



US011791569B2

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

(10) **Patent No.:** **US 11,791,569 B2**
(45) **Date of Patent:** **Oct. 17, 2023**

(54) **ANTENNA AND TERMINAL**
(71) Applicant: **Huawei Technologies Co., Ltd.**,
Shenzhen (CN)
(72) Inventors: **Jie Liu**, Wuhan (CN); **Jinjin Shao**,
Wuhan (CN); **Liang Ma**, Wuhan (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 430 days.

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(21) Appl. No.: **17/209,676**
(22) Filed: **Mar. 23, 2021**
(65) **Prior Publication Data**
US 2021/0210872 A1 Jul. 8, 2021

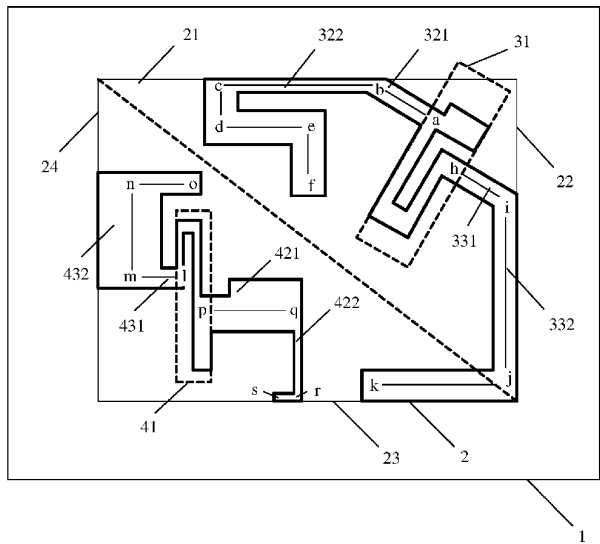
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UWB Applications," IEEE Antennas and Wireless Propagation
Letters, vol. 11, 2012, 4 pages.
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Related U.S. Application Data
(63) Continuation of application No.
PCT/CN2018/109201, filed on Sep. 30, 2018.
(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 21/28 (2006.01)
(Continued)
(52) **U.S. Cl.**
CPC **H01Q 21/28** (2013.01); **H01Q 1/38**
(2013.01); **H01Q 9/065** (2013.01);
(Continued)
(58) **Field of Classification Search**
CPC H01Q 21/28; H01Q 1/38; H01Q 9/065;
H01Q 21/0006; H01Q 1/3275; H01Q
1/36; H01Q 1/48

Primary Examiner — Joseph J Lauture
(74) *Attorney, Agent, or Firm* — SLATER MATSIL, LLP

(57) **ABSTRACT**
An antenna includes a first antenna having a first feeding
portion and at least one stub, and a second antenna having
a second feeding portion and at least one stub. The first
feeding portion is disposed on a first side of a first diagonal
line of the rectangular region. The at least one stub of the
first antenna extends from the first feeding portion in a first
direction. A first angle is between the first direction and a
long-edge direction of the rectangular region. The second
feeding portion is disposed on a second side of the first
diagonal line of the rectangular region. The at least one stub
of the second antenna extends from the second feeding
portion in a second direction. A second angle is between the
second direction and the long-edge direction of the rectan-
gular region and is different from the first angle.

See application file for complete search history. **20 Claims, 9 Drawing Sheets**





US011799189B2

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

(10) **Patent No.:** **US 11,799,189 B2**
(45) **Date of Patent:** **Oct. 24, 2023**

(54) **ELECTRONIC DEVICES HAVING ANTENNA ASSEMBLIES**

(58) **Field of Classification Search**
CPC H01Q 1/2266; H01Q 1/42; G06F 1/1698;
G06F 1/1656; H04B 1/034
See application file for complete search history.

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

(72) Inventors: **Yu Chen So**, Taipei (TW); **Ju-Hung Chen**, Taipei (TW); **Lien-Chia Chiu**, Taipei (TW); **Hao Ming Chen**, Taipei (TW)

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Primary Examiner — Hai V Tran
Assistant Examiner — Bamidele A Jegede
(74) *Attorney, Agent, or Firm* — Knobbe, Martens, Olson & Bear, LLP

(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 90 days.

(21) Appl. No.: **17/047,171**

(22) PCT Filed: **Jul. 19, 2018**

(86) PCT No.: **PCT/US2018/042781**

§ 371 (c)(1),
(2) Date: **Oct. 13, 2020**

(87) PCT Pub. No.: **WO2020/018095**

PCT Pub. Date: **Jan. 23, 2020**

(65) **Prior Publication Data**

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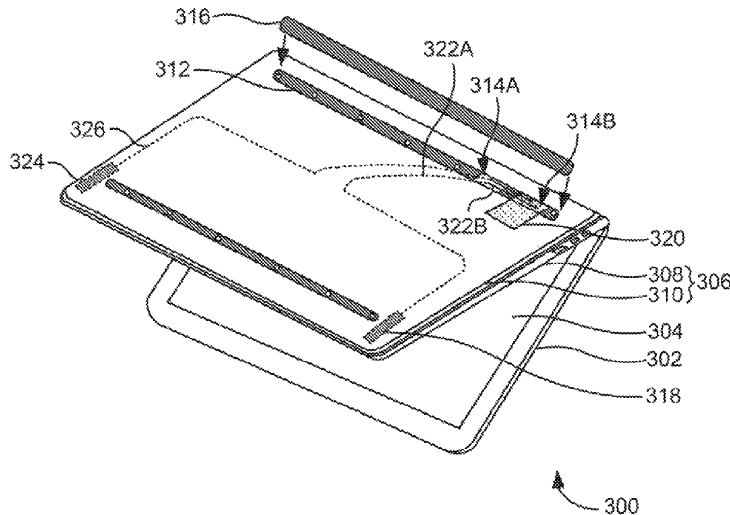
(51) **Int. Cl.**
H01Q 1/22 (2006.01)
G06F 1/16 (2006.01)
H01Q 1/42 (2006.01)
H04B 1/034 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/2266** (2013.01); **G06F 1/1698**
(2013.01); **H01Q 1/42** (2013.01); **H04B 1/034**
(2013.01)

(57) **ABSTRACT**

In one example, an electronic device may include a housing having an opening and an antenna assembly disposed in the housing. The antenna assembly may include an antenna mounted to the housing, an antenna module disposed corresponding to the opening, and a cable to connect the antenna to the antenna module via routing the cable through the opening.

14 Claims, 4 Drawing Sheets





US011799194B2

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

(10) **Patent No.:** **US 11,799,194 B2**
(45) **Date of Patent:** **Oct. 24, 2023**

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

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

(72) Inventors: **Sungchul Park**, Gyeonggi-do (KR);
Wonjoon Choi, Gyeonggi-do (KR)

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

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

(21) Appl. No.: **17/326,659**

(22) Filed: **May 21, 2021**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No.
PCT/KR2019/016021, filed on Nov. 21, 2019.

