



US 20210328329A1

(19) **United States**(12) **Patent Application Publication**
KIM et al.(10) **Pub. No.: US 2021/0328329 A1**(43) **Pub. Date: Oct. 21, 2021**(54) **ELECTRONIC APPARATUS INCLUDING
ANTENNA MODULE**(71) Applicant: **SAMSUNG ELECTRONICS CO.,
LTD.**, Suwon-si, Gyeonggi-do (KR)(72) Inventors: **Jaehyung KIM**, Suwon-si,
Gyeonggi-do (KR); **Jinkyu BANG**,
Suwon-si, Gyeonggi-do (KR); **Jaebong
CHUN**, Suwon-si, Gyeonggi-do (KR);
Hanbin LEE, Suwon-si, Gyeonggi-do
(KR); **Sangmin HAN**, Suwon-si,
Gyeonggi-do (KR)(21) Appl. No.: **17/272,164**(22) PCT Filed: **Aug. 30, 2019**(86) PCT No.: **PCT/KR2019/011114**

§ 371 (c)(1),

(2) Date: **Feb. 26, 2021**(30) **Foreign Application Priority Data**

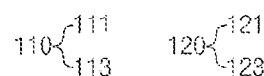
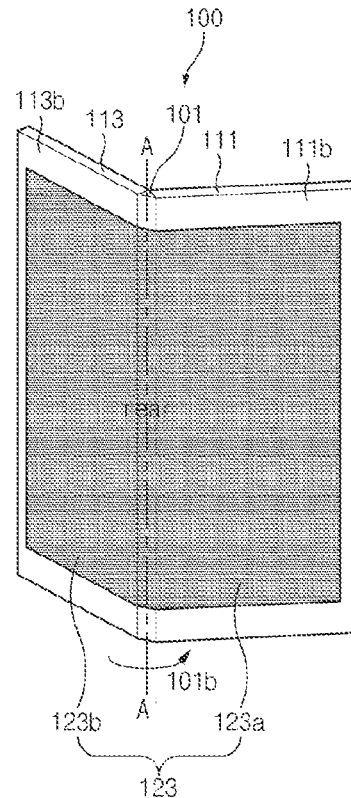
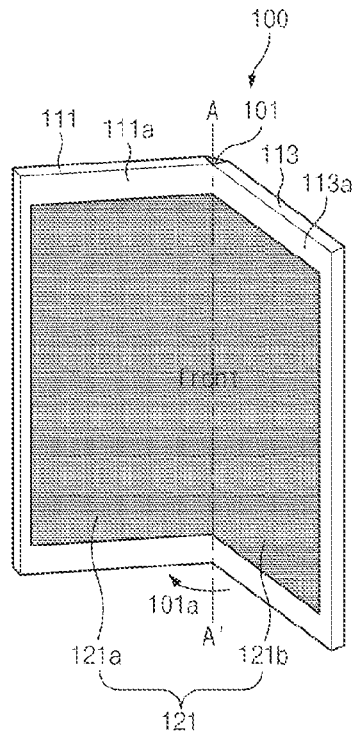
Aug. 30, 2018 (KR) 10-2018-0102800

Publication Classification(51) **Int. Cl.****H01Q 1/24** (2006.01)**H04M 1/02** (2006.01)**H01Q 21/06** (2006.01)**H01Q 3/34** (2006.01)**H01Q 9/04** (2006.01)(52) **U.S. Cl.**CPC **H01Q 1/243** (2013.01); **H04M 1/0218**(2013.01); **H01Q 9/0407** (2013.01); **H01Q****3/34** (2013.01); **H01Q 21/065** (2013.01)

(57)

ABSTRACT

Disclosed is an electronic apparatus comprising: a housing; a display; first antenna structure comprising a first array of antenna elements; second antenna structure comprising a second array of antenna elements; and at least one wireless communication circuit which is electrically connected to the first array and the second array, and transmits and/or receives signals having a frequency between 3 GHz and 100 GHz.





US 20210328330A1

(19) **United States**

(12) **Patent Application Publication**
CHOI et al.

(10) **Pub. No.: US 2021/0328330 A1**

(43) **Pub. Date: Oct. 21, 2021**

(54) **ANTENNA FOR WIRELESS
COMMUNICATION AND ELECTRONIC
DEVICE INCLUDING THE SAME**

H01Q 9/42 (2006.01)

H01Q 5/364 (2006.01)

H01Q 21/28 (2006.01)

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

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

CPC **H01Q 1/243** (2013.01); **H01Q 3/247**
(2013.01); **H01Q 9/42** (2013.01); **H01Q 5/364**
(2015.01); **H01Q 5/35** (2015.01); **H01Q 3/24**
(2013.01); **H01Q 1/24** (2013.01); **H01Q 1/245**
(2013.01); **H01Q 21/28** (2013.01)

(72) Inventors: **Nak Chung CHOI**, Seoul (KR); **Gyu
Sub KIM**, Seoul (KR); **Hyung Joo
LEE**, Gyeonggi-do (KR)

(21) Appl. No.: **17/363,843**

(22) Filed: **Jun. 30, 2021**

(57)

ABSTRACT

Related U.S. Application Data

(63) Continuation of application No. 16/871,492, filed on
May 11, 2020, now Pat. No. 11,075,447, which is a
continuation of application No. 15/698,187, filed on
Sep. 7, 2017, now Pat. No. 10,651,542.

Foreign Application Priority Data

Sep. 7, 2016 (KR) 10-2016-0114921

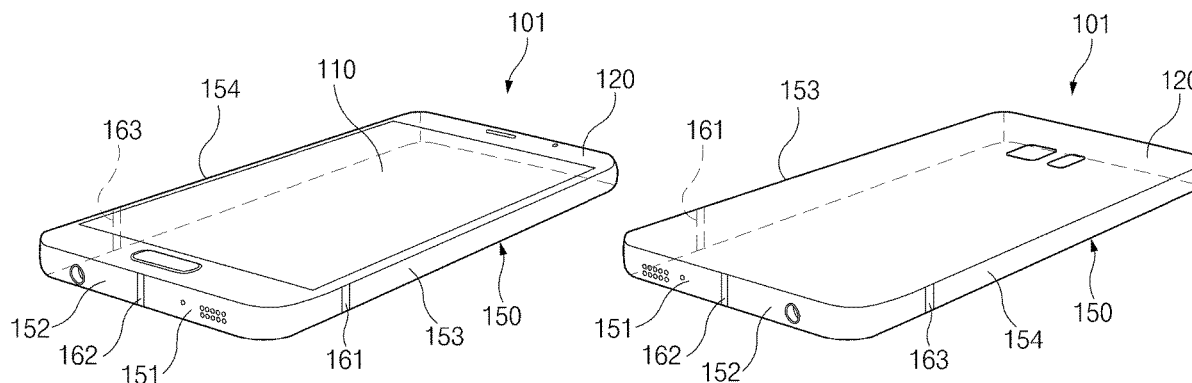
Publication Classification

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 3/24 (2006.01)

An electronic device is provided, which includes a housing;
a conductive member forming at least a part of the housing;
first to third nonconductive members separating the conduc-
tive member, wherein the conductive member includes a
first conductive pattern disposed between the first noncon-
ductive member and the second nonconductive member, and
a second conductive pattern disposed between the second
nonconductive member and the third nonconductive mem-
ber; a first feeding part connected to the first conductive
pattern; a second feeding part connected to the second
conductive pattern; a first ground part connected to the first
conductive pattern at a point adjacent to the second non-
conductive member; and a communication circuit electri-
cally connected with the conductive member.





US 20210328334A1

(19) **United States**(12) **Patent Application Publication**
Cooper et al.(10) **Pub. No.: US 2021/0328334 A1**(43) **Pub. Date: Oct. 21, 2021**(54) **ELECTRONIC DEVICES HAVING COMPACT
ULTRA-WIDEBAND ANTENNAS**(52) **U.S. Cl.**CPC *H01Q 1/422* (2013.01); *H01Q 1/243*
(2013.01); *H01Q 3/446* (2013.01); *H01Q*
1/526 (2013.01)(71) Applicant: **Apple Inc.**, Cupertino, CA (US)(72) Inventors: **Aaron J. Cooper**, San Jose, CA (US);
Amin Tayebi, San Jose, CA (US);
Carlo di Nallo, Belmont, CA (US);
Ana Papio Toda, San Jose, CA (US)

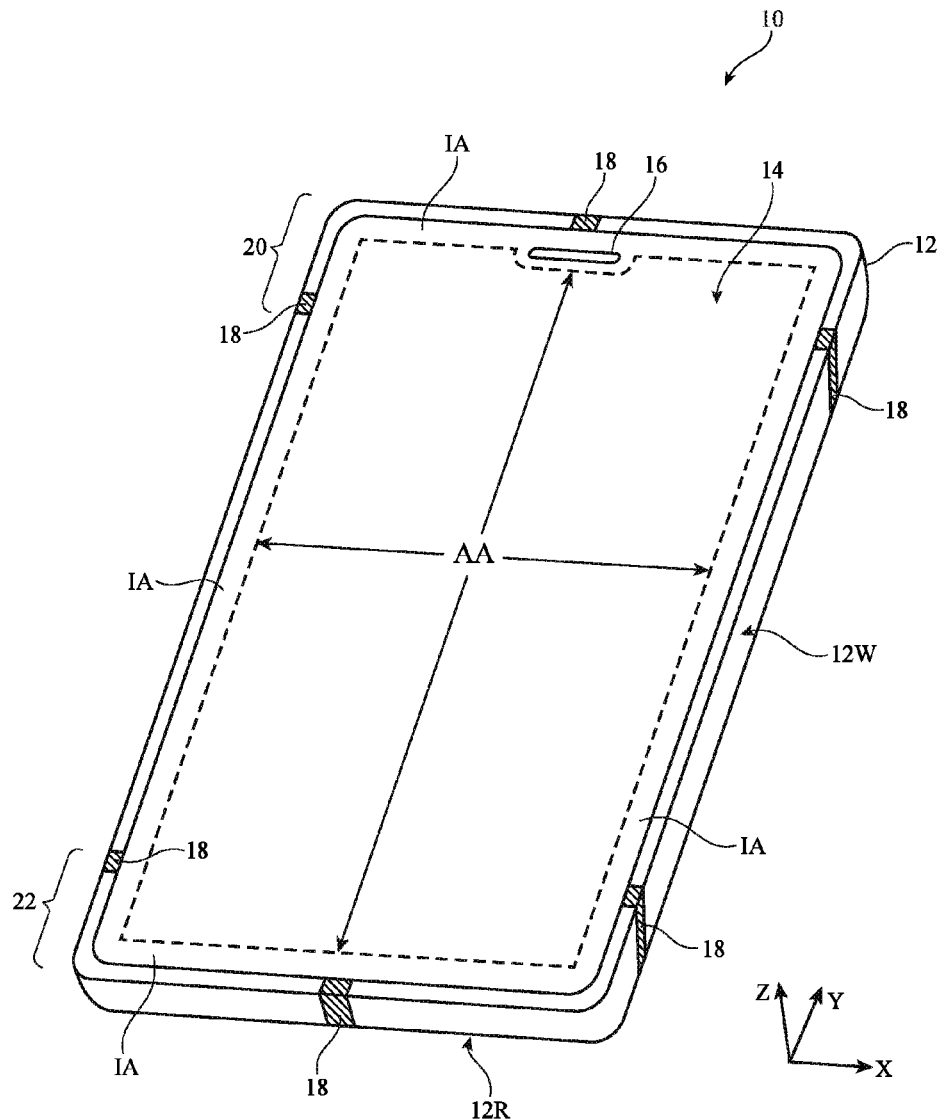
(57)

ABSTRACT

An electronic device may be provided with an antenna for receiving signals in first and second ultra-wideband communications bands. The antenna may include a shielding ring that runs around first and second arms. The first arm may radiate in the first band and the second arm may radiate in the second band. The first arm may have an end formed from a first segment of the ring and a radiating edge facing the second arm. The second arm may have an end formed from a second segment of the ring and a radiating edge facing the first arm. First and second sets of conductive vias may couple the ring to ground. The first set may form a return path for the first arm. The second set may form a return path for the second arm.

(21) Appl. No.: **16/849,776**(22) Filed: **Apr. 15, 2020****Publication Classification**(51) **Int. Cl.**

<i>H01Q 1/42</i>	(2006.01)
<i>H01Q 1/52</i>	(2006.01)
<i>H01Q 3/44</i>	(2006.01)
<i>H01Q 1/24</i>	(2006.01)

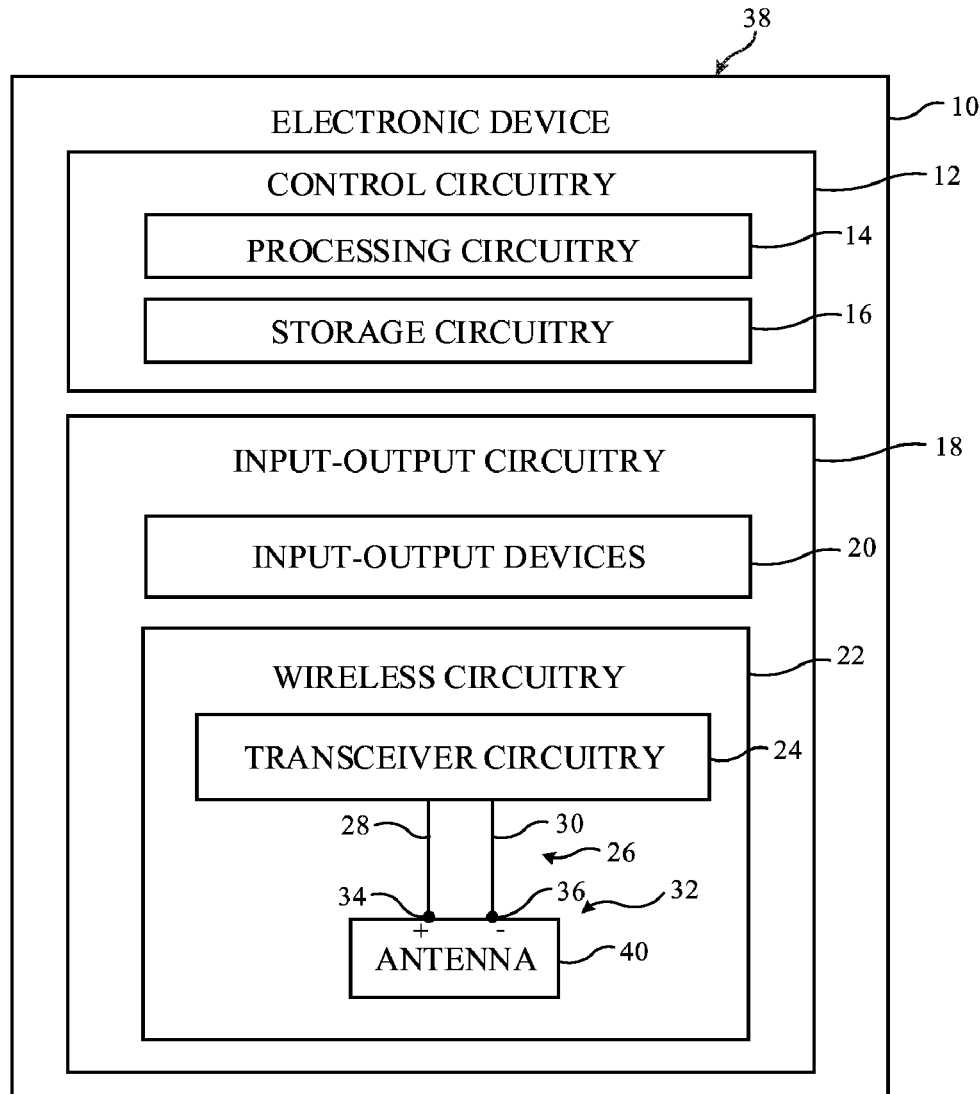




US 20210328346A1

(19) **United States**(12) **Patent Application Publication** (10) **Pub. No.: US 2021/0328346 A1**
Zhang et al. (43) **Pub. Date: Oct. 21, 2021**(54) **ELECTRONIC DEVICES HAVING
WIDEBAND ANTENNAS**(52) **U.S. Cl.**
CPC **H01Q 5/10** (2015.01); **H01Q 7/00**
(2013.01); **H01Q 5/328** (2015.01)(71) Applicant: **Apple Inc.**, Cupertino, CA (US)(72) Inventors: **Lijun Zhang**, San Jose, CA (US);
Jiangfeng Wu, San Jose, CA (US);
Mattia Pascolini, San Francisco, CA
(US); **Siwen Yong**, San Francisco, CA
(US); **Yi Jiang**, Cupertino, CA (US)(21) Appl. No.: **16/851,812**(22) Filed: **Apr. 17, 2020****Publication Classification**(51) **Int. Cl.**
H01Q 5/10 (2006.01)
H01Q 5/328 (2006.01)
H01Q 7/00 (2006.01)(57) **ABSTRACT**

An electronic device may include a curved cover layer and an antenna. The antenna may include a ground and a resonating element on a curved surface of a substrate. The curved surface may have a curvature that matches that of the cover layer. The resonating element may include first, second, and third arms fed by a feed. The first arm and a portion of the ground may form a loop antenna resonating element. The second arm and the first arm may form an inverted-F antenna resonating element, where a portion of the first arm forms a return path to the antenna ground for the inverted-F antenna resonating element. A gap between the first and second arms may form a distributed capacitance. The third arm may form an L-shaped antenna resonating element. The antenna may have a wide bandwidth from below 2.4 GHz to greater than 9.0 GHz.



