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

(10) **Patent No.:** **US 11,231,753 B2**
(45) **Date of Patent:** **Jan. 25, 2022**

- (54) **ELECTRONIC APPARATUS HAVING AN ANTENNA DEVICE**
- (71) Applicant: **LENOVO (SINGAPORE) PTE. LTD.**,
Singapore (SG)
- (72) Inventors: **Tabito Miyamoto**, Kanagawa (JP);
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- (73) Assignee: **LENOVO (SINGAPORE) 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 128 days.

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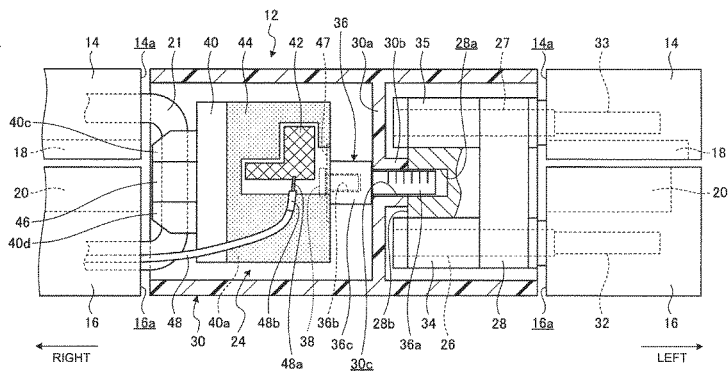
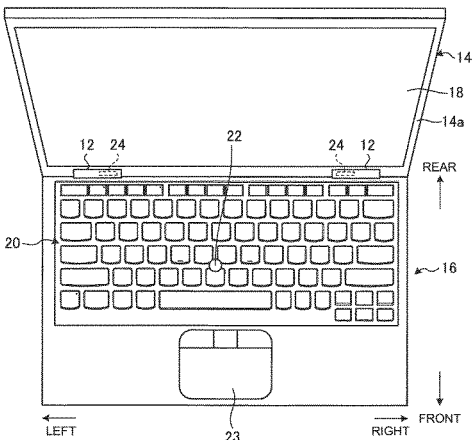
- (21) Appl. No.: **16/878,153**
- (22) Filed: **May 19, 2020**
- (65) **Prior Publication Data**
US 2020/0371562 A1 Nov. 26, 2020
- (30) **Foreign Application Priority Data**
May 20, 2019 (JP) JP2019-094491
- (51) **Int. Cl.**
G06F 1/16 (2006.01)
H01Q 1/24 (2006.01)
- (52) **U.S. Cl.**
CPC **G06F 1/1681** (2013.01); **G06F 1/1637**
(2013.01); **H01Q 1/243** (2013.01)
- (58) **Field of Classification Search**
CPC combination set(s) only.
See application file for complete search history.

- FOREIGN PATENT DOCUMENTS
- JP 2003-264414 A 9/2003
- JP 2018121149 A 8/2018
- Primary Examiner* — Lisa Lea-Edmonds
- (74) *Attorney, Agent, or Firm* — Antony P. Ng; Russell Ng PLLC

(57) **ABSTRACT**
An electronic apparatus is disclosed. The electronic apparatus includes a hinge device rotatably coupling a main body chassis and a display chassis; and an antenna device for transmitting and receiving a radio wave. The hinge device includes a metal hinge shaft, a metal bearing part, a metal chassis mount member, and a hinge chassis that is made of a radio wave transmissive material. The antenna device includes a holder component housed in the hinge chassis, an antenna element supported by the holder component and a ground element supported by the holder component and electrically connected to the bearing part.

13 Claims, 6 Drawing Sheets

10



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

(10) **Patent No.:** **US 11,233,311 B2**
(45) **Date of Patent:** **Jan. 25, 2022**

(54) **SYSTEM AND METHOD FOR AN ISOLATOR FOR A HINGE CAVITY OF AN INFORMATION HANDLING SYSTEM HAVING ONE OR MORE ANTENNA ELEMENTS**

(71) Applicant: **Dell Products, LP**, Round Rock, TX (US)
(72) Inventors: **Changsoo Kim**, Cedar Park, TX (US); **Suresh K. Ramasamy**, Cedar Park, TX (US); **Timothy C. Shaw**, Austin, TX (US); **Geroncio O. Tan**, Austin, TX (US)

(73) Assignee: **Dell Products, LP**, Round Rock, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 170 days.

(21) Appl. No.: **16/778,745**

(22) Filed: **Jan. 31, 2020**

(65) **Prior Publication Data**
US 2021/0242566 A1 Aug. 5, 2021

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/22 (2006.01)
H01Q 1/52 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/2266** (2013.01); **H01Q 1/52** (2013.01); **H01Q 1/521** (2013.01)

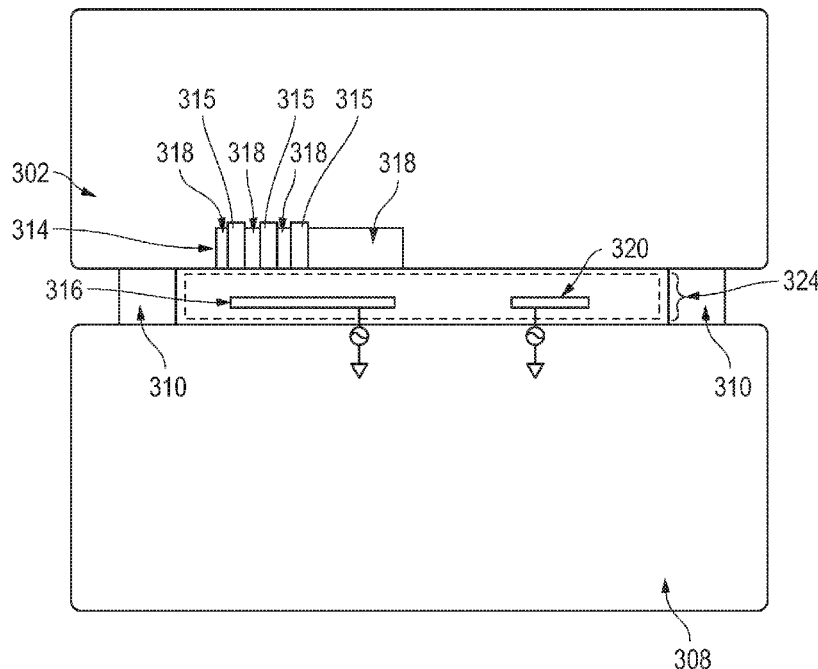
(58) **Field of Classification Search**
CPC H01Q 1/2266; H01Q 1/521; H01Q 1/52; H01Q 1/243
See application file for complete search history.

(56) **References Cited**
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Primary Examiner — Dieu Hien T Duong
(74) *Attorney, Agent, or Firm* — Prol Intellectual Property Law, PLLC; H. Kenneth Prol

(57) **ABSTRACT**
An information handling system to wirelessly transmit and receive data at an antenna may include a processor; a memory; a wireless adapter; a base metal chassis containing components of the information handling system, the base metal chassis including a C-cover and D-cover housing the components; a display metal chassis containing components of the information handling system, the display metal chassis including an A-cover and a B-cover housing the components; a hinge cavity formed at a hinge used to couple the base metal chassis and display metal chassis; a first antenna element formed within the C-cover near the hinge; a second antenna element formed within the C-cover near the hinge; and an edge resonant isolator formed into the A-cover to disrupt an electrical ground coupling path formed between the base metal chassis and display metal chassis at the hinge cavity, wherein the edge resonant isolator includes a plurality of slits formed into the A-cover.

20 Claims, 10 Drawing Sheets





US011233312B2

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

(10) **Patent No.:** **US 11,233,312 B2**
(45) **Date of Patent:** **Jan. 25, 2022**

(54) **ANTENNA DEVICE HAVING SLIT STRUCTURE AND ELECTRONIC DEVICE INCLUDING THE SAME**

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 13/10; H01Q 1/44
See application file for complete search history.

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

(56) **References Cited**

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Kyung-Bae Ko, Gyeonggi-do (KR);
Youngjung Kim, Seoul (KR);
Jong-Suk Kim, Gyeonggi-do (KR);
Taegyu Kim, Gyeonggi-do (KR);
Jinkyu Bang, Gyeonggi-do (KR);
Changha Yu, Gyeonggi-do (KR);
Young-Sung Lee, Gyeonggi-do (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 302 days.

(21) Appl. No.: **15/922,466**

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

(65) **Prior Publication Data**
US 2018/0269561 A1 Sep. 20, 2018

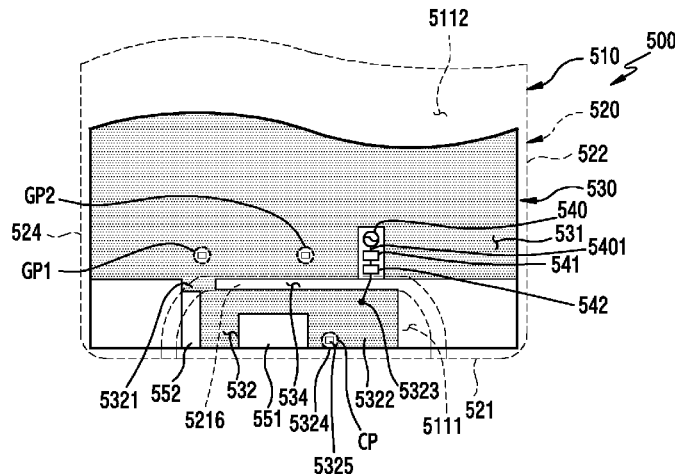
(30) **Foreign Application Priority Data**
Mar. 15, 2017 (KR) 10-2017-0032324

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 13/10 (2006.01)
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(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/085**
(2013.01); **H01Q 1/36** (2013.01); **H01Q 1/44**
(2013.01);
(Continued)

(57) **ABSTRACT**

An electronic device includes housing including first plate, second plate, and side member, wherein side member includes first side face in first direction having first length, second side face having second length greater than first length, third side face extending parallel to first side face having first length, and fourth side face; touch screen display disposed within housing, and exposed through portion of first plate; a PCB between first plate and second plate to be parallel to second plate, wherein PCB includes ground plane and first L-shaped ground extension between first conductive region of second plate and first plate, and first L-shaped ground extension includes first portion extending in second direction from ground plane and second portion extending in first direction from first portion; and at least one first
(Continued)





US011233314B2

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

(10) **Patent No.:** **US 11,233,314 B2**

(45) **Date of Patent:** ***Jan. 25, 2022**

(54) **MOBILE TERMINAL**

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

(72) Inventors: **Yunmo Kang**, Seoul (KR); **Kangjae Jung**, Seoul (KR); **Sungjoon Hong**, Seoul (KR); **Byungwoon Jung**, Seoul (KR); **Sungjung Rho**, Seoul (KR)

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

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

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **17/004,681**

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

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. 16/752,485, filed on Jan. 24, 2020, now Pat. No. 10,790,575, which is a (Continued)

(30) **Foreign Application Priority Data**

Sep. 19, 2012 (KR) 10-2012-0104152

(51) **Int. Cl.**

H01Q 1/24 (2006.01)
H01Q 21/30 (2006.01)

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

CPC **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 1/48** (2013.01); **H01Q 1/50** (2013.01);

(Continued)

(58) **Field of Classification Search**

CPC H01Q 1/242-245; H01Q 5/50; H01Q 7/00; H01Q 9/26; H01Q 13/10; H01Q 21/30
See application file for complete search history.

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Primary Examiner — Andrea Lindgren Baltzell

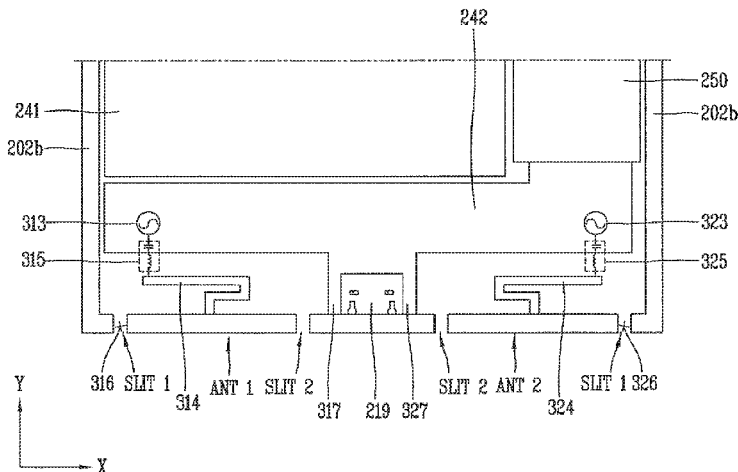
Assistant Examiner — Amal Patel

(74) *Attorney, Agent, or Firm* — Lee, Hong, Degerman, Kang & Waimey PC

(57) **ABSTRACT**

A mobile terminal comprises: a terminal body; and a first antenna device and a second antenna device disposed at one side of the terminal body in an adjacent manner, and formed to operate at different frequency bands, wherein the first antenna device and the second antenna device are provided with conductive members each having a slit at one side thereof, and wherein the conductive members form part of an appearance of the terminal body.

15 Claims, 13 Drawing Sheets



(12) **United States Patent**
Wakabayashi

(10) **Patent No.:** **US 11,233,322 B2**
(45) **Date of Patent:** **Jan. 25, 2022**

- (54) **COMMUNICATION DEVICE**
- (71) Applicant: **Sony Interactive Entertainment Inc.**,
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- (72) Inventor: **Minoru Wakabayashi**, Tokyo (JP)
- (73) Assignee: **Sony Interactive Entertainment Inc.**,
Tokyo (JP)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

- (56) **References Cited**
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- (21) Appl. No.: **16/765,211**
- (22) PCT Filed: **Nov. 30, 2018**
- (86) PCT No.: **PCT/JP2018/044238**
§ 371 (c)(1),
(2) Date: **May 19, 2020**
- (87) PCT Pub. No.: **WO2019/107553**
PCT Pub. Date: **Jun. 6, 2019**

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Primary Examiner — Graham P Smith
(74) *Attorney, Agent, or Firm* — Matthew B. Dernier, Esq.

- (65) **Prior Publication Data**
- US 2020/0280126 A1 Sep. 3, 2020

- (30) **Foreign Application Priority Data**
- Nov. 30, 2017 (JP) JP2017-230134

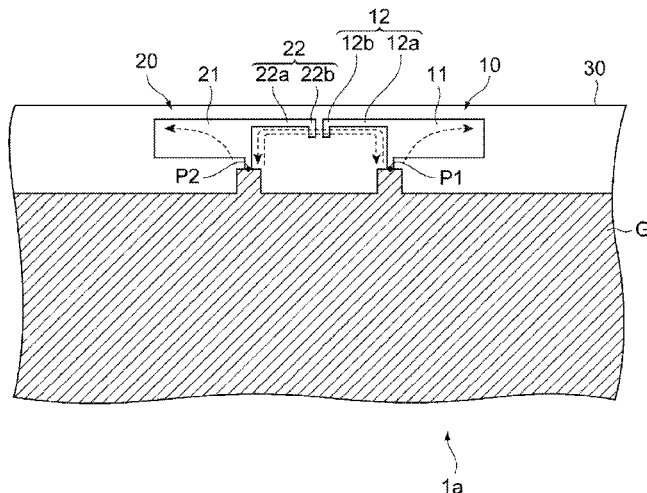
- (51) **Int. Cl.**
- H01Q 9/42** (2006.01)
H01Q 1/52 (2006.01)
H01Q 1/24 (2006.01)

- (52) **U.S. Cl.**
- CPC **H01Q 1/52** (2013.01); **H01Q 1/242** (2013.01); **H01Q 9/42** (2013.01)

- (58) **Field of Classification Search**
- CPC H01Q 1/52; H01Q 1/242; H01Q 9/42; H01Q 1/38
- See application file for complete search history.