(30) **Foreign Application Priority Data**

Nov. 23, 2018 (KR) 10-2018-0146637

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

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/422**
(2013.01); **H01Q 3/36** (2013.01); **H01Q**
21/065 (2013.01)

(58) **Field of Classification Search**
CPC H01Q 21/065; H01Q 1/422; H01Q 3/36;
H01Q 1/243; H01Q 21/08; H01Q 9/0407;
(Continued)

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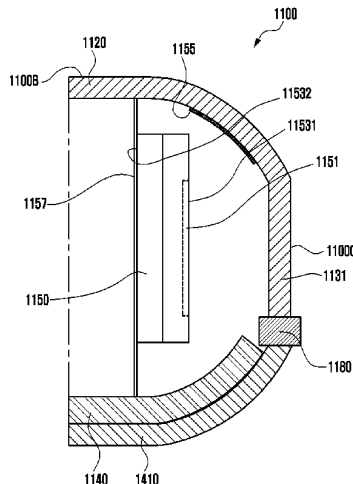
Primary Examiner — Ab Salam Alkassim, Jr.

(74) *Attorney, Agent, or Firm* — Cha & Reiter, LLC

(57) **ABSTRACT**

An electronic device, according to one embodiment of the present invention, may comprise: a first dielectric which forms at least a part of the front surface of the electronic device; a second dielectric which forms at least a part of the rear surface of the electronic device; a side surface member which surrounds a space formed between the front surface and the rear surface and of which a part comprises a third dielectric; a display positioned in the space and visually exposed through the first dielectric; and an antenna module positioned in the space. The antenna module comprises: a printed circuit board comprising a first surface which faces, in the space, the third dielectric, and a second surface which is oriented in a direction opposite to that of the first surface; and at least one antenna element which is disposed on the first surface or inside the printed circuit board so as to be adjacent to the first surface, and which forms a beam pattern toward the side surface member. In addition, other various embodiments are possible.

27 Claims, 27 Drawing Sheets





US011799204B2

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

(10) **Patent No.:** **US 11,799,204 B2**
(45) **Date of Patent:** **Oct. 24, 2023**

(54) **CONVERTIBLE NOTEBOOK COMPUTER**

2013/0257660 A1* 10/2013 Wong H01Q 5/371
343/702

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

(Continued)

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

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

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(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
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application No. TW 110137146.

(21) Appl. No.: **17/702,477**

(22) Filed: **Mar. 23, 2022**

Primary Examiner — Ab Salam Alkassim, Jr.

Assistant Examiner — Anh N Ho

(65) **Prior Publication Data**

US 2023/0107295 A1 Apr. 6, 2023

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

(30) **Foreign Application Priority Data**

Oct. 6, 2021 (TW) 110137146

(57) **ABSTRACT**

(51) **Int. Cl.**
H01Q 5/385 (2015.01)
H01Q 13/10 (2006.01)
H01Q 1/22 (2006.01)

A convertible notebook computer includes a metal mechanism element, a first radiation element, a second radiation element, a third radiation element, a first parasitic element, a second parasitic element, a third parasitic element, and a dielectric substrate. The metal mechanism element has a closed slot. The first radiation element has a feeding point. The second radiation element is coupled to the first radiation element. The third radiation element is coupled to the first radiation element. The first parasitic element is adjacent to the second radiation element. The second parasitic element is adjacent to the third radiation element. The third parasitic element is adjacent to the first radiation element. An antenna structure is formed by the closed slot of the metal mechanism element, the first radiation element, the second radiation element, the third radiation element, the first parasitic element, the second parasitic element, and the third parasitic element.

(52) **U.S. Cl.**
CPC **H01Q 5/385** (2015.01); **H01Q 1/2266**
(2013.01); **H01Q 13/10** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/385; H01Q 1/2266; H01Q 13/10
See application file for complete search history.

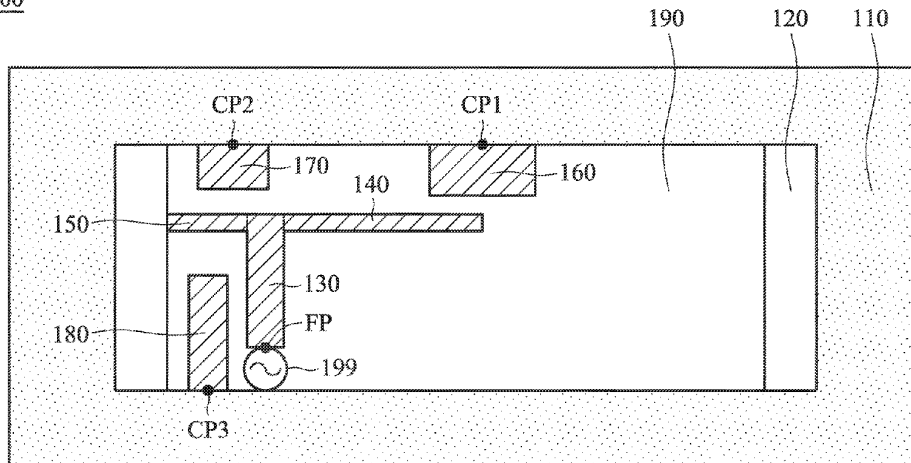
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15 Claims, 7 Drawing Sheets

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US011799505B2

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

(10) **Patent No.:** **US 11,799,505 B2**
(45) **Date of Patent:** **Oct. 24, 2023**

(54) **ANTENNA BANDWIDTH ENHANCEMENT FOR AN ELECTRONIC DEVICE**

(2015.01); **H01Q 9/30** (2013.01); **H01Q 21/28** (2013.01); **H04B 1/3888** (2013.01); **H04B 1/401** (2013.01)

(71) Applicant: **INTEL CORPORATION**, Santa Clara, CA (US)

(58) **Field of Classification Search**

CPC H04B 1/0064; H04B 1/3888; H04B 1/401; H01Q 1/243; H01Q 1/38; H01Q 5/321; H01Q 5/335; H01Q 5/50; H01Q 9/30; H01Q 21/28

(72) Inventors: **Simon Svendsen**, Aalborg (DK); **Ole Jagielski**, Viborg (DK)

See application file for complete search history.

(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 273 days.

(56) **References Cited**

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(Continued)

(21) Appl. No.: **16/926,971**

(22) Filed: **Jul. 13, 2020**

(65) **Prior Publication Data**

US 2021/0067180 A1 Mar. 4, 2021

Primary Examiner — Hai V Tran

Assistant Examiner — Michael M Bouizza

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

Related U.S. Application Data

(63) Continuation of application No. 15/719,781, filed on Sep. 29, 2017, now Pat. No. 10,715,187.

(57) **ABSTRACT**

Techniques are disclosed for configuring a broadband antenna system. An example electronic device includes a first antenna operating at a first frequency range and coupled to a first transceiver via a first signal path comprising a first indirect feed. The electronic device also includes a second antenna operating at a second frequency range and coupled to a second transceiver via a second signal path comprising a second indirect feed, wherein the first frequency range is lower than the second frequency range. The electronic device also includes a third antenna operating at the second frequency range and coupled to a third transceiver via a second signal path comprising a third indirect feed. Additionally, the first antenna is coupled to the first antenna and the second antenna by a capacitive coupling element.

