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(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.: US 2021/0328329 A1**

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

KIM et al.

(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.**

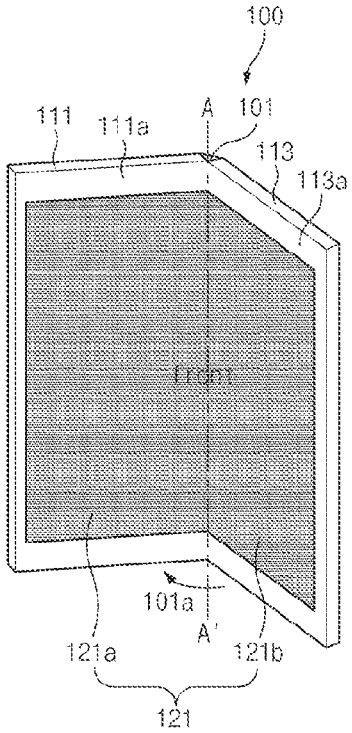
H01Q 1/24	(2006.01)
H04M 1/02	(2006.01)
H01Q 21/06	(2006.01)
H01Q 3/34	(2006.01)
H01Q 9/04	(2006.01)

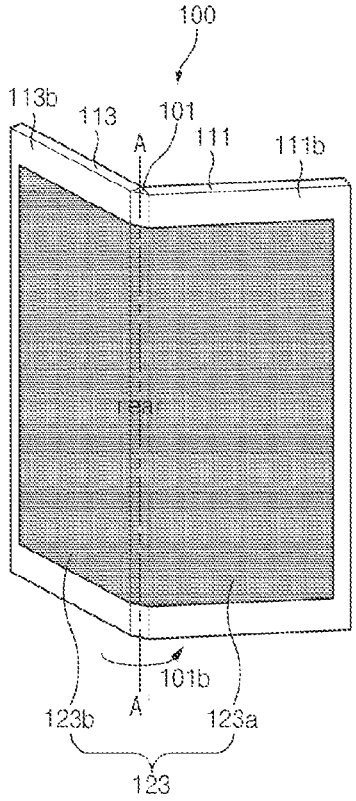
(52) **U.S. Cl.**

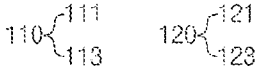
CPC ***H01Q 1/243*** (2013.01); ***H04M 1/0218*** (2013.01); ***H01Q 9/0407*** (2013.01); ***H01Q 3/34*** (2013.01); ***H01Q 21/065*** (2013.01)

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

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

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

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

(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**

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.

(30) **Foreign Application Priority Data**

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

Publication Classification

(51) **Int. Cl.**

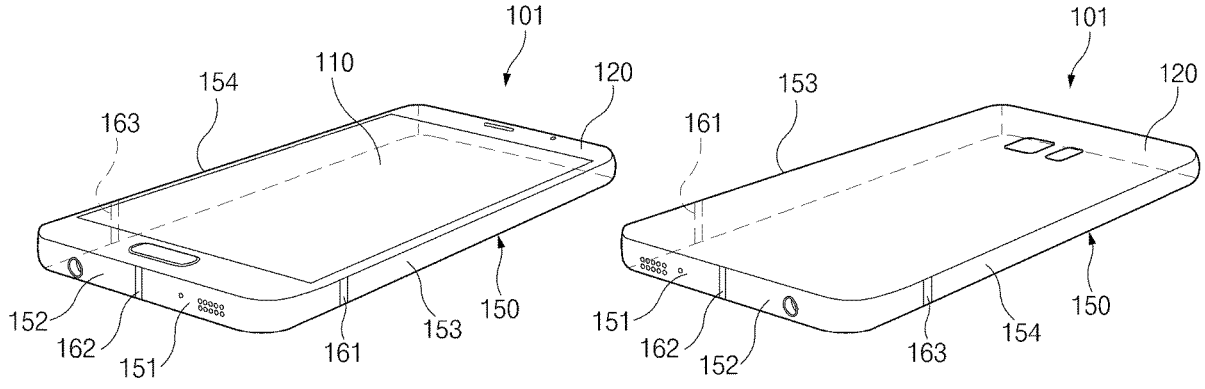
H01Q 1/24	(2006.01)
H01Q 3/24	(2006.01)
H01Q 9/42	(2006.01)
H01Q 5/364	(2006.01)
H01Q 21/28	(2006.01)

(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)

(57) **ABSTRACT**

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 conductive member, wherein the conductive member includes a first conductive pattern disposed between the first nonconductive member and the second nonconductive member, and a second conductive pattern disposed between the second nonconductive member and the third nonconductive member; 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 nonconductive member; and a communication circuit electrically connected with the conductive member.



US 20210328334A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2021/0328334 A1

Cooper et al. (43) Pub. Date: Oct. 21, 2021

(54) **ELECTRONIC DEVICES HAVING COMPACT ULTRA-WIDEBAND ANTENNAS**

(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)

(21) Appl. No.: **16/849,776**

(22) Filed: **Apr. 15, 2020**

Publication Classification

(51) **Int. Cl.**

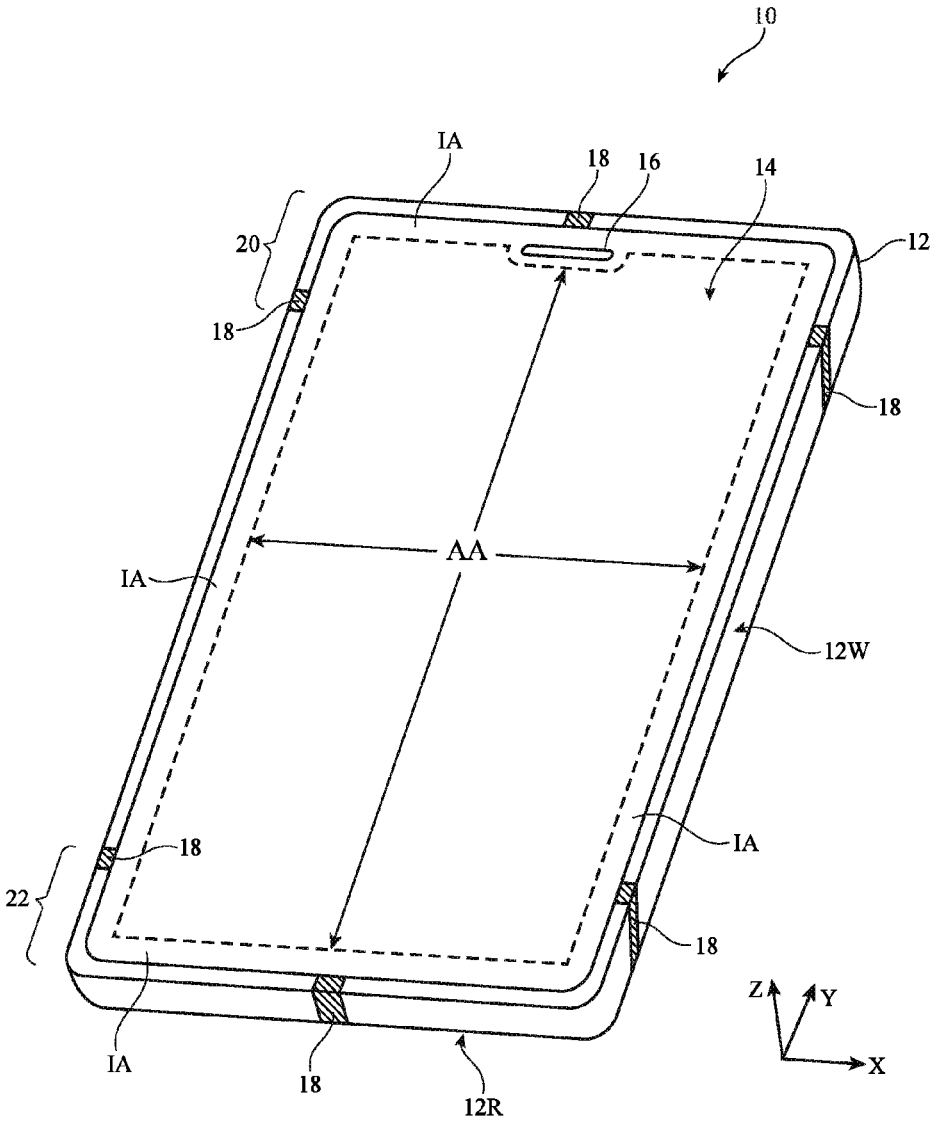
H01Q 1/42	(2006.01)
H01Q 1/52	(2006.01)
H01Q 3/44	(2006.01)
H01Q 1/24	(2006.01)

(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)

(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.



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**

(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.**

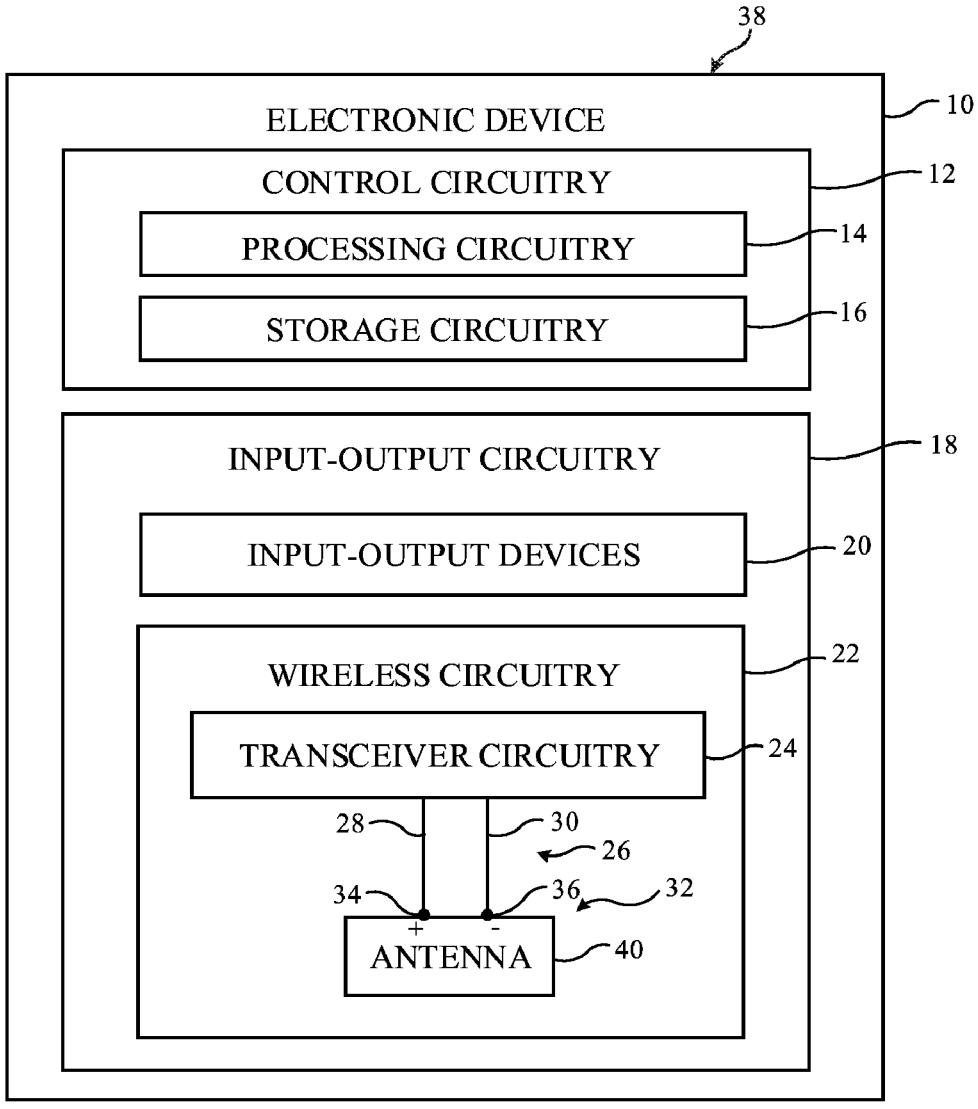
H01Q 5/10	(2006.01)
H01Q 5/328	(2006.01)
H01Q 7/00	(2006.01)

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

CPC ***H01Q 5/10*** (2015.01); ***H01Q 7/00*** (2013.01); ***H01Q 5/328*** (2015.01)

(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.



US 20210328348A1

(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.**

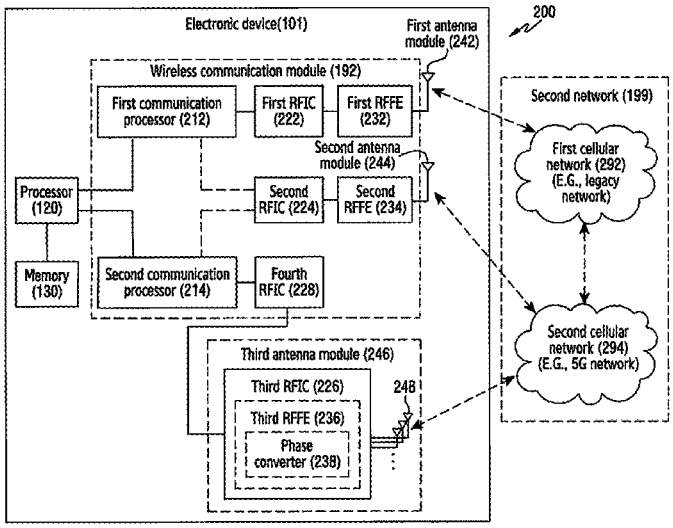
H01Q 9/04 (2006.01)
H01Q 5/10 (2006.01)
H04B 1/38 (2006.01)

(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.



