US012366888B2

(12) **United States Patent**
Yao

(10) **Patent No.: US 12,366,888 B2**
(45) **Date of Patent: Jul. 22, 2025**

(54) **ELECTRONIC DEVICE**

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

(72) Inventor: **Chengwei Yao**, Dongguan (CN)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 172 days.

(21) Appl. No.: **18/098,682**

(22) Filed: **Jan. 18, 2023**

(65) **Prior Publication Data**

US 2023/0176633 A1 Jun. 8, 2023

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2021/108622, filed on Jul. 27, 2021.

(30) **Foreign Application Priority Data**

Jul. 28, 2020 (CN) 202010737350.1

(51) **Int. Cl.**

G06F 1/16	(2006.01)
G06F 1/20	(2006.01)
H01Q 1/24	(2006.01)
H04R 9/02	(2006.01)

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

CPC ***G06F 1/1635*** (2013.01); ***G06F 1/1684*** (2013.01); ***G06F 1/203*** (2013.01); ***H01Q 1/243*** (2013.01); ***H04R 9/022*** (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

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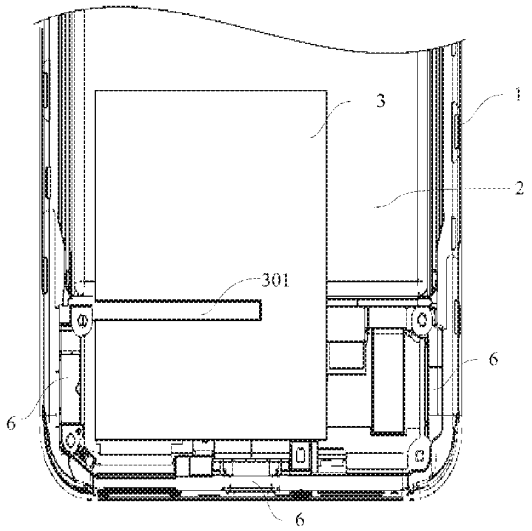
Primary Examiner — Courtney L Smith
(74) *Attorney, Agent, or Firm* — IPX PLLC

(57) **ABSTRACT**

An electronic device is provided. The electronic device includes a housing, a battery, an antenna, a speaker module, and a heat sink. The battery, the antenna, the speaker module, and the heat sink are all disposed in a cavity formed by the housing. The battery and the speaker module are disposed adjacent to each other. A gap exists between the battery and the speaker module. The antenna is disposed on a periphery of a region where the battery and the speaker module are located. The heat sink is disposed on the speaker module and the battery, and an opening is disposed on the heat sink, where the opening is opposite to the gap.

10 Claims, 3 Drawing Sheets



US012368220B2

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

(10) **Patent No.: US 12,368,220 B2**
(45) **Date of Patent: Jul. 22, 2025**

(54) **PHASE SHIFTER, ANTENNA AND ELECTRONIC DEVICE**

(71) Applicants: **Beijing BOE Technology Development Co., Ltd.**, Beijing (CN); **BOE TECHNOLOGY GROUP CO., LTD.**, Beijing (CN)

(72) Inventors: **Jia Fang**, Beijing (CN); **Feng Qu**, Beijing (CN)

(73) Assignees: **Beijing BOE Technology Development Co., Ltd.**, Beijing (CN); **BOE TECHNOLOGY GROUP CO., LTD.**, Beijing (CN)

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

(21) Appl. No.: **18/018,925**

(22) PCT Filed: **Feb. 21, 2022**

(86) PCT No.: **PCT/CN2022/077014**
§ 371 (c)(1),
(2) Date: **Jan. 31, 2023**

(87) PCT Pub. No.: **WO2023/155185**
PCT Pub. Date: **Aug. 24, 2023**

(65) **Prior Publication Data**

US 2024/0275008 A1 Aug. 15, 2024

(51) **Int. Cl.**
H01P 1/18 (2006.01)
H01Q 3/36 (2006.01)

(52) **U.S. Cl.**
CPC ***H01P 1/182*** (2013.01); ***H01Q 3/36*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 3/36; H01Q 1/22; H01Q 1/241; H01Q 3/44; H01Q 1/38; H01Q 3/34;
(Continued)

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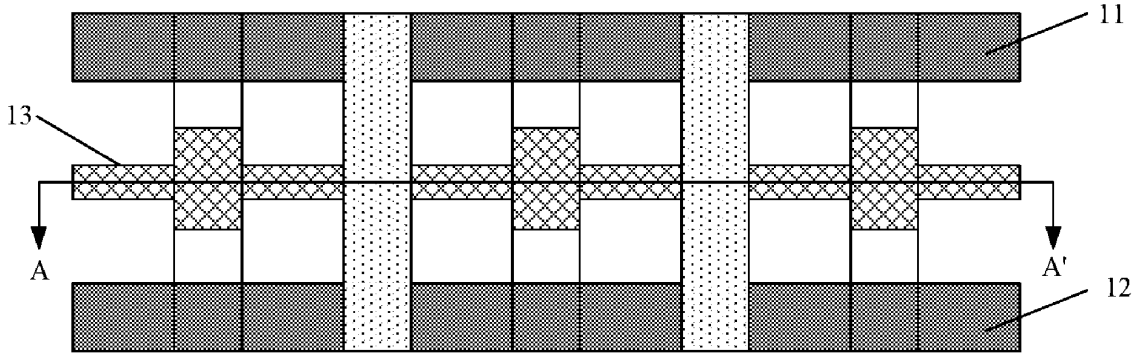
Primary Examiner — John W Poos
(74) *Attorney, Agent, or Firm* — HOUTTEMAN LAW LLC

(57) **ABSTRACT**

The present disclosure provides a phase shifter, an antenna and an electronic device. The phase shifter includes: a first dielectric substrate and a second dielectric substrate arranged opposite to each other, and an adjustable dielectric layer, a first electrode and a second electrode arranged between the first dielectric substrate and the second dielectric substrate, where the first electrode and the second electrode each extend in a first direction, and at least one of the first electrode and the second electrode includes a first sub-electrode and a second sub-electrode; the first sub-electrode is arranged on a side of the first dielectric substrate close to the adjustable dielectric layer, and the second sub-electrode is arranged on a side of the second dielectric substrate close to the adjustable dielectric layer, orthographic projections of the first sub-electrode and the second sub-electrode on the first dielectric substrate are partially overlapped with each other.

19 Claims, 7 Drawing Sheets



US012368228B2

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

(10) **Patent No.: US 12,368,228 B2**
(45) **Date of Patent: Jul. 22, 2025**

(54) **WIRELESS DONGLE**

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

(72) Inventors: **Lan-Yung Hsiao**, New Taipei (TW); **Ping-Chun Lu**, New Taipei (TW); **Shao-Kai Sun**, New Taipei (TW)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 108 days.

(21) Appl. No.: **18/540,853**

(22) Filed: **Dec. 14, 2023**

(65) **Prior Publication Data**

US 2024/0356195 A1 Oct. 24, 2024

(30) **Foreign Application Priority Data**

Apr. 18, 2023 (CN) 202320873417.3

(51) **Int. Cl.**

H01Q 1/22	(2006.01)
G06F 13/38	(2006.01)
G06F 13/42	(2006.01)
H01Q 9/04	(2006.01)

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

CPC ***H01Q 1/2275*** (2013.01); ***G06F 13/385*** (2013.01); ***G06F 13/4282*** (2013.01); ***H01Q 9/0407*** (2013.01); *G06F 2213/0042* (2013.01)

(58) **Field of Classification Search**

CPC .. H01Q 1/2275; H01Q 9/0407; G06F 13/385; G06F 13/4282

See application file for complete search history.

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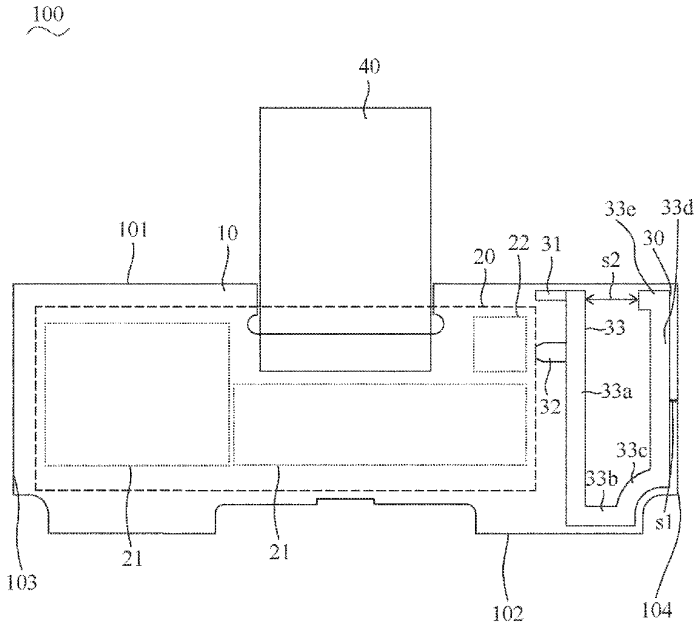
Primary Examiner — Hai V Tran

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

(57) **ABSTRACT**

A wireless dongle includes a circuit board, a universal serial bus connector, a wireless module and a printed antenna. The circuit board has a front edge, a rear edge, a left edge and a right edge. The universal serial bus connector is arranged at a middle of the front edge of the circuit board. The wireless module is arranged at a left area and a middle area of the circuit board. The universal serial bus connector is electrically connected to the wireless module. The wireless module includes a radio frequency chip. The radio frequency chip is arranged on a front right area of the wireless module. The printed antenna is arranged at a right area of the circuit board. The radio frequency chip is arranged between the universal serial bus connector and the printed antenna.

10 Claims, 4 Drawing Sheets



US012368229B2

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

(10) **Patent No.: US 12,368,229 B2**
(45) **Date of Patent: Jul. 22, 2025**

(54) **ANTENNA ARRAY WITH REPLACEABLE ANTENNA CELL**

(71) Applicant: **YTTEK TECHNOLOGY CORP.**, Hsinchu County (TW)

(72) Inventors: **Fang-Yao Kuo**, Hsinchu County (TW); **Wen-Chiang Chen**, Hsinchu (TW); **Hao-Ju Huang**, Taoyuan (TW)

(73) Assignee: **YTTEK TECHNOLOGY CORP.**, Hsinchu Country (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 200 days.

(21) Appl. No.: **18/459,449**

(22) Filed: **Sep. 1, 2023**

(65) **Prior Publication Data**

US 2024/0079760 A1 Mar. 7, 2024

Related U.S. Application Data

(60) Provisional application No. 63/374,508, filed on Sep. 2, 2022.

(51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01L 23/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 1/2283*** (2013.01); ***H01L 24/16*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 9/0457*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/2283; H01Q 1/48; H01Q 9/0457; H01Q 21/24; H01Q 1/523; H01Q 9/045;
(Continued)

(56) **References Cited**

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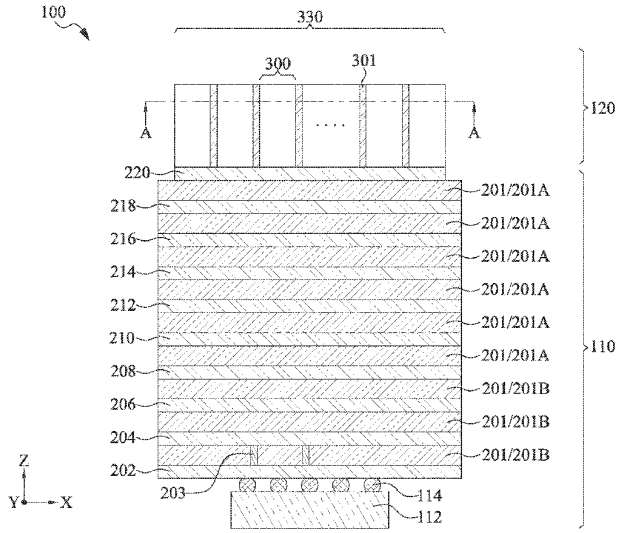
Primary Examiner — Seung H Lee
(74) *Attorney, Agent, or Firm* — WPAT, P.C.; Anthony King

(57) **ABSTRACT**

An antenna structure includes a first substrate and a second substrate. The first substrate includes: a semiconductor chip configured to transmit or receive a first radio-frequency (RF) signal; a first ground layer configured to provide ground to the semiconductor chip; and a signal layer arranged on a side of the first substrate opposite to the semiconductor chip and configured to transmit the first RF signal. The second substrate has an antenna array formed of antenna cells, each of the antenna cells including: a first antenna layer configured to radiate second RF signals based on the first RF signal; a second ground layer configured to provide ground to the first antenna layer. The antenna device further includes a plurality of connectors electrically coupling the semiconductor chip to the antenna array.

20 Claims, 30 Drawing Sheets



US012368231B2

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

(10) **Patent No.: US 12,368,231 B2**
(45) **Date of Patent: Jul. 22, 2025**

(54) **ELECTRONIC DEVICE FOR MIMO ANTENNA**

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

(72) Inventors: **Yuanpeng Li**, Shenzhen (CN); **Hanyang Wang**, Reading (GB); **Dawei Zhou**, Shenzhen (CN)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 176 days.

(21) Appl. No.: **18/259,909**

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

(86) PCT No.: **PCT/CN2021/140289**
§ 371 (c)(1),
(2) Date: **Jun. 29, 2023**

(87) PCT Pub. No.: **WO2022/143320**
PCT Pub. Date: **Jul. 7, 2022**

(65) **Prior Publication Data**

US 2024/0088541 A1 Mar. 14, 2024

(30) **Foreign Application Priority Data**

Dec. 30, 2020 (CN) 202011611722.2
Mar. 19, 2021 (CN) 202110296431.7

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/321 (2015.01)
H01Q 5/335 (2015.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 5/321*** (2015.01); ***H01Q 5/335*** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 5/321; H01Q 5/335
See application file for complete search history.

(56) **References Cited**

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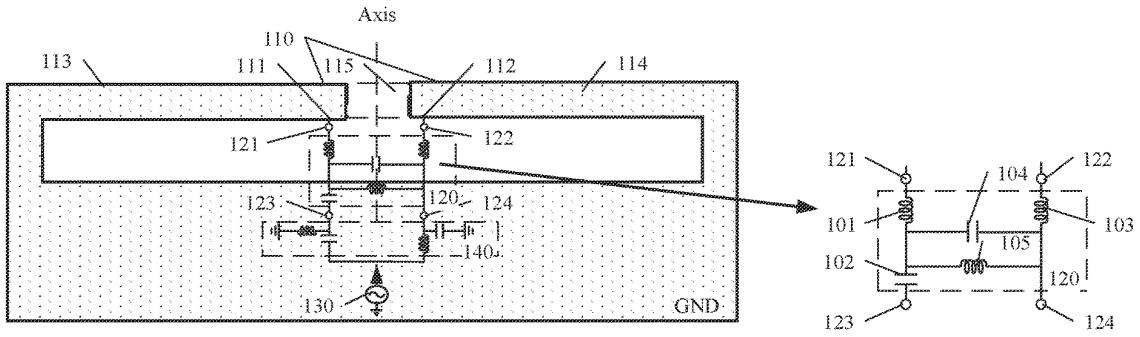
Primary Examiner — Monica C King
(74) *Attorney, Agent, or Firm* — Conley Rose, P.C.

(57) **ABSTRACT**

An electronic device includes an antenna structure having an antenna radiator, a first circuit, a first feeding element, and a second feeding element. The first circuit comprises feeding input ports configured to input electrical signals of the first feeding element and the second feeding element, and feeding output ports configured to feed processed electrical signals to the antenna radiator. The electrical signal of the first feeding element has a same phase on the feeding input ports. The electrical signal of the second feeding element has opposite phases on the feeding input ports.

20 Claims, 28 Drawing Sheets



US012368232B2

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

(10) **Patent No.: US 12,368,232 B2**
(45) **Date of Patent: Jul. 22, 2025**

(54) **SLIDABLE ELECTRONIC DEVICE INCLUDING FLEXIBLE DISPLAY AND ANTENNA**

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

(72) Inventors: **Seongyong An**, Suwon-si (KR); **Gyusub Kim**, Suwon-si (KR); **Kyungmoon Seol**, Suwon-si (KR); **Kyihyun Jang**, Suwon-si (KR); **Bumjin Cho**, Suwon-si (KR)

(73) Assignee: **SAMSUNG ELECTRONICS CO., LTD.**, Suwon-si (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 211 days.

