 A1 3/2010 Arkko et al.
(Continued)

(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)

FOREIGN PATENT DOCUMENTS

KR 10-2017-0056246 A 5/2017

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

OTHER PUBLICATIONS

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 649 days.

International Search Report dated Oct. 12, 2018.
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.

(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**

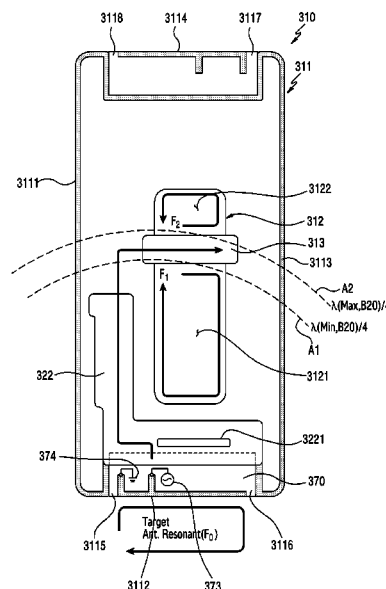
CPC H01Q 1/243; H01Q 13/10

See application file for complete search history.

(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**

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

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

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

8,648,752 B2 2/2014 Ramachandran et al.
8,654,024 B2 * 2/2014 Chou H01Q 1/243
343/749
8,754,817 B1 * 6/2014 Kuo H01Q 5/371
343/702
2004/0233111 A1 * 11/2004 Desclos H01Q 9/28
343/700 MS

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

2004/0246188 A1 12/2004 Egashira
(Continued)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 313 days.

FOREIGN PATENT DOCUMENTS

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

CN 1705164 12/2005
CN 102684726 9/2012

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

(Continued)

(86) PCT No.: **PCT/US2016/044794**

§ 371 (c)(1),

(2) Date: **Oct. 8, 2018**

OTHER PUBLICATIONS

Eom, S., et al., Embedded Antenna for Metallic Handheld Communication Devices, Jan. 2014, <<http://www.jpier.org/PIERB/pierb57/09.13101107.pdf>>.

(87) PCT Pub. No.: **WO2018/022100**

PCT Pub. Date: **Feb. 1, 2018**

Primary Examiner — Andrea Lindgren Baltzell

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

(65) **Prior Publication Data**

US 2019/0165451 A1 May 30, 2019

(57)

ABSTRACT

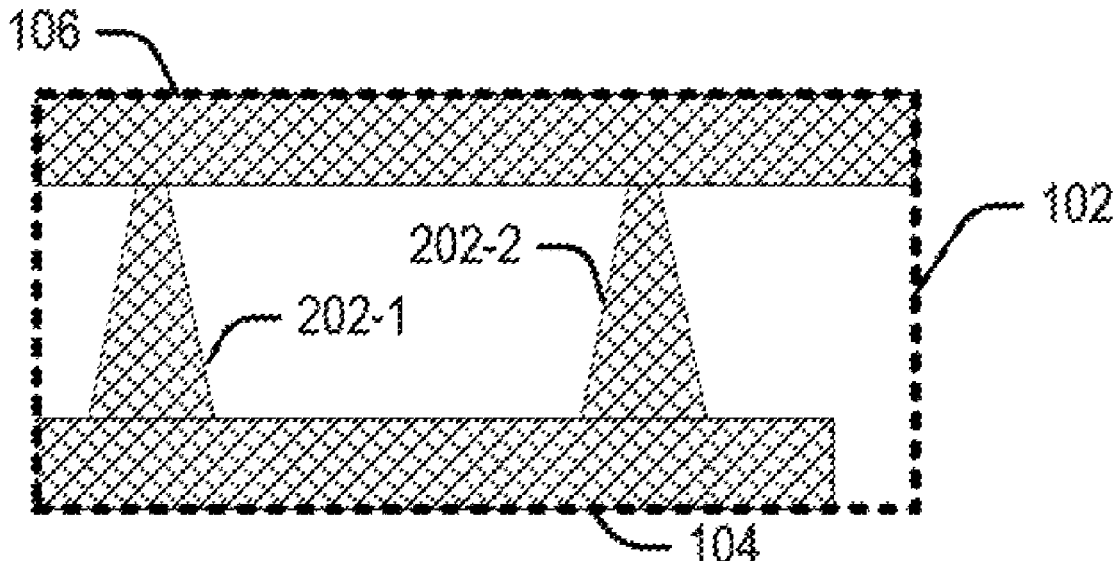
(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/42 (2006.01)

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.

(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

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 Mumbrau, 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**

U.S. PATENT DOCUMENTS

4,827,266 A 5/1989 Sato
5,489,912 A 2/1996 Holloway
(Continued)

FOREIGN PATENT DOCUMENTS

CN 1674354 9/2005
EP 1248317 3/2002
(Continued)

OTHER PUBLICATIONS

Boyle, K. R., A dual-fed, self-diplexing PIFA and RF Front-end,
Antennas and Propagation, IEEE Transactions on, Feb. 1, 2007, vol.
55, No. 2.

(Continued)

Primary Examiner — Andrea Lindgren Baltzell

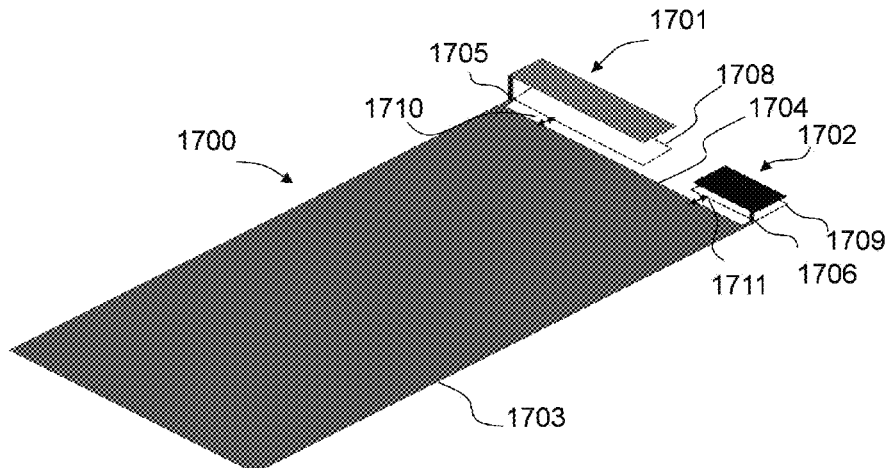
Assistant Examiner — Amal Patel

(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 com-
prises 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

U.S. PATENT DOCUMENTS

2020/0161749 A1* 5/2020 Onaka H01P 3/08
2020/0287298 A1* 9/2020 Ueda H01Q 21/24
2021/0066788 A1* 3/2021 Kim H01Q 1/243

* cited by examiner

Primary Examiner — Awat M Salih

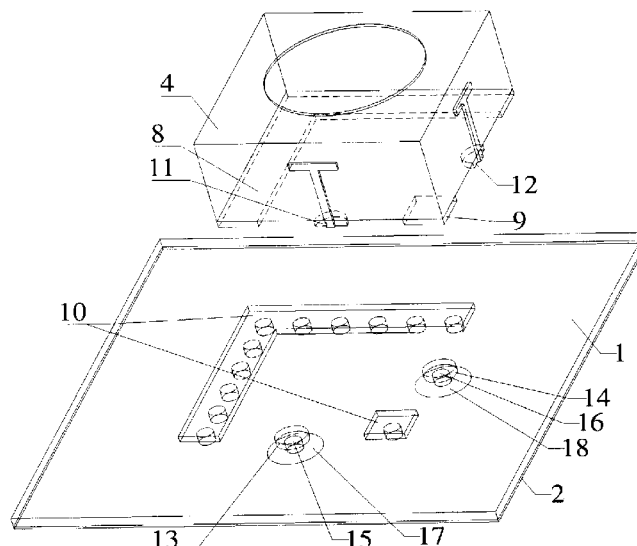
(74) *Attorney, Agent, or Firm* — Oliff PLC

(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**

U.S. PATENT DOCUMENTS

8,674,889 B2 3/2014 Bengtsson et al.

8,923,914 B2 12/2014 Kim et al.

(Continued)

FOREIGN PATENT DOCUMENTS

CN 103579757 A 2/2014

CN 103633451 A 3/2014

(Continued)

OTHER PUBLICATIONS

Wang Chen, "Research on Novel Multiband and Compact Antenna
Based on Composite Right/Left-Handed Transmission Lines Struc-
tures," South China University of Technology, 125 pages.