US 20210328349A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2021/0328349 A1

JIAN et al. (43) Pub. Date: Oct. 21, 2021

(54) **WIRELESS ELECTRONIC COMMUNICATIONS DEVICE**

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

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

(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

Publication Classification

(51) **Int. Cl.**

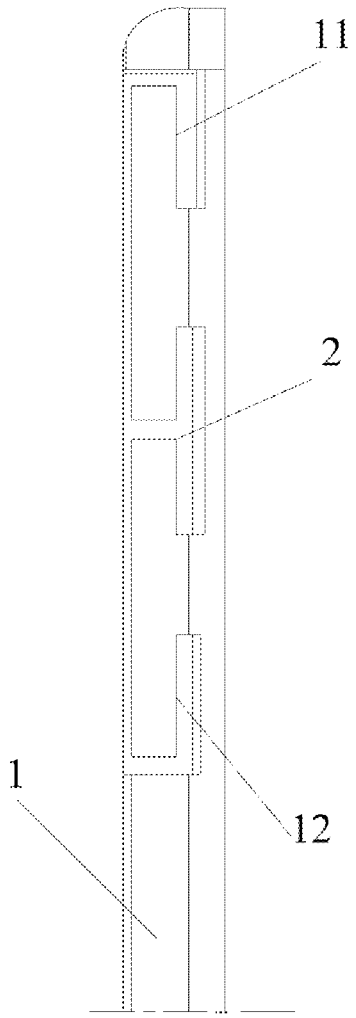
H01Q 9/04	(2006.01)
H01Q 1/24	(2006.01)
H04M 1/02	(2006.01)

(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)

(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**

(10) **Pub. No.: US 2021/0328350 A1**

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

TAKAYAMA et al.

(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.**

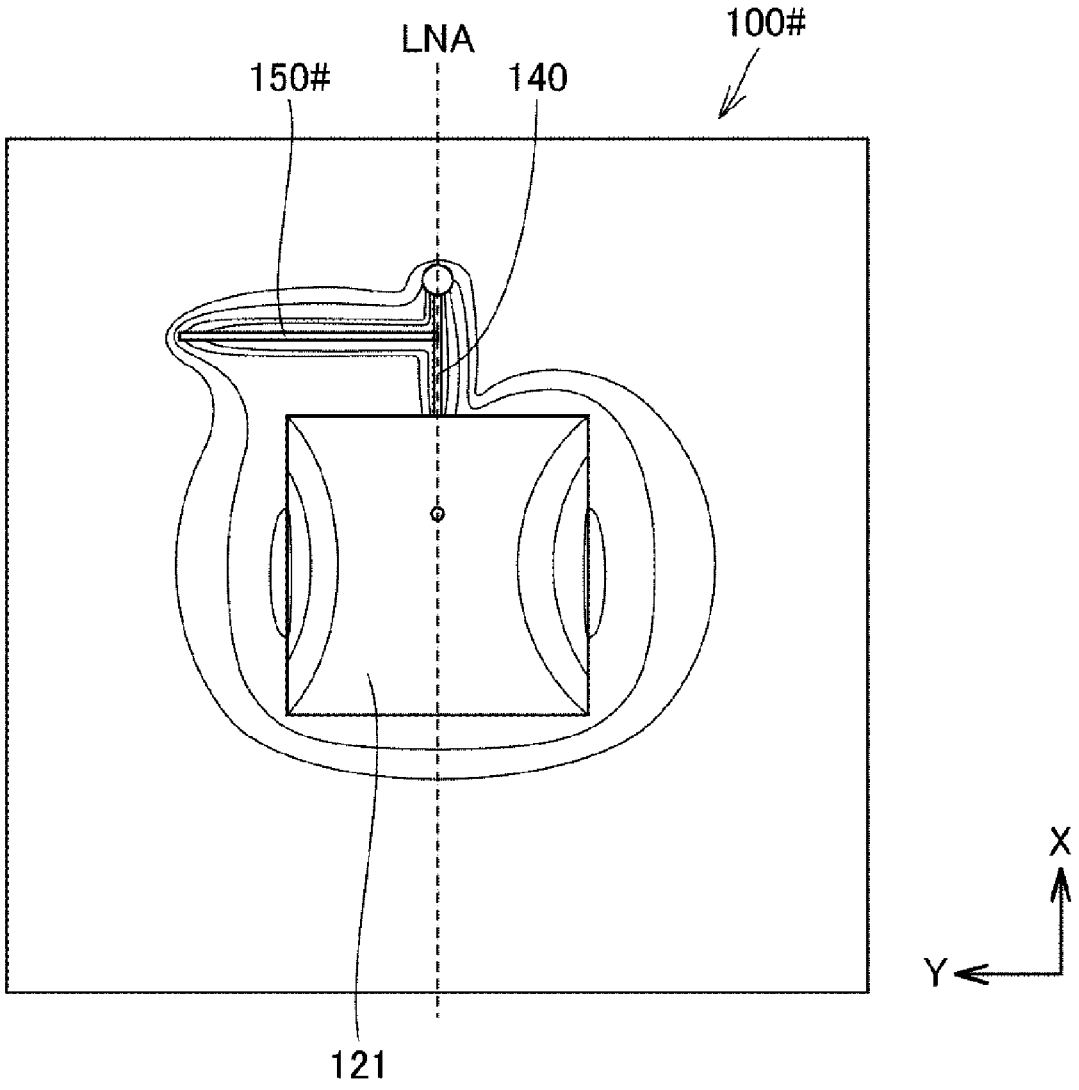
H01Q 9/04 (2006.01)
H01Q 1/50 (2006.01)
H01Q 5/378 (2006.01)

(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.



US 20210328351A1

(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**

(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.**

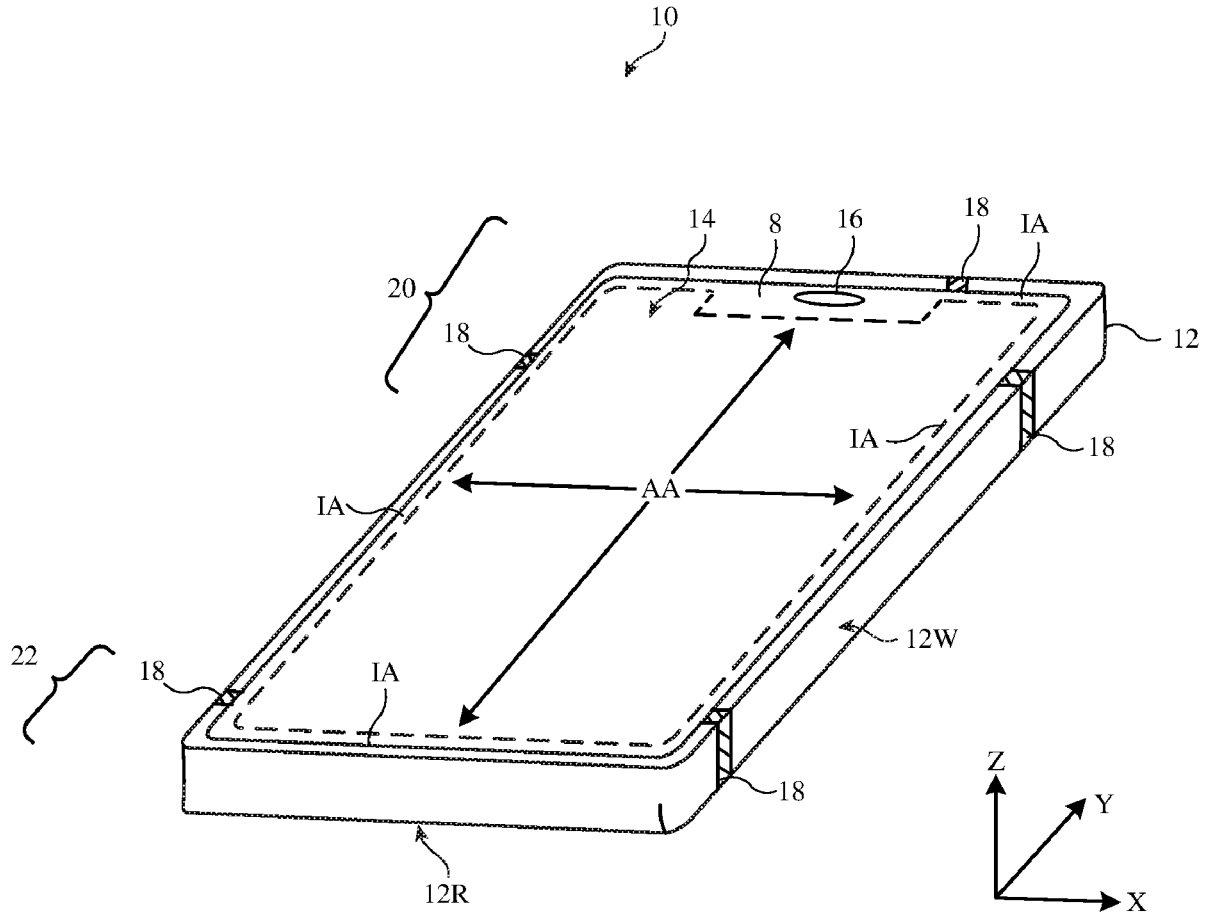
H01Q 9/04	(2006.01)
H01Q 5/35	(2006.01)
H01Q 5/385	(2006.01)

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

CPC ***H01Q 9/0485*** (2013.01); ***H01Q 5/385*** (2015.01); ***H01Q 5/35*** (2015.01)

(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.



US 20210328352A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2021/0328352 A1**

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

(54) **DIPOLE ANTENNA**

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

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

(21) Appl. No.: **17/014,459**

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

(30) **Foreign Application Priority Data**

Apr. 17, 2020 (TW) 109112933

Publication Classification

(51) **Int. Cl.**

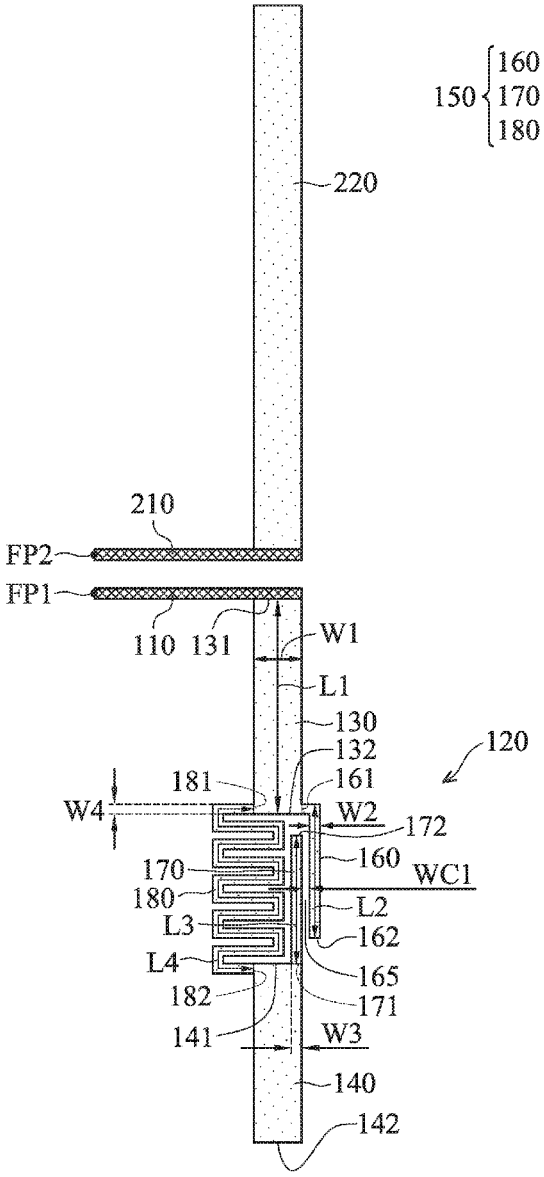
H01Q 9/44	(2006.01)
H01Q 5/35	(2006.01)
H01Q 1/24	(2006.01)

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

CPC ***H01Q 9/44*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 5/35*** (2015.01)

(57) **ABSTRACT**

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.



US 20210328354A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2021/0328354 A1**

KHALEDIAN et al. (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.**

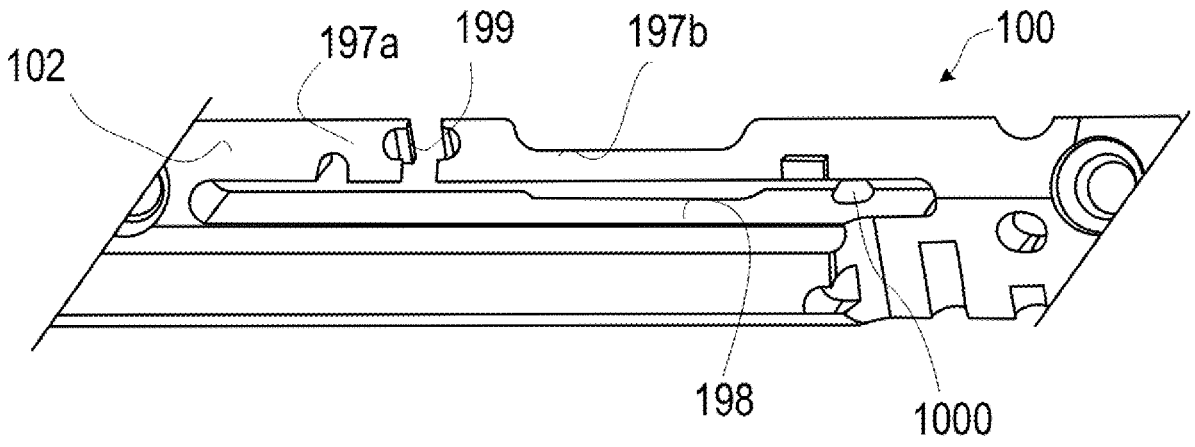
H01Q 13/10	(2006.01)
H01Q 1/22	(2006.01)
H01Q 1/38	(2006.01)
H01Q 21/06	(2006.01)
H01Q 1/24	(2006.01)

(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.



