



US011231753B2

(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**

(56) **References Cited**

(71) Applicant: **LENOVO (SINGAPORE) PTE. LTD.**,
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(72) Inventors: **Tabito Miyamoto**, Kanagawa (JP);
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Hiroaki Kinoshita, Kanagawa (JP)

(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.

U.S. PATENT DOCUMENTS

6,885,880 B1 * 4/2005 Ali G06F 1/1616
455/575.7
7,839,340 B2 * 11/2010 Yamazaki H01Q 9/40
343/702
8,059,039 B2 * 11/2011 Ayala Vazquez H01Q 1/2266
343/702
8,059,040 B2 * 11/2011 Ayala Vazquez H01Q 1/38
343/702
8,264,412 B2 * 9/2012 Ayala H01Q 1/2266
343/702
8,325,096 B2 * 12/2012 Ayala Vazquez H01Q 1/38
343/702
8,482,469 B2 * 7/2013 Ayala H01Q 9/42
343/702
10,720,693 B2 * 7/2020 Yamamoto H01Q 1/48

(Continued)

(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

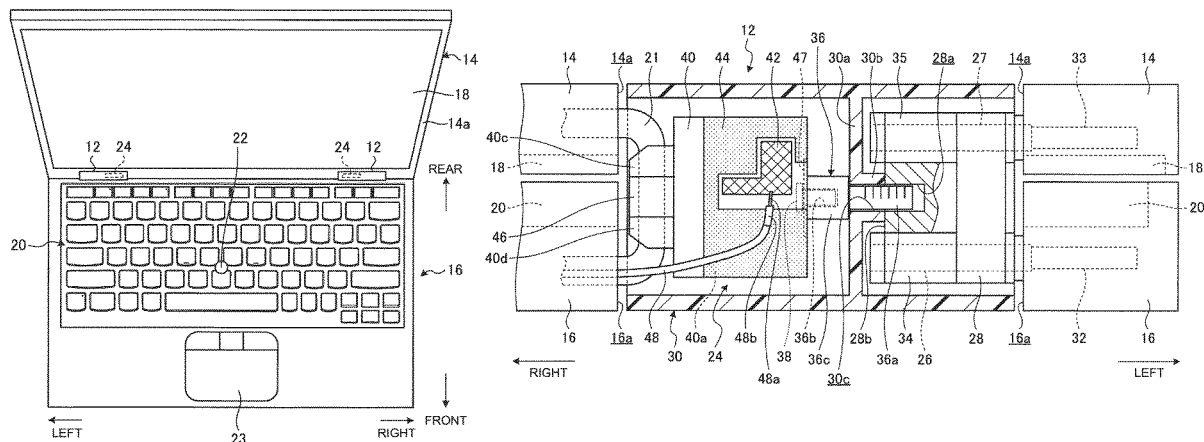
(74) *Attorney, Agent, or Firm* — Antony P. Ng; Russell
Ng PLLC

(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); **Gerancio 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**

U.S. PATENT DOCUMENTS

2013/0293426 A1* 11/2013 Hung H01Q 1/22 343/702
2014/0097993 A1* 4/2014 Hotta H01Q 1/243 343/702

* cited by examiner

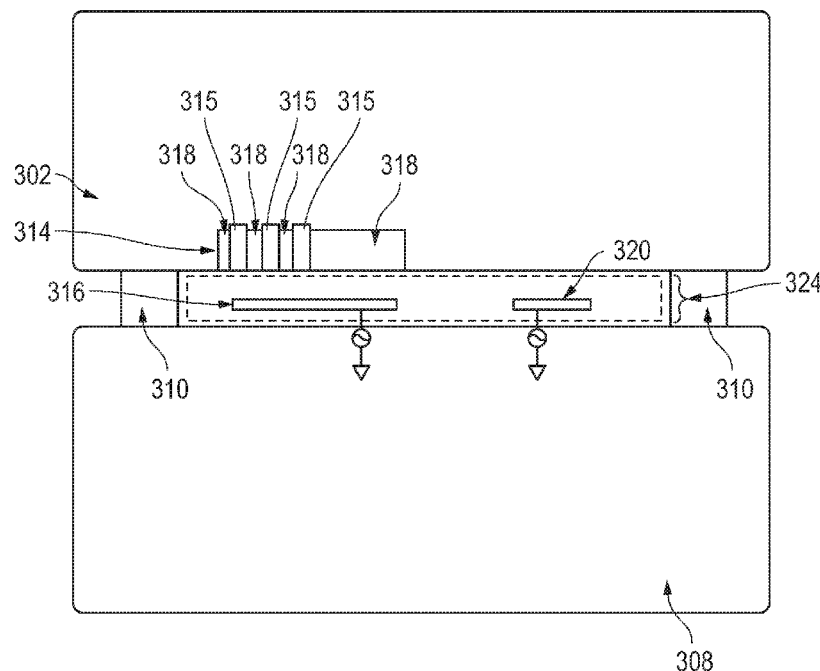
Primary Examiner — Dieu Hien T Duong

(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**

U.S. PATENT DOCUMENTS

7,535,431 B2 * 5/2009 Rowell H01Q 1/243
343/846
9,559,425 B2 * 1/2017 Zhu G01V 3/00
(Continued)

FOREIGN PATENT DOCUMENTS

CN 101304121 11/2008
CN 104701618 6/2015
KR 1020170019838 2/2017

(72) Inventors: **Jaehyung Kim**, Gyeonggi-do (KR);
Sang-Min Han, Gyeonggi-do (KR);
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)

OTHER PUBLICATIONS

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

European Search Report dated Aug. 10, 2018 issued in counterpart
application No. 18162022.0-1205, 9 pages.

(Continued)

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

Primary Examiner — Dameon E Levi

Assistant Examiner — Jennifer F Hu

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

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

(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)

(Continued)

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

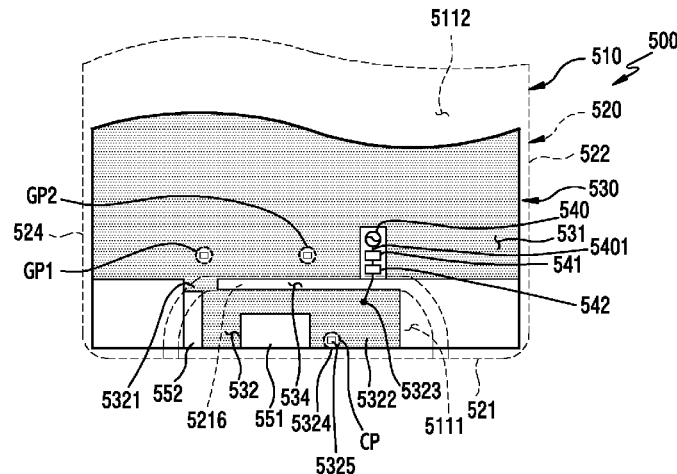
CPC **H01Q 1/243** (2013.01); **H01Q 1/085**
(2013.01); **H01Q 1/36** (2013.01); **H01Q 1/44**
(2013.01);

(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)



(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**

US 2020/0395654 A1 Dec. 17, 2020

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)
(Continued)

(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.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,160,058 B2 10/2015 Tsou et al.
9,287,612 B2 3/2016 Bolin et al.
(Continued)

FOREIGN PATENT DOCUMENTS

KR 1020090033596 4/2009
KR 1020100032681 3/2010
KR 1020120097877 9/2012

OTHER PUBLICATIONS

U.S. Appl. No. 15/860,427, Notice of Allowance dated Apr. 10, 2018, 22 pages.

(Continued)

Primary Examiner — Andrea Lindgren Baltzell

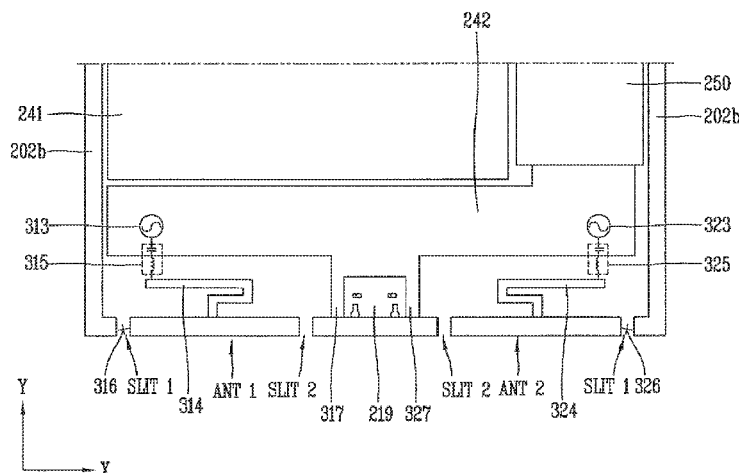
Assistant Examiner — Amal Patel

(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





US011233322B2

(12) **United States Patent**
Wakabayashi

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

(54) **COMMUNICATION DEVICE**

(56) **References Cited**

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

U.S. PATENT DOCUMENTS

(72) Inventor: **Minoru Wakabayashi,** Tokyo (JP)

7,352,328 B2 4/2008 Moon
2007/0069960 A1 3/2007 Moon
(Continued)

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

FOREIGN PATENT DOCUMENTS

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

JP 2007097167 A 4/2007
JP 2012182726 A 8/2012
(Continued)

(21) Appl. No.: **16/765,211**

OTHER PUBLICATIONS

(22) PCT Filed: **Nov. 30, 2018**

International Preliminary Report on Patentability and Written Opin-
ion for corresponding PCT Application No. PCT/JP2018/044238,
11 pages, dated Jun. 11, 2020.

(86) PCT No.: **PCT/JP2018/044238**

§ 371 (c)(1),
(2) Date: **May 19, 2020**

(Continued)

(87) PCT Pub. No.: **WO2019/107553**

PCT Pub. Date: **Jun. 6, 2019**

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

(57) **ABSTRACT**

(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)

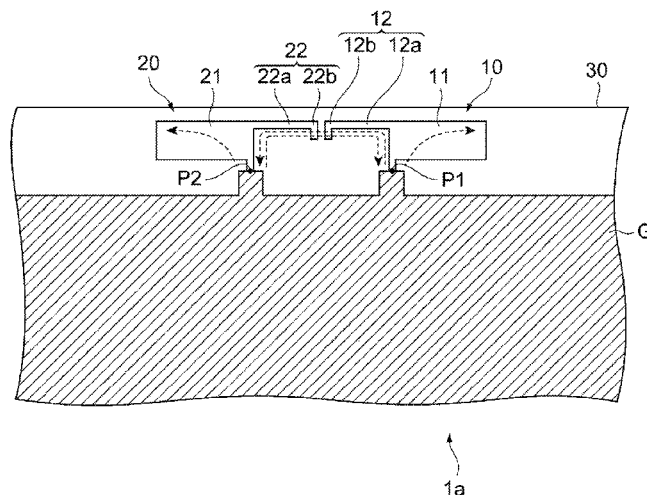
(58) **Field of Classification Search**

CPC H01Q 1/52; H01Q 1/242; H01Q 9/42;
H01Q 1/38

See application file for complete search history.