(Continued)

Primary Examiner — Junpeng Chen

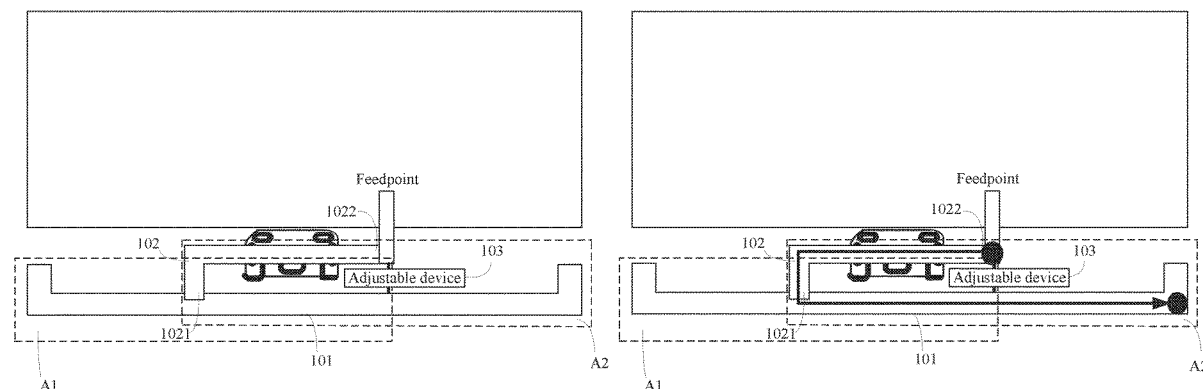
(74) *Attorney, Agent, or Firm* — Conley Rose, P.C.

(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**

U.S. PATENT DOCUMENTS

9,059,505 B1 * 6/2015 Asrani H01Q 1/243
2003/0112195 A1 6/2003 Cheng et al.
(Continued)

FOREIGN PATENT DOCUMENTS

CN 201533015 U 7/2010
CN 102570027 A 7/2012
(Continued)

OTHER PUBLICATIONS

Chinese Office Action and Search Report, dated Aug. 14, 2020, for Chinese Application No. 201710951672.4.

Primary Examiner — Andrea Lindgren Baltzell

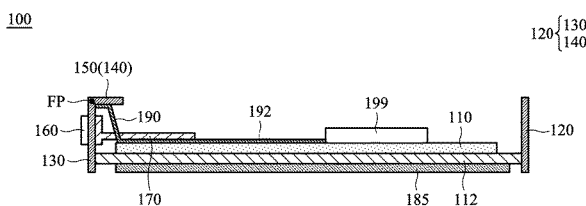
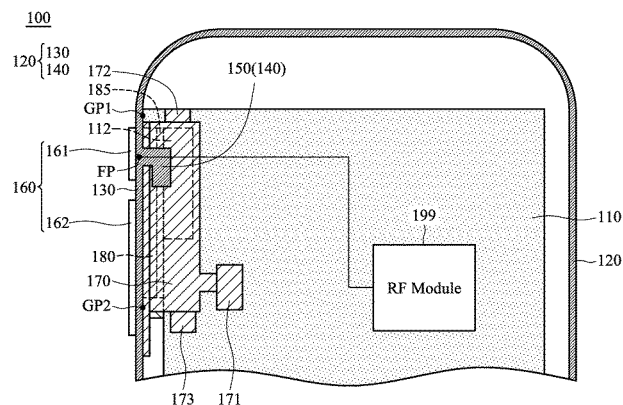
Assistant Examiner — Michael M Bouizza

(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**

(56) **References Cited**

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

U.S. PATENT DOCUMENTS

(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)

2007/0001911 A1 1/2007 Fujio et al.
2007/0139270 A1* 6/2007 Takei H01Q 1/38
343/700 MS
2009/0256754 A1* 10/2009 Tsai H01Q 25/00
343/700 MS

(Continued)

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

FOREIGN PATENT DOCUMENTS

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

KR 20170061295 A * 6/2017
TW M337864 U 8/2008

OTHER PUBLICATIONS

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

Chinese language office action dated Jul. 21, 2020, issued in application No. TW 108138963.

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

(Continued)

(65) **Prior Publication Data**

US 2021/0126356 A1 Apr. 29, 2021

Primary Examiner — Dieu Hien T Duong

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

(30) **Foreign Application Priority Data**

Oct. 29, 2019 (TW) 108138963

(57) **ABSTRACT**

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 1/52 (2006.01)

H01Q 5/307 (2015.01)

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

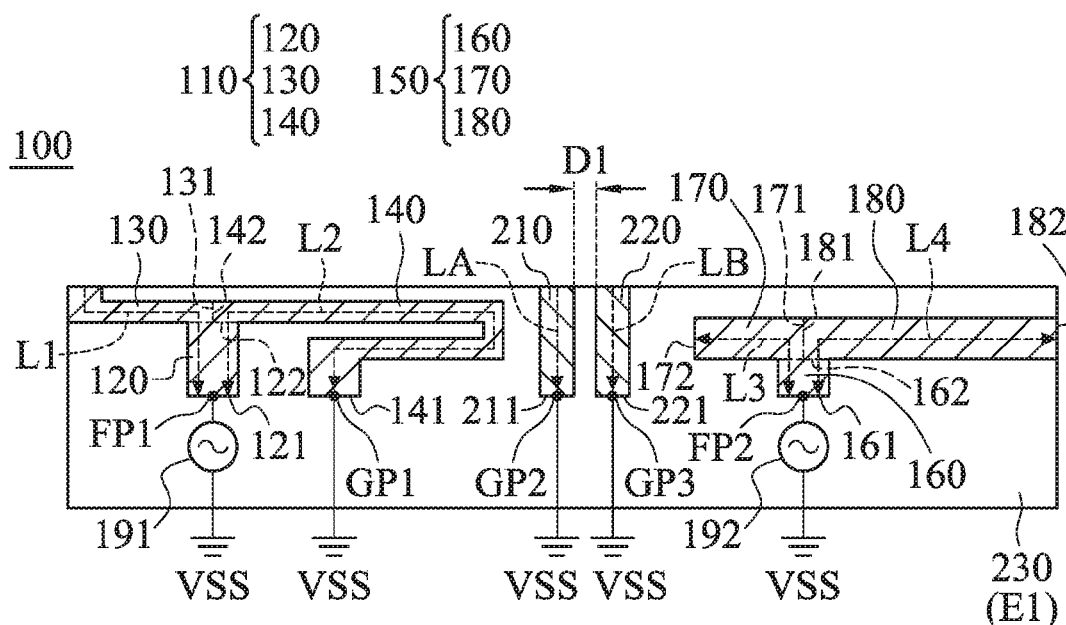
CPC **H01Q 1/521** (2013.01); **H01Q 5/307** (2015.01); **H01Q 1/242** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/521; H01Q 5/307; H01Q 1/242
See application file for complete search history.

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;

(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,116,529 A 9/1978 Yamaguchi

8,764,319 B2 7/2014 Oh et al.

(Continued)

FOREIGN PATENT DOCUMENTS

CN 201143819 11/2008

CN 103825086 5/2014

(Continued)

OTHER PUBLICATIONS

"International Search Report (Form PCT/ISA/210) of PCT/JP2017/030726," dated Nov. 14, 2017, with English translation thereof, pp. 1-2.

(Continued)

Primary Examiner — Collin X Beatty

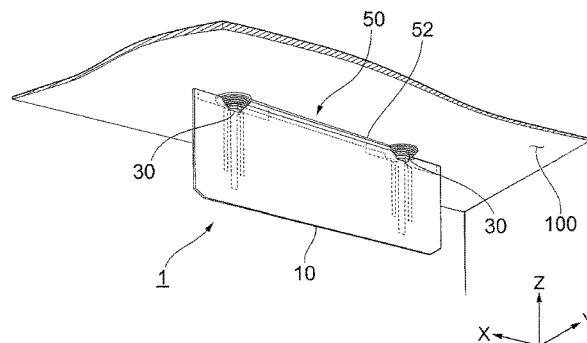
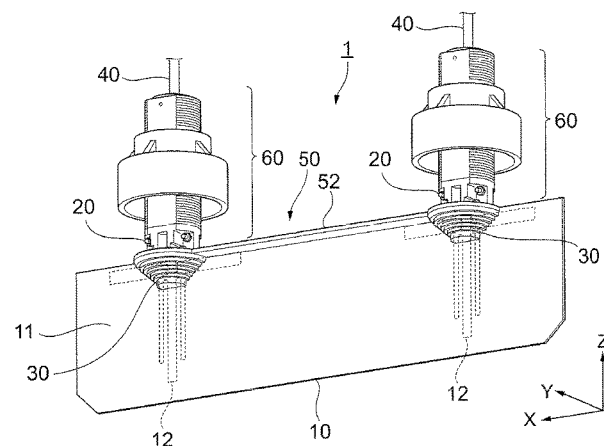
Assistant Examiner — Grant A Gagnon

(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**

U.S. PATENT DOCUMENTS

6,952,185 B1 10/2005 Ryken, Jr. et al.
7,023,909 B1 4/2006 Adams et al.

(Continued)

FOREIGN PATENT DOCUMENTS

CN 1798485 7/2006
CN 1815806 8/2006

(Continued)

OTHER PUBLICATIONS

Chinese Office Action dated Jun. 3, 2020 issued in counterpart
application No. 201580026193.0, 16 pages.