US 20210328362A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2021/0328362 A1**

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

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

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

(72) Inventors: **Sungchul PARK**, Gyeonggi-do (KR); **Wonjoon CHOI**, Gyeonggi-do (KR)

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

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

Related U.S. Application Data

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

(30) **Foreign Application Priority Data**

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

Publication Classification

(51) **Int. Cl.**

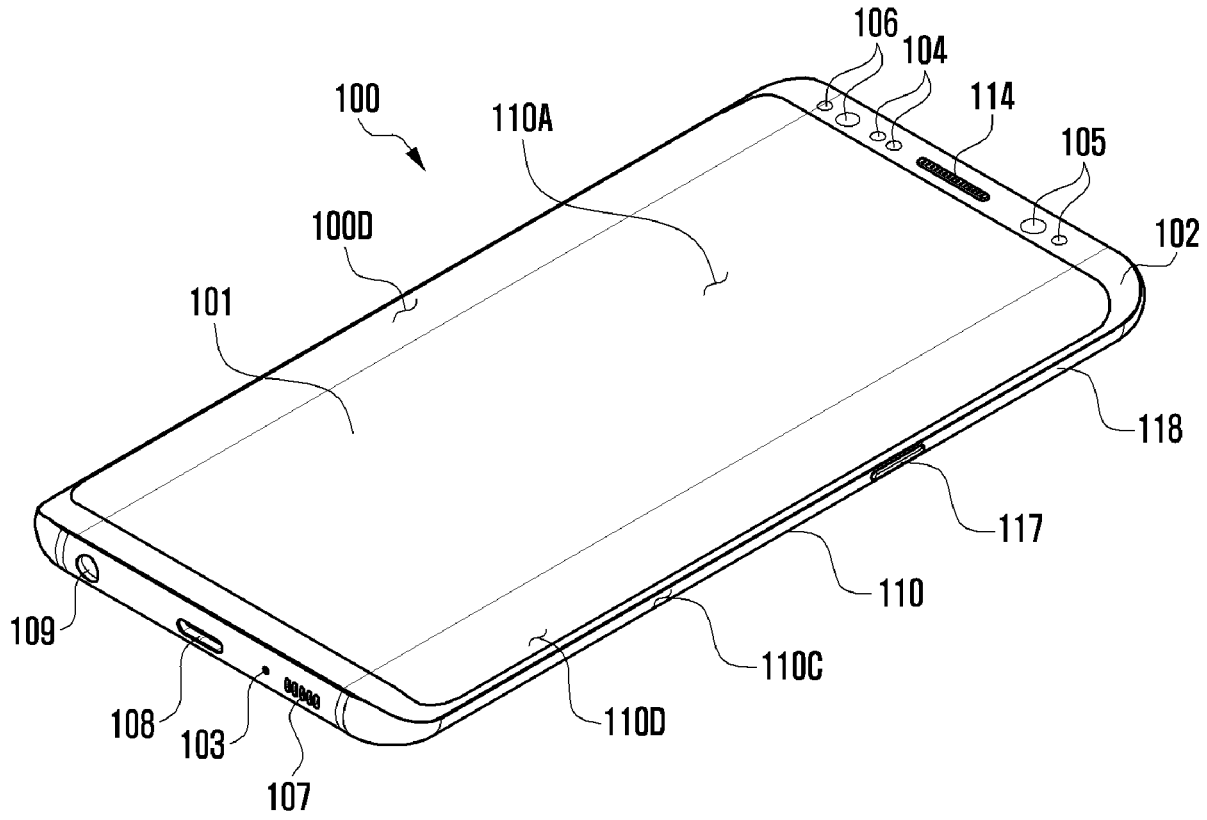
H01Q 21/06	(2006.01)
H01Q 3/36	(2006.01)
H01Q 1/24	(2006.01)
H01Q 1/42	(2006.01)

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

CPC ***H01Q 21/065*** (2013.01); ***H01Q 1/422*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 3/36*** (2013.01)

(57) **ABSTRACT**

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



US 20210328364A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2021/0328364 A1

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

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

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

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

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

(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.**

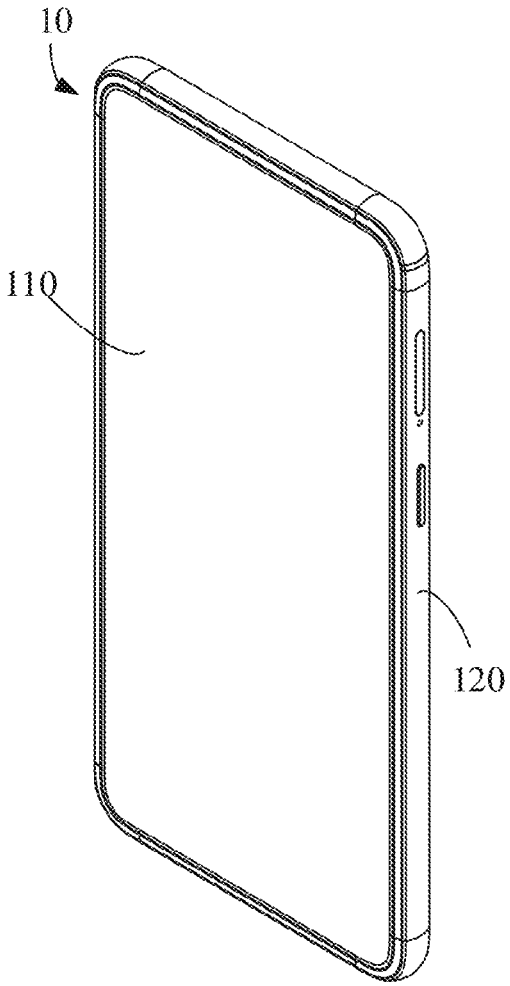
H01Q 21/24	(2006.01)
H01Q 9/04	(2006.01)
H01Q 21/08	(2006.01)
H01Q 5/42	(2006.01)

(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)

(57) **ABSTRACT**

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 the 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**

(10) **Pub. No.: US 2021/0336324 A1**

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

Oh et al.

(54) **ANTENNAS FOR METAL HOUSINGS**

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

(72) Inventors: **Sung Oh**, Palo Alto, CA (US); **Chris Kruger**, San Diego, CA (US)

(21) Appl. No.: **16/481,821**

(22) PCT Filed: **Mar. 16, 2018**

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

§ 371 (c)(1),
(2) Date: **Jul. 29, 2019**

Publication Classification

(51) **Int. Cl.**

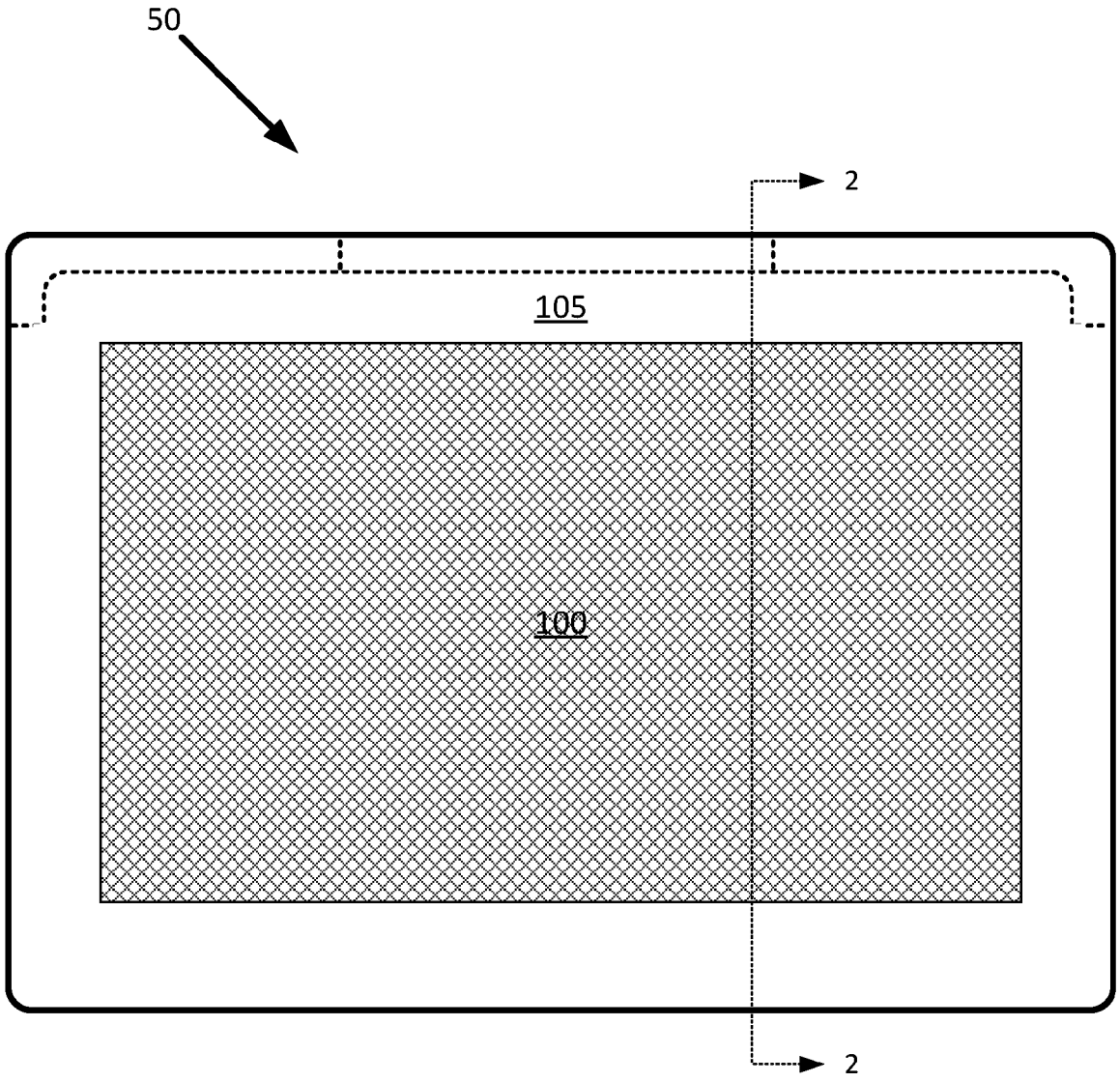
H01Q 1/22	(2006.01)
H01Q 13/10	(2006.01)
H01Q 21/28	(2006.01)
H01Q 1/48	(2006.01)
H01Q 9/42	(2006.01)

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

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)

(57) **ABSTRACT**

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.



US 20210336338A1

(19) **United States**

(12) **Patent Application Publication**

CHANG et al.

(10) **Pub. No.: US 2021/0336338 A1**

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

(54) **DUAL-BAND ANTENNA AND ANTENNA MODULE USING THE SAME**

(71) Applicants: **Inventec Appliances (Pudong) Corporation**, Shanghai (CN); **INVENTEC APPLIANCES CORP.**, New Taipei City (TW); **Inventec Appliances (Shanghai) Co. Ltd.**, Shanghai (CN)

(72) Inventors: **Yu-Wei CHANG**, New Taipei City (TW); **Shu-Yang TU**, New Taipei City (TW)

(21) Appl. No.: **17/038,136**

(22) Filed: **Sep. 30, 2020**

(30) **Foreign Application Priority Data**

Apr. 22, 2020 (CN) 202010321309.6

Publication Classification

(51) **Int. Cl.**

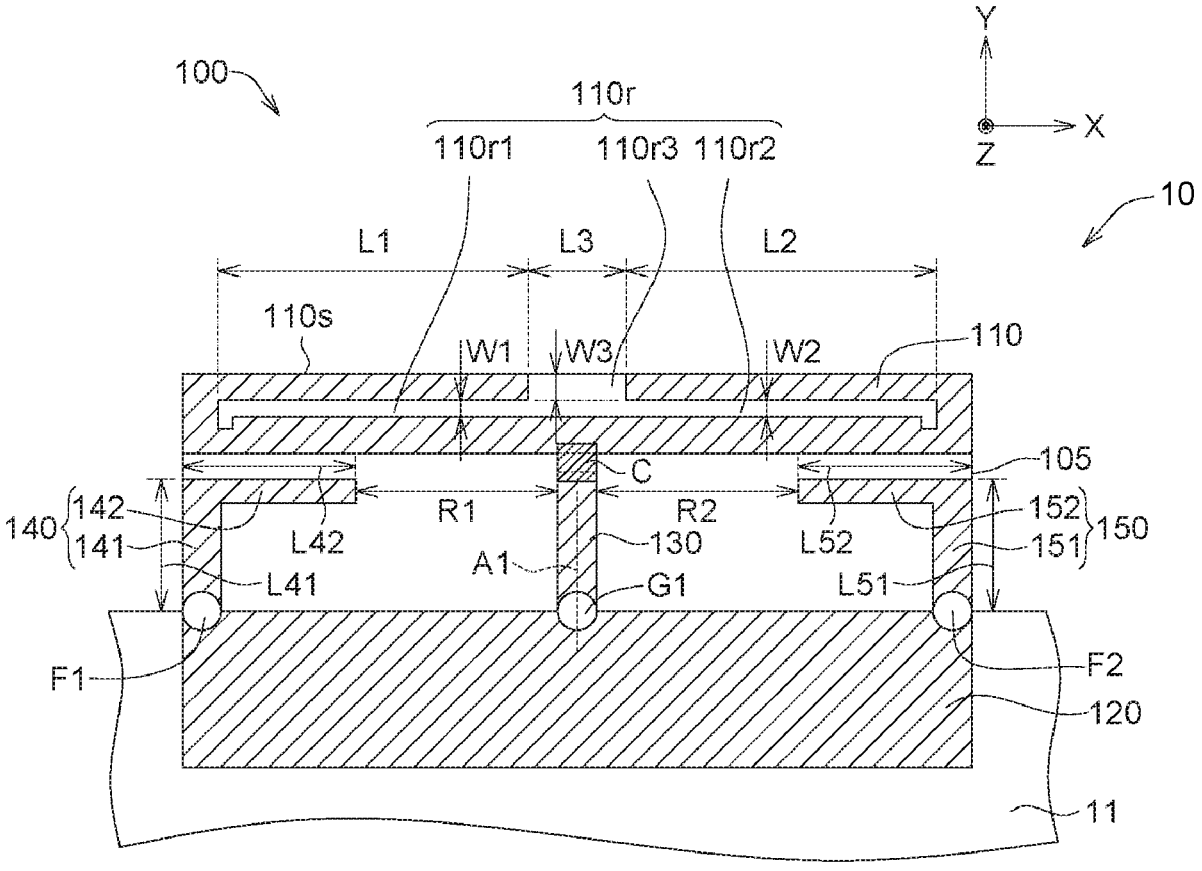
H01Q 5/30 (2006.01)
H01Q 13/06 (2006.01)
H01Q 1/48 (2006.01)

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

CPC ***H01Q 5/30*** (2015.01); ***H01Q 1/48*** (2013.01); ***H01Q 13/06*** (2013.01)

(57) **ABSTRACT**

A dual-band antenna includes a first conductive portion, a ground layer, a ground portion, a second conductive portion and a third conductive portion. The first conductive portion has a resonant cavity. The ground portion extends from the ground layer toward the first conductive portion. The second conductive portion extends from the ground layer toward the first conductive portion. The third conductive portion extends from the ground layer toward the first conductive portion. The second conductive portion and the third conductive portion are disposed symmetrically with respect to the ground portion.