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



(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.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2016/0211581 A1 7/2016 Sampo et al.
2018/0301798 A1 10/2018 Ikeda et al.

FOREIGN PATENT DOCUMENTS

CN 104319474 A 1/2015
DE 10 2004 050 598 A1 4/2006

(Continued)

OTHER PUBLICATIONS

Faycel Fezai, "Low Profile Dual-band Circularly Polarized Microstrip Antenna for GNSS Application", 4 pages, IEEE Xplore, Apr. 2015, (Year: 2015).*

(Continued)

Primary Examiner — Dieu Hien T Duong

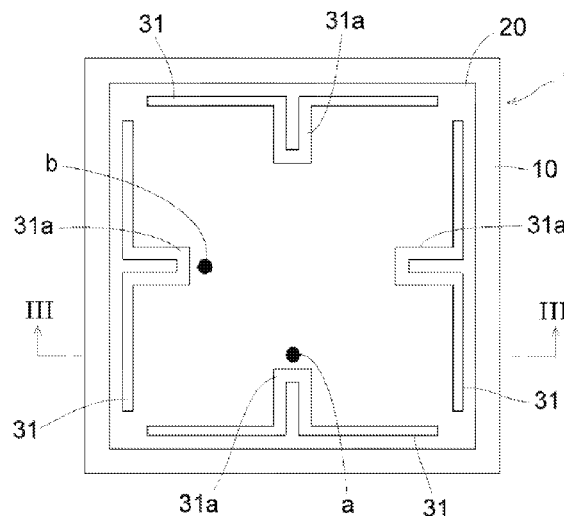
(74) *Attorney, Agent, or Firm* — Xsensus LLP

(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**

(56) **References Cited**

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

U.S. PATENT DOCUMENTS

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

2014/0071000 A1* 3/2014 Tani H01Q 1/243
343/700 MS
2014/0078001 A1* 3/2014 Matsuoka H01Q 5/385
343/700 MS

(73) Assignee: **Panasonic Intellectual Property Management Co., Ltd.**, Osaka (JP)

FOREIGN PATENT DOCUMENTS

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 16 days.

JP 6015944 B2 10/2016

OTHER PUBLICATIONS

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

International Search Report for related Application No. PCT/JP2018/048269, dated Mar. 12, 2019.

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

* cited by examiner

(65) **Prior Publication Data**

US 2020/0358197 A1 Nov. 12, 2020

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

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2018/048269, filed on Dec. 27, 2018.

Foreign Application Priority Data

Jan. 31, 2018 (JP) JP2018-015528

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

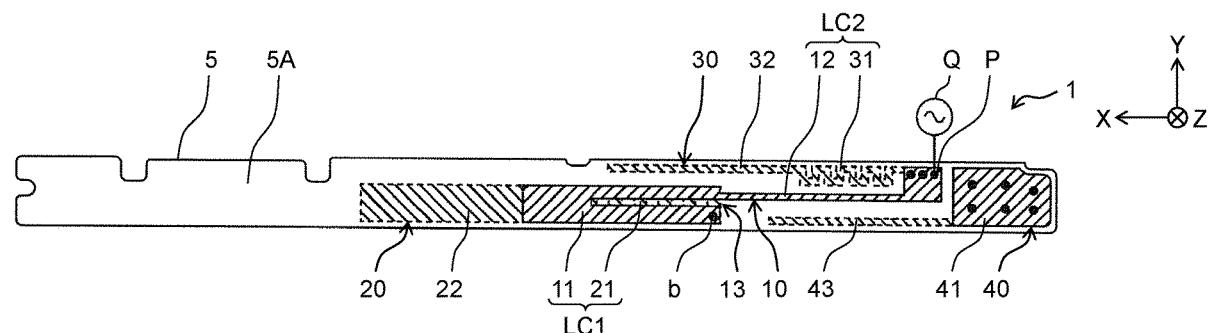
(52) **U.S. Cl.**
CPC **H01Q 9/42** (2013.01); **H01Q 1/38** (2013.01); **H01Q 5/307** (2015.01); **H01Q 1/2266** (2013.01)

(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.

(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**

(56) **References Cited**

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

U.S. PATENT DOCUMENTS

(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)

5,023,624 A * 6/1991 Heckaman H01L 23/66
333/247
5,903,239 A * 5/1999 Takahashi H01Q 1/2283
343/700 MS
6,982,672 B2 * 1/2006 Lin H01Q 1/38
343/700 MS
7,187,328 B2 * 3/2007 Tanaka H01Q 9/0407
343/700 MS

(Continued)

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

FOREIGN PATENT DOCUMENTS

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 137 days.

JP 2003-283239 A 10/2003
KR 10-0542829 B1 1/2006

(Continued)

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

OTHER PUBLICATIONS

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

Korean Office Action dated Feb. 19, 2020 In Counterpart Korean Patent Application No. 10-2019-0081483 (7 Pages in English and 6 Pages in Korean).

(65) **Prior Publication Data**

US 2020/0259267 A1 Aug. 13, 2020

Primary Examiner — Tho G Phan

(30) **Foreign Application Priority Data**

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

Feb. 8, 2019 (KR) 10-2019-0015001
Jul. 5, 2019 (KR) 10-2019-0081483

(57) **ABSTRACT**

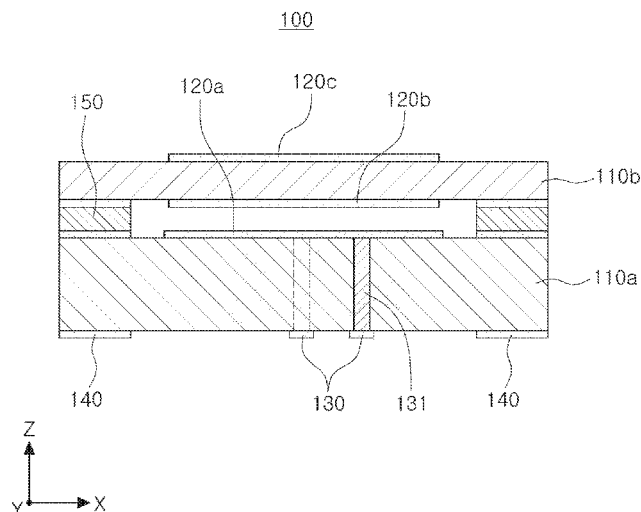
(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 21/00 (2006.01)
(Continued)

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.

(52) **U.S. Cl.**
CPC **H01Q 21/0025** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01);
(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)

19 Claims, 17 Drawing Sheets





US011233337B2

(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.**,
Suwon-si (KR)

(72) Inventors: **Jeong Ki Ryoo**, Suwon-si (KR); **Hong In Kim**, Suwon-si (KR); **Myeong Woo Han**, Suwon-si (KR); **Nam Ki Kim**, Suwon-si (KR); **Dae Ki Lim**, Suwon-si (KR); **Ju Hyoung Park**, 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 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.**
H01Q 21/10 (2006.01)
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.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,952,971 A * 9/1999 Strickland H01Q 1/38 343/700 MS
6,239,750 B1 * 5/2001 Snygg H01Q 1/246 343/700 MS

(Continued)

FOREIGN PATENT DOCUMENTS

CN 1451189 A 10/2003
CN 2593385 Y 12/2003

(Continued)

OTHER PUBLICATIONS

Korean Office Action dated Feb. 27, 2019 in the corresponding Korean Patent Application No. 10-2018-0072739 (4 pages in English and 4 pages in Korean).

(Continued)

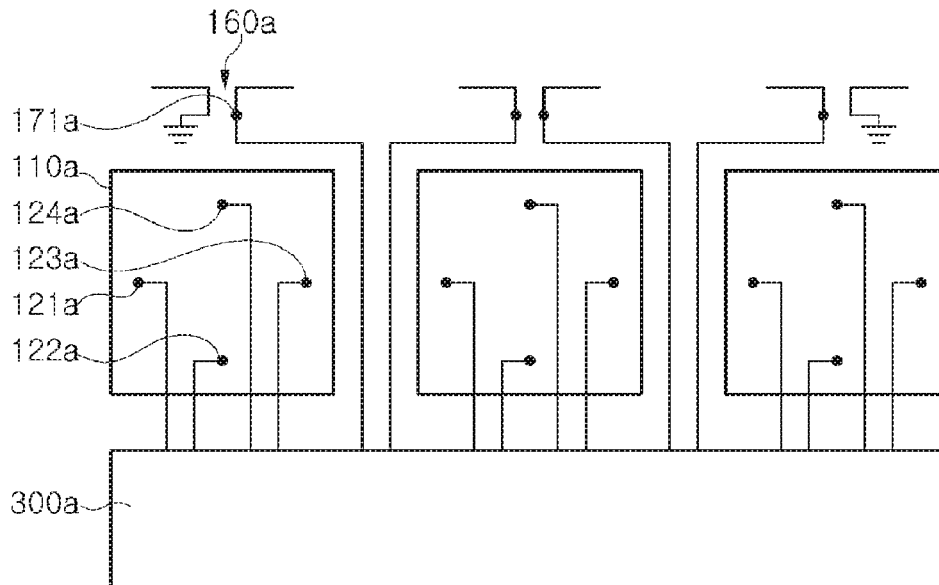
Primary Examiner — Ab Salam Alkassim, Jr.

(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

See application file for complete search history.