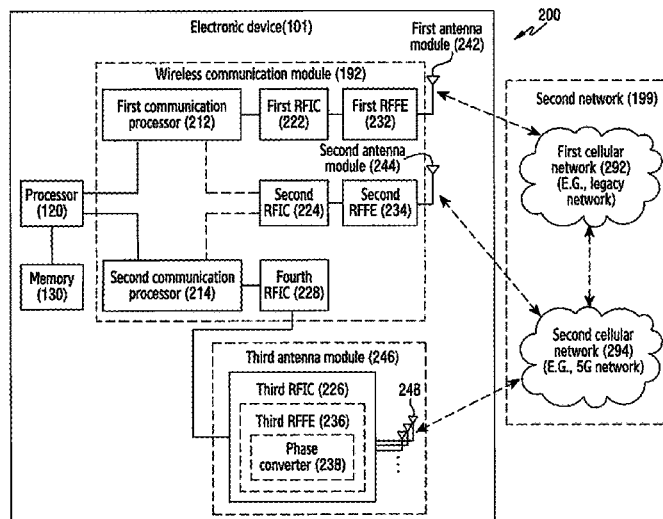
(19) **United States**(12) **Patent Application Publication** (10) **Pub. No.: US 2021/0328348 A1****Kim et al.**(43) **Pub. Date: Oct. 21, 2021**(54) **ELECTRONIC DEVICE INCLUDING MULTI-BAND ANTENNA**(71) Applicants: **Samsung Electronics Co., Ltd.**,
Gyeonggi-do (KR); **Postech Research
And Business Development
Foundation**, Gyeongsangbuk-do (KR)(72) Inventors: **Yeonwoo Kim**, Gyeonggi-do (KR);
Wonbin Hong, Gyeongsangbuk-do
(KR); **Junho Park**, Gyeongsangbuk-do
(KR); **Jaehyun Choi**,
Gyeongsangbuk-do (KR); **Sehyun
Park**, Gyeonggi-do (KR); **Sumin Yun**,
Gyeonggi-do (KR)(73) Assignee: **Samsung Electronics Co., Ltd.**(21) Appl. No.: **17/364,103**(22) Filed: **Jun. 30, 2021****Related U.S. Application Data**(63) Continuation of application No. PCT/KR2019/
018667, filed on Dec. 27, 2019.(30) **Foreign Application Priority Data**

Dec. 31, 2018 (KR) 10-2018-0174313

Publication Classification(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 5/10 (2006.01)
H04B 1/38 (2006.01)(52) **U.S. Cl.**
CPC **H01Q 9/0407** (2013.01); **H04B 1/38**
(2013.01); **H01Q 5/10** (2015.01)(57) **ABSTRACT**

An electronic device is provided. The electronic device includes a housing. The housing includes a first plate that is

directed outward in a first direction, a second plate that is directed outward in a second direction opposite to the first direction, and a side member that surrounds a space between the first and second plates. The electronic device further includes a first antenna structure located in the space, wherein the first antenna structure includes a first conductive structure including a first conductive layer, which is substantially parallel to the second plate and includes a first edge extending in a third direction perpendicular to the first direction and a first notch portion disposed at the first edge, and a first conductive wall, which is substantially perpendicular to the first conductive layer and includes a second notch portion extending from the first edge and connected to the first notch portion. The electronic device further includes a second conductive structure located in the first notch portion and electrically isolated from the first conductive structure; and a third conductive structure located between the first conductive layer and the first plate and electrically isolated from the first conductive structure and the second conductive structure. The third conductive structure includes a second conductive layer facing the first conductive layer and having a quadrilateral shape, the second conductive layer including a second edge extending parallel to the first edge, a third edge extending perpendicular to the second edge, a fourth edge extending parallel to the third edge, and a fifth edge extending parallel to the second edge, wherein a distance to the fifth edge from the first conductive wall is shorter than a distance to the second edge from the first conductive wall, a second conductive wall facing the first conductive wall and extending from the second edge, a third conductive wall connected to the third edge and the second conductive wall and perpendicular to the second conductive layer and the second conductive wall, and a fourth conductive wall connected to the fourth edge and the second conductive wall and perpendicular to the second conductive layer and the second conductive wall. The electronic device further includes a wireless communication circuit electrically connected to the second conductive structure and configured to transmit or receive a signal having a frequency of 3 GHz to 100 GHz.





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(19) **United States**

(12) **Patent Application Publication**
JIAN et al.

(10) **Pub. No.: US 2021/0328349 A1**

(43) **Pub. Date: Oct. 21, 2021**

(54) **WIRELESS ELECTRONIC
COMMUNICATIONS DEVICE**

Publication Classification

(71) Applicant: **VIVO MOBILE COMMUNICATION
CO., LTD**, Chang'an Dongguan (CN)

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 1/24 (2006.01)
H04M 1/02 (2006.01)

(72) Inventors: **Xianjing JIAN**, Chang'an Dongguan
(CN); **Huan-Chu HUANG**, Chang'an
Dongguan (CN)

(52) **U.S. Cl.**
CPC **H01Q 9/0421** (2013.01); **H01Q 1/243**
(2013.01); **H04M 1/0262** (2013.01); **H04M**
1/0274 (2013.01); **H04M 1/0277** (2013.01)

(73) Assignee: **VIVO MOBILE COMMUNICATION
CO., LTD**, Chang'an Dongguan (CN)

(21) Appl. No.: **17/360,590**

(22) Filed: **Jun. 28, 2021**

Related U.S. Application Data

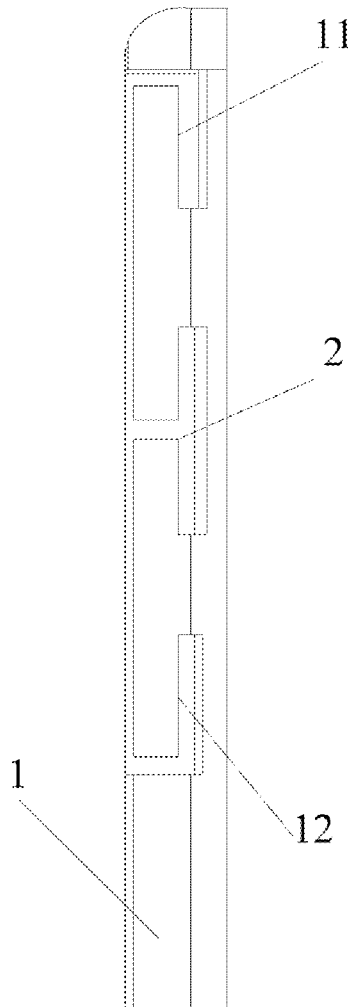
(63) Continuation of application No. PCT/CN2019/
126199, filed on Dec. 18, 2019.

(30) **Foreign Application Priority Data**

Dec. 28, 2018 (CN) 201811629703.5

(57) **ABSTRACT**

This application provides a wireless electronic communications device, including: a metal frame on which a first antenna and a second antenna are disposed, where a first preset distance is spaced between the first antenna and the second antenna, and a feeding structure is disposed on each of the first antenna and the second antenna; and a slot structure disposed between the first antenna and the second antenna, where an extension distance of the slot structure in a width direction of the metal frame is less than a width of the metal frame.





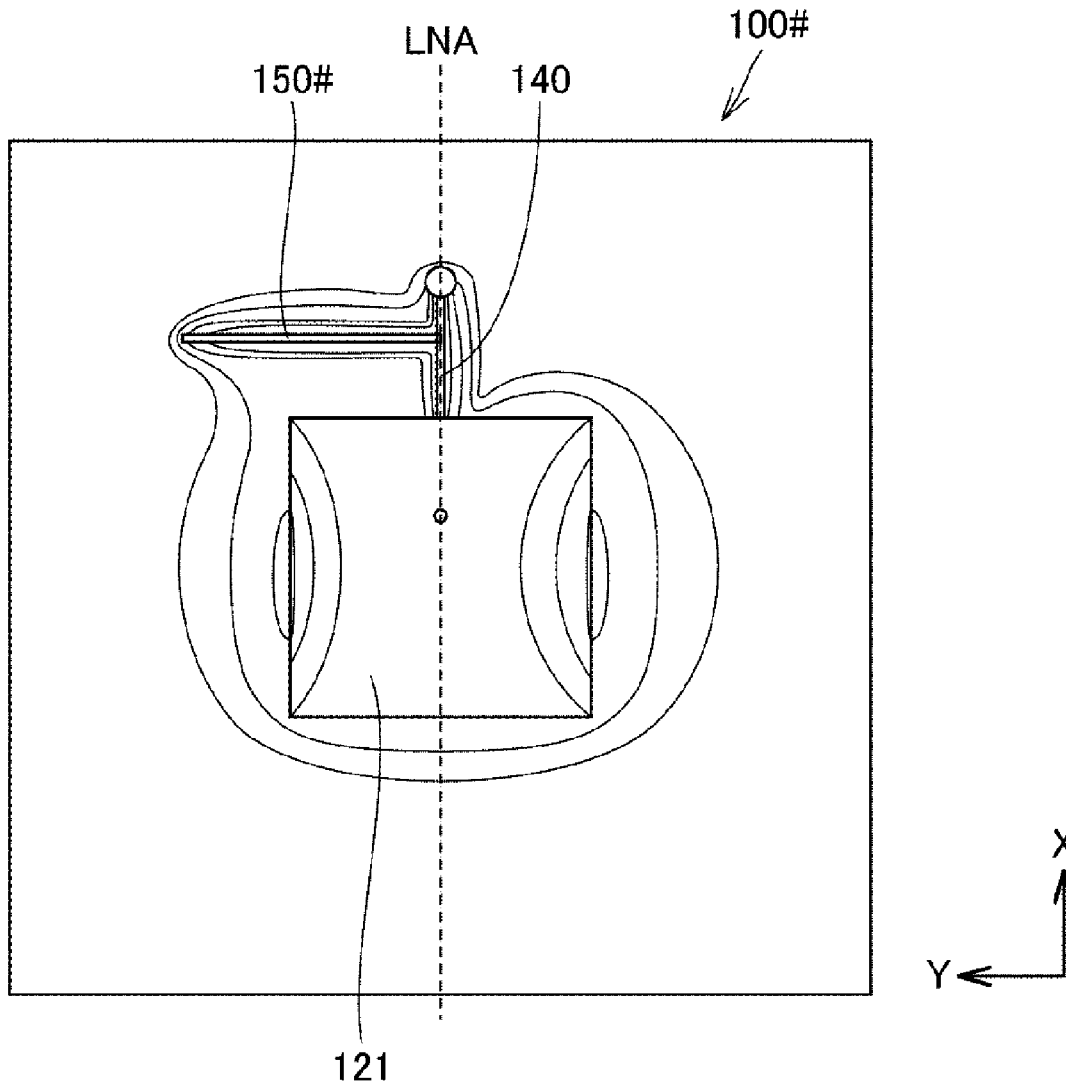
US 20210328350A1

(19) **United States**(12) **Patent Application Publication**
TAKAYAMA et al.(10) **Pub. No.: US 2021/0328350 A1**(43) **Pub. Date: Oct. 21, 2021**(54) **ANTENNA MODULE AND
COMMUNICATION DEVICE EQUIPPED
WITH THE SAME**(71) Applicant: **Murata Manufacturing Co., Ltd.**,
Kyoto (JP)(72) Inventors: **Keisei TAKAYAMA**, Kyoto (JP);
Kaoru SUDO, Kyoto (JP)(21) Appl. No.: **17/364,091**(22) Filed: **Jun. 30, 2021****Related U.S. Application Data**(63) Continuation of application No. PCT/JP2020/
000720, filed on Jan. 10, 2020.(30) **Foreign Application Priority Data**

Jan. 10, 2019 (JP) 2019-002322

Publication Classification(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 1/50 (2006.01)
H01Q 5/378 (2006.01)
(52) **U.S. Cl.**
CPC **H01Q 9/0421** (2013.01); **H01Q 5/378**
(2015.01); **H01Q 1/50** (2013.01)(57) **ABSTRACT**

An antenna module includes a dielectric substrate having a multilayer structure, a ground electrode disposed in the dielectric substrate, a plate-like fed element facing the ground electrode and disposed at a layer different from a layer including the ground electrode, a feed line for transferring a radio-frequency signal to a feed point of the fed element, and a stub. The stub branches off from the feed line at a branch point of the feed line and has an open end. The stub is disposed between the fed element and the ground electrode. When the dielectric substrate is viewed in plan view, the open end coincides with the fed element.