US 20210336339A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2021/0336339 A1**

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

(54) **ANTENNA STRUCTURE**

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

(72) Inventors: **Yun-Tsan LEE**, Hsinchu (TW); **Chia-Hao CHANG**, Hsinchu (TW)

(21) Appl. No.: **17/022,391**

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

(30) **Foreign Application Priority Data**

Apr. 24, 2020 (TW) 109113707

Publication Classification

(51) **Int. Cl.**

H01Q 5/371 (2006.01)

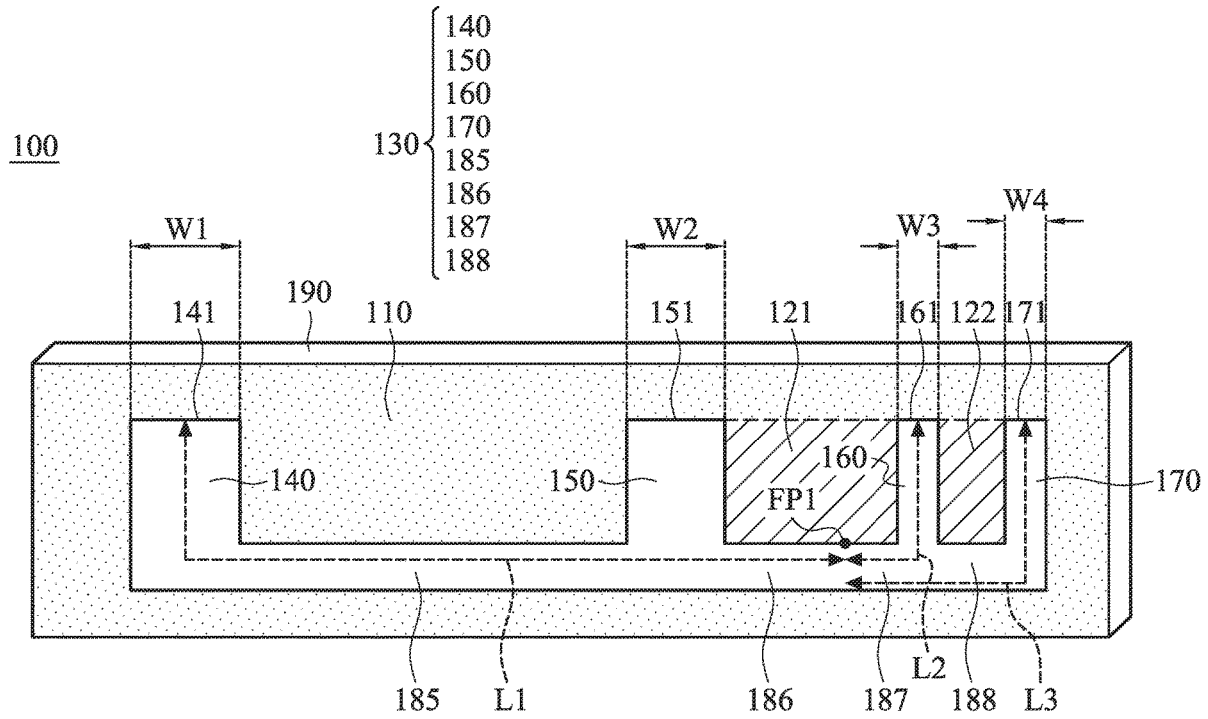
H01Q 1/48 (2006.01)

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

CPC ***H01Q 5/371*** (2015.01); *H01Q 1/243* (2013.01); ***H01Q 1/48*** (2013.01)

(57) **ABSTRACT**

An antenna structure includes a ground metal element, a first metal element, and a second metal element. The ground metal element has a slot. A feeding point is positioned at the first metal element. The first metal element and the second metal element are coupled to the ground metal element. The first metal element and the second metal element extend into the interior of the slot. The slot includes a first branch portion, a second branch portion, a third branch portion, and a fourth branch portion. The first metal element is disposed between the second branch portion and the third branch portion of the slot. The second metal element is disposed between the third branch portion and the fourth branch portion of the slot.



US 20210336343A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2021/0336343 A1**

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

(54) **SLOTTED PATCH ANTENNAS**

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

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

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

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

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

§ 371 (c)(1),
(2) Date: **Jul. 28, 2019**

Publication Classification

(51) **Int. Cl.**

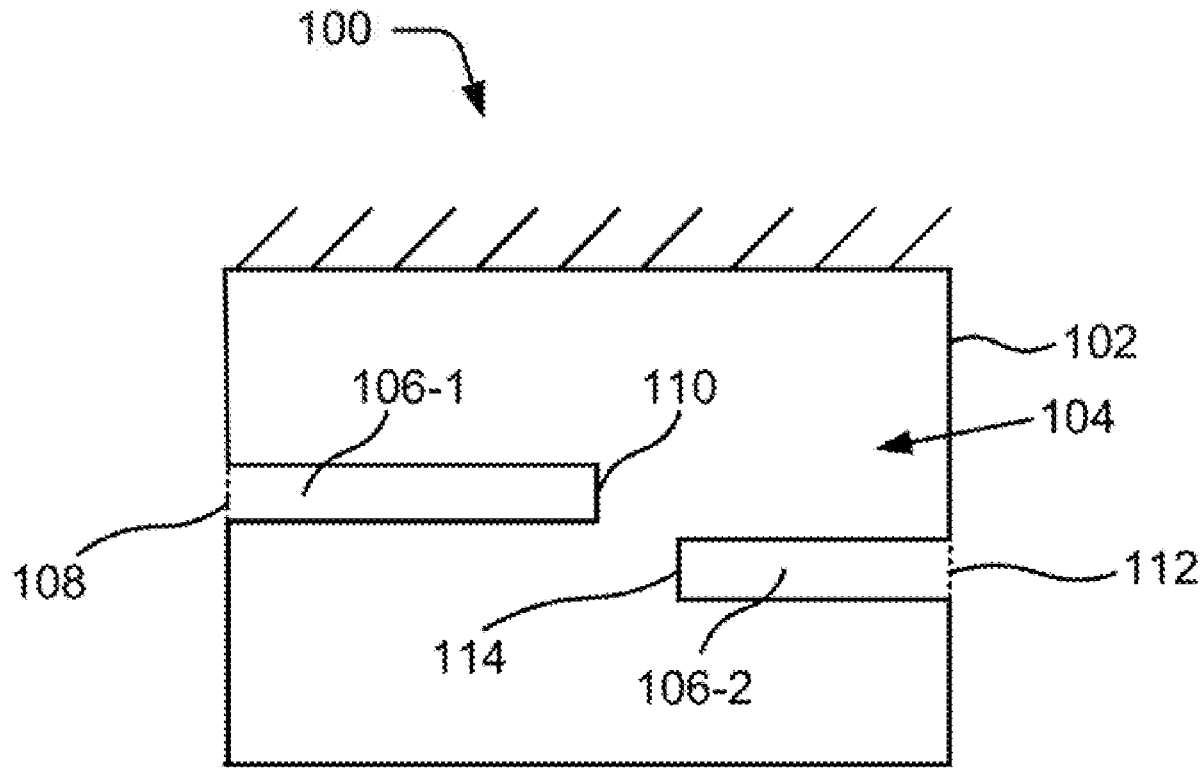
H01Q 9/04	(2006.01)
H01Q 13/10	(2006.01)
H01Q 1/22	(2006.01)
H01Q 1/36	(2006.01)
H01Q 9/40	(2006.01)

(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)

(57) **ABSTRACT**

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**

(10) **Pub. No.: US 2021/0336348 A1**

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

SUDO et al.

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

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

(72) Inventors: **Kaoru SUDO**, Kyoto (JP); **Kengo ONAKA**, Kyoto (JP); **Hirotsugu MORI**, Kyoto (JP)

(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.**

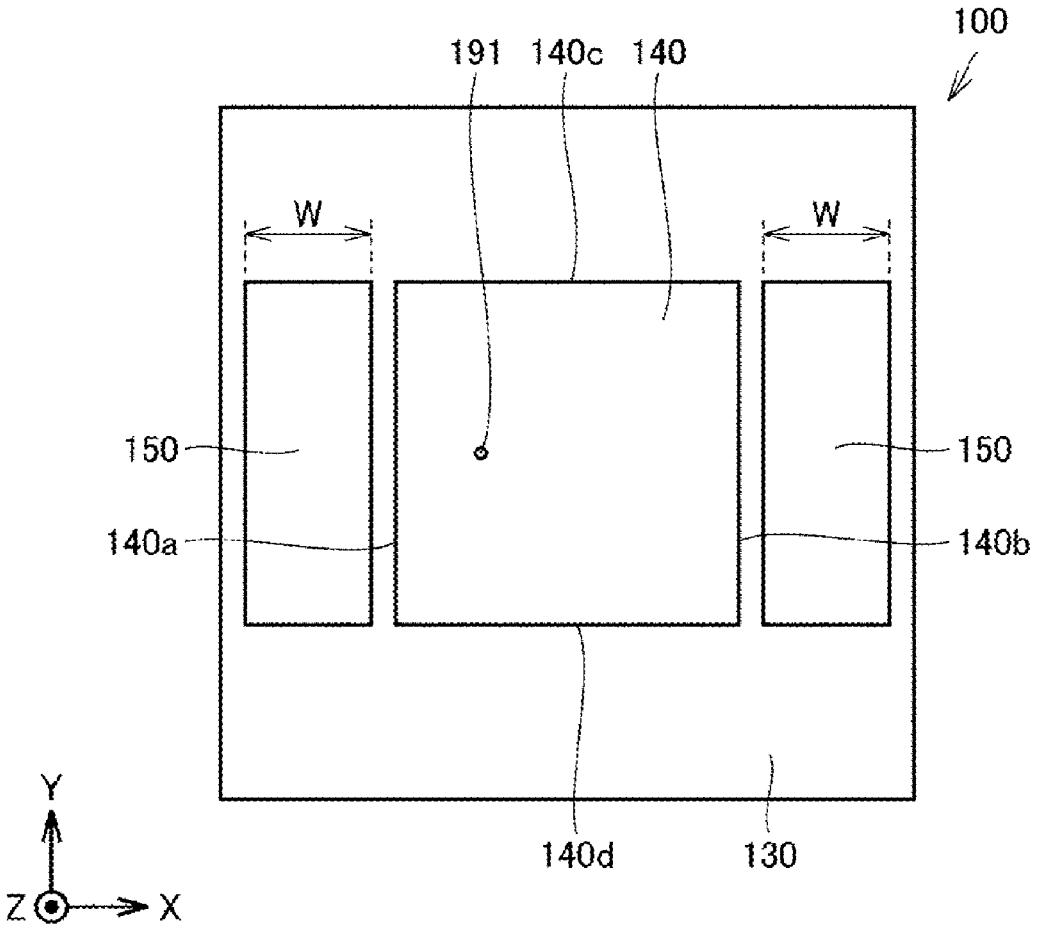
H01Q 13/08	(2006.01)
H01Q 1/42	(2006.01)
H01Q 5/385	(2006.01)

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

CPC ***H01Q 13/08*** (2013.01); ***H01Q 5/385*** (2015.01); ***H01Q 1/422*** (2013.01)

(57) **ABSTRACT**

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

(10) Pub. No.: US 2021/0336349 A1

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

TANBO

(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.**

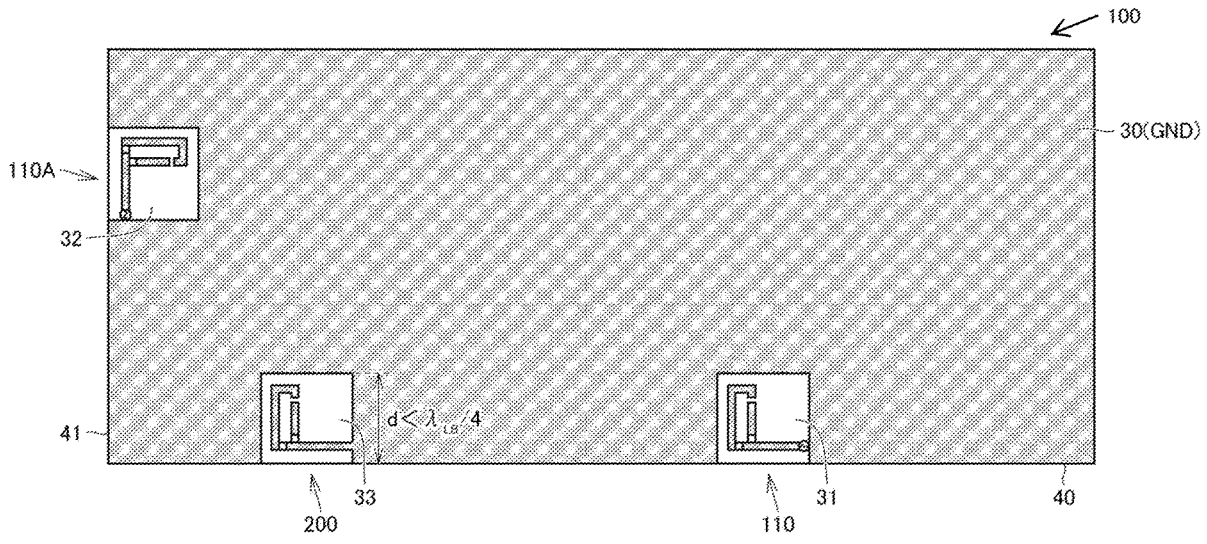
H01Q 13/10	(2006.01)
H01Q 1/48	(2006.01)
H01Q 5/307	(2006.01)

(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 (**110**A) 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 (**110**A) 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 (10) Pub. No.: US 2021/0336351 A1

Zhang et al. (43) Pub. Date: Oct. 28, 2021

(54) **DUAL-POLARIZED DUPLEX ANTENNA AND DUAL-BAND BASE STATION ANTENNA ARRAY COMPOSED THEREOF**

(71) Applicant: **South China University of Technology**, Guangzhou (CN)

(72) Inventors: **Xiuyin Zhang**, Guangzhou (CN); **Yufeng Wu**, Guangzhou (CN); **Yunfei Cao**, Guangzhou (CN); **Wen Duan**, Guangzhou (CN); **Yao Zhang**, Guangzhou (CN)

