US012412980B2

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

(10) **Patent No.: US 12,412,980 B2**
(45) **Date of Patent: Sep. 9, 2025**

(54) **ANTENNA AND ELECTRONIC DEVICE**

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

(72) Inventors: **Chunxin Li**, Beijing (CN); **Qianhong Wu**, Beijing (CN); **Jingwen Guo**, 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.: **18/018,921**

(22) PCT Filed: **Feb. 25, 2022**

(86) PCT No.: **PCT/CN2022/077850**
§ 371 (c)(1),
(2) Date: **Jan. 31, 2023**

(87) PCT Pub. No.: **WO2023/159457**
PCT Pub. Date: **Aug. 31, 2023**

(65) **Prior Publication Data**

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(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01H 59/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 9/0407*** (2013.01); ***H01H 59/00*** (2013.01); ***H01Q 1/22*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 21/065*** (2013.01); ***H01Q 23/00*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 9/0407; H01Q 1/22; H01Q 21/065; H01Q 23/00; H01H 59/00
See application file for complete search history.

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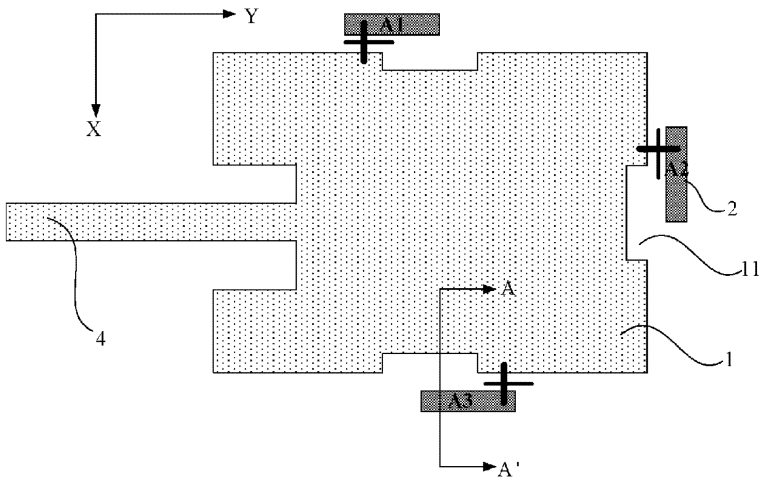
Primary Examiner — Hai V Tran
(74) *Attorney, Agent, or Firm* — HOUTTEMAN LAW LLC

(57) **ABSTRACT**

The present disclosure provides an antenna and electronic device. The antenna includes a dielectric substrate, and a first radiation patch, at least one second radiation patch and a feed unit disposed on the dielectric substrate; the feed unit is electrically connected with the first radiation patch; a switch unit is arranged between each second radiation patch and the first radiation patch; the switch unit includes a driving electrode and a membrane bridge arranged on the dielectric substrate, a bridge deck of the membrane bridge is suspended on a side, away from the dielectric substrate, of the driving electrode, and an insulating layer covers on a side, close to the bridge deck, of the driving electrode; the switch unit is configured to control whether the membrane bridge allows a current between the first radiation patch and the second radiation patch by controlling a voltage applied to the driving electrode.

20 Claims, 6 Drawing Sheets



US012412982B2

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

(10) **Patent No.: US 12,412,982 B2**
(45) **Date of Patent: Sep. 9, 2025**

(54) **PLANAR INVERTED-F ANTENNA SUPPORTING COMMUNICATION OF WIRELESS BROADBAND SIGNALS AND LOCATION SIGNALS WITHIN A SINGLE ELEMENT**

(71) Applicant: **PetPace LTD.**, Shefayim (IL)

(72) Inventors: **Lior Abraham**, Shefayim (IL); **Asaf Dagan**, Shefayim (IL); **Oren Elimelech**, Shefayim (IL)

(73) Assignee: **PetPace LTD**, Shefayim (IL)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 248 days.

(21) Appl. No.: **18/138,746**

(22) Filed: **Apr. 25, 2023**

(65) **Prior Publication Data**

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

(52) **U.S. Cl.**
CPC ***H01Q 9/0414*** (2013.01); ***H01Q 9/0421*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 9/0414; H01Q 9/0421; H01Q 1/243; H01Q 5/371
See application file for complete search history.

(56) **References Cited**

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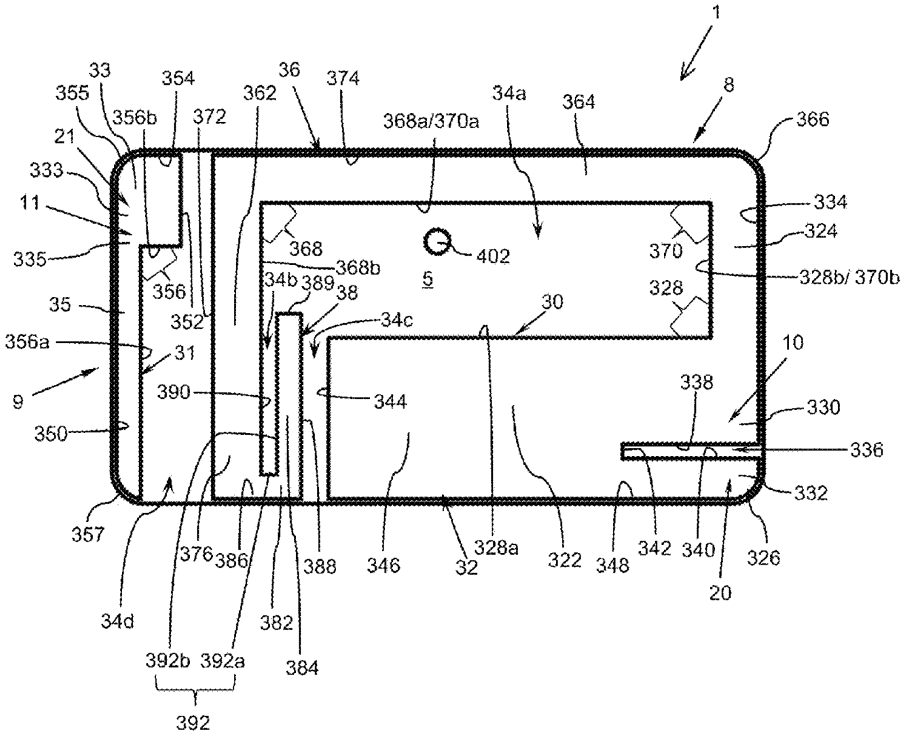
Primary Examiner — Dieu Hien T Duong
(74) *Attorney, Agent, or Firm* — Rivka Friedman

(57) **ABSTRACT**

A planar inverted-F antenna has a first planar radiating element, a first feed element electrically connected to a first area of the first planar radiating element, and a first ground element electrically connected to a second area of the first planar radiating element. The first planar radiating element is a multi-band radiating element configured to operate at a plurality of frequency bands including at least one frequency band at which location signals are communicated and multiple frequency bands at which wireless broadband signals are communicated. The first planar radiating element supports, within a single radiating element, communication of location signals and communication of wireless broadband signals. In certain embodiments, the first planar radiating element has a first substantially L-shaped region, a second substantially L-shaped region inverted with respect to, and forming a continuation of, the first region, and a third region forming a continuation of the first or second region.

20 Claims, 14 Drawing Sheets



US012412988B2

(12) **United States Patent**
Sudo

(10) **Patent No.: US 12,412,988 B2**
(45) **Date of Patent: Sep. 9, 2025**

(54) **ANTENNA MODULE AND COMMUNICATION DEVICE MOUNTED WITH SAME**

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

(72) Inventor: **Kaoru Sudo**, Nagaokakyo (JP)

(73) Assignee: **MURATA MANUFACTURING CO., LTD.**, Nagaokakyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 81 days.

(21) Appl. No.: **18/581,392**

(22) Filed: **Feb. 20, 2024**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. PCT/JP2022/029278, filed on Jul. 29, 2022.

(30) **Foreign Application Priority Data**

Sep. 22, 2021 (JP) 2021-154353

(51) **Int. Cl.**
H01Q 13/08 (2006.01)
H01Q 1/40 (2006.01)
H01Q 21/28 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 13/08*** (2013.01); ***H01Q 1/40*** (2013.01); ***H01Q 21/28*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 13/08; H01Q 1/40; H01Q 21/28
See application file for complete search history.

(56) **References Cited**

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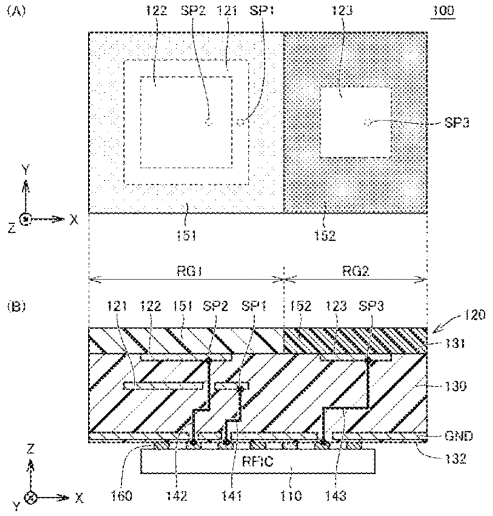
Primary Examiner — Henry Luong
(74) *Attorney, Agent, or Firm* — XSENSUS LLP

(57) **ABSTRACT**

An antenna module includes a dielectric substrate that has an upper surface and a lower surface; radiating elements that have a flat-plate shape; and dielectric layers. The radiating elements are arranged in the dielectric substrate and can radiate respective radio waves in mutually-different frequency bands. The dielectric layer is arranged in a manner to cover a first region in which the radiating element is arranged. The dielectric layer is arranged in a manner to cover a second region in which the radiating element is arranged. Dielectric constants of the dielectric layers are higher than a dielectric constant of the dielectric substrate. The first region and the second region are adjacent to each other. The radiating element overlaps with the radiating element or the radiating element in plan view in a normal direction of the dielectric.

20 Claims, 11 Drawing Sheets



US012413254B2

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

(10) **Patent No.: US 12,413,254 B2**
(45) **Date of Patent: Sep. 9, 2025**

(54) **ELECTRONIC DEVICE INCLUDING ANTENNA**

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

(72) Inventors: **Changha Yu**, Suwon-si (KR); **Yunsik Kim**, Suwon-si (KR); **Woosuk Kang**, Suwon-si (KR); **Mincheol Seo**, Suwon-si (KR); **Gyubok Park**, Suwon-si (KR); **Donghun Shin**, Suwon-si (KR); **Minkyung Lee**, 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 389 days.

(21) Appl. No.: **18/098,332**

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

(65) **Prior Publication Data**

US 2023/0253992 A1 Aug. 10, 2023

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2022/020297, filed on Dec. 14, 2022.

(30) **Foreign Application Priority Data**

Feb. 8, 2022 (KR) 10-2022-0016196

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

(52) **U.S. Cl.**
CPC ***H04B 1/0064*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 9/045*** (2013.01); ***H01Q 21/30*** (2013.01); ***H04M 1/0277*** (2013.01)

(58) **Field of Classification Search**
CPC H04B 1/0064; H01Q 1/243; H01Q 1/48; H01Q 9/045; H01Q 21/30; H01Q 5/328;
(Continued)

(56) **References Cited**

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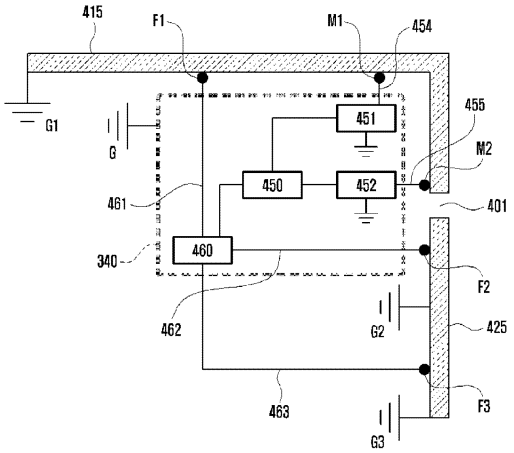
Primary Examiner — Nizar N Sivji
(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye P.C.