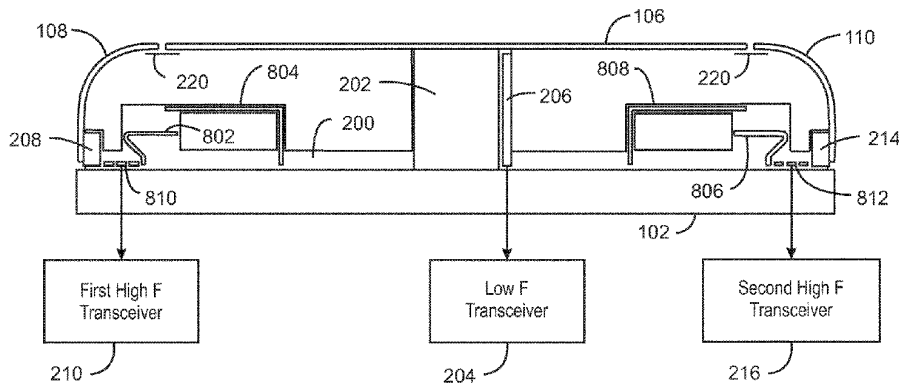
(51) **Int. Cl.**

H01Q 1/24 (2006.01)
H01Q 1/38 (2006.01)
H01Q 21/28 (2006.01)
H01Q 5/321 (2015.01)
H01Q 5/335 (2015.01)
H01Q 5/50 (2015.01)
H01Q 9/30 (2006.01)
H04B 1/00 (2006.01)
H04B 1/401 (2015.01)
H04B 1/3888 (2015.01)

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

CPC **H04B 1/0064** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 5/321** (2015.01); **H01Q 5/335** (2015.01); **H01Q 5/50**

31 Claims, 14 Drawing Sheets





US011802904B2

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

(10) **Patent No.:** **US 11,802,904 B2**
(45) **Date of Patent:** **Oct. 31, 2023**

(54) **ELECTRONIC COMPONENT TESTING APPARATUS, SOCKETS, AND REPLACEMENT PARTS FOR ELECTRONIC COMPONENT TESTING APPARATUS**

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

(72) Inventors: **Natsuki Shiota**, Tokyo (JP); **Hiroyuki Mineo**, Tokyo (JP)

(73) Assignee: **ADVANTEST Corporation**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 120 days.

(21) Appl. No.: **17/104,913**

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

(65) **Prior Publication Data**
US 2021/0190855 A1 Jun. 24, 2021

(30) **Foreign Application Priority Data**
Dec. 24, 2019 (JP) 2019-232547

(51) **Int. Cl.**
G01R 31/30 (2006.01)
G01R 31/28 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **G01R 31/2863** (2013.01); **G01R 29/10** (2013.01); **G01R 31/2822** (2013.01); **G01R 31/2867** (2013.01)

(58) **Field of Classification Search**
CPC G01R 31/02; G01R 31/28; G01R 31/2863; G01R 31/2867; G01R 31/30;
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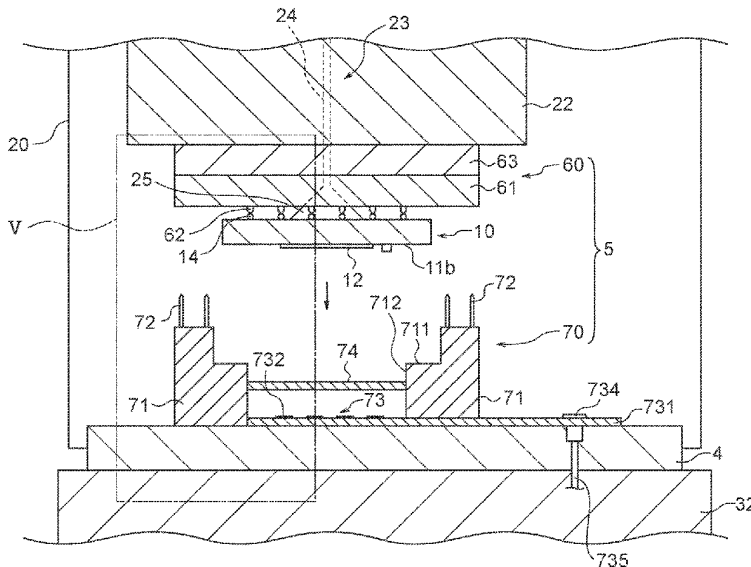
Primary Examiner — Neel D Shah

(74) *Attorney, Agent, or Firm* — Osha Bergman Watanabe & Burton LLP

(57) **ABSTRACT**

An electronic component testing apparatus is used for testing a device under test (DUT). The electronic component testing apparatus includes: a socket unit that is electrically connected to the DUT; a first wiring board; and a tester that comprises a test head in which the first wiring board is mounted. The socket unit includes a first socket and a second socket. The second socket includes a base and a test antenna unit. The tester tests the DUT by transmitting and receiving radio waves between a device antenna unit of the DUT and the test antenna unit while the DUT is electrically connected to the first socket and the first socket is electrically connected to the test head through the second socket.

16 Claims, 15 Drawing Sheets





US011804648B2

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

(10) **Patent No.:** **US 11,804,648 B2**
(45) **Date of Patent:** **Oct. 31, 2023**

(54) **BACK COVER WITH AN ANTENNA ELEMENT**

USPC 455/575.7
See application file for complete search history.

(71) Applicant: **Cheng Uei Precision Industry Co., Ltd.**, New Taipei (TW)

(56) **References Cited**

(72) Inventors: **James Cheng Lee**, La Habra, CA (US); **Kuo Yang Wu**, New Taipei (TW); **Lin Yean Lin**, New Taipei (TW); **Kuo Wei Chang**, New Taipei (TW); **Yu Chin Huang**, New Taipei (TW)

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(73) Assignee: **Cheng Uei Precision Industry Co., Ltd.**, New Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 363 days.

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(21) Appl. No.: **17/382,088**

Primary Examiner — Tan H Trinh

(22) Filed: **Jul. 21, 2021**

(74) *Attorney, Agent, or Firm* — LIN & ASSOCIATES
INTELLECTUAL PROPERTY, INC.

(65) **Prior Publication Data**

US 2022/0166128 A1 May 26, 2022

(57) **ABSTRACT**

Related U.S. Application Data

(60) Provisional application No. 63/116,995, filed on Nov. 23, 2020.

A back cover with an antenna element includes a cover body having a main portion, and an antenna element. A periphery of the main portion protrudes frontward to form a peripheral wall. The cover body is further equipped with a magnetic part. The antenna element is assembled in the cover body. The antenna element has a base portion, a connecting portion, a first extension portion and a second extension portion extended upward from the base portion. The first extension portion is disposed adjacent to one side of the peripheral wall of the cover body. The second extension portion is adjacent to the first extension portion. A length of the first extension portion is longer than a length of the second extension portion. A connecting portion is connected between the first extension portion and a top end of the second extension portion.

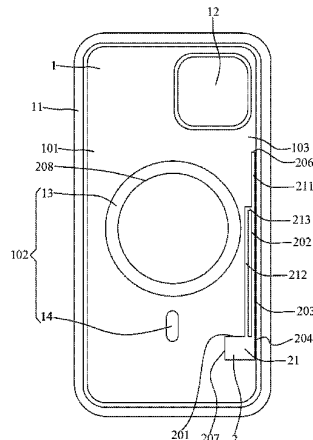
(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/36 (2006.01)
H01Q 1/46 (2006.01)
H04M 1/02 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/36** (2013.01); **H01Q 1/46** (2013.01); **H04M 1/026** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/36; H01Q 1/405; H01Q 1/46; H01Q 5/364; H01Q 9/42; H04M 1/0202; H04M 1/026

19 Claims, 2 Drawing Sheets

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US011804655B2

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

(10) **Patent No.:** **US 11,804,655 B2**
(45) **Date of Patent:** **Oct. 31, 2023**

(54) **WI-FI ANTENNA DEVICE AND WIRELESS COMMUNICATION DEVICE HAVING THE SAME**

(56) **References Cited**

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(71) Applicant: **LANNER ELECTRONICS INC.,**
New Taipei (TW)
(72) Inventors: **Jung-Tai Wu,** New Taipei (TW);
Yun-Hung Chen, New Taipei (TW)
(73) Assignee: **LANNER ELECTRONICS INC.,**
New Taipei (TW)

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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 66 days.