- (57) **ABSTRACT**
- A communication device includes a first antenna and a second antenna that perform wireless communication in frequency bands that at least partly overlap each other, in which each of the first antenna and the second antenna includes a body part that resonates in a frequency band that is a target of the wireless communication with the each of the first antenna and the second antenna, and a branch part that branches from the body part. Each of the ranch part of the first antenna and the branch part of the second antenna includes a coupling part, the coupling part in the first antenna and the coupling part in the second antenna being disposed with an interval left to cause capacitive coupling.

5 Claims, 9 Drawing Sheets





US011233329B2

(12) **United States Patent**
Sampo

(10) **Patent No.:** **US 11,233,329 B2**
(45) **Date of Patent:** **Jan. 25, 2022**

- (54) **SLOTTED PATCH ANTENNA**
- (71) Applicant: **YOKOWO CO., LTD.**, Tokyo (JP)
- (72) Inventor: **Takeshi Sampo**, Tomioka (JP)
- (73) Assignee: **YOKOWO 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 95 days.
- (21) Appl. No.: **16/491,776**
- (22) PCT Filed: **Mar. 2, 2018**
- (86) PCT No.: **PCT/JP2018/008168**
§ 371 (c)(1),
(2) Date: **Sep. 6, 2019**
- (87) PCT Pub. No.: **WO2018/164018**
PCT Pub. Date: **Sep. 13, 2018**

(65) **Prior Publication Data**
US 2021/0135366 A1 May 6, 2021

(30) **Foreign Application Priority Data**
Mar. 8, 2017 (JP) JP2017-043786

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

(52) **U.S. Cl.**
CPC **H01Q 9/0435** (2013.01); **H01Q 1/288**
(2013.01); **H01Q 5/35** (2015.01); **H01Q 13/10**
(2013.01)

(58) **Field of Classification Search**
CPC H01Q 9/0435; H01Q 5/35; H01Q 13/10;
H01Q 1/288
See application file for complete search history.

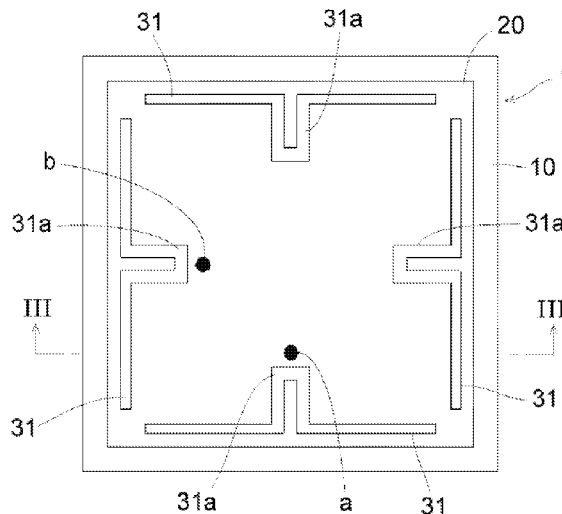
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Primary Examiner — Dieu Hien T Duong
(74) *Attorney, Agent, or Firm* — Xsensus LLP

(57) **ABSTRACT**
A slotted patch antenna includes a dielectric substrate, a radiation electrode which is provided on a major surface of the dielectric substrate, and a ground conductor which is disposed on a surface that is opposite to the major surface. The radiation electrode is formed with a slots having at least one of a meandering portion, a curve portion, or a folded portion. An external shape of the radiation electrode is a square, and totally two pairs of slots are formed inside the square, each of the slots being along respective sides of the square. Each of the slots is arranged so as to be line-symmetrical with respect to an axis of symmetry that is parallel with one of the sides of the square and passes through a center of the square, and to be point-symmetrical with respect to the center of the square.

6 Claims, 9 Drawing Sheets





US011233331B2

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

(10) **Patent No.:** **US 11,233,331 B2**
(45) **Date of Patent:** **Jan. 25, 2022**

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

(72) Inventors: **Kazuya Nakano**, Osaka (JP);
Yasuharu Matsuoka, Osaka (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 16 days.

(21) Appl. No.: **16/940,752**

(22) Filed: **Jul. 28, 2020**

(65) **Prior Publication Data**
US 2020/0358197 A1 Nov. 12, 2020

Related U.S. Application Data
(63) Continuation of application No. PCT/JP2018/048269, filed on Dec. 27, 2018.

(30) **Foreign Application Priority Data**
Jan. 31, 2018 (JP) JP2018-015528

(51) **Int. Cl.**
H01Q 9/42 (2006.01)
H01Q 5/307 (2015.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 9/42** (2013.01); **H01Q 1/38** (2013.01); **H01Q 5/307** (2015.01); **H01Q 1/2266** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/38; H01Q 5/364; H01Q 5/321; H01Q 5/378; H01Q 5/307
See application file for complete search history.

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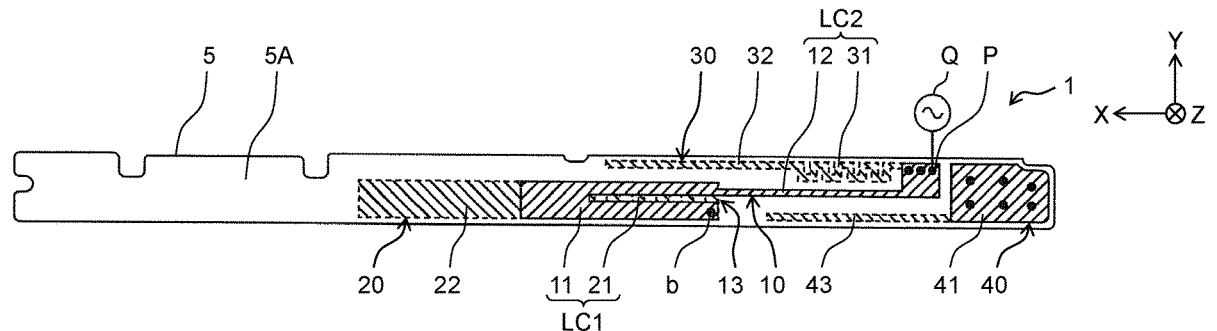
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Primary Examiner — Ricardo I Magallanes
(74) *Attorney, Agent, or Firm* — Renner, Otto, Boisselle & Sklar, LLP

(57) **ABSTRACT**
An antenna device includes a dielectric substrate having a first main surface and a second main surface, a feedpoint provided at a predetermined position of the dielectric substrate, a first radiating element provided on the first main surface and extending from the feedpoint in a predetermined direction, an interlayer connection conductor connected to the first radiating element, a second radiating element provided on the second main surface and extending from the interlayer connection conductor in the predetermined direction, and a third radiating element extending from the feedpoint in the predetermined direction on a path different from a path of the first radiating element. The first radiating element has a U-shaped part that turns away from the feedpoint in a predetermined direction and then turns back and approaches the feedpoint. The third radiating element has a meander-shaped part that meanders by repeatedly approaching and going away from the first radiating element in the plan view.

11 Claims, 30 Drawing Sheets



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

(10) **Patent No.:** **US 11,233,336 B2**
(45) **Date of Patent:** **Jan. 25, 2022**

(54) **CHIP ANTENNA AND CHIP ANTENNA MODULE INCLUDING THE SAME**

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

(72) Inventors: **Ju Hyoung Park**, Suwon-si (KR); **Kyu Bum Han**, Suwon-si (KR); **Jae Yeong Kim**, Suwon-si (KR); **Jeong Ki Ryoo**, Suwon-si (KR); **Sung Nam Cho**, Suwon-si (KR); **Sung Yong An**, 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 137 days.

(21) Appl. No.: **16/670,139**

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

(65) **Prior Publication Data**
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(30) **Foreign Application Priority Data**
Feb. 8, 2019 (KR) 10-2019-0015001
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(Continued)

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(Continued)

(58) **Field of Classification Search**
CPC H01Q 19/10; H01Q 1/22; H01Q 1/2283; H01Q 1/24; H01Q 1/243; H01Q 1/38;
(Continued)

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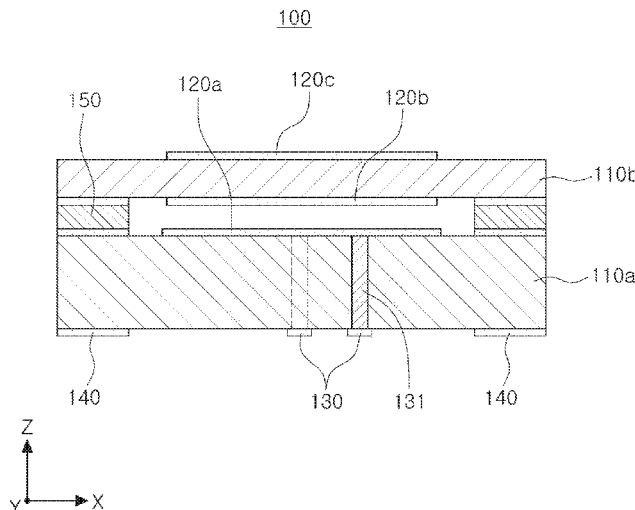
Primary Examiner — Tho G Phan

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

(57) **ABSTRACT**

A chip antenna includes a first ceramic substrate, a second ceramic substrate disposed to face the first ceramic substrate, a first patch disposed on one surface of the first ceramic substrate to operate as a feeding patch, a second patch disposed on the second ceramic substrate to operate as a radiation patch, at least one feed via penetrating through the first ceramic substrate in a thickness direction to provide a feed signal to the first patch, and a bonding pad disposed on a second surface of the first ceramic substrate opposite the first surface. A thickness of the first ceramic substrate is greater than a thickness of the second ceramic substrate.

19 Claims, 17 Drawing Sheets



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

(10) **Patent No.:** **US 11,233,337 B2**
(45) **Date of Patent:** **Jan. 25, 2022**

(54) **ANTENNA APPARATUS**
(71) Applicant: **Samsung Electro-Mechanics Co., Ltd.**,
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(72) Inventors: **Jeong Ki Ryoo**, Suwon-si (KR); **Hong In Kim**,
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(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 522 days.

(21) Appl. No.: **16/169,367**

(22) Filed: **Oct. 24, 2018**

(65) **Prior Publication Data**

US 2019/0273325 A1 Sep. 5, 2019

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

(52) **U.S. Cl.**
CPC **H01Q 21/061** (2013.01); **H01Q 5/35**
(2015.01); **H01Q 9/045** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 9/0407; H01Q 9/045; H01Q 9/0478;
H01Q 9/0442; H01Q 9/0435; H01Q
9/0428; H01Q 21/065; H01Q 21/067
See application file for complete search history.

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lish and 4 pages in Korean).

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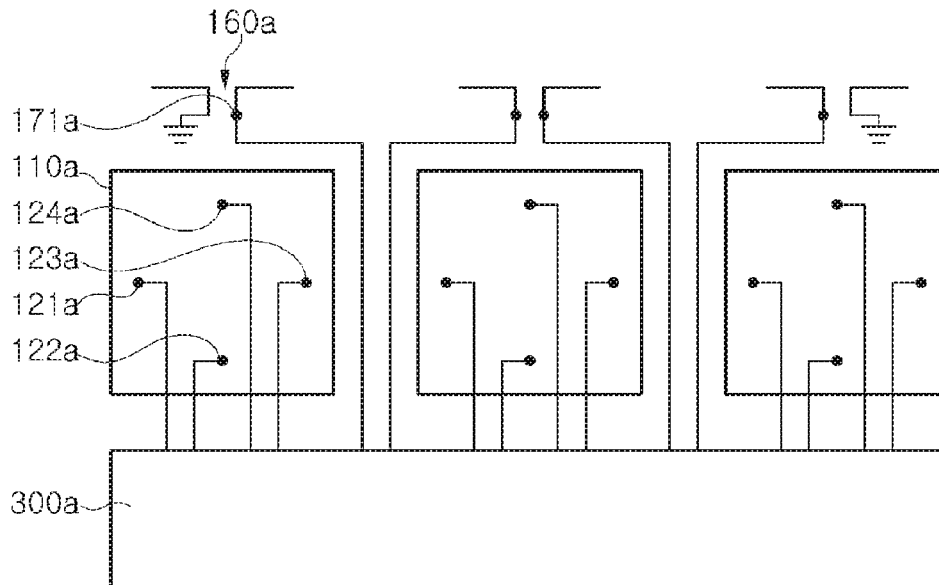
Primary Examiner — Ab Salam Alkassim, Jr.

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

(57) **ABSTRACT**

An antenna apparatus includes patch antennas arranged in an N×1 array, first feed vias, second feed vias, third feed vias, and fourth feed vias connected to a point offset from a center of each of the patch antennas, in a first direction, second direction, third direction, and fourth direction, respectively a first RF signal of a first phase passes through the first feed vias and the second feed vias, a second RF signal of a second phase passes through the third feed vias and the fourth feed vias, and wherein a line between the point in the first direction and the point in the second direction is oblique to a direction of an array of the patch antennas, and a line between the point in the third direction and the point in the fourth direction is oblique to the direction of the array.

16 Claims, 8 Drawing Sheets





US011233338B2

(12) **United States Patent**
Zhang

(10) **Patent No.:** **US 11,233,338 B2**

(45) **Date of Patent:** **Jan. 25, 2022**

(54) **ANTENNA ASSEMBLY FOR A
BEAMFORMING ANTENNA AND BASE
STATION ANTENNA**

21/26 (2013.01); H01Q 19/06 (2013.01);
H01Q 21/0031 (2013.01)

(58) **Field of Classification Search**

CPC H01Q 21/061; H01Q 1/246; H01Q 19/10;
H01Q 21/26; H01Q 21/0031; H01Q
19/06

(71) Applicant: **CommScope Technologies LLC,**
Hickory, NC (US)

See application file for complete search history.

(72) Inventor: **Xun Zhang,** Suzhou (CN)

(56) **References Cited**

(73) Assignee: **CommScope Technologies LLC,**
Hickory, NC (US)

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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.

2018/0131078 A1* 5/2018 Shoostari H01Q 21/0031

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Primary Examiner — Joseph J Lauture

(21) Appl. No.: **17/072,214**

(74) *Attorney, Agent, or Firm* — Myers Bigel, P.A.

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

(57) **ABSTRACT**

(65) **Prior Publication Data**

US 2021/0135371 A1 May 6, 2021

The present invention relates to an antenna assembly for a beamforming antenna, comprising a reflector and an antenna array that includes a plurality of first radiating elements that are arranged as a first vertically extending array, the first radiating elements extending forwardly from the reflector; and a plurality of second radiating elements that are arranged as a second vertically extending array, the second radiating elements extending forwardly from the reflector. Two adjacent first radiating elements are spaced apart from one another by a first distance, and a first radiating element and an adjacent second radiating element are spaced apart from one another by a second distance. The first distance is substantially equal to the second distance. The antenna assembly further comprises a plurality of parasitic elements that are placed along sides of the first and second of the vertically extending arrays.