(Continued)

Primary Examiner — Dimary S Lopez Cruz

Assistant Examiner — Patrick R Holecek

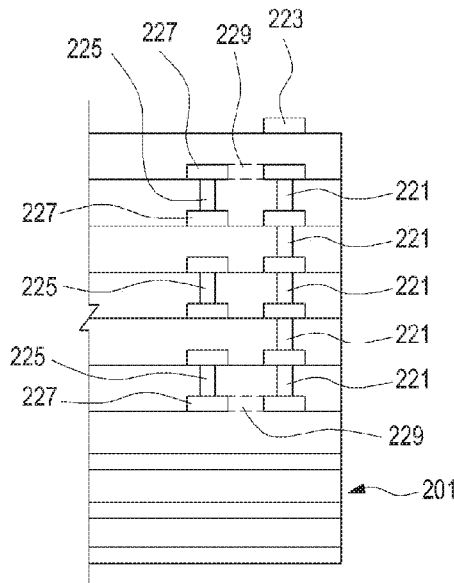
(74) *Attorney, Agent, or Firm* — The Farrell Law Firm,
P.C.

(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 adja-
cently 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**

U.S. PATENT DOCUMENTS

2003/0201944 A1* 10/2003 Aikawa H01Q 13/10
343/770

* cited by examiner

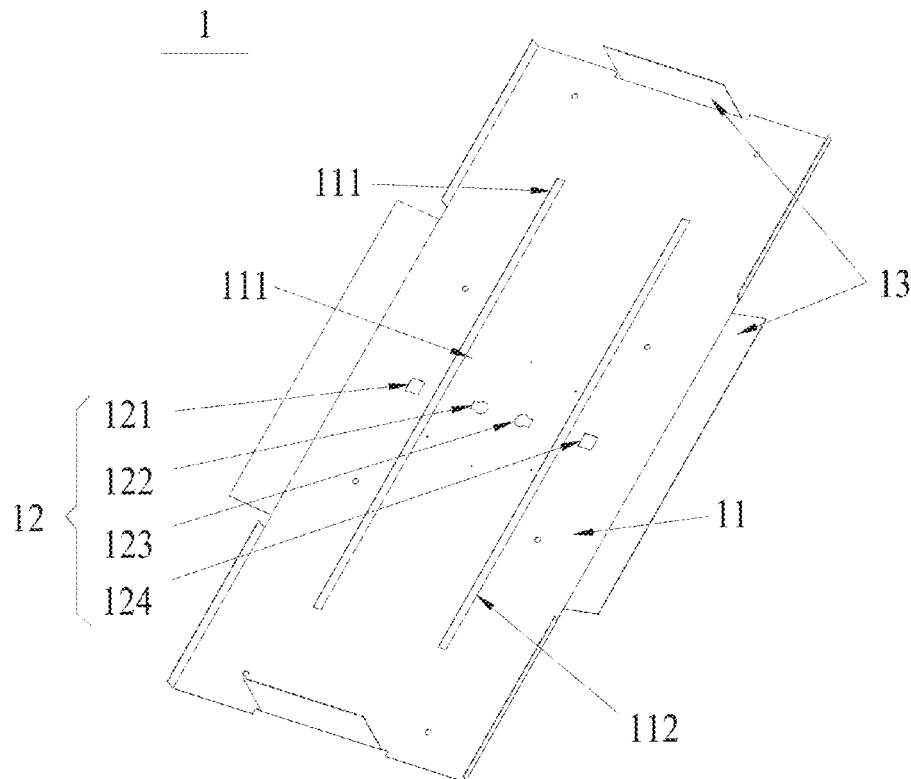
Primary Examiner — Seokjin Kim

(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





(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**

U.S. PATENT DOCUMENTS

8,648,770 B2 * 2/2014 Schneider H01Q 9/0421
343/893

9,590,314 B2 * 3/2017 Celik H01Q 9/0464
10,680,338 B2 * 6/2020 Leung H01Q 9/0492

FOREIGN PATENT DOCUMENTS

CN 105206911 12/2015
CN 106450760 2/2017

(Continued)

OTHER PUBLICATIONS

"International Search Report (Form PCT/ISA/210) of PCT/CN2019/
076009", dated May 29, 2019, with English translation thereof, pp.
1-4.

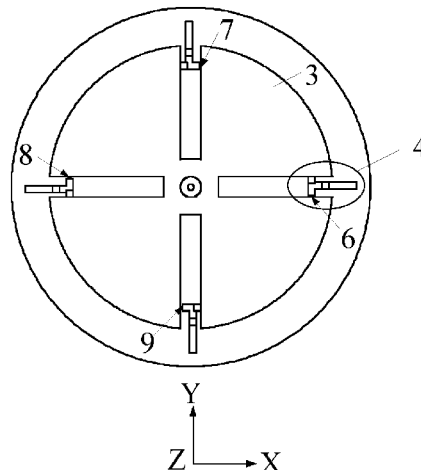
Primary Examiner — Hasan Islam

(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**

(56) **References Cited**

U.S. PATENT DOCUMENTS

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

8,830,133 B2 * 9/2014 Weily H01Q 19/10
343/770

2015/0042513 A1 2/2015 Foo

(Continued)

(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)

FOREIGN PATENT DOCUMENTS

CN 2916958 Y 6/2007

CN 107528115 A 12/2017

KR 10-2017-0016377 A 2/2017

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

OTHER PUBLICATIONS

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

Extended European Search Report dated Aug. 25, 2021 regarding
Application No. 19854647.5, 11 pages.

(21) Appl. No.: **17/195,401**

Primary Examiner — Tung X Le

(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)

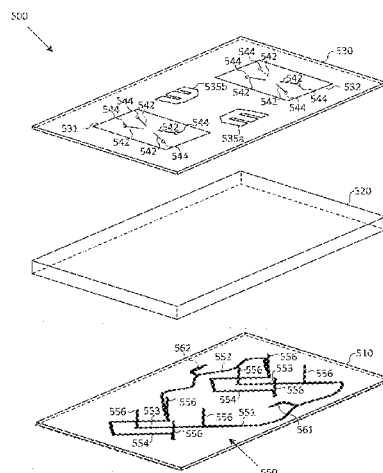
(52) **U.S. Cl.**
CPC **H01Q 5/35** (2015.01); **H01Q 5/50**
(2015.01); **H01Q 9/045** (2013.01); **H01Q**
21/065 (2013.01)

(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)

(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





(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)

(56) **References Cited**

U.S. PATENT DOCUMENTS

2016/0365638 A1* 12/2016 Luk H01Q 9/285
2017/0040703 A1 2/2017 Cheng et al.

FOREIGN PATENT DOCUMENTS

CN 101242027 A 8/2008
CN 203760675 U 8/2014
CN 104934702 A 9/2015

(Continued)

OTHER PUBLICATIONS

Z. Chen, H. Liu, J. Yu, and X. Chen, "High gain, broadband and dual-polarized substrate integrated waveguide cavity-backed slot antenna array for 60 GHz band," IEEE Access., vol. 6, pp. 31012-31022, 2018.

(Continued)

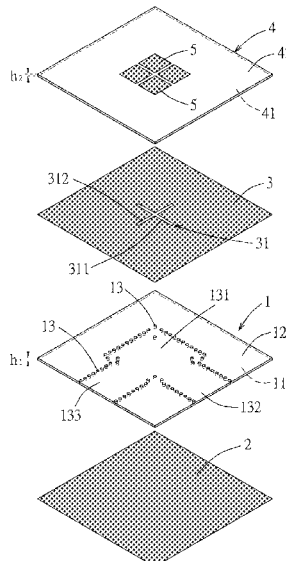
Primary Examiner — Robert Karacsony

(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



(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**

(56) **References Cited**

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

U.S. PATENT DOCUMENTS

(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)

5,677,698 A 10/1997 Snowden
7,129,902 B2 * 10/2006 Bancroft H01Q 13/10
343/767

(Continued)

FOREIGN PATENT DOCUMENTS

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

CN 1201437 5/2005
CN 101895007 11/2010

(Continued)

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

OTHER PUBLICATIONS

“Office Action of Taiwan Counterpart Application,” dated Oct. 9, 2018, pp. 1-6.

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

Primary Examiner — Andrea Lindgren Baltzell

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

Assistant Examiner — Amal Patel

(65) **Prior Publication Data**

US 2019/0036223 A1 Jan. 31, 2019

(74) *Attorney, Agent, or Firm* — J.C. Patents

(30) **Foreign Application Priority Data**

Jul. 25, 2017 (TW) 106124894

(57) **ABSTRACT**

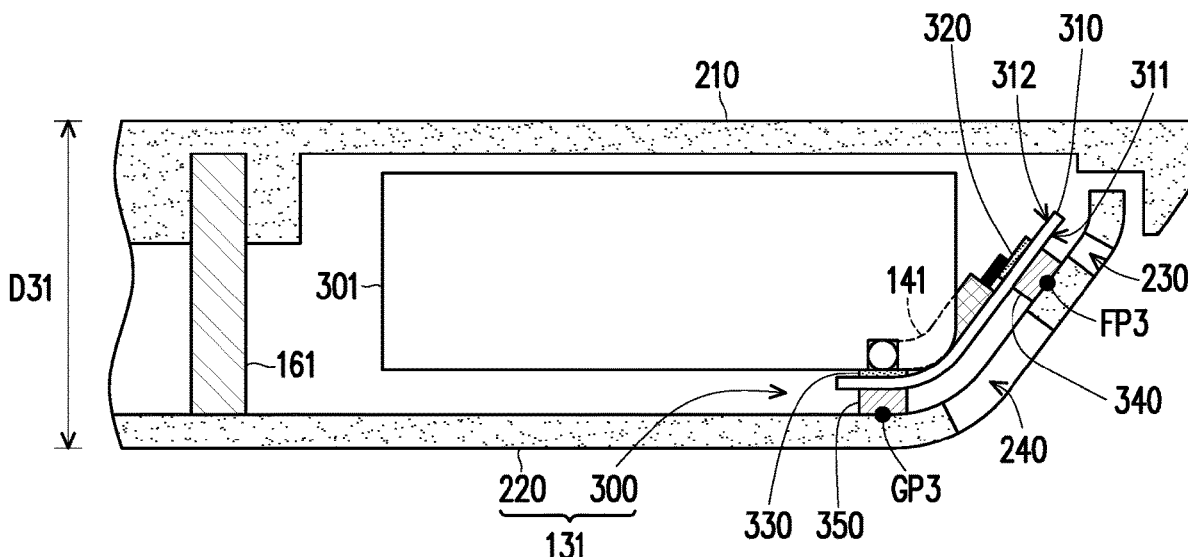
(51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 1/24 (2006.01)
(Continued)

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.