(57) **ABSTRACT**

An electronic device may include a housing including a first side surface and a second side surface; a support member disposed inside the housing and connected to a part of the first and second side surfaces; a first opening formed between the first side surface and the support member, and a second opening formed among a part of the first side surface, the second side surface, and the support member; a printed circuit board disposed on the support member and having a ground; a first conductive portion disposed between a first segmenting portion formed in the first side surface and a second segmenting portion formed in the second side surface, and including a first ground portion, a first feeding point, a first point, and/or a second point; a second conductive portion disposed between the first segmenting portion and a third segmenting portion formed in the first side
(Continued)



US012418098B2

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

(10) **Patent No.: US 12,418,098 B2**
(45) **Date of Patent: *Sep. 16, 2025**

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

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

(72) Inventors: **Seongyong An**, Suwon-si (KR); **Hyeonuk Kang**, Suwon-si (KR); **Jiho Kim**, Suwon-si (KR); **Kyungmoon Seol**, Suwon-si (KR); **Kyihyun Jang**, Suwon-si (KR); **Jaebong Chun**, Suwon-si (KR)

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

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

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **18/624,302**

(22) Filed: **Apr. 2, 2024**

(65) **Prior Publication Data**

US 2024/0250409 A1 Jul. 25, 2024

Related U.S. Application Data

(63) Continuation of application No. 17/511,910, filed on Oct. 27, 2021, now Pat. No. 11,949,149, which is a (Continued)

(30) **Foreign Application Priority Data**

Oct. 30, 2020 (KR) 10-2020-0143807

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 1/38	(2006.01)
H04B 1/38	(2015.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/24*** (2013.01); ***H01Q 1/38*** (2013.01); ***H04B 1/38*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/24; H01Q 1/38; H04B 1/38
See application file for complete search history.

(56) **References Cited**

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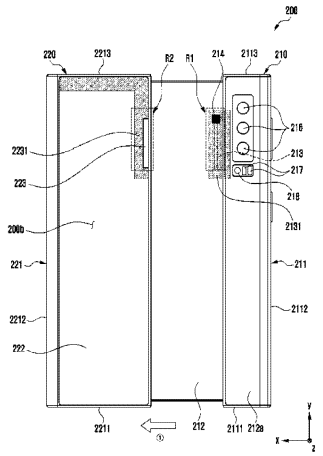
U.S. Appl. No. 17/511,910, filed Oct. 27, 2021, An et al.
(Continued)

Primary Examiner — Raymond S Dean
(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye P.C.

(57) **ABSTRACT**

According to various embodiments, an electronic device includes: a first housing including a first area, a second housing coupled to be slidable in a first direction from the first housing and including a second area overlapping the first area in a slide-in state, an antenna structure disposed in the first housing to overlap the first area when the first housing is viewed from the top, a conductive part disposed in the second area and electromagnetically connected to the antenna structure in the slide-in state, and wireless communication circuitry electrically connected to the antenna structure. The wireless communication circuitry may be configured to transmit and/or receive radio signals in at least one designated frequency band through the antenna structure and the conductive part in the slide-in state.

20 Claims, 18 Drawing Sheets



US012418099B2

(12) **United States Patent**
Wu

(10) **Patent No.: US 12,418,099 B2**
(45) **Date of Patent: Sep. 16, 2025**

(54) **ANTENNA DEVICE AND MOBILE TERMINAL**

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

(72) Inventor: **Xiaopu Wu**, 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 86 days.

(21) Appl. No.: **18/385,051**

(22) Filed: **Oct. 30, 2023**

(65) **Prior Publication Data**

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Related U.S. Application Data

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/48 (2006.01)
H01Q 5/35 (2015.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 5/35*** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/48; H01Q 5/35; H01Q 3/24; H01Q 21/28; H01Q 9/42; H01Q 1/242; H01Q 1/36; H01Q 5/307; H01Q 21/00
See application file for complete search history.

(56) **References Cited**

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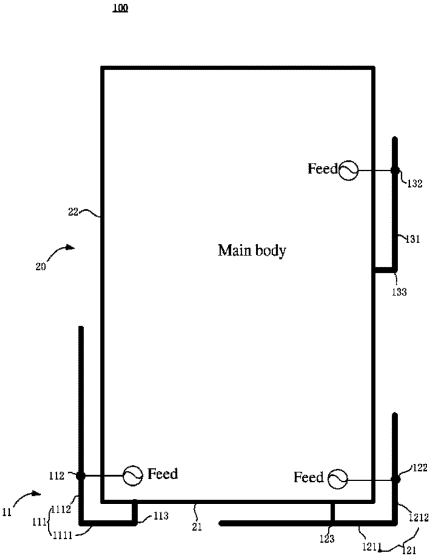
Primary Examiner — Seung H Lee
(74) *Attorney, Agent, or Firm* — Sheppard, Mullin, Richter &Hampton LLP

(57) **ABSTRACT**

Provided is an antenna device. The antenna device includes a first antenna. The first antenna includes a first radiator. The first radiator includes a first branch and a second branch that are connected to each other. The second branch bends and extends from an end of the first branch. The first antenna supports both a first operation mode and a second operation mode. The first antenna covers a bandwidth greater than 190 MHz by using the first operation mode and the second operation mode together. In addition, a mobile terminal is provided.

18 Claims, 10 Drawing Sheets



US012418100B2

(12) **United States Patent**
Wu

(10) **Patent No.: US 12,418,100 B2**
(45) **Date of Patent: Sep. 16, 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 127 days.

(21) Appl. No.: **18/503,330**

(22) Filed: **Nov. 7, 2023**

(65) **Prior Publication Data**

US 2024/0072418 A1 Feb. 29, 2024

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2022/086365, filed on Apr. 12, 2022.

(30) **Foreign Application Priority Data**

May 26, 2021 (CN) 202110582433.2

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

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 5/335*** (2015.01); ***H03H 7/38*** (2013.01); ***H04B 1/0064*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 5/335; H01Q 5/35; H03H 7/38; H04B 1/0064
See application file for complete search history.

(56) **References Cited**

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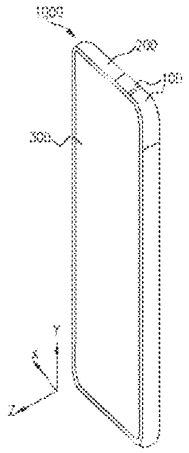
WIPO, International Search Report and Written Opinion for International Application No. PCT/CN2022/086365, Jul. 18, 2022.
(Continued)

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

(57) **ABSTRACT**

Provided are an antenna assembly and an electronic device. The antenna assembly includes a first radiator, a second radiator, a first matching module, a first feeding module, a second matching module, and a second feeding module. The first radiator has a first ground end, a first coupling end, and a first feeding point. The second radiator has a second coupling end, a second ground end, and a second feed point. A first coupling gap is defined between the second coupling end and the first coupling end. The first matching module is electrically connected between the first feeding point and the first feeding module. The second matching module is electrically connected between the second feeding point and the second feeding module. The first radiator and the second radiator support multiple resonant modes, where at least one resonant mode is a ⅛ to ¼ wavelength mode.

20 Claims, 25 Drawing Sheets



US012418111B2

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

(10) **Patent No.: US 12,418,111 B2**
(45) **Date of Patent: Sep. 16, 2025**

(54) **ANTENNA STRUCTURE**

(71) Applicant: **Quanta Computer Inc.**, Taoyuan (TW)

(72) Inventors: **Chun-I Lin**, Taoyuan (TW); **Bo-Wei Lin**, Taoyuan (TW)

(73) Assignee: **QUANTA COMPUTER 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 153 days.

(21) Appl. No.: **18/500,384**

(22) Filed: **Nov. 2, 2023**

(65) **Prior Publication Data**

US 2025/0112363 A1 Apr. 3, 2025

(30) **Foreign Application Priority Data**

Sep. 28, 2023 (TW) 112137402

(51) **Int. Cl.**
H01Q 5/307 (2015.01)
H01Q 1/48 (2006.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 5/307*** (2015.01); ***H01Q 1/48*** (2013.01); ***H01Q 9/0421*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/48; H01Q 5/307; H01Q 5/371; H01Q 5/378; H01Q 9/0421; H01Q 9/42
See application file for complete search history.

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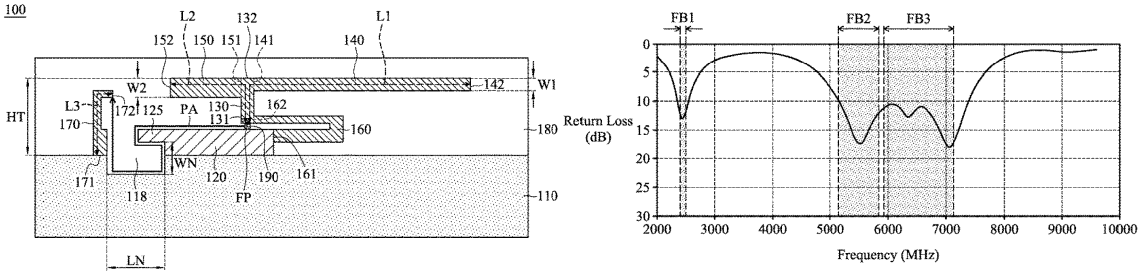
Primary Examiner — Sean Kayes
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

An antenna structure includes a main ground element, an extension ground element, a feeding radiation element, a first radiation element, a second radiation element, a shorting radiation element, a third radiation element, and a dielectric substrate. The extension ground element is coupled to the main ground element. A notch region is defined by the main ground element and the extension ground element. The feeding radiation element has a feeding point. The first radiation element is coupled to the feeding radiation element. The second radiation element is coupled to the feeding radiation element. The second radiation element and the first radiation element substantially extend in opposite directions. The feeding radiation element is also coupled through the shorting radiation element to the extension ground element. The third radiation element is coupled to the main ground element.

9 Claims, 4 Drawing Sheets



US012418113B2

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

(10) **Patent No.: US 12,418,113 B2**
(45) **Date of Patent: Sep. 16, 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 104 days.

(21) Appl. No.: **18/404,879**

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

(65) **Prior Publication Data**

US 2024/0332801 A1 Oct. 3, 2024

(30) **Foreign Application Priority Data**

Mar. 28, 2023 (CN) 202320631225.1

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

(52) **U.S. Cl.**
CPC ***H01Q 9/0414*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/48*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 9/0414; H01Q 1/243; H01Q 1/48
See application file for complete search history.

(56) **References Cited**

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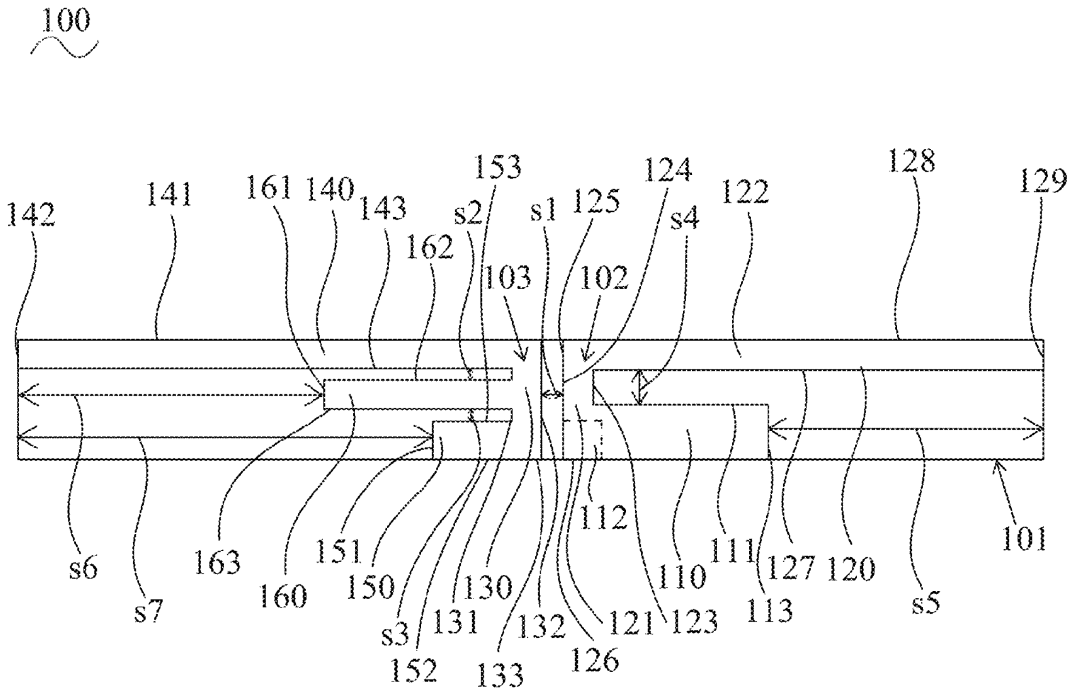
Primary Examiner — Graham P Smith
(74) *Attorney, Agent, or Firm* — Cheng-Ju Chiang

(57) **ABSTRACT**

A multiband printed antenna includes a radiation unit and a grounding unit. The radiation unit is arranged at a right of a circuit board. The radiation unit includes a first radiation part, and a second radiation part which is extended upward and then is bent rightward from a left of a top edge of the first radiation part. The grounding unit is arranged at a left of the circuit board. The grounding unit is separated from the radiation unit. The grounding unit includes a first extension, a second extension straightly extended leftward from a top of a first left edge of the first extension, a grounding part straightly extended leftward from a bottom of the first left edge of the first extension, and a third extension straightly extended leftward from a middle of the first left edge of the first extension.