(30) **Foreign Application Priority Data**

Nov. 6, 2019 (CN) 201911073578.9

(51) **Int. Cl.**

H01Q 21/00 (2006.01)

H01Q 21/06 (2006.01)

H01Q 1/24 (2006.01)

H01Q 19/10 (2006.01)

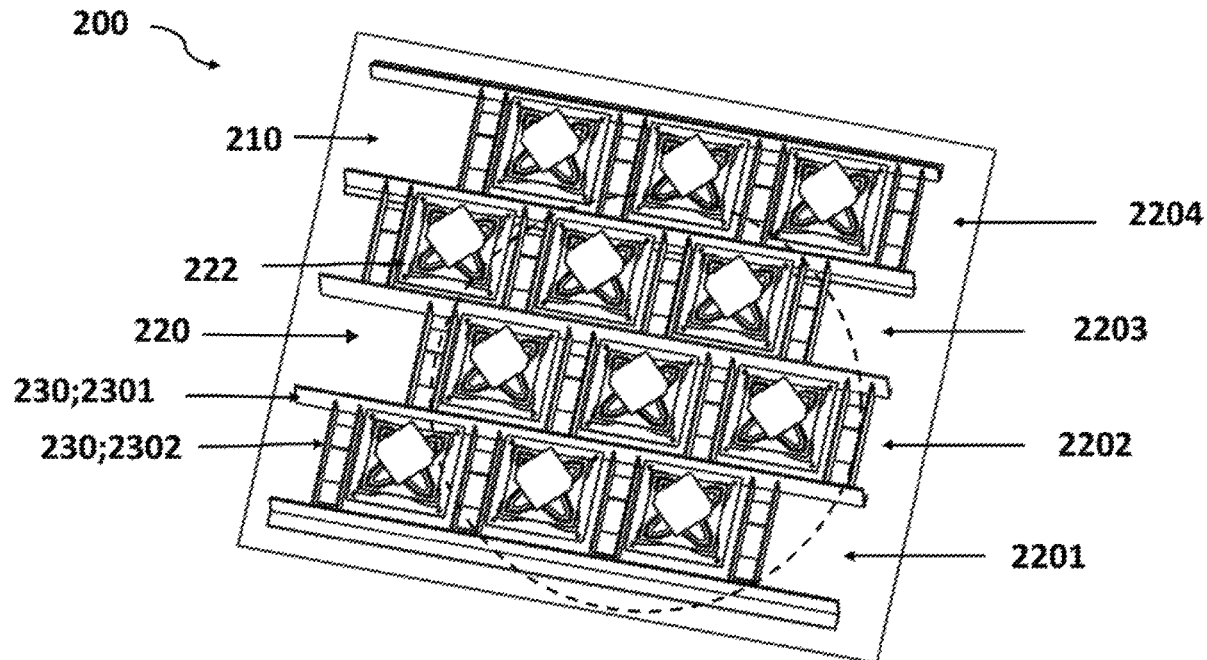
H01Q 21/26 (2006.01)

H01Q 19/06 (2006.01)

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

CPC **H01Q 21/061** (2013.01); **H01Q 1/246**
(2013.01); **H01Q 19/10** (2013.01); **H01Q**

20 Claims, 5 Drawing Sheets



(12) **United States Patent**
Jamaly

(10) **Patent No.:** **US 11,233,339 B2**
(45) **Date of Patent:** **Jan. 25, 2022**

(54) **METHODS AND SYSTEMS FOR IMPLEMENTING AND OPERATING MULTIPLE-INPUT AND MULTIPLE-OUTPUT (MIMO) ANTENNAS**

(71) Applicant: **Swisscom AG**, Bern (CH)

(72) Inventor: **Nima Jamaly**, Bern (CH)

(73) Assignee: **SWISSCOM AG**

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 48 days.

(21) Appl. No.: **16/578,208**

(22) Filed: **Sep. 20, 2019**

(65) **Prior Publication Data**

US 2020/0153121 A1 May 14, 2020

(30) **Foreign Application Priority Data**

Sep. 20, 2018 (GB) 1815362
Aug. 1, 2019 (GB) 1911016

(51) **Int. Cl.**
H01Q 21/24 (2006.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 21/245** (2013.01); **H01Q 9/0464** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 21/245; H01Q 9/0464; H01Q 1/52; H01Q 7/00; H01Q 25/001; H01Q 1/38; H01Q 1/50; H01Q 5/25; H01Q 15/24; H04B 1/0053; H04B 7/0413
See application file for complete search history.

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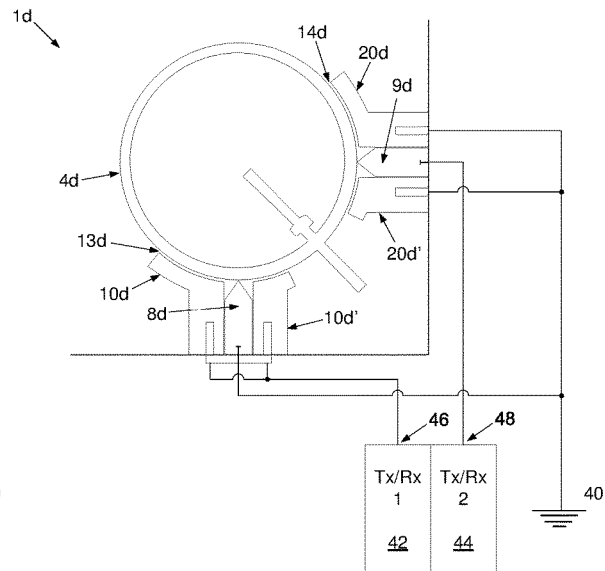
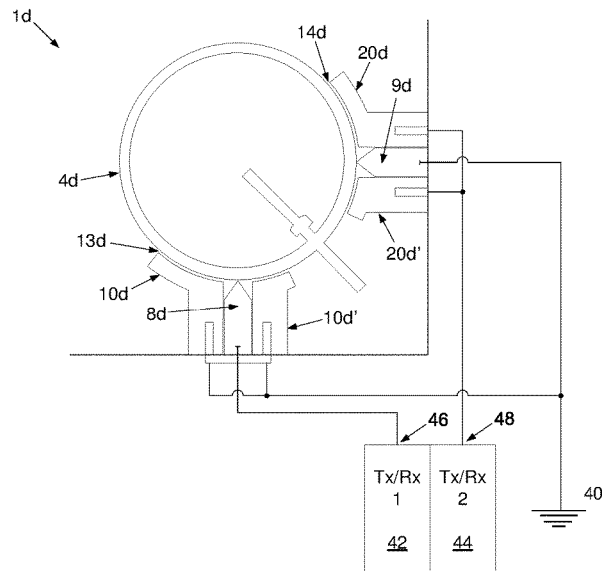
(Continued)

Primary Examiner — Lam T Mai
(74) *Attorney, Agent, or Firm* — McAndrews, Held & Malloy, Ltd.

(57) **ABSTRACT**

Methods and systems for implementing and operating antennas, particularly multiple-input and multiple-output (MIMO) antennas, for radio telecommunications.

20 Claims, 9 Drawing Sheets





US011239186B2

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

(10) **Patent No.:** **US 11,239,186 B2**
(45) **Date of Patent:** **Feb. 1, 2022**

(54) **DIE WITH EMBEDDED COMMUNICATION CAVITY**

(2013.01); *H01L 25/0655* (2013.01); *H01Q 1/2283* (2013.01); *H05K 1/0243* (2013.01);
(Continued)

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

(58) **Field of Classification Search**
CPC H01L 23/66; H05K 1/0243; H05K 3/4967
See application file for complete search history.

(72) Inventors: **Digvijay Raorane**, Chandler, AZ (US);
Vijay K. Nair, Mesa, AZ (US)

(56) **References Cited**

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

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

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(21) Appl. No.: **16/334,965**

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(22) PCT Filed: **Sep. 23, 2016**

WO WO-2018057007 A1 3/2018

(86) PCT No.: **PCT/US2016/053503**

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§ 371 (c)(1),
(2) Date: **Mar. 20, 2019**

*International Application Serial No. PCT/US2016/053503, International Search Report dated Jun. 7, 2017", 3 pgs.
(Continued)

(87) PCT Pub. No.: **WO2018/057007**

PCT Pub. Date: **Mar. 29, 2018**

Primary Examiner — Sarah K Salerno

(65) **Prior Publication Data**

US 2019/0267336 A1 Aug. 29, 2019

(74) *Attorney, Agent, or Firm* — Schwegman Lundberg & Woessner, P.A.

(51) **Int. Cl.**
H01L 23/66 (2006.01)
H01L 23/498 (2006.01)
(Continued)

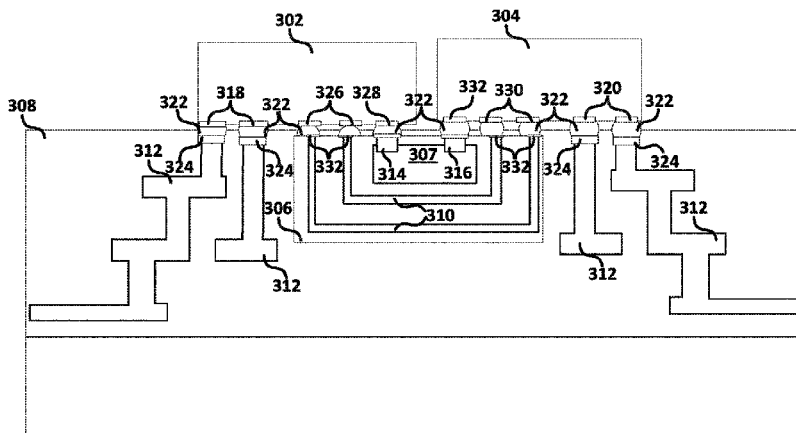
(57) **ABSTRACT**

Generally discussed herein are systems, devices, and methods that include a communication cavity. According to an example a device can include a substrate with a first cavity formed therein, first and second antennas exposed in and enclosed by the cavity, and an interconnect structure formed on the substrate, the interconnect structure including alternating conductive material layers and inter-layer dielectric layers.

(52) **U.S. Cl.**
CPC *H01L 23/66* (2013.01); *G06F 1/183* (2013.01); *H01L 23/00* (2013.01); *H01L 23/13* (2013.01); *H01L 23/48* (2013.01); *H01L 23/49816* (2013.01); *H01L 23/522* (2013.01); *H01L 23/5383* (2013.01); *H01L 23/5386* (2013.01); *H01L 24/09* (2013.01); *H01L 24/24*

12 Claims, 13 Drawing Sheets

300 ↙



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

(10) **Patent No.:** **US 11,239,544 B2**
(45) **Date of Patent:** **Feb. 1, 2022**

(54) **BASE STATION ANTENNA AND MULTIBAND BASE STATION ANTENNA**

(58) **Field of Classification Search**
CPC H01Q 1/246; H01Q 5/307; H01Q 21/062;
H01Q 21/26; H01Q 5/321; H01Q 9/16
See application file for complete search history.

(71) Applicant: **CommScope Technologies LLC**,
Hickory, NC (US)

(72) Inventors: **Ligang Wu**, Suzhou (CN); **Lei Yang**,
Suzhou (CN); **Hangsheng Wen**, Suzhou
(CN)

(56) **References Cited**

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(73) Assignee: **CommScope Technologies LLC**,
Hickory, NC (US)

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

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(21) Appl. No.: **17/081,373**

Primary Examiner — Joseph J Lature

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

(74) *Attorney, Agent, or Firm* — Myers Bigel, P.A.

(65) **Prior Publication Data**

US 2021/0135343 A1 May 6, 2021

(57) **ABSTRACT**

(30) **Foreign Application Priority Data**

Oct. 31, 2019 (CN) 201911056960.9
Dec. 25, 2019 (CN) 201911351453.8

A base station antenna that extends along a first longitudinal axis includes a first array configured to emit electromagnetic radiation. The first array includes a first column of radiating elements, the first column including a first radiating element and a pair of second radiating elements. The first radiating element is a cross dipole radiating element and the pair of second radiating elements includes a pair of second radiating elements that are disposed facing each other on both sides of the first longitudinal axis, where each of the second radiating elements includes first and second radiating arms that extend respectively in opposite directions substantially along the first longitudinal axis, and a third radiating arm that extends toward the first longitudinal axis substantially perpendicular to the first and second radiating arms.

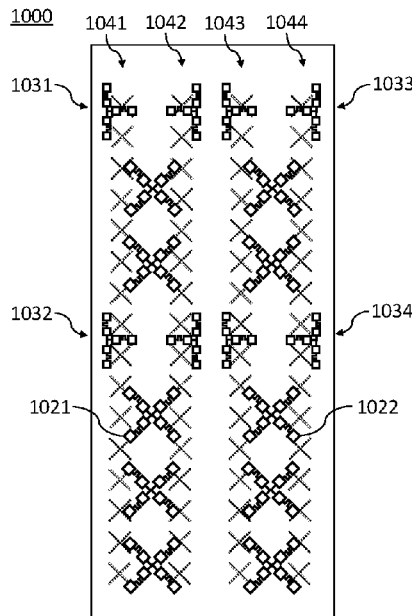
(51) **Int. Cl.**

H01Q 21/26 (2006.01)
H01Q 1/24 (2006.01)
H01Q 5/307 (2015.01)
H01Q 21/06 (2006.01)
H01Q 5/321 (2015.01)

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

CPC **H01Q 1/246** (2013.01); **H01Q 5/307**
(2015.01); **H01Q 21/062** (2013.01); **H01Q**
21/26 (2013.01); **H01Q 5/321** (2015.01)

20 Claims, 8 Drawing Sheets





US011239546B2

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

(10) **Patent No.:** **US 11,239,546 B2**

(45) **Date of Patent:** **Feb. 1, 2022**

(54) **MULTIPLE FEED SLOT ANTENNA**

(56) **References Cited**

(71) Applicant: **Motorola Mobility LLC**, Chicago, IL (US)

U.S. PATENT DOCUMENTS

(72) Inventors: **Junsheng Zhao**, Vernon Hills, IL (US);
Eric Le Roy Krenz, Crystal Lake, IL (US); **Hugh Smith**, Palatine, IL (US)

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(73) Assignee: **Motorola Mobility LLC**, Chicago, IL (US)

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

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(21) Appl. No.: **16/353,218**

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(22) Filed: **Mar. 14, 2019**

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(65) **Prior Publication Data**

US 2020/0295447 A1 Sep. 17, 2020

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(51) **Int. Cl.**
H01Q 1/38 (2006.01)
G06F 1/16 (2006.01)
H01Q 1/24 (2006.01)
H01Q 21/00 (2006.01)

Primary Examiner — Daniel D Chang

(74) *Attorney, Agent, or Firm* — FIG. 1 Patents

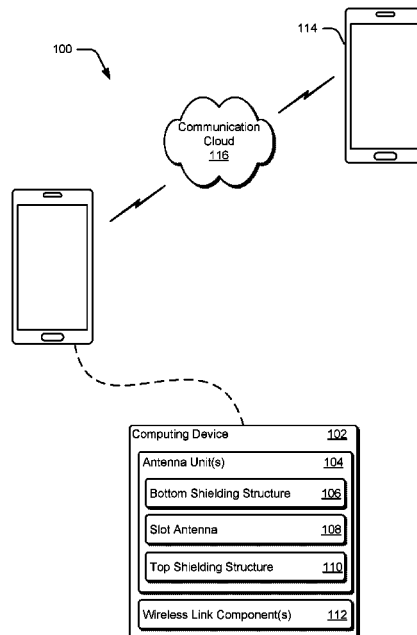
(52) **U.S. Cl.**
CPC **H01Q 1/38** (2013.01); **G06F 1/1698** (2013.01); **H01Q 1/243** (2013.01); **H01Q 21/0043** (2013.01)

(57) **ABSTRACT**

Multiple feed, front-shielded, coplanar waveguide, direct-fed, cavity-backed slot antennas are described. Various implementations form an antenna unit capable of millimeter waveform and/or microwave waveform transmissions. An antenna comprises a conductive plate that includes an aperture. The aperture has a shape that extends along an axis that bisects the aperture into first and second bisected portions, the first bisected portion having a first geometry type, and the second portion having a second geometry type that is a bilateral symmetry shape type of the first geometry type. In implementations, the aperture is configured to radiate wave-

(58) **Field of Classification Search**
CPC H01Q 13/18; H01Q 1/243; H01Q 21/0037; H01Q 1/40; H01Q 1/2266
See application file for complete search history.

(Continued)



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

(10) **Patent No.:** **US 11,239,547 B2**
(45) **Date of Patent:** **Feb. 1, 2022**

(54) **TERAHERTZ ELEMENT AND SEMICONDUCTOR DEVICE**

(71) Applicant: **ROHM CO., LTD.**, Kyoto (JP)

(72) Inventors: **Toshikazu Mukai**, Kyoto (JP);
Jaeyoung Kim, Kyoto (JP);
Tomoichiro Toyama, Kyoto (JP)

(73) Assignee: **ROHM 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 230 days.