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Primary Examiner — Hai V Tran
Assistant Examiner — Michael M Bouizza

(21) Appl. No.: **17/730,525**

(22) Filed: **Apr. 27, 2022**

(65) **Prior Publication Data**
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(57) **ABSTRACT**

(30) **Foreign Application Priority Data**

Aug. 4, 2021 (TW) 110128769

A Wi-Fi antenna device is disclosed. The Wi-Fi antenna device comprises a ground plane, a plurality of first inverted-F antennas, a plurality of second inverted-F antennas and a plurality of third inverted-F antennas, thereby being capable of transceiving multi-band wireless signals. Particularly, there is an included angle between any two of the first inverted-F antennas. In the same way, any two of the second inverted-F antennas and any two of the third inverted-F antennas are both arranged to have said included angle therebetween. By such an arrangement, an omni radiation pattern can be measured on X-Y plane, X-Z plane and Y-Z plane in case of this novel Wi-Fi antenna device being applied in an environment. Therefore, the Wi-Fi antenna device according to the present invention has a significant potential for replacing the conventional multi-band antenna so as to be applied in a Wi-Fi router.

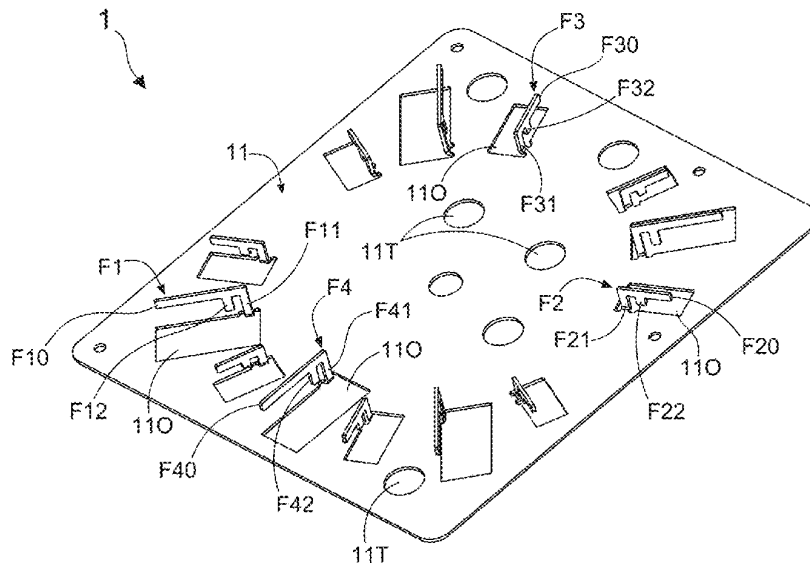
(51) **Int. Cl.**
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H01Q 9/04 (2006.01)
H01Q 9/30 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 9/0414** (2013.01); **H01Q 9/30** (2013.01); **H01Q 21/20** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 9/0414; H01Q 9/30; H01Q 21/20;
H01Q 1/02; H01Q 1/42; H01Q 3/08;
H01Q 5/42; H01Q 9/0421; H01Q 21/205;
H01Q 1/2291

See application file for complete search history.

16 Claims, 9 Drawing Sheets





US011804657B2

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

(10) **Patent No.:** **US 11,804,657 B2**
(45) **Date of Patent:** **Oct. 31, 2023**

(54) **CHASSIS FOR AN ELECTRONIC DEVICE, ELECTRONIC DEVICE, ANTENNA MODULE, AND METHOD FOR FABRICATING AN ELECTRONIC DEVICE**

(58) **Field of Classification Search**
CPC H01Q 13/10; H01Q 1/2266; H01Q 1/2291; H01Q 1/526; H01Q 5/371
See application file for complete search history.

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

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(72) Inventors: **Jayprakash Thakur**, Bangalore (IN); **Maruti Tamrakar**, Chennai (IN); **Sagar Gupta**, Ghaziabad (IN); **Harry G. Skinner**, Beaverton, OR (US); **Prakash Kurma Raju**, Bangalore (IN)

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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 95 days.

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(21) Appl. No.: **17/448,746**

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(22) Filed: **Sep. 24, 2021**

EP	2911033	A1*	8/2015	G06F 1/1656
WO	2013155015	A1	10/2013	

(65) **Prior Publication Data**

US 2022/0200154 A1 Jun. 23, 2022

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(30) **Foreign Application Priority Data**

Dec. 23, 2020 (EP) 20216793

Primary Examiner — Hoang V Nguyen
(74) *Attorney, Agent, or Firm* — 2SPL Patent Attorneys
PartG mbB

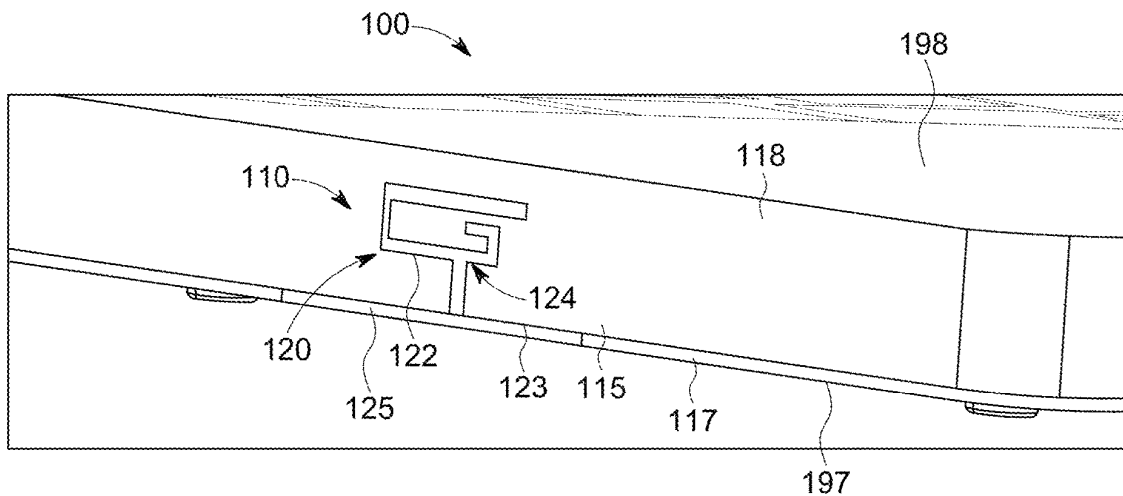
(51) **Int. Cl.**
H01Q 13/10 (2006.01)
H05K 1/02 (2006.01)

(57) **ABSTRACT**

A chassis for an electronic device is provided. The chassis comprises a chassis part made of conducting material. At least one slot antenna is formed in the chassis part made of conducting material.