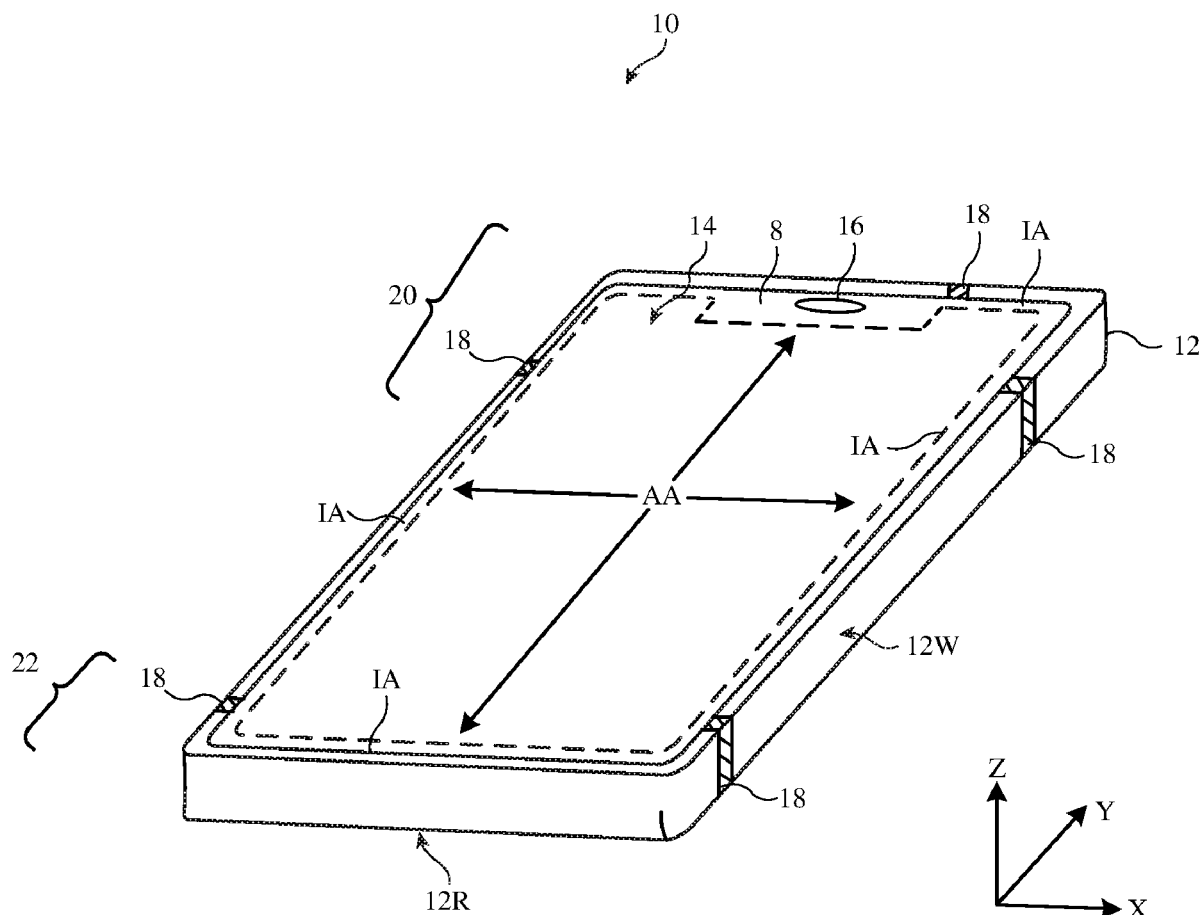
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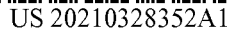
(19) **United States**(12) **Patent Application Publication** (10) **Pub. No.: US 2021/0328351 A1**

Avser et al.

(43) **Pub. Date:** **Oct. 21, 2021**(54) **ELECTRONIC DEVICES HAVING
DIELECTRIC RESONATOR ANTENNAS
WITH PARASITIC PATCHES**(52) **U.S. Cl.**
CPC **H01Q 9/0485** (2013.01); **H01Q 5/385**
(2015.01); **H01Q 5/35** (2015.01)(71) Applicant: **Apple Inc.**, Cupertino, CA (US)(72) Inventors: **Bilgehan Avser**, Mountain View, CA
(US); **Harish Rajagopalan**, San Jose,
CA (US); **Jennifer M. Edwards**, San
Francisco, CA (US); **Simone Paulotto**,
Redwood City, CA (US)(21) Appl. No.: **16/851,848**(22) Filed: **Apr. 17, 2020****Publication Classification**(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 5/35 (2006.01)
H01Q 5/385 (2006.01)(57) **ABSTRACT**

An electronic device may be provided with a phased antenna array and a display cover layer. The phased antenna array may include a probe-fed dielectric resonator antenna that radiates through the cover layer. The antenna may include a dielectric resonating element that is excited by one or two feed probes. One or more floating parasitic elements and/or grounded parasitic elements may be patterned onto the dielectric resonating element. The parasitic elements may create boundary conditions on the dielectric resonating element that serve to isolate the antenna from cross polarization interference.

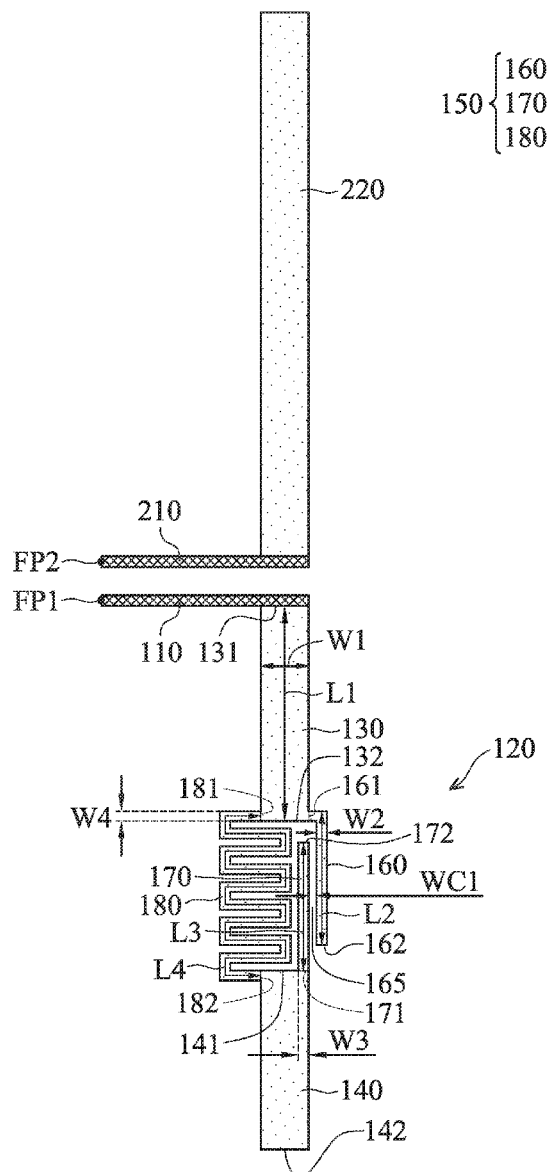




(12) **Patent Application Publication**
Huang

(43) **Pub. Date:** **Oct. 21, 2021**

A dipole antenna includes a first conductor, a second conductor, a first radiation element, and a second radiation element. The first conductor has a first feeding point. The second conductor has a second feeding point. The first radiation element is coupled to the first conductor. The second radiation element is coupled to the second conductor. The dipole antenna covers an operation frequency band. The first radiation element at least includes a first meandering structure. The first meandering structure is configured to suppress the frequency multiplication resonance with respect to the operation frequency band.





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(19) **United States**(12) **Patent Application Publication**
KHALEDIAN et al.(10) **Pub. No.: US 2021/0328354 A1**(43) **Pub. Date: Oct. 21, 2021**(54) **COMMUNICATION DEVICE HAVING
METALLIC FRAME THAT INCLUDES A
T-SHAPED SLOT ANTENNA**(71) Applicant: **MOTOROLA MOBILITY LLC,**
CHICAGO, IL (US)(72) Inventors: **SEIRAN KHALEDIAN,** CHICAGO,
IL (US); **FARHAD FARZAMI,**
CHICAGO, IL (US)(21) Appl. No.: **16/850,933**(22) Filed: **Apr. 16, 2020****Publication Classification**(51) **Int. Cl.**

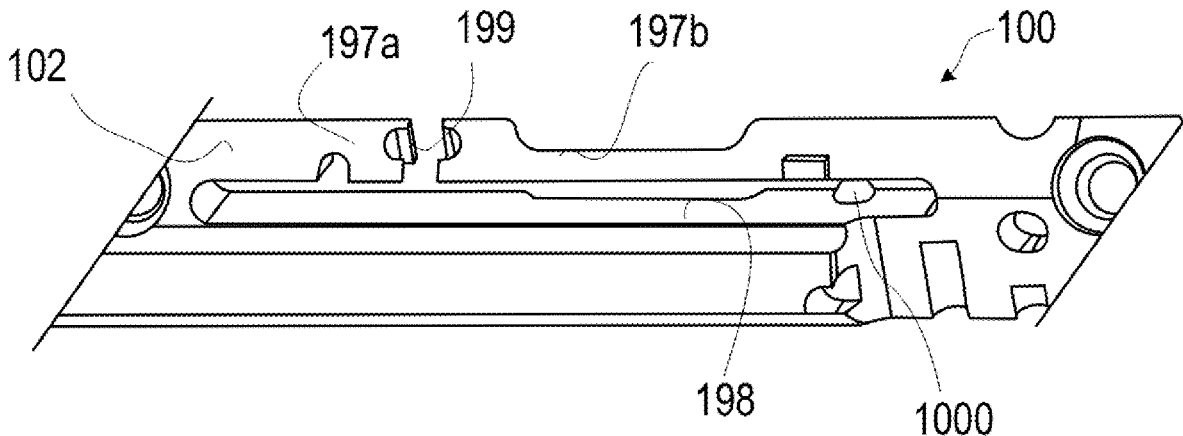
<i>H01Q 13/10</i>	(2006.01)
<i>H01Q 1/22</i>	(2006.01)
<i>H01Q 1/38</i>	(2006.01)
<i>H01Q 21/06</i>	(2006.01)
<i>H01Q 1/24</i>	(2006.01)

(52) **U.S. Cl.**CPC *H01Q 13/10* (2013.01); *H01Q 1/2291*
(2013.01); *H04M 1/022* (2013.01); *H01Q*
21/064 (2013.01); *H01Q 1/243* (2013.01);
H01Q 1/38 (2013.01)

(57)

ABSTRACT

A communication device is made with a metallic frame having an interior mounting surface for receiving one or more functional components. The metallic frame includes a first frame member having a first portion extending uninterrupted across one lateral side of the metallic frame. The first portion provides structural support to the communication device. A T-shaped slot antenna is formed in a second portion of the first frame member adjacent to the first portion. The T-shaped slot antenna has first and second arms separated at a gap and partially encompassing a slot. The second portion of the first frame member enables radio frequency communication by at least one of the functional components via the T-shaped slot antenna of the communication device.





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(19) **United States**

(12) **Patent Application Publication**
JIA

(10) **Pub. No.: US 2021/0328364 A1**

(43) **Pub. Date: Oct. 21, 2021**

(54) **MILLIMETER WAVE MODULE AND
ELECTRONIC DEVICE**

H01Q 21/08 (2006.01)

H01Q 5/42 (2006.01)

(71) Applicant: **GUANGDONG OPPO MOBILE
TELECOMMUNICATIONS CORP.,
LTD.**, Dongguan (CN)

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

CPC *H01Q 21/24* (2013.01); *H01Q 5/42*
(2015.01); *H01Q 21/08* (2013.01); *H01Q*
9/0435 (2013.01)

(72) Inventor: **YUHU JIA**, Dongguan (CN)

(21) Appl. No.: **17/359,981**

(57)

ABSTRACT

(22) Filed: **Jun. 28, 2021**

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2020/
079162, filed on Mar. 13, 2020.

(30) **Foreign Application Priority Data**

Mar. 20, 2019 (CN) 201910211082.7

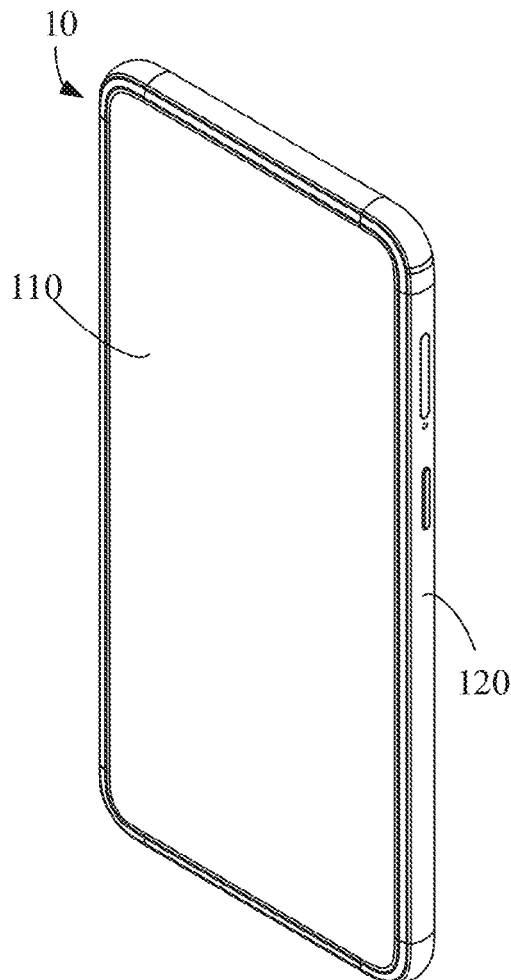
Publication Classification

(51) **Int. Cl.**

H01Q 21/24 (2006.01)

H01Q 9/04 (2006.01)

A millimeter wave module and an electronic device are provided herein. The millimeter wave module includes an antenna substrate and an antenna array. The antenna substrate has a first direction and a second direction perpendicular to each other. The antenna array is located on the antenna substrate. The antenna array includes a plurality of dual-polarized antenna array elements for radiating millimeter wave signal. At least one of the dual-polarized antenna array elements is configured to radiate millimeter wave signal in a first radiation mode when being fed in the first direction, and radiate the millimeter wave signal in a second radiation mode when being fed in the second direction.