(21) Appl. No.: **16/619,440**

(22) PCT Filed: **Jun. 26, 2018**

(86) PCT No.: **PCT/JP2018/024179**
§ 371 (c)(1),
(2) Date: **Dec. 4, 2019**

(87) PCT Pub. No.: **WO2019/004204**
PCT Pub. Date: **Jan. 3, 2019**

(65) **Prior Publication Data**
US 2020/0168985 A1 May 28, 2020

(30) **Foreign Application Priority Data**
Jun. 27, 2017 (JP) JP2017-125370
Oct. 18, 2017 (JP) JP2017-202021

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01L 23/66 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/38** (2013.01); **H01L 23/66** (2013.01); **H01L 24/48** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC ... H01Q 1/38; H01L 23/66; H01L 2223/6677;
H03B 7/06; H03B 7/08
See application file for complete search history.

(56) **References Cited**
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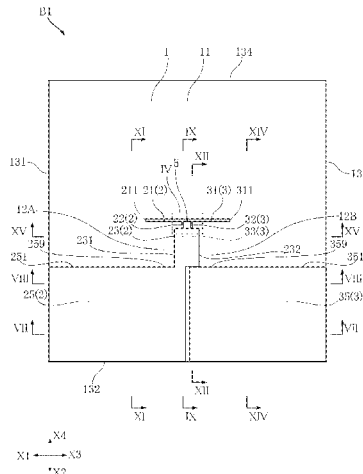
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Primary Examiner — Tucker J Wright
(74) *Attorney, Agent, or Firm* — Hamre, Schumann,
Mueller & Larson, P.C.

(57) **ABSTRACT**

A terahertz element of an aspect of the present disclosure includes a semiconductor substrate, first and second conductive layers, and an active element. The first and second conductive layers are on the substrate and mutually insulated. The active element is on the substrate and electrically connected to the first and second conductive layers. The first conductive layer includes a first antenna part extending along a first direction, a first capacitor part offset from the active element in a second direction as viewed in a thickness direction of the substrate, and a first conductive part connected to the first capacitor part. The second conductive layer includes a second capacitor part, stacked over and insulated from the first capacitor part. The substrate includes a part exposed from the first and

(Continued)





US011239548B2

(12) **United States Patent**
Merulla

(10) **Patent No.:** **US 11,239,548 B2**

(45) **Date of Patent:** **Feb. 1, 2022**

(54) **COSECANT SQUARED ANTENNA
RADIATION PATTERN**

(71) Applicant: **The Government of the United States,
as represented by the Secretary of the
Army, Washington, DC (US)**

(72) Inventor: **Emanuel Merulla, Bel Air, MD (US)**

(73) Assignee: **The Government of the United States,
as represented by the Secretary of the
Army, Washington, DC (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.: **16/907,392**

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

(65) **Prior Publication Data**

US 2020/0321692 A1 Oct. 8, 2020

Related U.S. Application Data

(62) Division of application No. 15/468,146, filed on Mar.
24, 2017, now Pat. No. 1,077,573.

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 9/27	(2006.01)
H01Q 1/38	(2006.01)
H01Q 5/335	(2015.01)
H01Q 21/20	(2006.01)

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

CPC **H01Q 1/38** (2013.01); **H01Q 5/335**
(2015.01); **H01Q 9/27** (2013.01); **H01Q**
21/205 (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/38; H01Q 5/335; H01Q 9/27;
H01Q 21/205

See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Hoang V Nguyen

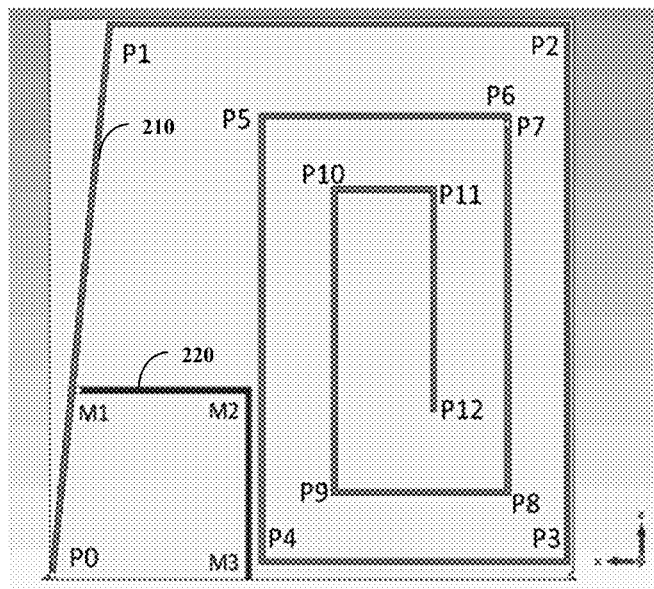
(74) *Attorney, Agent, or Firm* — Ronald Krosky

(57) **ABSTRACT**

Various embodiments are described that relate to an antenna. In one embodiment, the antenna can be a low profile, multi-band (e.g., dual band), emulated GPS constellation antenna. In one embodiment, the antenna can form a cube with two open sides and four circuit board sides. The four circuit boards can include a first hardware portion that allows functioning in a higher frequency band and a second hardware portion that allows functioning in a lower frequency band.

20 Claims, 10 Drawing Sheets

↙ 200A





US011239556B2

(12) **United States Patent**
Martel

(10) **Patent No.:** **US 11,239,556 B2**

(45) **Date of Patent:** **Feb. 1, 2022**

(54) **MULTI-BAND ANTENNA**

(71) Applicants: **Office National d'Etudes et de Recherches Aérospatiales**, Palaiseau (FR); **AIRBUS OPERATIONS (S.A.S.)**, Toulouse (FR)

(72) Inventor: **Cédric Martel**, Pechabou (FR)

(73) Assignees: **OFFICE NATIONAL D'ETUDES ET DE RECHERCHES AEROSPATIALES**, Palaiseau (FR); **AIRBUS OPERATIONS (S.A.S.)**, Toulouse (FR)

(*) 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.: **17/032,928**

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

(65) **Prior Publication Data**
US 2021/0098877 A1 Apr. 1, 2021

(30) **Foreign Application Priority Data**
Sep. 27, 2019 (FR) 19 10719

(51) **Int. Cl.**
H01Q 5/15 (2015.01)
H01Q 5/357 (2015.01)
H01Q 1/28 (2006.01)
H01Q 1/38 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 5/15** (2015.01); **H01Q 1/28** (2013.01); **H01Q 5/357** (2015.01)

(58) **Field of Classification Search**

CPC H01Q 5/15; H01Q 5/357; H01Q 1/28; H01Q 1/38; H01Q 21/30; H01Q 9/0421; H01Q 9/0414
See application file for complete search history.

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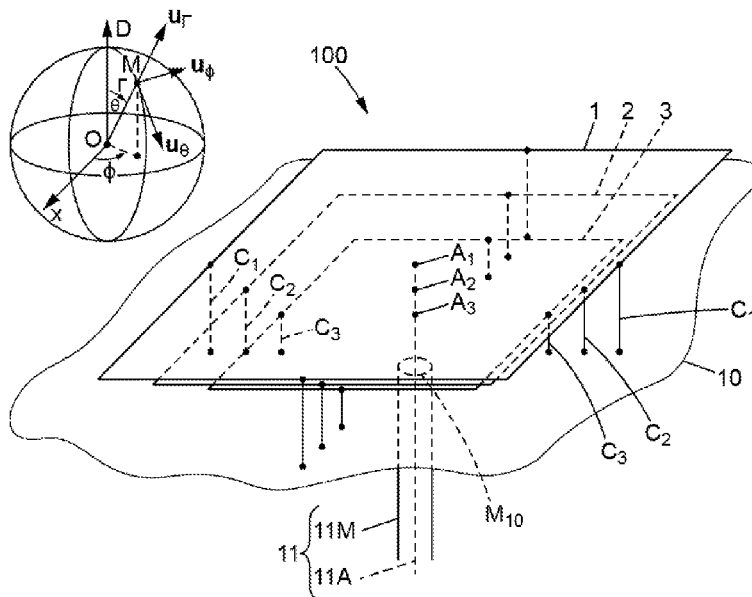
Primary Examiner — Hoang V Nguyen

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

(57) **ABSTRACT**

A multi-band antenna (100) including a metal base plate (10) forming an electrical ground plane, and a plurality of metal patches (1 to 3) superimposed on top of the metal base plate. The metal patches are connected in parallel between a signal lead wire (11A) and the metal base plate. The metal patches have respective surface areas which increase with the distance of each metal patch from the metal base plate. The antenna provides as many different resonant frequency values as there are patches.

18 Claims, 5 Drawing Sheets





US011239557B2

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

(10) **Patent No.:** US 11,239,557 B2

(45) **Date of Patent:** Feb. 1, 2022

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

(58) **Field of Classification Search**

CPC H01Q 5/307; H01Q 5/378
See application file for complete search history.

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

(56) **References Cited**

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(72) Inventors: **Chien-Yi Wu**, Taipei (TW);
Cheng-Hsiung Wu, Taipei (TW);
Chao-Hsu Wu, Taipei (TW);
Ching-Hsiang Ko, Taipei (TW);
Tse-Hsuan Wang, Taipei (TW);
Shih-Keng Huang, Taipei (TW); **Yi-Ru Yang**, Taipei (TW); **Sheng-Chin Hsu**, Taipei (TW)

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

Primary Examiner — Daniel Munoz

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 33 days.

(21) Appl. No.: 17/006,546

(57) **ABSTRACT**

(22) Filed: Aug. 28, 2020

An antenna structure including a first radiator and a second radiator is provided. The first radiator includes a first section, a second section, and a third section. The first section has a feed-in end. The second section is adjacent to the first section and connected to a position of the first section close to the feed-in end. The third section is connected to the second section and the feed-in end to encircle a space. The second radiator is disposed around the first section and the second section. The second radiator includes a first end and a second end opposite to each other. The first end is a ground end. A coupling interval is formed between the second end and the third section. A first frequency band, a second frequency band, and a third frequency band are resonated by the first radiator and the second radiator.

(65) **Prior Publication Data**

US 2021/0091466 A1 Mar. 25, 2021

(30) **Foreign Application Priority Data**

Sep. 24, 2019 (TW) 108134438

(51) **Int. Cl.**

H01Q 5/307 (2015.01)

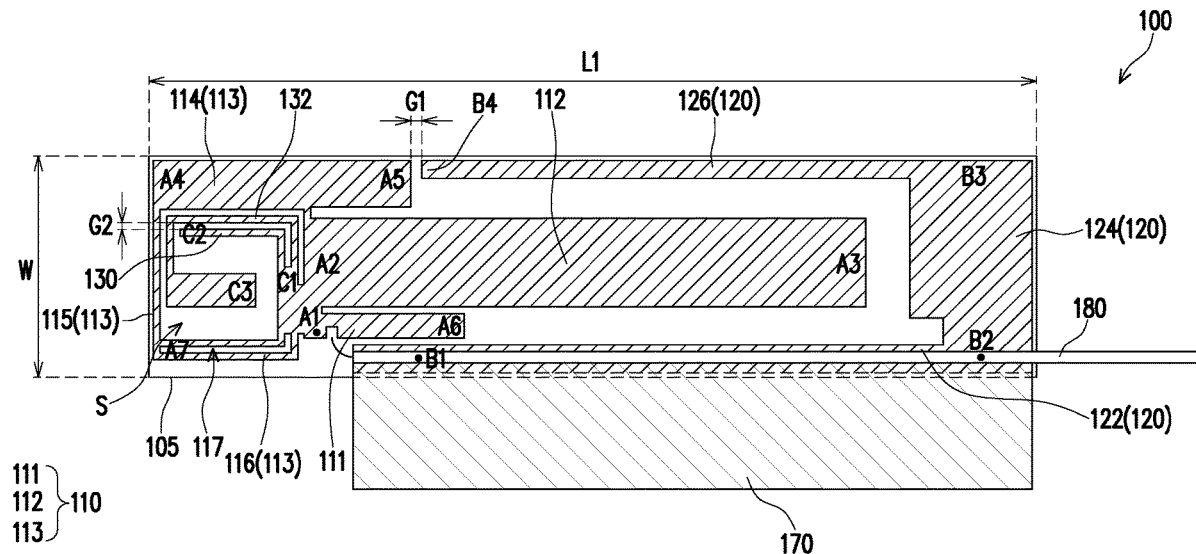
H01Q 1/48 (2006.01)

H01Q 5/10 (2015.01)

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

CPC **H01Q 5/307** (2015.01); **H01Q 1/48** (2013.01); **H01Q 5/10** (2015.01)

20 Claims, 8 Drawing Sheets





US011239559B2

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

(10) **Patent No.:** **US 11,239,559 B2**
(45) **Date of Patent:** **Feb. 1, 2022**

(54) **COMMUNICATION DEVICE AND NOTEBOOK COMPUTER DEVICE**

(56) **References Cited**

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

(72) Inventors: **Huang-Tse Peng**, Hsinchu (TW);
Hsiang-Feng Hsieh, Hsinchu (TW);
Wan-Ju Huang, Hsinchu (TW)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 45 days.

(21) Appl. No.: **16/595,937**

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

(65) **Prior Publication Data**

US 2020/0168992 A1 May 28, 2020

(30) **Foreign Application Priority Data**

Nov. 23, 2018 (TW) 107141861

(51) **Int. Cl.**

H01Q 5/371 (2015.01)
H01Q 1/24 (2006.01)
H01Q 5/28 (2015.01)
H01Q 5/328 (2015.01)
H01Q 5/45 (2015.01)
H01Q 9/42 (2006.01)

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

CPC **H01Q 5/371** (2015.01); **H01Q 1/244** (2013.01); **H01Q 5/28** (2015.01); **H01Q 5/328** (2015.01); **H01Q 5/45** (2015.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 5/371; H01Q 5/328; H01Q 9/42; H01Q 5/45; H01Q 1/244; H01Q 5/28; H01Q 1/2266; H01Q 5/385; H01Q 5/392

See application file for complete search history.

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Primary Examiner — Dimary S Lopez Cruz

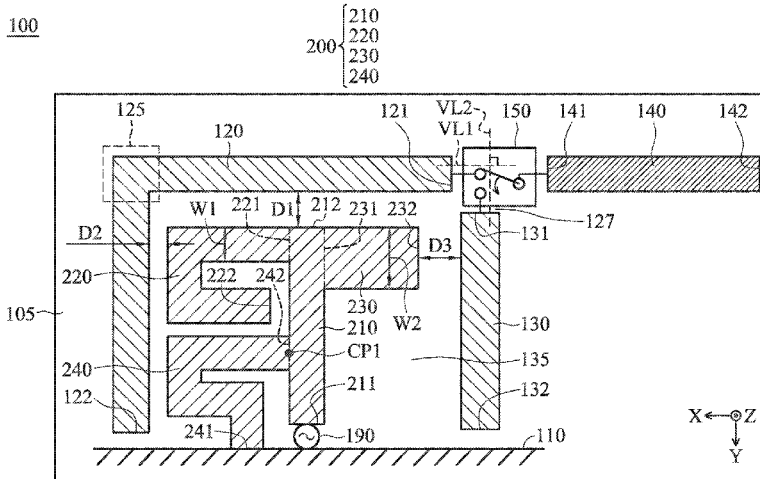
Assistant Examiner — Michael M Bouizza

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

(57) **ABSTRACT**

A communication device includes a ground element, an antenna structure, a first reflector, a second reflector, a first tuning element, and a switch element. The first reflector is disposed adjacent to the antenna structure. The second reflector is disposed adjacent to the antenna structure. The second reflector is separate from the first reflector. The switch element is coupled to the first tuning element. When the switch element is enabled, the switch element couples the first tuning element to the first reflector or the second reflector. When the switch element is disabled, the first tuning element is separate from the first reflector and the second reflector.