(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.

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.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,552,912 B2 10/2013 Wang et al.
9,425,498 B2 * 8/2016 Lee H01Q 9/42
(Continued)

FOREIGN PATENT DOCUMENTS

CN 203660057 U 6/2014
CN 107845857 A 3/2018
TW M257522 2/2005

Primary Examiner — Vibol Tan

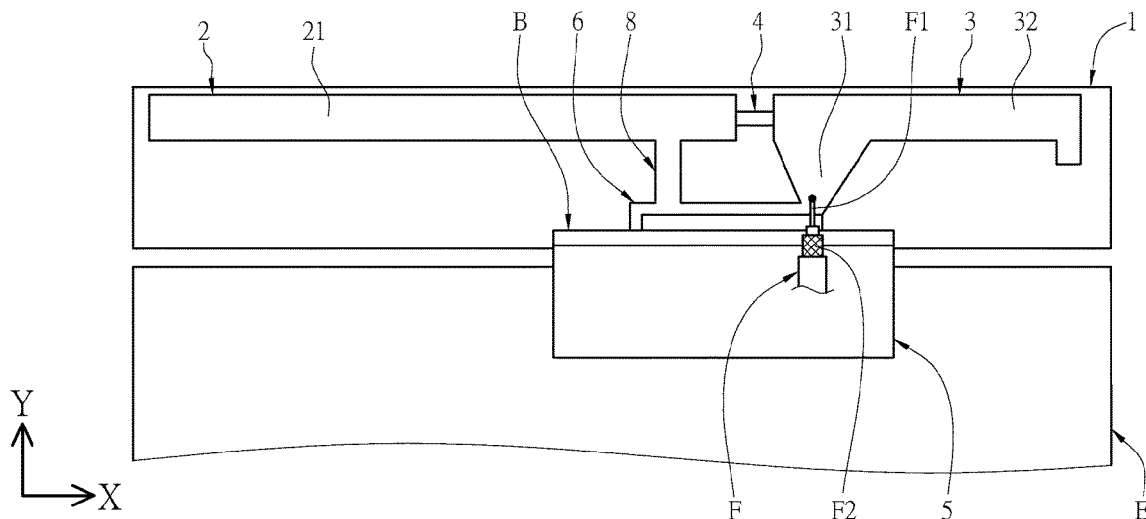
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(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

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(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**

(56) **References Cited**

U.S. PATENT DOCUMENTS

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

6,822,616 B2 * 11/2004 Durham H01Q 3/46
343/795

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

7,577,398 B2 * 8/2009 Judd G01S 19/25
342/357.48

8,325,093 B2 * 12/2012 Holland H01Q 9/285
343/700 MS

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

9,172,147 B1 * 10/2015 Manry, Jr. H01Q 15/0086
9,368,879 B1 * 6/2016 Manry, Jr. H01Q 1/286

2017/0366208 A1 * 12/2017 Filipovic G01S 7/023
2018/0175512 A1 * 6/2018 Isom H01Q 1/405

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

* cited by examiner

Primary Examiner — Andrea Lindgren Baltzell

Assistant Examiner — Patrick R Holecek

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

(74) *Attorney, Agent, or Firm* — Suiter Swantz pc llo

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

(57) **ABSTRACT**

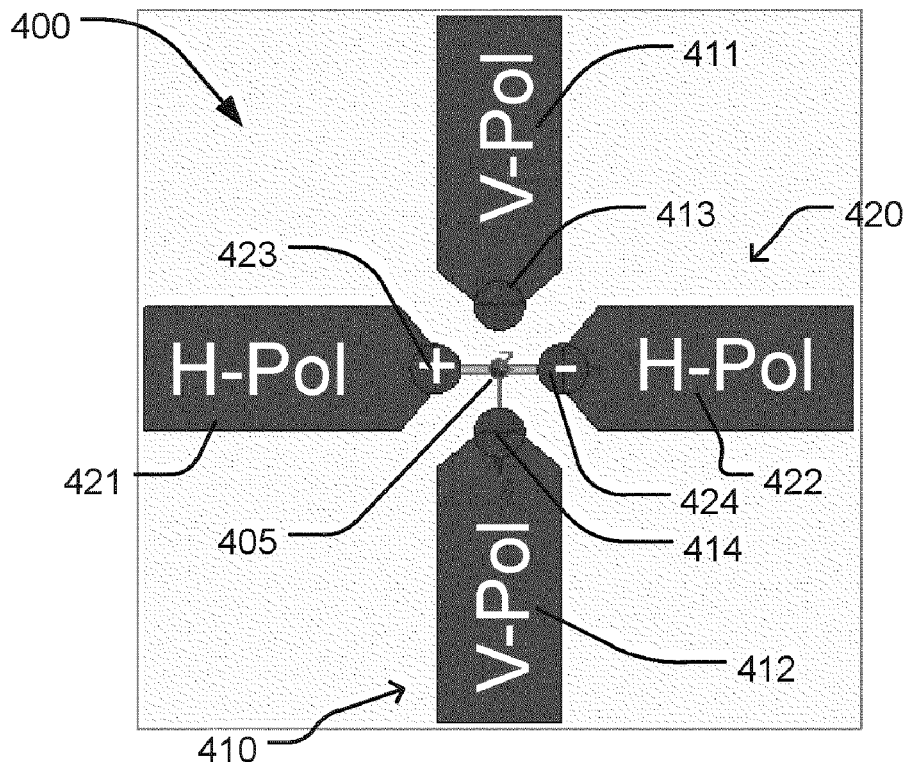
(51) **Int. Cl.**
H01Q 21/06 (2006.01)
H01Q 21/22 (2006.01)

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.

(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.

11 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
Litterer**, 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.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,912,076 B2 * 3/2018 Bisiules H01Q 21/0006
9,960,474 B2 * 5/2018 Katipally H01Q 21/24
(Continued)

FOREIGN PATENT DOCUMENTS

KR 10-2012-0086841 8/2012
KR 10-1703741 2/2017

(Continued)

OTHER PUBLICATIONS

International Search Report and Written Opinion dated Feb. 11,
2019, from International Application No. PCT/US2018/057453, 14
pages.

(Continued)

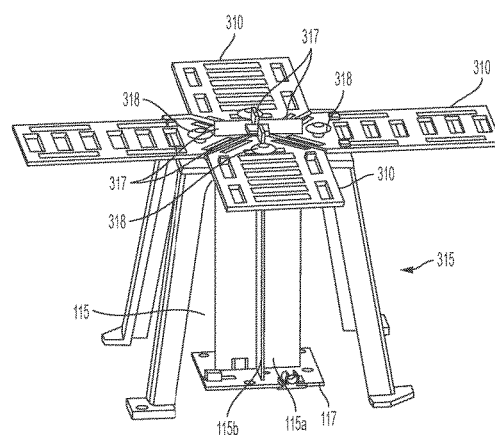
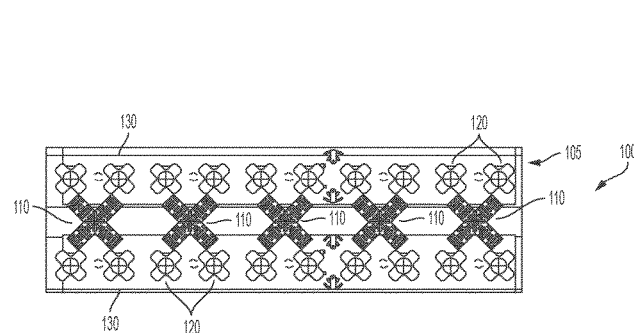
Primary Examiner — Vibol Tan

(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 as 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**

U.S. PATENT DOCUMENTS

4,401,988 A * 8/1983 Kaloj H01Q 19/005
343/700 MS
4,835,538 A 5/1989 McKenna et al.
(Continued)

FOREIGN PATENT DOCUMENTS

JP S63-88904 A 4/1988
JP S63-189002 A 8/1988
(Continued)

OTHER PUBLICATIONS

International Search Report for International Application No. PCT/JP2018/018898 dated Aug. 7, 2018.