US 20210336324A1

(19) **United States**(12) **Patent Application Publication**
Oh et al.(10) **Pub. No.: US 2021/0336324 A1**(43) **Pub. Date: Oct. 28, 2021**(54) **ANTENNAS FOR METAL HOUSINGS****H01Q 21/28** (2006.01)**H01Q 1/48** (2006.01)**H01Q 9/42** (2006.01)(71) Applicant: **Hewlett-Packard Development
Company, L.P.**, Spring, TX (US)(52) **U.S. Cl.**(72) Inventors: **Sung Oh**, Palo Alto, CA (US); **Chris
Kruger**, San Diego, CA (US)CPC **H01Q 1/2266** (2013.01); **H01Q 13/10**
(2013.01); **H01Q 9/42** (2013.01); **H01Q**
1/2291 (2013.01); **H01Q 1/48** (2013.01);
H01Q 21/28 (2013.01)(21) Appl. No.: **16/481,821**(22) PCT Filed: **Mar. 16, 2018**

(57)

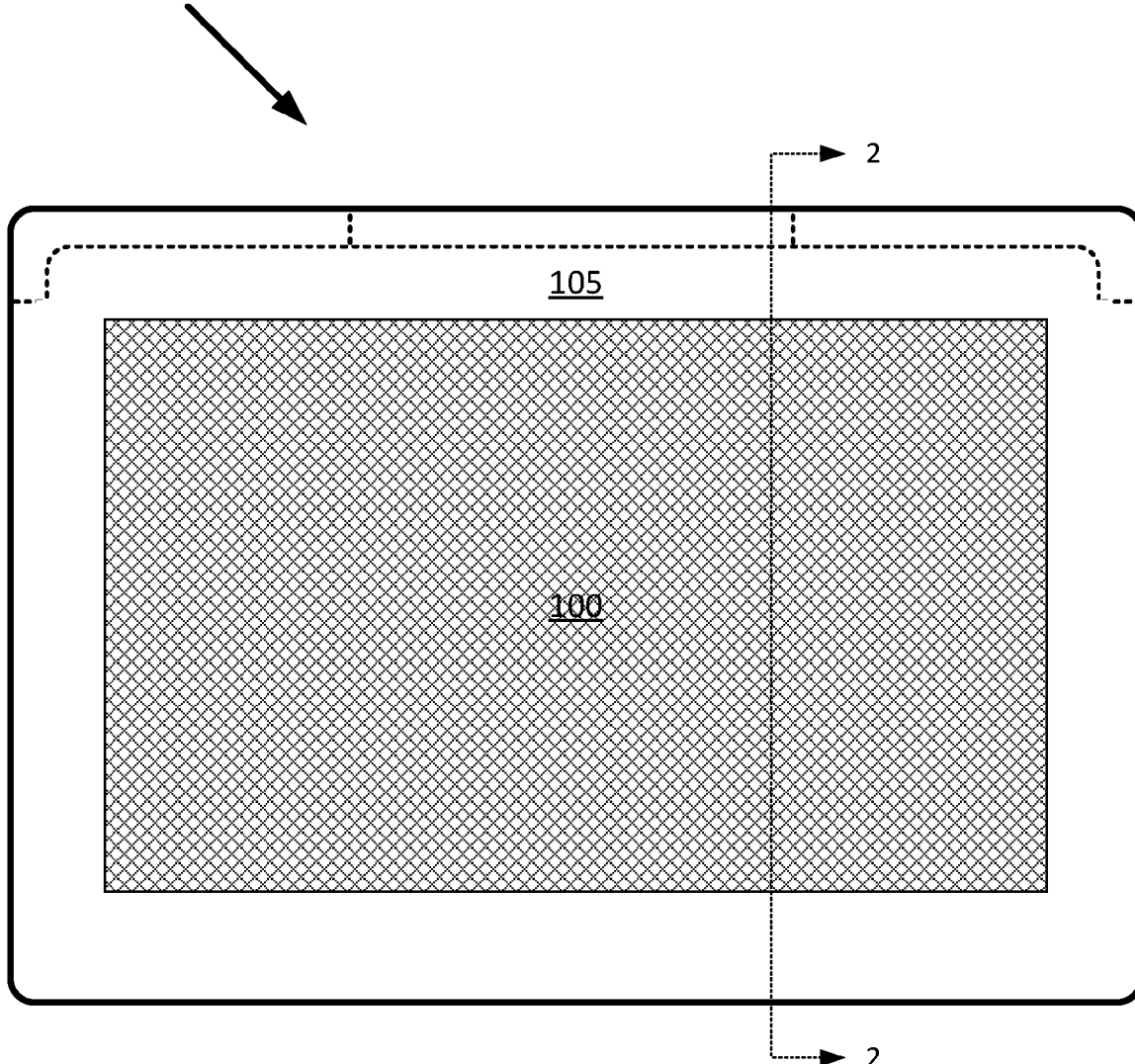
ABSTRACT(86) PCT No.: **PCT/US2018/022816**

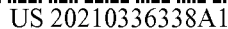
§ 371 (c)(1),

(2) Date: **Jul. 29, 2019****Publication Classification**(51) **Int. Cl.****H01Q 1/22** (2006.01)**H01Q 13/10** (2006.01)

An example of a device including a display panel and a border region around the display panel is provided. The device includes a cover disposed on the display panel and the border region. The cover is to protect the display panel and the border region. The device also includes an antenna with a keep-out area disposed within a portion of the border region. The device includes a bezel disposed in the keep-out area to support the cover. The bezel includes a partially filled portion to reduce a resonance shift of the antenna.

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(43) **Pub. Date:** **Oct. 28, 2021**

[illegible]



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(19) **United States**

(12) **Patent Application Publication**
Hung

(10) **Pub. No.: US 2021/0336343 A1**

(43) **Pub. Date: Oct. 28, 2021**

(54) **SLOTTED PATCH ANTENNAS**

H01Q 1/22 (2006.01)

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

H01Q 1/36 (2006.01)

H01Q 9/40 (2006.01)

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

(52) **U.S. Cl.**
CPC *H01Q 9/0421* (2013.01); *H01Q 13/106*
(2013.01); *H01Q 9/40* (2013.01); *H01Q*
1/2266 (2013.01); *H01Q 1/36* (2013.01);
H01Q 9/0442 (2013.01)

(21) Appl. No.: **16/481,477**

(22) PCT Filed: **Jul. 17, 2017**

(86) PCT No.: **PCT/US2017/042332**

(57) **ABSTRACT**

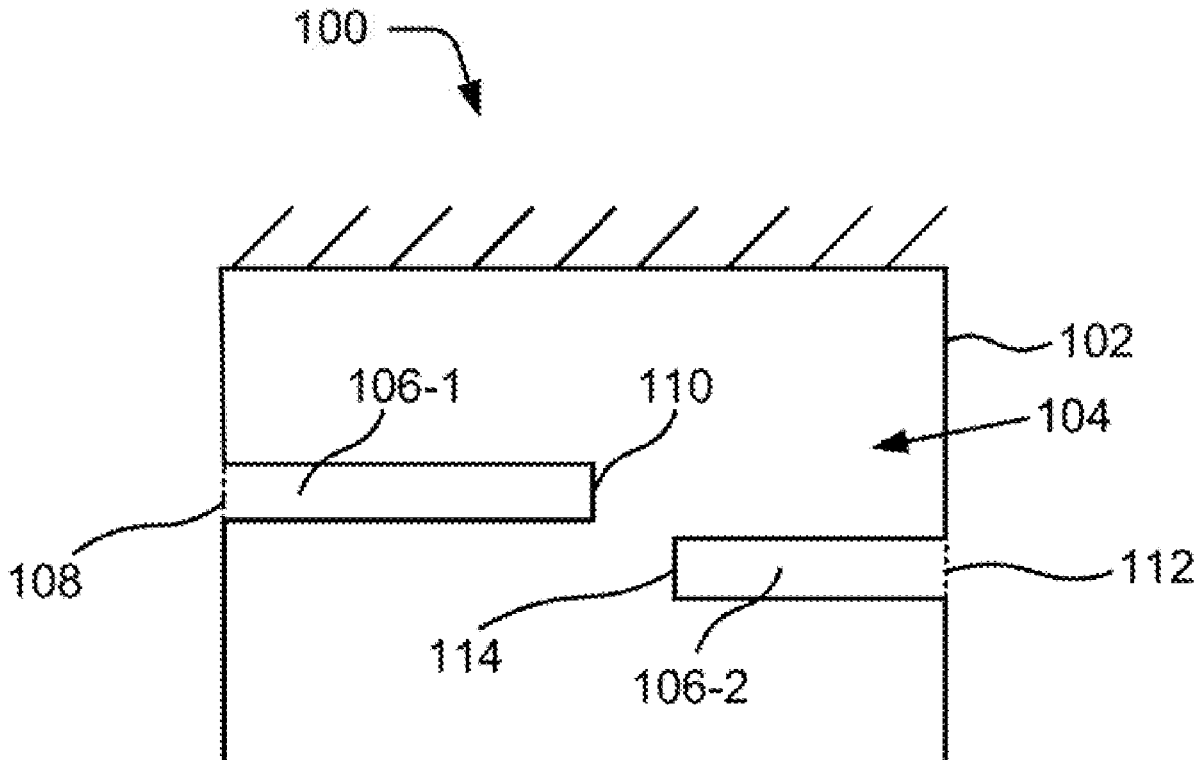
§ 371 (c)(1),

(2) Date: **Jul. 28, 2019**

Publication Classification

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 13/10 (2006.01)

The present subject matter describes antennas. In an example of the present subject matter, an antenna comprises a patch antenna element having a radiating surface. Two slots are formed on the radiating surface, each of the two slots having an open circuit edge and a short circuit edge.





US 20210336348A1

(19) **United States**(12) **Patent Application Publication**
SUDO et al.(10) **Pub. No.: US 2021/0336348 A1**(43) **Pub. Date: Oct. 28, 2021**(54) **ANTENNA MODULE AND
COMMUNICATION DEVICE**(52) **U.S. Cl.**CPC *H01Q 13/08* (2013.01); *H01Q 5/385*
(2015.01); *H01Q 1/422* (2013.01)(71) Applicant: **Murata Manufacturing Co., Ltd.**,
Kyoto (JP)(72) Inventors: **Kaoru SUDO**, Kyoto (JP); **Kengo**
ONAKA, Kyoto (JP); **Hirotsugu**
MORI, Kyoto (JP)

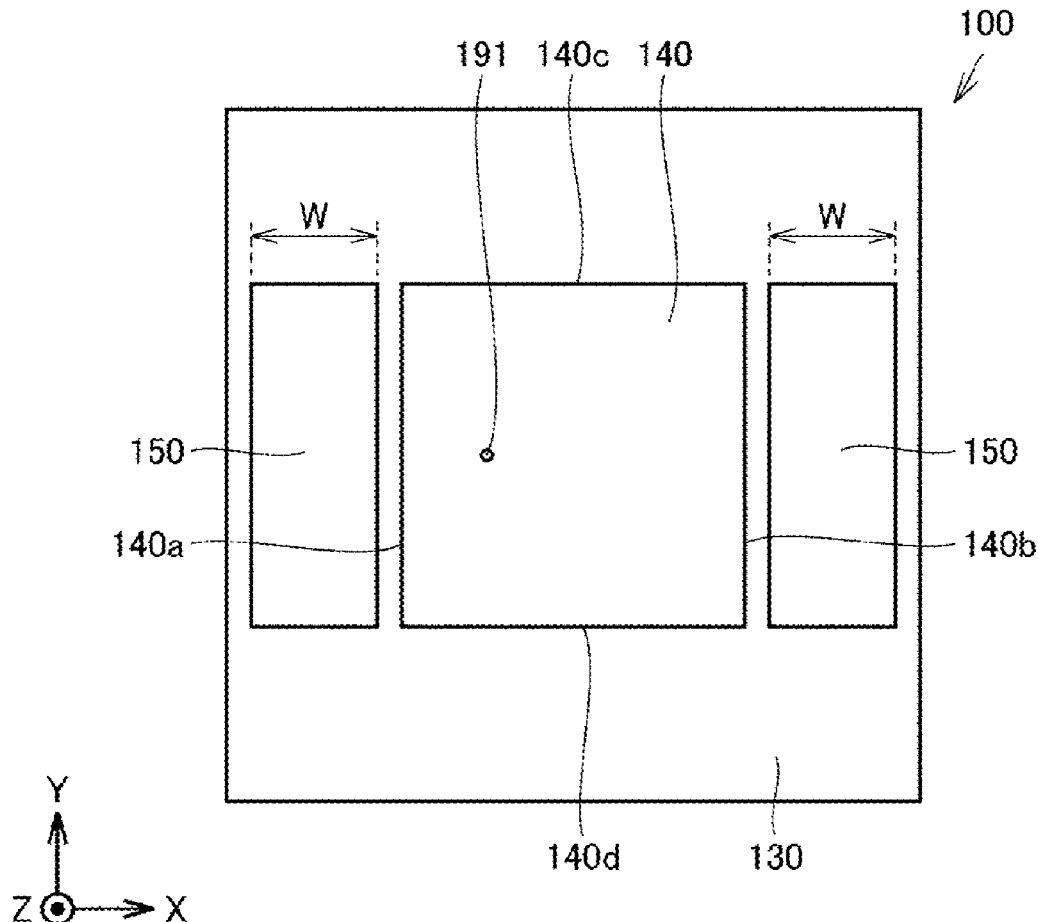
(57)

ABSTRACT(21) Appl. No.: **17/370,504**(22) Filed: **Jul. 8, 2021****Related U.S. Application Data**(63) Continuation of application No. PCT/JP2020/
004062, filed on Feb. 4, 2020.(30) **Foreign Application Priority Data**

Feb. 8, 2019 (JP) 2019-021976

Publication Classification(51) **Int. Cl.***H01Q 13/08* (2006.01)*H01Q 1/42* (2006.01)*H01Q 5/385* (2006.01)

The present disclosure reduces a loss of strength of a radio-frequency signal radiated from an antenna module covered with a housing. An antenna module (100) includes a dielectric substrate (130), a driven element (141), and a ground conductor (190). The dielectric substrate (130) has a multilayer structure. The driven element (141) is disposed in or on the dielectric substrate (130). The ground conductor (190) is disposed between the driven element (140) and a mounting surface (132) on which a power supply circuit is mountable. The power supply circuit supplies the driven element (140) with radio-frequency power. The dielectric substrate has at least one groove (150). The at least one groove (150) is separate from the driven element (140) when the antenna module (100) is viewed in plan. The at least one groove (150) extends toward the ground conductor (190) from a layer on which the driven element (140) is disposed.





US 20210336349A1

(19) **United States**(12) **Patent Application Publication**
TANBO(10) **Pub. No.: US 2021/0336349 A1**(43) **Pub. Date: Oct. 28, 2021**(54) **ANTENNA MODULE AND
COMMUNICATION DEVICE
INCORPORATING THE SAME**(71) Applicant: **Murata Manufacturing Co., Ltd.,**
Kyoto (JP)(72) Inventor: **Yasuo TANBO**, Kyoto (JP)(21) Appl. No.: **17/369,370**(22) Filed: **Jul. 7, 2021****Related U.S. Application Data**(63) Continuation of application No. PCT/JP2020/
002728, filed on Jan. 27, 2020.(30) **Foreign Application Priority Data**

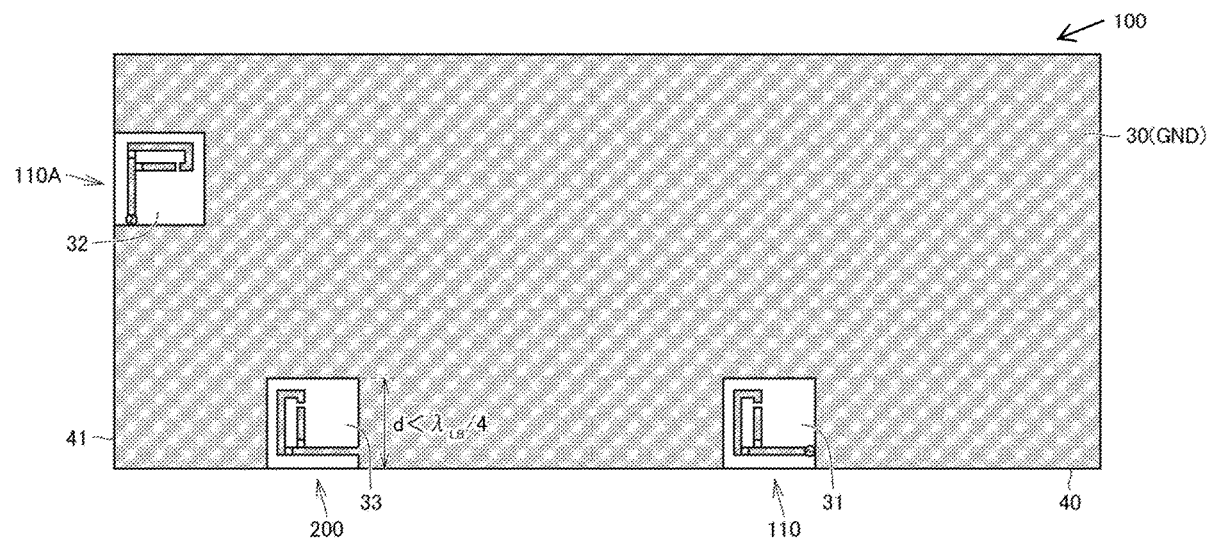
Feb. 1, 2019 (JP) 2019-016980

Publication Classification(51) **Int. Cl.****H01Q 13/10** (2006.01)**H01Q 1/48** (2006.01)**H01Q 5/307** (2006.01)(52) **U.S. Cl.**CPC **H01Q 13/10** (2013.01); **H01Q 5/307**
(2015.01); **H01Q 1/48** (2013.01)

(57)

ABSTRACT

An antenna module (10) includes a ground electrode (30) in which a slit (33) is formed in such a manner as to form an opening along a perimeter of the ground electrode, a first antenna (110) and a second antenna (110A) arranged in or on the ground electrode (30), and a coupling reducing electrode (200) connected to the ground electrode (30) within the slit (33). The slit (33) is formed on a path leading from the first antenna (110) to the second antenna (110A) along the perimeter of the ground electrode. The coupling reducing electrode (200) includes a first conductor (220) having a length corresponding to a first frequency and a second conductor (230) having a length corresponding to a second frequency, which is higher than the first frequency.