19 Claims, 6 Drawing Sheets





(12) **United States Patent**
Alfaro

(10) **Patent No.:** **US 11,239,560 B2**
(45) **Date of Patent:** **Feb. 1, 2022**

- (54) **ULTRA WIDE BAND ANTENNA**
- (71) Applicant: **DESARROLLO DE TECNOLOGIA E INFORMÁTICA APLICADA, S.A.P.I. DE C.V., Monterrey (MX)**
- (72) Inventor: **Roy Michel Alfaro, Monterrey (MX)**
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 334 days.
- (21) Appl. No.: **16/221,161**
- (22) Filed: **Dec. 14, 2018**
- (65) **Prior Publication Data**
US 2019/0190153 A1 Jun. 20, 2019
Related U.S. Application Data
- (60) Provisional application No. 62/598,900, filed on Dec. 14, 2017.
- (51) **Int. Cl.**
H01Q 5/50 (2015.01)
H01Q 9/42 (2006.01)
H01Q 5/25 (2015.01)
H01Q 9/40 (2006.01)
H01Q 1/38 (2006.01)
H01Q 9/04 (2006.01)
- (52) **U.S. Cl.**
CPC **H01Q 5/50** (2015.01); **H01Q 5/25** (2015.01); **H01Q 9/045** (2013.01); **H01Q 9/40** (2013.01); **H01Q 9/42** (2013.01); **H01Q 1/38** (2013.01)
- (58) **Field of Classification Search**
CPC H01Q 5/50; H01Q 5/25; H01Q 9/045; H01Q 9/40; H01Q 9/42; H01Q 1/38
See application file for complete search history.

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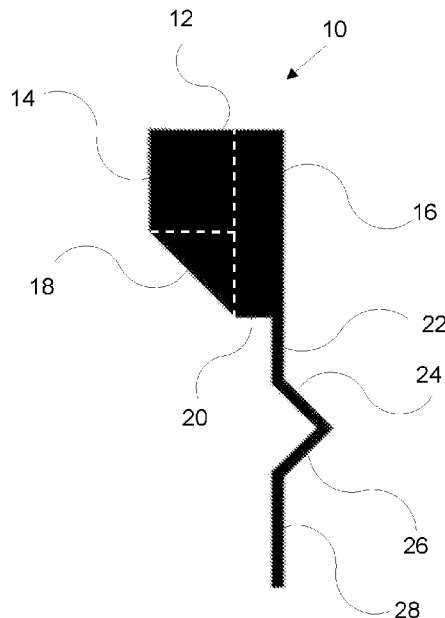
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Primary Examiner — Dimary S Lopez Cruz
Assistant Examiner — Noel Maldonado
(74) *Attorney, Agent, or Firm* — Staas & Halsey LLP

(57) **ABSTRACT**

A monopole-radiating element of antenna has a single order fractal signal feed. No series or shunt impedance matching elements are connected to the radiating element to control the antenna operating parameters.

7 Claims, 2 Drawing Sheets



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

(10) **Patent No.:** **US 11,239,867 B2**
(45) **Date of Patent:** **Feb. 1, 2022**

(54) **ELECTRONIC DEVICE INCLUDING CIRCUIT CHANGING FEED PATH**
(71) Applicant: **Samsung Electronics Co., Ltd.**, Gyeonggi-do (KR)
(72) Inventors: **Jeongwan Park**, Gyeonggi-do (KR); **Seho Kim**, Gyeonggi-do (KR); **Min Sakong**, Gyeonggi-do (KR); **Moonsoo Son**, Gyeonggi-do (KR); **Dongryul Shin**, Gyeonggi-do (KR); **Sooyoung Jang**, Gyeonggi-do (KR); **Yoonjae Lee**, Gyeonggi-do (KR)

(73) Assignee: **Samsung Electronics Co., Ltd**
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 14 days.

(21) Appl. No.: **16/552,329**

(22) Filed: **Aug. 27, 2019**

(65) **Prior Publication Data**
US 2020/0067539 A1 Feb. 27, 2020

(30) **Foreign Application Priority Data**
Aug. 27, 2018 (KR) 10-2018-0100429

(51) **Int. Cl.**
H04B 1/00 (2006.01)
H04B 1/40 (2015.01)
H01Q 1/24 (2006.01)

(52) **U.S. Cl.**
CPC **H04B 1/0064** (2013.01); **H04B 1/40** (2013.01); **H01Q 1/243** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 23/00; H01Q 5/335; H01Q 5/35; H04B 1/0064; H04B 1/40
See application file for complete search history.

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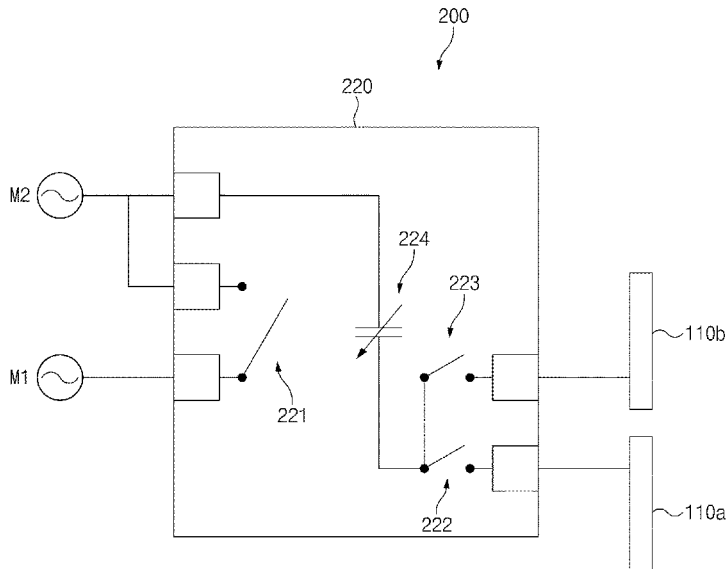
European Search Report dated Jul. 22, 2021 issued in counterpart application No. 19855901.5-1205, 12 pages.
(Continued)

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

(57) **ABSTRACT**

An electronic device is provided that includes a first antenna element that includes a first portion of a housing, and a second antenna element that include a second portion of the housing that is different from the first portion of the housing. The electronic device also includes a memory that stores feed conditions, each for applying a current to one of the first antenna element and the second antenna element. A tuner of the electronic device is controlled such that a first current flows to one of the first antenna element and the second antenna element, based on a first feed condition of the stored feed conditions, and a processor of the electronic device transmits or receives a signal in a specified frequency band based on an electrical path formed through the tuner.

8 Claims, 21 Drawing Sheets





(12) **United States Patent**
Hamabe

(10) **Patent No.:** **US 11,240,909 B2**
(45) **Date of Patent:** **Feb. 1, 2022**

(54) **ANTENNA DEVICE**

(56) **References Cited**

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

U.S. PATENT DOCUMENTS

(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 285 days.

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(21) Appl. No.: **16/711,654**

(22) Filed: **Dec. 12, 2019**

(65) **Prior Publication Data**

US 2020/0196439 A1 Jun. 18, 2020

(Continued)

(30) **Foreign Application Priority Data**

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Dec. 17, 2018 (JP) JP2018-235812

JP 2015-070542 4/2015

(51) **Int. Cl.**
H05K 1/02 (2006.01)
H01Q 9/04 (2006.01)

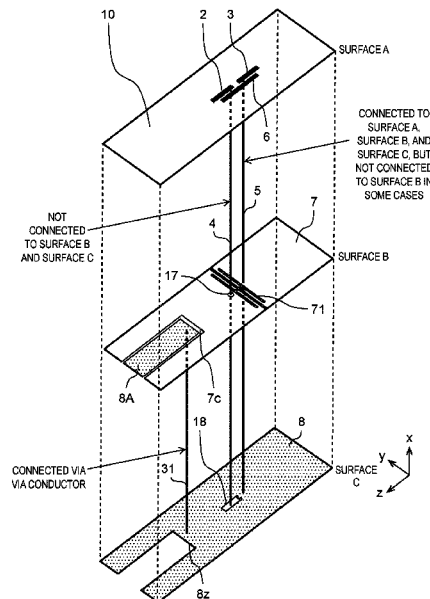
Primary Examiner — Don P Le
(74) *Attorney, Agent, or Firm* — Wenderoth, Lind & Ponack, L.L.P.

(52) **U.S. Cl.**
CPC **H05K 1/0243** (2013.01); **H01Q 9/045**
(2013.01); **H05K 2201/10098** (2013.01)

(57) **ABSTRACT**
An antenna device includes an antenna, a first ground conductor, and an artificial magnetic conductor. The artificial magnetic conductor is sandwiched between the antenna and the first ground conductor, and separated from the antenna and the first ground conductor. The first ground conductor includes a first cutaway part on one end side, the first cutaway part having a substantially rectangular shape.

(58) **Field of Classification Search**
CPC H05K 1/0243; H05K 2201/10098; H05K 1/0298; H05K 1/165; H05K 1/0253; H01Q 9/045; H01Q 1/48; H01Q 5/378; H01Q 15/006; H01Q 9/065
USPC 343/700 MS
See application file for complete search history.

7 Claims, 7 Drawing Sheets





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

(10) **Patent No.:** **US 11,245,174 B2**
(45) **Date of Patent:** **Feb. 8, 2022**

(54) **ELECTRONIC APPARATUS**
(71) Applicant: **Dynabook Inc.**, Tokyo (JP)

(72) Inventors: **Toshiyuki Hirota**, Hino Tokyo (JP);
Hikaru Hirata, Tachikawa Tokyo (JP);
Tomofumi Miyamoto, Hamura Tokyo (JP);
Shingo Koide, Tachikawa Tokyo (JP)

(73) Assignee: **DYNABOOK 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 107 days.

(21) Appl. No.: **16/450,721**

(22) Filed: **Jun. 24, 2019**

(65) **Prior Publication Data**
US 2020/0235461 A1 Jul. 23, 2020

(30) **Foreign Application Priority Data**
Jan. 21, 2019 (JP) JP2019-007872

(51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01Q 1/48 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/2266** (2013.01); **H01Q 1/48** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/2258; H01Q 1/2266; H01Q 1/243; H01Q 1/42; H01Q 1/422; H01Q 1/48
See application file for complete search history.

(56) **References Cited**
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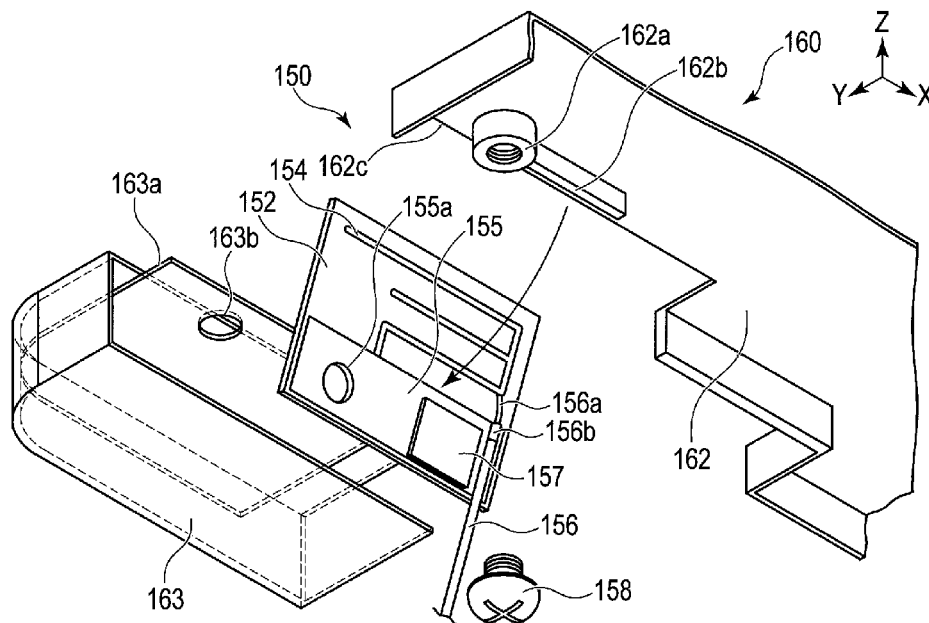
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Primary Examiner — Dimary S Lopez Cruz
Assistant Examiner — Patrick R Holecsek
(74) *Attorney, Agent, or Firm* — Knobbe, Martens, Olson & Bear LLP

(57) **ABSTRACT**
The housing includes a first base portion and a second base portion which are conductive respectively. The first base portion and the second base portion are disposed in contact. The antenna element is connected to the antenna ground. The antenna ground is formed on the antenna board. The gasket is located between the first base portion and the antenna ground in a height direction of the housing, and is conductive. The fixing member fixes the second base portion and the antenna ground so that the second base portion and the antenna ground are electrically connectable to each other in a state where the gasket is in contact with the first base portion and the antenna ground.

7 Claims, 6 Drawing Sheets



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

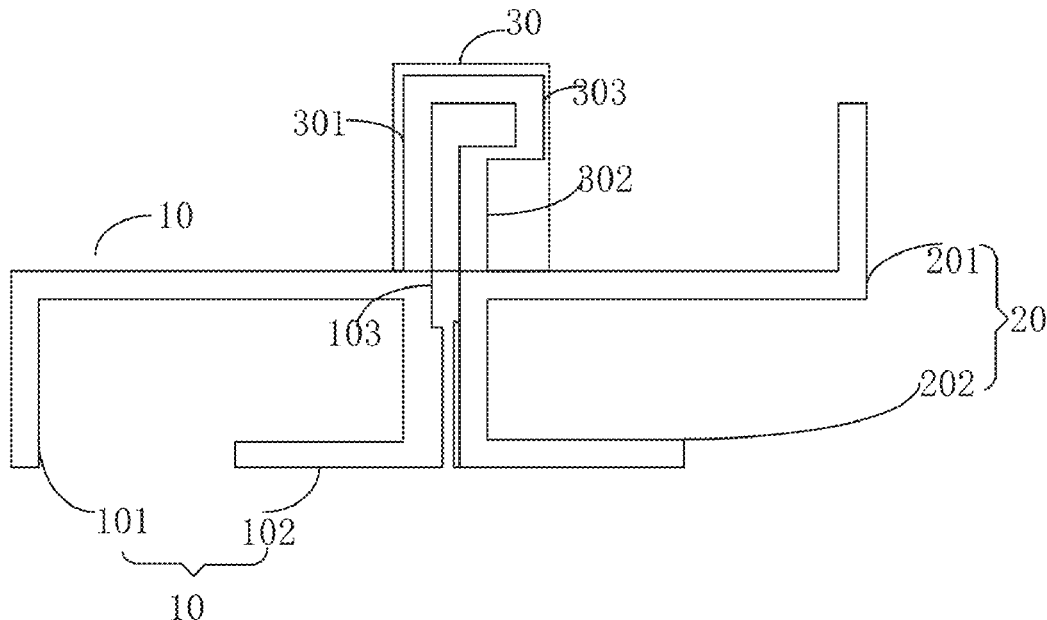
(10) **Patent No.:** **US 11,245,178 B2**
(45) **Date of Patent:** **Feb. 8, 2022**

- (54) **WIFI ANTENNA AND WIRELESS COMMUNICATION DEVICE**
- (71) Applicant: **AAC Technologies Pte. Ltd.**,
Singapore (SG)
- (72) Inventors: **Yachuan Shen**, Shenzhen (CN); **Lei Zheng**, Shenzhen (CN); **Yongsheng Peng**, Shenzhen (CN); **Hongjun Wang**, 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.: **16/996,932**
- (22) Filed: **Aug. 19, 2020**
- (65) **Prior Publication Data**
US 2020/0411951 A1 Dec. 31, 2020
- Related U.S. Application Data**
- (63) Continuation of application No. PCT/CN2019/094080, filed on Jun. 30, 2019.
- (51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01Q 5/20 (2015.01)
H01Q 5/307 (2015.01)
H01Q 9/26 (2006.01)
- (52) **U.S. Cl.**
CPC **H01Q 1/2291** (2013.01); **H01Q 5/20** (2015.01); **H01Q 5/307** (2015.01); **H01Q 9/26** (2013.01)

- (58) **Field of Classification Search**
CPC H01Q 1/2291; H01Q 5/20; H01Q 5/307;
H01Q 9/26
See application file for complete search history.
- (56) **References Cited**
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- Primary Examiner* — Andrea Lindgren Baltzell
Assistant Examiner — Amal Patel
(74) *Attorney, Agent, or Firm* — W&G Law Group

(57) **ABSTRACT**
A WIFI antenna, including: a dipole including a first radiator and a second radiator that are arranged opposite to and spaced apart from each other; a feeding port provided at adjacent ends of the first radiator and the second radiator; a balun structure including a first access portion, a second access portion provided opposite to the first access portion, and an intermediate portion connecting the first access portion with the second access portion, and the intermediate portion having an annular structure; the first access portion of the balun structure is connected to the first radiator at the feeding port, and the second access portion is connected to the second radiator at the feeding port. Setting of the WIFI antenna provides characteristics of omnidirectional radiation, high gain and high physical stability, which not only improves the gain, but also fully covers the WIFI frequency band.