(Continued)

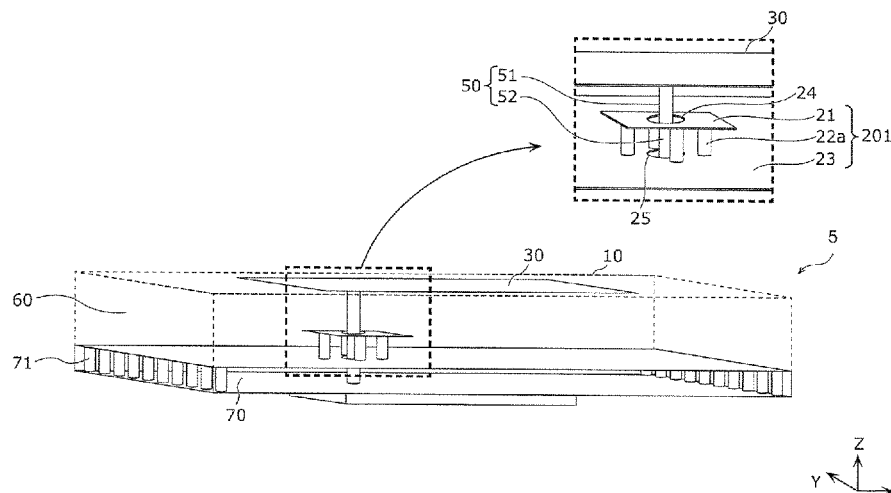
Primary Examiner — Tuan A Tran

(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



(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.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,119,748 B2 10/2006 Autti
7,623,073 B2 11/2009 Teshirogi et al.
(Continued)

FOREIGN PATENT DOCUMENTS

CN 101103491 A 1/2008
CN 102823062 A 12/2012
(Continued)

OTHER PUBLICATIONS

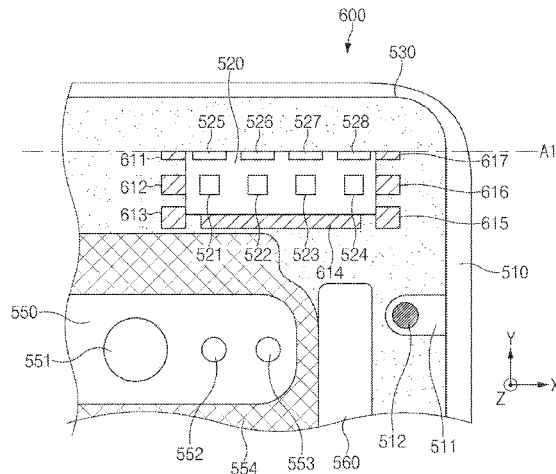
Chinese Office Action dated Dec. 22, 2020, issued in Chinese Application No. 202010101982.9.
(Continued)

Primary Examiner — Joseph J Lature
(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**

(56) **References Cited**

U.S. PATENT DOCUMENTS

(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.

10,631,420 B1 *	4/2020	Xiong	.....	H05K 5/0017
2011/0032157 A1 *	2/2011	Suh	.....	H01Q 5/371
				343/702
2017/0068383 A1 *	3/2017	Chern	.....	G06F 3/04166
2017/0142241 A1 *	5/2017	Kim	.....	H01Q 5/385
2018/0123234 A1 *	5/2018	Wang	.....	H01Q 9/42
2018/0331416 A1 *	11/2018	Yu	.....	H01Q 9/42
2019/0006740 A1 *	1/2019	Kuang	.....	H01Q 13/10
2019/0070760 A1 *	3/2019	Huang	.....	H04M 1/0202
2019/0229429 A1 *	7/2019	Wu	.....	H01Q 1/243
2020/0076080 A1 *	3/2020	Liu	.....	H01Q 5/50
2020/0321688 A1 *	10/2020	Khripkov	.....	H01Q 1/243
2020/0412412 A1 *	12/2020	Su	.....	H01Q 1/38

* cited by examiner

(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.

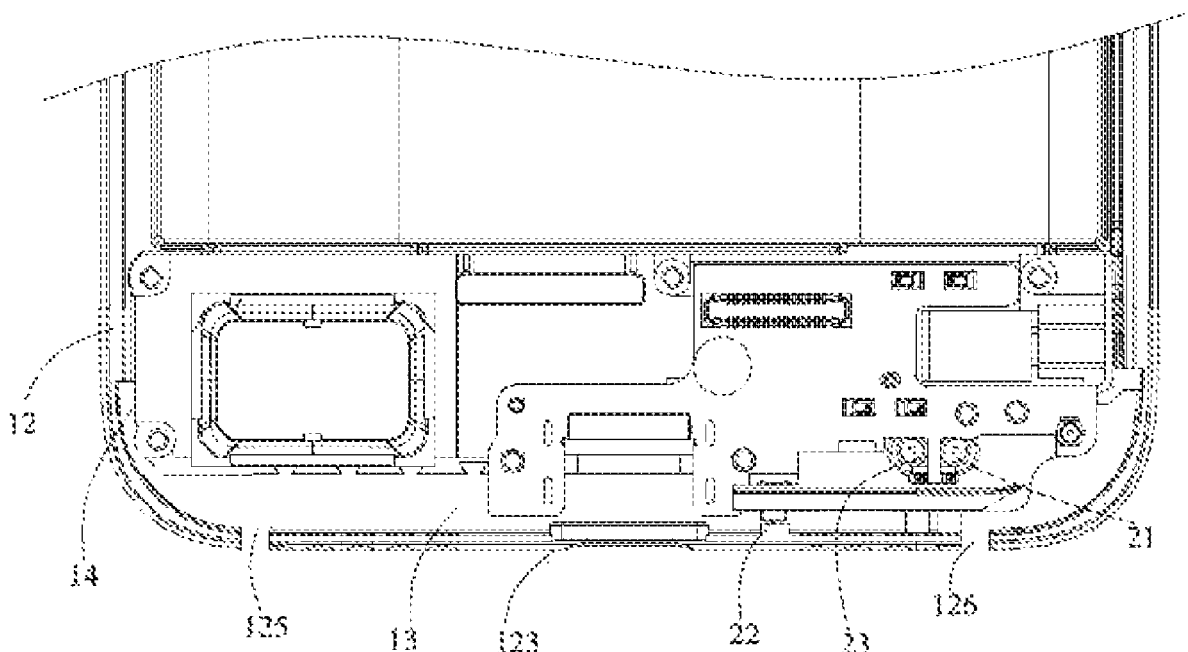
Primary Examiner — Lewis G West

(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**

(56) **References Cited**

U.S. PATENT DOCUMENTS

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

6,424,311	B1	7/2002	Tsai et al.
8,159,399	B2	4/2012	Dorsey et al.
9,252,490	B2	2/2016	Wei
2007/0257847	A1	11/2007	Su et al.
2014/0141731	A1	5/2014	Abudul Gaffoor et al.
2014/0242930	A1	8/2014	Barker et al.
2014/0375515	A1*	12/2014	Qiu H01Q 1/243 343/745

(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)

(Continued)

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

FOREIGN PATENT DOCUMENTS

CN	204651490	9/2015
WO	WO-2017007040	1/2017

(21) Appl. No.: **16/481,279**

OTHER PUBLICATIONS

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

Moradikordalivand Ali et al., Common Elements Wideband MIMO Antenna System., Sep. 2014, IEEE.

(86) PCT No.: **PCT/US2018/021328**

Primary Examiner — Hoang V Nguyen

§ 371 (c)(1),

(74) *Attorney, Agent, or Firm* — Perry + Currier Inc.

(2) Date: **Jul. 26, 2019**

(57)

ABSTRACT

(87) PCT Pub. No.: **WO2019/172904**

PCT Pub. Date: **Sep. 12, 2019**

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.

(51) **Int. Cl.**

H01Q 21/28 (2006.01)

H01Q 1/24 (2006.01)

H01Q 3/34 (2006.01)

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

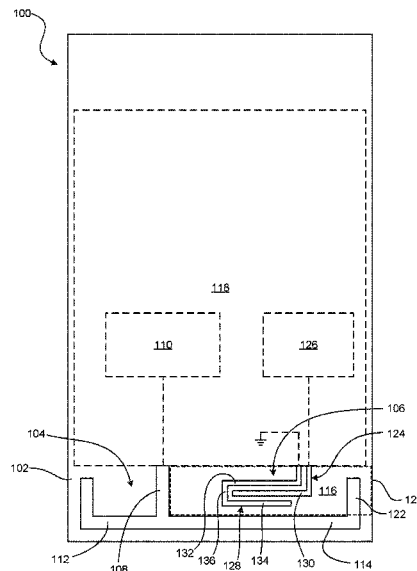
CPC **H01Q 21/28** (2013.01); **H01Q 1/241** (2013.01); **H01Q 3/34** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 21/28; H01Q 1/241; H01Q 3/34

See application file for complete search history.

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**

(56) **References Cited**

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

U.S. PATENT DOCUMENTS

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

4,071,846 A 1/1978 Oltman, Jr.
6,232,923 B1 5/2001 Guinn et al.
6,320,542 B1 11/2001 Yamamoto et al.
(Continued)

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

FOREIGN PATENT DOCUMENTS

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

CN 102110897 A 6/2011
CN 102842753 A 12/2012
(Continued)

OTHER PUBLICATIONS

(21) Appl. No.: **16/727,631**

S.S. Khade et al, Yagi Uda Antenna with Integrated Balun for
WLAN Application, International Journal of Computer Applica-
tions (0975-8887), International Conference on Reliability, Infocom
Technologies and Optimization, 2013, pp. 21-24.