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

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

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

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

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

* cited by examiner

Primary Examiner — Joseph J Lauture

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

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

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

(65) **Prior Publication Data**

US 2021/0135371 A1 May 6, 2021

(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)

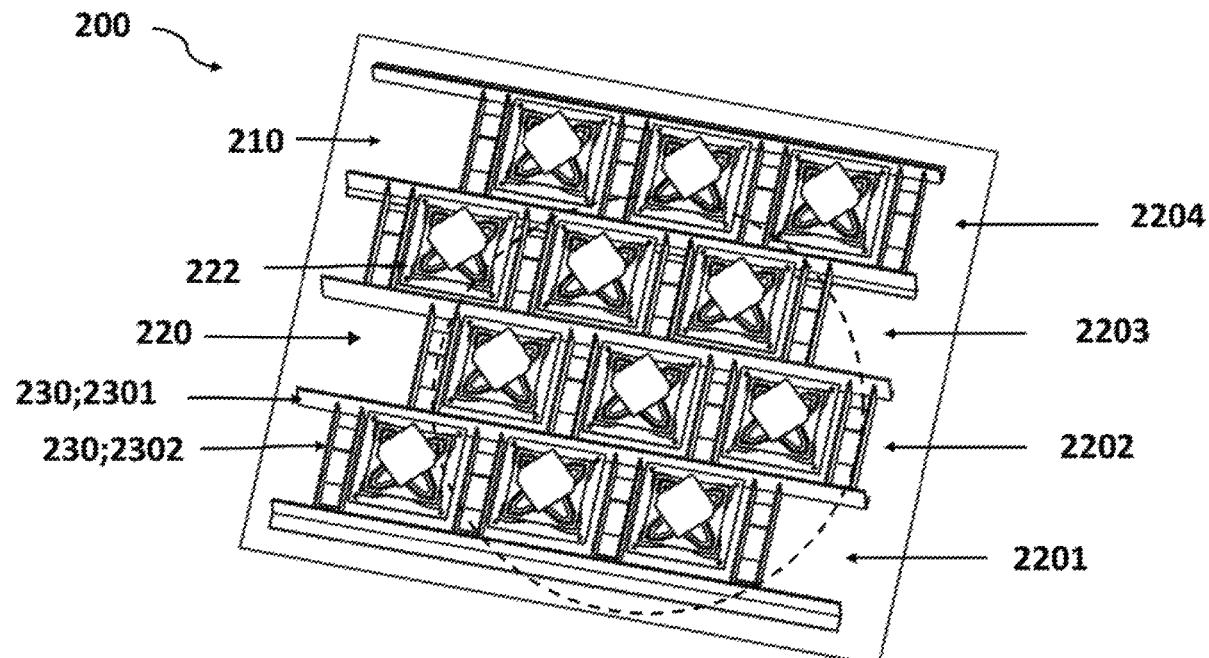
(52) **U.S. Cl.**

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

(57) **ABSTRACT**

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.

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.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,489,913 A	2/1996	Raguenet et al.	
10,297,918 B2 *	5/2019	Zhang	H01Q 9/0464
2004/0051675 A1 *	3/2004	Inoue	H01Q 5/40
			343/728
2004/0135726 A1	7/2004	Shamir et al.	
2007/0052587 A1 *	3/2007	Cheng	H01Q 9/0457
			343/700 MS
2007/0164868 A1 *	7/2007	Deavours	H01Q 9/0442
			340/572.7
2008/0018867 A1 *	1/2008	Fujiwara	G03F 7/70975
			355/30
2008/0048867 A1	2/2008	Oliver et al.	
2008/0136720 A1 *	6/2008	Parsche	H01Q 21/24
			343/741
2009/0256653 A1	10/2009	Hung et al.	

(Continued)

FOREIGN PATENT DOCUMENTS

JP 2014078772 A 5/2014

OTHER PUBLICATIONS

"Design of a Low Profile Unidirectional UWB Antenna for Multi-Service Base Station", Carlos Ramiro Penafiel-Ojeda, et al., 11th European Conference on Antennas and Propagation (EUCAP), 2017, pp. 3575-3579.

(Continued)

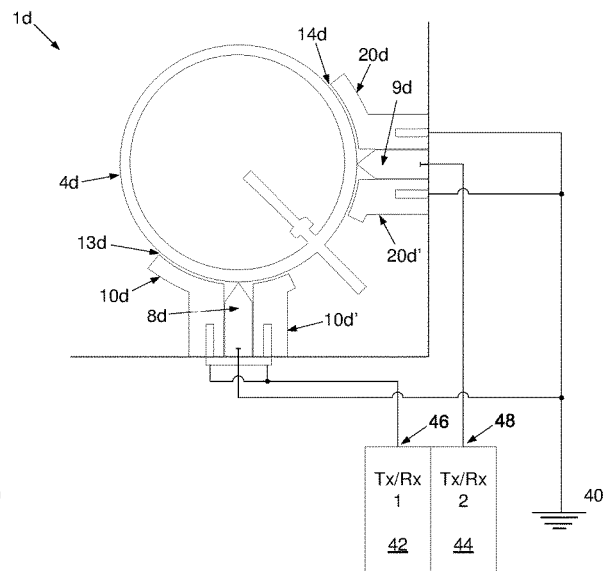
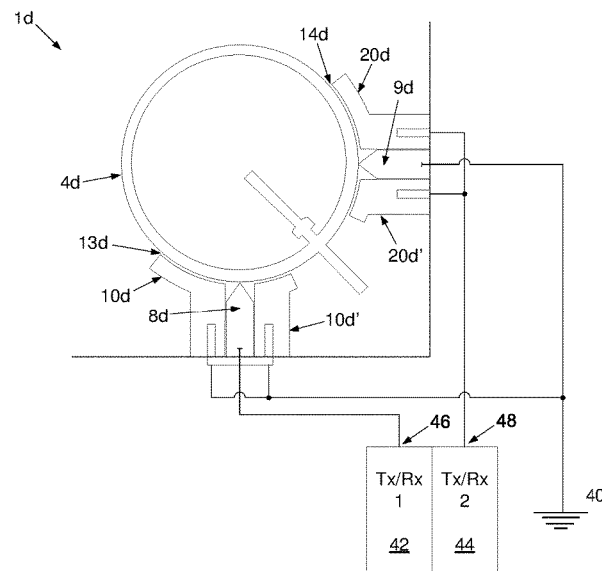
Primary Examiner — Lam T Mai

(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)

U.S. PATENT DOCUMENTS

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

2008/0186247 A1 8/2008 Cotte et al.
2009/0207080 A1* 8/2009 Floyd *H01L 23/66*
343/700 MS

(Continued)

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

FOREIGN PATENT DOCUMENTS

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

WO WO-2018057007 A1 3/2018

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

OTHER PUBLICATIONS

§ 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)

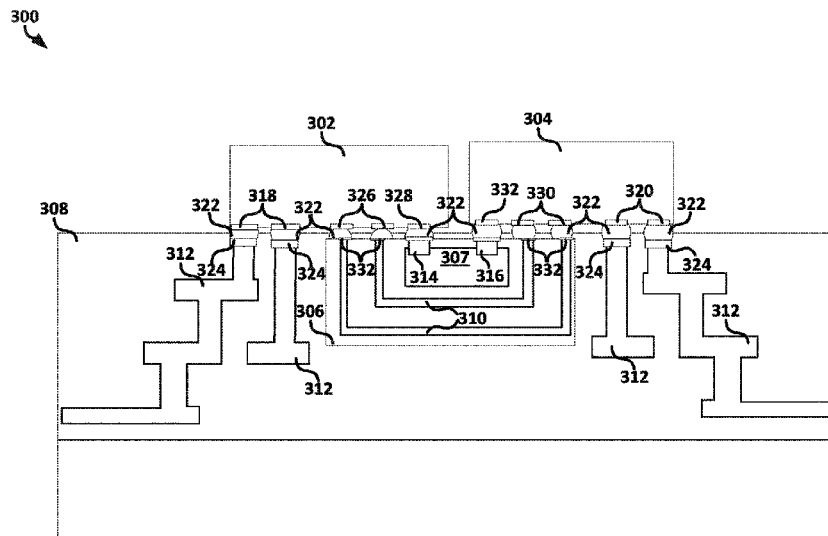
ABSTRACT

(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*

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.

12 Claims, 13 Drawing Sheets





US011239544B2

(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**

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

(72) Inventors: **Ligang Wu**, Suzhou (CN); **Lei Yang**,
Suzhou (CN); **Hangsheng Wen**, 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 0 days.

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

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

(65) **Prior Publication Data**

US 2021/0135343 A1 May 6, 2021

(30) **Foreign Application Priority Data**

Oct. 31, 2019 (CN) 201911056960.9

Dec. 25, 2019 (CN) 201911351453.8

(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)

(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.

(56)

References Cited

U.S. PATENT DOCUMENTS

9,077,070 B2 7/2015 Zimmerman et al.
2015/0214617 A1* 7/2015 Shang H01Q 1/52
343/722

2018/0367199 A1* 12/2018 Zimmerman H01Q 25/001

* cited by examiner

Primary Examiner — Joseph J Lauture

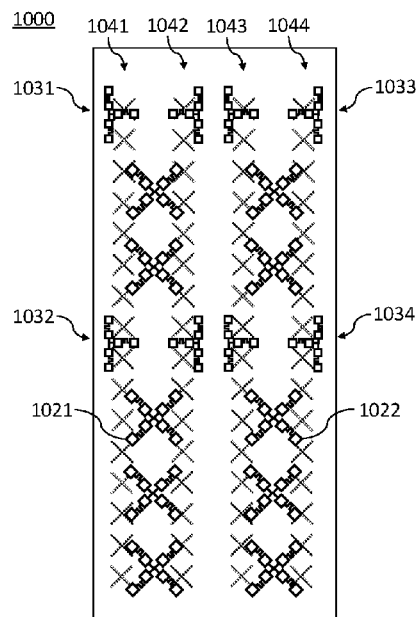
(74) *Attorney, Agent, or Firm* — Myers Bigel, P.A.

(57)

ABSTRACT

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.

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)

4,245,222 A 1/1981 Eng et al.
4,590,478 A 5/1986 Powers et al.
5,517,203 A * 5/1996 Fiedziuszko H01P 1/2086 333/202
5,581,266 A 12/1996 Peng et al.
(Continued)

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

FOREIGN PATENT DOCUMENTS

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

CN 109066054 12/2018
CN 109066054 A 12/2018
(Continued)

OTHER PUBLICATIONS

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

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

“Invitation to Pay Fees and Partial International Search Report”, Application No. PCT/US2019/064407, dated Mar. 11, 2020, 12 pages.