12 Claims, 6 Drawing Sheets





US011245179B2

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

(10) **Patent No.:** **US 11,245,179 B2**
(45) **Date of Patent:** **Feb. 8, 2022**

- (54) **ANTENNA AND METHOD FOR STEERING ANTENNA BEAM DIRECTION FOR WIFI APPLICATIONS**
- (71) Applicant: **Ethertronics, Inc.**, San Diego, CA (US)
- (72) Inventors: **Sebastian Rowson**, San Diego, CA (US); **Laurent Desclos**, San Diego, CA (US); **Jeffrey Shamblin**, San Marcos, CA (US)
- (73) Assignee: **Ethertronics, Inc.**, San Diego, CA (US)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 77 days.
- (21) Appl. No.: **16/751,903**
- (22) Filed: **Jan. 24, 2020**
- (65) **Prior Publication Data**
US 2020/0161746 A1 May 21, 2020

Related U.S. Application Data

- (63) Continuation of application No. 16/048,987, filed on Jul. 30, 2018, now Pat. No. 10,547,102, which is a continuation of application No. 15/660,907, filed on Jul. 26, 2017, now Pat. No. 10,056,679, which is a continuation of application No. 14/965,881, filed on Dec. 10, 2015, now Pat. No. 9,748,637, which is a continuation-in-part of application No. 14/144,461, filed on Dec. 30, 2013, now Pat. No. 9,240,634, which is a continuation of application No. 13/726,477, filed on Dec. 24, 2012, now Pat. No. 8,648,755, which is a continuation of application No. 13/029,564, filed on Feb. 17, 2011, now Pat. No. 8,362,962, which is a continuation of application No.

(Continued)

- (51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 3/00 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/04 (2006.01)
- (52) **U.S. Cl.**
CPC *H01Q 1/243* (2013.01); *H01Q 3/00* (2013.01); *H01Q 9/0421* (2013.01)
- (58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/24; H01Q 1/38; H01Q 1/48; H01Q 3/00; H01Q 9/04; H01Q 9/0421; H01Q 19/10
See application file for complete search history.

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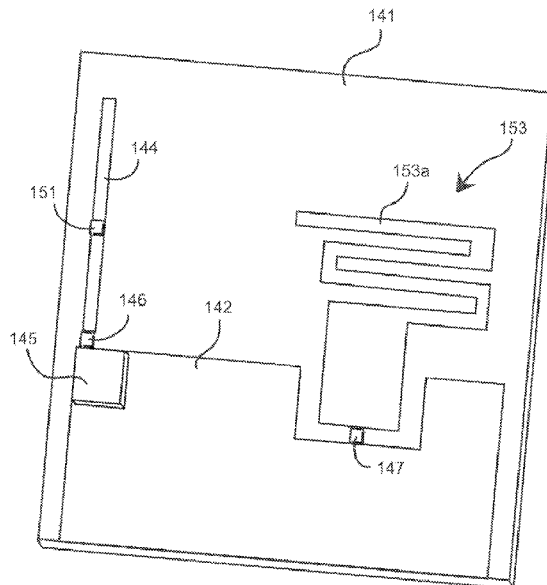
Primary Examiner — Tho G Phan

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

(57) **ABSTRACT**

An antenna comprising an IMD element and one or more parasitic and active tuning elements is disclosed. The IMD element, when used in combination with the active tuning and parasitic elements, allows antenna operation at multiple resonant frequencies. In addition, the direction of antenna radiation pattern may be arbitrarily rotated in accordance with the parasitic and active tuning elements. Unique antenna architectures for beam steering in Wi-Fi band applications is further described.

10 Claims, 16 Drawing Sheets



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

(10) **Patent No.:** **US 11,245,182 B2**
(45) **Date of Patent:** **Feb. 8, 2022**

(54) **ANTENNA ELEMENT**

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

(72) Inventors: **Hongjuan Han**, Shenzhen (CN);
Yuehua Yue, 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 16 days.

(21) Appl. No.: **16/995,840**

(22) Filed: **Aug. 18, 2020**

(65) **Prior Publication Data**
US 2020/0411976 A1 Dec. 31, 2020

Related U.S. Application Data
(63) Continuation of application No.
PCT/CN2019/094076, filed on Jun. 30, 2019.

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/38 (2006.01)
H01Q 1/48 (2006.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/38** (2013.01); **H01Q 1/246**
(2013.01); **H01Q 1/48** (2013.01); **H01Q**
9/0407 (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/24-48; H01Q 9/0407; H01Q
21/24-26

See application file for complete search history.

(56) **References Cited**

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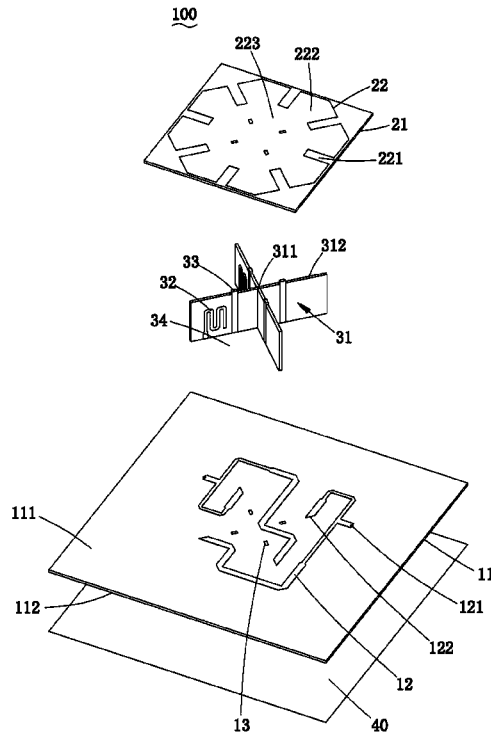
Primary Examiner — Hasan Islam

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

(57) **ABSTRACT**

The invention provides an antenna element having a feed unit, a first radiation unit and a second radiation unit, wherein the feed unit includes two differential feed circuits and four grounding ends. Each differential feed circuit includes an input end and two output ends. The first radiation unit includes a first radiation body. The second radiation unit includes four second radiation bodies and four grounding elements. According to the antenna element provided by the invention, through feeding of the first radiation body and the second radiation bodies in a coupled feeding manner, the number of solder joints can be reduced; and through arrangement of the second radiation bodies extending in a serpentine form, the profile height of the antenna element can be reduced and the requirements of customers on miniaturization of a base station are met.

8 Claims, 3 Drawing Sheets





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

(10) **Patent No.:** **US 11,245,183 B2**
(45) **Date of Patent:** **Feb. 8, 2022**

(54) **MULTI-ANTENNA SYSTEM AND MOBILE TERMINAL**

(71) Applicant: **AAC Technologies Pte. Ltd.**,
Singapore (SG)
(72) Inventors: **Shijie Liu**, Shenzhen (CN); **Ge Zhang**,
Shenzhen (CN); **Yue Liang**, 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 32 days.

(21) Appl. No.: **16/524,053**
(22) Filed: **Jul. 27, 2019**

(65) **Prior Publication Data**
US 2020/0044331 A1 Feb. 6, 2020

(30) **Foreign Application Priority Data**
Aug. 3, 2018 (CN) 201810879378.1

(51) **Int. Cl.**
H01Q 1/52 (2006.01)
H01Q 21/06 (2006.01)
H01Q 1/24 (2006.01)
(52) **U.S. Cl.**
CPC **H01Q 1/523** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 21/06** (2013.01)

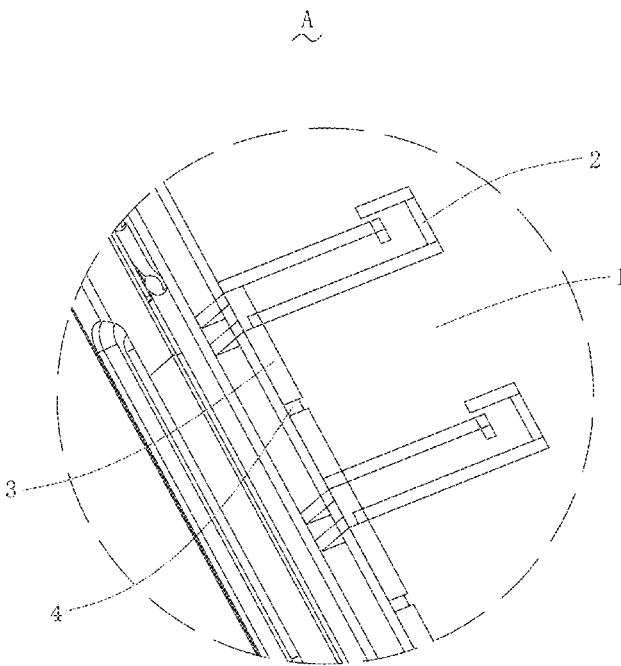
(58) **Field of Classification Search**
None
See application file for complete search history.

(56) **References Cited**
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Primary Examiner — Crystal L Hammond
(74) *Attorney, Agent, or Firm* — W&G Law Group

(57) **ABSTRACT**
The present disclosure provides a multi-antenna system comprising at least two antenna units and a neutralization line for connecting two adjacent antenna units, and the neutralization line is provided with an inductor element. The invention also provides a mobile terminal. The multi-antenna system and the mobile terminal provided by the present disclosure could significantly increase the isolation degree between the antenna units by providing a neutralization line between the two adjacent antenna units for connecting the same and providing an inductor element on the neutralization line, thereby reducing the mutual coupling interference between antenna units and improving the antenna performance.

8 Claims, 5 Drawing Sheets



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

(10) **Patent No.:** **US 11,245,188 B2**
(45) **Date of Patent:** **Feb. 8, 2022**

(54) **ANTENNA DEVICE HAVING A DIPOLE ANTENNA AND A LOOP SHAPED ANTENNA INTEGRATED FOR IMPROVING ANTENNA BANDWIDTH AND ANTENNA GAIN**

H01Q 7/08; H01Q 5/00; H01Q 5/10;
H01Q 5/20; H01Q 5/314; H01Q 5/321;
H01Q 5/328; H01Q 5/335; H01Q 5/364;
H01Q 5/378; H01Q 5/385; H01Q 5/392;
H01Q 5/40; H01Q 5/42; H01Q 5/45;
H01Q 5/47; H01Q 5/48; H01Q 5/49;
H01Q 5/50; H01Q 1/36

(71) Applicant: **MEDIATEK INC.**, Hsin-Chu (TW)

(72) Inventors: **Chung-Hsin Chiang**, Hsin-Chu (TW);
Yeh-Chun Kao, Hsin-Chu (TW);
Shih-Huang Yeh, Hsin-Chu (TW)

See application file for complete search history.

(73) Assignee: **MEDIATEK INC.**, 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.

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Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Winston Hsu

(21) Appl. No.: **16/240,795**

(22) Filed: **Jan. 7, 2019**

(65) **Prior Publication Data**

US 2019/0214741 A1 Jul. 11, 2019

Related U.S. Application Data

(60) Provisional application No. 62/616,027, filed on Jan. 11, 2018.

(51) **Int. Cl.**
H01Q 5/35 (2015.01)

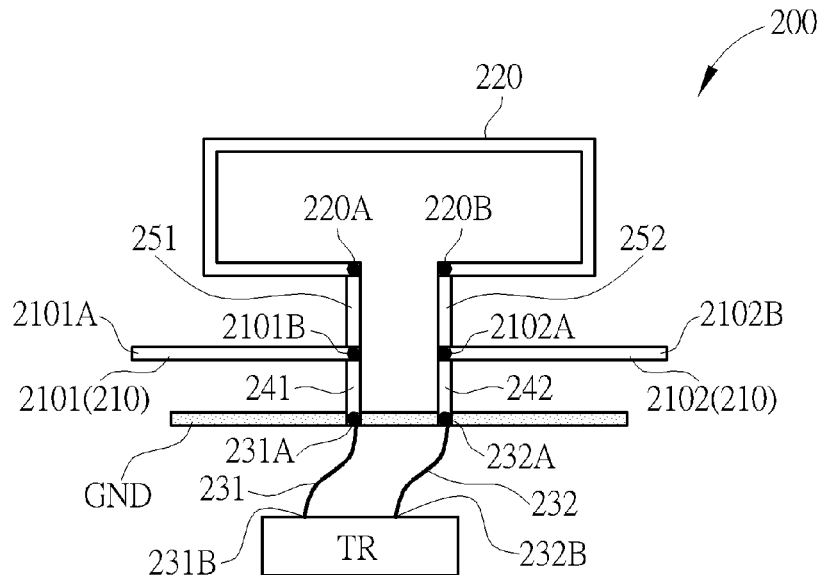
(52) **U.S. Cl.**
CPC **H01Q 5/35** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 5/30; H01Q 5/307; H01Q 5/342;
H01Q 5/35; H01Q 5/357; H01Q 5/371;
H01Q 21/24; H01Q 21/28; H01Q 9/16;
H01Q 9/26; H01Q 9/065; H01Q 9/18;
H01Q 9/20; H01Q 9/22; H01Q 9/24;
H01Q 9/265; H01Q 7/00; H01Q 7/005;
H01Q 7/02; H01Q 7/04; H01Q 7/06;

(57) **ABSTRACT**

An antenna device includes a first dipole antenna, a second loop shaped antenna, a first feed line and a second feed line. The first dipole antenna operates at a first frequency band. The first dipole antenna includes a first portion and a second portion. The second loop shaped antenna operates at a second frequency band different from the first frequency band. A first terminal of the second loop shaped antenna is coupled to a second terminal of the first portion of the first dipole antenna. A second terminal of the second loop shaped antenna is coupled to a first terminal of the second portion of the first dipole antenna. The first feed line is coupled to the second terminal of the first portion of the first dipole antenna. The second feed line is coupled to the first terminal of the second portion of the first dipole antenna.