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

(Continued)

(65) **Prior Publication Data**

US 2021/0203084 A1 Jul. 1, 2021

Primary Examiner — Thien T Mai

(74) *Attorney, Agent, or Firm* — Banner & Witcoff, Ltd.

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

(57) **ABSTRACT**

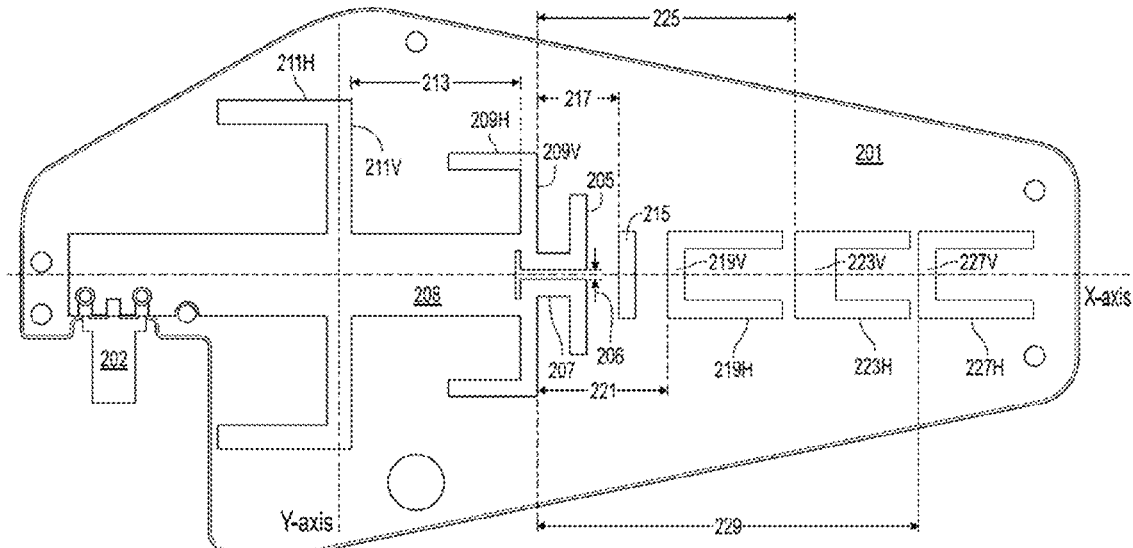
A dual band antenna that allows the independent optimiza-
tion of each frequency band by adjusting the sizes of the
antenna elements. For example, an antenna may have two
different drivers, one for the high-frequency and one for the
low frequency. By using elements orthogonally connected to
the low frequency 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 mini-
mal impact on performance in the high frequency band.

(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.

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.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,864,882 B1 * 1/2018 Geist G07B 15/063

2006/0006484 A1 * 1/2006 Seneviratne B81B 3/0016

257/415

2006/0232476 A1 * 10/2006 Li H01Q 1/243

343/700 MS

2013/0187825 A1 * 7/2013 Andujar Linares H01Q 1/50

343/853

2014/0071009 A1 * 3/2014 Cheng H01Q 5/371

343/770

2016/0104938 A1 * 4/2016 Hsu H01Q 13/106

343/767

2017/0317511 A1 * 11/2017 Keysar H02J 7/00308

* cited by examiner

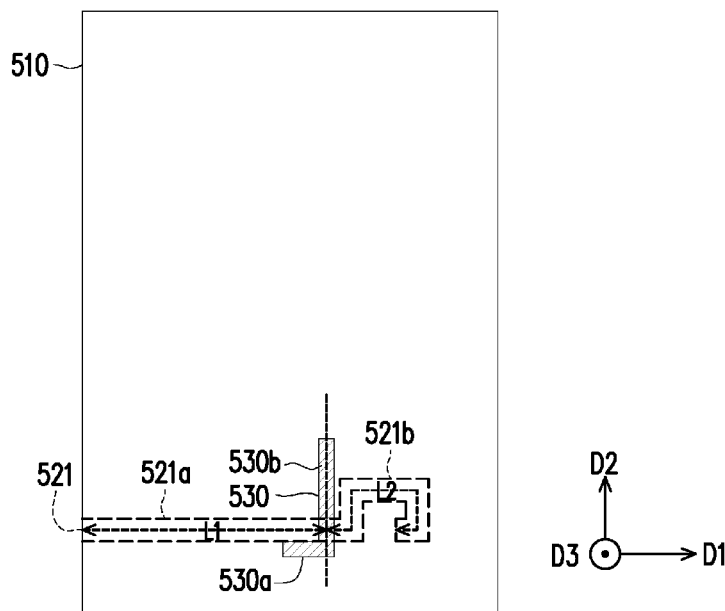
Primary Examiner — Toan C Ly

(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





(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**

U.S. PATENT DOCUMENTS

7,911,386 B1 3/2011 Itoh et al.
2005/0116867 A1* 6/2005 Park H01Q 9/0457
343/725

(Continued)

FOREIGN PATENT DOCUMENTS

JP 2007097115 A 4/2007

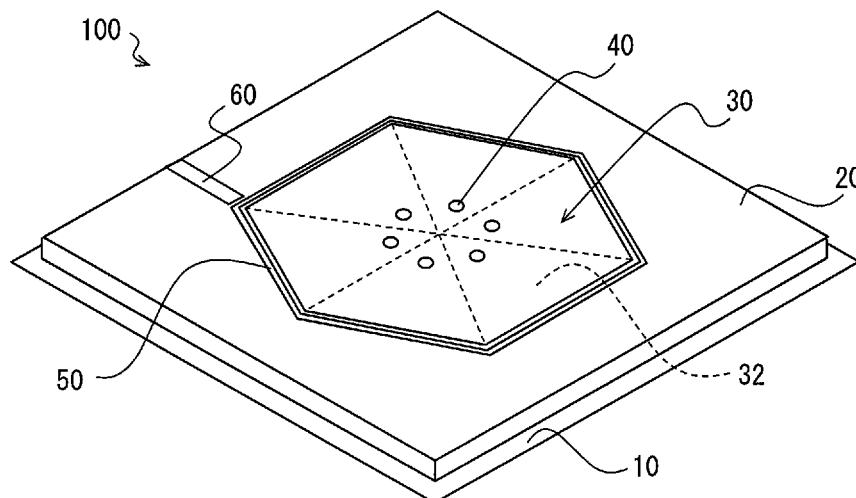
Primary Examiner — Hoang V Nguyen

(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



(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)

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,067,053 A * 5/2000 Runyon H01Q 1/246
343/700 MS
8,708,446 B2 * 4/2014 Kondo B41J 11/002
347/16

(Continued)

FOREIGN PATENT DOCUMENTS

CN 102299409 A 12/2011
CN 204011714 U 12/2014

(Continued)

OTHER PUBLICATIONS

Feb. 6, 2018 International Search Report issued in International
Patent Application No. PCT/CN2017/084202.

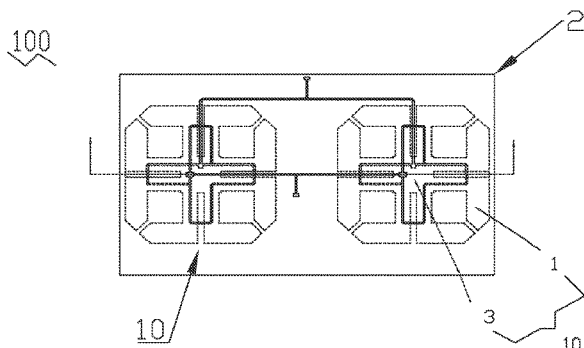
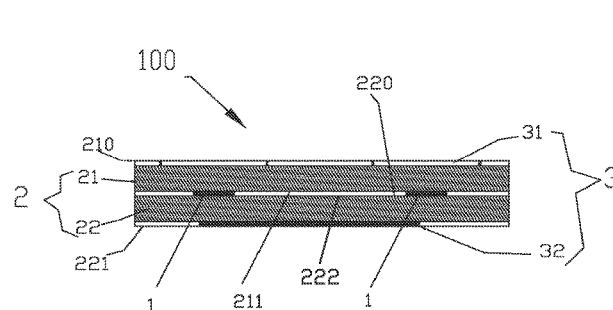
Primary Examiner — Tung X Le

(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 receiv-
ing 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**

U.S. PATENT DOCUMENTS

6,697,022 B2	2/2004	Ponce et al.
7,339,530 B2	3/2008	Ying et al.
7,405,704 B1	7/2008	Lin
9,122,446 B2	9/2015	Jervis et al.
2004/0160370 A1	8/2004	Ghosh et al.
2005/0017914 A1	1/2005	Huang
2006/0001580 A1	1/2006	Usui et al.
2007/0035455 A1	2/2007	Tseng
2010/0176994 A1	7/2010	Chang
2012/0050134 A1*	3/2012	Wu H01Q 1/2258 343/908
2012/0162040 A1	6/2012	Taura
2014/0292613 A1	10/2014	Hsiao et al.