(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.**

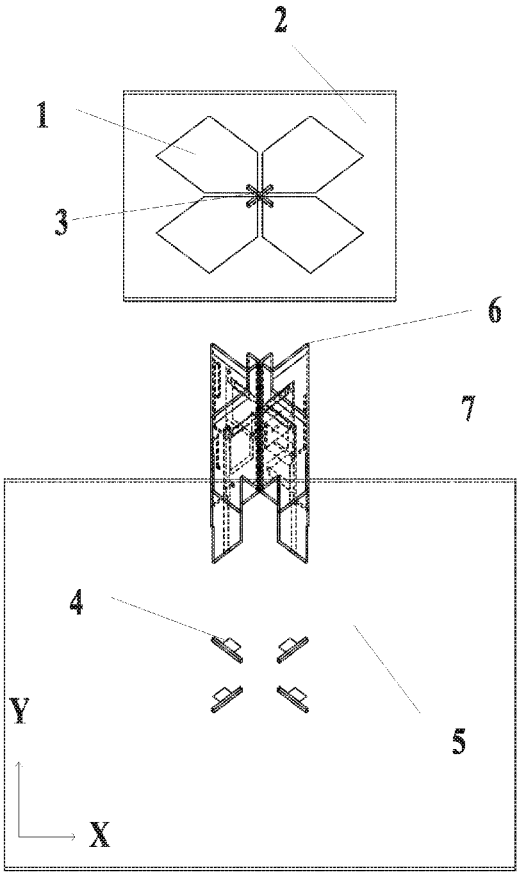
H01Q 21/06	(2006.01)
H01Q 19/10	(2006.01)
H01Q 21/00	(2006.01)
H01Q 15/24	(2006.01)
H01Q 15/00	(2006.01)

(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)

(57) **ABSTRACT**

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**

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.**

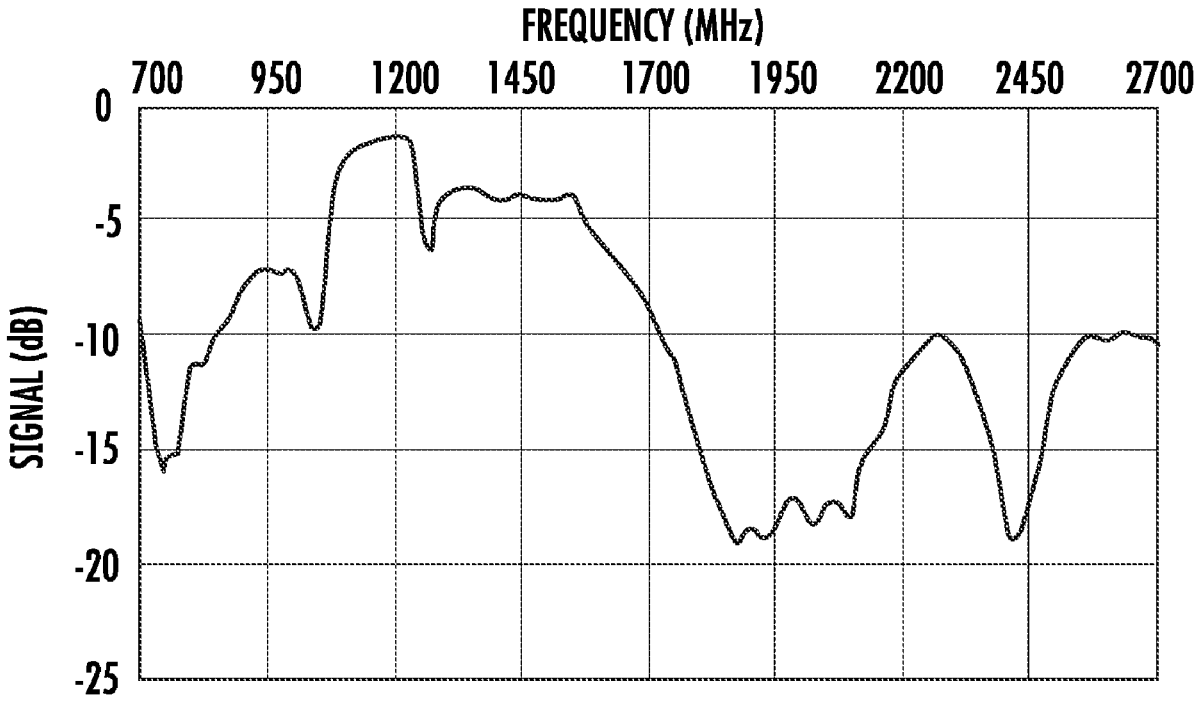
H01Q 21/20	(2006.01)
H01Q 1/24	(2006.01)
H01Q 1/38	(2006.01)
H01Q 5/371	(2006.01)
H01Q 5/30	(2006.01)
H01Q 1/36	(2006.01)
H01Q 1/48	(2006.01)

(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)

(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**

(10) **Pub. No.: US 2021/0336355 A1**

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

KRUGER et al.

(54) **CO-LOCATED ANTENNAS WITH COUPLED ARMS**

(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.**

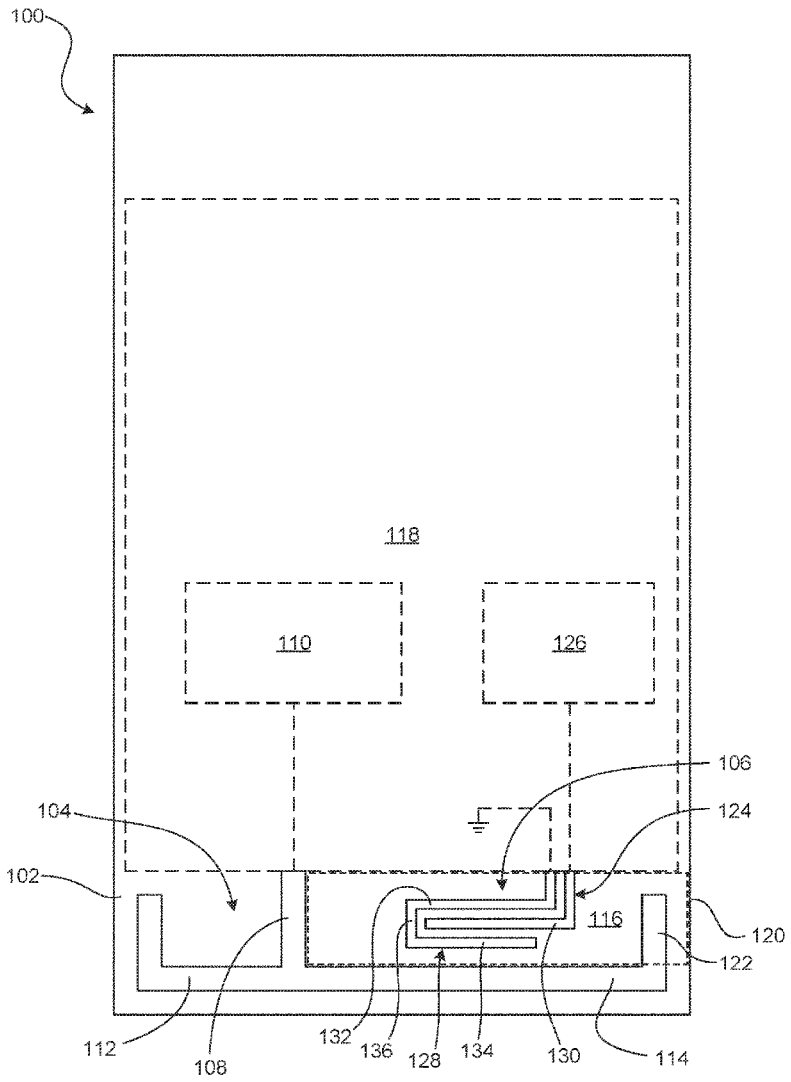
H01Q 21/28	(2006.01)
H01Q 3/34	(2006.01)
H01Q 1/24	(2006.01)

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

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

(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**

(10) **Pub. No.: US 2021/0343195 A1**

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

JUNG et al.

(54) **FOLDABLE ELECTRONIC DEVICE INCLUDING ANTENNA**

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

(72) Inventors: **Hojin JUNG**, Suwon-si (KR); **Boochul BAE**, Suwon-si (KR); **Jongoh LIM**, Suwon-si (KR)

(21) Appl. No.: **17/377,501**

(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

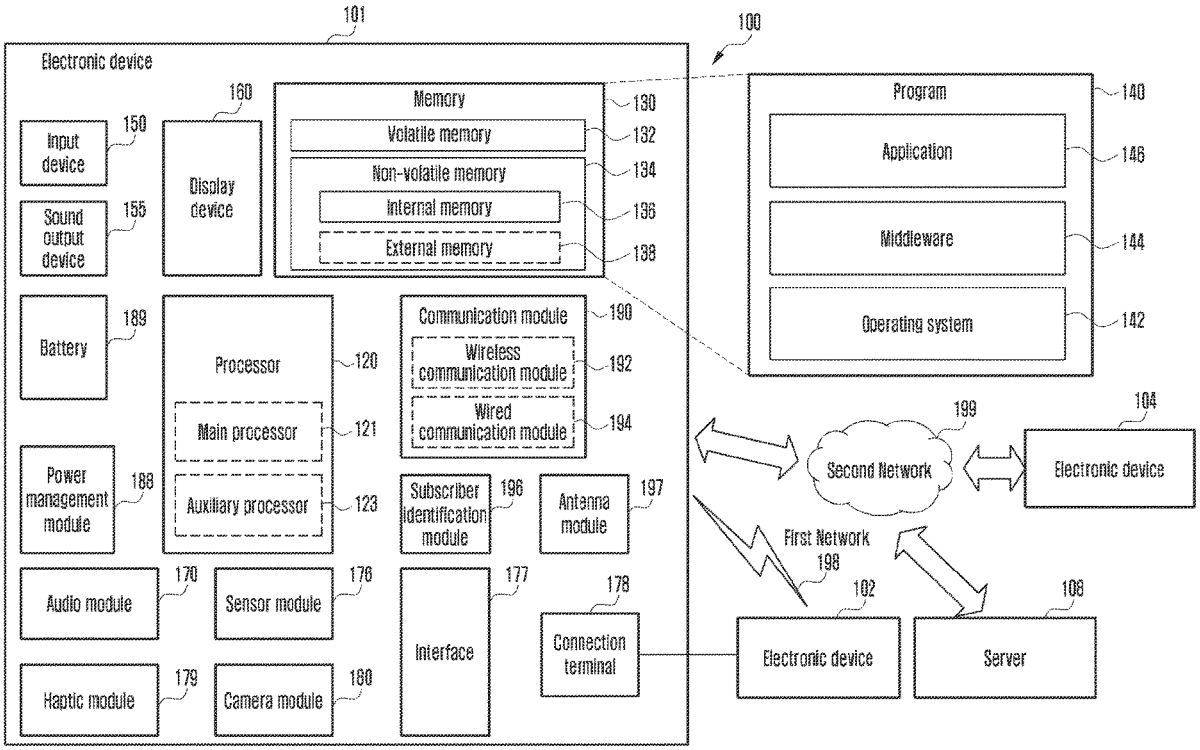
Publication Classification

(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)

(57) **ABSTRACT**

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** (10) **Pub. No.: US 2021/0344103 A1**

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

(54) **COMMUNICATION DEVICE**

(71) Applicant: **Huawei Technologies Co., Ltd.**, Shenzhen (CN)

(72) Inventors: **Alexander Khripkov**, Helsinki (FI); **Linsheng Li**, Shenzhen (CN); **Ruiyuan Tian**, Helsinki (FI)

(21) Appl. No.: **17/375,689**

(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.**

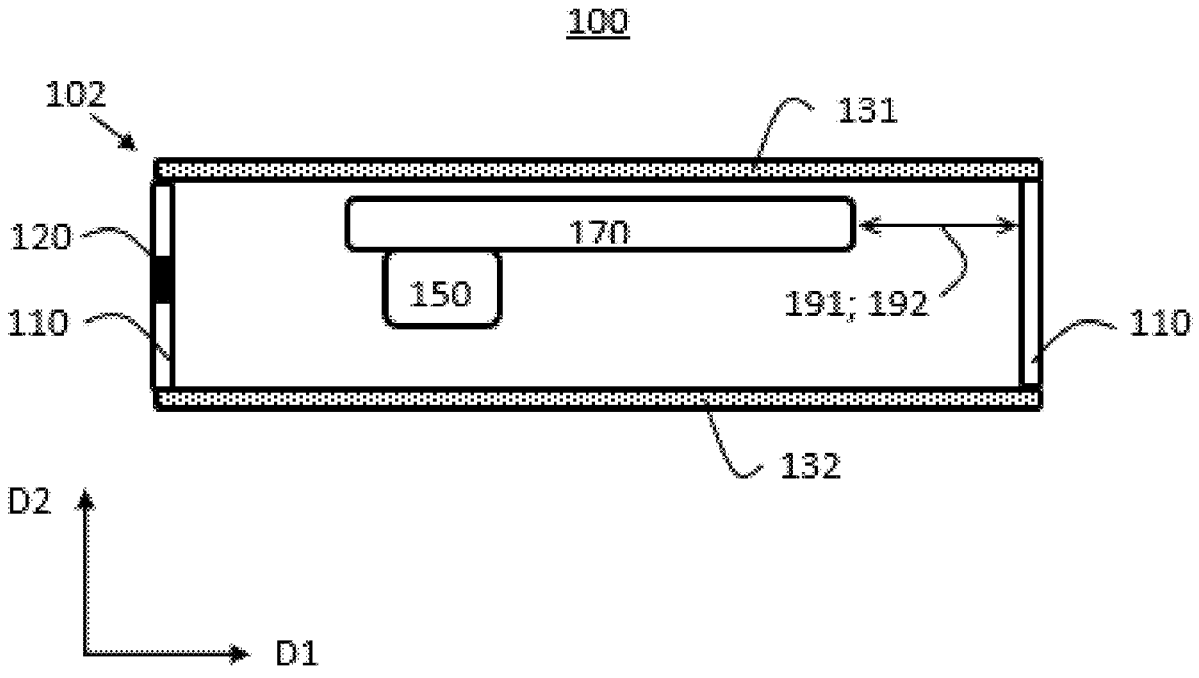
H01Q 1/24	(2006.01)
H01Q 5/307	(2006.01)
H01Q 9/04	(2006.01)
H01Q 13/10	(2006.01)
H01Q 21/24	(2006.01)
H01Q 21/28	(2006.01)

(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)

(57) **ABSTRACT**

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 (10) Pub. No.: US 2021/0344108 A1