19 Claims, 9 Drawing Sheets





US011245192B2

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

(10) **Patent No.:** **US 11,245,192 B2**

(45) **Date of Patent:** **Feb. 8, 2022**

(54) **CHIP ANTENNA**

(56) **References Cited**

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

U.S. PATENT DOCUMENTS

(72) Inventors: **Dae Ki Lim**, Suwon-si (KR); **Young Sik Hur**, Suwon-si (KR); **Kyu Bum Han**, Suwon-si (KR); **Ju Hyoung Park**, Suwon-si (KR); **Myeong Woo Han**, Suwon-si (KR); **Jeong Ki Ryoo**, Suwon-si (KR)

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

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(21) Appl. No.: **17/002,006**

Primary Examiner — Lam T Mai

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

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

(65) **Prior Publication Data**

US 2021/0313694 A1 Oct. 7, 2021

(30) **Foreign Application Priority Data**

Apr. 2, 2020 (KR) 10-2020-0040210

(51) **Int. Cl.**

H01Q 9/04	(2006.01)
H01Q 1/02	(2006.01)
H01Q 1/22	(2006.01)

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

CPC **H01Q 9/045** (2013.01); **H01Q 1/02** (2013.01); **H01Q 1/2283** (2013.01)

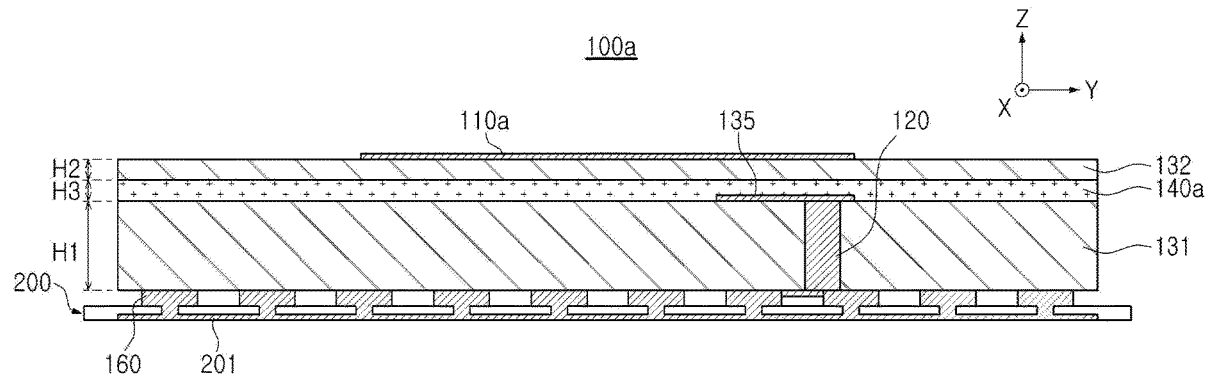
(58) **Field of Classification Search**

CPC H01Q 1/02; H01Q 1/2283; H01Q 9/045
See application file for complete search history.

(57) **ABSTRACT**

A chip antenna includes: a first dielectric layer; a second dielectric layer upwardly spaced apart from the first dielectric layer; a patch antenna pattern disposed on the second dielectric layer; a feed via extending through the first dielectric layer; a feed pattern disposed between the first and second dielectric layers, electrically connected to the feed via, and spaced apart from the patch antenna pattern; and an adhesive layer adhered to the first and second dielectric layers. The adhesive layer includes a cavity surrounding the feed pattern between the first and second dielectric layers and; and a vent disposed between the cavity and an external side surface of the adhesive layer.

24 Claims, 15 Drawing Sheets





US011245203B2

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

(10) **Patent No.:** **US 11,245,203 B2**

(45) **Date of Patent:** **Feb. 8, 2022**

(54) **ANTENNA MODULE, SYSTEM, AND METHOD**

(56) **References Cited**

(71) Applicant: **Amphenol Antenna Solutions, Inc.**,
Rockford, IL (US)

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(72) Inventors: **Kostyantyn Semonov**, Denver, NC (US); **Ryan Michael Nagel**, Tucson, AZ (US); **André Falconio Armand Fournier**, Marietta, GA (US)

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(73) Assignee: **AMPHENOL ANTENNA SOLUTIONS, INC.**, Rockford, IL (US)

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

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(21) Appl. No.: **16/778,671**

(22) Filed: **Jan. 31, 2020**

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(65) **Prior Publication Data**

US 2021/0242608 A1 Aug. 5, 2021

Primary Examiner — Hoang V Nguyen

(51) **Int. Cl.**
H01Q 21/28 (2006.01)
H01Q 1/24 (2006.01)
H01Q 19/00 (2006.01)
H01Q 21/12 (2006.01)
H01Q 1/42 (2006.01)
H01Q 1/36 (2006.01)

(74) *Attorney, Agent, or Firm* — Kunzler Bean & Adamson

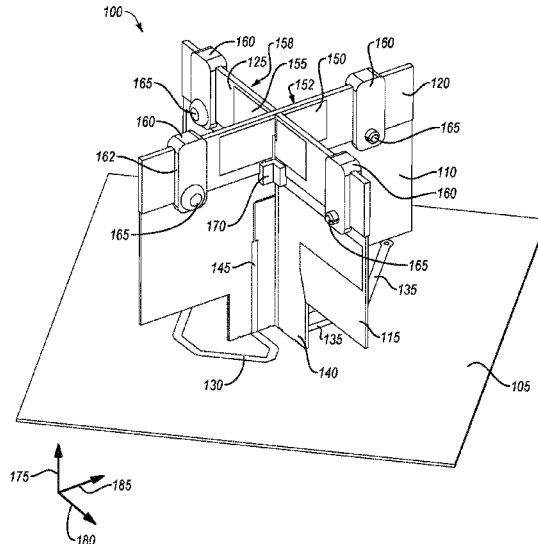
(52) **U.S. Cl.**
CPC **H01Q 21/28** (2013.01); **H01Q 1/24** (2013.01); **H01Q 1/36** (2013.01); **H01Q 1/42** (2013.01); **H01Q 19/005** (2013.01); **H01Q 21/12** (2013.01)

(57) **ABSTRACT**

One antenna module includes a first circuit board and a second circuit board connected to the first circuit board. The antenna module includes a first antenna disposed on the first circuit board. The antenna module also includes a second antenna disposed on the second circuit board. The second circuit board has a first side and a second side opposite the first side. The second antenna includes a first parasitic strip and a second parasitic strip. The first parasitic strip is disposed on the first side of the second circuit board, and the second parasitic strip is disposed on the second side of the second circuit board.

(58) **Field of Classification Search**
CPC H01Q 21/26; H01Q 21/28; H01Q 21/12; H01Q 19/005
See application file for complete search history.

21 Claims, 8 Drawing Sheets



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

(10) **Patent No.:** **US 11,245,204 B1**
(45) **Date of Patent:** **Feb. 8, 2022**

(54) **ANTENNA MODULE**

(71) Applicant: **Wistron Corporation**, New Taipei (TW)

(72) Inventors: **Po-Tsang Lin**, New Taipei (TW);
Ying-Sheng Fang, New Taipei (TW);
Cheng-Wei Chen, New Taipei (TW)

(73) Assignee: **Wistron Corporation**, 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 8 days.

(21) Appl. No.: **17/013,819**

(22) Filed: **Sep. 7, 2020**

(30) **Foreign Application Priority Data**

Aug. 7, 2020 (TW) 109126837

(51) **Int. Cl.**
H01Q 21/28 (2006.01)
H01Q 5/35 (2015.01)
H01Q 1/24 (2006.01)

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

(58) **Field of Classification Search**

CPC H01G 1/243; H01G 5/35
See application file for complete search history.

(56) **References Cited**

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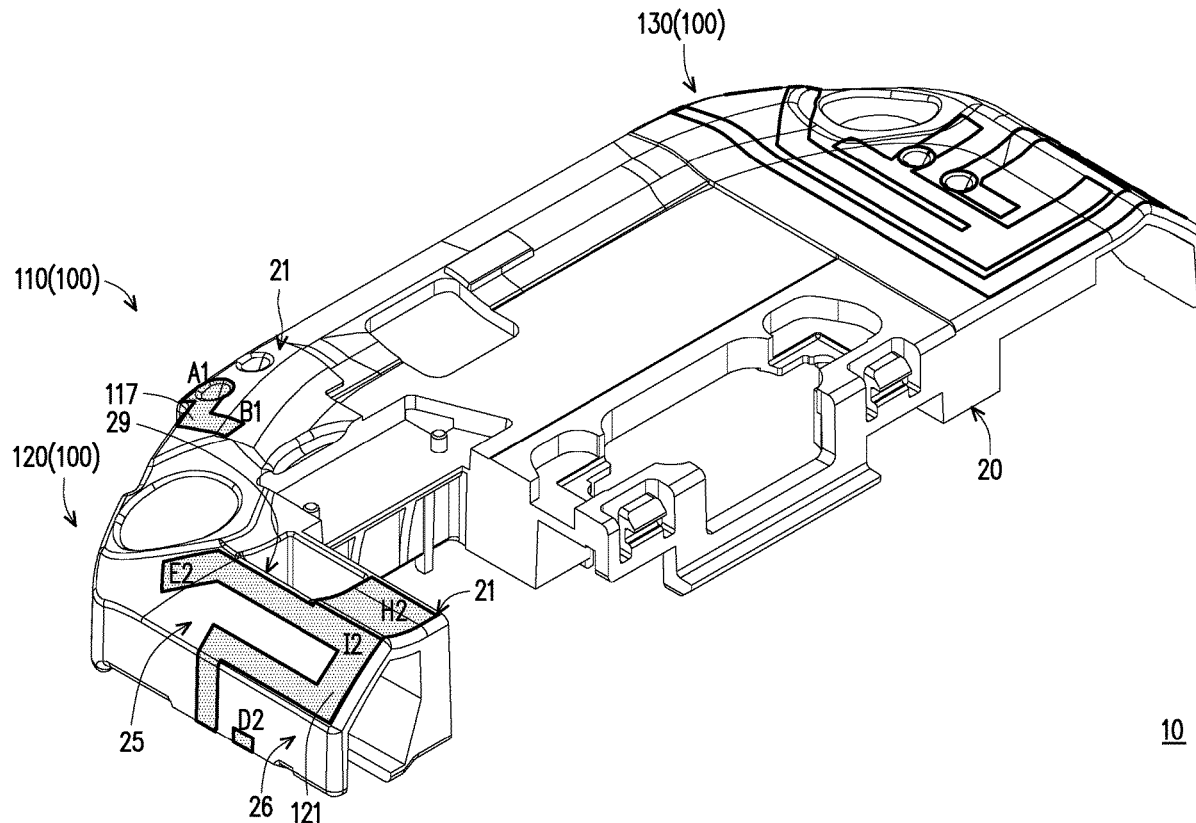
Primary Examiner — Graham P Smith

(74) *Attorney, Agent, or Firm* — JCIPRNET

(57) **ABSTRACT**

An antenna module includes first and second antennas. The first antenna includes first, second and third radiators. A first end of the first antenna is a first feed-in end. The second and third radiators are connected to a second end of the first radiator. The second radiator has a first ground. The second antenna includes fourth, fifth and sixth radiators. The fifth radiator is connected to a second feed-in end of the fourth radiator. A second ground is located at an intersection between the fifth and sixth radiators. The antenna module covers first, second and third frequency bands.

21 Claims, 12 Drawing Sheets





(12) **United States Patent**
Rogers

(10) **Patent No.:** **US 11,251,513 B2**
(45) **Date of Patent:** **Feb. 15, 2022**

(54) **WAVEGUIDE TO LAMINATED CIRCUIT BOARD TRANSITION COMPRISING A LATERAL COUPLING THROUGH A SIDEWALL OF THE WAVEGUIDE**

(71) Applicant: **The Boeing Company**, Chicago, IL (US)

(72) Inventor: **John E. Rogers**, Owens Cross Roads, AL (US)

(73) Assignee: **THE BOEING COMPANY**, Chicago, IL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 26 days.

(21) Appl. No.: **16/560,767**

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

(65) **Prior Publication Data**

US 2021/0066777 A1 Mar. 4, 2021

(51) **Int. Cl.**
H01P 5/107 (2006.01)
H01P 11/00 (2006.01)

(52) **U.S. Cl.**
CPC **H01P 5/107** (2013.01); **H01P 11/006** (2013.01); **H01P 11/007** (2013.01)

(58) **Field of Classification Search**
CPC H01P 5/107
USPC 333/26
See application file for complete search history.

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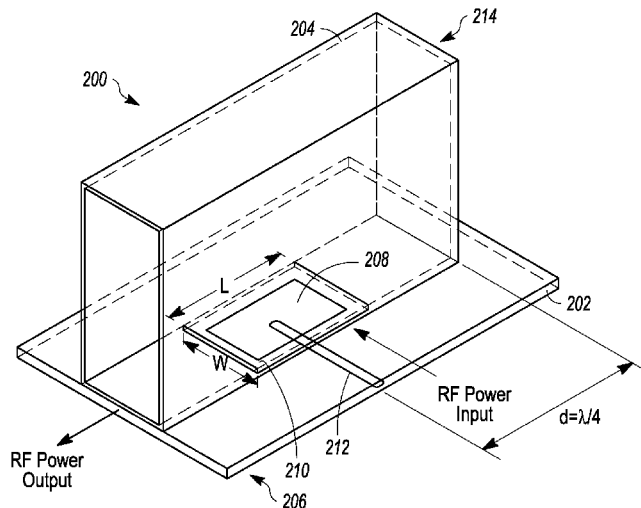
Primary Examiner — Benny T Lee

(74) *Attorney, Agent, or Firm* — Gates & Cooper LLP

(57) **ABSTRACT**

A feed line to waveguide lateral transition is described consisting of: a proximity coupled antenna element on the top surface of a composite RF board, an embedded microstrip or stripline feed line, a ground plane on the bottom surface of the RF board, and a waveguide with an aperture enclosing the antenna element with a signal propagation through the waveguide being perpendicular to the antenna element.

20 Claims, 12 Drawing Sheets



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

(10) **Patent No.:** **US 11,251,521 B2**
(45) **Date of Patent:** **Feb. 15, 2022**

(54) **ANTENNA STRUCTURE**
(71) Applicant: **Wistron NeWeb Corp.**, Hsinchu (TW)
(72) Inventors: **Tzu-Min Wu**, Hsinchu (TW); **Kuo-Jen Lai**, Hsinchu (TW); **Kuang-Yuan Ku**, Hsinchu (TW)
(73) Assignee: **WISTRON NEWEB CORP.**, Hsinchu (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 51 days.

(21) Appl. No.: **17/014,502**

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

(65) **Prior Publication Data**
US 2021/0249766 A1 Aug. 12, 2021

(30) **Foreign Application Priority Data**
Feb. 7, 2020 (TW) 109103799

(51) **Int. Cl.**
H01Q 1/52 (2006.01)
H01Q 9/06 (2006.01)
H01Q 5/48 (2015.01)
H01Q 1/24 (2006.01)
H01Q 1/38 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/521** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 5/48** (2015.01); **H01Q 9/065** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/48; H01Q 9/065; H01Q 1/521; H01Q 1/243; H01Q 1/38
See application file for complete search history.

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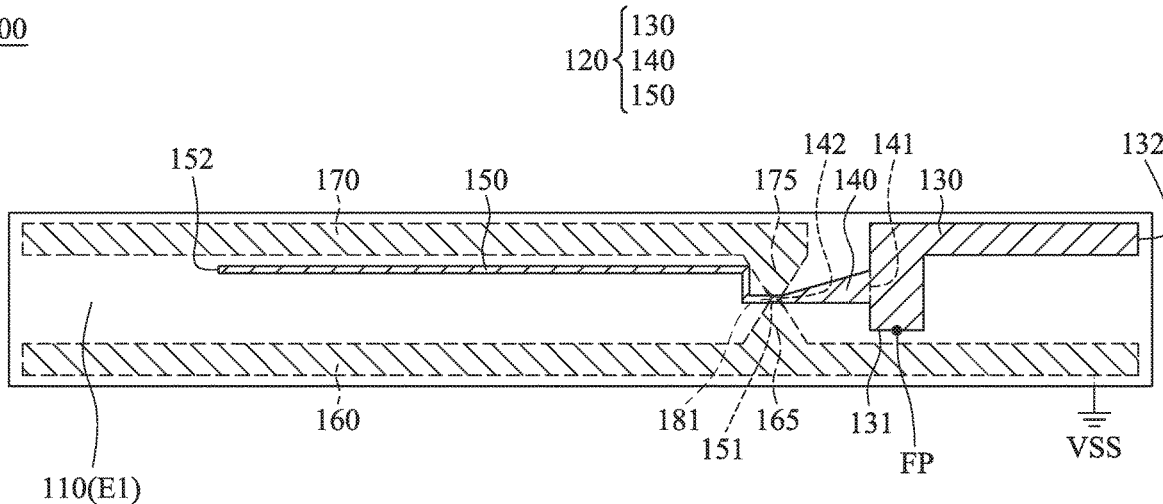
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Primary Examiner — Graham P Smith
Assistant Examiner — Jae K Kim
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**
An antenna structure includes a substrate, a feeding radiation element, a first grounding radiation element, a second grounding radiation element, and a first circuit element. The substrate has a first surface and a second surface which are opposite to each other. The feeding radiation element includes a body portion, a bridging portion, and an extension portion. The body portion has a feeding point. The bridging portion is coupled between the body portion and the extension portion. The first grounding radiation element is coupled to a ground voltage. The first circuit element is coupled between the first grounding radiation element and the second grounding radiation element. The bridging portion of the feeding radiation element is disposed on the first surface of the substrate. The first circuit element is disposed on the second surface of the substrate.