OTHER PUBLICATIONS

Chandra et al., "Cavity-Backed Slot Antennas for Wireless Portable Devices", Retrieved from Internet: <https://ieeexplore.ieee.org/document/7481809/>, 2016, 4 Pages.

Chen et al., "Small-Size Lte/wwan Two-strip Monopole Exciter Antenna Integration With Metal Covers", IEEE, Retrieved from Internet: <https://ieeexplore.ieee.org/document/7476835/>, 2016, 3 Pages.

Wood, "Multi-Function Antenna Fits in Laptop Hinge", Retrieved from Internet: <http://newatlas.com/sat-antenna-laptop-hinge/44073/>, 2016, 3 Pages.

* cited by examiner

Primary Examiner — Graham P Smith

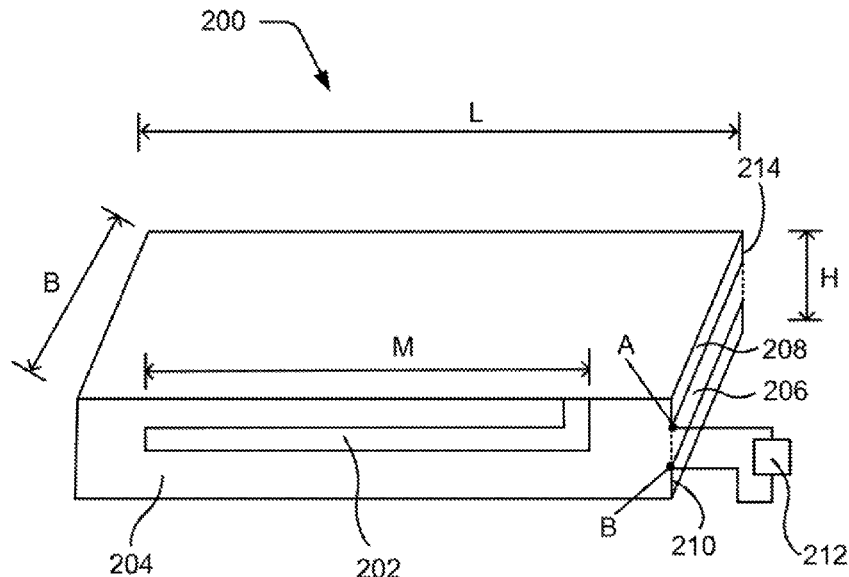
(74) *Attorney, Agent, or Firm* — HPI Patent Department

(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**

(56) **References Cited**

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

U.S. PATENT DOCUMENTS

7,079,078 B2 * 7/2006 Yuanzhu H01P 1/38
343/700 MS
7,102,571 B2 * 9/2006 McCarrick H01Q 1/38
343/700 MS

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

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

(Continued)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 38 days.

FOREIGN PATENT DOCUMENTS

JP 2008-098919 A 4/2008
KR 10-2007-0014785 * 8/2008

(Continued)

(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)

OTHER PUBLICATIONS

Korean Office Action dated Apr. 17, 2020 in corresponding Korean
Patent Application No. 10-2019-0093172 (9 pages in English, 6
pages in Korean).

(Continued)

Primary Examiner — Jean B Jeanglaude

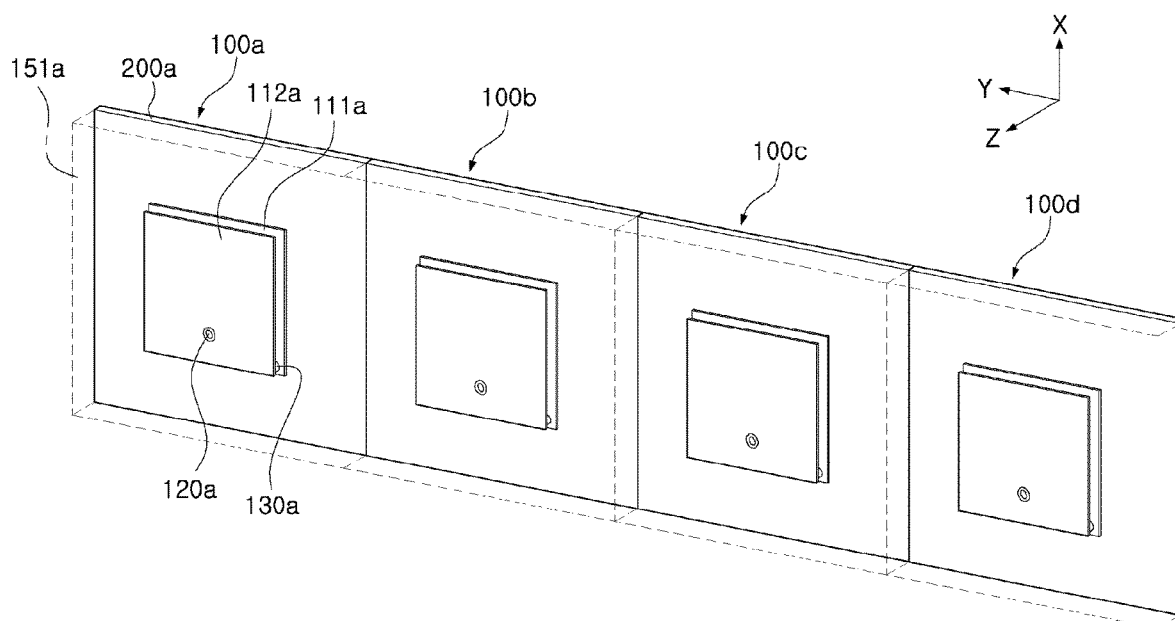
(74) *Attorney, Agent, or Firm* — NSIP Law

(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 fre-
quency 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
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(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.,
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RESEARCH AND BUSINESS
DEVELOPMENT FOUNDATION**,
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(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

(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

U.S. PATENT DOCUMENTS

9,391,375 B1 * 7/2016 Bales H01Q 21/24
10,062,972 B1 * 8/2018 Strassner, II H01Q 3/28
(Continued)

FOREIGN PATENT DOCUMENTS

CN 103872459 A 6/2014
CN 106104915 A 11/2016
(Continued)

OTHER PUBLICATIONS

Office action dated Jul. 5, 2021 from China Patent Office in a
counterpart China Patent Application No. 201910923759.X (all the
cited references are listed in this IDS.) (English translation is also
submitted herewith.).

Primary Examiner — Jason Crawford

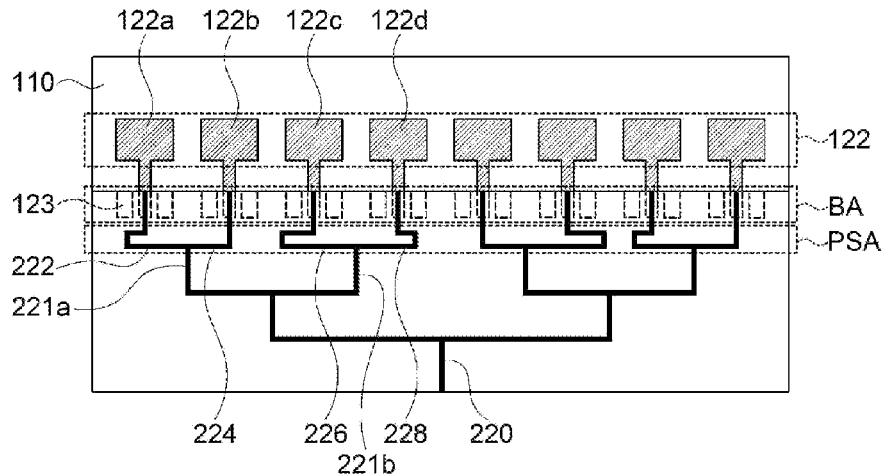
(74) *Attorney, Agent, or Firm* — The PL Law Group,
PLLC

(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 plural-
ity of individual wirings, each of which electrically con-
nected 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**

(56) **References Cited**

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

U.S. PATENT DOCUMENTS

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

5,764,193	A	6/1998	Uchino	
6,917,333	B2	7/2005	Ikegaya	
9,300,037	B2	3/2016	Hiroiku	
2003/0090425	A1	5/2003	Ikegaya	
2012/0280879	A1	11/2012	Zimmerman et al.	
2013/0082898	A1 *	4/2013	Asanuma	H01Q 9/40 343/893
2014/0176391	A1 *	6/2014	Tayama	H01Q 1/50 343/905
2015/0054702	A1 *	2/2015	Rogers	H01Q 13/08 343/753

(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**

FOREIGN PATENT DOCUMENTS

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

CN	1417886	A	5/2003
CN	102959802	A	3/2013
CN	103703618	A	4/2014
JP	61099402		5/1986

(86) PCT No.: **PCT/JP2017/005337**

§ 371 (c)(1),

(2) Date: **Jul. 30, 2019**

(Continued)

(87) PCT Pub. No.: **WO2018/150468**

PCT Pub. Date: **Aug. 23, 2018**

Notice of Reasons for Refusal for corresponding JP Application No.
2019-500071, 5 pages, dated Oct. 8, 2020.

(Continued)

(65) **Prior Publication Data**

US 2020/0044302 A1 Feb. 6, 2020

Primary Examiner — Jimmy T Vu

(74) Attorney, Agent, or Firm — Matthew B. Dernier,
Esq.