(65) **Prior Publication Data**

US 2020/0295447 A1 Sep. 17, 2020

(Continued)

Primary Examiner — Daniel D Chang

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

(51) **Int. Cl.**

H01Q 1/38 (2006.01)
G06F 1/16 (2006.01)
H01Q 1/24 (2006.01)
H01Q 21/00 (2006.01)

(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)

(58) **Field of Classification Search**

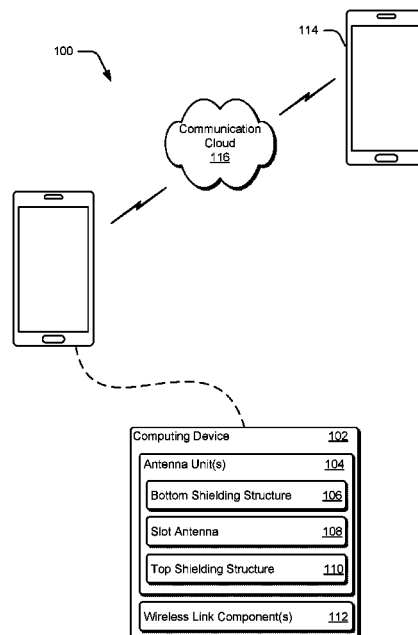
CPC H01Q 13/18; H01Q 1/243; H01Q 21/0037; H01Q 1/40; H01Q 1/2266
See application file for complete search history.

(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-

(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**
U.S. PATENT DOCUMENTS

2010/0026401 A1* 2/2010 Mukai H03B 7/08
331/107 T
2015/0364535 A1 12/2015 Triyoso et al.

FOREIGN PATENT DOCUMENTS

DE 10 2015 208 657 A1 12/2015
JP 3-21857 U 3/1991
(Continued)

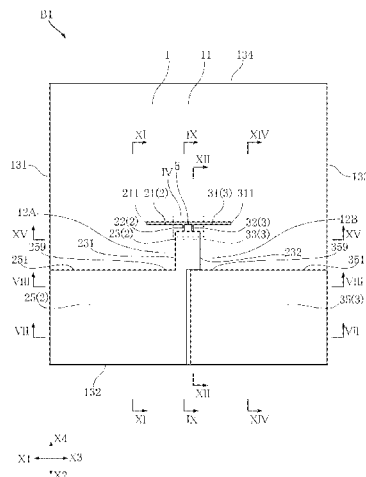
OTHER PUBLICATIONS

International Search Report issued in PCT/JP2018/024179, dated Aug. 28, 2018 (2 pages).
(Continued)

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**

U.S. PATENT DOCUMENTS

4,668,954 A * 5/1987 Tomasi G01C 21/165
342/387
5,557,282 A * 9/1996 Mertens G01S 7/2813
342/123
2003/0052831 A1* 3/2003 Knop H01Q 13/0266
343/786

* cited by examiner

Primary Examiner — Hoang V Nguyen

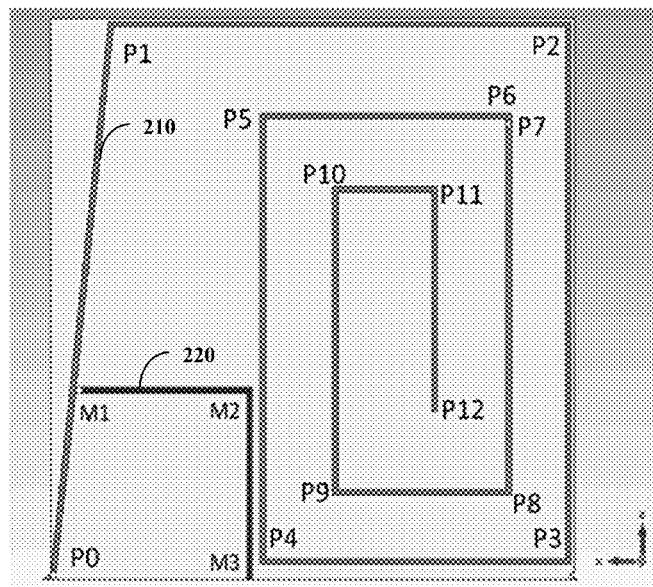
(74) *Attorney, Agent, or Firm* — Ronald Krosky

(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 Aéronautiques**, 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.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,827,271 A * 5/1989 Berneking H01Q 9/0414
343/700 MS

5,767,810 A * 6/1998 Hagiwara H01Q 9/0421
343/700 MS

6,118,406 A 9/2000 Josypenko

6,750,825 B1 1/2004 Delaveaud et al.

2003/0146872 A1* 8/2003 Kellerman H01Q 5/385
343/700 MS

2014/0197994 A1 7/2014 Hossain

FOREIGN PATENT DOCUMENTS

FR 2 709 878 3/1995

OTHER PUBLICATIONS

Search Report for FR1910719.

(Continued)

Primary Examiner — Hoang V Nguyen

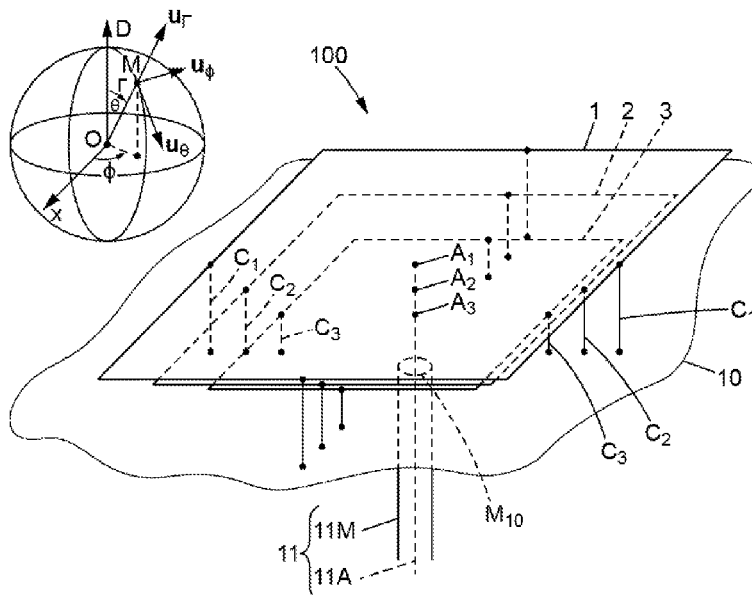
(74) Attorney, Agent, or Firm — Nixon & Vanderhye P.C.

(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





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**

U.S. PATENT DOCUMENTS

8,199,057 B2	6/2012	Ishizuka et al.	
9,843,092 B2 *	12/2017	Tu	H01Q 13/10
10,454,156 B1 *	10/2019	Yang	H01Q 5/335
2010/0265146 A1 *	10/2010	Montgomery	H01Q 1/38
			343/722
2012/0001815 A1 *	1/2012	Wong	H01Q 9/0414
			343/749
2012/0075156 A1	3/2012	Noguchi et al.	
2017/0352945 A1 *	12/2017	Chang	H01Q 1/36
2018/0183147 A1	6/2018	Ku et al.	

FOREIGN PATENT DOCUMENTS

CN	101496224 A	7/2009
TW	M545375 U	7/2017

* cited by examiner

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

(72) Inventors: **Huang-Tse Peng**, Hsinchu (TW);
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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**

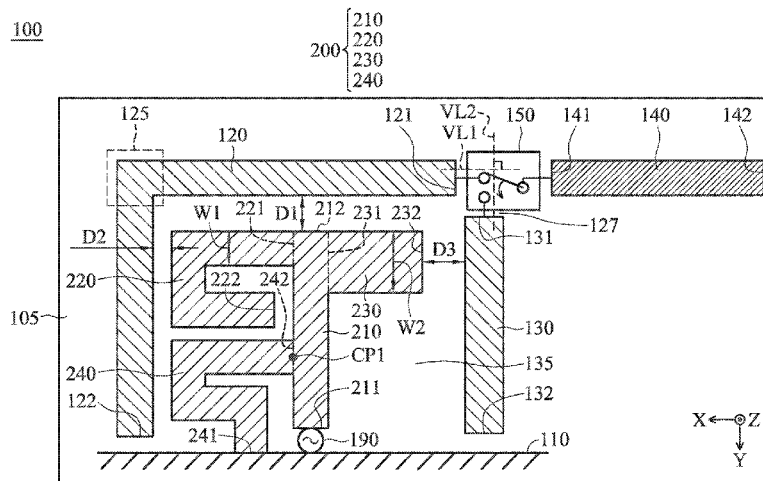
CPC H01Q 5/371; H01Q 5/328; H01Q 9/42; H01Q 5/45; H01Q 1/244; H01Q 5/28; H01Q 1/2266; H01Q 5/385; H01Q 5/392

See application file for complete search history.

(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**

(56) **References Cited**

(71) Applicant: **DESARROLLO DE TECNOLOGIA
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S.A.P.I. DE C.V., Monterrey (MX)**

U.S. PATENT DOCUMENTS

(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.

6,157,344 A *	12/2000	Bateman	G06F 1/1616 343/700 MS
6,300,914 B1	10/2001	Yang	
6,525,691 B2	2/2003	Varadan et al.	
6,917,334 B2	7/2005	Chen	
6,917,336 B2	7/2005	Rowser et al.	
6,975,277 B2	12/2005	Tran	
7,239,283 B2	7/2007	Chua	
7,248,223 B2	7/2007	Habib et al.	
7,265,717 B2	9/2007	Saitou et al.	
7,365,701 B2	4/2008	Werner et al.	
7,403,164 B2	7/2008	Sanz et al.	
7,417,588 B2	8/2008	Castany et al.	
7,436,360 B2	10/2008	Chen et al.	
7,791,539 B2	9/2010	Soler Castany et al.	
8,237,615 B2	8/2012	Anguera et al.	
8,405,552 B2	3/2013	Bae et al.	
8,738,103 B2	5/2014	Puente Baliarda et al.	
9,343,810 B2	5/2016	Chen et al.	
2004/0017317 A1	1/2004	Schmiade	
2008/0024369 A1 *	1/2008	Shinkai	H01Q 9/42 343/700 MS
2008/0094297 A1	4/2008	Petkov et al.	
2009/0195459 A1	8/2009	Chua	
2019/0081388 A1 *	3/2019	Lo Hine Tong	H01Q 7/00