9 Claims, 6 Drawing Sheets



US012406830B2

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

(10) **Patent No.: US 12,406,830 B2**
(45) **Date of Patent: Sep. 2, 2025**

(54) **APPARATUS FOR TREATING SUBSTRATE AND METHOD FOR TREATING SUBSTRATE**

(71) Applicant: **SEMES CO., LTD.**, Chungcheongnam-do (KR)

(72) Inventors: **Sun Ryum Lee**, Chungcheongnam-do (KR); **Loung Sue Chang**, Chungcheongnam-do (KR); **Jung Yoon Yang**, Chungcheongnam-do (KR); **In Seong Lim**, Gyeonggi-do (KR); **Seung Hoon Jeon**, Gyeonggi-do (KR)

(73) Assignee: **SEMES CO., LTD.**, Chungcheongnam-Do (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 730 days.

(21) Appl. No.: **17/547,303**

(22) Filed: **Dec. 10, 2021**

(65) **Prior Publication Data**

US 2022/0199364 A1 Jun. 23, 2022

(30) **Foreign Application Priority Data**

Dec. 21, 2020 (KR) 10-2020-0180320

(51) **Int. Cl.**
H01J 37/32 (2006.01)

(52) **U.S. Cl.**
CPC ***H01J 37/3222*** (2013.01); ***H01J 37/3244*** (2013.01)

(58) **Field of Classification Search**
CPC H01J 37/3222; H01J 37/3244
USPC ..... 118/723 AN
See application file for complete search history.

(56) **References Cited**

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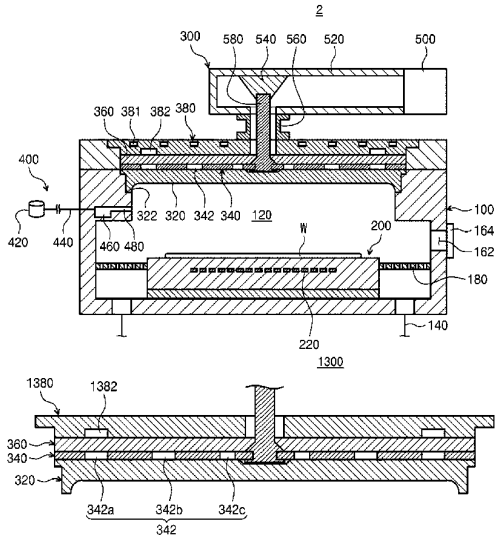
Primary Examiner — Charlee J. C. Bennett
(74) *Attorney, Agent, or Firm* — Carter, DeLuca & Farrell LLP

(57) **ABSTRACT**

Disclosed is a microwave application unit for applying a microwave to generate plasma. The microwave application unit includes an antenna plate disposed on the support unit and having a plurality of slots; a power supply configured to apply a microwave to the antenna plate; a dielectric plate disposed above the antenna plate to face the antenna plate; an upper plate disposed above the dielectric plate; and a transmissive plate provided below the antenna plate and configured to transmit the microwave to the processing space, wherein an adjustment groove configured to adjust an electric field is formed on an lower surface of the upper plate.

17 Claims, 13 Drawing Sheets



US012407086B2

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

(10) **Patent No.: US 12,407,086 B2**
(45) **Date of Patent: Sep. 2, 2025**

(54) **ELECTRONIC DEVICE**

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

(72) Inventors: **Chien-Yi Wu**, Taipei (TW); **Chao-Hsu Wu**, Taipei (TW); **Chih-Wei Liao**, Taipei (TW); **Hau Yuen Tan**, Taipei (TW); **Shih-Keng Huang**, Taipei (TW); **Wen-Hgin Chuang**, Taipei (TW); **Lin-Hsu Chiang**, Taipei (TW); **Chang-Hua Wu**, Taipei (TW); **Han-Wei Wang**, Taipei (TW); **Chun-Jung Hu**, Taipei (TW)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 261 days.

(21) Appl. No.: **18/364,362**

(22) Filed: **Aug. 2, 2023**

(65) **Prior Publication Data**

US 2024/0079758 A1 Mar. 7, 2024

(30) **Foreign Application Priority Data**

Sep. 2, 2022 (TW) 111133432

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

(52) **U.S. Cl.**
CPC ***H01Q 1/2266*** (2013.01); ***H01Q 1/36*** (2013.01); ***H01Q 9/0407*** (2013.01); ***H01Q 21/28*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/2266; H01Q 9/0407; H01Q 21/28; H01Q 1/48; H01Q 1/243; H01Q 9/0421; H01Q 9/42
See application file for complete search history.

(56) **References Cited**

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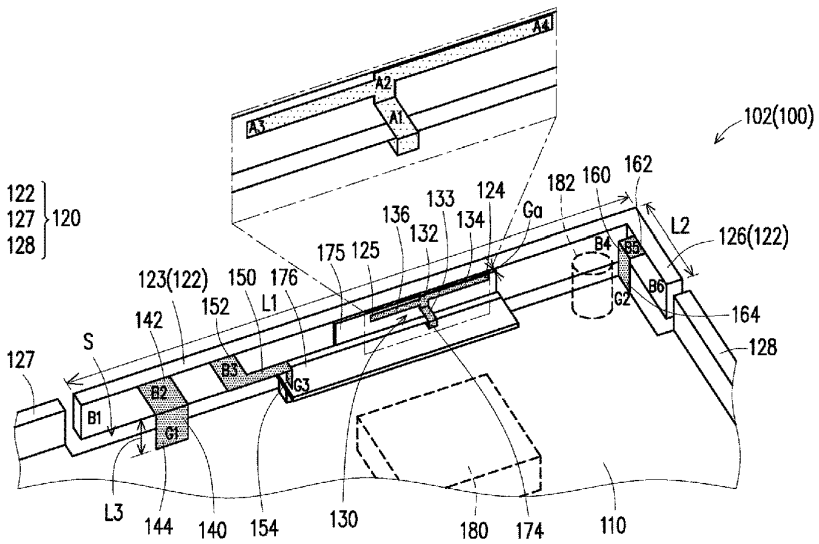
* cited by examiner

Primary Examiner — Dimary S Lopez Cruz
Assistant Examiner — Anna N Hamadyk
(74) *Attorney, Agent, or Firm* — J.C. PATENTS

(57) **ABSTRACT**

An electronic device includes a metal back cover, a metal frame, and a first, second, third, and fourth radiators. The metal frame includes a discrete part and two connection parts. The connection parts are located by two sides of the discrete part, separated from the discrete part, and connected to the metal back cover. A U-shaped slot is formed between the discrete part and the metal back cover and between the discrete part and the connection parts. The first radiator is separated from the discrete part and includes a feed end. The second, third, and fourth radiators are connected to the discrete part and the metal back cover. The third radiator is located between the first and second radiators. The first radiator is located between the third and fourth radiators. The discrete part and the first, second, third, and fourth radiators form an antenna module together.

11 Claims, 5 Drawing Sheets



US012407102B2

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

(10) **Patent No.: US 12,407,102 B2**
(45) **Date of Patent: Sep. 2, 2025**

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

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

(72) Inventors: **Ning Ma**, Shenzhen (CN); **Ben Lai**, Wuhan (CN); **Dong Yu**, Shanghai (CN); **Pengfei Wu**, Shanghai (CN); **Yuan Zhou**, 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 194 days.

(21) Appl. No.: **18/043,278**

(22) PCT Filed: **Aug. 2, 2021**

(86) PCT No.: **PCT/CN2021/110098**
§ 371 (c)(1),
(2) Date: **Feb. 27, 2023**

(87) PCT Pub. No.: **WO2022/042219**
PCT Pub. Date: **Mar. 3, 2022**

(65) **Prior Publication Data**

US 2023/0335908 A1 Oct. 19, 2023

(30) **Foreign Application Priority Data**

Aug. 28, 2020 (CN) 202010884837.2

(51) **Int. Cl.**
H01Q 5/35 (2015.01)
H01Q 1/22 (2006.01)
H01Q 1/24 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 5/35*** (2015.01); ***H01Q 1/2291*** (2013.01); ***H01Q 1/245*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 9/0442; H01Q 1/2291; H01Q 1/48; H01Q 1/243; H01Q 1/245; H01Q 5/328;
(Continued)

(56) **References Cited**

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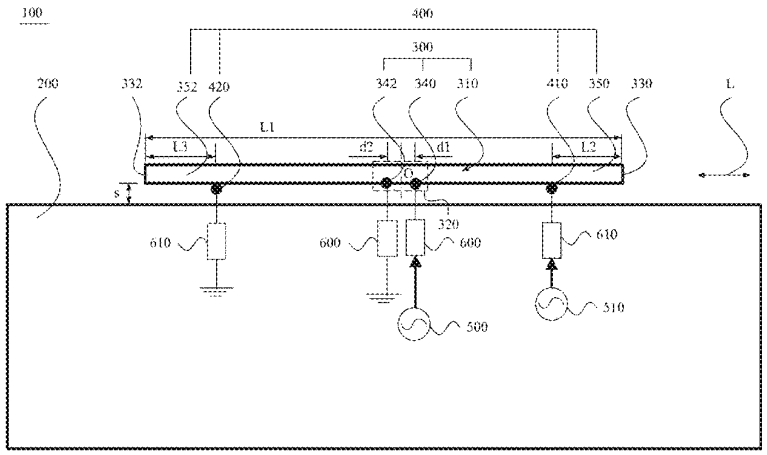
Primary Examiner — Dimary S Lopez Cruz
Assistant Examiner — Anna N Hamadyk
(74) *Attorney, Agent, or Firm* — Fish & Richardson P.C.

(57) **ABSTRACT**

An example antenna system includes a first antenna including a strip-shaped antenna radiator. The antenna radiator has a first end and a second end. At least one of a first radiator section in which the first end is located or a second radiator section in which the second end is located is used as a radiator of a second antenna. One of two first filters is connected between the first antenna radio frequency source and an antenna feed point, and the other first filter is connected between a ground and an antenna ground point. One of two second filters is connected between the second antenna radio frequency source and at least one of the first
(Continued)



US012407103B2

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

(10) **Patent No.: US 12,407,103 B2**
(45) **Date of Patent: Sep. 2, 2025**

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

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

(72) Inventors: **Zhe-You Qian**, Hsinchu (TW); **Shih-Chiang Wei**, Hsinchu (TW); **Hsieh-Chih Lin**, 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 119 days.

(21) Appl. No.: **18/423,401**

(22) Filed: **Jan. 26, 2024**

(65) **Prior Publication Data**

US 2024/0304991 A1 Sep. 12, 2024

(30) **Foreign Application Priority Data**

Mar. 8, 2023 (TW) 112108394

(51) **Int. Cl.**
H01Q 5/378 (2015.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 5/378*** (2015.01); ***H01Q 9/0421*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/378; H01Q 9/0421; H01Q 5/328; H01Q 1/243
See application file for complete search history.

(56) **References Cited**

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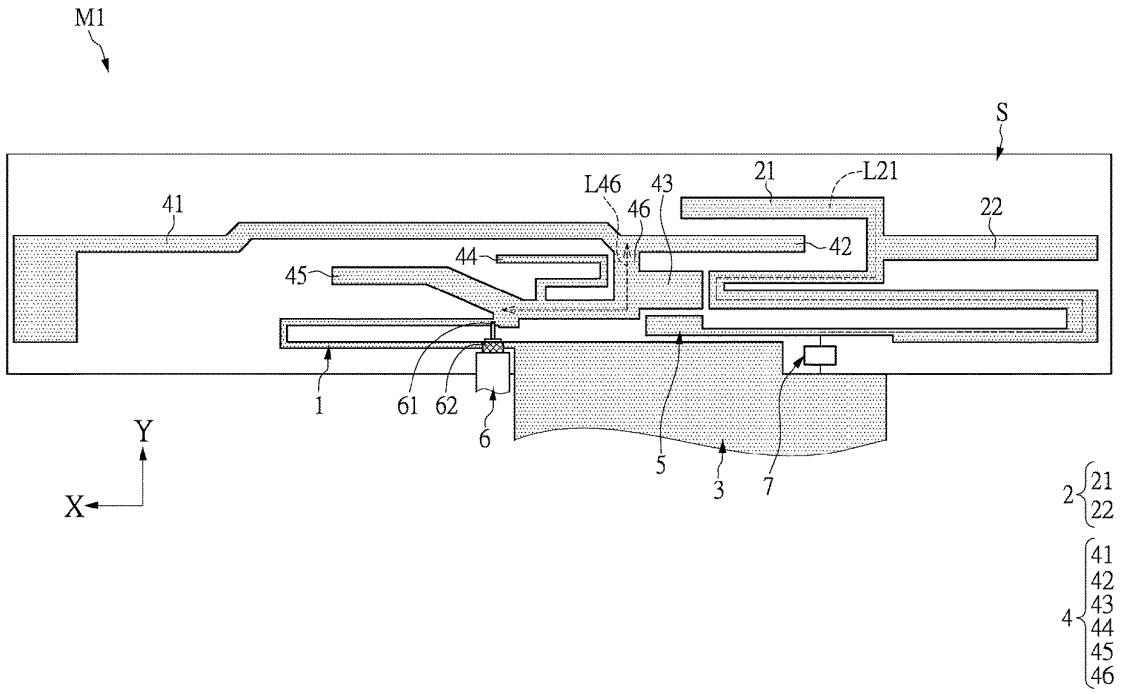
Primary Examiner — Dieu T Duong
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

An electronic device includes a housing and an antenna structure disposed in the housing. The antenna structure includes a grounding element, a shorting radiation element, a feeding radiation element, a radiating element, a parasitic radiation element, and a feeding element. The shorting radiation element is connected to the grounding element. The feeding radiation element includes a feeding portion, a first radiating portion, a second radiating portion, and a third radiating portion. The feeding portion is connected to the shorting radiation element, the first radiating portion, the second radiating portion, and the third radiating portion. The radiating element is connected to the grounding element. The parasitic radiation element is connected to the radiating element. The parasitic radiation element is located between the third radiating portion and the grounding element.