(51) **Int. Cl.**

H01P 3/06 (2006.01)

H01Q 1/50 (2006.01)

(57) **ABSTRACT**

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

CPC **H01P 3/06** (2013.01); **H01Q 1/50**
(2013.01); **H01R 2201/02** (2013.01)

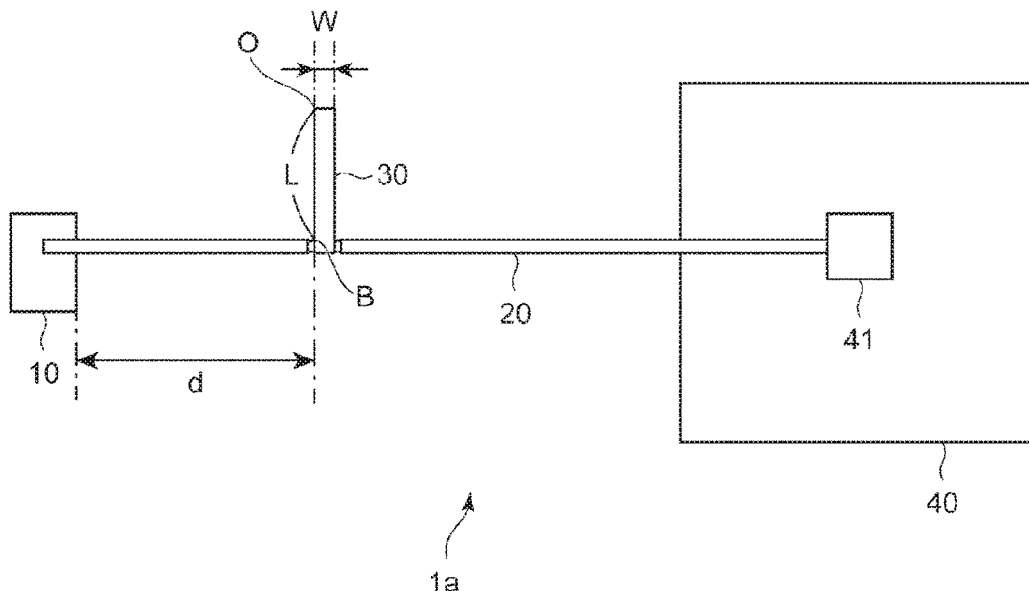
Disclosed herein is an electronic device including a coaxial
cable connected to an antenna and a conductive body having
a strip-like shape and being electrically coupled to an
external conductor of the coaxial cable, an end of the
conductive body not being electrically connected other
conductive members.

(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.

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**

(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.

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,320,542 B1 11/2001 Yamamoto et al.

9,806,422 B2 10/2017 Garcia et al.

(Continued)

FOREIGN PATENT DOCUMENTS

JP 2004-007038 A 1/2004

KR 10-2019-0098529 A 8/2019

OTHER PUBLICATIONS

Ito Osamu, JP2004007038 English translation, Jan. 8, 2004, pp. 1-8 (Year: 2004).*

(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 and 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)

(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.**

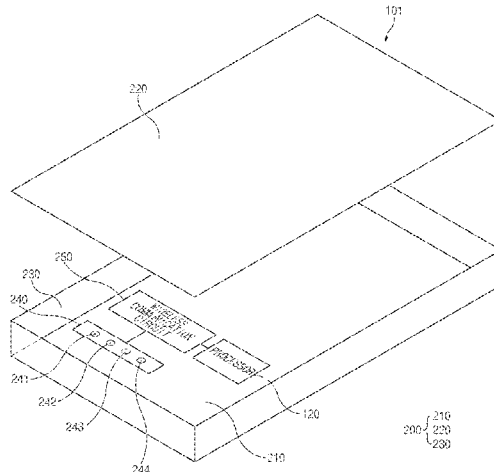
H01Q 1/22 (2006.01)

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)





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**

(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.

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,091,365 A 7/2000 Derneryd et al.
2016/0261047 A1 9/2016 Wallace et al.

(Continued)

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

FOREIGN PATENT DOCUMENTS

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

CN 1248348 A 3/2000
EP 3065219 A1 9/2016

(Continued)

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

OTHER PUBLICATIONS

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

International Search Report for International Application No. PCT/
JP2020/019609 dated Aug. 4, 2020.

(65) **Prior Publication Data**

US 2021/0135364 A1 May 6, 2021

(Continued)

Primary Examiner — Dieu Hien T Duong

(74) *Attorney, Agent, or Firm* — Pearne & Gordon LLP

Related U.S. Application Data

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

Foreign Application Priority Data

Jun. 28, 2019 (JP) JP2019-120911

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

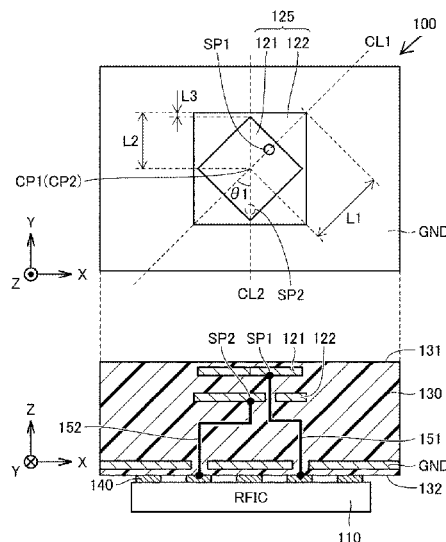
(Continued)

(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)

(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



(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**

(56) **References Cited**

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

U.S. PATENT DOCUMENTS

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

5,008,681 A	4/1991	Cavallaro	
6,765,536 B2	7/2004	Phillips et al.	
6,987,493 B2	1/2006	Chen	
7,068,234 B2	6/2006	Sievenpiper	
7,079,079 B2	7/2006	Jo	
7,084,831 B2	8/2006	Takagi	
7,136,020 B2 *	11/2006	Yamaki	H01Q 9/285

(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.

7,215,289 B2	5/2007	Harano	
7,468,700 B2 *	12/2008	Milosavljevic	H01Q 1/243

(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.

7,830,320 B2	11/2010	Shamblin	
7,911,402 B2	3/2011	Rowson et al.	
8,362,962 B2	1/2013	Rowson et al.	
8,446,318 B2	5/2013	Ali et al.	
8,648,755 B2	2/2014	Rowson et al.	
8,717,241 B2	5/2014	Shamblin et al.	
8,976,068 B2	3/2015	Hamabe	
9,001,000 B2	4/2015	Satou	
9,240,634 B2	1/2016	Rowson et al.	
9,680,210 B2 *	6/2017	Ella	H01Q 21/30
2002/0067312 A1	6/2002	Hilgers	
2003/0201942 A1 *	10/2003	Poilasne	H01Q 21/30

(Continued)

Primary Examiner — Hasan Islam

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

(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)

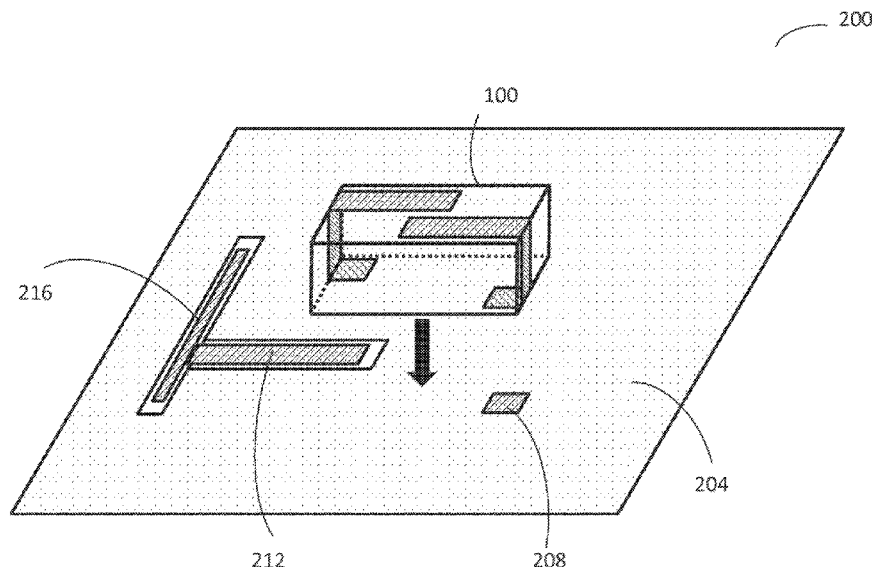
(58) **Field of Classification Search**
CPC H01Q 1/38; H01Q 5/50; H01Q 19/005; H01Q 9/0407

See application file for complete search history.

(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;
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,207,898 B2 * 6/2012 Koyanagi H01Q 9/42
343/702
8,362,960 B2 * 1/2013 Mumbru H01Q 5/371
343/702

(Continued)

FOREIGN PATENT DOCUMENTS

CN 1270409 8/2006
KR 20140013827 2/2014

(Continued)

OTHER PUBLICATIONS

“Search Report of Europe Counterpart Application”, dated Jun. 16,
2020, p.1-p.13.

(Continued)

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