* cited by examiner

Primary Examiner — Dimary S Lopez Cruz

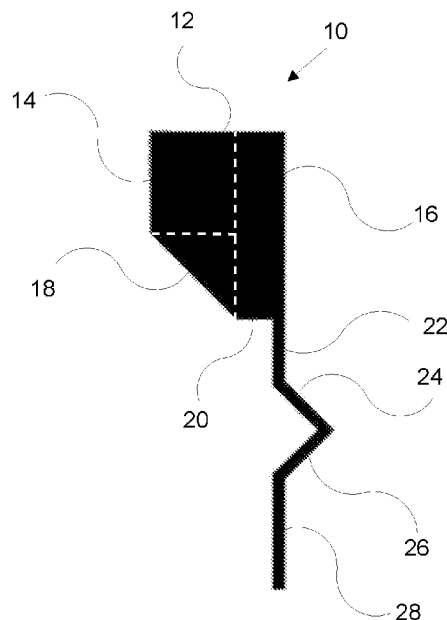
Assistant Examiner — Noel Maldonado

(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.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,685,694 B2 6/2017 Choi et al.
10,224,608 B2 3/2019 Lee et al.
(Continued)

FOREIGN PATENT DOCUMENTS

CN 107799885 3/2018
CN 108232419 6/2018
(Continued)

OTHER PUBLICATIONS

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

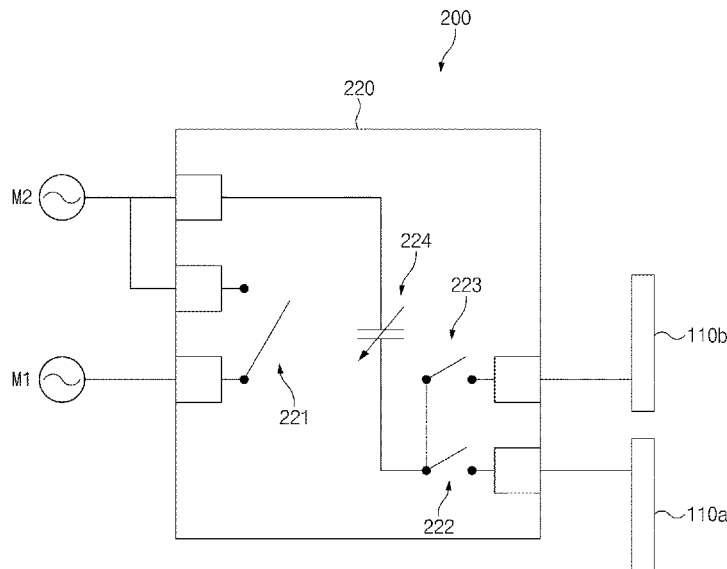
Primary Examiner — David Bilodeau

(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





US011240909B2

(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.

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

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

(65) **Prior Publication Data**

US 2020/0196439 A1 Jun. 18, 2020

2003/0231142 A1* 12/2003 McKinzie, III H01Q 15/008
343/909
2006/0092079 A1* 5/2006 de Rochemont H01Q 15/006
343/700 MS
2007/0285318 A1* 12/2007 Sotoudeh H01Q 1/243
343/702
2011/0156972 A1* 6/2011 Korva H01Q 1/48
343/745
2012/0256811 A1* 10/2012 Colburn H05K 1/165
343/907
2013/0249752 A1* 9/2013 Alexopoulos H01Q 1/38
343/745
2014/0203993 A1* 7/2014 Toyao H01P 5/107
343/867
2014/0225795 A1* 8/2014 Yu H01Q 13/085
343/767
2017/0033435 A1* 2/2017 Nakano H01Q 1/48
2017/0033468 A1* 2/2017 Wong H01Q 15/0086
2017/0187229 A1* 6/2017 Hosseini H02J 7/0042
2019/0098750 A1* 3/2019 Woo H05K 1/0236

(Continued)

(30) **Foreign Application Priority Data**

FOREIGN PATENT DOCUMENTS

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.

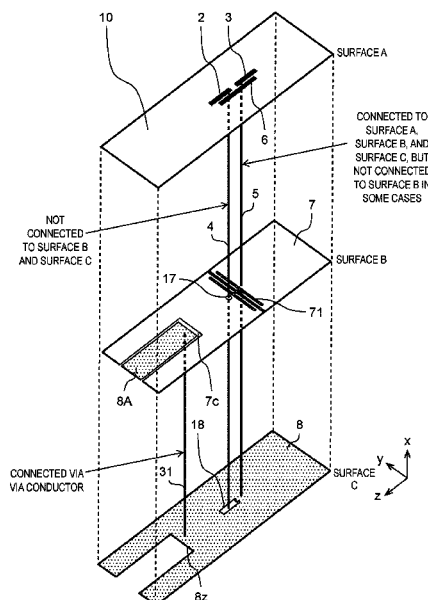
(52) **U.S. Cl.**
CPC **H05K 1/0243** (2013.01); **H01Q 9/045**
(2013.01); **H05K 2201/10098** (2013.01)

(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.

(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.

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**

(56) **References Cited**

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

U.S. PATENT DOCUMENTS

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

5,722,055 A	2/1998	Kobayashi et al.	
8,059,039 B2 *	11/2011	Ayala Vazquez	H01Q 1/2266 343/702
8,264,412 B2 *	9/2012	Ayala	H01Q 1/2266 343/702
8,310,404 B2	11/2012	Kishimoto et al.	
2006/0077104 A1	4/2006	Usui et al.	
2008/0055184 A1	3/2008	Noro et al.	

(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.

FOREIGN PATENT DOCUMENTS

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

JP	2003-264413 A	9/2003
JP	2006-115089 A	4/2006
JP	2008-61084 A	3/2008
JP	2009-157631 A	7/2009

* cited by examiner

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

Primary Examiner — Dimary S Lopez Cruz

Assistant Examiner — Patrick R Holecsek

(65) **Prior Publication Data**

US 2020/0235461 A1 Jul. 23, 2020

(74) *Attorney, Agent, or Firm* — Knobbe, Martens, Olson & Bear LLP

(30) **Foreign Application Priority Data**

Jan. 21, 2019 (JP) JP2019-007872

(57) **ABSTRACT**

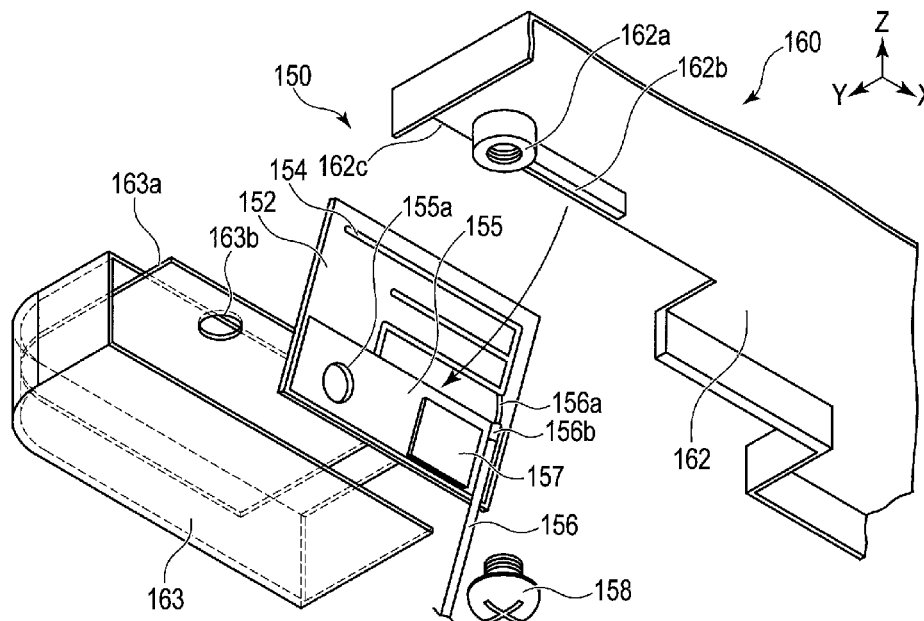
(51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01Q 1/48 (2006.01)

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.

(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.

7 Claims, 6 Drawing Sheets





US011245178B2

(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**

U.S. PATENT DOCUMENTS

2009/0284432 A1* 11/2009 Cuzzolino H01Q 9/42
343/821

FOREIGN PATENT DOCUMENTS

CN 104577308 A * 4/2015

* cited by examiner

Primary Examiner — Andrea Lindgren Baltzell

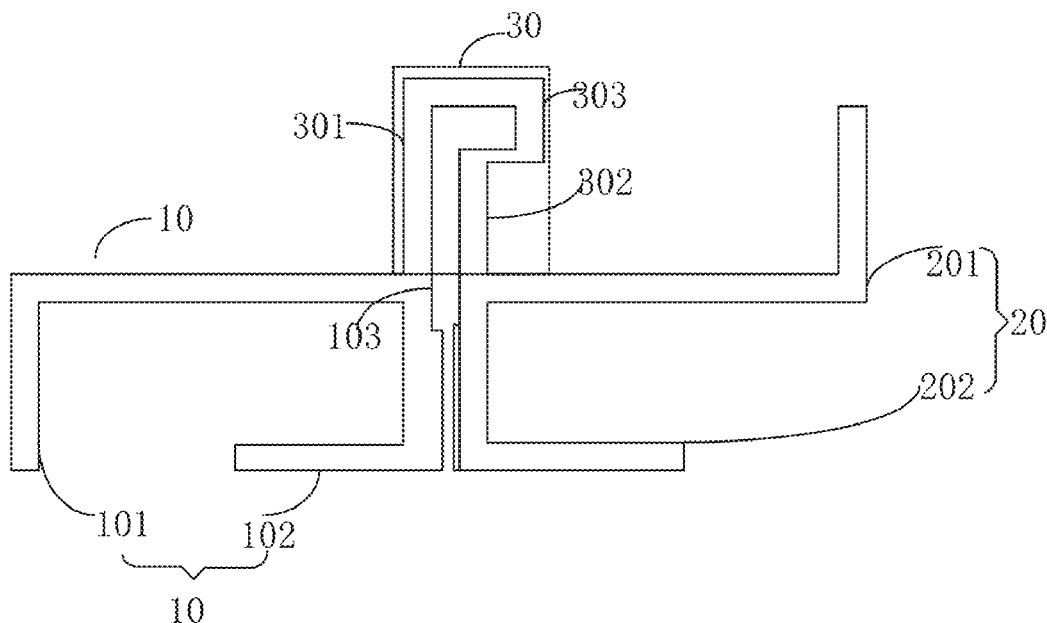
Assistant Examiner — Amal Patel

(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



(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.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,236,102 A 3/1941 Kilster
2,318,516 A 5/1943 Newbold
(Continued)