(21) Appl. No.: **18/346,557**

(22) Filed: **Jul. 3, 2023**

(65) **Prior Publication Data**

US 2023/0352814 A1 Nov. 2, 2023

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2023/004743, filed on Apr. 7, 2023.

(30) **Foreign Application Priority Data**

Apr. 8, 2022 (KR) 10-2022-0044190
Jun. 8, 2022 (KR) 10-2022-0069471

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
G06F 1/16 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***G06F 1/1624*** (2013.01); ***G06F 1/1652*** (2013.01);
(Continued)

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

(56) **References Cited**

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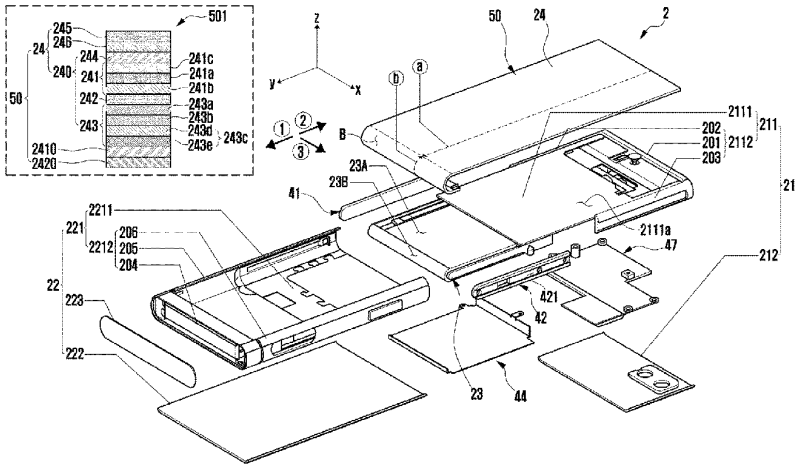
Primary Examiner — Wilson Lee
(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye, P.C.

(57) **ABSTRACT**

According to an example embodiment, a slidable electronic device may include a first housing, a second housing configured to be slidable with respect to the first housing, a flexible display module comprising a flexible display including a first area configured to be seen in a state in which the second housing is slid-in with respect to the first housing, and a second area configured to be at least partially drawn out to the outside to be seen in a state in which the second housing is slid-out with respect to the first housing, and a wireless communication circuit, wherein the second housing includes a first conductive pattern electrically connected to the wireless communication circuit and a second conductive pattern physically separated from the first conductive pattern and configured to operate as an antenna ground.

20 Claims, 31 Drawing Sheets



US012368241B2

(12) **United States Patent**
Göttl

(10) **Patent No.: US 12,368,241 B2**
(45) **Date of Patent: Jul. 22, 2025**

(54) **MOBILE COMMUNICATION ANTENNA FOR TRANSMITTING AND/OR RECEIVING MOBILE COMMUNICATION SIGNALS**

(71) Applicant: **Telefonaktiebolaget LM Ericsson (publ)**, Stockholm (SE)

(72) Inventor: **Maximilian Göttl**, Frasdorf (DE)

(73) Assignee: **TELEFONAKTIEBOLAGET LM ERICSSON (PUBL)**, Stockholm (SE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 140 days.

(21) Appl. No.: **18/027,740**

(22) PCT Filed: **Sep. 23, 2020**

(86) PCT No.: **PCT/EP2020/076591**
§ 371 (c)(1),
(2) Date: **Mar. 22, 2023**

(87) PCT Pub. No.: **WO2022/063399**
PCT Pub. Date: **Mar. 31, 2022**

(65) **Prior Publication Data**

US 2023/0378648 A1 Nov. 23, 2023

(51) **Int. Cl.**
H01Q 5/42 (2015.01)
H01Q 5/35 (2015.01)
H01Q 21/24 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 5/42*** (2015.01); ***H01Q 5/35*** (2015.01); ***H01Q 21/24*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/42; H01Q 5/35; H01Q 21/24; H01Q 1/246
See application file for complete search history.

(56) **References Cited**

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WO 2004/051796 A1 6/2004

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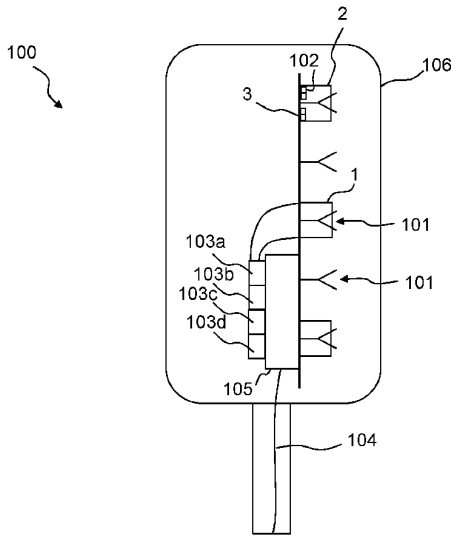
Primary Examiner — David E Lotter
(74) *Attorney, Agent, or Firm* — Rothwell, Figg, Ernst & Manbeck, P.C.

(57) **ABSTRACT**

A mobile communication antenna (**1**) comprises a reflector arrangement (**3**) and a first radiator array (**5***a*) with dual-polarized radiators (**2**) and a second radiator array (**5***b*) with dual-polarized radiators (**2**). Each radiator (**2**) comprises four feed sections (**7***a*, **7***b*, **7***c*, **7***d*). At least one radiator (**2**) is configured to transmit and receive four different mobile communication signals (S**1**, S**2**, S**3**, S**4**) via the first, second, third and fourth feed sections (**7***a*, **7***b*, **7***c*, **7***d*), thereby forming a multi signal radiator (**2***b*). The remaining radiators (**2**) of the first and second radiator array (**5***a*) are configured to transmit and receive two different mobile communication signals (S**1**, S**2**, S**3**, S**4**) of these four different mobile communication signals (S**1**, S**2**, S**3**, S**4**) via the first, second, third and fourth feed sections (**7***a*, **7***b*, **7***c*, **7***d*), thereby forming a dual signal radiator (**2***a*).

16 Claims, 12 Drawing Sheets



US012368245B2

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

(10) **Patent No.: US 12,368,245 B2**
(45) **Date of Patent: Jul. 22, 2025**

(54) **ANTENNA ASSEMBLY AND WIRELESS DEVICE**

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

(72) Inventors: **Zui Tao**, Nanjing (CN); **Xiao Zhou**, Shanghai (CN); **Jie Zhao**, Nanjing (CN)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 289 days.

(21) Appl. No.: **17/723,972**

(22) Filed: **Apr. 19, 2022**

(65) **Prior Publication Data**

US 2022/0247088 A1 Aug. 4, 2022

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2020/088783, filed on May 6, 2020.

(30) **Foreign Application Priority Data**

Oct. 22, 2019 (CN) 201911005244.8

(51) **Int. Cl.**

H01Q 21/00	(2006.01)
H01Q 1/22	(2006.01)
H01Q 9/16	(2006.01)
H01Q 21/20	(2006.01)

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

CPC ***H01Q 21/0075*** (2013.01); ***H01Q 1/2291*** (2013.01); ***H01Q 9/16*** (2013.01); ***H01Q 21/205*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 9/065; H01Q 9/16; H01Q 21/26; H01Q 21/205; H01Q 3/24; H01Q 9/285; H01P 3/08; H01P 3/081–088

See application file for complete search history.

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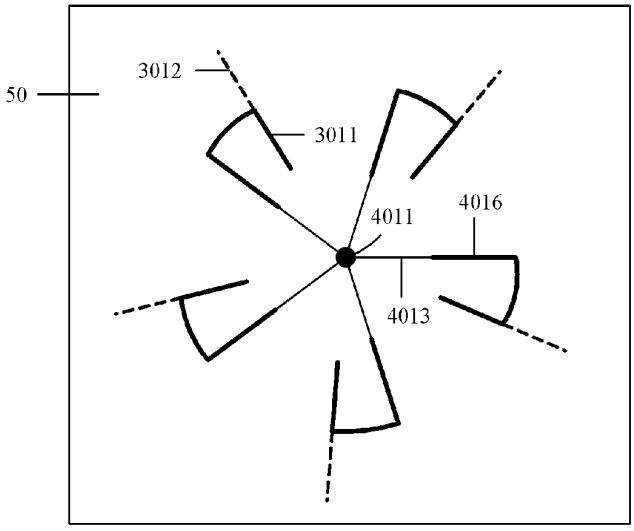
Primary Examiner — Dameon E Levi
Assistant Examiner — Aladdin Abdulbaki
(74) *Attorney, Agent, or Firm* — Conley Rose, P.C.

(57) **ABSTRACT**

An antenna assembly includes N elements, a feeding network, and a printed circuit board (PCB). N is an integer greater than or equal to 3. The N elements and the feeding network are located on the PCB. The N elements are all connected to the feeding network, each element has a radial part, the radial part of each element points to an antenna phase center, and a length of the radial part of each element is greater than a sum of lengths of other non-radial parts.

20 Claims, 6 Drawing Sheets



US012368470B2

(12) **United States Patent**
Van Wiemeersch et al.

(10) **Patent No.: US 12,368,470 B2**
(45) **Date of Patent: Jul. 22, 2025**

(54) **PLACEMENT OF MOBILE WIRELESS DEVICE ON A DISPLAY PANEL WITH A HIDDEN ANTENNA**

(71) Applicant: **FORD GLOBAL TECHNOLOGIES, LLC**, Dearborn, MI (US)

(72) Inventors: **John R. Van Wiemeersch**, Novi, MI (US); **Jayanthi Rao**, West Bloomfield, MI (US); **Mark W. Larry**, Macomb, MI (US); **Eugene Karpinsky**, Farmington Hills, MI (US)

(73) Assignee: **FORD GLOBAL TECHNOLOGIES, LLC**, Dearborn, MI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 358 days.

(21) Appl. No.: **18/135,310**

(22) Filed: **Apr. 17, 2023**

(65) **Prior Publication Data**

US 2024/0348287 A1 Oct. 17, 2024

(51) **Int. Cl.**

H04B 5/00	(2024.01)
H01Q 1/32	(2006.01)
H04B 5/72	(2024.01)
H04M 1/725	(2021.01)
H04W 4/80	(2018.01)
H04W 76/14	(2018.01)

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

CPC ***H04B 5/72*** (2024.01); ***H01Q 1/3233*** (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

(56) **References Cited**

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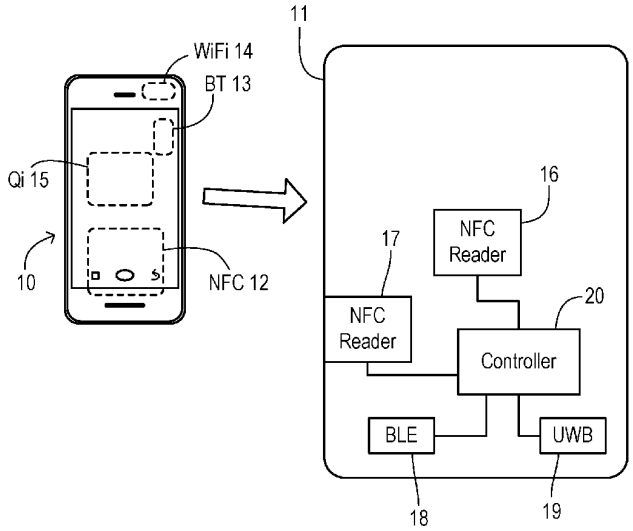
Primary Examiner — Tuan A Tran

(74) *Attorney, Agent, or Firm* — Frank L. Lollo; MacMillan, Sobanski & Todd, LLC

(57) **ABSTRACT**

A near-field communication (NFC) reader is integrated with a display panel in a passenger cabin of a vehicle by constructing a hidden antenna of the reader into a portion of the display panel. The display comprises a touchscreen display providing a display surface coincident with a touch-sensitive input detector. A trigger monitor is configured to detect a user activity by a user which is indicative of a potential for the user to attempt pairing of a mobile NFC device with the hidden antenna. A positioning messenger is configured to generate a depiction on the display surface indicating a region to be covered on the display surface by the mobile NFC device to align a mobile antenna on the mobile NFC device with the hidden antenna. The NFC device may be a smartphone, a key fob, or an NFC transponder card.

20 Claims, 5 Drawing Sheets



US012368795B2

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

(10) **Patent No.: US 12,368,795 B2**
(45) **Date of Patent: Jul. 22, 2025**

(54) **ELECTRONIC DEVICE**

(71) Applicant: **Honor Device Co., Ltd.**, Shenzhen (CN)

(72) Inventors: **Qiao Sun**, Shenzhen (CN); **Kun Li**, Shenzhen (CN); **Silei Huyan**, Shenzhen (CN); **Mao Ye**, Shenzhen (CN)

(73) Assignee: **HONOR DEVICE CO., LTD.**, Shenzhen (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 406 days.

(21) Appl. No.: **18/001,753**

(22) PCT Filed: **Aug. 25, 2021**

(86) PCT No.: **PCT/CN2021/114443**
§ 371 (c)(1),
(2) Date: **Dec. 14, 2022**

(87) PCT Pub. No.: **WO2022/127175**
PCT Pub. Date: **Jun. 23, 2022**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Dec. 15, 2020 (CN) 202023019475.5

(51) **Int. Cl.**
H05K 7/20 (2006.01)
H01Q 1/02 (2006.01)
H04M 1/02 (2006.01)

(52) **U.S. Cl.**
CPC ***H05K 7/2039*** (2013.01); ***H01Q 1/02*** (2013.01); ***H04M 1/0277*** (2013.01)

(58) **Field of Classification Search**
CPC H05K 7/2039; H01Q 1/02; H04M 1/0277
See application file for complete search history.

(56) **References Cited**

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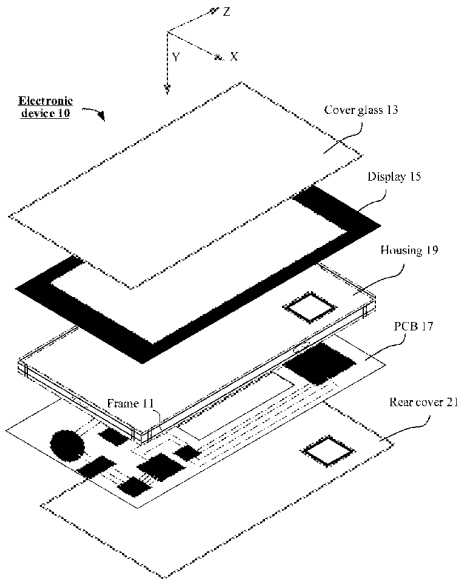
Primary Examiner — Curtis B Odom
(74) *Attorney, Agent, or Firm* — Conley Rose, P.C.

(57) **ABSTRACT**

Embodiments of this application provide an electronic device, in which a heat sink in the electronic device is multiplexed as a heat dissipation component and a radiator of an antenna. The heat sink provided by the embodiments of this application can be used as a heat dissipation component to distribute heat evenly, such as to cool down an overheated electronic element. In addition, the heat sink can be used as a radiator of an antenna to form an antenna unit with a feed unit and generate radiation to the outside. The heat sink in a first region can be used as a main radiator of the antenna unit to meet the demand for the number of antennas in a 5G wireless communication system, and can also be applied to other communication systems.

20 Claims, 12 Drawing Sheets



US012369279B2

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

(10) **Patent No.: US 12,369,279 B2**
(45) **Date of Patent: Jul. 22, 2025**

(54) **NON-PLANAR ANTENNAS FOR PORTABLE STORAGE DEVICES**

(71) Applicant: **WESTERN DIGITAL TECHNOLOGIES, INC.**, San Jose, CA (US)

(72) Inventors: **Aadesh Gupta**, Bengaluru (IN); **Sudhan Immanuel G**, Bengaluru (IN)

(73) Assignee: **Western Digital Technologies, Inc.**, San Jose, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 171 days.