(52) **U.S. Cl.**
CPC **H01Q 13/10** (2013.01); **H05K 1/0237** (2013.01); **H05K 1/0277** (2013.01)

18 Claims, 22 Drawing Sheets





US011804661B2

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

(10) **Patent No.:** **US 11,804,661 B2**
(45) **Date of Patent:** **Oct. 31, 2023**

(54) **ARRAY ANTENNA**

(71) Applicant: **FUJIKURA LTD.**, Tokyo (JP)

(72) Inventors: **Shailendra Kaushal**, Sakura (JP); **Ning Guan**, Sakura (JP); **Asahi Kan**, Sakura (JP)

(73) Assignee: **FUJIKURA 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 271 days.

(21) Appl. No.: **17/430,004**

(22) PCT Filed: **Mar. 18, 2020**

(86) PCT No.: **PCT/JP2020/011931**

§ 371 (c)(1),

(2) Date: **Aug. 11, 2021**

(87) PCT Pub. No.: **WO2020/255503**

PCT Pub. Date: **Dec. 24, 2020**

(65) **Prior Publication Data**

US 2022/0149539 A1 May 12, 2022

(30) **Foreign Application Priority Data**

Jun. 18, 2019 (JP) 2019-112683

(51) **Int. Cl.**

H01Q 1/38 (2006.01)

H01Q 21/00 (2006.01)

(Continued)

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

CPC **H01Q 21/0075** (2013.01); **H01Q 1/38** (2013.01); **H01Q 13/08** (2013.01); **H01Q 21/06** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/38; H01Q 21/0075; H01Q 21/06; H01Q 13/08

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(56) **References Cited**

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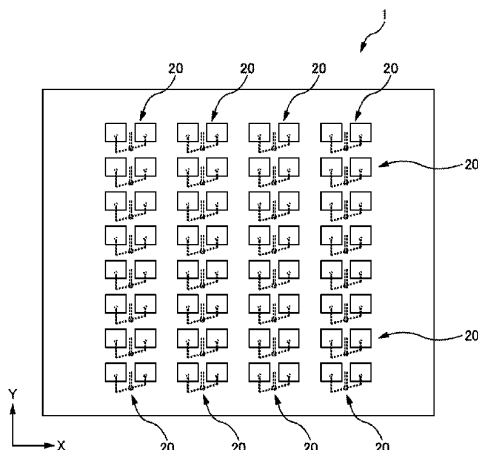
Primary Examiner — Peguy Jean Pierre

(74) *Attorney, Agent, or Firm* — WHDA, LLP

(57) **ABSTRACT**

Wiring and a wiring path of a feed line for feeding power to a radiation element is simplified. An array antenna includes a first conductive pattern layer, first dielectric layer, conductive ground layer, second dielectric layer, second conductive pattern layer, third dielectric layer, and radiation element pattern layer that are layered in this order. The radiation element pattern layer includes radiation element pairs arranged in a two-dimensional array pattern. Each of the radiation element pairs includes a first radiation element and a second radiation element arranged side by side with an interval therebetween. The second conductive pattern layer includes branch feed lines arranged in a two-dimensional array pattern to correspond to the radiation element pairs, respectively. The first conductive pattern layer includes feed lines corresponding to the branch feed lines, respectively.

5 Claims, 21 Drawing Sheets





US011804869B2

(12) **United States Patent**
Jin

(10) **Patent No.:** **US 11,804,869 B2**
(45) **Date of Patent:** ***Oct. 31, 2023**

(54) **RADIO FREQUENCY SWITCH**
(71) Applicant: **Taiwan Semiconductor Manufacturing Co., Ltd.**, Hsin-Chu (TW)
(72) Inventor: **Jun-De Jin**, Hsinchu (TW)
(73) Assignee: **Taiwan Semiconductor Manufacturing Co., Ltd.**, Hsin-Chu (TW)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.
This patent is subject to a terminal disclaimer.

(58) **Field of Classification Search**
CPC H04B 1/48; H01L 23/66; H01L 29/513; H01L 29/516; H01L 29/6684; H01L 29/78391; H01L 29/7851; H01L 29/785; H01L 29/51; H01Q 1/50; H03K 17/687
See application file for complete search history.

(56) **References Cited**
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Primary Examiner — Yuwen Pan
Assistant Examiner — Fatuma G Sherif
(74) *Attorney, Agent, or Firm* — Duane Morris LLP

(21) Appl. No.: **17/461,621**
(22) Filed: **Aug. 30, 2021**

(57) **ABSTRACT**
Disclosed is a RF switch module and methods to fabricate and operate such RF switch to alternatively couple an antenna to either a transmitter transmission line or a receiver transmission line to realize lower distortion of a signal at high frequencies with improved insertion loss and without affecting isolation. In one embodiment, a Radio Frequency (RF) switch module, includes, a switch circuit for switching between transmitting first signals from a transmitter unit to an antenna and transmitting second signals from the antenna to the receiver unit, wherein the switch circuit comprises a plurality of field effect transistors (FETs), wherein each of the plurality of FETs comprises stacked gate dielectrics and at least three metal contacts to a conductive gate, wherein the stacked gate dielectrics comprises at least one first dielectric layer, wherein the first dielectric layer comprises a negative-capacitance material.

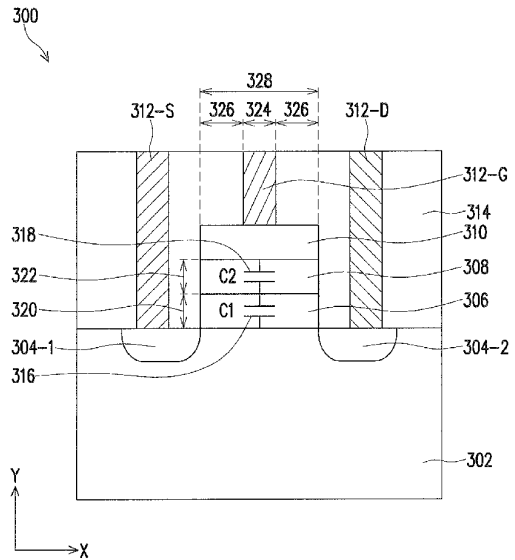
(65) **Prior Publication Data**
US 2021/0391891 A1 Dec. 16, 2021

Related U.S. Application Data
(63) Continuation of application No. 16/668,707, filed on Oct. 30, 2019, now Pat. No. 11,128,339.

(51) **Int. Cl.**
H04B 1/48 (2006.01)
H01Q 1/50 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H04B 1/48** (2013.01); **H01L 23/66** (2013.01); **H01L 29/513** (2013.01); **H01L 29/516** (2013.01); **H01L 29/6684** (2013.01); **H01L 29/7851** (2013.01); **H01L 29/78391** (2014.09); **H01Q 1/50** (2013.01)

20 Claims, 17 Drawing Sheets





US011811144B2

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

(10) **Patent No.:** **US 11,811,144 B2**
(45) **Date of Patent:** **Nov. 7, 2023**

- (54) **ANTENNA DEVICE**
- (71) Applicant: **CommScope Technologies LLC**, Hickory, NC (US)
- (72) Inventors: **Changfu Chen**, Suzhou (CN); **Xiaotuo Wang**, Suzhou (CN); **Xun Zhang**, Suzhou (CN)
- (73) Assignee: **CommScope Technologies LLC**, Hickory, NC (US)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 127 days.
- (21) Appl. No.: **17/348,890**
- (22) Filed: **Jun. 16, 2021**
- (65) **Prior Publication Data**
US 2021/0399438 A1 Dec. 23, 2021
- (30) **Foreign Application Priority Data**
Jun. 18, 2020 (CN) 202010559668.5
- (51) **Int. Cl.**
H01Q 15/14 (2006.01)
H01Q 21/24 (2006.01)
H01Q 1/52 (2006.01)
- (52) **U.S. Cl.**
CPC **H01Q 21/24** (2013.01); **H01Q 1/52** (2013.01); **H01Q 15/14** (2013.01)
- (58) **Field of Classification Search**
CPC H01Q 21/24; H01Q 1/52; H01Q 15/14
See application file for complete search history.