FOREIGN PATENT DOCUMENTS

KR 20020041771 6/2002

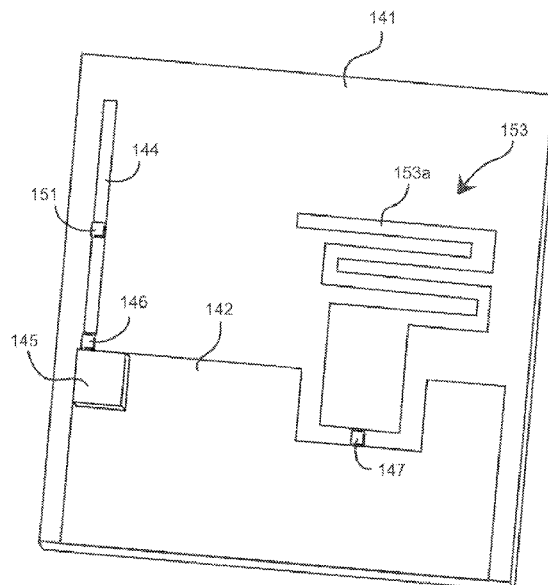
Primary Examiner — Tho G Phan

(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





US011245182B2

(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**

U.S. PATENT DOCUMENTS

2017/0117634 A1* 4/2017 Park H01Q 9/285

2020/0106195 A1* 4/2020 Fleancu H01Q 1/246

2021/0175639 A1* 6/2021 Wang H01Q 1/38

* cited by examiner

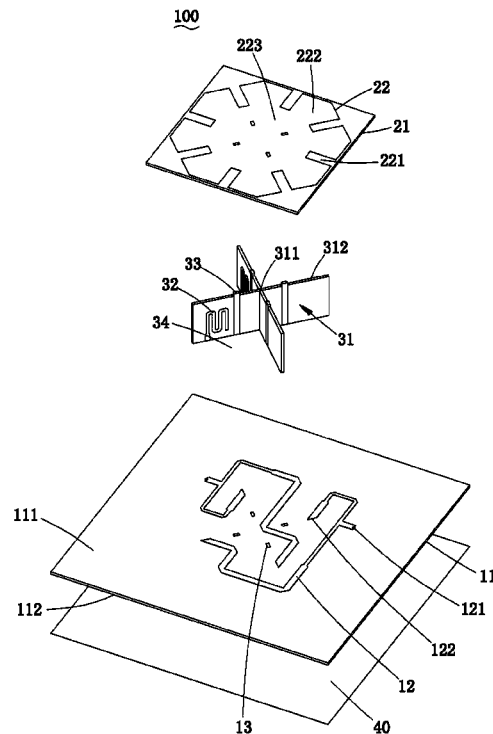
Primary Examiner — Hasan Islam

(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





US011245183B2

(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**

U.S. PATENT DOCUMENTS

9,369,187 B1 *	6/2016	Sammeta	H04B 1/40
9,543,644 B2 *	1/2017	Wu	H01Q 1/523
2009/0219213 A1 *	9/2009	Lee	H01P 5/185
			343/700 MS
2010/0141536 A1 *	6/2010	Zhang	H01Q 1/243
			343/702
2011/0237207 A1 *	9/2011	Bauder	H01Q 1/521
			455/78
2012/0218162 A1 *	8/2012	Aoki	H01Q 1/242
			343/835
2019/0165466 A1 *	5/2019	Xu	H01Q 1/521
2019/0326683 A1 *	10/2019	Su	H01Q 21/0006

* cited by examiner

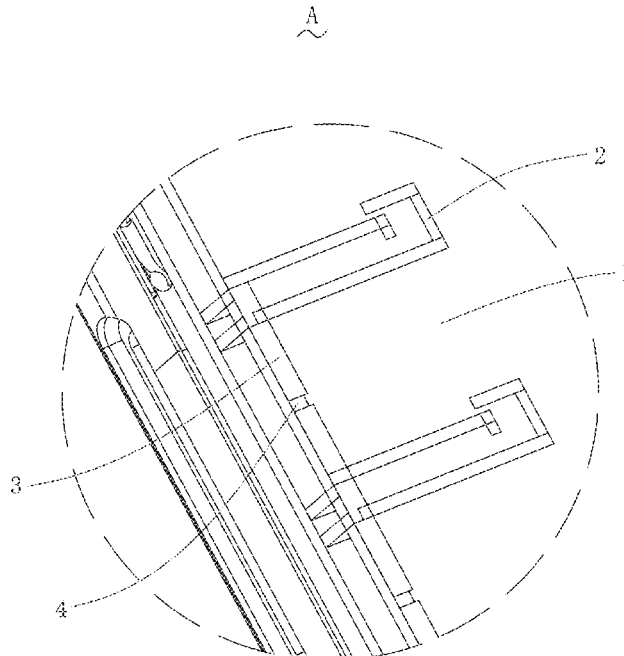
Primary Examiner — Crystal L Hammond

(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.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,198,826 A * 3/1993 Ito H01Q 1/38
343/713
6,946,958 B2 * 9/2005 Gundlach G06K 19/0724
340/13.27
7,102,577 B2 * 9/2006 Richard H01Q 1/242
343/702

(Continued)

(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;

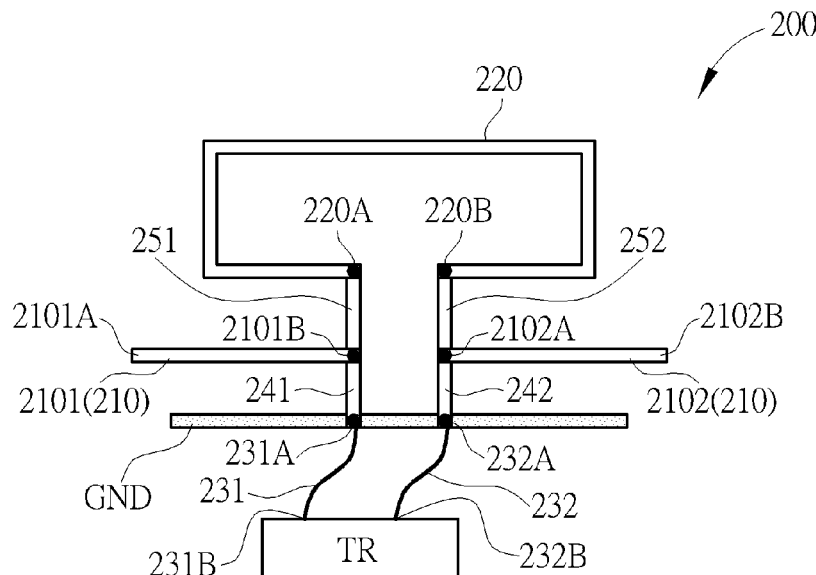
Primary Examiner — Hoang V Nguyen

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

(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)

10,700,024 B2 *	6/2020	So	H01L 24/82
11,133,592 B2 *	9/2021	Kang	H01Q 1/2283
2016/0172317 A1 *	6/2016	Tsai	H01L 24/33
			257/428
2017/0125895 A1	5/2017	Baks et al.	
2019/0207304 A1 *	7/2019	Kim	H01Q 9/0414
2020/0303805 A1 *	9/2020	Ryoo	H01Q 21/28
2020/0328518 A1 *	10/2020	Park	H01Q 5/40
2020/0328530 A1 *	10/2020	Park	H01Q 1/2283
2021/0151853 A1 *	5/2021	Park	H01Q 1/243
2021/0151899 A1 *	5/2021	Park	H01Q 21/065

(Continued)

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

FOREIGN PATENT DOCUMENTS

KR	10-0586936 B1	6/2006
KR	10-0805028 B1	2/2008

(Continued)

Primary Examiner — Lam T Mai

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

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

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

(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)

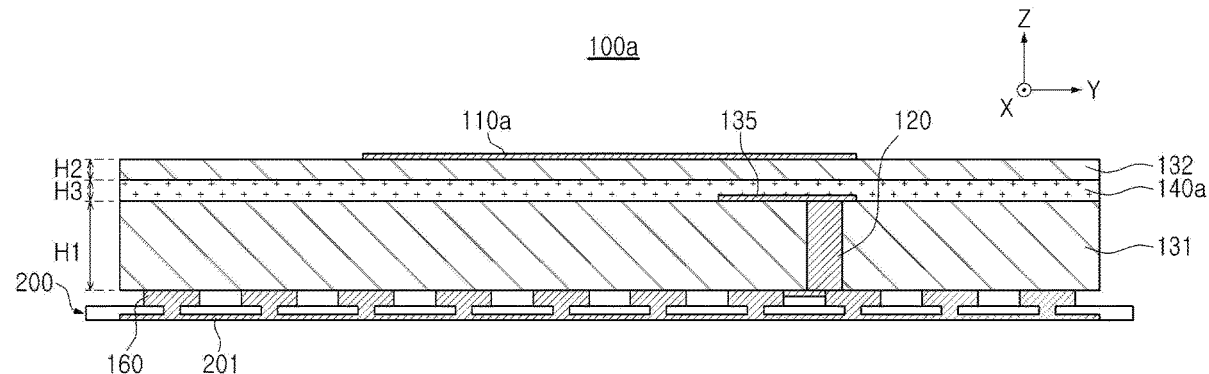
(58) **Field of Classification Search**

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

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**

U.S. PATENT DOCUMENTS

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

10,424,830 B2 9/2019 Semonov et al.
2014/0028516 A1 1/2014 Semonov et al.
2018/0115067 A1 4/2018 Chen et al.

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

FOREIGN PATENT DOCUMENTS

WO WO-2012102576 A2 * 8/2012 H01Q 21/08

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

OTHER PUBLICATIONS

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

He et al., A novel broadband dual-polarized dipole antenna element for 2G/3G/LTE base stations, IEEE International Conference on RFID Technology and Applications, 2016, Abstract.

Cui et al., A Novel Broadband Planar Antenna for 2G/3G/LTE Base Stations, IEEE Transactions on Antennas and Propagation, May 5, 2013, pp. 2767-2774, vol. 61, No. 5.

He et al., A Novel Dual-Broadband and Dual-Polarized Antenna for 2G/3G/LTE Base Stations, IEEE Transactions on Antennas and Propagation, Sep. 9, 2016, pp. 4113-4118, vol. 64, No. 9.