US 20210336351A1

(19) **United States**(12) **Patent Application Publication****Zhang et al.**(10) **Pub. No.: US 2021/0336351 A1**(43) **Pub. Date: Oct. 28, 2021**(54) **DUAL-POLARIZED DUPLEX ANTENNA AND
DUAL-BAND BASE STATION ANTENNA
ARRAY COMPOSED THEREOF****H01Q 21/00** (2006.01)**H01Q 15/24** (2006.01)**H01Q 15/00** (2006.01)(71) Applicant: **South China University of
Technology, Guangzhou (CN)**(52) **U.S. Cl.****CPC** **H01Q 21/061** (2013.01); **H01Q 19/104**
(2013.01); **H01Q 15/0013** (2013.01); **H01Q**
15/24 (2013.01); **H01Q 21/0006** (2013.01)(72) Inventors: **Xiuyin Zhang, Guangzhou (CN);**
Yufeng Wu, Guangzhou (CN); Yunfei
Cao, Guangzhou (CN); Wen Duan,
Guangzhou (CN); Yao Zhang,
Guangzhou (CN)(57) **ABSTRACT**(21) Appl. No.: **16/491,400**(22) PCT Filed: **Oct. 18, 2018**(86) PCT No.: **PCT/CN2018/110819**

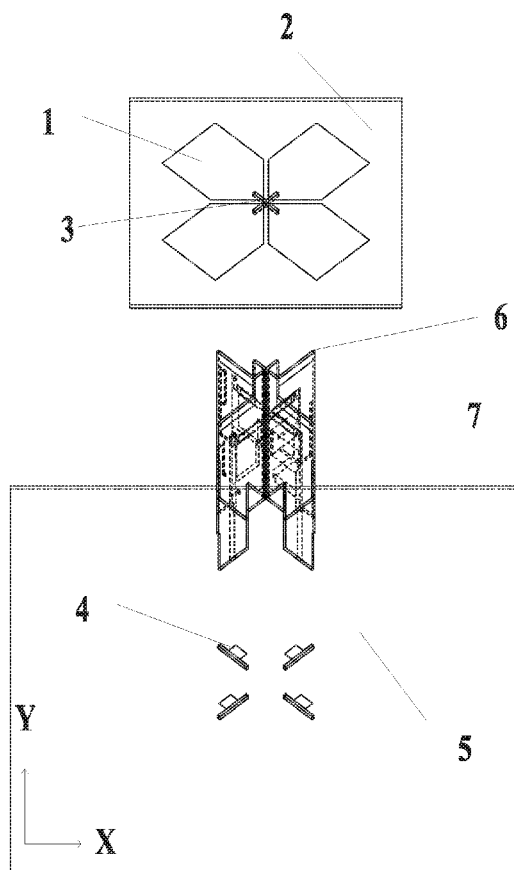
§ 371 (c)(1),

(2) Date: **Sep. 5, 2019**(30) **Foreign Application Priority Data**

May 22, 2018 (CN) 201810493019.2

Publication Classification(51) **Int. Cl.****H01Q 21/06** (2006.01)**H01Q 19/10** (2006.01)

A dual-polarized duplex antenna includes a top-layer dielectric substrate; a metal reflective ground plate below the top-layer dielectric substrate; vertically-placed duplex baluns for duplexing operation between the top-layer dielectric substrate and the metal reflective ground plate; and four dipole arms horizontally printed on an upper surface of the top-layer dielectric substrate. Each of the duplex balun includes a vertical dielectric substrate, a balun feedline printed on a front side of the vertical dielectric substrate, and a ground plane with a printed slot line printed on a reverse side of the vertical dielectric substrate. The balun feedline includes a low-pass filter, a high-pass filter and a microstrip feeding structure serving as a connection. The low-pass filter and the high-pass filter are located on two sides of the slot line, and are connected together by the microstrip feeding structure.





US 20210336354A1

(19) **United States**(12) **Patent Application Publication**
Dorsey(10) **Pub. No.: US 2021/0336354 A1**(43) **Pub. Date: Oct. 28, 2021**(54) **FLEXIBLE POLYMER ANTENNA WITH
MULTIPLE GROUND RESONATORS**(71) Applicant: **Taoglas Group Holdings Limited**, San
Diego, CA (US)(72) Inventor: **Jason Philip Dorsey**, Oceanside, CA
(US)(21) Appl. No.: **17/140,666**(22) Filed: **Jan. 4, 2021***H01Q 1/38* (2006.01)*H01Q 5/371* (2006.01)*H01Q 5/30* (2006.01)*H01Q 1/36* (2006.01)*H01Q 1/48* (2006.01)(52) **U.S. Cl.**CPC *H01Q 21/20* (2013.01); *H01Q 1/242*(2013.01); *H01Q 1/38* (2013.01); *H01Q 1/48*(2013.01); *H01Q 5/30* (2015.01); *H01Q 1/241*(2013.01); *H01Q 1/36* (2013.01); *H01Q 5/371*

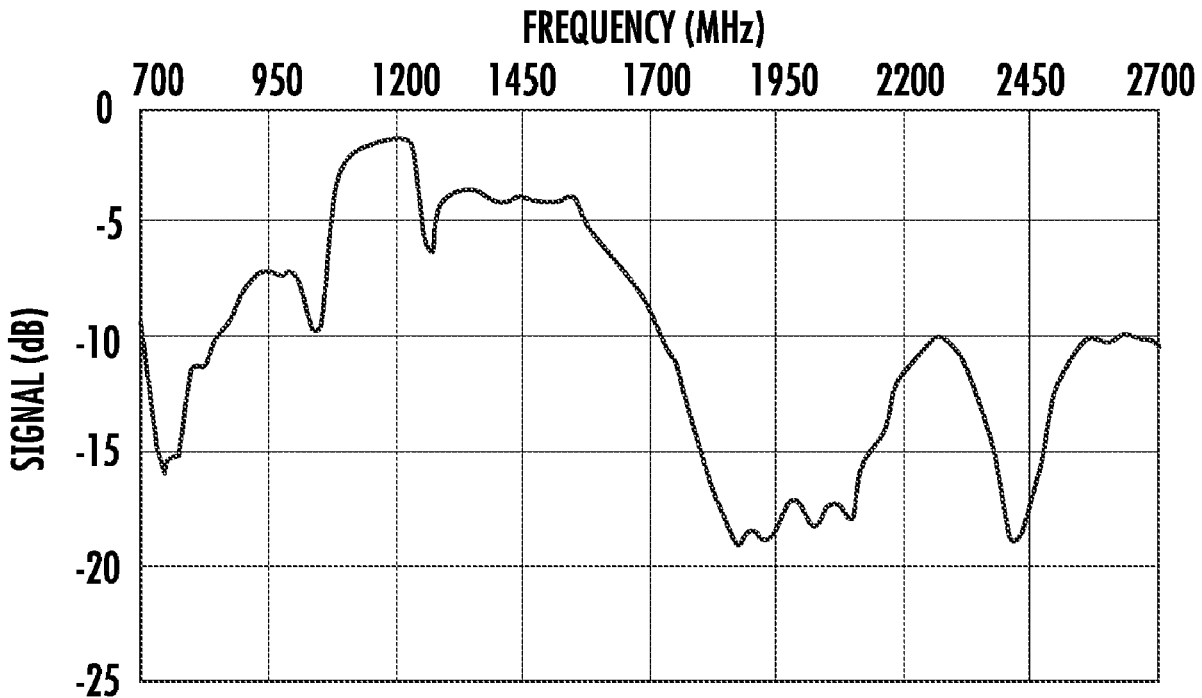
(2015.01)

Related U.S. Application Data(63) Continuation of application No. 16/665,942, filed on
Oct. 28, 2019, now Pat. No. 10,886,633, which is a
continuation of application No. 16/140,977, filed on
Sep. 25, 2018, now Pat. No. 10,461,439, which is a
continuation of application No. 15/351,263, filed on
Nov. 14, 2016, now Pat. No. 10,103,451.(60) Provisional application No. 62/254,140, filed on Nov.
11, 2015.**Publication Classification**(51) **Int. Cl.***H01Q 21/20* (2006.01)*H01Q 1/24* (2006.01)

(57)

ABSTRACT

The disclosure concerns an antenna assembly having a substrate with an antenna radiating element and a ground conductor disposed on the substrate, the ground conductor further characterized by a plurality of ground resonators, wherein a length associated with each of the ground resonators increases as the ground resonators are distanced from the antenna radiating element. Additionally, a coaxial cable is routed around the antenna assembly for configuring the coaxial cable as an additional ground resonator associated with the antenna assembly. The resulting antenna provides wide band performance between 700 MHz and 2700 MHz with improved efficiency compared with conventional antennas.





US 20210336355A1

(19) **United States**(12) **Patent Application Publication**
KRUGER et al.(10) **Pub. No.: US 2021/0336355 A1**(43) **Pub. Date: Oct. 28, 2021**(54) **CO-LOCATED ANTENNAS WITH COUPLED ARMS**(52) **U.S. Cl.**CPC *H01Q 21/28* (2013.01); *H01Q 1/241* (2013.01); *H01Q 3/34* (2013.01)(71) Applicant: **Hewlett-Packard Development Company, L.P.**, Spring, TX (US)(72) Inventors: **Chris KRUGER**, San Diego, CA (US);
Sung OH, Palo Alto, CA (US)(21) Appl. No.: **16/481,279**(22) PCT Filed: **Mar. 7, 2018**(86) PCT No.: **PCT/US2018/021328**

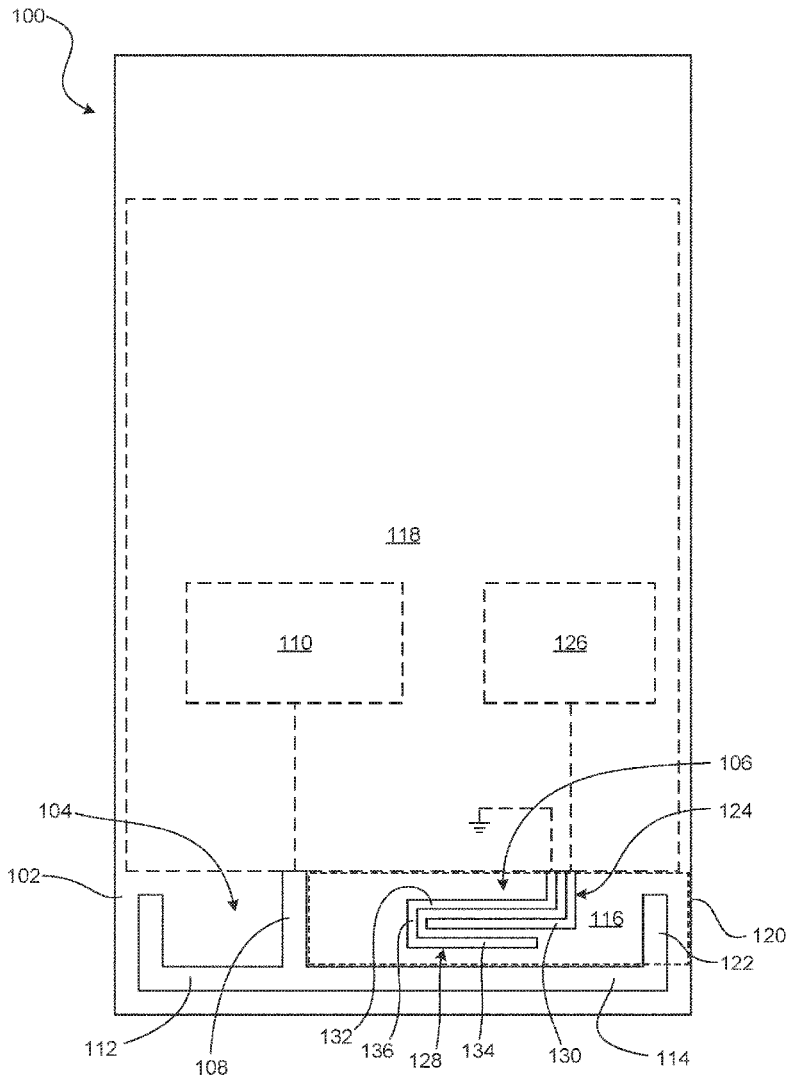
§ 371 (c)(1),

(2) Date: **Jul. 26, 2019****Publication Classification**(51) **Int. Cl.***H01Q 21/28* (2006.01)*H01Q 3/34* (2006.01)*H01Q 1/24* (2006.01)

(57)

ABSTRACT

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





US 20210343195A1

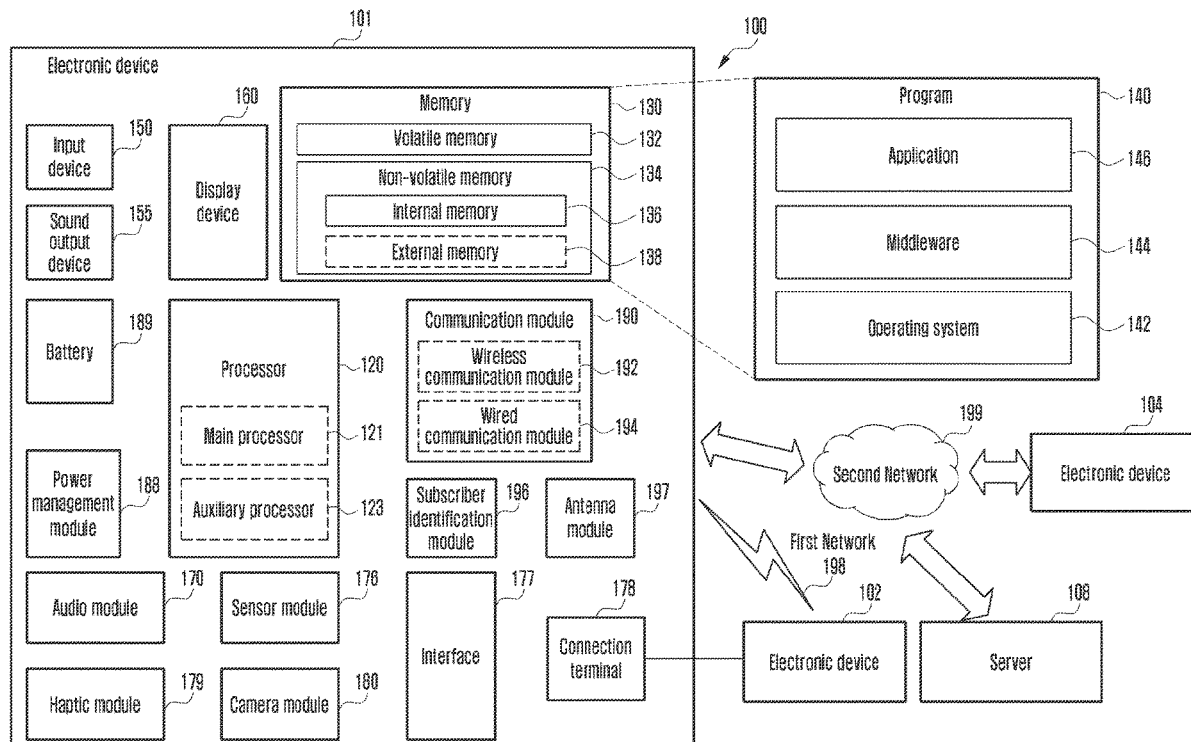
(19) **United States**(12) **Patent Application Publication**
JUNG et al.(10) **Pub. No.: US 2021/0343195 A1**(43) **Pub. Date: Nov. 4, 2021**(54) **FOLDABLE ELECTRONIC DEVICE
INCLUDING ANTENNA****Publication Classification**

- (51) **Int. Cl.**
G09F 9/30 (2006.01)
G06F 1/16 (2006.01)
- (52) **U.S. Cl.**
CPC **G09F 9/301** (2013.01); **H01Q 1/08**
(2013.01); **G06F 1/1656** (2013.01); **G06F**
1/1681 (2013.01)

(21) Appl. No.: **17/377,501**(57) **ABSTRACT**(22) Filed: **Jul. 16, 2021****Related U.S. Application Data**(63) Continuation of application No. 16/536,558, filed on
Aug. 9, 2019, now Pat. No. 11,069,265.(30) **Foreign Application Priority Data**

Aug. 10, 2018 (KR) 10-2018-0093954
Aug. 2, 2019 (KR) 10-2019-0094397

Various embodiments relate to an electronic device including an antenna. The electronic device may include: a foldable housing; a flexible display disposed on the foldable housing wherein at least a part of the flexible display is configured to be folded; and a frame disposed on a boundary portion of the flexible display and coupled to a side member of the foldable housing. The side member may include a conductive portion electrically connected to a communication circuit, and the frame may include a low-permittivity material.