19 Claims, 9 Drawing Sheets



US012407105B2

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

(10) **Patent No.: US 12,407,105 B2**
(45) **Date of Patent: Sep. 2, 2025**

(54) **TRI-BAND ANTENNA MODULE**

(71) Applicant: **Arcadyan Technology Corporation**, Hsinchu (TW)

(72) Inventors: **Ting-Ren Li**, Hsinchu County (TW); **Kuo-Chang Lo**, Miaoli County (TW)

(73) Assignee: **Arcadyan Technology Corporation** (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 148 days.

(21) Appl. No.: **18/139,332**

(22) Filed: **Apr. 25, 2023**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

May 16, 2022 (TW) 111118223

(51) **Int. Cl.**
H01Q 5/307 (2015.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 9/0421*** (2013.01); ***H01Q 5/307*** (2015.01)

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

(56) **References Cited**

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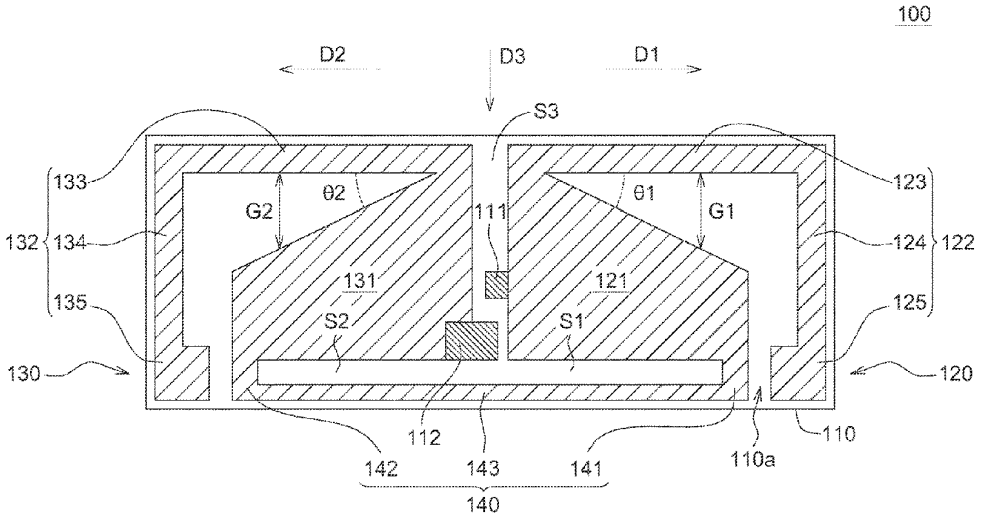
Primary Examiner — Dameon E Levi
Assistant Examiner — Anh N Ho
(74) *Attorney, Agent, or Firm* — Innovation Counsel LLP

(57) **ABSTRACT**

A tri-band antenna module includes a substrate, a first radiator, a second radiator, and a short-circuit structure. The substrate has a signal feed-in terminal and a ground terminal. The signal feed-in terminal is connected to the first radiator, and the ground terminal is connected to the second radiator. The first radiator includes a first extension block and a second extension block, and the second radiator includes a third extension block and a fourth extension block. The first extension block and the second extension block are separated by a first interval, and the third extension block and the fourth extension block are separated by a second interval. The short-circuit structure is connected between the first extension block and the third extension block, and the short-circuit structure is respectively separated from the first extension block and the third extension block by a first slot and a second slot.

13 Claims, 6 Drawing Sheets



US012407110B2

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

(10) **Patent No.: US 12,407,110 B2**
(45) **Date of Patent: Sep. 2, 2025**

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

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

(72) Inventors: **Jikang Wang**, Shanghai (CN); **Laiwei Shen**, Shanghai (CN); **Jiaming Wang**, Shanghai (CN); **Liang Xue**, 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 245 days.

(21) Appl. No.: **18/259,581**

(22) PCT Filed: **Dec. 29, 2021**

(86) PCT No.: **PCT/CN2021/142660**
§ 371 (c)(1),
(2) Date: **Jun. 27, 2023**

(87) PCT Pub. No.: **WO2022/143803**
PCT Pub. Date: **Jul. 7, 2022**

(65) **Prior Publication Data**

US 2024/0055778 A1 Feb. 15, 2024

(30) **Foreign Application Priority Data**

Dec. 30, 2020 (CN) 202011628760.9

(51) **Int. Cl.**
H01Q 21/28 (2006.01)
H01Q 21/30 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 21/28*** (2013.01); ***H01Q 21/30*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 7/00; H01Q 9/26; H01Q 13/10; H01Q 21/0006; H01Q 21/24; H01Q 21/28; H01Q 21/29; H01Q 21/30
See application file for complete search history.

(56) **References Cited**

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2022/0166132	A1 *	5/2022	Chu	H04B 1/0064

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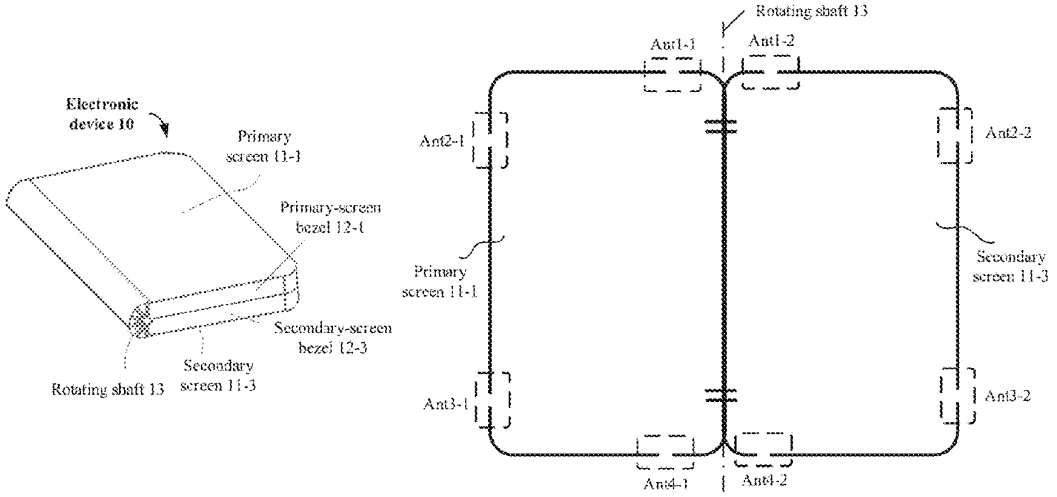
Primary Examiner — Raymond R Chai

(57) **ABSTRACT**

A foldable electronic device having a primary screen portion with a primary-screen antenna, and a secondary screen portion with a secondary-screen antenna. Positions of the primary-screen antenna and the secondary-screen antenna overlap when the electronic device is folded. The primary-screen antenna and the secondary-screen antenna may excite two antenna patterns of high isolation. In this way, even if the primary-screen antenna and the secondary-screen antenna operate on a same frequency band and overlap, good isolation performance can also be obtained.

20 Claims, 28 Drawing Sheets



US012407112B2

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

(10) **Patent No.: US 12,407,112 B2**
(45) **Date of Patent: Sep. 2, 2025**

(54) **ANTENNA, ULTRA WIDE BAND ANTENNA ARRAY, AND ELECTRONIC DEVICE**

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

(72) Inventors: **Yu Wang**, Shenzhen (CN); **Zhijun Zhang**, 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 0 days.

(21) Appl. No.: **18/275,497**

(22) PCT Filed: **Dec. 14, 2022**

(86) PCT No.: **PCT/CN2022/138846**
§ 371 (c)(1),
(2) Date: **Aug. 2, 2023**

(87) PCT Pub. No.: **WO2023/179113**
PCT Pub. Date: **Sep. 28, 2023**

(65) **Prior Publication Data**

US 2024/0380130 A1 Nov. 14, 2024

(30) **Foreign Application Priority Data**

Mar. 24, 2022 (CN) 202210295360.3

(51) **Int. Cl.**
H01Q 21/30 (2006.01)
H01Q 1/22 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 21/30*** (2013.01); ***H01Q 1/22*** (2013.01); ***H01Q 9/0414*** (2013.01);
(Continued)

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

(56) **References Cited**

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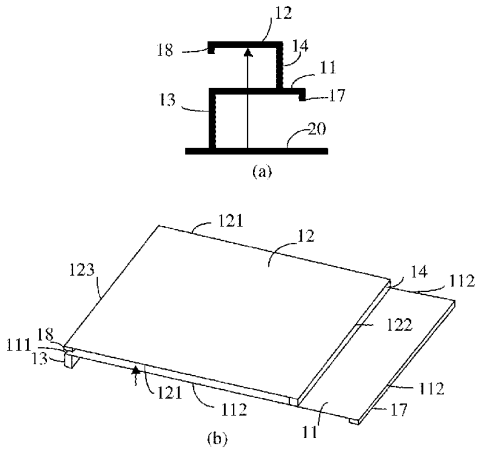
Primary Examiner — Anh Q Tran

(57) **ABSTRACT**

This application provides an antenna, an ultra wide band antenna array, and an electronic device, where the antenna operates in a target frequency band and is arranged on a metal substrate, and the antenna includes a first radiation patch, a second radiation patch, a first short-circuit wall, and a second short-circuit wall, a projection of the first radiation patch on the metal substrate overlaps with a projection of the second radiation patch on the metal substrate, a projection of the first short-circuit wall on the metal substrate does not overlap with a projection of the second short-circuit wall on the metal substrate, the first short-circuit wall is respectively connected to the first radiation patch and the metal substrate,
(Continued)



US012407113B2

(12) **United States Patent**
Wu

(10) **Patent No.: US 12,407,113 B2**
(45) **Date of Patent: Sep. 2, 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 238 days.

(21) Appl. No.: **18/343,396**

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

(65) **Prior Publication Data**

US 2023/0344152 A1 Oct. 26, 2023

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2021/131214, filed on Nov. 17, 2021.

(30) **Foreign Application Priority Data**

Dec. 29, 2020 (CN) 202011608717.6

(51) **Int. Cl.**
H01Q 21/30 (2006.01)
H01Q 1/36 (2006.01)
H01Q 1/52 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 21/30*** (2013.01); ***H01Q 1/36*** (2013.01); ***H01Q 1/521*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/36; H01Q 1/521; H01Q 21/30; H01Q 5/328; H01Q 5/335; H01Q 5/35; H01Q 9/42
See application file for complete search history.

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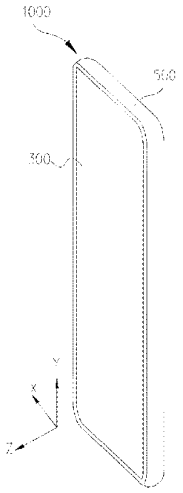
(Continued)

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

(57) **ABSTRACT**

An antenna assembly and an electronic device are provided in implementations of the disclosure. The antenna assembly includes a first antenna element and a second antenna element. The first antenna element is configured to generate multiple first resonant modes to transmit/receive an electromagnetic wave signal of a first band. The first antenna element includes a first radiator. The second antenna element is configured to generate at least one second resonant mode to transmit/receive an electromagnetic wave signal of a second band. A maximum frequency of the first band is less than a minimum frequency of the second band. The second antenna element includes a second radiator. A first gap is defined between the second radiator and the first radiator. The second radiator is configured to be in capacitive coupling with the first radiator through the first gap.

19 Claims, 11 Drawing Sheets



US012400979B2

(12) **United States Patent**
Chang Chien et al.

(10) **Patent No.: US 12,400,979 B2**
(45) **Date of Patent: Aug. 26, 2025**

(54) **INTEGRATED ANTENNA PACKAGE STRUCTURE AND MANUFACTURING METHOD THEREOF**

(71) Applicant: **Powertech Technology Inc.**, Hsinchu County (TW)

(72) Inventors: **Shang-Yu Chang Chien**, Hsinchu County (TW); **Nan-Chun Lin**, Hsinchu County (TW); **Hung-Hsin Hsu**, Hsinchu County (TW)

(73) Assignee: **Powertech Technology Inc.**, Hsinchu County (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 430 days.