- (56) **References Cited**
- U.S. PATENT DOCUMENTS
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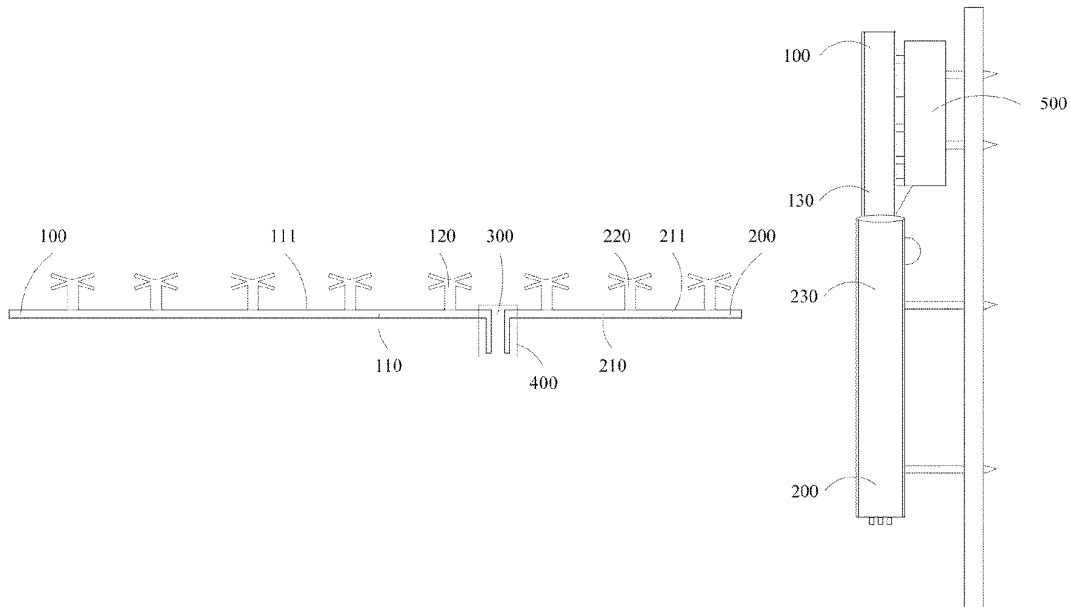
"Extended European Search Report for European Application No. 21179745.1, dated Nov. 12, 2021, 16 pages".

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Primary Examiner — Dieu Hien T Duong
(74) *Attorney, Agent, or Firm* — Myers Bigel, P.A.

- (57) **ABSTRACT**
- The present disclosure relates to an antenna device comprising: a first antenna comprising a first reflecting member configured to reflect at least a portion of a signal radiated by the antenna device; a second antenna comprising a second reflecting member configured to reflect at least a portion of the signal radiated by the antenna device, there is a spacing between the first reflecting member and the second reflecting member; and a coupling capacitor comprising a first polar plate and a second polar plate, the first polar plate is disposed on a side, close to the spacing, of a first reflecting surface of the first reflecting member, and the second polar plate is disposed on a side, close to the spacing, of a second reflecting surface of the second reflecting member.

20 Claims, 7 Drawing Sheets





US011811149B2

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

(10) **Patent No.:** **US 11,811,149 B2**
(45) **Date of Patent:** **Nov. 7, 2023**

(54) **MULTI-BAND ANTENNA**

(71) Applicant: **Cheng Uei Precision Industry Co., LTD.**, New Taipei (TW)

(72) Inventors: **Ming-Ju Lin**, New Taipei (TW);
Chih-Chung Wang, New Taipei (TW);
Lan-Yung Hsiao, New Taipei (TW);
Shao-Kai Sun, New Taipei (TW)

(73) Assignee: **CHENG UEI PRECISION INDUSTRY CO., LTD.**, New Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 86 days.

(21) Appl. No.: **17/725,382**

(22) Filed: **Apr. 20, 2022**

(65) **Prior Publication Data**

US 2022/0376393 A1 Nov. 24, 2022

(30) **Foreign Application Priority Data**

May 20, 2021 (CN) 202121081400.1

(51) **Int. Cl.**
H01Q 5/371 (2015.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 5/371** (2015.01); **H01Q 9/045** (2013.01); **H01Q 9/0421** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 5/371; H01Q 9/0421; H01Q 9/045;
H01Q 1/48
See application file for complete search history.

(56) **References Cited**

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343/700 MS
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Primary Examiner — Dieu Hien T Duong

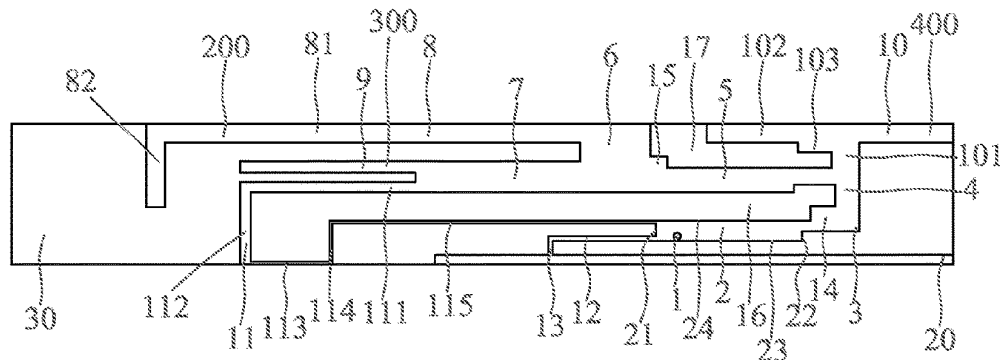
(74) *Attorney, Agent, or Firm* — Cheng-Ju Chiang

(57) **ABSTRACT**

A multi-band antenna includes a lower grounding portion, a feed-in portion, a feeding point, an upper grounding portion, a first extending portion, a second extending portion, a third extending portion, a fourth extending portion, a fifth extending portion, a first branch, a second branch, a third branch and a loop portion. The feed-in portion, the first extending portion, the second extending portion, the third extending portion, the fourth extending portion and the first branch form a first radiation portion. The feed-in portion, the first extending portion, the second extending portion, the third extending portion, the fifth extending portion and the second branch form a second radiation portion. The feed-in portion, the first extending portion, the second extending portion and the third branch form a third radiation portion.

20 Claims, 7 Drawing Sheets

100





US011811153B2

(12) **United States Patent**
Yamauchi

(10) **Patent No.:** **US 11,811,153 B2**
(45) **Date of Patent:** **Nov. 7, 2023**

(54) **WIRELESS MODULE**

- (71) Applicant: **LAPIS Technology Co., Ltd.**,
Yokohama (JP)
- (72) Inventor: **Shigeki Yamauchi**, Yokohama (JP)
- (73) Assignee: **LAPIS TECHNOLOGY CO., LTD.**,
Yokohama (JP)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 22 days.