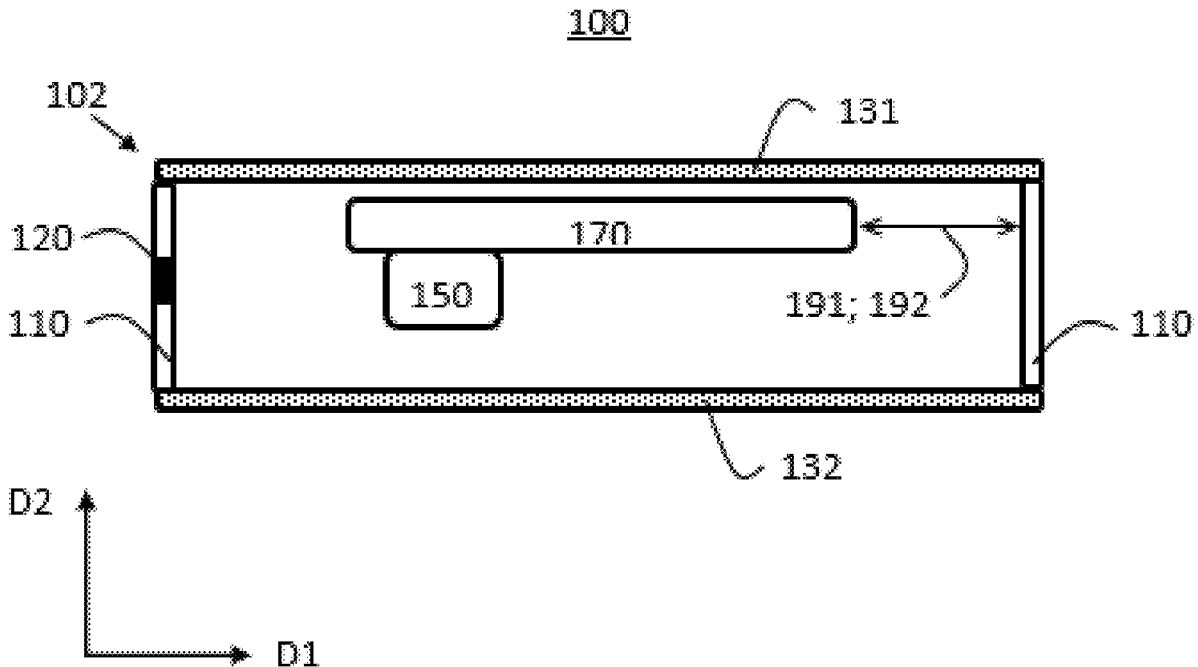
US 20210344103A1

(19) **United States**(12) **Patent Application Publication**
Khripkov et al.(10) **Pub. No.: US 2021/0344103 A1**(43) **Pub. Date: Nov. 4, 2021**(54) **COMMUNICATION DEVICE****H01Q 21/24** (2006.01)**H01Q 21/28** (2006.01)(71) Applicant: **Huawei Technologies Co., Ltd.**,
Shenzhen (CN)(52) **U.S. Cl.**CPC **H01Q 1/243** (2013.01); **H01Q 5/307**
(2015.01); **H01Q 21/28** (2013.01); **H01Q**
13/10 (2013.01); **H01Q 21/24** (2013.01);
H01Q 9/0485 (2013.01)(72) Inventors: **Alexander Khripkov**, Helsinki (FI);
Linsheng Li, Shenzhen (CN); **Ruiyuan**
Tian, Helsinki (FI)(21) Appl. No.: **17/375,689**

(57)

ABSTRACT(22) Filed: **Jul. 14, 2021****Related U.S. Application Data**(63) Continuation of application No. 16/612,605, filed on
Nov. 11, 2019, now Pat. No. 11,075,446, filed as
application No. PCT/EP2017/061429 on May 12,
2017.**Publication Classification**(51) **Int. Cl.****H01Q 1/24** (2006.01)**H01Q 5/307** (2006.01)**H01Q 9/04** (2006.01)**H01Q 13/10** (2006.01)

A communication device for wireless communication includes a housing having a front dielectric cover, a back dielectric cover, a metal frame circumferentially arranged between the front dielectric cover and the back dielectric cover, and an aperture. The metal frame forms a first antenna that is configured to radiate in a first set of frequency bands. The communication device further includes a circuit arranged inside the housing. The circuit is electrically isolated from the metal frame and includes at least one first feed line coupled to the metal frame and configured to feed the first antenna with a first set of radio frequency signals in the first set of frequency bands. The communication device further includes a second antenna arranged inside the housing and configured to radiate in a second frequency band non-overlapping with the first frequency band.





US 20210344108A1

(19) **United States**(12) **Patent Application Publication**
YUEN et al.(10) **Pub. No.: US 2021/0344108 A1**(43) **Pub. Date: Nov. 4, 2021**(54) **A BROADBAND ANTENNA COMPOSED OF
LINES AND ITS APPLICATION****Publication Classification**

- (51) **Int. Cl.**
H01Q 1/36 (2006.01)
- (52) **U.S. Cl.**
CPC H01Q 1/36 (2013.01)

(71) Applicant: **Innovation Sound Technology Co.,
LTD., Guangdong (CN)**(72) Inventors: **Shunming YUEN, Guangdong (CN);
Wai Yin MUNG, Guangdong (CN); Ka
Ming WU, Guangdong (CN)**(21) Appl. No.: **16/610,981**(22) PCT Filed: **Aug. 29, 2018**(86) PCT No.: **PCT/CN2018/102929**

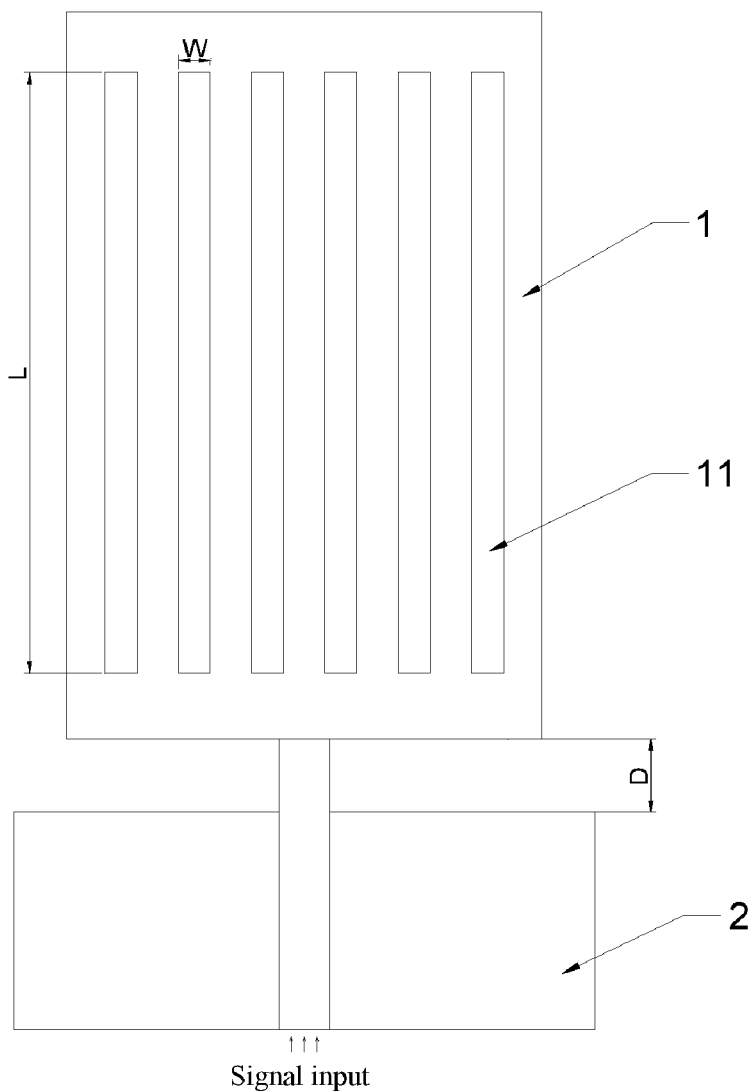
§ 371 (c)(1),

(2) Date: **Nov. 5, 2019**(30) **Foreign Application Priority Data**

Aug. 24, 2018 (CN) 201810974054.6

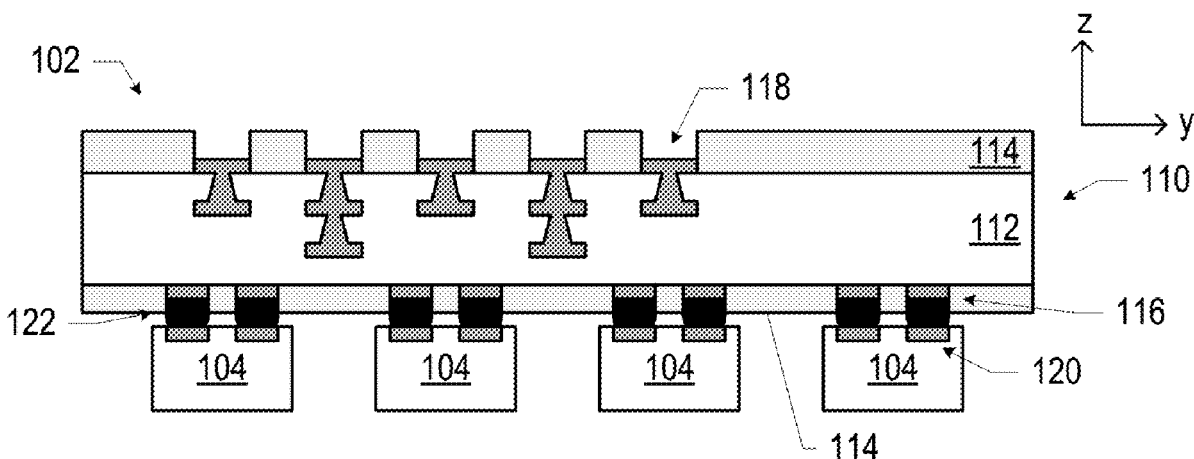
(57) **ABSTRACT**

The present invention discloses a broadband antenna composed of lines, comprising a top metal sheet, a bottom metal sheet, and a plurality of lines that are arranged equidistantly in parallel, and attached unto the top metal sheet. The broadband antenna proposed in the present invention is composed of a plurality of lines attached onto a metal sheet. Different antenna frequencies may be obtained by changing the length of the lines. In this way, antennas of lines with different lengths can be designed according to the characteristics of the short-range radio technology, and the matching application of several short-range radio technologies, such as Bluetooth, ZigBee and cellular communication, can be achieved.





US 20210344116A1

(19) **United States**(12) **Patent Application Publication**
Dalmia et al.(10) **Pub. No.: US 2021/0344116 A1**(43) **Pub. Date: Nov. 4, 2021**(54) **ANTENNA MODULES AND
COMMUNICATION DEVICES**continuation of application No. 16/000,795, filed on
Jun. 5, 2018, now Pat. No. 10,797,394.(71) Applicant: **Intel Corporation**, Santa Clara, CA
(US)**Publication Classification**(72) Inventors: **Sidharth Dalmia**, Portland, OR (US);
Trang Thai, Hillsboro, OR (US);
William James Lambert, Chandler, AZ
(US); **Zhichao Zhang**, Chandler, AZ
(US); **Jiwei Sun**, Chandler, AZ (US)(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 1/22 (2006.01)
H01Q 1/08 (2006.01)
(52) **U.S. Cl.**
CPC **H01Q 9/0407** (2013.01); **H01Q 11/14**
(2013.01); **H01Q 1/085** (2013.01); **H01Q**
1/2283 (2013.01)(73) Assignee: **Intel Corporation**, Santa Clara, CA
(US)(21) Appl. No.: **17/373,926**(57) **ABSTRACT**(22) Filed: **Jul. 13, 2021****Related U.S. Application Data**(63) Continuation of application No. 17/014,081, filed on
Sep. 8, 2020, now Pat. No. 11,121,468, which is aDisclosed herein are antenna boards, antenna modules, and
communication devices. For example, in some embodi-
ments, an antenna module may include: an antenna patch
support including a flexible portion; an integrated circuit
(IC) package coupled to the antenna patch support; and an
antenna patch coupled to the antenna patch support.

(19) **United States**

(12) **Patent Application Publication**
Chan et al.

(10) **Pub. No.: US 2021/0344119 A1**

(43) **Pub. Date: Nov. 4, 2021**

(54) **ANTENNA STRUCTURE**

(30) **Foreign Application Priority Data**

(71) Applicants: **Chun-Cheng Chan**, Taipei City (TW);
Shih-Chia Liu, Taipei City (TW);
Yen-Hao Yu, Taipei City (TW);
Li-Chun Lee, Taipei City (TW);
Jui-Hung Lai, Taipei City (TW);
Chih-Heng Lin, Taipei City (TW)

Mar. 3, 2020 (TW) 109106932

Publication Classification

(51) **Int. Cl.**
H01Q 21/06 (2006.01)
H01Q 1/48 (2006.01)
(52) **U.S. Cl.**
CPC **H01Q 21/06** (2013.01); **H01Q 1/48** (2013.01)

(72) Inventors: **Chun-Cheng Chan**, Taipei City (TW);
Shih-Chia Liu, Taipei City (TW);
Yen-Hao Yu, Taipei City (TW);
Li-Chun Lee, Taipei City (TW);
Jui-Hung Lai, Taipei City (TW);
Chih-Heng Lin, Taipei City (TW)

(57) **ABSTRACT**

The disclosure provides an antenna structure including a ground plane, a first coupling antenna and a reference antenna. The first coupling antenna includes a first excitation source connected to the ground plane. The first excitation source is configured to excite a first resonant mode, and the first coupling antenna forms a first zero current area on the ground plane in response to the first resonant mode. The reference antenna includes a second excitation source connected to the ground plane. The second excitation source is configured to excite a second resonant mode, and the reference antenna forms a second zero current area on the ground plane in response to the second resonant mode. The first excitation source is located in the second zero current area, and the second excitation source is located in the first zero current area.