(21) Appl. No.: **18/071,632**

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

(65) **Prior Publication Data**

US 2023/0197647 A1 Jun. 22, 2023

(30) **Foreign Application Priority Data**

Dec. 16, 2021 (TW) 110147083

(51) **Int. Cl.**
H01L 23/52 (2006.01)
H01L 21/56 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01L 23/66*** (2013.01); ***H01L 21/561*** (2013.01); ***H01L 23/49838*** (2013.01); ***H01L 23/552*** (2013.01); ***H01L 24/16*** (2013.01); ***H01L 24/96*** (2013.01); ***H01L 24/97*** (2013.01); ***H01Q 1/2283*** (2013.01); ***H01Q 1/526*** (2013.01); *H01L 23/49816* (2013.01); *H01L 23/49822* (2013.01); *H01L 2223/6616* (2013.01); *H01L 2223/6677* (2013.01); *H01L 2224/16225* (2013.01); *H01L 2224/95001* (2013.01); *H01L 2224/96* (2013.01); *H01L 2224/97* (2013.01);
(Continued)

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

(56) **References Cited**

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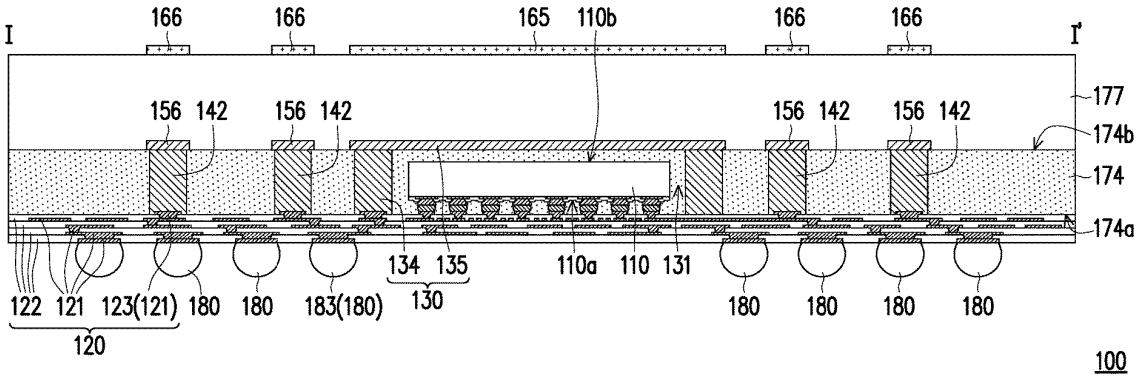
Primary Examiner — Nicholas J Tobergte
(74) *Attorney, Agent, or Firm* — JCIPRNET

(57) **ABSTRACT**

Provided is an integrated antenna package structure including a chip, a circuit structure, a shielding body, an encapsulant, a first antenna layer, a dielectric body, and a second antenna layer. The circuit structure is electrically connected to the chip. The shielding body is disposed on the circuit structure and has an accommodating space. The chip is disposed in the accommodating space of the shielding body. The encapsulant is disposed on the circuit structure and covers the chip. The first antenna layer is disposed on the circuit structure and is electrically connected to the circuit structure. The dielectric body is disposed on the encapsulant. The second antenna layer is disposed on the dielectric body. A manufacturing method of the integrated antenna package structure is also provided.

17 Claims, 7 Drawing Sheets



US012401106B2

(12) **United States Patent**
Grävendieck

(10) **Patent No.: US 12,401,106 B2**
(45) **Date of Patent: Aug. 26, 2025**

(54) **PHASE SHIFTER ASSEMBLY AS WELL AS ANTENNA FOR RADIOFREQUENCY SIGNALS**

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

(72) Inventor: **Jan Grävendieck**, Rosenheim (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.: **18/551,017**

(22) PCT Filed: **Mar. 29, 2021**

(86) PCT No.: **PCT/EP2021/058113**
§ 371 (c)(1),
(2) Date: **Sep. 18, 2023**

(87) PCT Pub. No.: **WO2022/207063**
PCT Pub. Date: **Oct. 6, 2022**

(65) **Prior Publication Data**

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(51) **Int. Cl.**
H01P 1/18 (2006.01)
H01P 5/16 (2006.01)

(52) **U.S. Cl.**
CPC ***H01P 1/184*** (2013.01); ***H01P 5/16*** (2013.01)

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

(56) **References Cited**

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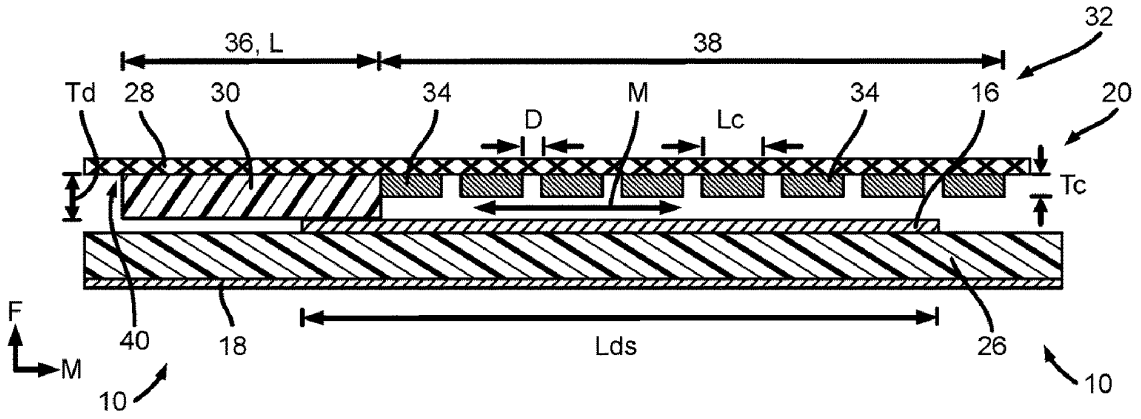
Primary Examiner — Wilson Lee
(74) *Attorney, Agent, or Firm* — Weisberg I.P. Law, P.A.

(57) **ABSTRACT**

A phase shifter assembly has a signal conductor, a ground conductor and a shifting device. The shifting device is movable with respect to the signal conductor, wherein the shifting device has an active section with a dielectric component and a passive section with a compensation component. The phase shifter assembly has a first impedance in the active section of the shifting device and a second impedance in the passive section of the shifting device, wherein the first impedance corresponds to the second impedance. The compensation component is spaced apart from the signal conductor in the first direction. Further, an antenna is shown.

22 Claims, 5 Drawing Sheets



US012401110B2

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

(10) **Patent No.: US 12,401,110 B2**
(45) **Date of Patent: Aug. 26, 2025**

(54) **ELECTRONIC DEVICE COMPRISING ANTENNA**

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

(72) Inventors: **Gyusub Kim**, Suwon-si (KR); **Jiho Kim**, Suwon-si (KR); **Kyungmoon Seol**, Suwon-si (KR); **Seongyong An**, Suwon-si (KR); **Minkyung Lee**, Suwon-si (KR); **Kyihyun Jang**, Suwon-si (KR); **Myunghun Jeong**, Suwon-si (KR); **Nakchung Choi**, 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 129 days.

(21) Appl. No.: **18/493,239**

(22) Filed: **Oct. 24, 2023**

(65) **Prior Publication Data**

US 2024/0106103 A1 Mar. 28, 2024

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2023/014812, filed on Sep. 26, 2023.

(30) **Foreign Application Priority Data**

Sep. 26, 2022 (KR) 10-2022-0121327
Oct. 27, 2022 (KR) 10-2022-0140147

(51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01Q 1/48 (2006.01)
H01Q 5/40 (2015.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/22*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 5/40*** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/22; H01Q 1/243; H01Q 1/38–48; H01Q 1/52; H01Q 5/30–40
See application file for complete search history.

(56) **References Cited**

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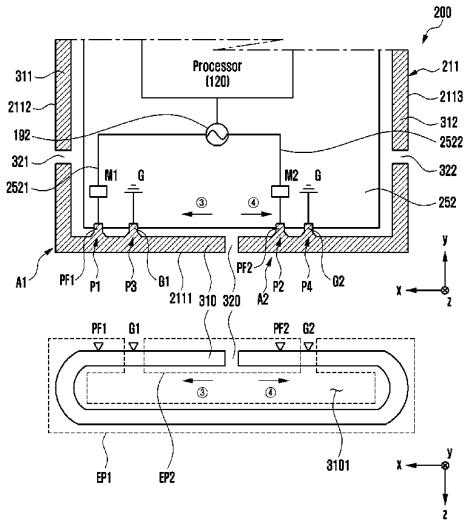
International Search Report dated Jan. 4, 2024, issued in International Application No. PCT/KR2023/014812.

Primary Examiner — Hasan Islam
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

An electronic device is provided. The electronic device includes a housing including a lateral member including a first side surface, a second side surface, and a third side surface, a first conductive portion segmented through a first segmentation portion, a substrate including a ground, and a wireless communication circuit disposed on the substrate, the first conductive portion includes a first power feed unit, a second power feed unit, a first ground part, and a second ground part.

20 Claims, 37 Drawing Sheets



US012401116B2

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

(10) **Patent No.: US 12,401,116 B2**
(45) **Date of Patent: Aug. 26, 2025**

(54) **ELECTRONIC DEVICE WITH MULTI-FEED ANTENNA STRUCTURES**

(71) Applicant: **Apple Inc.**, Cupertino, CA (US)

(72) Inventors: **Yuancheng Xu**, San Jose, CA (US); **Enrique Ayala Vazquez**, Watsonville, CA (US); **Nikolaj P Kammersgaard**, Copenhagen (DK); **Yiren Wang**, Cupertino, CA (US); **Yuan Tao**, Santa Clara, CA (US); **Han Wang**, Campbell, CA (US); **Haozhan Tian**, San Jose, CA (US); **Hao Xu**, Cupertino, CA (US); **Hongfei Hu**, Cupertino, CA (US); **Mattia Pascolini**, San Francisco, CA (US)

(73) Assignee: **Apple Inc.**, Cupertino, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 97 days.

(21) Appl. No.: **18/458,949**

(22) Filed: **Aug. 30, 2023**

(65) **Prior Publication Data**

US 2024/0079766 A1 Mar. 7, 2024

Related U.S. Application Data

(60) Provisional application No. 63/403,977, filed on Sep. 6, 2022.

(51) **Int. Cl.**

H01Q 1/38	(2006.01)
H01Q 1/50	(2006.01)
H01Q 13/10	(2006.01)

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

CPC ***H01Q 1/38*** (2013.01); ***H01Q 1/50*** (2013.01); ***H01Q 13/10*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/38; H01Q 1/50; H01Q 13/10; H01Q 5/328; H01Q 5/335; H01Q 9/42; H01Q 1/243

See application file for complete search history.

(56) **References Cited**

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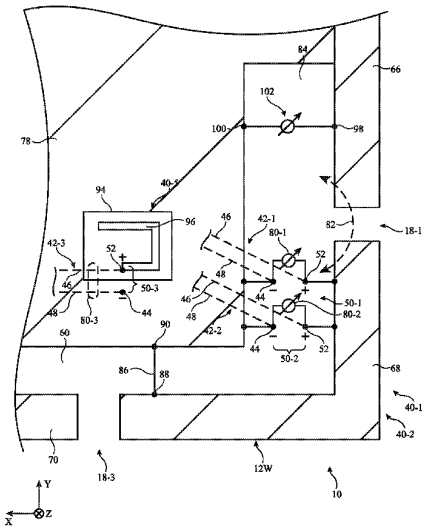
Primary Examiner — Seung H Lee

(74) *Attorney, Agent, or Firm* — Treyz Law Group, P.C.; Michael H. Lyons

(57) **ABSTRACT**

An electronic device may be provided with peripheral conductive housing structures having a first segment and a second segment. First and second antenna feeds may be coupled between the first segment and the ground structures. The first feed may convey signals in a first band and the second feed may convey signals in a second band. The first segment may be near-field coupled to a slot between the second segment and the ground structures. A first tuner may be coupled between the second segment and the ground structures and may adjust a resonance of the first segment in the first and second bands. A second tuner coupled to the first feed may perform impedance matching in the first band and aperture tuning in the second band. A third tuner coupled to the second feed may perform impedance matching in the second band and aperture tuning in the first band.

20 Claims, 8 Drawing Sheets



US012401119B2

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

(10) **Patent No.: US 12,401,119 B2**
(45) **Date of Patent: Aug. 26, 2025**

(54) **MULTIBAND ANTENNA**

(71) Applicant: **Japan Aviation Electronics Industry, Limited**, Tokyo (JP)

(72) Inventors: **Hiroshi Toyao**, Tokyo (JP); **Kenta Tsuchiya**, Tokyo (JP)

(73) Assignee: **Japan Aviation Electronics Industry, Limited**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 300 days.