(21) Appl. No.: **17/957,330**

(22) Filed: **Sep. 30, 2022**

(65) **Prior Publication Data**

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(51) **Int. Cl.**

H05K 7/20	(2006.01)
G06F 1/20	(2006.01)
H01Q 9/04	(2006.01)
H05K 1/02	(2006.01)
H05K 3/46	(2006.01)

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

CPC ***H05K 7/2039*** (2013.01); ***G06F 1/206*** (2013.01); ***H01Q 9/0407*** (2013.01); ***H05K 1/0243*** (2013.01); ***H05K 3/46*** (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

(56) **References Cited**

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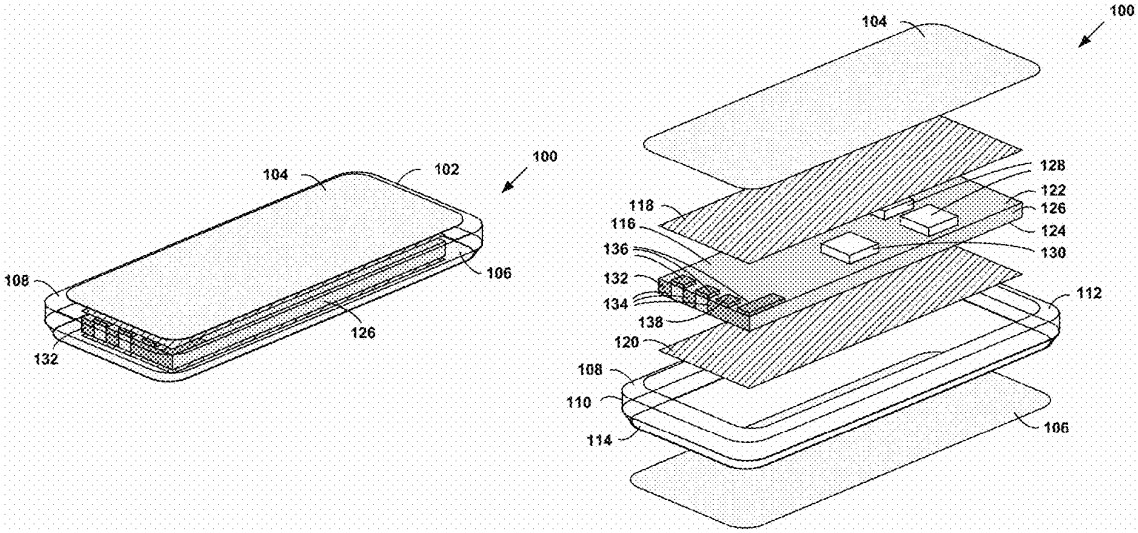
Primary Examiner — Mukundbhai G Patel

(74) *Attorney, Agent, or Firm* — PEARL COHEN ZEDEK LATZER BARATZ LLP

(57) **ABSTRACT**

A portable storage device is provided that includes a first heat sink and a second heat sink, and a printed circuit board disposed between the first heat sink and the second heat sink. The printed circuit board includes a top side, a bottom side, and a peripheral edge disposed between the top side and the bottom side, and a side-plated antenna disposed on the peripheral edge of the printed circuit board. The side-plated antenna is configured to transmit and receive radio frequency signals.

17 Claims, 25 Drawing Sheets



US012373008B2

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

(10) **Patent No.: US 12,373,008 B2**
(45) **Date of Patent: Jul. 29, 2025**

(54) **ELECTRONIC DEVICE**

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

(72) Inventors: **Jangsun Yoo**, Suwon-si (KR); **Kwanghyun Kim**, Suwon-si (KR); **Myeonggil Lee**, Suwon-si (KR); **Jihye Moon**, Suwon-si (KR); **Kyueun Park**, Suwon-si (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 210 days.

(21) Appl. No.: **18/188,057**

(22) Filed: **Mar. 22, 2023**

(65) **Prior Publication Data**

US 2023/0221775 A1 Jul. 13, 2023

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2021/012992, filed on Sep. 24, 2021.

(30) **Foreign Application Priority Data**

Sep. 24, 2020 (KR) 10-2020-0124270

(51) **Int. Cl.**
G06F 1/16 (2006.01)
H01Q 1/22 (2006.01)
H01Q 1/36 (2006.01)

(52) **U.S. Cl.**
CPC ***G06F 1/1688*** (2013.01); ***G06F 1/1656*** (2013.01); ***G06F 1/1698*** (2013.01); ***H01Q 1/2266*** (2013.01); ***H01Q 1/36*** (2013.01)

(58) **Field of Classification Search**
CPC G06F 1/1688; G06F 1/1698; H01Q 1/2266
See application file for complete search history.

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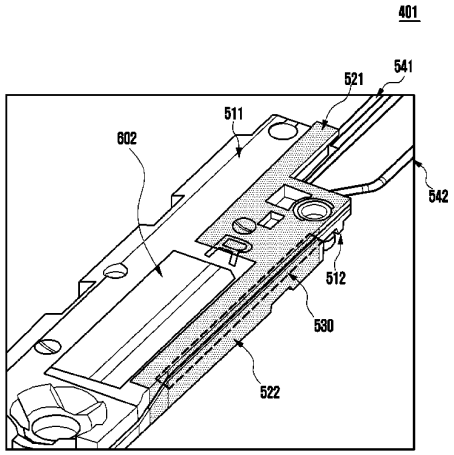
Primary Examiner — Adrian S Wilson
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

An electronic device including a housing is provided. The electronic device includes a display module, a communication module, a processor, and a speaker, wherein the speaker includes a speaker enclosure in which a first case and a second case are combined, and the speaker enclosure is arranged in the inner space of the housing and spaced apart from the housing at a predetermined interval, a first antenna pattern is arranged on the surface of the first case, a second antenna pattern is arranged on the surface of the second case, the first antenna pattern and the second antenna pattern are electrically coupled to each other, and the first antenna pattern and the second antenna pattern may be arranged to prevent overlapping with a speaker component arranged inside the speaker enclosure.

16 Claims, 23 Drawing Sheets



US012374775B2

(12) **United States Patent**
Yousefbeiki

(10) **Patent No.: US 12,374,775 B2**
(45) **Date of Patent: Jul. 29, 2025**

(54) **INSULATING GLAZING UNIT WITH ANTENNA UNIT**

(71) Applicants: **AGC GLASS EUROPE**, Louvain-la-neuve (BE); **AGC INC.**, Chiyoda-ku (JP); **AGC FLAT GLASS NORTH AMERICA, INC.**, Alpharetta, GA (US); **AGC VIDROS DO BRASIL LTDA**, Sao Paulo (BR)

(72) Inventor: **Mohsen Yousefbeiki**, Gosselies (BE)

(73) Assignees: **AGC GLASS EUROPE**, Louvain-la-Neuve (BE); **AGC INC.**, Chiyoda-ku (JP); **AGC FLAT GLASS NORTH AMERICA, INC.**, Alpharetta, GA (US); **AGC VIDROS DO BRASIL LTDA**, Sao Paulo (BR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 854 days.

(21) Appl. No.: **17/425,903**

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

(86) PCT No.: **PCT/EP2020/052384**
§ 371 (c)(1),
(2) Date: **Jul. 26, 2021**

(87) PCT Pub. No.: **WO2020/157252**
PCT Pub. Date: **Aug. 6, 2020**

(65) **Prior Publication Data**

US 2022/0166126 A1 May 26, 2022

(30) **Foreign Application Priority Data**

Jan. 31, 2019 (EP) 19154766

(51) **Int. Cl.**
H01Q 1/12 (2006.01)
E06B 3/663 (2006.01)
H01Q 1/44 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/1271*** (2013.01); ***E06B 3/66309*** (2013.01); ***H01Q 1/44*** (2013.01); *E06B 2003/6638* (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/1271; H01Q 1/44; H01Q 1/002; H01Q 1/007; H01Q 1/02; E06B 3/66309; E06B 2003/6638
See application file for complete search history.

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Primary Examiner — Dameon E Levi
Assistant Examiner — Bamidele A Immanuel
(74) *Attorney, Agent, or Firm* — Oblon, McClelland, Maier & Neustadt, L.L.P.

(57) **ABSTRACT**

An insulating glazing unit extends along a plane, P, defined by a longitudinal axis, X, and a vertical axis, Z; having a width, W, measured along the longitudinal axis, X, and a length, L, measured along the vertical axis, Z, and includes

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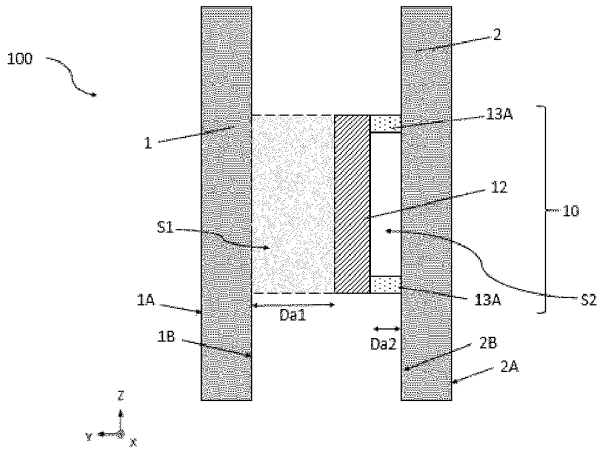

US012374776B2

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

(10) **Patent No.: US 12,374,776 B2**
(45) **Date of Patent: Jul. 29, 2025**

(54) **ENCAPSULATED WIRELESS ANTENNA FOR REDUCING THE IMPACT OF RADIO FREQUENCY INTERFERENCE**

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

(72) Inventors: **Bala Subramanya**, Bangalore (IN); **Prakash Kurma Raju**, Bangalore (IN); **Jayprakash Thakur**, Bangalore (IN); **Zaman Zaid Mulla**, Mumbai (IN); **Praveen Kumar**, Bangalore (IN); **Yagnesh Vinodrai Waghela**, Bangalore (IN); **Maruti Tamrakar**, Chhattisgarh (IN); **Prasanna Pichumani**, Bangalore (IN); **Harry Skinner**, Beaverton, OR (US)

(73) Assignee: **INTEL CORPORATION**, Santa Clara, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 189 days.

(21) Appl. No.: **18/361,952**

(22) Filed: **Jul. 31, 2023**

(65) **Prior Publication Data**

US 2025/0046983 A1 Feb. 6, 2025

(51) **Int. Cl.**

H01Q 1/22	(2006.01)
H01Q 1/40	(2006.01)
H01Q 1/48	(2006.01)
H01Q 1/52	(2006.01)

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

CPC ***H01Q 1/2266*** (2013.01); ***H01Q 1/40*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 1/52*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/2266; H01Q 1/40; H01Q 1/48; H01Q 1/52; H01Q 1/243

See application file for complete search history.

(56) **References Cited**

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2023/0187812	A1 *	6/2023	Lee	H01L 23/66 343/700 MS

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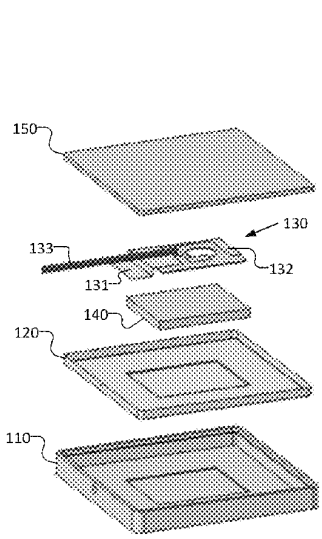
Primary Examiner — Seung H Lee
(74) *Attorney, Agent, or Firm* — VIERING, JENTSCHURA & PARTNER mbB

(57) **ABSTRACT**

Disclosed herein is an encapsulated antenna for reducing the impact of radio frequency interference (RFI) that may couple to the antenna at frequencies within the Wi-FI 5/6e bandwidths. The encapsulated antenna device may include an insulating housing and a metal layer arranged within a cavity of the housing. The encapsulated antenna device also includes an antenna device comprising a ground terminal and an antenna body, wherein the ground terminal is connected to the metal layer, wherein the antenna body is arranged above the metal layer and within the cavity. The encapsulated antenna device also includes a spacer between the metal layer and the antenna body that provides an offset distance between the metal layer and the antenna body.

20 Claims, 6 Drawing Sheets



US012374793B2

(12) **United States Patent**
Wu

(10) **Patent No.: US 12,374,793 B2**
(45) **Date of Patent: Jul. 29, 2025**

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

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

(72) Inventor: **Xiaopu Wu**, Guangdong (CN)

(73) Assignee: **GUANGDONG OPPO MOBILE TELECOMMUNICATIONS CORP., LTD.**, Guangdong (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 231 days.

(21) Appl. No.: **18/340,161**

(22) Filed: **Jun. 23, 2023**

(65) **Prior Publication Data**

US 2023/0420846 A1 Dec. 28, 2023

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2021/130976, filed on Nov. 16, 2021.

(30) **Foreign Application Priority Data**

Dec. 29, 2020 (CN) 202011603132.5

(51) **Int. Cl.**
H01Q 5/35 (2015.01)
H01Q 1/48 (2006.01)
H01Q 5/335 (2015.01)

(52) **U.S. Cl.**
CPC ***H01Q 5/35*** (2015.01); ***H01Q 1/48*** (2013.01); ***H01Q 5/335*** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/36; H01Q 1/48; H01Q 1/50; H01Q 5/10; H01Q 5/328;
(Continued)

(56) **References Cited**

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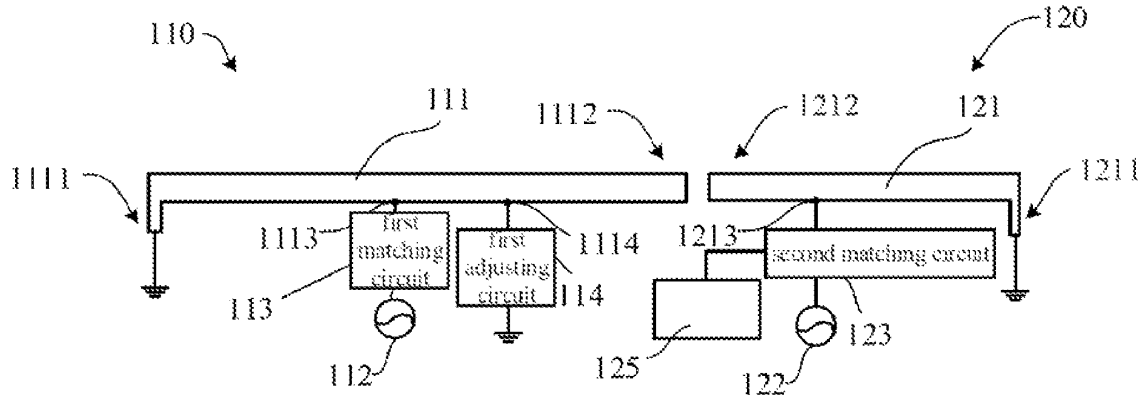
Primary Examiner — Raymond R Chai
(74) *Attorney, Agent, or Firm* — Ladas & Parry LLP

(57) **ABSTRACT**

The present application provides an antenna assembly and an electronic device. The antenna assembly includes a first antenna and a second antenna. The first antenna includes a first radiator, a first signal source, and a first matching circuit, the first radiator has a first feed point, and the first signal source is electrically connected to the first matching circuit to the first feed point. The second antenna includes a second radiator, a third radiator, a second signal source, and a second matching circuit, the second radiator and the first radiator are spaced apart from and coupled to each other, the second radiator has a second feed point, the second signal source is electrically connected to the second matching circuit to the second feed point, and the second signal source is also electrically connected to the second matching circuit to the third radiator.

18 Claims, 12 Drawing Sheets



US012374795B2

(12) **United States Patent**
Li

(10) **Patent No.: US 12,374,795 B2**
(45) **Date of Patent: Jul. 29, 2025**

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

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

(72) Inventor: **Chin-Tang Li**, New Taipei (TW)

(73) Assignee: **PANELSEMI CORPORATION**, New Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 133 days.

(21) Appl. No.: **18/194,160**

(22) Filed: **Mar. 31, 2023**

(65) **Prior Publication Data**

US 2023/0318184 A1 Oct. 5, 2023

(30) **Foreign Application Priority Data**

Apr. 1, 2022 (TW) 111112938

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 1/22 (2006.01)
H01Q 1/48 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 9/0407*** (2013.01); ***H01Q 1/22*** (2013.01); ***H01Q 1/48*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/22; H01Q 1/243; H01Q 1/48; H01Q 9/0407; H01Q 9/045
See application file for complete search history.