(21) Appl. No.: **17/545,745**

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

(65) **Prior Publication Data**

US 2022/0181782 A1 Jun. 9, 2022

(30) **Foreign Application Priority Data**

Dec. 8, 2020 (JP) 2020-203361

(51) **Int. Cl.**

H01Q 1/22 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/04 (2006.01)

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

CPC **H01Q 9/0421** (2013.01); **H01Q 1/2283**
(2013.01); **H01Q 1/243** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/24; H01Q 1/243; H01Q 1/22;
H01Q 1/2283; H01Q 9/04; H01Q 9/0421;
H01Q 7/00

See application file for complete search history.

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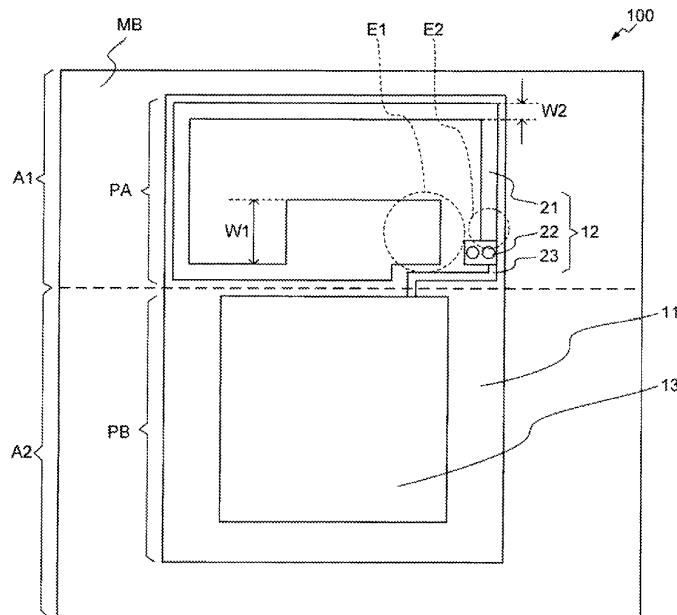
Primary Examiner — Thai Pham

(74) *Attorney, Agent, or Firm* — Rabin & Berdo, P.C.

(57) **ABSTRACT**

A wireless module has a multilayer substrate, an element installation section formed in one region in a substrate plane of the multilayer substrate, and an antenna. The antenna includes a conductor unit formed in another region in the substrate plane of the multilayer substrate. The conductor unit has a first end and a second end that extend along an outer periphery of the other region and that are separated from each other in a direction of the extension, and is formed in a loop as seen from a direction perpendicular to a substrate surface of the multilayer substrate. A feed unit connected to the first end of the conductor unit receives input of an AC signal of a prescribed frequency. A short-circuit line has a first end connected to a ground and a second end connected to the conductor unit through the feed unit.

7 Claims, 6 Drawing Sheets





US011815964B2

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

(10) **Patent No.:** **US 11,815,964 B2**
(45) **Date of Patent:** **Nov. 14, 2023**

(54) **ANTENNA STRUCTURE AND DISPLAY DEVICE COMPRISING SAME**

(71) Applicant: **DONGWOO FINE-CHEM CO., LTD.**, Jeollabuk-do (KR)

(72) Inventors: **Jong Min Kim**, Gyeonggi-do (KR); **Han Sub Ryu**, Gyeongsangbuk-do (KR); **Dong Pil Park**, Incheon (KR)

(73) Assignee: **DONGWOO FINE-CHEM CO., LTD.**, Jeollabuk-Do (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 547 days.

(21) Appl. No.: **17/154,266**

(22) Filed: **Jan. 21, 2021**

(65) **Prior Publication Data**

US 2021/0141426 A1 May 13, 2021

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2019/009004, filed on Jul. 22, 2019.

(30) **Foreign Application Priority Data**

Jul. 23, 2018 (KR) 10-2018-0085540

(51) **Int. Cl.**

G06F 1/16 (2006.01)

G06F 1/18 (2006.01)

(Continued)

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

CPC **G06F 1/1698** (2013.01); **G06F 1/1626** (2013.01); **G06F 1/189** (2013.01);

(Continued)

(58) **Field of Classification Search**

CPC G06F 1/1698; G06F 1/189; G06F 1/1626; H01Q 1/38; H01Q 1/364; H01Q 9/045; H01Q 1/22; H01Q 9/0485; H01Q 1/46
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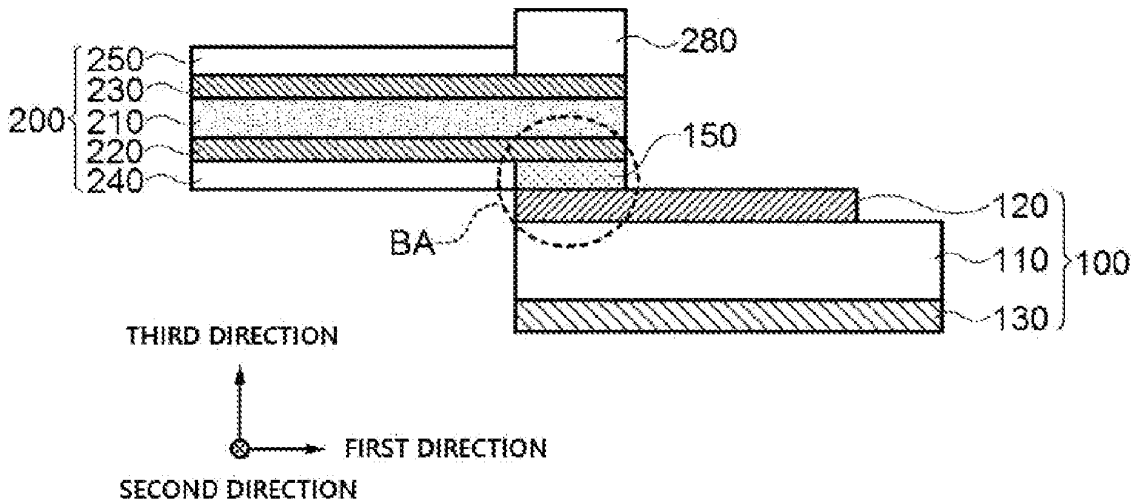
Primary Examiner — Khai M Nguyen

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

(57) **ABSTRACT**

An antenna structure of an embodiment of the present invention includes a film antenna including a dielectric layer and an antenna electrode layer formed on an upper surface of the dielectric layer, and a flexible circuit board including a power supply wiring electrically connected to the antenna electrode layer. A bonding region is defined by a region in which the antenna electrode layer and the power supply wiring are overlapped with each other in a planar direction, and the bonding region has a length of 1.5 mm or less. Signal efficiency and radiation reliability may be improved by adjusting a length of the bonding region.

18 Claims, 4 Drawing Sheets





US011817629B2

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

(10) **Patent No.:** **US 11,817,629 B2**

(45) **Date of Patent:** **Nov. 14, 2023**

(54) **DECOUPLED DIPOLE CONFIGURATION FOR ENABLING ENHANCED PACKING DENSITY FOR MULTIBAND ANTENNAS**

(58) **Field of Classification Search**

CPC H01Q 21/062; H01Q 21/26; H01Q 5/378; H01Q 21/06

USPC 343/797

See application file for complete search history.