(21) Appl. No.: **18/127,176**

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

(65) **Prior Publication Data**

US 2023/0335901 A1 Oct. 19, 2023

(30) **Foreign Application Priority Data**

Apr. 18, 2022 (JP) 2022-068160

(51) **Int. Cl.**

H01Q 5/307	(2015.01)
H01Q 1/38	(2006.01)
H01Q 1/48	(2006.01)
H01Q 5/378	(2015.01)
H01Q 13/10	(2006.01)

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

CPC ***H01Q 5/307*** (2015.01); ***H01Q 1/48*** (2013.01); ***H01Q 13/106*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 13/10; H01Q 1/48; H01Q 5/371; H01Q 1/38; H01Q 5/378; H01Q 9/0421; H01Q 9/42; H01Q 5/364; H01Q 13/106; H01Q 21/28; H01Q 5/35; H01Q 9/0407

See application file for complete search history.

(56) **References Cited**

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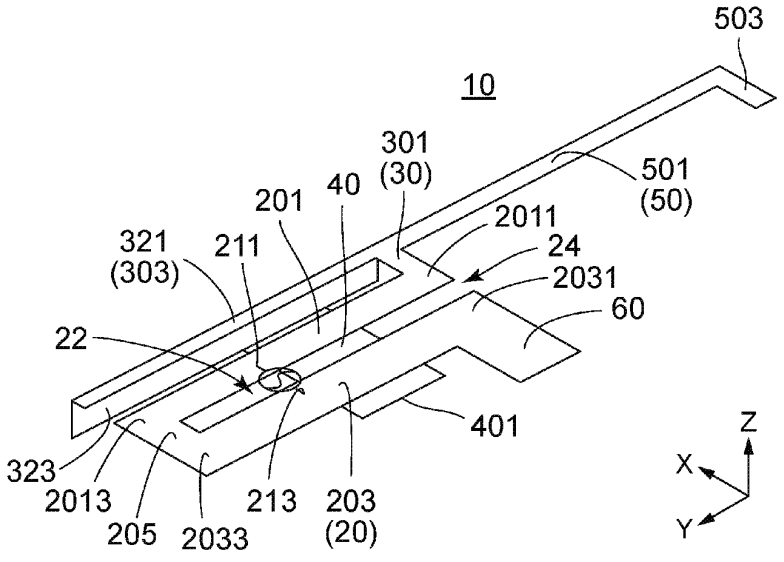
Primary Examiner — Wei (Victor) Y Chan
(74) *Attorney, Agent, or Firm* — Collard & Roe, P.C.

(57) **ABSTRACT**

First and second slot edge portions of a conductive main portion are long in a first direction and sandwich a slot in a second direction. An open portion is formed a part different from the first slot edge portion and opens the slot outside the conductive main portion. A first part of a radiation element extends from an end portion of the first slot edge portion in the second direction. A second part of the radiation element extends from an end portion of the first part in the first direction. An additional element extends from the second part toward a second specific area through a first specific area. In a third direction, the first specific area and the second specific area overlap with the first slot edge portion and the second slot edge portion, respectively.

6 Claims, 9 Drawing Sheets



US012401120B2

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

(10) **Patent No.: US 12,401,120 B2**
(45) **Date of Patent: Aug. 26, 2025**

(54) **ANTENNA MODULE**

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

(72) Inventors: **Chin-Ting Huang**, Taipei (TW); **Hsi-Kai Hung**, Taipei (TW); **Sony Chayadi**, Taipei (TW); **Chun-Kai Wang**, Taipei (TW)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 361 days.

(21) Appl. No.: **18/186,879**

(22) Filed: **Mar. 20, 2023**

(65) **Prior Publication Data**

US 2023/0344127 A1 Oct. 26, 2023

(30) **Foreign Application Priority Data**

Apr. 25, 2022 (TW) 111115609

(51) **Int. Cl.**
H01Q 5/307 (2015.01)
H01Q 1/48 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 5/307*** (2015.01); ***H01Q 1/48*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/22; H01Q 1/243; H01Q 1/32; H01Q 1/52; H01Q 5/30–40; H01Q 1/38–48
See application file for complete search history.

(56) **References Cited**

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2011/0080323	A1	4/2011	Thiam et al.	

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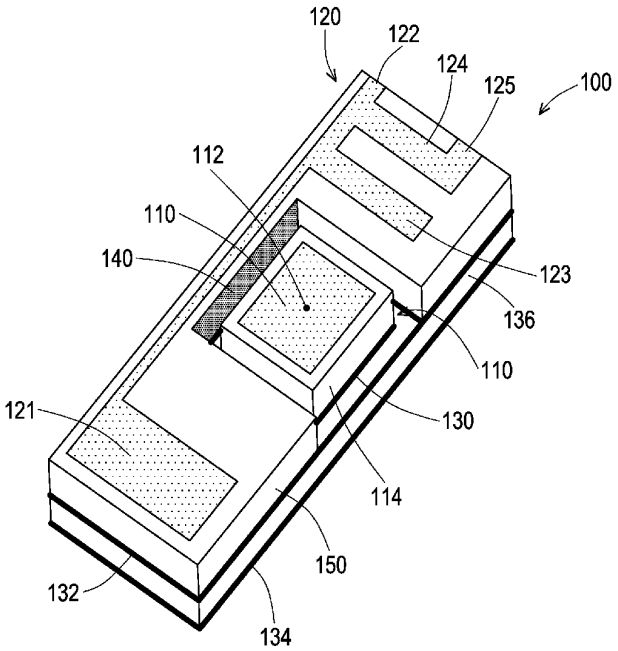
Primary Examiner — Hasan Islam
(74) *Attorney, Agent, or Firm* — J.C. PATENTS

(57) **ABSTRACT**

An antenna module includes a first antenna, a second antenna, a first ground plane, and a second ground plane. The first antenna is used to excite at a first frequency band. The second antenna is disposed beside the first antenna and includes a first radiator with a feeding end, a second radiator connected to the first radiator, and a third radiator connected to the first radiator and including a ground end. The first radiator excites at a second frequency band, and a part of the first radiator and the second radiator excite at a third frequency band. The first ground plane is located below the first antenna and spaced apart from the first antenna. The second ground plane is located below the second antenna and spaced apart from the first ground plane. The ground end is connected to the second ground plane.

10 Claims, 4 Drawing Sheets



US012401125B2

(12) **United States Patent**
Yoshikawa

(10) **Patent No.: US 12,401,125 B2**
(45) **Date of Patent: Aug. 26, 2025**

(54) **ANTENNA AND ARRAY ANTENNA**

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

(72) Inventor: **Hiromichi Yoshikawa**, Yokohama (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 125 days.

(21) Appl. No.: **18/553,841**

(22) PCT Filed: **Dec. 9, 2021**

(86) PCT No.: **PCT/JP2021/045386**
§ 371 (c)(1),
(2) Date: **Oct. 4, 2023**

(87) PCT Pub. No.: **WO2022/224482**
PCT Pub. Date: **Oct. 27, 2022**

(65) **Prior Publication Data**

US 2024/0113434 A1 Apr. 4, 2024

(30) **Foreign Application Priority Data**

Apr. 19, 2021 (JP) 2021-070632

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

(52) **U.S. Cl.**
CPC ***H01Q 9/0414*** (2013.01); ***H01Q 9/0457*** (2013.01); ***H01Q 21/0006*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 9/0414; H01Q 9/0457; H01Q 21/0006; H01Q 5/378; H01Q 25/005; H01Q 21/10; H01Q 13/08
See application file for complete search history.

(56) **References Cited**

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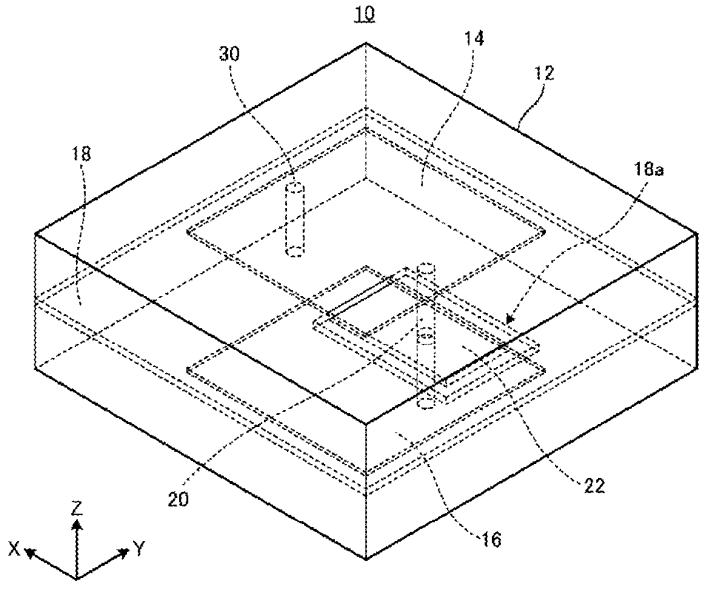
Primary Examiner — David E Lotter
(74) *Attorney, Agent, or Firm* — HAUPTMAN HAM, LLP

(57) **ABSTRACT**

An antenna includes a first resonator extending in a first plane direction; a second resonator spaced apart from the first resonator in a first direction and extending in the first plane direction; a third resonator positioned between the first resonator and the second resonator in the first direction and magnetically or capacitively connected to or electrically connected to each of the first resonator and the second resonator; a reference conductor extending in the first plane direction, positioned between the first resonator and the second resonator in the first direction, and serving as a potential reference of the first resonator and the second resonator; and a feeder line connected to the first resonator. The reference conductor surrounds at least a part of the third resonator in the first plane direction.

13 Claims, 13 Drawing Sheets



US012401135B2

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

(10) **Patent No.: US 12,401,135 B2**
(45) **Date of Patent: Aug. 26, 2025**

(54) **ELECTRONIC DEVICE INCLUDING ANTENNA**

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

(72) Inventors: **Dongyeon Kim**, Suwon-si (KR); **Hosaeng Kim**, Suwon-si (KR)

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

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

(21) Appl. No.: **17/846,576**

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

(65) **Prior Publication Data**

US 2024/0332819 A1 Oct. 3, 2024

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2022/007891, filed on Jun. 3, 2022.

(30) **Foreign Application Priority Data**

Jun. 3, 2021 (KR) 10-2021-0072081

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/25 (2015.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 21/065*** (2013.01); ***H01Q 5/25*** (2015.01); ***H01Q 9/0428*** (2013.01); ***H01Q 21/24*** (2013.01); *H01Q 1/243* (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 21/065; H01Q 5/25; H01Q 9/0414; H01Q 1/38; H01Q 9/0428; H01Q 21/24; H01Q 9/0407
See application file for complete search history.

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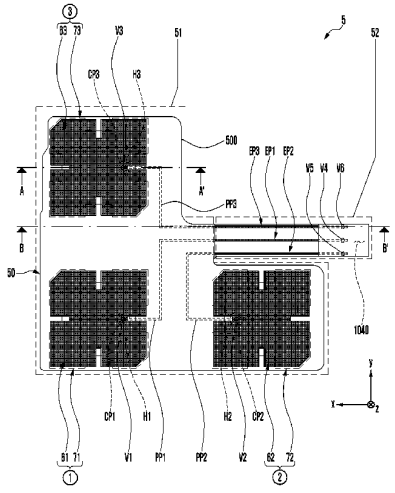
(Continued)

Primary Examiner — Dimary S Lopez Cruz
Assistant Examiner — Anna N Hamadyk
(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye P.C.

(57) **ABSTRACT**

According to an embodiment of the present disclosure, an electronic device may include: a housing; an antenna structure positioned in the housing and including a printed circuit board, multiple first antenna elements, multiple second antenna elements, and multiple electrical paths; and a wireless communication circuit electrically connected to the multiple first antenna elements through the electrical paths. The antenna structure may include antenna elements arranged for enhancing a communication performance and/or may be capable of securing the quality and the accuracy of the positioning for the signal source even though there are various directions or orientations where the electronic device faces, or various polarization characteristics of a signal transmitted from the signal source.

20 Claims, 22 Drawing Sheets



US012394884B2

(12) **United States Patent**
Yang

(10) **Patent No.: US 12,394,884 B2**
(45) **Date of Patent: Aug. 19, 2025**

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

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

(72) Inventor: **Fan Yang**, 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 553 days.

(21) Appl. No.: **17/940,874**

(22) Filed: **Sep. 8, 2022**

(65) **Prior Publication Data**

US 2023/0006360 A1 Jan. 5, 2023

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2021/073548, filed on Jan. 25, 2021.