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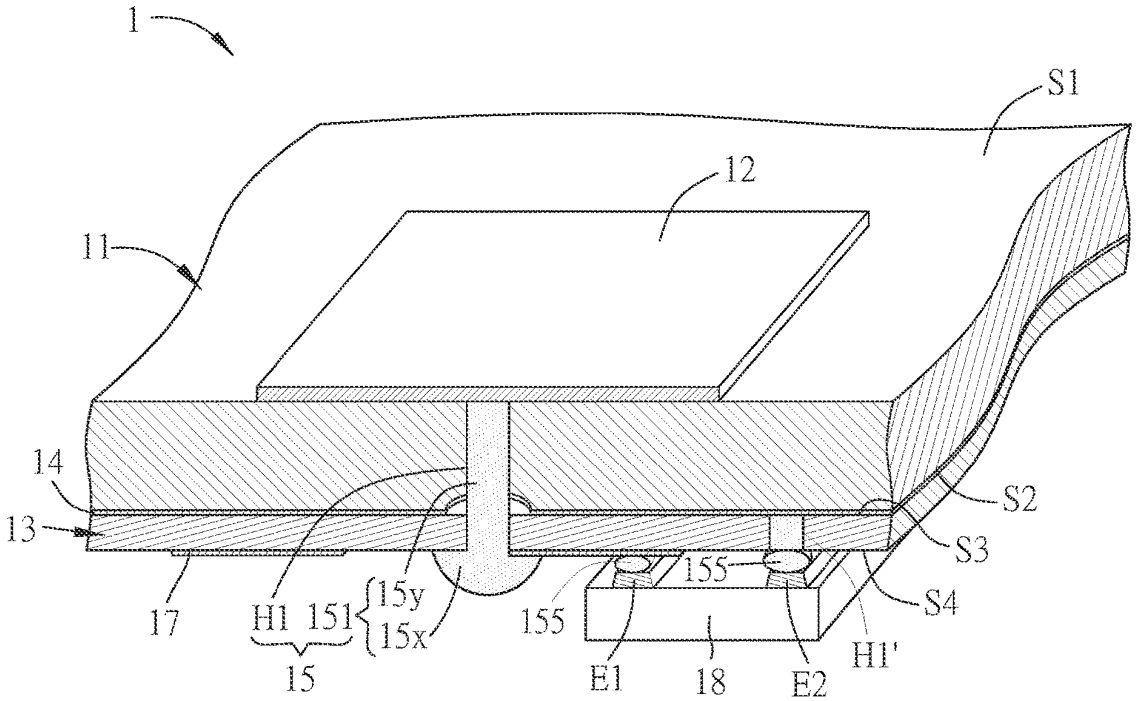
Primary Examiner — Hoang V Nguyen
(74) *Attorney, Agent, or Firm* — Muncy, Geissler, Olds & Lowe, P.C.

(57) **ABSTRACT**

An antenna device includes a first substrate, an antenna element, a second substrate, a circuitry, and one or more conductive structures. The antenna element is arranged on one surface of the first substrate, and the second substrate is arranged on another surface of the first substrate. The conductive structure defines a through hole at least penetrating through the second substrate and a conductive member arranged in the through hole. At least some of the conductive structures are electrically connected to the antenna element and the circuitry, and the antenna elements are electrically connected to corresponding electronic elements.

17 Claims, 6 Drawing Sheets



US012374796B2

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

(10) **Patent No.: US 12,374,796 B2**
(45) **Date of Patent: Jul. 29, 2025**

(54) **ANTENNA DEVICE AND DISPLAY DEVICE INCLUDING THE SAME**

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

(72) Inventors: **Jong Min Kim**, Gyeonggi-do (KR); **Young Jun Lee**, Seoul (KR); **Yoon Ho Huh**, Seoul (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 166 days.

(21) Appl. No.: **17/945,509**

(22) Filed: **Sep. 15, 2022**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. PCT/KR2021/003140, filed on Mar. 15, 2021.

(30) **Foreign Application Priority Data**

Mar. 16, 2020 (KR) 10-2020-0032104

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/38 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 9/0414*** (2013.01); ***H01Q 1/241*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/38*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 9/0414; H01Q 1/241; H01Q 1/38; H01Q 1/422; H01Q 1/243; H01Q 1/44;
(Continued)

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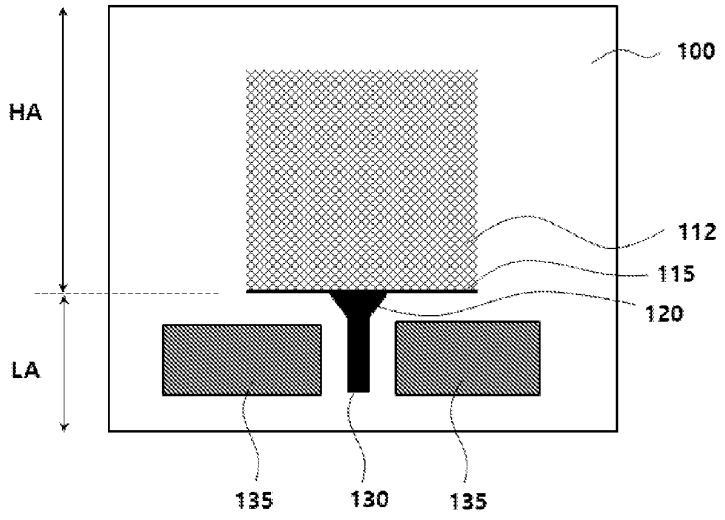
Primary Examiner — Dameon E Levi
Assistant Examiner — Yonchan J Kim
(74) *Attorney, Agent, or Firm* — The PL Law Group, PLLC

(57) **ABSTRACT**

An antenna device according to an embodiment includes a dielectric layer including a high transmittance area and a low transmittance area, and an antenna unit disposed on the dielectric layer. The antenna unit includes a radiator disposed on the high transmittance area of the dielectric layer and having a mesh structure, a signal pad disposed on the low transmittance area of the dielectric layer and having a solid pattern structure, and an impedance matching pattern connecting the radiator and the signal pad on the low transmittance area of the dielectric layer. The impedance matching pattern has a larger width than that of the signal pad and has a solid pattern structure.

13 Claims, 6 Drawing Sheets



US012374799B2

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

(10) **Patent No.: US 12,374,799 B2**
(45) **Date of Patent: Jul. 29, 2025**

(54) **ELECTRONIC DEVICE INCLUDING ANTENNA**

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

(72) Inventors: **Namjun Cho**, Suwon-si (KR); **Hyoseok Na**, Suwon-si (KR); **Junghwan Son**, Suwon-si (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 204 days.

(21) Appl. No.: **18/054,312**

(22) Filed: **Nov. 10, 2022**

(65) **Prior Publication Data**

US 2023/0163475 A1 May 25, 2023

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2022/095136, filed on Oct. 19, 2022.

(30) **Foreign Application Priority Data**

Nov. 22, 2021 (KR) 10-2021-0161047
Jan. 5, 2022 (KR) 10-2022-0001626

(51) **Int. Cl.**
H01Q 1/42 (2006.01)
H01Q 9/28 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 9/285*** (2013.01); ***H01Q 1/422*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 9/285; H01Q 1/422; H01Q 21/08; H01Q 21/28; H01Q 1/2283; H01Q 1/243; H01L 21/7621; H01L 2224/29021
See application file for complete search history.

(56) **References Cited**

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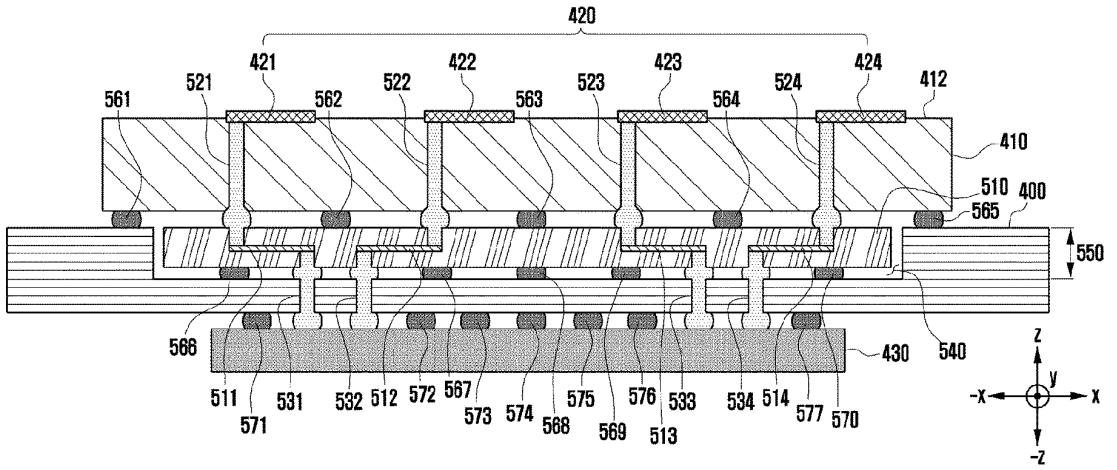
Primary Examiner — Dameon E Levi
Assistant Examiner — Jordan E. DeWitt
(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye P.C.

(57) **ABSTRACT**

According to various embodiment, an electronic device may include: a housing, a first substrate disposed in an inner space of the housing and including a first surface facing a first direction, a second surface facing a direction opposite to the first surface, and a first recess area at least partially corresponding to the first surface, a second substrate at least partially disposed in the first recess area of the first substrate, a third substrate at least partially disposed on one surface of the second substrate and including multiple antenna elements comprising at least one antenna, and a wireless communication circuit disposed on the second surface of the first substrate and electrically connected to the second substrate. The second substrate may include at least one matching circuit electrically connected to the wireless communication circuit corresponding to each of the multiple elements.

10 Claims, 20 Drawing Sheets



US012374808B2

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

(10) **Patent No.: US 12,374,808 B2**
(45) **Date of Patent: Jul. 29, 2025**

(54) **UWB ANTENNA AND ELECTRONIC DEVICE INCLUDING SAME**

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

(72) Inventors: **Dongyeon Kim**, Suwon-si (KR); **Minsoo Kim**, Suwon-si (KR); **Hosaeng Kim**, Suwon-si (KR); **Youngsuk Yoo**, Suwon-si (KR); **Woosup Lee**, Suwon-si (KR); **Sukgi Hong**, Suwon-si (KR); **Haeyeon Kim**, Suwon-si (KR); **Youngjoon Lim**, Suwon-si (KR)

(73) Assignee: **SAMSUNG ELECTRONICS CO., LTD.**, Suwon-si (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 144 days.

(21) Appl. No.: **18/106,245**

(22) Filed: **Feb. 6, 2023**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. PCT/KR2021/009976, filed on Jul. 30, 2021.

(30) **Foreign Application Priority Data**

Aug. 4, 2020 (KR) 10-2020-0097250

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 9/04 (2006.01)
H01Q 21/06 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 21/065*** (2013.01); ***H01Q 9/0414*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/24; H01Q 1/241; H01Q 1/38; H01Q 21/06; H01Q 21/065; H01Q 21/24;
(Continued)

(56) **References Cited**

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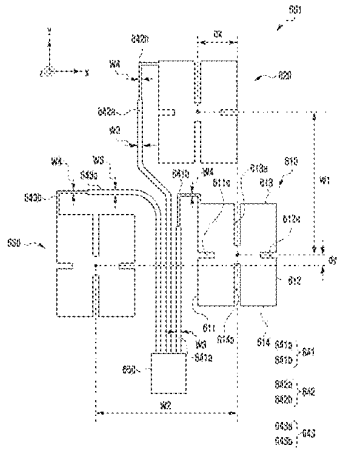
Primary Examiner — Tho G Phan
(74) *Attorney, Agent, or Firm* — Sughrue Mion, PLLC

(57) **ABSTRACT**

An ultra-wide band (UWB) antenna including a dielectric substrate, and first and second conductive layers arranged on opposite sides of the dielectric substrate. The first conductive layer includes a first, second and third patch antennae, each configured to receive a first UWB signal and a second UWB signal, wherein the second and third patch antennae are spaced apart from the first patch antenna in specific directions. The first conductive layer also includes first, second, and third transmission lines connecting, respectively, the first, second, and third patch antennae to a connector. The second conductive layer includes a ground pattern overlapping the first, second, and third patch antennae and the first, second, and third transmission lines, when
(Continued)



US012374809B2

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

(10) **Patent No.: US 12,374,809 B2**
(45) **Date of Patent: Jul. 29, 2025**

(54) **ANTENNA STRUCTURE, ELECTRONIC DEVICE, AND WIRELESS NETWORK SYSTEM**

(71) Applicants: **Honor Device Co., Ltd.**, Shenzhen (CN); **TSINGHUA UNIVERSITY**, Beijing (CN)

(72) Inventors: **Xiaopeng Zhang**, Beijing (CN); **Zhijun Zhang**, Shenzhen (CN); **Dawei Zhou**, Shenzhen (CN)

(73) Assignees: **Honor Device Co., Ltd.**, Shenzhen (CN); **TSINGHUA UNIVERSITY**, Beijing (CN)

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

(21) Appl. No.: **18/274,465**

(22) PCT Filed: **Dec. 28, 2022**

(86) PCT No.: **PCT/CN2022/142628**
§ 371 (c)(1),
(2) Date: **Jul. 27, 2023**

(87) PCT Pub. No.: **WO2023/138324**
PCT Pub. Date: **Jul. 27, 2023**

(65) **Prior Publication Data**

US 2024/0097348 A1 Mar. 21, 2024

(30) **Foreign Application Priority Data**

Jan. 18, 2022 (CN) 202210056873.9

(51) **Int. Cl.**
H01Q 21/06 (2006.01)
H01Q 9/04 (2006.01)
H01Q 21/00 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 21/065*** (2013.01); ***H01Q 9/0457*** (2013.01); ***H01Q 21/0075*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 21/065; H01Q 9/0457; H01Q 21/0075; H01Q 1/2291; H01Q 5/30;
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(56) **References Cited**

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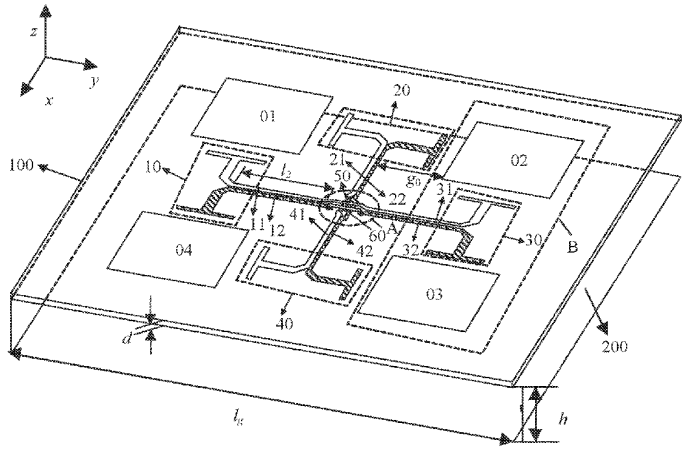
Primary Examiner — David E Lotter
(74) *Attorney, Agent, or Firm* — Leydig, Voit & Mayer, Ltd.

(57) **ABSTRACT**

An antenna structure, an electronic device, and a wireless network system are provided, and relate to the field of antenna technologies. A patch antenna array includes four patch antennas. The four patch antennas are arranged in two rows and two columns. One of the feeding structures is included between two of the patch antennas in each row. One of the feeding structures is included between two of the patch antennas in each column. The feeding structure located between the two patch antennas in each column is connected to the first feeding port, so that the four patch antennas all generate polarization in a first direction. The
(Continued)



US012374810B2

(12) **United States Patent**
Chiang

(10) **Patent No.: US 12,374,810 B2**
(45) **Date of Patent: Jul. 29, 2025**

(54) **ANTENNA SYSTEM FOR ACCESSING WIRELESS SIGNAL OF MULTIPLE FREQUENCY BAND**

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

(72) Inventor: **Chung-Hsin Chiang**, Hsinchu (TW)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 213 days.

(21) Appl. No.: **18/098,064**

(22) Filed: **Jan. 17, 2023**

(65) **Prior Publication Data**

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Related U.S. Application Data

(60) Provisional application No. 63/311,514, filed on Feb. 18, 2022.