YUEN et al. (43) Pub. Date: Nov. 4, 2021

(54) **A BROADBAND ANTENNA COMPOSED OF LINES AND ITS APPLICATION**

(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

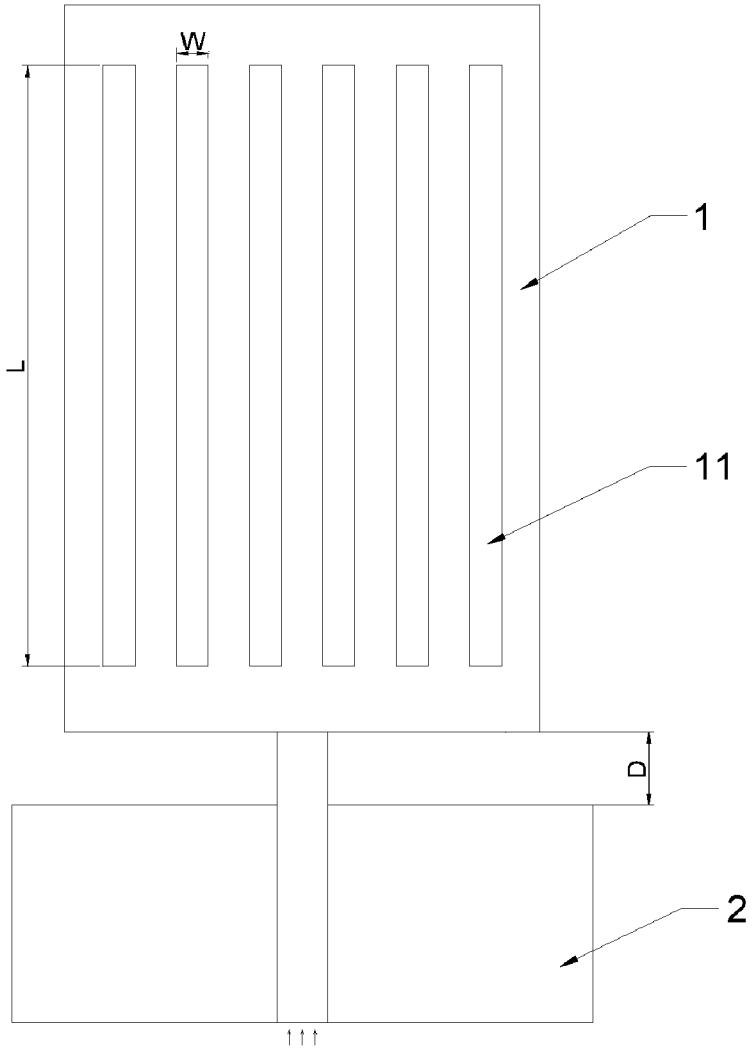
Publication Classification

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

(52) **U.S. Cl.**
CPC ***H01Q 1/36*** (2013.01)

(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** (10) **Pub. No.: US 2021/0344116 A1**

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

(54) **ANTENNA MODULES AND COMMUNICATION DEVICES**

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

(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)

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

(21) Appl. No.: **17/373,926**

(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 a continuation of application No. 16/000,795, filed on Jun. 5, 2018, now Pat. No. 10,797,394.

Publication Classification

(51) **Int. Cl.**

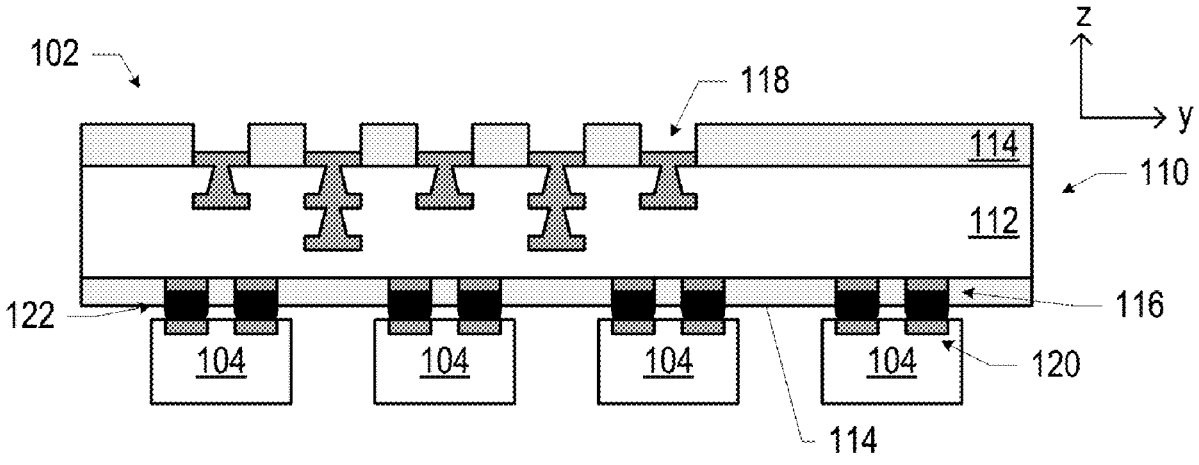
H01Q 9/04	(2006.01)
H01Q 1/22	(2006.01)
H01Q 1/08	(2006.01)

(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)

(57) **ABSTRACT**

Disclosed herein are antenna boards, antenna modules, and communication devices. For example, in some embodiments, 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.



US 20210344119A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2021/0344119 A1**

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

(54) **ANTENNA STRUCTURE**

(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)

(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)

(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.

(30) **Foreign Application Priority Data**

Mar. 3, 2020 (TW) 109106932

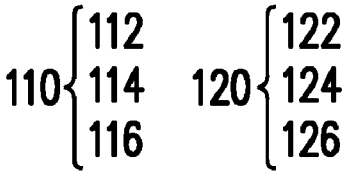
Publication Classification

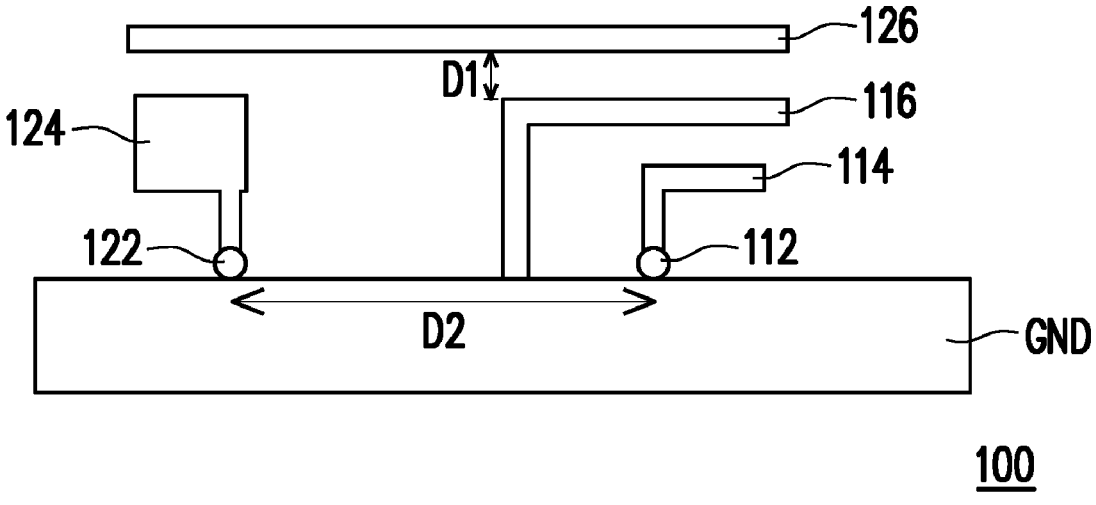
(51) **Int. Cl.**
H01Q 21/06 (2006.01)
H01Q 1/48 (2006.01)

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

(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.





US 20210344121A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2021/0344121 A1**

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

(54) **ANTENNA HAVING RADIATION STRUCTURE OF GIVEN DIRECTION AND ELECTRONIC DEVICE INCLUDING SAME**

(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)

(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.**

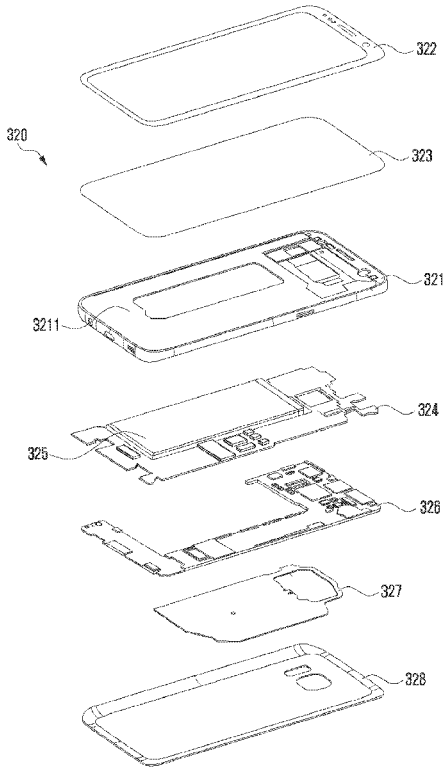
H01Q 21/06	(2006.01)
H01Q 5/30	(2006.01)
H01Q 3/36	(2006.01)
G06F 3/041	(2006.01)
H01Q 1/24	(2006.01)

(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)

(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.



US 20210351493A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2021/0351493 A1**

PUENTE BALIARDA et al. (43) **Pub. Date: Nov. 11, 2021**

(54) **MULTIPLE-BODY-CONFIGURATION MULTIMEDIA AND SMARTPHONE MULTIFUNCTION WIRELESS DEVICES**

(71) Applicant: **Fractus, S.A.**, Barcelona (ES)

(72) Inventors: **Carles PUENTE BALIARDA**, Barcelona (ES); **Josep MUMBRU**, Asnières-sur-Seine (FR); **Jordi ILARIO**, Barcelona (ES)

(21) Appl. No.: **17/246,192**

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

Related U.S. Application Data

(63) Continuation of application No. 16/832,820, filed on Mar. 27, 2020, now Pat. No. 11,031,677, which is a continuation of application No. 15/856,626, filed on Dec. 28, 2017, now Pat. No. 10,644,380, which is a continuation of application No. 14/738,090, filed on Jun. 12, 2015, now Pat. No. 9,899,727, which is a continuation of application No. 14/246,491, filed on Apr. 7, 2014, now Pat. No. 9,099,773, which is a continuation of application No. 11/614,429, filed on Dec. 21, 2006, now Pat. No. 8,738,103.

(60) Provisional application No. 60/856,410, filed on Nov. 3, 2006, provisional application No. 60/831,544, filed on Jul. 18, 2006.

(30) **Foreign Application Priority Data**

Jul. 18, 2006 (EP) 06117352.2

Publication Classification

(51) **Int. Cl.**

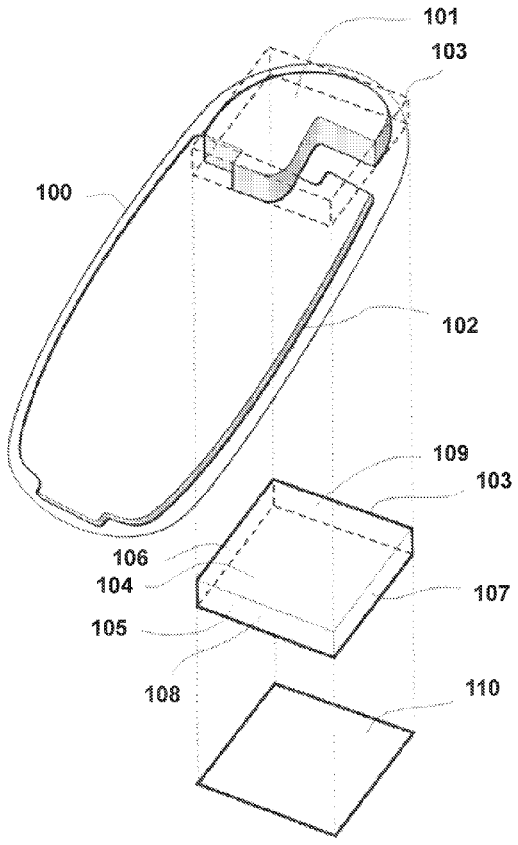
H01Q 1/24	(2006.01)
H01Q 5/371	(2006.01)
H01Q 5/40	(2006.01)
H01Q 1/36	(2006.01)
H01Q 9/04	(2006.01)

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

CPC ***H01Q 1/243*** (2013.01); ***H01Q 5/371*** (2015.01); ***H01Q 9/0421*** (2013.01); ***H01Q 1/36*** (2013.01); ***H01Q 9/0407*** (2013.01); ***H01Q 5/40*** (2015.01)

(57) **ABSTRACT**

A multifunction wireless device having at least one of multimedia functionality and smartphone functionality, the multifunction wireless device including an upper body and a lower body, the upper body and the lower body being adapted to move relative to each other in at least one of a clamshell, a slide, and a twist manner. The multifunction wireless device further includes an antenna system disposed within at least one of the upper body and the lower body and having a shape with a level of complexity of an antenna contour defined by complexity factors F_{21} having a value of at least 1.05 and not greater than 1.80 and F32 having a value of at least 1.10 and not greater than 1.90.



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**

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

(72) Inventors: **Dohyuk Ha**, Gyeonggi-do (KR); **Junsig Kum**, Gyeonggi-do (KR); **Jungyub Lee**, Gyeonggi-do (KR); **Youngju Lee**, Seoul (KR)

(21) Appl. No.: **17/385,254**

(22) Filed: **Jul. 26, 2021**

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.