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

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

* cited by examiner

(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**

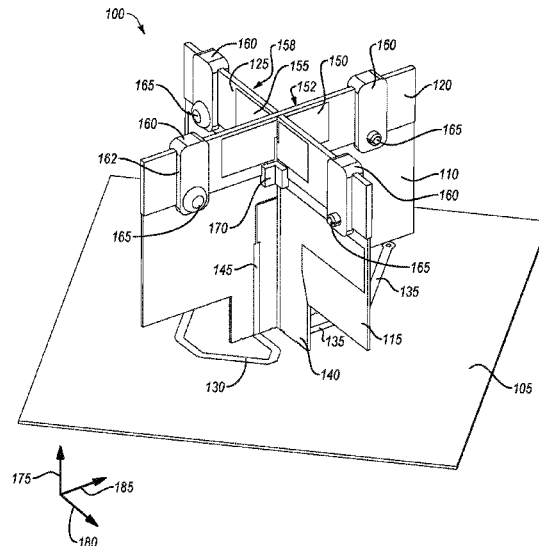
One antenna module includes a first circuit board and a second circuit board connected to the first circuit board. The antenna module includes a first antenna disposed on the first circuit board. The antenna module also includes a second antenna disposed on the second circuit board. The second circuit 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**

U.S. PATENT DOCUMENTS

6,448,932 B1 9/2002 Stoiljkovic et al.

OTHER PUBLICATIONS

“Office Action of Taiwan Counterpart Application”, dated Apr. 8, 2021, p. 1-p. 7.

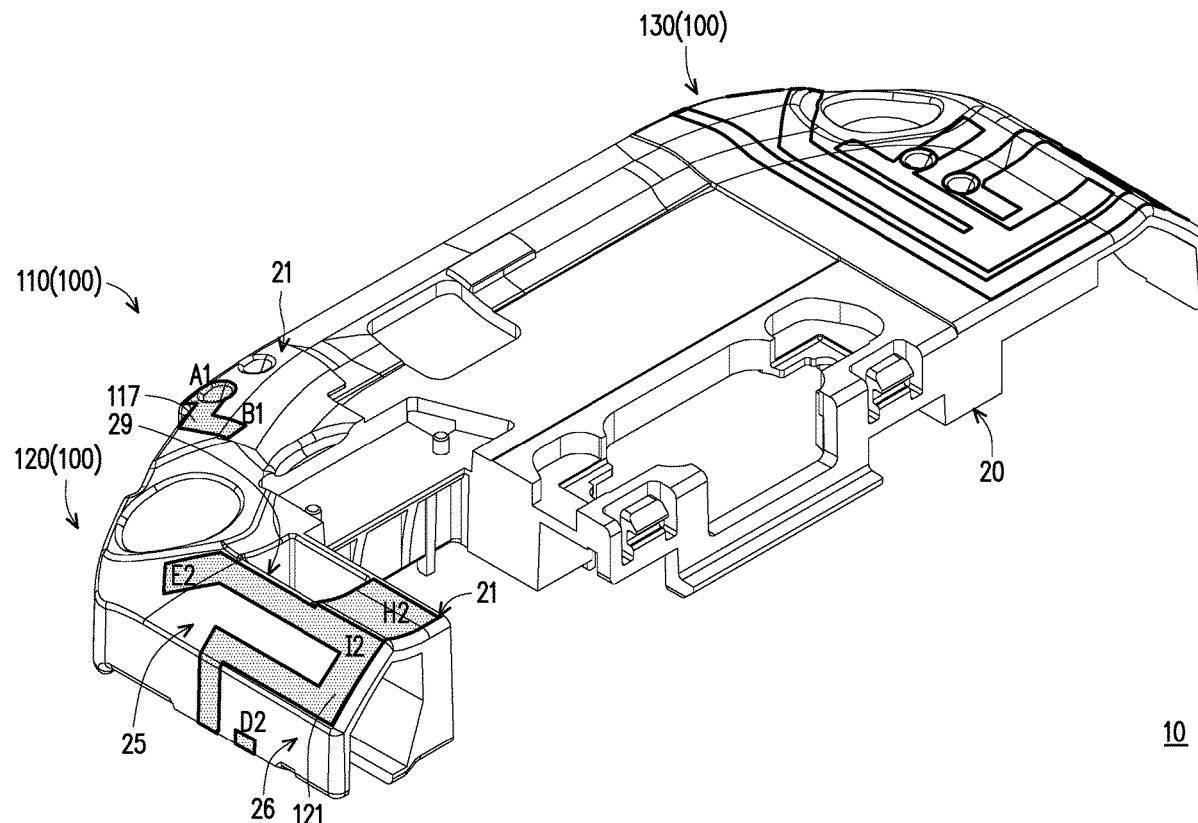
Primary Examiner — Graham P Smith

(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.

- (56) **References Cited**
 U.S. PATENT DOCUMENTS
- 7,680,464 B2 * 3/2010 Pleva et al. H01P 5/107 455/81
- 7,911,292 B2 * 3/2011 Byun et al. H01P 5/107 333/26
- 9,692,100 B2 * 6/2017 Baba et al. H01P 3/085

OTHER PUBLICATIONS

Ponchak, G.E., et al., "A New Rectangular Waveguide to Coplanar Waveguide Transition", NASA Technical Memorandum 102477, 1990 IEEE MTT-S International Microwave Symposium, Dallas, Texas, May 8-10, 1990, pp. 1-4.

Grabherr, W., et al., "Microstrip to Waveguide Transition Compatible With MM-Wave Integrated Circuits", IEEE Transactions on Microwave Theory and Techniques, Sep. 1994, pp. 1842-1843, vol. 42, No. 9.

Simon, W., et al., "A Novel Coplanar Transmission Line to Rectangular Waveguide Transition", 1998 IEEE MTT-S Digest, pp. 257-260.

Kaneda, N., et al., "A Broadband Microstrip-to-Waveguide Transition Using Quasi-Yagi Antenna", IEEE Transactions on Microwave Theory and Techniques, Dec. 1999, pp. 1-4, vol. 47, Issue 12.

Lin, T-H., et al., "CPW to Waveguide Transition with Tapered Slotline Probe", IEEE Microwave and Wireless Components Letters, Jul. 2001, pp. 314-316, vol. 11, No. 7.

Iizuka, H., et al., "Millimeter-wave microstrip line to waveguide transition fabricated on a single layer dielectric substrate," IEICE Transactions on Communications, Jun. 2002, pp. 13-18, vol. 37, No. 2.

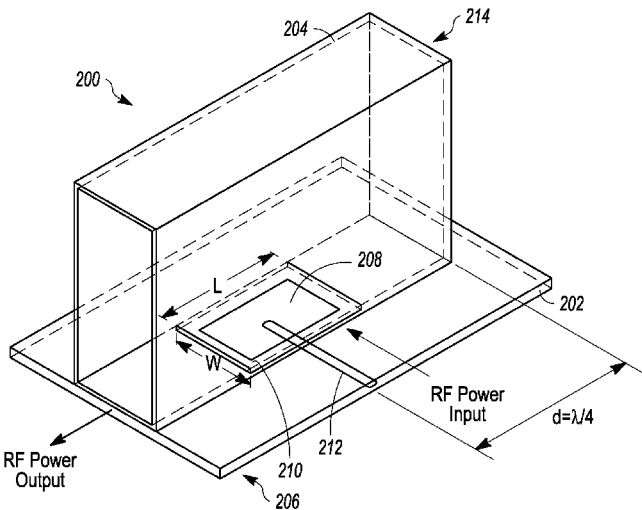
* cited by examiner

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.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,336,229 B1 * 2/2008 Tseng H01Q 1/2258 343/700 MS

8,134,517 B2 3/2012 Wang et al.

8,823,590 B2 * 9/2014 Tseng H01Q 9/42 343/700 MS

11,198,011 B2 * 12/2021 Yeh A61N 1/372 (Continued)

FOREIGN PATENT DOCUMENTS

CN 105122541 A * 12/2015 H01Q 9/0421

JP 2009182608 A * 8/2009 H01Q 1/243

(Continued)

Primary Examiner — Graham P Smith

Assistant Examiner — Jae K Kim

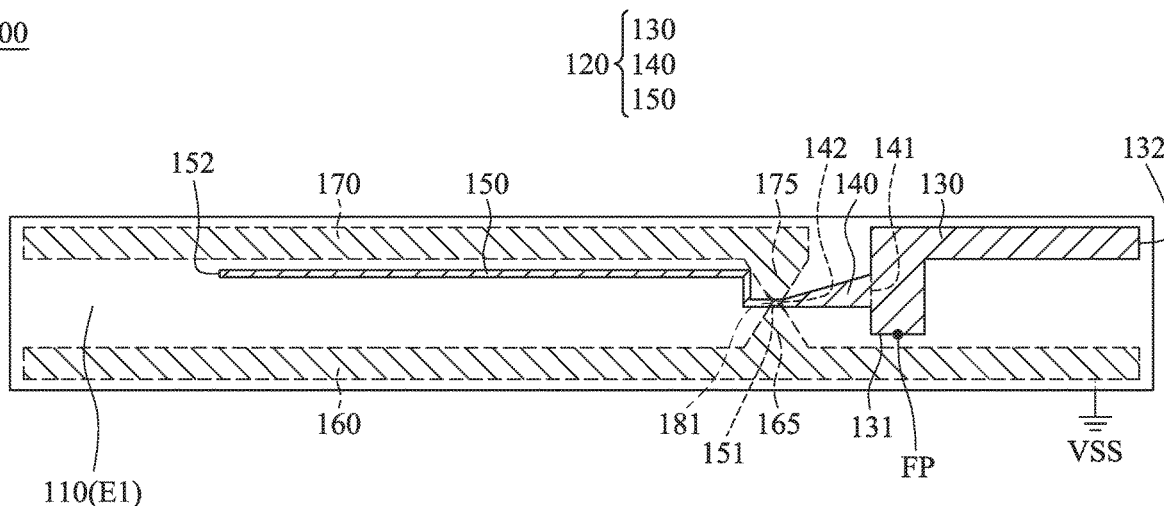
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(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

100





US011251528B2

(12) **United States Patent**
Sone

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

(54) **ANTENNA DEVICE**

(56) **References Cited**

(71) Applicant: **YOKOWO CO., LTD.**, Tokyo (JP)

U.S. PATENT DOCUMENTS

(72) Inventor: **Takayuki Sone**, Tomioka (JP)

5,402,134 A * 3/1995 Miller H01Q 1/3275
343/713

(73) Assignee: **YOKOWO CO., LTD.**, Tokyo (JP)

5,778,306 A * 7/1998 Kommrusch H04B 1/48
333/101

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 84 days.