(51) **Int. Cl.**
H01Q 21/30 (2006.01)
H01Q 5/48 (2015.01)

(52) **U.S. Cl.**
CPC ***H01Q 21/30*** (2013.01); ***H01Q 5/48*** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/521; H01Q 5/40; H01Q 5/48; H01Q 15/006; H01Q 21/08; H01Q 21/28; H01Q 21/30
See application file for complete search history.

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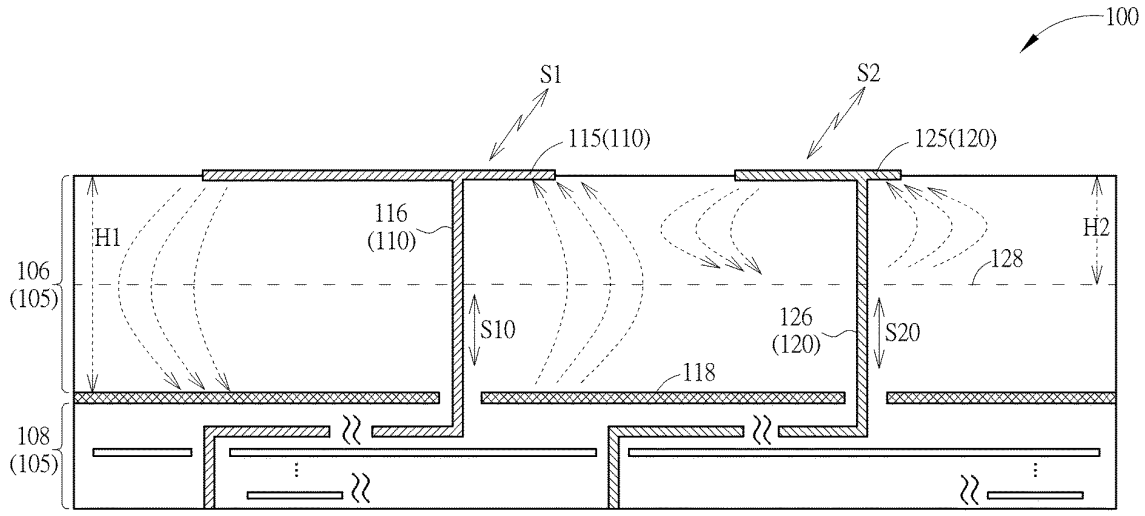
Primary Examiner — Raymond R Chai
(74) *Attorney, Agent, or Firm* — Winston Hsu

(57) **ABSTRACT**

An antenna system includes a first antenna and a second antenna. The first antenna can include a first horizontal portion and be used to access a first wireless signal. The first wireless signal can be wirelessly transmitted and/or received over air through the first horizontal portion and a first reference layer. The second antenna can include a second horizontal portion and be used to access a second wireless signal. The second wireless signal can be wirelessly transmitted and/or received over the air through the second horizontal portion and a second reference layer different from the first reference layer. The first wireless signal can be in a first frequency band, the second wireless signal can be in a second frequency band, and frequencies in the second frequency band can be higher than frequencies in the first frequency band.

20 Claims, 16 Drawing Sheets



US012375596B2

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

(10) **Patent No.: US 12,375,596 B2**
(45) **Date of Patent: Jul. 29, 2025**

(54) **APPARATUS HAVING SLOT ANTENNA USING CAMERA COVER IN ELECTRONIC DEVICE**

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

(72) Inventors: **Minkyung Lee**, Suwon-si (KR); **Mincheol Seo**, Suwon-si (KR); **Donghun Shin**, Suwon-si (KR); **Yoonjung Kim**, Suwon-si (KR); **Huiwon Cho**, Suwon-si (KR)

(73) Assignee: **SAMSUNG ELECTRONICS CO., LTD.**, Gyeonggi-Do (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 223 days.

(21) Appl. No.: **18/212,696**

(22) Filed: **Jun. 21, 2023**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. PCT/KR2021/019534, filed on Dec. 21, 2021.

(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**
H04M 1/02 (2006.01)
H01Q 13/10 (2006.01)

(52) **U.S. Cl.**
CPC ***H04M 1/0264*** (2013.01); ***H01Q 13/10*** (2013.01)

(58) **Field of Classification Search**
CPC H04M 1/0264; H01Q 13/10; H01Q 5/307; H01Q 1/44; H01Q 21/28; H01Q 1/243; H01Q 13/106
See application file for complete search history.

(56) **References Cited**

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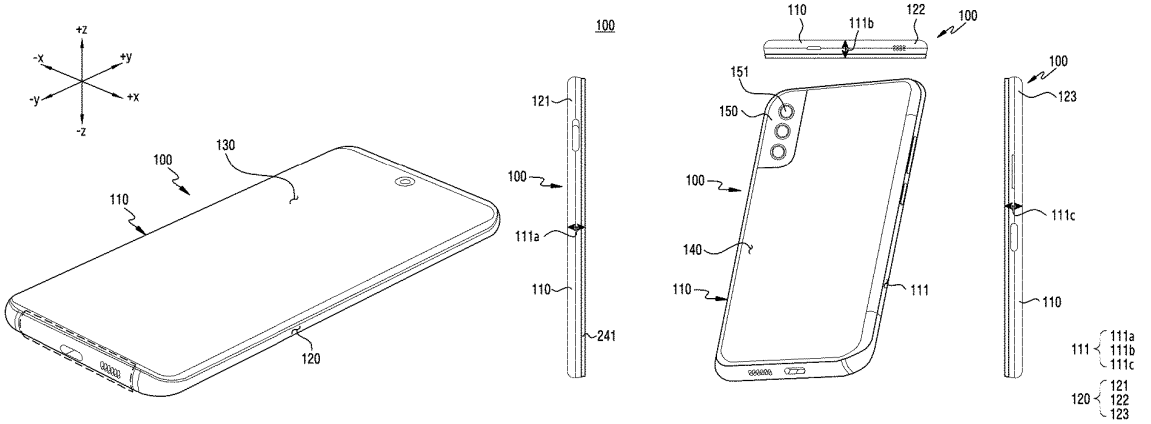
Primary Examiner — Mekonnen D Dagnew
(74) *Attorney, Agent, or Firm* — CANTOR COLBURN LLP

(57) **ABSTRACT**

An electronic device includes a camera cover, a wireless communication circuit, a first frame, a second frame and a third frame, extends from a second surface along a part not included in a first surface and the second surface among the periphery of the camera cover, and is connected to the camera cover. The second frame is positioned away from the first frame to form a part of the second surface, and extends from the second surface to form a part of a third surface. The third frame has a gap from the first frame in a specific direction in a first area and is connected to the first frame in a second area. The wireless communication circuit can receive a signal of a specific frequency band by feeding power to a slot structure comprising the gap between the first frame and the third frame.

15 Claims, 22 Drawing Sheets



US012381311B2

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

(10) **Patent No.: US 12,381,311 B2**
(45) **Date of Patent: Aug. 5, 2025**

(54) **MULTIBAND PRINTED ANTENNA**

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

(72) Inventors: **Lan-Yung Hsiao**, New Taipei (TW); **Ping-Chun Lu**, New Taipei (TW); **Shao-Kai Sun**, New Taipei (TW)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 111 days.

(21) Appl. No.: **18/404,882**

(22) Filed: **Jan. 4, 2024**

(65) **Prior Publication Data**

US 2024/0332787 A1 Oct. 3, 2024

(30) **Foreign Application Priority Data**

Mar. 30, 2023 (CN) 202320660804.9

(51) **Int. Cl.**

H01Q 5/371	(2015.01)
H01Q 1/24	(2006.01)
H01Q 1/38	(2006.01)
H01Q 1/48	(2006.01)
H01Q 5/25	(2015.01)
H01Q 5/321	(2015.01)

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

CPC ***H01Q 1/38*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 5/25*** (2015.01); ***H01Q 5/321*** (2015.01)

(58) **Field of Classification Search**

CPC H01Q 1/38; H01Q 1/243; H01Q 1/48; H01Q 5/25; H01Q 5/321; H01Q 9/0421; H01Q 9/42; H01Q 5/371

See application file for complete search history.

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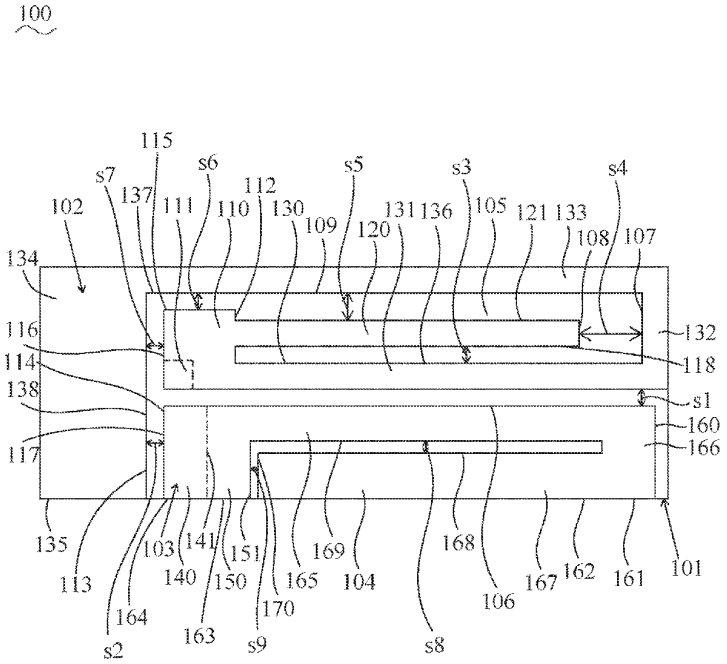
Primary Examiner — David E Lotter

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

(57) **ABSTRACT**

A multiband printed antenna includes a radiator arranged on an upper portion and one end of a circuit board, and a grounding body. The radiator includes a feed-in part, a first radiation part straightly extended rightward from an upper section of a first right edge of the feed-in part, and a second radiation part sequentially extended rightward, then extended upward, later extended leftward, and further extended downward from a lower section of the first right edge of the feed-in part. The grounding body is arranged on a lower portion of the circuit board. The grounding body is positioned adjacent to a lower portion of a second right edge of the radiator. The grounding body is separated from the radiator.

20 Claims, 5 Drawing Sheets



US012381313B2

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

(10) **Patent No.: US 12,381,313 B2**
(45) **Date of Patent: Aug. 5, 2025**

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

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

(72) Inventors: **Shih-Chiang Wei**, Hsinchu (TW); **Yung-Chieh Yu**, Hsinchu (TW)

(73) Assignee: **WISTRON NEWEB CORPORATION**, Hsinchu (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 221 days.

(21) Appl. No.: **18/321,028**

(22) Filed: **May 22, 2023**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Oct. 3, 2022 (TW) 111137466

(51) **Int. Cl.**
H01Q 5/328 (2015.01)
H01Q 1/22 (2006.01)
H01Q 1/48 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/48*** (2013.01); ***H01Q 1/2266*** (2013.01); ***H01Q 5/328*** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/48; H01Q 1/2266; H01Q 5/328; H01Q 5/321; H01Q 9/26; H01Q 9/42; H01Q 5/392
See application file for complete search history.

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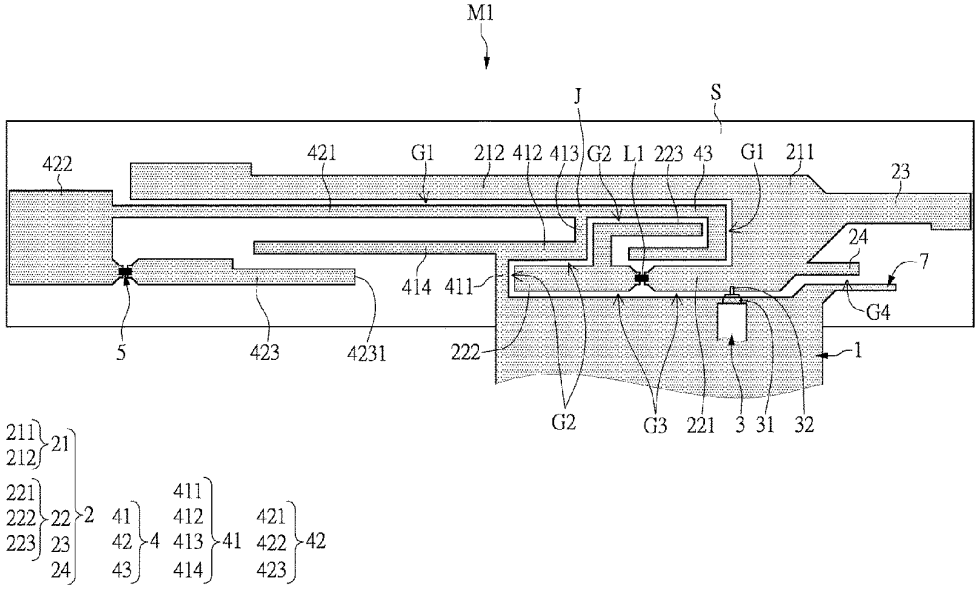
Primary Examiner — Dameon E Levi
Assistant Examiner — Jordan E. DeWitt
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

An antenna structure and an electronic device are provided. The electronic device includes a housing and the antenna structure disposed in the housing. The antenna structure includes a grounding element, a feeding radiation element, a feeding element, a first grounding radiation element, and a switching element. The feeding radiation element includes a first radiating portion, a second radiating portion, and a third radiating portion. The first radiating portion and the second radiating portion jointly surround the first grounding radiation element. The first radiating portion and the first grounding radiation element are separate from each other and coupled with each other. The switching element is electrically connected to the first grounding radiation element.

20 Claims, 10 Drawing Sheets



US012381322B2

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

(10) **Patent No.: US 12,381,322 B2**
(45) **Date of Patent: Aug. 5, 2025**

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

(71) Applicant: **HONOR DEVICE CO., LTD.**, Shenzhen (CN)

(72) Inventors: **Xiaotao Cai**, Shenzhen (CN); **Tiezhu Liang**, Shenzhen (CN); **Yafang Yu**, Shenzhen (CN); **Wenlong Hu**, Shenzhen (CN)

(73) Assignee: **Honor Device Co., Ltd.**, Shenzhen (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 88 days.

(21) Appl. No.: **18/044,639**

(22) PCT Filed: **Jan. 24, 2022**

(86) PCT No.: **PCT/CN2022/073600**
§ 371 (c)(1),
(2) Date: **Mar. 9, 2023**

(87) PCT Pub. No.: **WO2022/218005**
PCT Pub. Date: **Oct. 20, 2022**

(65) **Prior Publication Data**

US 2024/0297436 A1 Sep. 5, 2024

(30) **Foreign Application Priority Data**

Apr. 12, 2021 (CN) 202110391085.0

(51) **Int. Cl.**
H01Q 5/342 (2015.01)
H01Q 1/24 (2006.01)
H01Q 9/42 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 5/342*** (2015.01); ***H01Q 1/243*** (2013.01); ***H01Q 9/42*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/342; H01Q 1/243; H01Q 9/42
See application file for complete search history.

(56) **References Cited**

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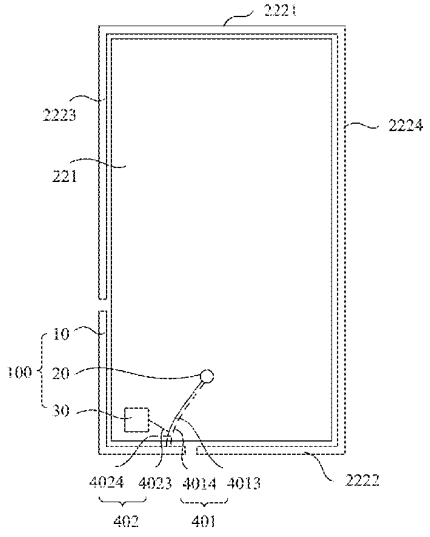
(Continued)

Primary Examiner — Dieu Hien T Duong
(74) *Attorney, Agent, or Firm* — Fish & Richardson P.C.

(57) **ABSTRACT**

Embodiments of this application provide an antenna apparatus and an electronic device. The antenna apparatus is provided with a non-resonant unit and a feed unit, to respectively feed a radiation unit and a non-resonant unit. Through feeding power distribution design, the non-resonant unit can assist in exciting a floor characteristic mode. In addition, since a size of the non-resonant unit is much smaller than an electrical length required for resonance of an antenna on this frequency band, the non-resonant unit does not generate a resonance curve on a resonance curve and has no resonance point, to improve radiation efficiency of the antenna without generating new resonance, so as to improve a use effect of a user.