(30) **Foreign Application Priority Data**

Mar. 12, 2020 (CN) 202010169503.7
Mar. 12, 2020 (CN) 202020306450.4

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/44 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/44*** (2013.01); ***H01Q 5/328*** (2015.01); ***H01Q 5/335*** (2015.01)

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

(56) **References Cited**

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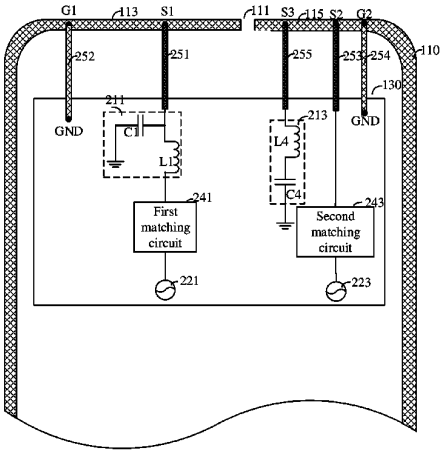
(Continued)

Primary Examiner — Ab Salam Alkassim, Jr.
(74) *Attorney, Agent, or Firm* — Sheppard, Mullin, Richter & Hampton LLP

(57) **ABSTRACT**

Provided is an antenna assembly including a conductive frame, and a resonance unit. The conductive frame is divided into first and second conductive branch by a slot. The resonance unit includes first and second resonance circuits. One terminal of the second resonance circuit is grounded, and another terminal is connected to the second conductive branch. A first signal source is capable of feeing a first current signal to the first conductive branch through the first resonance circuit and the first feeding point, enabling the first conductive branch to radiate a first radio frequency signal. The second signal source is capable of feeding a second current signal to the second conductive branch through the second feeding point, enabling the second conductive branch, under a resonance of the second resonance circuit, to radiate a second radio frequency signal.

20 Claims, 7 Drawing Sheets



US012394890B2

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

(10) **Patent No.: US 12,394,890 B2**
(45) **Date of Patent: Aug. 19, 2025**

(54) **TERMINAL DEVICE WITH NOISE SUPPRESSION STRUCTURE**

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

(72) Inventors: **Qi Gao**, Shenzhen (CN); **Longfei Shi**, Shenzhen (CN); **Jiaqi Chen**, Shenzhen (CN); **Jing Yang**, Shenzhen (CN); **Keyu Si**, Shenzhen (CN); **Ming Yin**, 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 153 days.

(21) Appl. No.: **18/010,137**

(22) PCT Filed: **May 12, 2022**

(86) PCT No.: **PCT/CN2022/092368**
§ 371 (c)(1),
(2) Date: **Dec. 13, 2022**

(87) PCT Pub. No.: **WO2022/242532**
PCT Pub. Date: **Nov. 24, 2022**

(65) **Prior Publication Data**

US 2023/0238694 A1 Jul. 27, 2023

(30) **Foreign Application Priority Data**

May 19, 2021 (CN) 202110547199.X

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

(52) **U.S. Cl.**
CPC ***H01Q 1/52*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/526*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/52; H01Q 1/243; H04M 1/026
See application file for complete search history.

(56) **References Cited**

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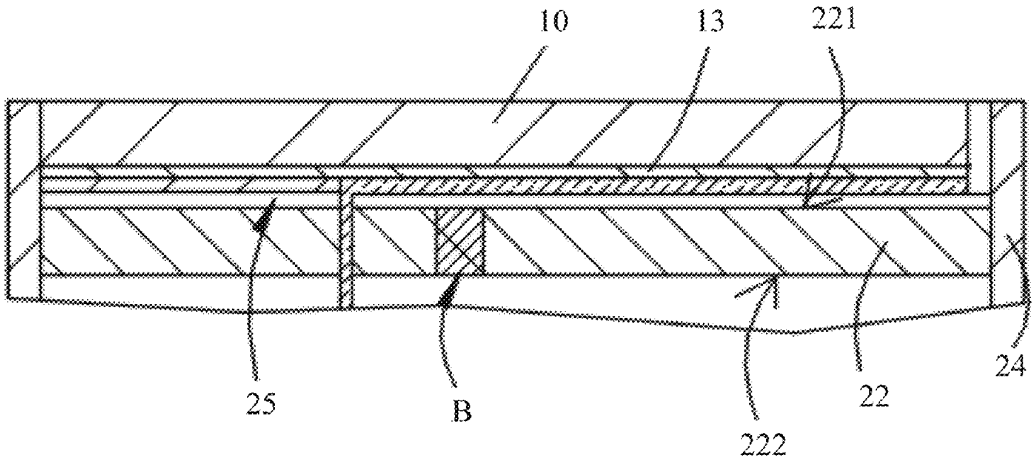
Primary Examiner — Alexander H Taningco
Assistant Examiner — Austin M Back
(74) *Attorney, Agent, or Firm* — Leydig, Voit & Mayer, Ltd.

(57) **ABSTRACT**

This application provides a terminal device, including a noise suppression structure, where the noise suppression structure is disposed on the metal middle plate, the noise suppression structure includes a hollow region running through the first surface and the second surface, and the hollow region communicates with the first cavity, so that digital signal noise that uses the first cavity as a transmission medium has a propagation path in a direction toward the antenna, the propagation path passes through the hollow region, and the hollow region is used to suppress the digital signal noise transmitted through the propagation path, so as to prevent antenna operating performance from being affected by the digital signal noise.

19 Claims, 13 Drawing Sheets



US012395200B2

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

(10) **Patent No.: US 12,395,200 B2**
(45) **Date of Patent: Aug. 19, 2025**

(54) **ELECTRONIC DEVICE COMPRISING ANTENNA, AND OPERATION METHOD THEREOF**

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

(72) Inventors: **Himchan Yun**, Suwon-si (KR); **Nakchung Choi**, Suwon-si (KR); **Shinho Yoon**, Suwon-si (KR); **Soonho Hwang**, 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 383 days.

(21) Appl. No.: **18/105,667**

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

(65) **Prior Publication Data**

US 2023/0188173 A1 Jun. 15, 2023

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2021/010191, filed on Aug. 4, 2021.

(30) **Foreign Application Priority Data**

Aug. 4, 2020 (KR) 10-2020-0097307

(51) **Int. Cl.**
H04B 1/3888 (2015.01)
H04B 1/3827 (2015.01)
H04M 1/02 (2006.01)

(52) **U.S. Cl.**
CPC ***H04B 1/3838*** (2013.01); ***H04B 1/3888*** (2013.01); ***H04M 1/0202*** (2013.01)

(58) **Field of Classification Search**
CPC .. H04B 1/3838; H04B 1/3888; H04M 1/0202
(Continued)

(56) **References Cited**

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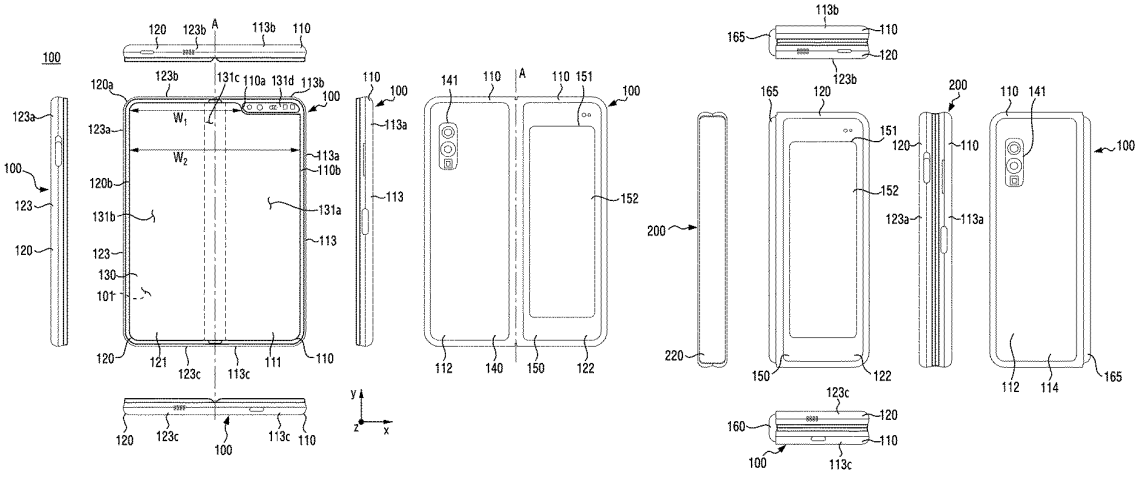
Primary Examiner — April G Gonzales
(74) *Attorney, Agent, or Firm* — Sughrue Mion, PLLC

(57) **ABSTRACT**

An electronic device includes a frame structure forming at least a part of the side surface of the electronic device, the frame structure including a first insulating portion, a second insulating portion, a third insulating portion, a first conductive portion, a second conductive portion and a third conductive portion, a wireless communication circuit, a first switching circuit configured to connect the wireless communication circuit and at least one of the first conductive portion and the second conductive portion, a second switching circuit configured to connect the wireless communication circuit and at least one of the second conductive portion and the third conductive portion, and a proximity sensor configured to detect a proximity of a human body.

20 Claims, 24 Drawing Sheets



US012395228B2

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

(10) **Patent No.: US 12,395,228 B2**
(45) **Date of Patent: Aug. 19, 2025**

(54) **TECHNIQUES FOR REPEATING A TRANSPORT BLOCK USING SPATIAL DIVISION MULTIPLEXING**

(71) Applicant: **QUALCOMM Incorporated**, San Diego, CA (US)

(72) Inventors: **Fang Yuan**, Beijing (CN); **Wooseok Nam**, San Diego, CA (US); **Mostafa Khoshnevisan**, San Diego, CA (US); **Tao Luo**, San Diego, CA (US); **Xiaoxia Zhang**, San Diego, CA (US)

(73) Assignee: **QUALCOMM Incorporated**, San Diego, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 237 days.

(21) Appl. No.: **17/996,567**

(22) PCT Filed: **Apr. 21, 2020**

(86) PCT No.: **PCT/CN2020/085764**
§ 371 (c)(1),
(2) Date: **Oct. 19, 2022**

(87) PCT Pub. No.: **WO2021/212295**
PCT Pub. Date: **Oct. 28, 2021**

(65) **Prior Publication Data**

US 2023/0208568 A1 Jun. 29, 2023

(51) **Int. Cl.**
H04B 7/04 (2017.01)
H04B 7/06 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04B 7/0697*** (2013.01); ***H04B 7/04*** (2013.01); ***H04L 1/1864*** (2013.01); ***H04L 1/189*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H04B 7/0697; H04B 7/04; H04L 1/1864; H04L 1/1896; H04L 1/189; H04L 5/0025; H04L 5/0044
See application file for complete search history.

(56) **References Cited**

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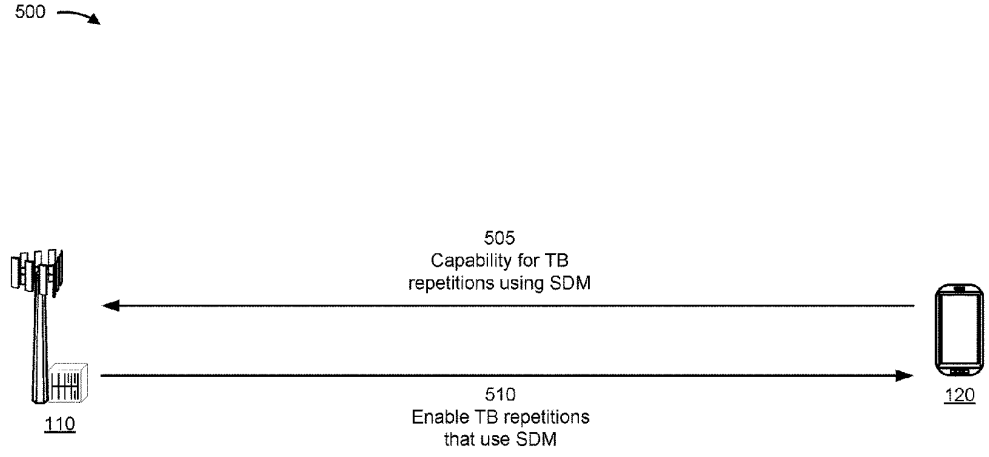
Primary Examiner — Kent Krueger
(74) *Attorney, Agent, or Firm* — Dalei Dong; Harrity & Harrity, LLP

(57) **ABSTRACT**

Various aspects of the present disclosure generally relate to wireless communication. In some aspects, a user equipment (UE) may transmit, to a base station, an indication that the UE is capable of transmitting or receiving transport block (TB) repetitions using spatial division multiplexing (SDM). The UE may receive, from the base station and based at least in part on the indication, at least one downlink control information (DCI) message that schedules a TB in a first
(Continued)



US012399204B2

(12) **United States Patent**
Tankielun

(10) **Patent No.: US 12,399,204 B2**
(45) **Date of Patent: Aug. 26, 2025**

(54) **MODULAR ANTENNA WITH MOUNTING MODULE**

(71) Applicant: **Rohde & Schwarz GmbH & Co. KG**, Munich (DE)

(72) Inventor: **Adam Tankielun**, Munich (DE)

(73) Assignee: **Rohde & Schwarz GmbH & Co. KG**, Munich (DE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 266 days.