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

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Primary Examiner — Hai V Tran

(74) *Attorney, Agent, or Firm* — Meunier Carlin & Curfman LLC

(57) **ABSTRACT**

Disclosed is a decoupling dipole structure that renders a midband dipole effectively transparent to a nearby lowband dipole. This not only improves the beam quality in the lowband without sacrificing beam quality in the midband, it also enables different lowband dipoles to be employed to customize the lowband performance of the multiband antenna without requiring a redesign of the midband dipoles or of the array face.

11 Claims, 6 Drawing Sheets

(21) Appl. No.: **17/552,674**

(22) Filed: **Dec. 16, 2021**

(65) **Prior Publication Data**

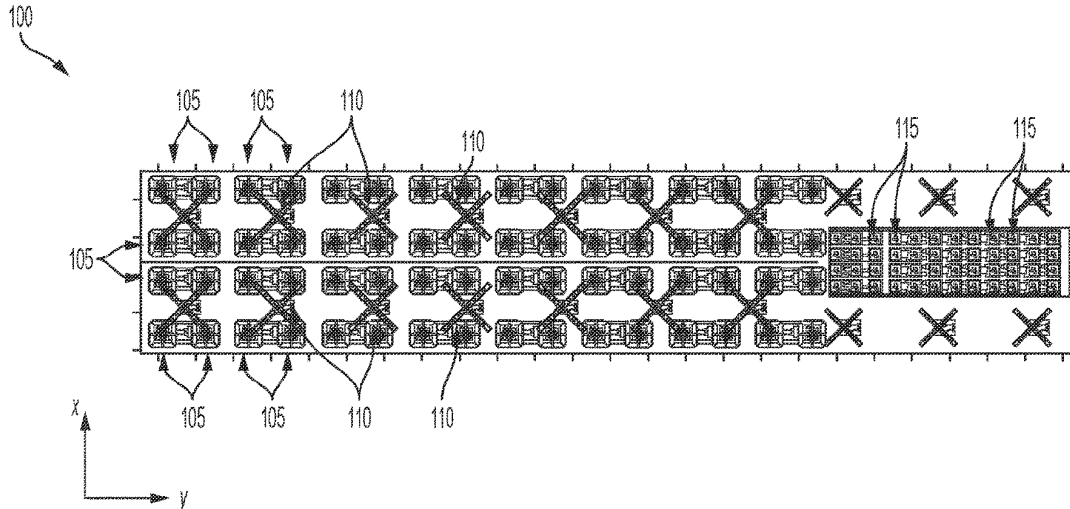
US 2022/0200164 A1 Jun. 23, 2022

Related U.S. Application Data

(60) Provisional application No. 63/128,550, filed on Dec. 21, 2020.

(51) **Int. Cl.**
H01Q 21/06 (2006.01)
H01Q 21/26 (2006.01)
H01Q 5/378 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 21/062** (2013.01); **H01Q 5/378** (2015.01); **H01Q 21/06** (2013.01); **H01Q 21/26** (2013.01)





US011817630B2

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

(10) **Patent No.:** **US 11,817,630 B2**
(45) **Date of Patent:** **Nov. 14, 2023**

(54) **SUBSTRATE INTEGRATED
WAVEGUIDE-FED FABRY-PEROT CAVITY
FILTERING WIDEBAND MILLIMETER
WAVE ANTENNA**

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(71) Applicant: **City University of Hong Kong**, Hong Kong (HK)

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(72) Inventors: **Haotao Hu**, Hong Kong (HK); **Chi Hou Chan**, Hong Kong (HK)

Gao et al, Low-Profile Circularly Polarized Fabry-Perot Resonator Antenna Array with Substrate Integrated Waveguide Feed Network, 2017, IEEE 5th International Symposium on Electromagnetic Compatibility (EMC-Beijing), pp. 1-3 (Year: 2017).*

(73) Assignee: **City University of Hong Kong**, Hong Kong (HK)

(Continued)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 59 days.

Primary Examiner — Ab Salam Alkassim, Jr.

Assistant Examiner — Anh N Ho

(21) Appl. No.: **17/477,578**

(74) *Attorney, Agent, or Firm* — Idea Intellectual Limited; Margaret A. Burke; Sam T. Yip

(22) Filed: **Sep. 17, 2021**

(65) **Prior Publication Data**

US 2023/0092871 A1 Mar. 23, 2023

(57) **ABSTRACT**

(51) **Int. Cl.**
H01Q 19/185 (2006.01)
H01Q 21/06 (2006.01)
(Continued)

The present invention provides wideband millimeter-wave SIW-fed FPC filtering antenna comprising a partially reflecting surface (PRS) and a filtering source configured to radiate a millimeter-wavelength electromagnetic wave. The filtering source comprises a conductive reflecting plane configured to work with the PRS to form a Fabry-Perot cavity; radiating elements including a pair of shorted radiating patches electrically connected to a ground plane through a pair of probes; and a substrate integrated waveguide (SIW) feeding structure coupled to the pair of radiating patches through a coupling aperture. The SIW-fed FPC filtering antenna has the advantages of wider bandwidth, higher directivity/gain, reduced structural complexity, compact size and appropriate feeding type for millimeter-wave applications.

(52) **U.S. Cl.**
CPC **H01Q 21/065** (2013.01); **H01P 1/2088** (2013.01); **H01Q 15/006** (2013.01); **H01Q 19/185** (2013.01)

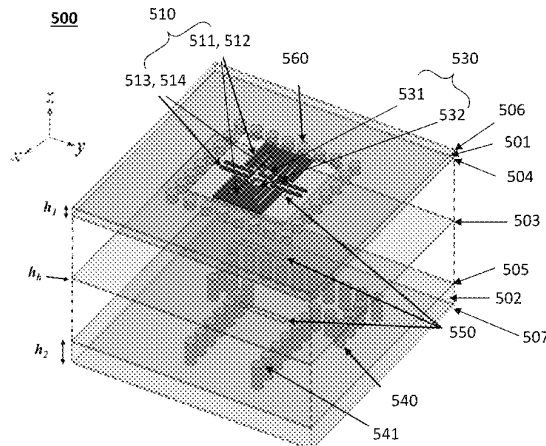
(58) **Field of Classification Search**
CPC .. H01Q 21/065; H01Q 15/006; H01Q 19/185; H01Q 1/38; H01Q 9/0407; H01P 1/2088
See application file for complete search history.

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9 Claims, 24 Drawing Sheets
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(54) **ANTENNA ARRANGEMENT FOR MOBILE RADIO SYSTEMS WITH AT LEAST ONE DUAL-POLARISED TURNSTILE ANTENNA**

(58) **Field of Classification Search**
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(57) **ABSTRACT**

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An antenna arrangement comprises a dual-polarised turnstile antenna, which comprises a first and a second dipole antenna element, which are aligned perpendicular to one another. The first and second dipole antenna elements each comprises two dipole halves. The dipole halves of both dipole antenna elements comprise a dipole section and a coupling section, which are galvanically connected to each other and to a first end of a ground connection medium or a signal connection medium. The coupling sections each extend along the closest dipole section of the adjacent other first and/or second dipole antenna element, wherein a spacing gap is formed between a coupling side of the respective coupling section of the first and/or second dipole antenna

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