14 Claims, 28 Drawing Sheets



US012381324B2

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

(10) **Patent No.: US 12,381,324 B2**
(45) **Date of Patent: Aug. 5, 2025**

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

(71) Applicant: **SAMSUNG DISPLAY CO., LTD.**, Yongin-si (KR)

(72) Inventors: **Hyun Jae Lee**, Yongin-si (KR); **Kiseo Kim**, Yongin-si (KR); **Sunghwan Kim**, Yongin-si (KR); **Youngsik Kim**, Yongin-si (KR); **Youngseok Yoo**, Yongin-si (KR)

(73) Assignee: **SAMSUNG DISPLAY CO., LTD.**, Yongin-si (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 206 days.

(21) Appl. No.: **18/352,673**

(22) Filed: **Jul. 14, 2023**

(65) **Prior Publication Data**

US 2024/0106121 A1 Mar. 28, 2024

(30) **Foreign Application Priority Data**

Sep. 22, 2022 (KR) 10-2022-0120177

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/48 (2015.01)

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

(58) **Field of Classification Search**
CPC H01Q 1/243; G06F 3/0443; G06F 1/1698; G09G 2370/16
See application file for complete search history.

(56) **References Cited**

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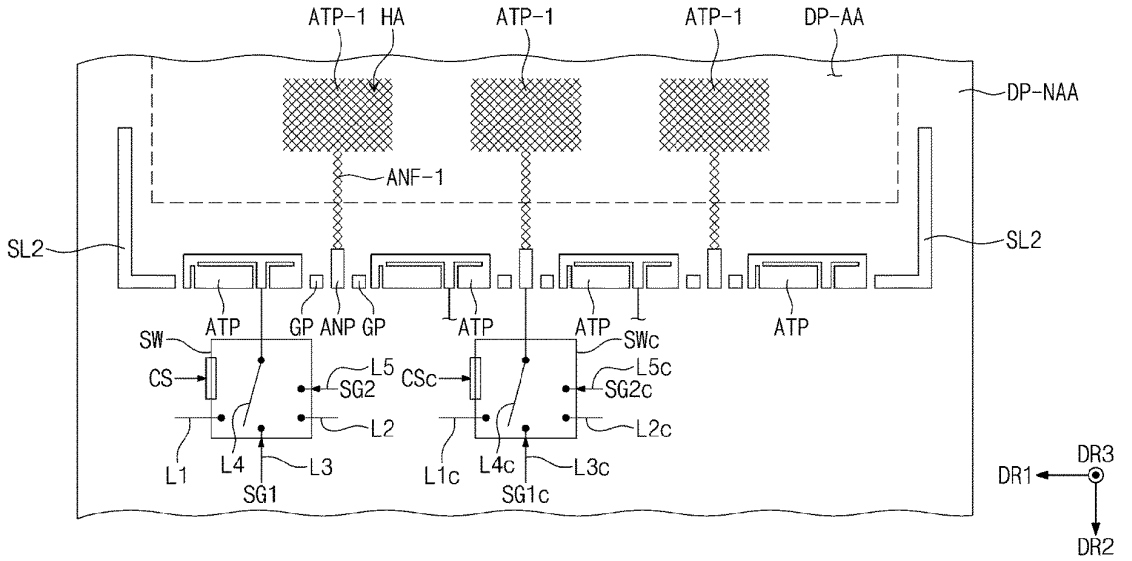
Primary Examiner — Kevin M Nguyen
(74) *Attorney, Agent, or Firm* — F. CHAU & ASSOCIATES, LLC

(57) **ABSTRACT**

An electronic device includes a display layer in which an active region and a peripheral region proximate to the active region are defined and a controller that is configured to control the display layer. The display layer includes a plurality of pixels, a plurality of antenna patterns that transmit and receive a first signal having a predetermined frequency, and a switch connected to at least one of the plurality of antenna patterns. The controller provides, to the switch, a control signal to control the switch. The switch includes a first line to which a ground voltage is provided, a second line that is floated, a third line to which the first signal is provided, and a fourth line connected to the at least one of the plurality of antenna patterns and electrically connected to the first line, the second line, or the third line based on the control signal.

30 Claims, 13 Drawing Sheets



US012381328B2

(12) **United States Patent**
Chiang

(10) **Patent No.: US 12,381,328 B2**
(45) **Date of Patent: Aug. 5, 2025**

(54) **DUAL CIRCULARLY POLARIZED ANTENNA ARRAY**

(71) Applicant: **AUDEN TECHNO CORP.**, Taoyuan (TW)

(72) Inventor: **Chi-Ming Chiang**, Taoyuan (TW)

(73) Assignee: **AUDEN TECHNO CORP.**, Taoyuan (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 112 days.

(21) Appl. No.: **18/539,814**

(22) Filed: **Dec. 14, 2023**

(65) **Prior Publication Data**

US 2025/0202118 A1 Jun. 19, 2025

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 21/06 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 9/0428*** (2013.01); ***H01Q 21/065*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 9/0428; H01Q 21/065; H01Q 1/38
See application file for complete search history.

(56) **References Cited**

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2024/0305014 A1* 9/2024 Huang H01Q 9/0414
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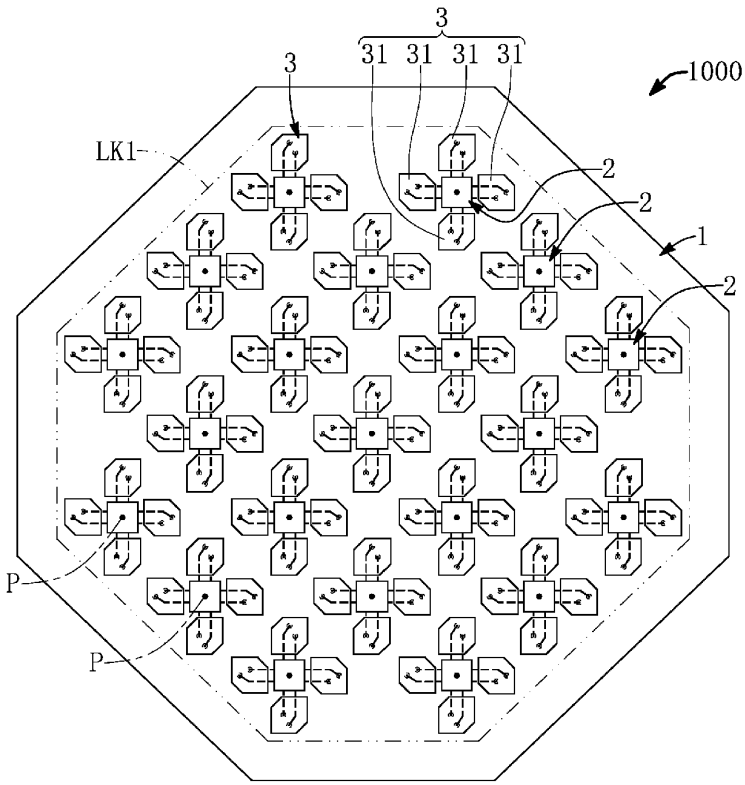
* cited by examiner

Primary Examiner — David E Lotter
(74) *Attorney, Agent, or Firm* — Li & Cai Intellectual Property (USA) Office

(57) **ABSTRACT**

A dual circularly polarized antenna array includes an insulating substrate, an M number of feed modules, and an M number of antenna groups. The insulating substrate includes an M number of preset points. The M antenna groups are respectively disposed on the M preset points, and each antenna group includes four antennas. Any two opposite ones of the four antennas jointly have a 180-degree rotational symmetry relative to a corresponding one of the M preset points. Each antenna includes a conductive sheet, and a first feed point and a second feed point that are electrically coupled to one of the M feed modules. The first feed points of the four antennas can jointly generate a left-hand circular polarization through one of the M feed modules, and the second feed points of the four antennas can jointly generate a right-hand circular polarization through one of the M feed modules.

10 Claims, 8 Drawing Sheets



US012381596B2

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

(10) **Patent No.: US 12,381,596 B2**
(45) **Date of Patent: Aug. 5, 2025**

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

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

(72) Inventors: **Wuxin Huang**, Dongguan (CN); **Si Li**, Dongguan (CN)

(73) Assignee: **GUANGDONG OPPO MOBILE TELECOMMUNICATIONS CORP., LTD.**, Dongguan (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 416 days.

(21) Appl. No.: **17/992,346**

(22) Filed: **Nov. 22, 2022**

(65) **Prior Publication Data**

US 2023/0101129 A1 Mar. 30, 2023

Related U.S. Application Data

(63) Continuation-in-part of application No. PCT/CN2021/089682, filed on Apr. 25, 2021.

(30) **Foreign Application Priority Data**

May 26, 2020 (CN) 202010456231.9
May 26, 2020 (CN) 202011051896.8

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/22 (2006.01)
H04B 5/26 (2024.01)

(52) **U.S. Cl.**
CPC ***H04B 5/26*** (2024.01); ***H01Q 1/2216*** (2013.01); ***H01Q 1/243*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/335; H01Q 5/35; H01Q 9/42; H01Q 1/36; H01Q 1/22; H01Q 1/44;
(Continued)

(56) **References Cited**

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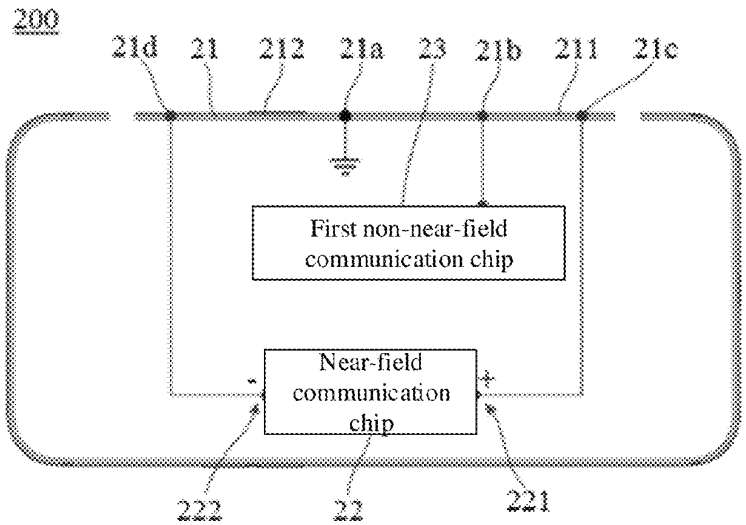
(Continued)

Primary Examiner — Angelica Perez
(74) *Attorney, Agent, or Firm* — Sheppard, Mullin, Richter & Hampton LLP

(57) **ABSTRACT**

Provided are an antenna apparatus and an electronic device. The antenna apparatus includes a radiator, a near-field communication chip and a first non-near-field communication chip. The radiator includes a ground point and a first feeding point that are spaced apart from each other, and the ground point is grounded. The near-field communication chip is configured to provide a differential excitation current. The first non-near-field communication chip is configured to provide a first non-near-field communication excitation current.

20 Claims, 9 Drawing Sheets



US012381972B2

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

(10) **Patent No.: US 12,381,972 B2**
(45) **Date of Patent: Aug. 5, 2025**

(54) **ANTENNA FOR A MOBILE TERMINAL THAT OVERLAPS A SIDE BUTTON**

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

(72) Inventors: **Hongjo Shim**, Seoul (KR); **Hyunwoo Kim**, Seoul (KR); **Sungwook Chang**, Seoul (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 6 days.

(21) Appl. No.: **17/766,692**

(22) PCT Filed: **Oct. 18, 2019**

(86) PCT No.: **PCT/KR2019/013708**
§ 371 (c)(1),
(2) Date: **Apr. 5, 2022**

(87) PCT Pub. No.: **WO2021/075605**
PCT Pub. Date: **Apr. 22, 2021**

(65) **Prior Publication Data**

US 2024/0089367 A1 Mar. 14, 2024

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H04M 1/724 (2021.01)
H04M 1/725 (2021.01)

(52) **U.S. Cl.**
CPC ***H04M 1/725*** (2013.01); ***H04M 1/724*** (2021.01); *H04M 2250/12* (2013.01)

(58) **Field of Classification Search**
CPC .. H04M 1/725; H04M 1/724; H04M 2250/12; H04M 1/02; H01Q 1/24; H01Q 1/243; H01Q 1/38
See application file for complete search history.

(56) **References Cited**

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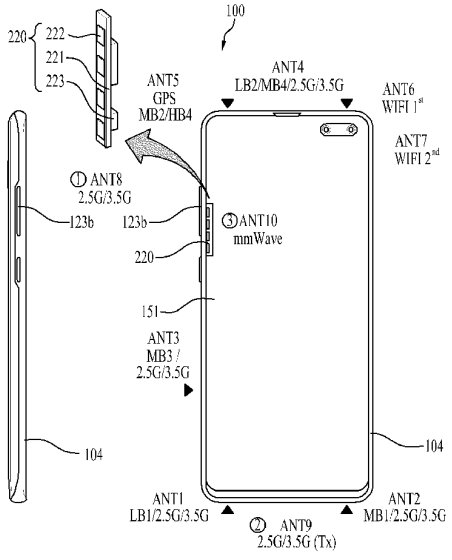
(Continued)

Primary Examiner — Angelica Perez
(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

Provided is a mobile terminal which can additionally mount antennas without needing to change the positions of buttons and thus without reducing the usability thereof, the mobile terminal comprising: an antenna module disposed inside the side surface of a case; and a user input module overlappingly disposed inside the antenna module and including a force sensor for pressure sensing.

13 Claims, 14 Drawing Sheets



US012388166B2

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

(10) **Patent No.: US 12,388,166 B2**
(45) **Date of Patent: Aug. 12, 2025**

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

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

(72) Inventors: **Dongjin Jung**, Gyeonggi-do (KR); **Chanju Park**, Gyeonggi-do (KR); **Jungi Jeong**, Gyeonggi-do (KR); **Taeksun Kwon**, Gyeonggi-do (KR); **Jungwoo Seo**, Gyeonggi-do (KR); **Junhwa Oh**, Gyeonggi-do (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 142 days.

(21) Appl. No.: **18/547,977**

(22) PCT Filed: **Apr. 28, 2022**

(86) PCT No.: **PCT/KR2022/006082**
§ 371 (c)(1),
(2) Date: **Aug. 25, 2023**

(87) PCT Pub. No.: **WO2022/250310**
PCT Pub. Date: **Dec. 1, 2022**

(65) **Prior Publication Data**

US 2024/0136703 A1 Apr. 25, 2024
US 2024/0235009 A9 Jul. 11, 2024

(30) **Foreign Application Priority Data**

May 25, 2021 (KR) 10-2021-0066644

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

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 21/0075*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/38; H01Q 21/0075; H01Q 1/246; H01Q 9/0414; H01Q 21/08; H01Q 21/24
See application file for complete search history.

(56) **References Cited**

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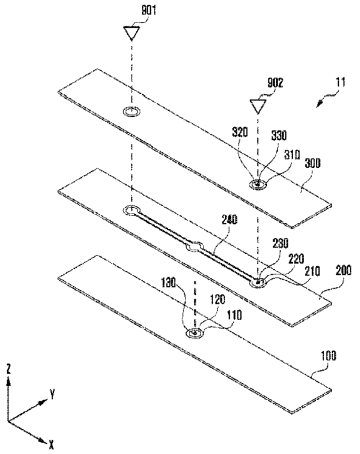
(Continued)

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

(57) **ABSTRACT**

An antenna module, according to various embodiments, may comprise: a first layer including a first etching region, a first via pad disposed to be spaced apart from an edge of the first etching region, and a first via hole disposed on one surface of the first via pad; and a second layer stacked on one surface of the first layer, and including a second etching region, a plurality of second via pads disposed to be spaced apart from an edge of the second etching region, a plurality of second via holes disposed on one surface of the plurality of second
(Continued)



US012388167B2

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

(10) **Patent No.: US 12,388,167 B2**
(45) **Date of Patent: Aug. 12, 2025**

(54) **ANTENNA AND ANTENNA SYSTEM**

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

(72) Inventors: **Liqiao Jing**, Shenzhen (CN); **Dashuang Liao**, Shenzhen (CN); **Guanxi Zhang**, Shanghai (CN)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 155 days.