(Continued)

FOREIGN PATENT DOCUMENTS

(21) Appl. No.: **16/487,096**

CN 103548199 A 1/2014
JP 2010-21856 A 1/2010

(22) PCT Filed: **Feb. 28, 2018**

(Continued)

(86) PCT No.: **PCT/JP2018/007479**

OTHER PUBLICATIONS

§ 371 (c)(1),

(2) Date: **Aug. 20, 2019**

International Search Report and Written Opinion dated Apr. 24, 2018 for PCT/JP2018/007479 filed on Feb. 28, 2018, 6 pages including English Translation of the International Search Report.

(87) PCT Pub. No.: **WO2018/159668**

PCT Pub. Date: **Sep. 7, 2018**

(Continued)

(65) **Prior Publication Data**

US 2021/0135363 A1 May 6, 2021

Primary Examiner — Thien M Le

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

(30) **Foreign Application Priority Data**

Feb. 28, 2017 (JP) JP2017-037653

(57) **ABSTRACT**

(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)

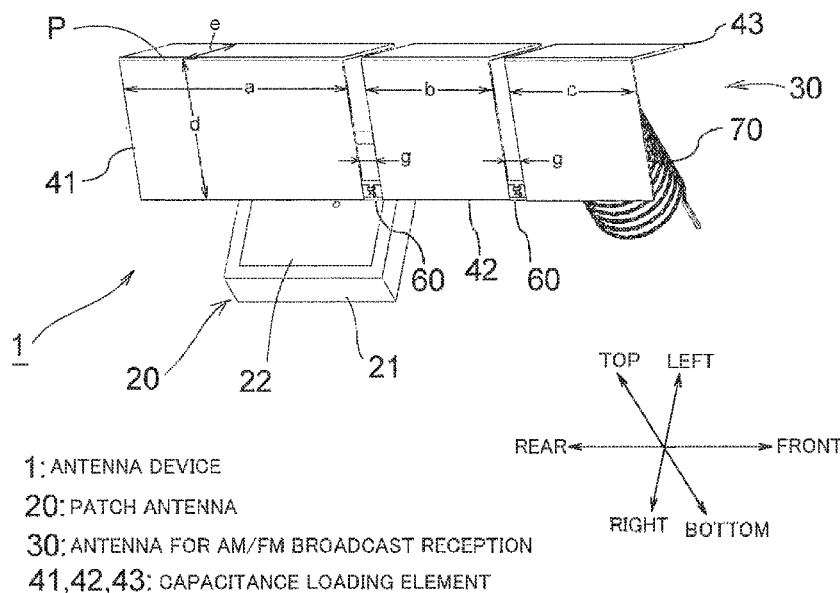
An antenna device includes a patch antenna serving as a first antenna; and a second antenna including capacitance loading elements, the capacitance loading elements being located above the patch antenna and also arranged separately in a predetermined direction. Also, an antenna device includes a patch 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.

(58) **Field of Classification Search**

CPC H01Q 1/36

See application file for complete search history.

18 Claims, 14 Drawing Sheets



(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**

(56) **References Cited**

(71) Applicant: **NEC Platforms, Ltd.**, Kawasaki (JP)

U.S. PATENT DOCUMENTS

(72) Inventor: **Tatsuya Matsuura**, Kanagawa (JP)

2015/0288071 A1* 10/2015 Toyao H01Q 5/328
343/700 MS

(73) Assignee: **NEC Platforms, Ltd.**, Kanagawa (JP)

FOREIGN PATENT DOCUMENTS

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 243 days.

JP	2015-046689	A	3/2015
JP	2016-131319	A	7/2016
JP	2018-129595	A	8/2018
WO	2014/073703	A1	5/2014

(21) Appl. No.: **16/717,505**

OTHER PUBLICATIONS

(22) Filed: **Dec. 17, 2019**

Japanese Office Action for JP Application No. 2019-000192 dated May 11, 2021 with English Translation.

(65) **Prior Publication Data**
US 2020/0220269 A1 Jul. 9, 2020

* cited by examiner

(30) **Foreign Application Priority Data**

Primary Examiner — Dieu Hien T Duong

(74) *Attorney, Agent, or Firm* — Sughrue Mion, PLLC

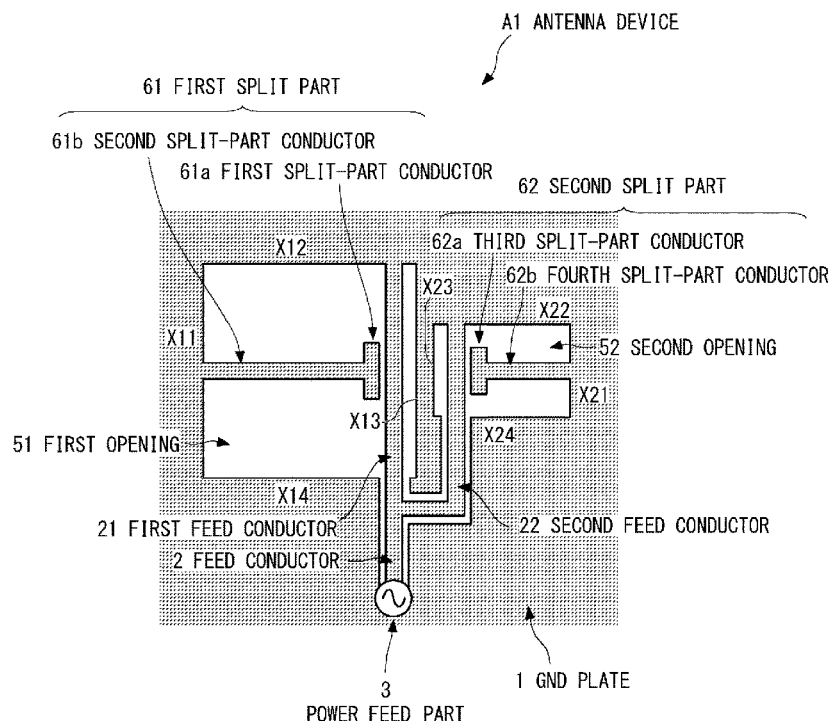
Jan. 4, 2019 (JP) JP2019-000192

(57) **ABSTRACT**

(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.

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





(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.**,
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(72) Inventors: **Junhong Zhang**, Dongguan (CN);
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(73) Assignee: **Huawei Technologies Co., Ltd.**,
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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 26 days.

(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**

US 2020/0343643 A1 Oct. 29, 2020

(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)

(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**

U.S. PATENT DOCUMENTS

2,380,333 A 7/1945 Scheldorf

4,044,321 A * 8/1977 Vasile H03H 9/02866
333/194

(Continued)

FOREIGN PATENT DOCUMENTS

CN 101399395 A 4/2009

CN 101536254 A 9/2009

(Continued)

Primary Examiner — Graham P Smith

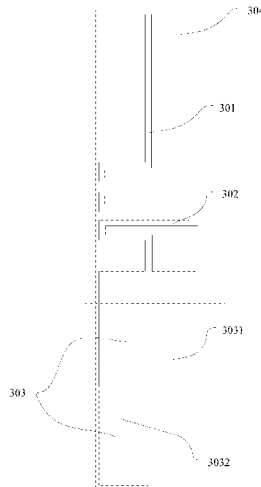
Assistant Examiner — Jae K Kim

(74) *Attorney, Agent, or Firm* — Slater Matsil, LLP

(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**

(71) Applicant: **HUAWEI TECHNOLOGIES CO.,
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(72) Inventors: **Chaoming Luo**, Shenzhen (CN); **Keli
Zou**, Chengdu (CN); **Guangjian Wang**,
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(73) Assignee: **HUAWEI TECHNOLOGIES CO.,
LTD.**, Guangdong (CN)

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

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

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

(65) **Prior Publication Data**

US 2020/0343649 A1 Oct. 29, 2020

Related U.S. Application Data

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

(30) **Foreign Application Priority Data**

Jan. 27, 2018 (CN) 201810080107.X

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

(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.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,672,384 A 6/1987 Roy et al.
6,538,614 B2 * 3/2003 Fleming H01Q 9/045
343/767

(Continued)

FOREIGN PATENT DOCUMENTS

CN 102255144 A 11/2011
CN 202121061 U 1/2012

(Continued)

OTHER PUBLICATIONS

Esmaeili Mahbubeh et al: Coaxial-fed dual-layer SIW horn antenna
with improved E-plane radiation pattern 2017 47th European Micro-
wave Conference(EUMC) European Microwave Association Oct.
10, 2017 pp. 66-69, XP033284599.

(Continued)

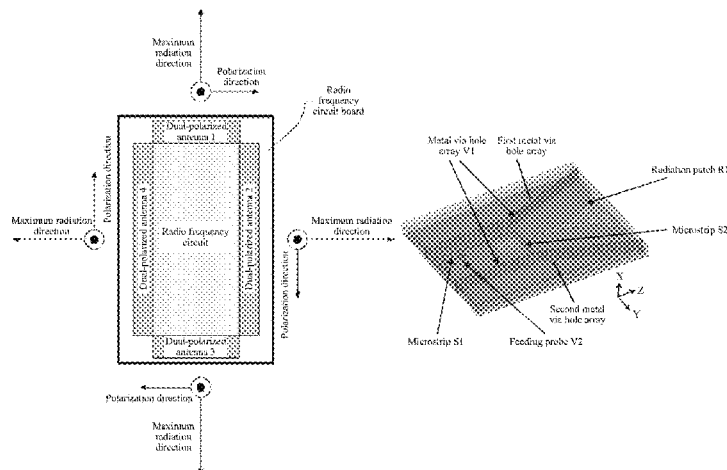
Primary Examiner — Vibol Tan

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

(57) **ABSTRACT**

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)



(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);
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(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**

US 2021/0152680 A1 May 20, 2021

(30) **Foreign Application Priority Data**

Nov. 14, 2019 (KR) 10-2019-0146244
Nov. 13, 2020 (KR) 10-2020-0152183

(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.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,554,620 B2 * 6/2009 Kim H04M 1/0266 349/40
8,587,939 B2 * 11/2013 McClure G06F 1/1626 361/679.3

(Continued)

FOREIGN PATENT DOCUMENTS

CN 106129585 A 11/2016
EP 3 313 000 A1 4/2018

(Continued)

OTHER PUBLICATIONS

Extended European Search Report dated Mar. 11, 2021 for EP Application No. 20207510.7.

(Continued)

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