(30) **Foreign Application Priority Data**

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

Publication Classification

(51) **Int. Cl.**

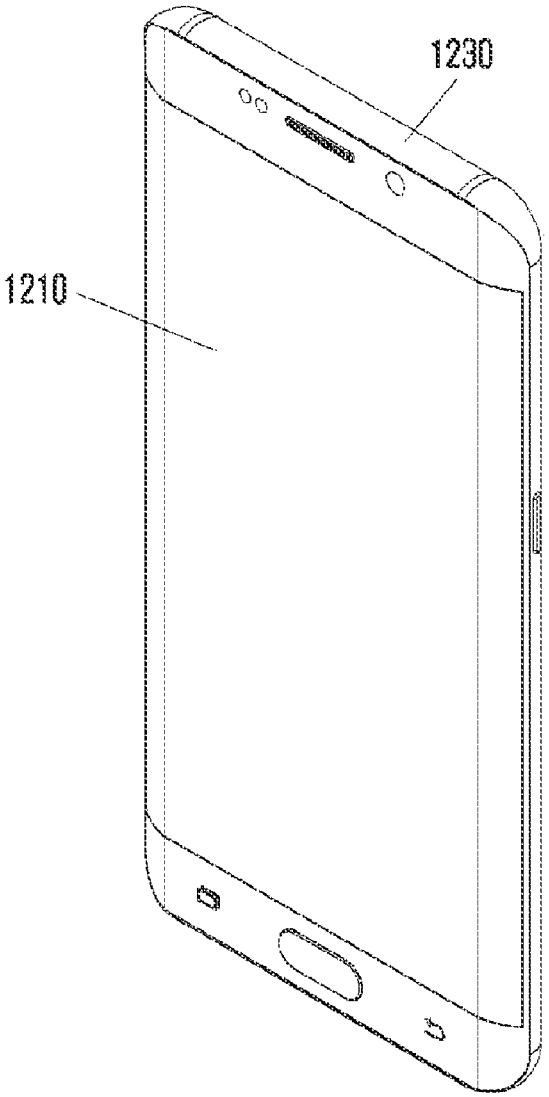
H01Q 1/42	(2006.01)
H01Q 1/22	(2006.01)
H01Q 1/52	(2006.01)

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

CPC ***H01Q 1/42*** (2013.01); ***H01Q 1/528*** (2013.01); ***H01Q 1/2283*** (2013.01)

(57) **ABSTRACT**

Disclosed is an antenna device including an antenna substrate 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** (10) **Pub. No.: US 2021/0351509 A1**

LIN et al. (43) **Pub. Date: Nov. 11, 2021**

(54) **ELECTRONIC DEVICE**

(71) Applicant: **WISTRON NEWEB CORPORATION**, HSINCHU (TW)

(72) Inventors: **HSIEH-CHIH LIN**, HSINCHU (TW); **SHIH-HSIEN TSENG**, HSINCHU (TW)

(21) Appl. No.: **17/153,045**

(22) Filed: **Jan. 20, 2021**

(30) **Foreign Application Priority Data**

May 7, 2020 (TW) 109115256

Publication Classification

(51) **Int. Cl.**

H01Q 5/314 (2006.01)

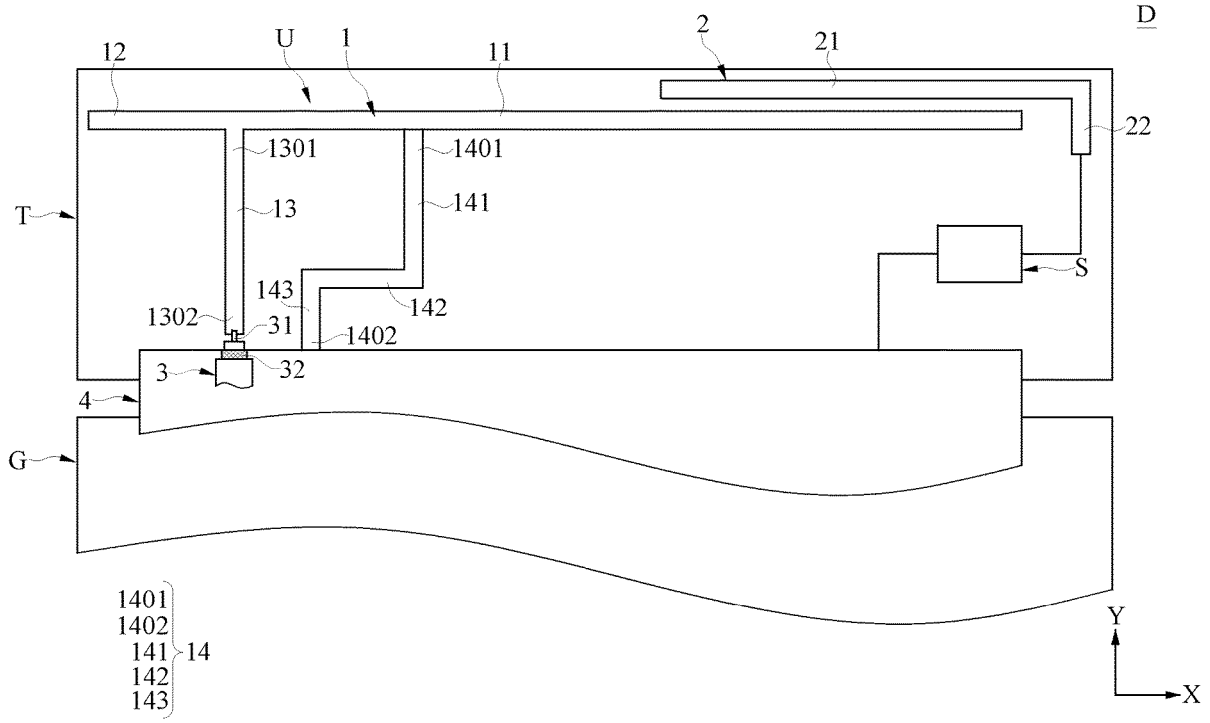
H01Q 1/38 (2006.01)

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

CPC ***H01Q 5/314*** (2015.01); ***H01Q 1/38*** (2013.01)

(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 incudes 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.



US 20210351511A1

(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.: US 2021/0351511 A1**

(43) **Pub. Date: Nov. 11, 2021**

Weisman et al.

(54) **DIFFERENTIAL ON-CHIP LOOP ANTENNA**

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

(72) Inventors: **Nir Weisman**, Hod Hasharon M (IL); **Omer Asaf**, Oranit M (IL); **Eyal Goldberger**, Moshav Beherotaim M (IL)

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

(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.**

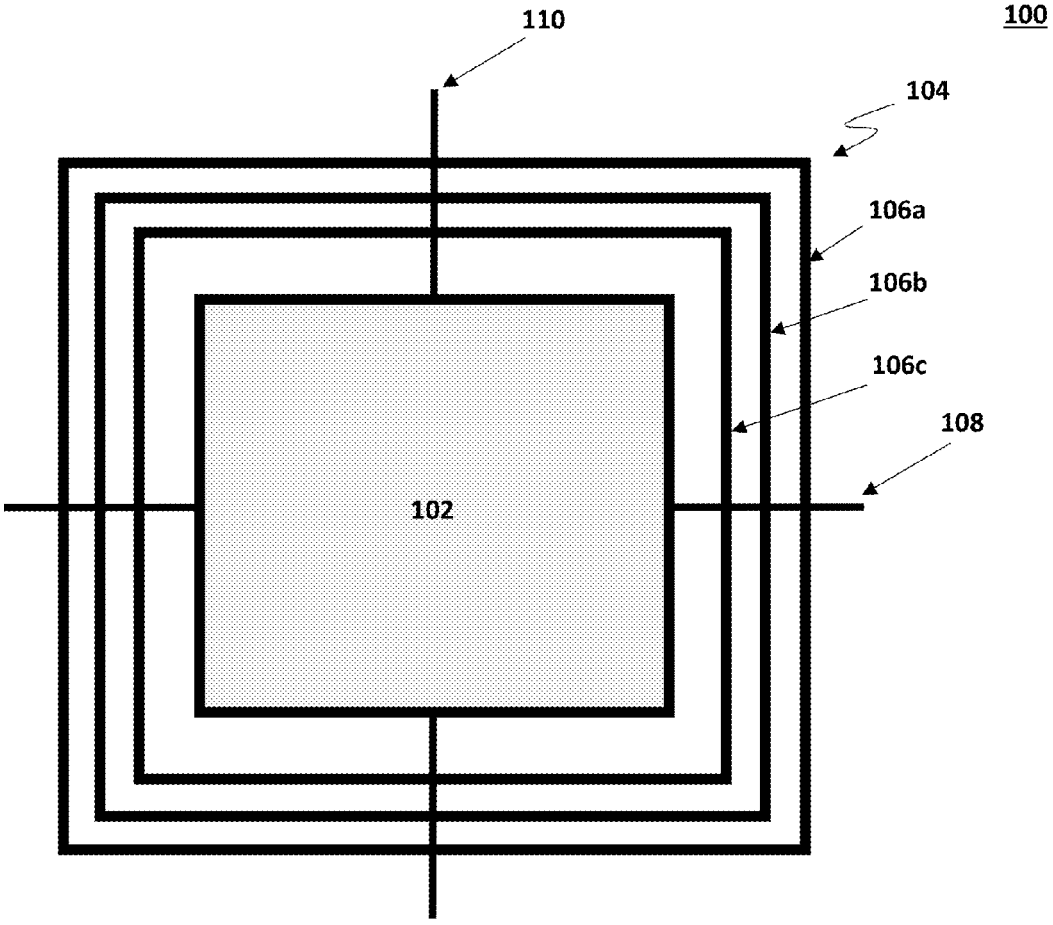
H01Q 7/00	(2006.01)
H01L 23/66	(2006.01)
H01Q 1/22	(2006.01)
H01Q 21/06	(2006.01)
H01L 23/552	(2006.01)
H01Q 5/371	(2006.01)
H01Q 25/00	(2006.01)

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

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)

(57) **ABSTRACT**

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.



US 20210351519A1

(19) **United States**

(12) **Patent Application Publication**

KORVA

(10) **Pub. No.: US 2021/0351519 A1**

(43) **Pub. Date: Nov. 11, 2021**

(54) **ANTENNA ARRANGEMENT**

(71) Applicant: **NOKIA SOLUTIONS AND NETWORKS OY**, Espoo (FI)

(72) Inventor: **Heikki Tapani KORVA**, Tupos (FI)

(73) Assignee: **NOKIA SOLUTIONS AND NETWORKS OY**, Espoo (FI)

(21) Appl. No.: **17/316,377**

(22) Filed: **May 10, 2021**

(30) **Foreign Application Priority Data**

May 11, 2020 (FI) 20205470

Publication Classification

(51) **Int. Cl.**

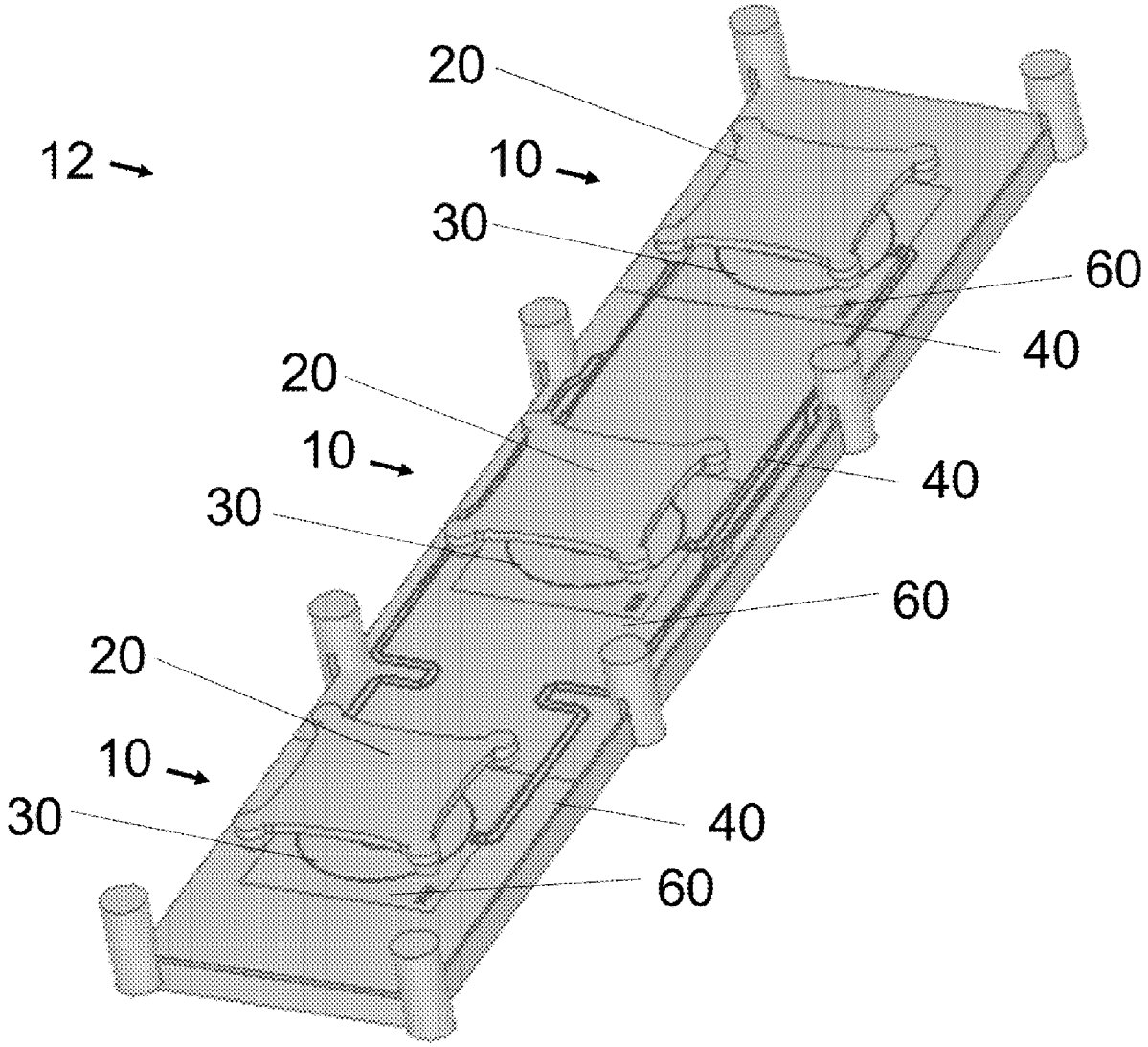
H01Q 21/06 (2006.01)
H01Q 9/04 (2006.01)
H01Q 25/00 (2006.01)

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

CPC ***H01Q 21/065*** (2013.01); ***H01Q 25/001*** (2013.01); ***H01Q 9/0407*** (2013.01)

(57) **ABSTRACT**

An antenna arrangement is provided that includes a patch radiator, a feed arrangement, for the patch radiator and a cavity for the feed arrangement. The feed arrangement includes a slot in a conductive layer located between the patch radiator and the cavity.