(21) Appl. No.: **18/343,084**

(22) Filed: **Jun. 28, 2023**

(65) **Prior Publication Data**

US 2023/0335903 A1 Oct. 19, 2023

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2021/071502, filed on Jan. 13, 2021.

(30) **Foreign Application Priority Data**

Dec. 29, 2020 (WO) PCT/CN2020/140503

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/42 (2015.01)
H01Q 15/00 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/246*** (2013.01); ***H01Q 5/42*** (2015.01); ***H01Q 15/0026*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/42; H01Q 1/246; H01Q 5/40; H01Q 5/42; H01Q 5/45; H01Q 5/48; H01Q 5/49; H01Q 15/0006; H01Q 15/0013; H01Q 15/002; H01Q 15/0026; H01Q 15/0053; H01Q 15/006; H01Q 15/0066; H01Q 15/0073; H01Q 15/008; H01Q 15/0086; H01Q 15/0093; H01Q 19/108; H01Q 21/062; H01Q 21/26; H01Q 21/28
See application file for complete search history.

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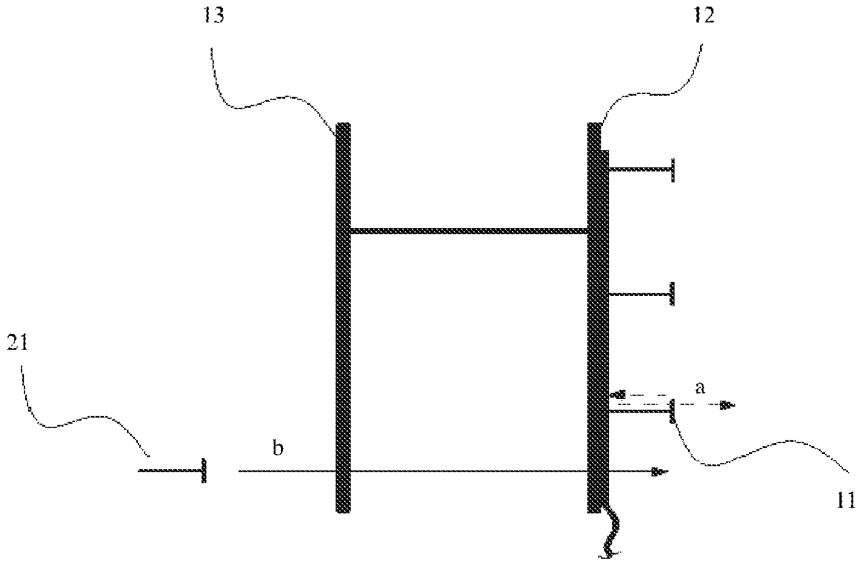
(Continued)

Primary Examiner — Robert Karacsony
(74) *Attorney, Agent, or Firm* — Maier & Maier, PLLC

(57) **ABSTRACT**

An antenna and an antenna system that has the antenna, and relates to the field of wireless communication technologies. The antenna can allow a high frequency to pass through and block a low frequency or allow the low frequency to pass through and block the high frequency, and can be used in combination with other antennas to form an antenna system. In addition, in the antenna system, the antenna can also share a same antenna aperture surface with other antennas. The antenna can reduce costs while meeting a working requirement of a multi-band antenna, and can be used for flexible and changeable usage scenarios.

20 Claims, 5 Drawing Sheets



US012388172B2

(12) **United States Patent**
Yoshino

(10) **Patent No.: US 12,388,172 B2**
(45) **Date of Patent: Aug. 12, 2025**

(54) **ANTENNA DEVICE, RECTIFIER CIRCUIT, AND ELECTRONIC DEVICE**

(71) Applicant: **SONY SEMICONDUCTOR SOLUTIONS CORPORATION**, Kanagawa (JP)

(72) Inventor: **Yoshitaka Yoshino**, Tokyo (JP)

(73) Assignee: **Sony Semiconductor Solutions Corporation**, Kanagawa (JP)

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

(21) Appl. No.: **18/001,702**

(22) PCT Filed: **Apr. 28, 2021**

(86) PCT No.: **PCT/JP2021/016925**
§ 371 (c)(1),
(2) Date: **Dec. 13, 2022**

(87) PCT Pub. No.: **WO2021/261076**
PCT Pub. Date: **Dec. 30, 2021**

(65) **Prior Publication Data**

US 2023/0238691 A1 Jul. 27, 2023

(30) **Foreign Application Priority Data**

Jun. 22, 2020 (JP) 2020-107199

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/38 (2006.01)
H04B 3/56 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/38*** (2013.01); ***H01Q 1/248*** (2013.01); ***H04B 3/56*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/38; H01Q 1/246; H01Q 1/248; H04B 3/56; H02J 50/001; H02J 50/005; H02J 50/27
See application file for complete search history.

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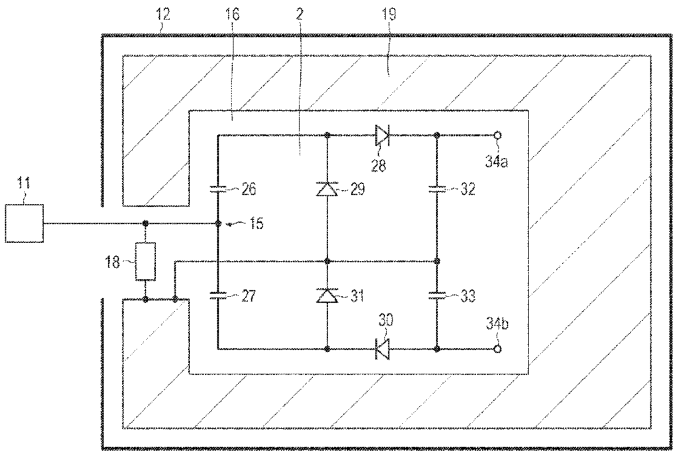
Primary Examiner — David E Lotter
(74) *Attorney, Agent, or Firm* — Sheridan Ross PC

(57) **ABSTRACT**

Provided is an antenna device including an antenna unit including a rectifier circuit that receives electric field energy of a radio wave or a quasi-electrostatic field (near field) in a space and rectifies an AC signal into a direct current, the antenna unit including a first antenna element that is a conductor to be in contact with or connected to an industrial product metal portion and a second antenna element that is a conductor different from the first antenna element and provided not to be electrically connected to the industrial product metal portion, in which an input line output from the first antenna element to a rectifier circuit unit of the AC

(Continued)



US012388177B2

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

(10) **Patent No.: US 12,388,177 B2**
(45) **Date of Patent: Aug. 12, 2025**

(54) **DUAL RESONANT WIDEBAND MEANDERED PCB ANTENNA**

(71) Applicant: **Silicon Laboratories Inc.**, Austin, TX (US)

(72) Inventors: **Marton Komancsik**, Budapest (HU); **Zoltan Vida**, Budapest (HU); **Attila Zolomy**, Budapest (HU)

(73) Assignee: **Silicon Laboratories Inc.**, Austin, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 169 days.

(21) Appl. No.: **18/079,124**

(22) Filed: **Dec. 12, 2022**

(65) **Prior Publication Data**

US 2024/0195063 A1 Jun. 13, 2024

(51) **Int. Cl.**
H01Q 5/10 (2015.01)
H01Q 1/38 (2006.01)
H01Q 1/50 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 5/10*** (2015.01); ***H01Q 1/38*** (2013.01); ***H01Q 1/50*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/38; H01Q 1/50; H01Q 5/10
See application file for complete search history.

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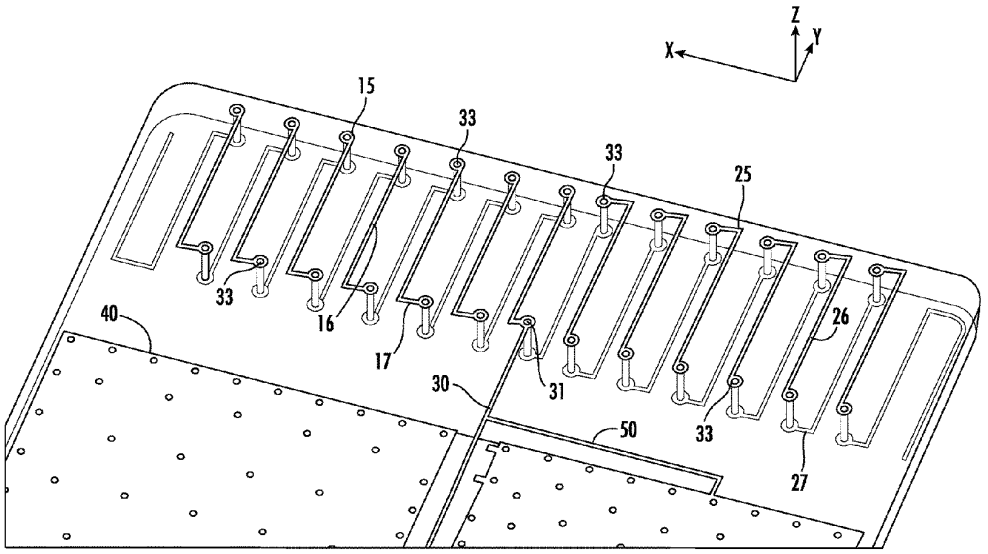
Primary Examiner — Raymond R Chai
(74) *Attorney, Agent, or Firm* — Nields, Lemack & Frame, LLC

(57) **ABSTRACT**

A dual resonant wideband meandered PCB antenna is disclosed. The antenna includes two meandered paths that are joined at a common feeding path. The meandered paths have different lengths, which results in different resonance frequencies. The antenna may also include a short circuit stub connected to the feeding path for impedance matching. In some embodiments, the antenna is formed on one layer of a printed circuit board. In another embodiment, to conserve space, the antenna may be formed on multiple layers of the printed circuit board.

14 Claims, 10 Drawing Sheets



US012388180B2

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

(10) **Patent No.: US 12,388,180 B2**
(45) **Date of Patent: Aug. 12, 2025**

(54) **ANTENNA STRUCTURE AND WIRELESS COMMUNICATION DEVICE HAVING SAME**

(71) Applicants: **Futaijing Precision Electronics (Yantai) Co., Ltd.**, Yantai (CN); **HON HAI PRECISION INDUSTRY CO., LTD.**, New Taipei (TW)

(72) Inventors: **Jia-Ying Xie**, New Taipei (TW); **Jia-Hung Hsiao**, New Taipei (TW)

(73) Assignees: **Futaijing Precision Electronics (Yantai) Co., Ltd.**, Yantai (CN); **HON HAI PRECISION INDUSTRY CO., LTD.**, New Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 256 days.

(21) Appl. No.: **17/868,237**

(22) Filed: **Jul. 19, 2022**

(65) **Prior Publication Data**

US 2023/0070301 A1 Mar. 9, 2023

(30) **Foreign Application Priority Data**

Sep. 7, 2021 (CN) 202111045974.8

(51) **Int. Cl.**
H01Q 5/335 (2015.01)
H01Q 1/24 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 5/335*** (2015.01); ***H01Q 1/243*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/335; H01Q 1/243; H01Q 5/328; H01Q 5/385; H01Q 3/22; H01Q 23/00; H01Q 3/44; H01Q 3/247
See application file for complete search history.

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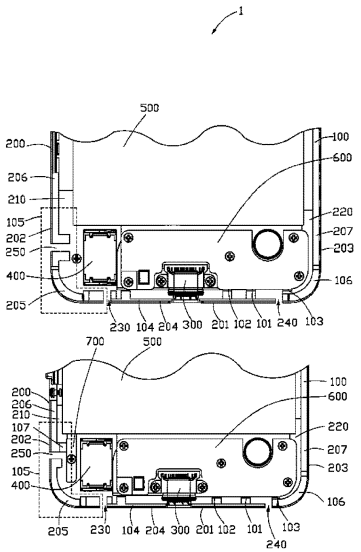
Primary Examiner — Dimary S Lopez Cruz
Assistant Examiner — Bamidele A Immanuel
(74) *Attorney, Agent, or Firm* — ScienBiziP, P.C.

(57) **ABSTRACT**

An antenna structure and a wireless communication device having the antenna structure are provided, the antenna structure includes a metal frame, a feeding portion, a first ground portion, and a second ground portion. The metal frame defines a first gap, a second gap, and a third gap, the metal frame between the first gap and the second gap forms a first radiating portion, the metal frame between the first gap and the third gap and the metal frame on a side of the third gap cooperatively form a second radiating portion, the metal frame on a side of the second gap forms a third radiating portion. The feeding portion is connected to the first radiating portion. The first ground portion is apart from the feeding portion and connected to the first radiating portion. The second ground portion closes to the second gap and is connected to the third radiating portion.

8 Claims, 14 Drawing Sheets



US012388181B2

(12) **United States Patent**
Wu

(10) **Patent No.: US 12,388,181 B2**
(45) **Date of Patent: Aug. 12, 2025**

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

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

(72) Inventor: **Xiaopu Wu**, Guangdong (CN)

(73) Assignee: **GUANGDONG OPPO MOBILE TELECOMMUNICATIONS CORP., LTD.**, Guangdong (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 198 days.

(21) Appl. No.: **18/354,475**

(22) Filed: **Jul. 18, 2023**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. PCT/CN2021/134511, filed on Nov. 30, 2021.

(30) **Foreign Application Priority Data**

Jan. 28, 2021 (CN) 202110122572.7

(51) **Int. Cl.**
H01Q 5/335 (2015.01)
H01Q 1/22 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 5/335*** (2015.01); ***H01Q 1/22*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/342; H01Q 5/35; H01Q 1/241; H01Q 5/378; H01Q 5/40; H01Q 9/42;
(Continued)

(56) **References Cited**

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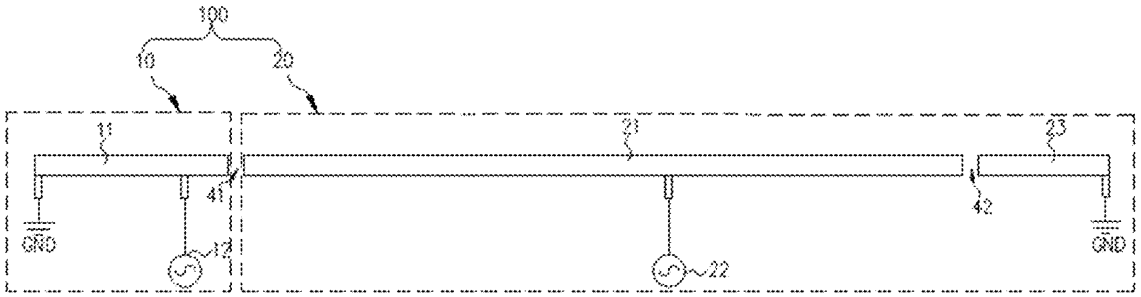
Primary Examiner — Hai V Tran
(74) *Attorney, Agent, or Firm* — Hodgson Russ LLP

(57) **ABSTRACT**

Provided is an antenna assembly and an electronic device. The antenna assembly includes the following. A first antenna including a first radiator and a first signal source electrically connected to the first radiator. A second antenna including a second radiator and a third radiator, one end of the second radiator is spaced apart from one end of the first radiator with a first coupling gap, and the other end of the second radiator is spaced apart from one end of the third radiator with a second coupling gap. The first radiator is configured to generate at least one resonant mode under excitation of the first signal source, and a part of the second radiator that is close to the second coupling gap is configured to generate at least one resonant mode under excitation of the first signal source through coupling of the first radiator.

20 Claims, 16 Drawing Sheets



US012388182B2

(12) **United States Patent**
Wu

(10) **Patent No.: US 12,388,182 B2**
(45) **Date of Patent: Aug. 12, 2025**

(54) **ANTENNA AND ELECTRONIC DEVICE**

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

(72) Inventor: **Xiaopu Wu**, Guangdong (CN)

(73) Assignee: **GUANGDONG OPPO MOBILE TELECOMMUNICATIONS CORP., LTD.**, Guangdong (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 147 days.

(21) Appl. No.: **18/461,616**

(22) Filed: **Sep. 6, 2023**

(65) **Prior Publication Data**

US 2023/0411847 A1 Dec. 21, 2023

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2022/082912, filed on Mar. 25, 2022.