20 Claims, 18 Drawing Sheets

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(12) **United States Patent**
Sone

(10) **Patent No.:** **US 11,251,528 B2**
(45) **Date of Patent:** **Feb. 15, 2022**

(54) **ANTENNA DEVICE**
(71) Applicant: **YOKOWO CO., LTD.**, Tokyo (JP)
(72) Inventor: **Takayuki Sone**, Tomioka (JP)
(73) Assignee: **YOKOWO 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 84 days.

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(21) Appl. No.: **16/487,096**
(22) PCT Filed: **Feb. 28, 2018**
(86) PCT No.: **PCT/JP2018/007479**
§ 371 (c)(1),
(2) Date: **Aug. 20, 2019**
(87) PCT Pub. No.: **WO2018/159668**
PCT Pub. Date: **Sep. 7, 2018**

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(65) **Prior Publication Data**
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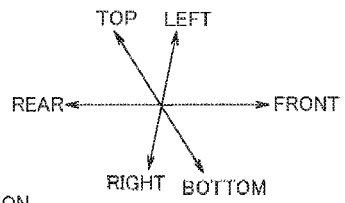
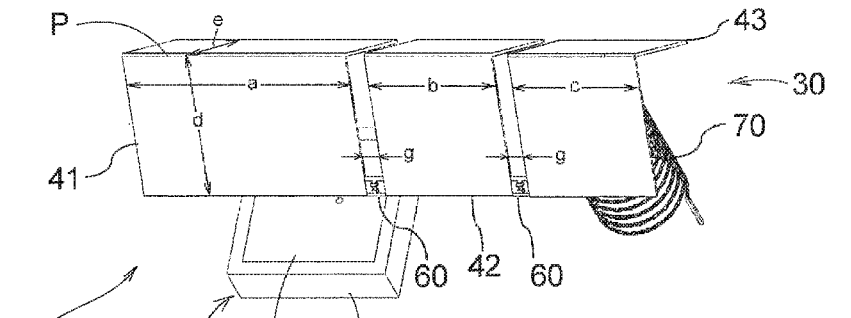
(30) **Foreign Application Priority Data**
Feb. 28, 2017 (JP) JP2017-037653

Primary Examiner — Thien M Le
(74) *Attorney, Agent, or Firm* — Xsensus LLP

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 9/04 (2006.01)
H01Q 1/36 (2006.01)
(52) **U.S. Cl.**
CPC **H01Q 9/0407** (2013.01); **H01Q 1/36** (2013.01)
(58) **Field of Classification Search**
CPC H01Q 1/36
See application file for complete search history.

(57) **ABSTRACT**
An antenna device includes a patch antenna serving as a first antenna; and a second antenna including capacitance loading elements, the capacitance loading elements being located above the patch antenna and also arranged separately in a predetermined direction. Also, an antenna device includes a patch antenna serving as a first antenna; and a second antenna including capacitance loading elements, the capacitance loading elements being located above the patch antenna, and a slit-like cutout part in a predetermined direction being formed in at least one of side edges of the capacitance loading elements.

18 Claims, 14 Drawing Sheets



- 1: ANTENNA DEVICE
- 20: PATCH ANTENNA
- 30: ANTENNA FOR AM/FM BROADCAST RECEPTION
- 41,42,43: CAPACITANCE LOADING ELEMENT



US011251531B2

(12) **United States Patent**
Matsuura

(10) **Patent No.:** **US 11,251,531 B2**
(45) **Date of Patent:** **Feb. 15, 2022**

- (54) **ANTENNA DEVICE AND RADIO APPARATUS**
- (71) Applicant: **NEC Platforms, Ltd.**, Kawasaki (JP)
- (72) Inventor: **Tatsuya Matsuura**, Kanagawa (JP)
- (73) Assignee: **NEC Platforms, Ltd.**, Kanagawa (JP)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 243 days.

- (56) **References Cited**
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- (21) Appl. No.: **16/717,505**
- (22) Filed: **Dec. 17, 2019**
- (65) **Prior Publication Data**
- US 2020/0220269 A1 Jul. 9, 2020

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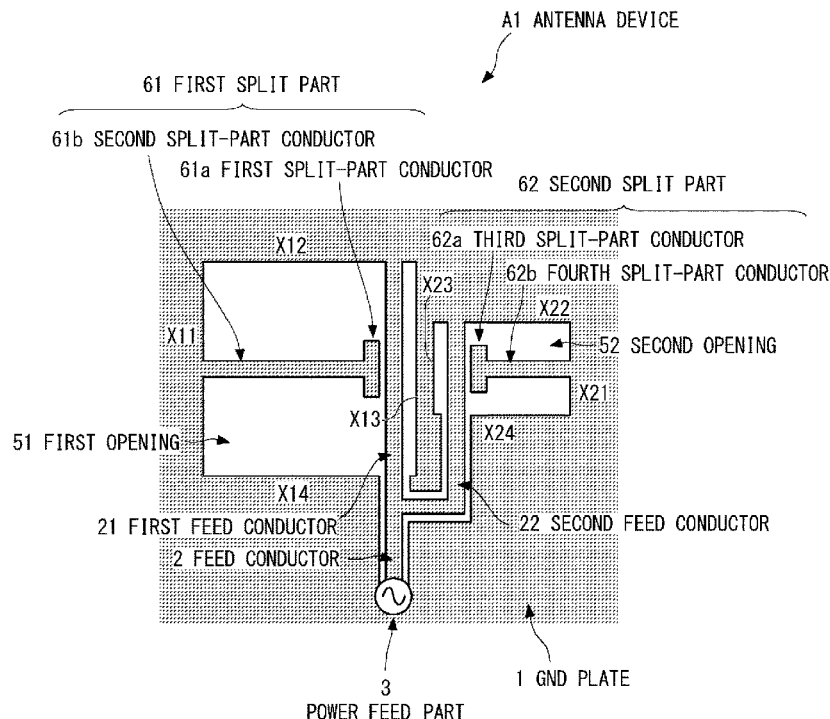
- (30) **Foreign Application Priority Data**
- Jan. 4, 2019 (JP) JP2019-000192

- * cited by examiner
- Primary Examiner* — Dieu Hien T Duong
- (74) *Attorney, Agent, or Firm* — Sughrue Mion, PLLC

- (51) **Int. Cl.**
- H01Q 1/38** (2006.01)
- H01Q 9/04** (2006.01)
- H01Q 1/48** (2006.01)
- (52) **U.S. Cl.**
- CPC **H01Q 9/045** (2013.01); **H01Q 1/48** (2013.01)
- (58) **Field of Classification Search**
- CPC H01Q 9/045; H01Q 1/48; H01Q 21/30
- See application file for complete search history.

- (57) **ABSTRACT**
- An antenna device includes first and second openings formed inside a GND plate, a first feed conductor formed from a first outer peripheral side, which is one of the outer peripheral sides of the first opening, to a second outer peripheral side, and supplied with AC power, a first split part formed in an opening region of the first opening, a first feed conductor formed from a third outer peripheral side, which is one of the outer peripheral sides of the second opening, to a fourth outer peripheral side, and supplied with the AC power common to the first feed conductor, and a second split part formed in an opening region of the second opening.

10 Claims, 14 Drawing Sheets





US011251534B2

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

(10) **Patent No.:** **US 11,251,534 B2**
(45) **Date of Patent:** **Feb. 15, 2022**

- (54) **ANTENNA AND TERMINAL**
- (71) Applicant: **Huawei Technologies Co., Ltd.**,
Shenzhen (CN)
- (72) Inventors: **Junhong Zhang**, Dongguan (CN);
Zhenghao Li, Shenzhen (CN); **Shuhui Sun**, Shenzhen (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 26 days.

- (58) **Field of Classification Search**
CPC . H01Q 11/14; H01Q 1/38; H01Q 5/10; H01Q 13/16; H01Q 9/065
See application file for complete search history.

- (56) **References Cited**
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Primary Examiner — Graham P Smith
Assistant Examiner — Jae K Kim
 (74) *Attorney, Agent, or Firm* — Slater Matsil, LLP

- (21) Appl. No.: **16/956,188**
- (22) PCT Filed: **Aug. 23, 2018**
- (86) PCT No.: **PCT/CN2018/101975**
§ 371 (c)(1),
(2) Date: **Jun. 19, 2020**

- (87) PCT Pub. No.: **WO2019/119843**
PCT Pub. Date: **Jun. 27, 2019**

- (65) **Prior Publication Data**
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- (30) **Foreign Application Priority Data**
Dec. 21, 2017 (CN) 201711398107.6
Feb. 11, 2018 (CN) 201810142705.5

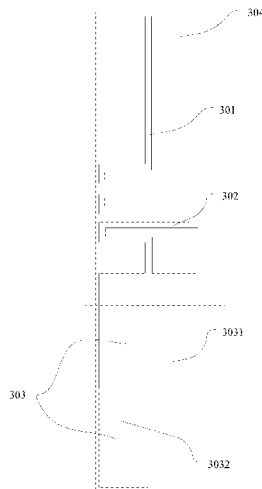
- (51) **Int. Cl.**
H01Q 11/14 (2006.01)
H01Q 1/38 (2006.01)
(Continued)

- (52) **U.S. Cl.**
CPC **H01Q 11/14** (2013.01); **H01Q 1/38** (2013.01); **H01Q 9/065** (2013.01); **H01Q 13/16** (2013.01)

- (57) **ABSTRACT**

An antenna radiates signals in Band41 whose center frequency is λ_1 and Band42 whose center frequency is λ_2 . A medium substrate is used as a carrier of a top radiating element, a phase inversion unit, and a bottom radiating element; an end of the top radiating element is connected to an end of the phase inversion unit; the other end of the phase inversion unit is connected to an end of the bottom radiating element, a length of the phase inversion unit is $3\lambda_2/2$, and the length of the phase inversion unit is greater than $\lambda_1/2$; and the phase inversion unit includes at least two current phase inversion points, a part between the at least two current phase inversion points does not produce radiation, and the top radiating element and the bottom radiating element horizontally radiate the signal in the Band41 and the signal in the Band42 omnidirectionally.

20 Claims, 46 Drawing Sheets





US011251541B2

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

(10) **Patent No.:** **US 11,251,541 B2**
(45) **Date of Patent:** **Feb. 15, 2022**

(54) **DUAL-POLARIZED ANTENNA, RADIO FREQUENCY FRONT-END APPARATUS, AND COMMUNICATIONS DEVICE**

(58) **Field of Classification Search**
CPC H01Q 25/001; H01Q 13/02; H01Q 13/085; H01Q 21/24; H01Q 13/06; H01Q 21/064; H01Q 13/0275; H01Q 19/08; H01Q 5/55
See application file for complete search history.

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

(56) **References Cited**

(72) Inventors: **Chaoming Luo**, Shenzhen (CN); **Keli Zou**, Chengdu (CN); **Guangjian Wang**, Chengdu (CN); **Guolong Huang**, Chengdu (CN)

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(73) Assignee: **HUAWEI TECHNOLOGIES CO., LTD.**, Guangdong (CN)

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

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(21) Appl. No.: **16/923,287**

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

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(65) **Prior Publication Data**
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Related U.S. Application Data

(63) Continuation of application No. PCT/CN2018/122934, filed on Dec. 22, 2018.

Primary Examiner — Vibol Tan
(74) *Attorney, Agent, or Firm* — Westerman, Hattori, Daniels & Adrian, LLP

(30) **Foreign Application Priority Data**

Jan. 27, 2018 (CN) 201810080107.X

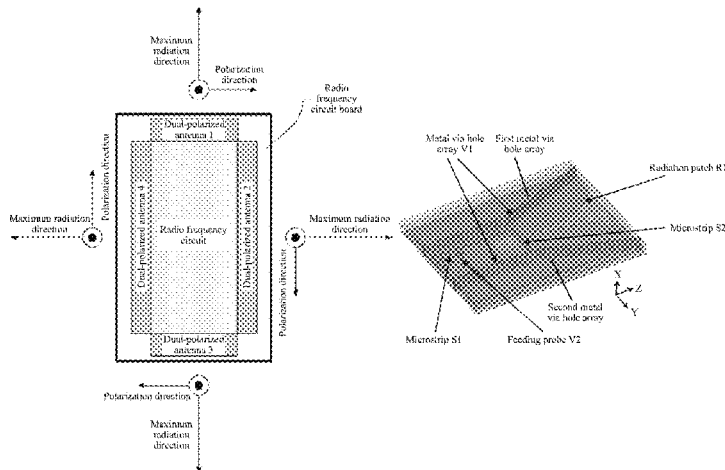
(57) **ABSTRACT**

(51) **Int. Cl.**
H01Q 25/00 (2006.01)
H01Q 13/02 (2006.01)
(Continued)

This application discloses a dual-polarized antenna, a radio frequency front-end apparatus, and a communications device. The dual-polarized antenna is a planar antenna, and a maximum radiation direction of the dual-polarized antenna is parallel to an antenna plane. A radio frequency circuit may be disposed at a side opposite to the maximum radiation direction of the dual-polarized antenna and located on a same circuit board as the dual-polarized antenna. A low profile feature is implemented, and the radio frequency circuit and the dual-polarized antenna do not need to be

(Continued)

(52) **U.S. Cl.**
CPC **H01Q 25/001** (2013.01); **H01Q 13/02** (2013.01); **H01Q 13/0275** (2013.01); **H01Q 13/085** (2013.01); **H01Q 21/064** (2013.01)





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

(10) **Patent No.:** **US 11,252,268 B2**
(45) **Date of Patent:** **Feb. 15, 2022**

(54) **ELECTRONIC DEVICE INCLUDING ANTENNA**
(71) Applicant: **SAMSUNG ELECTRONICS CO., LTD.**, Suwon-si (KR)
(72) Inventors: **Sungmin Lee**, Suwon-si (KR); **Yonghan Lee**, Suwon-si (KR); **Hyoseok Na**, 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.: **17/097,296**
(22) Filed: **Nov. 13, 2020**

(65) **Prior Publication Data**
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(30) **Foreign Application Priority Data**
Nov. 14, 2019 (KR) 10-2019-0146244
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(51) **Int. Cl.**
H04M 1/02 (2006.01)
H01Q 1/24 (2006.01)
H01Q 7/00 (2006.01)

(52) **U.S. Cl.**
CPC **H04M 1/0245** (2013.01); **H01Q 1/243** (2013.01); **H04M 1/0266** (2013.01); **H01Q 7/00** (2013.01)

(58) **Field of Classification Search**
CPC .. H04M 1/0245; H04M 1/0266; H01Q 1/243; H01Q 7/00

See application file for complete search history.

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Primary Examiner — Lewis G West
(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye P.C.

(57) **ABSTRACT**
According to an embodiment, an electronic device may include: a housing including a first surface and a second surface facing away from the first surface; a display at least partially accommodated in the housing and viewable through the first surface; a conductive layer disposed between the display and the second surface and including a first opening; a support disposed between the second surface and the conductive layer and including a conductive portion; and a wireless communication circuit electrically connected to the conductive layer, and configured to transmit and/or receive a signal through an antenna including at least a portion of the conductive layer surrounding the first opening.

21 Claims, 37 Drawing Sheets