(73) Assignee: **COMPAL ELECTRONICS, INC.**,
Taipei City (TW)

(21) Appl. No.: **17/374,954**

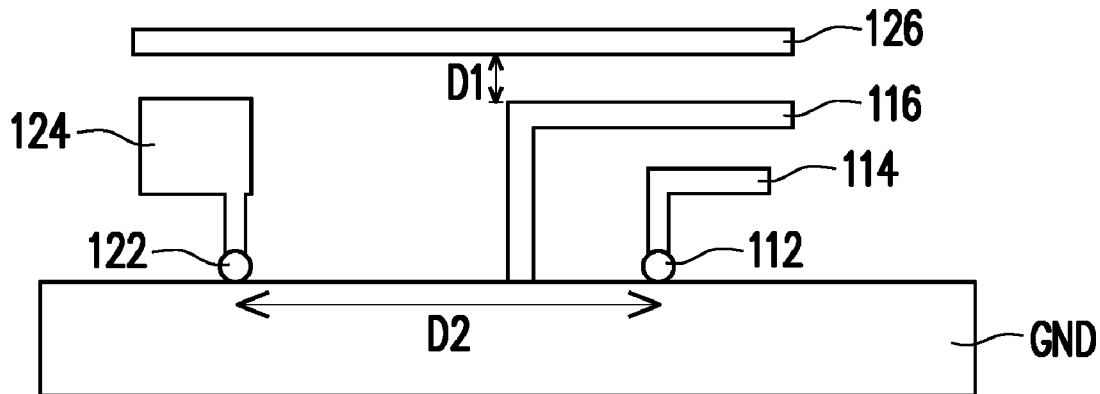
(22) Filed: **Jul. 13, 2021**

Related U.S. Application Data

(63) Continuation-in-part of application No. 16/995,784,
filed on Aug. 17, 2020.

(60) Provisional application No. 63/053,694, filed on Jul.
19, 2020.

110 { 112
114
116 } 120 { 122
124
126 }





US 20210344121A1

(19) **United States**(12) **Patent Application Publication**
YUN et al.(10) **Pub. No.: US 2021/0344121 A1**(43) **Pub. Date: Nov. 4, 2021**(54) **ANTENNA HAVING RADIATION
STRUCTURE OF GIVEN DIRECTION AND
ELECTRONIC DEVICE INCLUDING SAME****G06F 3/041** (2006.01)**H01Q 1/24** (2006.01)(52) **U.S. Cl.****CPC** **H01Q 21/065** (2013.01); **H01Q 5/30**
(2015.01); **H01Q 1/243** (2013.01); **G06F**
3/0412 (2013.01); **H01Q 3/36** (2013.01)(71) Applicant: **SAMSUNG ELECTRONICS CO.,
LTD.**, Suwon-si (KR)(72) Inventors: **Sumin YUN**, Suwon-si (KR);
Dongyeon KIM, Suwon-si (KR);
Yoonjung KIM, Suwon-si (KR);
Seongjin PARK, Suwon-si (KR);
Sehyun PARK, Suwon-si (KR);
Myunghun JEONG, Suwon-si (KR);
Jehun JONG, Suwon-si (KR); **Jaehoon**
JO, Suwon-si (KR)

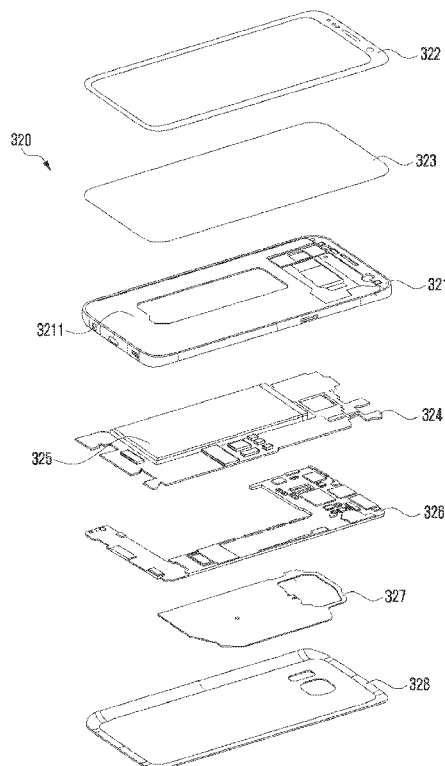
(57)

ABSTRACT

An electronic device may include a housing including a first plate facing a first direction, a second plate facing a second direction opposite the first direction, and a side housing surrounding a space between the first plate and the second plate, wherein the side housing includes a first portion, including an external metal portion having a first face facing an outside and a second face facing the space and an internal polymer portion having a third face contacting the second face and a fourth face facing the space, a touch screen display positioned within the space to be viewable through the first plate, wherein an edge of the touch screen display is spaced apart from the first portion of the side housing and when the first plate is viewed from above, the gap is covered by a peripheral portion of the first glass plate, an antenna structure comprising at least one antenna and configured to include a substrate having a fifth face substantially parallel to the second face and a sixth face facing a direction opposite the fifth face and at least one conductive pattern positioned between the fifth face and the sixth face and extending toward the peripheral portion of the first plate, and wireless communication circuitry operatively connected to the at least one conductive pattern and configured to form a directivity beam using at least a part of the at least one conductive pattern.

(21) Appl. No.: **17/373,888**(22) Filed: **Jul. 13, 2021****Related U.S. Application Data**(63) Continuation of application No. 16/676,691, filed on
Nov. 7, 2019, now Pat. No. 11,081,808.(30) **Foreign Application Priority Data**

Nov. 9, 2018 (KR) 10-2018-0137020

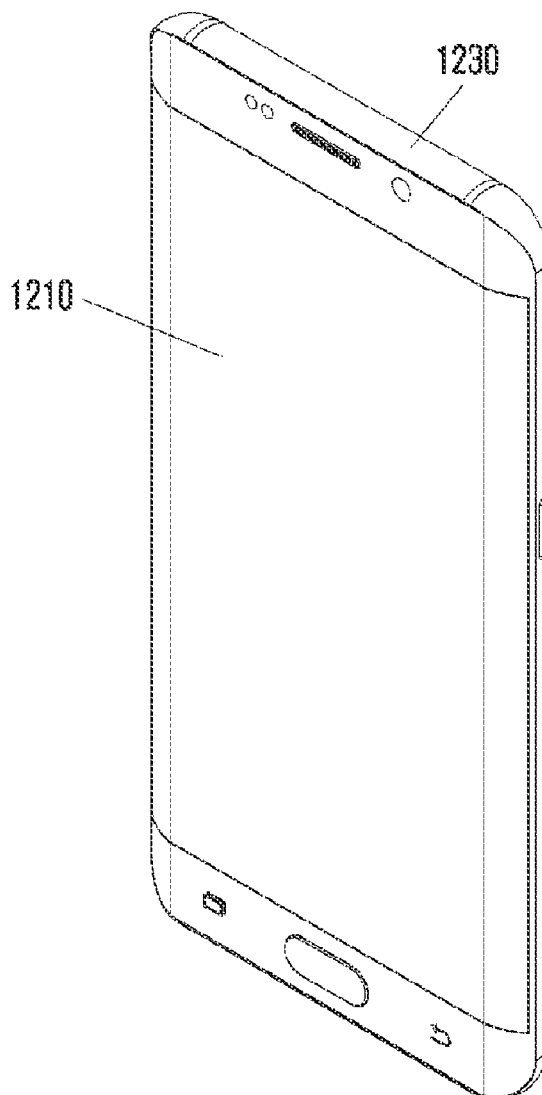
Publication Classification(51) **Int. Cl.****H01Q 21/06** (2006.01)**H01Q 5/30** (2006.01)**H01Q 3/36** (2006.01)



US 20210351502A1

(19) **United States**(12) **Patent Application Publication** (10) **Pub. No.: US 2021/0351502 A1**
Ha et al. (43) **Pub. Date: Nov. 11, 2021**(54) **ANTENNA DEVICE AND ELECTRONIC
DEVICE INCLUDING SAME**(30) **Foreign Application Priority Data**

Nov. 23, 2016 (KR) 10-2016-0156609

(71) Applicant: **Samsung Electronics Co., Ltd.**,
Gyeonggi-do (KR)**Publication Classification**(72) Inventors: **Dohyuk Ha**, Gyeonggi-do (KR); **Junsig
Kum**, Gyeonggi-do (KR); **Jungyub
Lee**, Gyeonggi-do (KR); **Youngju Lee**,
Seoul (KR)(51) **Int. Cl.**
H01Q 1/42 (2006.01)
H01Q 1/22 (2006.01)
H01Q 1/52 (2006.01)(21) Appl. No.: **17/385,254**(52) **U.S. Cl.**
CPC **H01Q 1/42** (2013.01); **H01Q 1/528**
(2013.01); **H01Q 1/2283** (2013.01)(22) Filed: **Jul. 26, 2021**(57) **ABSTRACT****Related U.S. Application Data**(63) Continuation of application No. 16/462,054, filed on
May 17, 2019, now Pat. No. 11,108,148, filed as
application No. PCT/KR2017/013179 on Nov. 20,
2017.Disclosed is an antenna device including an antenna sub-
strate in which an array antenna comprising at least one
radiation element is disposed, and a cover separated by a
predetermined distance or more from the antenna substrate
and comprising at least one repeating radiation element
disposed to correspond to the at least one radiation element.



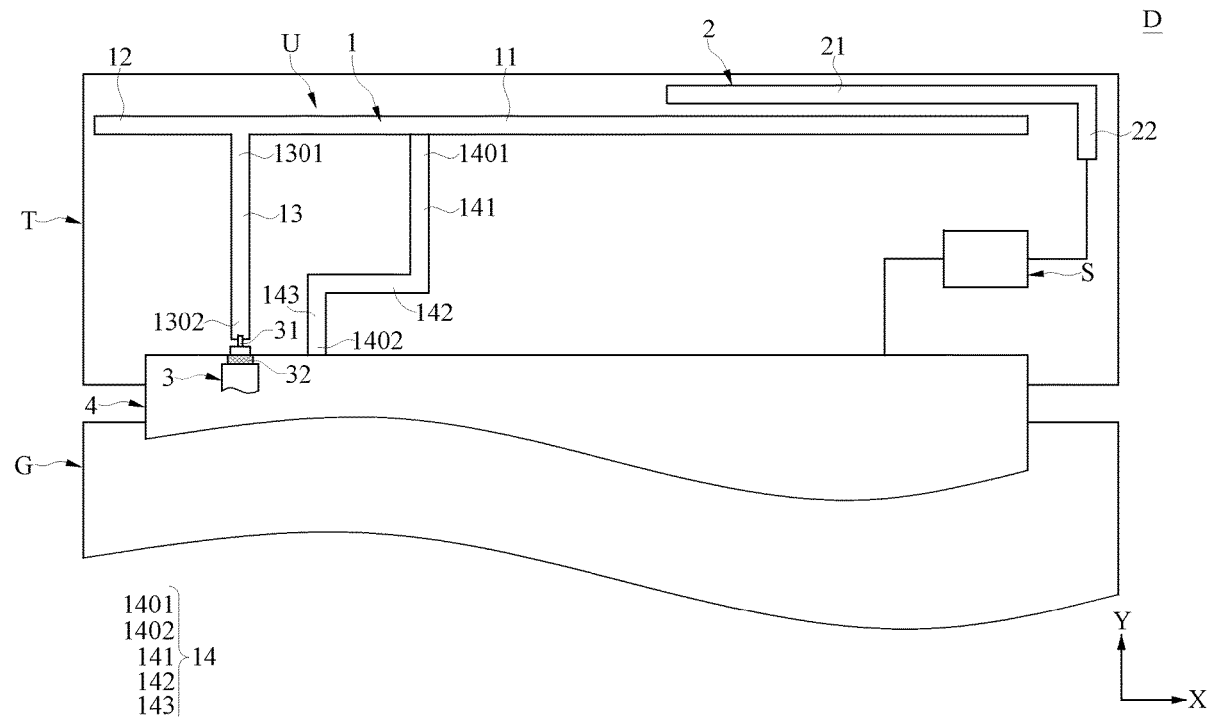
US 20210351509A1

(19) **United States**(12) **Patent Application Publication**
LIN et al.(10) **Pub. No.: US 2021/0351509 A1**(43) **Pub. Date: Nov. 11, 2021**(54) **ELECTRONIC DEVICE**(52) **U.S. Cl.**(71) Applicant: **WISTRON NEWEB CORPORATION, HSINCHU (TW)**CPC **H01Q 5/314** (2015.01); **H01Q 1/38** (2013.01)(72) Inventors: **HSIEH-CHIH LIN, HSINCHU (TW); SHIH-HSIEN TSENG, HSINCHU (TW)**(57) **ABSTRACT**

An electronic device including an antenna structure and a switching circuit is provided. The antenna structure includes a first radiating element, a second radiating element, a feeding element and a grounding element. The first radiating element includes a first radiating part and a feeding part. The second radiating element is coupled with the first radiating element, and includes a main body and an arm that is electrically connected to the switching circuit. The feeding element includes a feeding end electrically connected to the feeding part, and a grounding end electrically connected to the grounding element. The antenna structure generates a first operation bandwidth and second operation bandwidth when the switching circuit is switched to a first and second mode, respectively. A central frequency of the first operation bandwidth is different from that of the second operation bandwidth.