US 20210356550A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2021/0356550 A1**

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

(54) **ELECTRONIC DEVICE INCLUDING ANTENNA FOR MEASURING ANGLE OF ARRIVAL**

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

(72) Inventors: **Muyeol LEE**, Gyeonggi-do (KR); **Seunghoon KIM**, Gyeonggi-do (KR); **Jeongsik KIM**, Gyeonggi-do (KR); **Changwoo SON**, Gyeonggi-do (KR); **Jiwoo LEE**, Gyeonggi-do (KR)

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

(21) Appl. No.: **17/321,924**

(22) Filed: **May 17, 2021**

(30) **Foreign Application Priority Data**

May 15, 2020 (KR) 10-2020-0058323

Publication Classification

(51) **Int. Cl.**

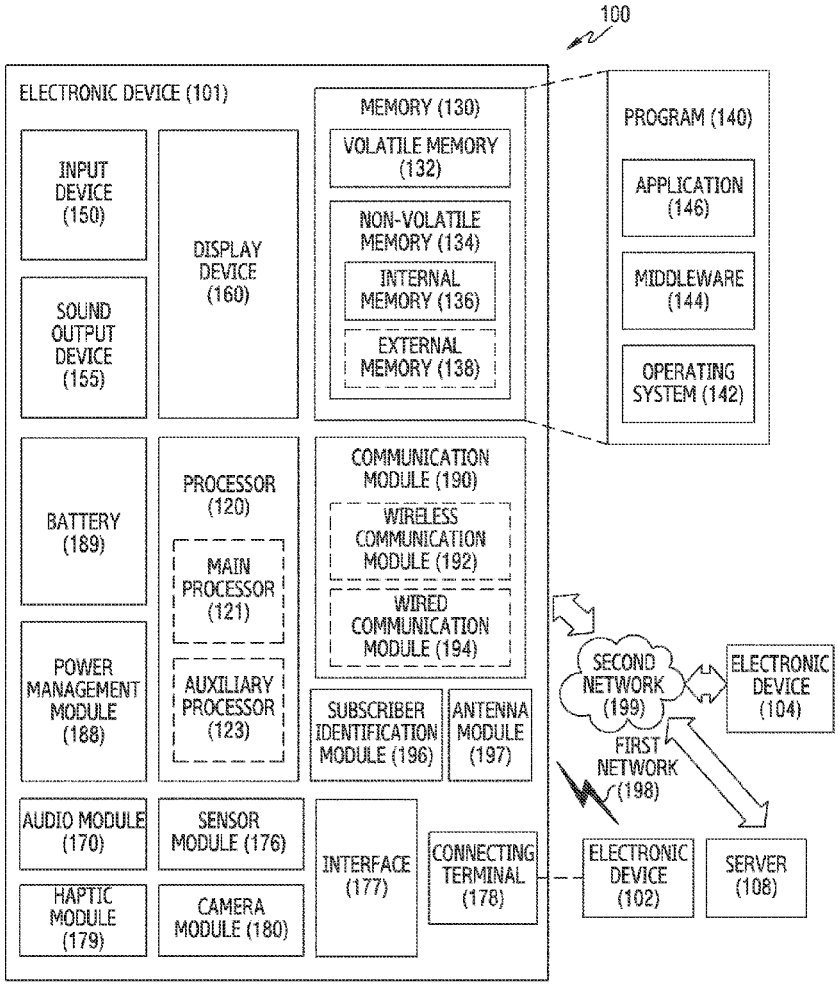
G01S 3/48	(2006.01)
H01Q 1/52	(2006.01)
G01S 3/50	(2006.01)

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

CPC ***G01S 3/48*** (2013.01); ***G01S 3/50*** (2013.01); ***H01Q 1/526*** (2013.01)

(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 circuity 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.



US 20210359393A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2021/0359393 A1**

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

(54) **ELECTRONIC DEVICE**

(71) Applicant: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

(72) Inventors: **CHO-KANG HSU**, New Taipei (TW); **MIN-HUI HO**, New Taipei (TW)

(21) Appl. No.: **17/307,159**

(22) Filed: **May 4, 2021**

(30) **Foreign Application Priority Data**

May 15, 2020 (CN) 202010414590.8

Publication Classification

(51) **Int. Cl.**

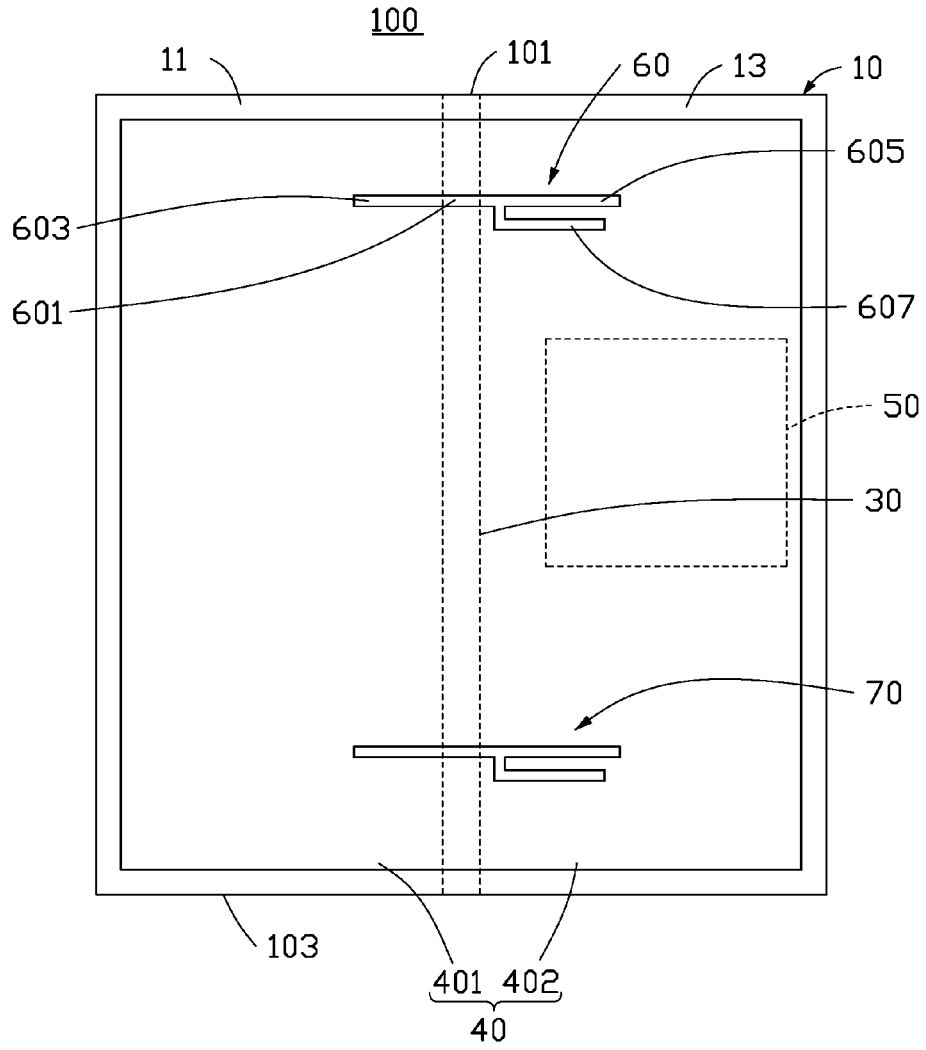
H01Q 1/24	(2006.01)
H01Q 13/10	(2006.01)
H04M 1/02	(2006.01)
H01Q 21/06	(2006.01)
H01Q 9/42	(2006.01)

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

CPC ***H01Q 1/243*** (2013.01); ***H01Q 13/10*** (2013.01); ***H04M 1/0268*** (2013.01); *H04M 2250/16* (2013.01); ***H01Q 21/064*** (2013.01); ***H01Q 9/42*** (2013.01); ***H04M 1/0216*** (2013.01)

(57) **ABSTRACT**

An antenna for a foldable electronic device which functions equally well in both folded and unfolded states includes a rotating shaft and a housing. The overall housing is made of metallic material and includes a first housing and a second housing. The first housing connects to the second housing through the rotating shaft. The housing further defines at least one group of slots to form at least one slot antenna. The at least one slot antenna crosses the rotating shaft and extends to the first housing and/or the second housing. By setting at least one slot antenna to correspond to the rotating shaft, the foldable electronic device achieves high radiation performance whether the first and second housing are folded or unfolded.



US 20210359410A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2021/0359410 A1**

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

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

(71) Applicant: **WISTRON NEWEB CORPORATION**, HSINCHU (TW)

(72) Inventors: **KUAN-HUNG LI**, HSINCHU (TW); **SHANG-CHING TSENG**, HSINCHU (TW); **YU-YU CHIANG**, HSINCHU (TW)

(21) Appl. No.: **17/149,785**

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

(30) **Foreign Application Priority Data**

May 18, 2020 (TW) 109116357

Publication Classification

(51) **Int. Cl.**

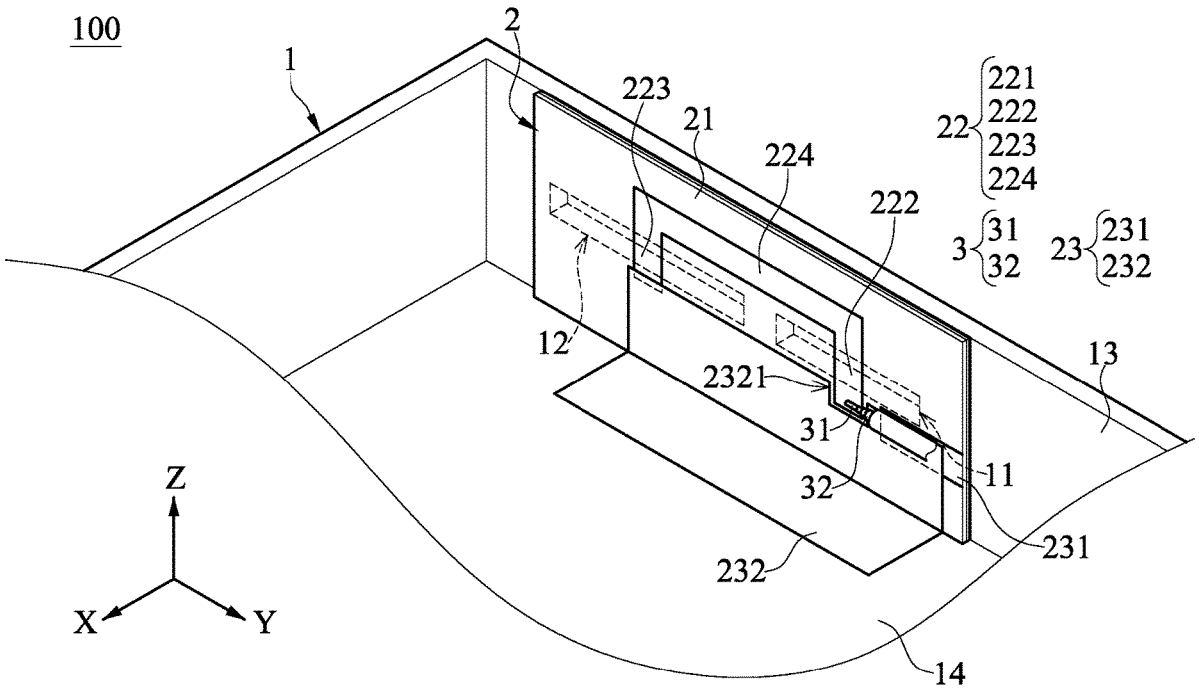
H01Q 5/10	(2006.01)
H01Q 1/38	(2006.01)
H01Q 13/10	(2006.01)
H01Q 5/35	(2006.01)

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

CPC ***H01Q 5/10*** (2015.01); ***H01Q 5/35*** (2015.01); ***H01Q 13/10*** (2013.01); ***H01Q 1/38*** (2013.01)

(57) **ABSTRACT**

An electronic device and an antenna module are provided. The electronic device includes a metal cover and the antenna module. The metal cover has a short slot and a long slot. The antenna module includes a substrate and an antenna structure. The antenna structure includes a first excitation segment, a second excitation segment, and a connection segment. Two projection regions respectively defined by orthogonally projecting the first excitation segment and the second excitation segment onto the metal cover overlap with the shot slot and the long slot, respectively. When a signal source is fed into the antenna structure, a first frequency band generated by the antenna structure and the short slot, a second frequency band generated by the antenna structure and the long slot, and a third frequency band generated by the antenna structure are different from each other in terms of corresponding frequency ranges.



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

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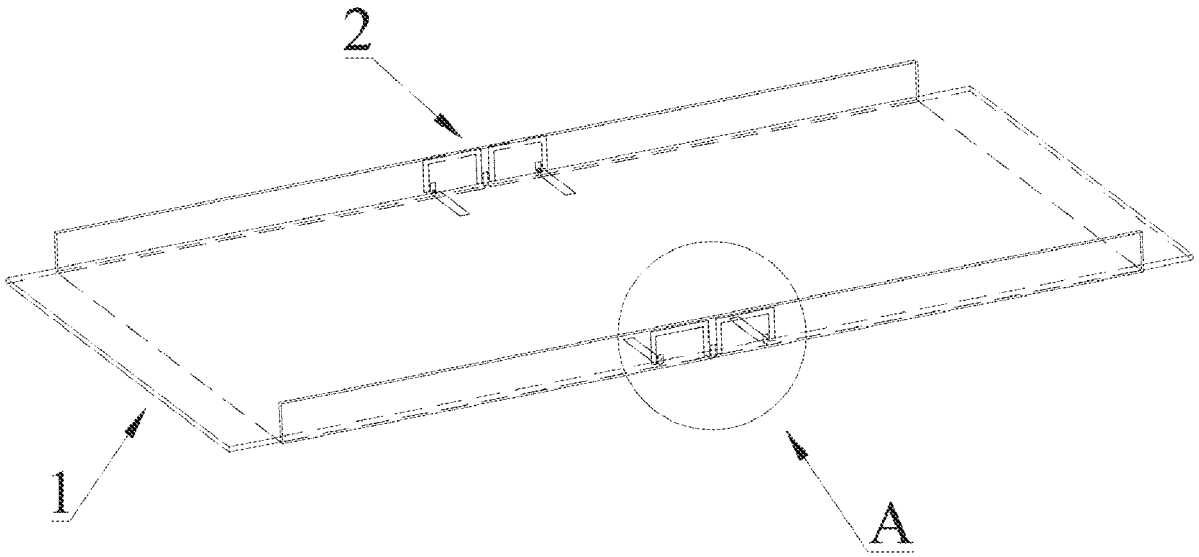
(57) **ABSTRACT**

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.



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(54) **LOW PROFILE DUAL-FREQUENCY ANTENNA DEVICE**

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(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.