(30) **Foreign Application Priority Data**

Apr. 13, 2021 (CN) 202110396848.0

(51) **Int. Cl.**
H01Q 5/335 (2015.01)
H01Q 5/357 (2015.01)
H03H 7/38 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 5/335*** (2015.01); ***H01Q 5/357*** (2015.01); ***H03H 7/38*** (2013.01)

(58) **Field of Classification Search**
CPC H03H 7/38; H01Q 9/045; H01Q 5/378; H01Q 5/335; H01Q 1/50; H01Q 1/38;
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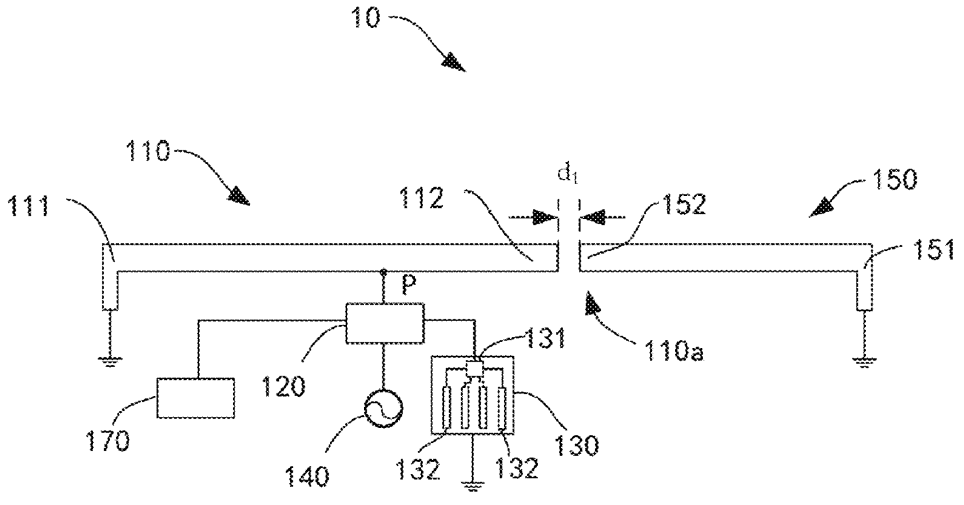
Primary Examiner — Renan Luque
(74) *Attorney, Agent, or Firm* — Hodgson Russ LLP

(57) **ABSTRACT**

An antenna and an electronic device are provided. The antenna includes a first radiator, a matching circuit, a first adjustment circuit, a signal source, and a second radiator. The first adjustment circuit is electrically connected to the matching circuit. The signal source electrically connects the matching circuit to the feed point. A gap is defined between the second radiator and the first radiator, the second radiator is coupled to the first radiator via the gap. The antenna has at least two resonant modes. Transmission/reception of electromagnetic wave signals in a middle band (MB) and a high-band (HB), in an MB of long-term evolution (LTE) and an MB of new radio (NR), or in an HB of LTE and an HB of NR is supported by the at least two resonant modes cooperatively at the same moment.

19 Claims, 11 Drawing Sheets



US012388184B2

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

(10) **Patent No.: US 12,388,184 B2**
(45) **Date of Patent: Aug. 12, 2025**

(54) **ANTENNA ARRANGEMENT**

(71) Applicants: **AGC GLASS EUROPE**, Louvain-la-Neuve (BE); **AGC INC.**, Chiyoda Ku (JP); **AGC FLAT GLASS NORTH AMERICA, INC.**, Alpharetta, GA (US); **AGC VIDROS DO BRASIL LTDA**, Sao Paulo (BR)

(72) Inventors: **Mohsen Yousefbeiki**, Gosselies (BE); **Rafik Addaci**, Gosselies (BE)

(73) Assignees: **AGC GLASS EUROPE**, Louvain-la-Neuve (BE); **AGC INC.**, Chiyoda Ku (JP); **AGC FLAT GLASS NORTH AMERICA, INC.**, Alpharetta, GA (US); **AGC VIDROS DO BRASIL LTDA**, Sao Paulo (BR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 116 days.

(21) Appl. No.: **18/252,204**

(22) PCT Filed: **Nov. 16, 2021**

(86) PCT No.: **PCT/EP2021/081827**
§ 371 (c)(1),
(2) Date: **May 9, 2023**

(87) PCT Pub. No.: **WO2022/101498**
PCT Pub. Date: **May 19, 2022**

(65) **Prior Publication Data**

US 2023/0411855 A1 Dec. 21, 2023

(30) **Foreign Application Priority Data**

Nov. 16, 2020 (EP) 20207878

(51) **Int. Cl.**
H01Q 1/12 (2006.01)
H01Q 1/38 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 9/045*** (2013.01); ***H01Q 1/1271*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 1/42*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 9/045; H01Q 1/1271; H01Q 1/38; H01Q 1/42; H01Q 1/007
See application file for complete search history.

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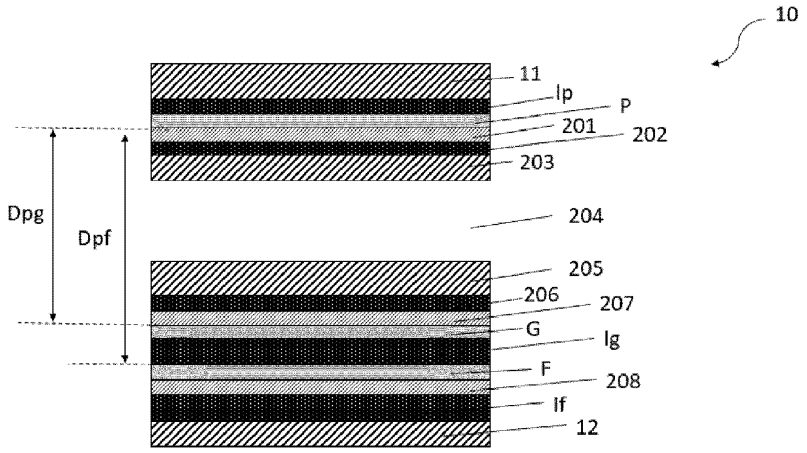
Primary Examiner — David E Lotter
(74) *Attorney, Agent, or Firm* — Oblon, McClelland, Maier & Neustadt, L.L.P.

(57) **ABSTRACT**

An antenna arrangement includes a first transparent dielectric panel and a second transparent dielectric panel. The second transparent dielectric panel is in front of the first transparent dielectric panel and separated by at least one panel interlayer from the first transparent dielectric panel. The antenna arrangement further includes a patch network attached and separated by at least one patch interlayer from the first transparent dielectric panel, a feeding network attached and separated by at least one feed interlayer from
(Continued)



US012388185B2

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

(10) **Patent No.: US 12,388,185 B2**
(45) **Date of Patent: Aug. 12, 2025**

(54) **ANTENNA**

(71) Applicant: **Chengdu Tianma Micro-Electronics Co., Ltd.**, Chengdu (CN)

(72) Inventors: **Zhenyu Jia**, Chengdu (CN); **Kerui Xi**, Chengdu (CN); **Baiquan Lin**, Chengdu (CN); **Linzhi Wang**, Chengdu (CN); **Xiaonan Han**, Chengdu (CN); **Yifan Xing**, Chengdu (CN); **Aowen Li**, Chengdu (CN); **Qiongqin Mao**, Chengdu (CN)

(73) Assignee: **Chengdu Tianma Micro-Electronics Co., Ltd.**, Chengdu (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 111 days.

(21) Appl. No.: **18/407,161**

(22) Filed: **Jan. 8, 2024**

(65) **Prior Publication Data**

US 2025/0007170 A1 Jan. 2, 2025

(30) **Foreign Application Priority Data**

Jun. 29, 2023 (CN) 202310790215.7

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01P 1/18 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 9/045*** (2013.01); ***H01P 1/18*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 9/045; H01Q 1/38; H01Q 1/50; H01Q 1/52; H01Q 3/36; H01P 1/18
See application file for complete search history.

(56) **References Cited**

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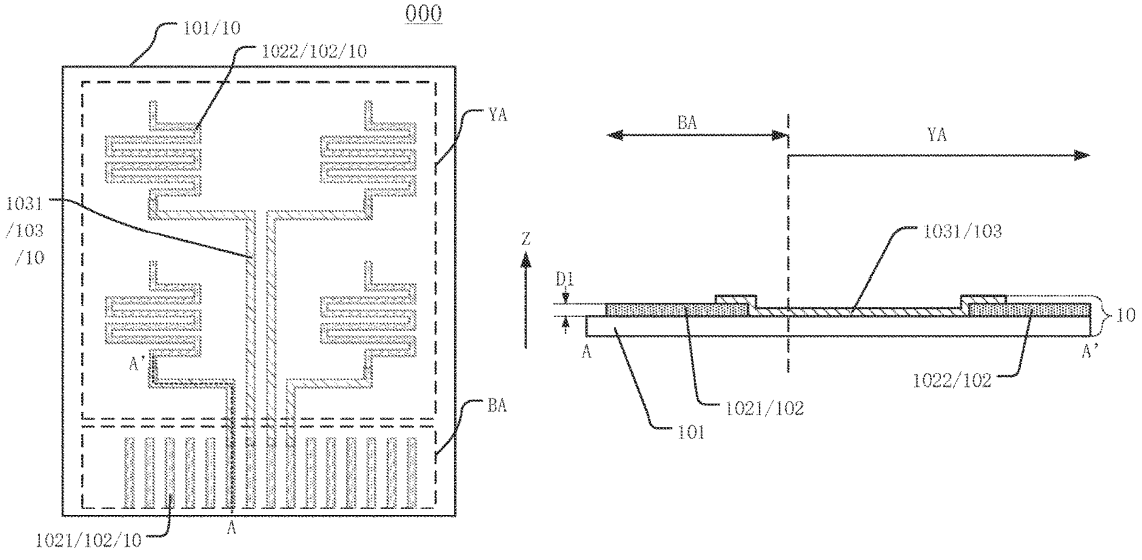
Primary Examiner — Dieu Hien T Duong
(74) *Attorney, Agent, or Firm* — Anova Law Group, PLLC

(57) **ABSTRACT**

An antenna includes a first base plate. The first base plate has a phase shifter array area and a bonding area. The first base plate includes a first substrate, a first metal layer, and a first conductive layer. The first conductive layer is made of a high-resistance conductive material. The first metal layer includes conductive pads and phase shifter units. At least some conductive pads are in the bonding area, and at least some phase shifter units are located in the phase shifter array area. The first conductive layer includes bias voltage lines, and one conductive pad is electrically connected to a corresponding phase shifter unit through at least one bias voltage line. At least some sections of one bias voltage line partially overlap with one corresponding phase shifter unit, and at least some sections of one bias voltage line overlap with one corresponding conductive pad.

20 Claims, 23 Drawing Sheets



US012388195B2

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

(10) **Patent No.: US 12,388,195 B2**
(45) **Date of Patent: Aug. 12, 2025**

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

(71) Applicant: **DELTA ELECTRONICS, INC.**, Taoyuan (TW)

(72) Inventors: **Chieh-Tsao Hwang**, Taoyuan (TW); **Siang-Rong Hsu**, Taoyuan (TW); **Yen-Ting Chen**, Taoyuan (TW)

(73) Assignee: **DELTA ELECTRONICS, INC.**, Taoyuan (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 127 days.

(21) Appl. No.: **18/451,845**

(22) Filed: **Aug. 18, 2023**

(65) **Prior Publication Data**

US 2024/0275032 A1 Aug. 15, 2024

(30) **Foreign Application Priority Data**

Feb. 10, 2023 (CN) 202310093286.1

(51) **Int. Cl.**
H01Q 9/42 (2006.01)
H01Q 5/364 (2015.01)
H01Q 21/28 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 21/28*** (2013.01); ***H01Q 5/364*** (2015.01); ***H01Q 9/42*** (2013.01)

(58) **Field of Classification Search**
CPC .. H01Q 1/36; H01Q 1/38; H01Q 1/48; H01Q 1/50; H01Q 1/52; H01Q 5/364; H01Q 9/42; H01Q 21/00; H01Q 21/28; H01Q 23/00
See application file for complete search history.

(56) **References Cited**

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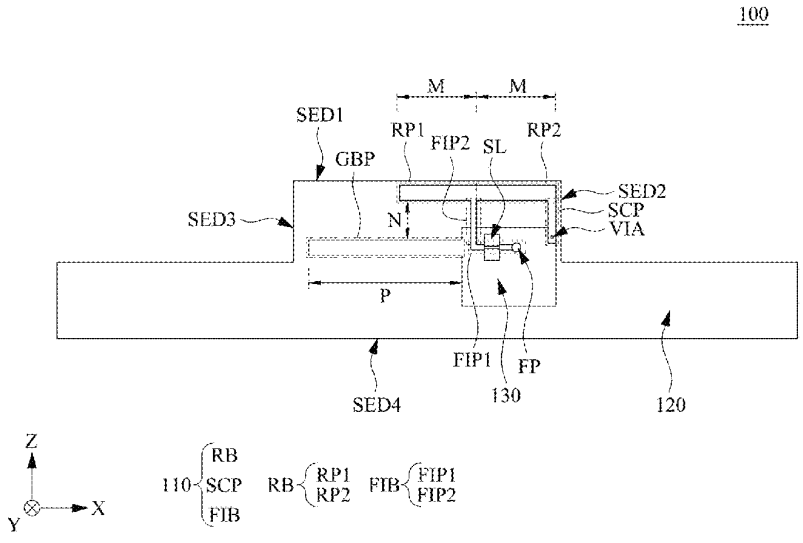
Primary Examiner — Daniel Munoz
(74) *Attorney, Agent, or Firm* — CKC & Partners Co., LLC

(57) **ABSTRACT**

An antenna structure, which comprises a substrate, a ground plane and an antenna element. The substrate comprises a first surface and a second surface opposite to the first surface. The ground plane comprises a ground branch. The antenna element comprises a feed-in body, a radiating body and a short circuit part. The feed-in body is configured for receiving a feed-in signal, wherein projection of a part of the feed-in body to the first surface overlaps with the ground plane. The radiating body comprises a first radiating part and a second radiating part connected to the first radiating part. The short circuit part is connected to the second radiating part, and configured for connecting the ground plane through a via hole.

20 Claims, 15 Drawing Sheets



US012388409B2

(12) **United States Patent**
Kishino

(10) **Patent No.: US 12,388,409 B2**
(45) **Date of Patent: Aug. 12, 2025**

(54) **COMPOSITE FILTER AND COMMUNICATION DEVICE**

(71) Applicant: **KYOCERA Corporation**, Kyoto (JP)

(72) Inventor: **Tetsuya Kishino**, Nara (JP)

(73) Assignee: **KYOCERA Corporation**, Kyoto (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 221 days.

(21) Appl. No.: **18/044,880**

(22) PCT Filed: **Sep. 10, 2021**

(86) PCT No.: **PCT/JP2021/033259**
§ 371 (c)(1),
(2) Date: **Mar. 10, 2023**

(87) PCT Pub. No.: **WO2022/054896**
PCT Pub. Date: **Mar. 17, 2022**

(65) **Prior Publication Data**

US 2023/0344401 A1 Oct. 26, 2023

(30) **Foreign Application Priority Data**

Sep. 11, 2020 (JP) 2020-152617

(51) **Int. Cl.**

H03H 7/46	(2006.01)
H01P 5/22	(2006.01)
H03H 9/64	(2006.01)
H03H 9/72	(2006.01)
H04B 1/00	(2006.01)

(52) **U.S. Cl.**
CPC ***H03H 7/463*** (2013.01); ***H01P 5/227*** (2013.01); ***H03H 9/6483*** (2013.01); ***H03H 9/725*** (2013.01); ***H04B 1/0057*** (2013.01)

(58) **Field of Classification Search**
CPC H03H 7/463; H03H 9/6483; H03H 9/725; H03H 7/46; H03H 9/72; H01P 5/227; H01P 1/397; H04B 1/0057
See application file for complete search history.

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Primary Examiner — Andrea Lindgren Baltzell
Assistant Examiner — Kimberly E Glenn
(74) *Attorney, Agent, or Firm* — Volpe Koenig

(57) **ABSTRACT**

A splitter simultaneously inputs two signals having different frequencies within a transmission band to a transmission terminal. A transmission filter system and a reception filter system that are connected to an antenna terminal share a first hybrid coupler. Two transmission filters and a second hybrid coupler are located between the first hybrid coupler and the transmission terminal. A reception filter is located between the first hybrid coupler and the reception terminal.

8 Claims, 15 Drawing Sheets