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Publication Classification(51) **Int. Cl.****H01Q 5/314** (2006.01)**H01Q 1/38** (2006.01)



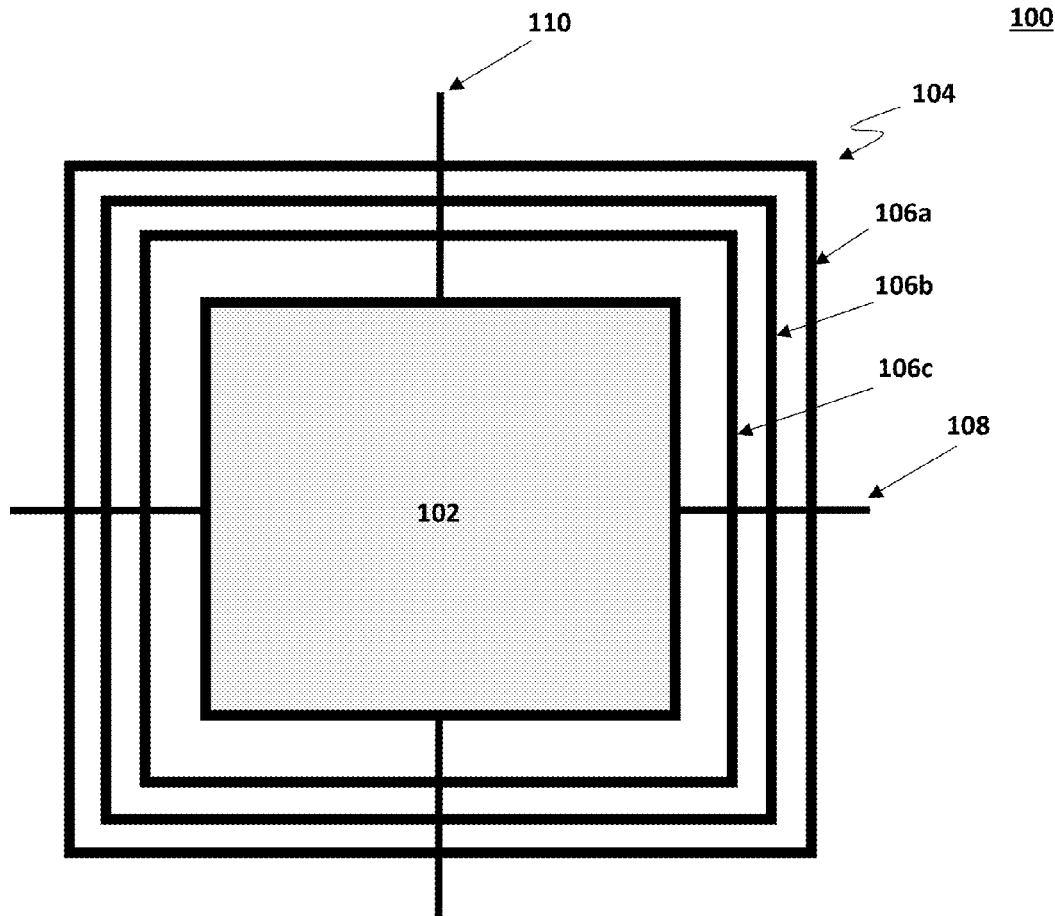
US 20210351511A1

(19) **United States**(12) **Patent Application Publication**
Weisman et al.(10) **Pub. No.: US 2021/0351511 A1**(43) **Pub. Date: Nov. 11, 2021**(54) **DIFFERENTIAL ON-CHIP LOOP ANTENNA****H01L 23/552** (2006.01)**H01Q 5/371** (2006.01)**H01Q 25/00** (2006.01)(71) Applicant: **Intel Corporation**, Santa Clara, CA
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Goldberger, Moshav Beherotaim M
(IL)CPC **H01Q 7/00** (2013.01); **H01L 23/66**
(2013.01); **H01Q 1/2283** (2013.01); **H01L**
2223/6677 (2013.01); **H01L 23/552** (2013.01);
H01Q 5/371 (2015.01); **H01Q 25/001**
(2013.01); **H01Q 21/06** (2013.01)(73) Assignee: **Intel Corporation**, Santa Clara, CA
(US)

(57)

ABSTRACT(21) Appl. No.: **17/381,073**(22) Filed: **Jul. 20, 2021****Related U.S. Application Data**(63) Continuation of application No. 15/716,930, filed on
Sep. 27, 2017, now Pat. No. 11,108,156.**Publication Classification**(51) **Int. Cl.****H01Q 7/00** (2006.01)**H01L 23/66** (2006.01)**H01Q 1/22** (2006.01)**H01Q 21/06** (2006.01)

Aspects of the embodiments are directed to an on-chip loop antenna and methods of manufacturing the same. In some embodiments, the on-chip loop antenna is in an integrated circuit (IC) die. The IC die comprises metal loops substantially centered around a core region of the IC die in a metallization stack of the IC die, a dielectric between spaces of the metal loops, an electric circuit in the core region electrically connected to the metal loops with an interconnect, and a ground plane in the metallization stack electrically connected to the loops with a first plurality of vias and to the electric circuit with a second plurality of vias. The first plurality of vias is different from the second plurality of vias, and the electric circuit includes an inductor. In some embodiments, the on-chip loop antenna can be carried by a semiconductor package.





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(19) **United States**(12) **Patent Application Publication**
LEE et al.(10) **Pub. No.: US 2021/0356550 A1**(43) **Pub. Date: Nov. 18, 2021**(54) **ELECTRONIC DEVICE INCLUDING
ANTENNA FOR MEASURING ANGLE OF
ARRIVAL****Publication Classification**

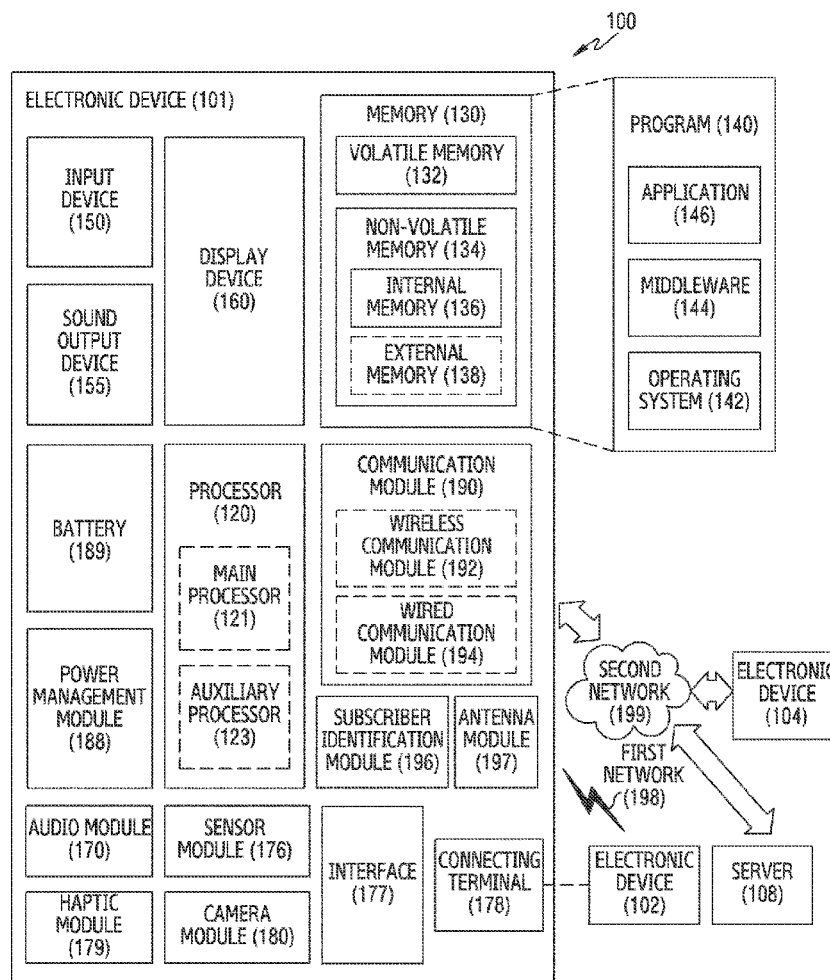
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G01S 3/50 (2006.01)
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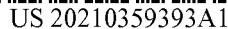
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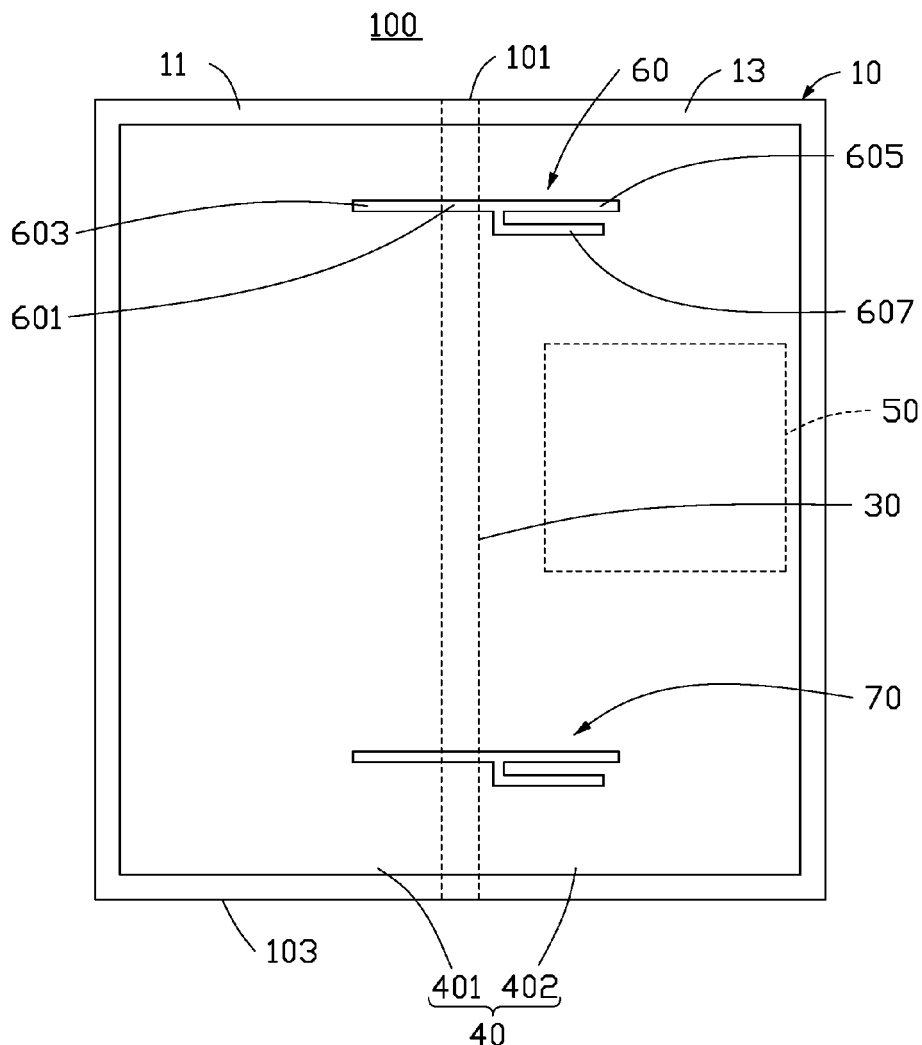
(57) **ABSTRACT**

An electronic device is provided. The electronic device includes a flexible printed circuit board (FPCB) including a first conductive patch and a second conductive patch, a wireless communication circuitry electrically coupled with the first conductive patch and the second conductive patch, and a processor electrically coupled with the wireless communication circuitry. The first conductive patch is fed from the wireless communication circuitry at a first point located at a first edge of the first conductive patch or a second point located at a second edge different from the first edge, and operates as an antenna radiator which receives a radio frequency (RF) signal of a specified frequency band, the second conductive patch is fed from the wireless communication circuitry at a third point of the second conductive patch, and operates as an antenna radiator which transmits or receive an RF signal of a specified frequency band.





(43) **Pub. Date:** **Nov. 18, 2021**





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(19) **United States**

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(54) **COMPACT 5G MIMO ANTENNA SYSTEM
AND MOBILE TERMINAL**

Publication Classification

(71) Applicant: **SHENZHEN SUNWAY
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(51) **Int. Cl.**
H01Q 21/29 (2006.01)
H01Q 5/50 (2006.01)
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CPC **H01Q 21/29** (2013.01); **H01Q 5/50**
(2015.01); **H01Q 1/48** (2013.01); **H01Q 1/52**
(2013.01); **H01Q 5/20** (2015.01)

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(57) **ABSTRACT**

(21) Appl. No.: **16/492,747**

A compact 5G MIMO antenna system includes at least two antenna assemblies. Each antenna assembly includes a first antenna unit and a second antenna unit, wherein the first antenna unit includes a first radiation assembly, a first feed branch and a ground branch; the second antenna unit includes a second radiation assembly, a second feed branch and the ground branch; the ground branch is located between the first radiation assembly and the second radiation assembly; the first feed branch is arranged close to an end, away from the ground branch, of the first radiation assembly; and the second feed branch is arranged close to an end, away from ground branch, of the second radiation assembly. The antenna system improves the isolation between the first antenna unit and the second antenna unit and compacts the overall structure of the antenna assembly, which has simple structure, high antenna efficiency, and convenient use.

(22) PCT Filed: **Jun. 13, 2019**

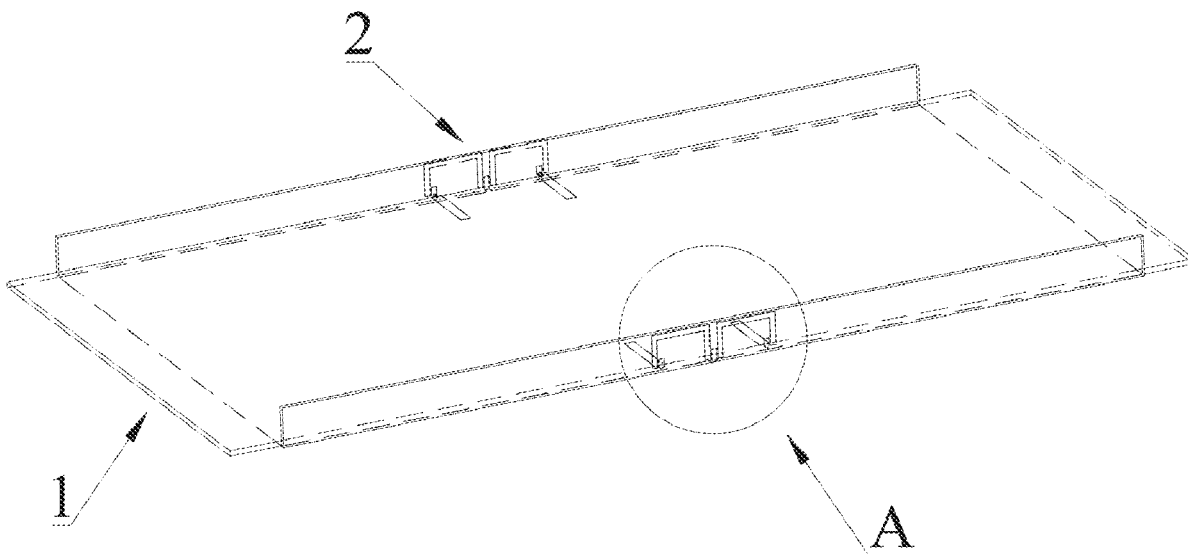
(86) PCT No.: **PCT/CN2019/091054**

§ 371 (c)(1),

(2) Date: **Sep. 10, 2019**

(30) **Foreign Application Priority Data**

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May 16, 2019	(CN)	201920717346.1





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(19) **United States**(12) **Patent Application Publication**
ZHANG et al.(10) **Pub. No.: US 2021/0359428 A1**(43) **Pub. Date: Nov. 18, 2021**(54) **LOW PROFILE DUAL-FREQUENCY
ANTENNA DEVICE**(52) **U.S. Cl.**CPC *H01Q 21/30* (2013.01); *H01Q 1/2291*
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(CN)

(57)

ABSTRACT

A low profile dual-frequency antenna device comprises an insulative carrier having a first surface and a second surface which are opposite and a conductor unit, the conductor unit comprises a first conductor which is provided to the first surface and a second conductor which is provided to the second surface and connected with the first conductor, a first radiation slot as a low frequency slot antenna is formed between the first conductor and the second conductor, the first conductor is formed with a second radiation slot, a third radiation slot which is communicated with the first radiation slot and the second radiation slot, a fourth radiation slot and a fifth radiation slot, and the third radiation slot, the fourth radiation slot and the fifth radiation slot together constitute a high frequency slot antenna, the second radiation slot decides an impedance and a resonance frequency width of each antenna, a first side edge and a second side edge is oppositely positioned at a location where the second radiation slot and the third radiation slot are communicated, the first conductor has a signal feeding-in portion thereon close to the first side edge, the first conductor has a ground portion thereon close to the second side edge.

(73) Assignee: **Molex, LLC**, Lisle, IL (US)(21) Appl. No.: **17/320,738**(22) Filed: **May 14, 2021**(30) **Foreign Application Priority Data**

May 14, 2020 (CN) 202010407138.9

Publication Classification(51) **Int. Cl.***H01Q 21/30* (2006.01)*H01Q 21/06* (2006.01)*H01Q 1/22* (2006.01)