(21) Appl. No.: **18/181,392**

(22) Filed: **Mar. 9, 2023**

(65) **Prior Publication Data**

US 2024/0302418 A1 Sep. 12, 2024

(51) **Int. Cl.**
H01Q 1/12 (2006.01)
G01R 29/08 (2006.01)

(52) **U.S. Cl.**
CPC ***G01R 29/0864*** (2013.01); ***H01Q 1/12*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/12; G01R 29/0864
See application file for complete search history.

(56) **References Cited**

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2023/0052735	A1 *	2/2023	Chang	H01Q 5/22

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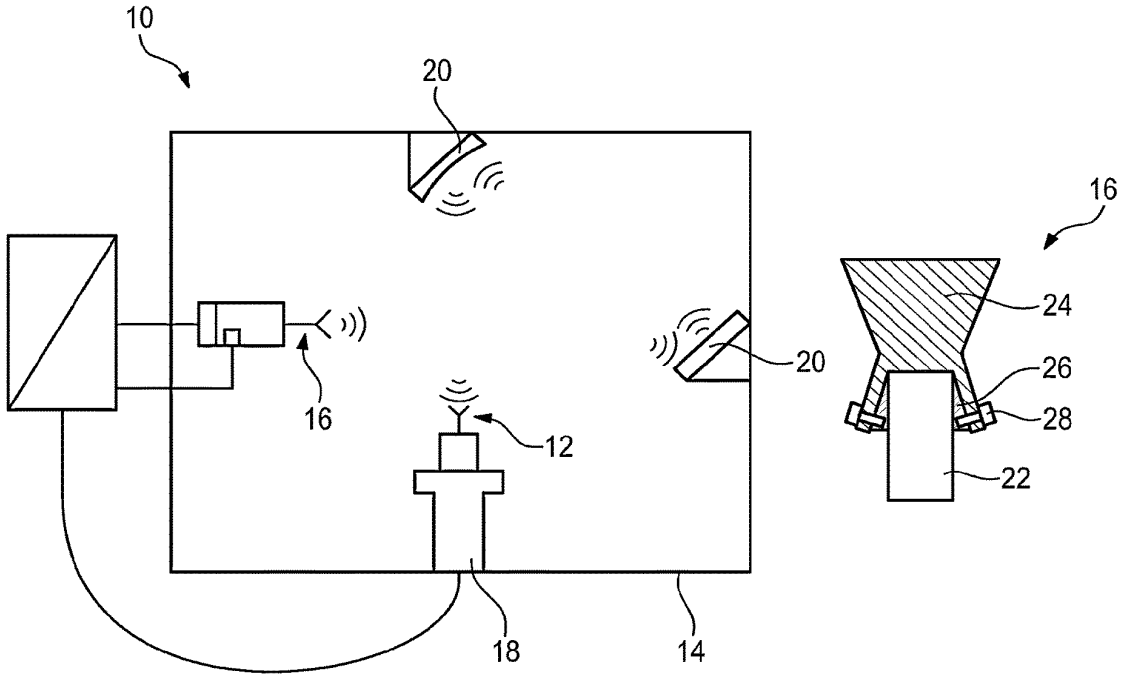
Primary Examiner — Hai V Tran
(74) *Attorney, Agent, or Firm* — CHRISTENSEN O'CONNOR JOHNSON KINDNESS PLLC

(57) **ABSTRACT**

A mounting apparatus for a modular antenna is described, wherein the mounting apparatus is attachable to a plurality of different radiation apparatus or modules and/or to a plurality of different feeding apparatus or modules. The mounting apparatus has a surface facing a measurement direction, wherein the surface is configured such that a surface parameter of the mounting apparatus is smaller than a predefined threshold, wherein the surface parameter is associated with a ratio of a first projected area and a second projected area. The first projected area corresponds to an area confined by the surface of the mounting apparatus facing the measurement direction and projected onto a plane being perpendicular to the measurement direction. The second projected area corresponds to an aperture of the modular antenna projected onto the plane being perpendicular to the measurement direction. Further, a modular antenna and an over-the-air measurement system are described.

14 Claims, 5 Drawing Sheets



US012399350B2

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

(10) **Patent No.: US 12,399,350 B2**
(45) **Date of Patent: Aug. 26, 2025**

(54) **LENS DESIGN FOR FULL-DUPLEX COMMUNICATION COMPRISING A LENS HAVING A FIRST CURVATURE CONFIGURED TO DISPERSE A REFLECTION OFF THE LENS AWAY FROM A RECEIVING ELEMENT**

(71) Applicant: **QUALCOMM Incorporated**, San Diego, CA (US)

(72) Inventors: **Danlu Zhang**, San Diego, CA (US); **Yehonatan Dallal**, Kfar Saba (IL); **Idan Michael Horn**, Hod Hasharon (IL); **Shay Landis**, Hod Hasharon (IL)

(73) Assignee: **QUALCOMM Incorporated**, San Diego, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 681 days.

(21) Appl. No.: **17/742,146**

(22) Filed: **May 11, 2022**

(65) **Prior Publication Data**

US 2023/0367105 A1 Nov. 16, 2023

(51) **Int. Cl.**
G02B 13/00 (2006.01)
G02B 1/115 (2015.01)

(52) **U.S. Cl.**
CPC ***G02B 13/0055*** (2013.01); ***G02B 1/115*** (2013.01)

(58) **Field of Classification Search**
CPC ... G02B 13/0055; H01Q 19/062; H01Q 15/08
See application file for complete search history.

(56) **References Cited**

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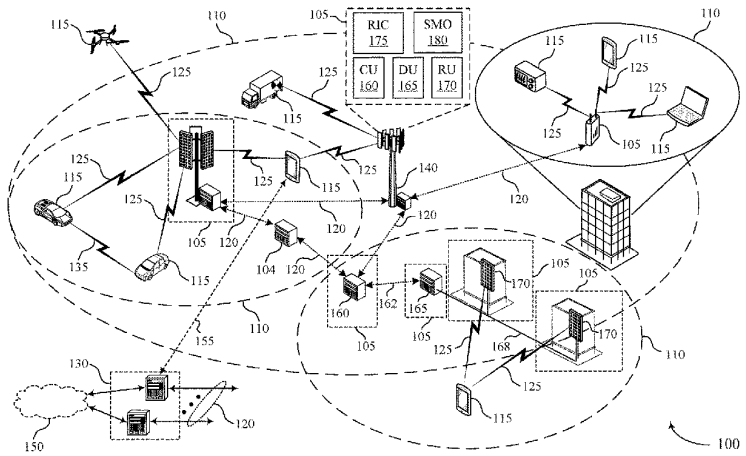
Primary Examiner — Paul C Lee
(74) *Attorney, Agent, or Firm* — Holland & Hart LLP/Qualcomm

(57) **ABSTRACT**

This disclosure provides systems, methods and apparatus, including computer programs encoded on computer storage media, for lens design for full-duplex communication. In some aspects, a device may use a lens design that enables full-duplex operation through a lens by facilitating an avoidance or mitigation of self-interference during full-duplex operation. The lens may have a first, antenna-facing surface and a second, outward-facing surface and, to avoid or mitigate self-interference due to reflection off the lens, the first surface may have a first curvature associated with a relatively small radius. In such examples, the device may transmit wireless signaling from a transmitting element and a reflection off the lens may be dispersed or otherwise oriented away from a receiving element in accordance with a design of the first curvature. In some implementations, the lens may include an anti-reflective coating to further reduce reflection off the lens.

30 Claims, 12 Drawing Sheets



US012400100B2

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

(10) **Patent No.: US 12,400,100 B2**
(45) **Date of Patent: Aug. 26, 2025**

(54) **ON-METAL RFID TAG**

(71) Applicant: **HID Global Corp.**, Austin, TX (US)

(72) Inventors: **Badredin Mohamed Turki**, Farnham (GB); **Charles Vilner**, Crawley (GB)

(73) Assignee: **HID Global Corp.**, 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 0 days.

(21) Appl. No.: **18/511,345**

(22) Filed: **Nov. 16, 2023**

(65) **Prior Publication Data**

US 2024/0169178 A1 May 23, 2024

Related U.S. Application Data

(60) Provisional application No. 63/384,105, filed on Nov. 17, 2022.

(51) **Int. Cl.**
G06K 19/077 (2006.01)

(52) **U.S. Cl.**
CPC . ***G06K 19/07749*** (2013.01); ***G06K 19/07722*** (2013.01)

(58) **Field of Classification Search**
CPC G06K 19/07749; G06K 19/07722
USPC 235/492
See application file for complete search history.

(56) **References Cited**

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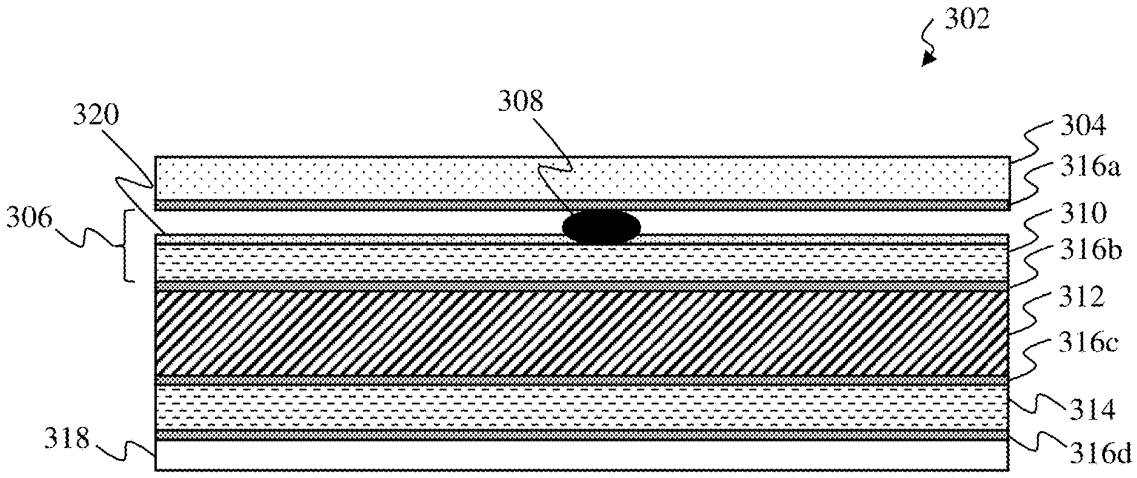
(Continued)

Primary Examiner — Allyson N Trail
(74) *Attorney, Agent, or Firm* — Schwegman Lundberg & Woessner, P.A.

(57) **ABSTRACT**

A radio frequency identification (RFID) tag including a face stock layer, an antenna inlay beneath the face stock layer and comprising a radio frequency (RF) antenna and an integrated circuit (IC) chip, a spacer layer beneath the antenna inlay, and a metal ground plane. The antenna inlay may include a near-field communication (NFC) or high frequency (HF) antenna, and optionally may include an ultra-high frequency (UHF) antenna. The spacer may be made of a flexible polypropylene, and the metal ground plane may be made of aluminum.

16 Claims, 6 Drawing Sheets



US012400979B2

(12) **United States Patent**
Chang Chien et al.

(10) **Patent No.: US 12,400,979 B2**
(45) **Date of Patent: Aug. 26, 2025**

(54) **INTEGRATED ANTENNA PACKAGE STRUCTURE AND MANUFACTURING METHOD THEREOF**

(71) Applicant: **Powertech Technology Inc.**, Hsinchu County (TW)

(72) Inventors: **Shang-Yu Chang Chien**, Hsinchu County (TW); **Nan-Chun Lin**, Hsinchu County (TW); **Hung-Hsin Hsu**, Hsinchu County (TW)

(73) Assignee: **Powertech Technology Inc.**, Hsinchu County (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 430 days.

(21) Appl. No.: **18/071,632**

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

(65) **Prior Publication Data**

US 2023/0197647 A1 Jun. 22, 2023

(30) **Foreign Application Priority Data**

Dec. 16, 2021 (TW) 110147083

(51) **Int. Cl.**
H01L 23/52 (2006.01)
H01L 21/56 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01L 23/66*** (2013.01); ***H01L 21/561*** (2013.01); ***H01L 23/49838*** (2013.01); ***H01L 23/552*** (2013.01); ***H01L 24/16*** (2013.01); ***H01L 24/96*** (2013.01); ***H01L 24/97*** (2013.01); ***H01Q 1/2283*** (2013.01); ***H01Q 1/526*** (2013.01); *H01L 23/49816* (2013.01); *H01L 23/49822* (2013.01); *H01L 2223/6616* (2013.01); *H01L 2223/6677* (2013.01); *H01L 2224/16225* (2013.01); *H01L 2224/95001* (2013.01); *H01L 2224/96* (2013.01); *H01L 2224/97* (2013.01);
(Continued)

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

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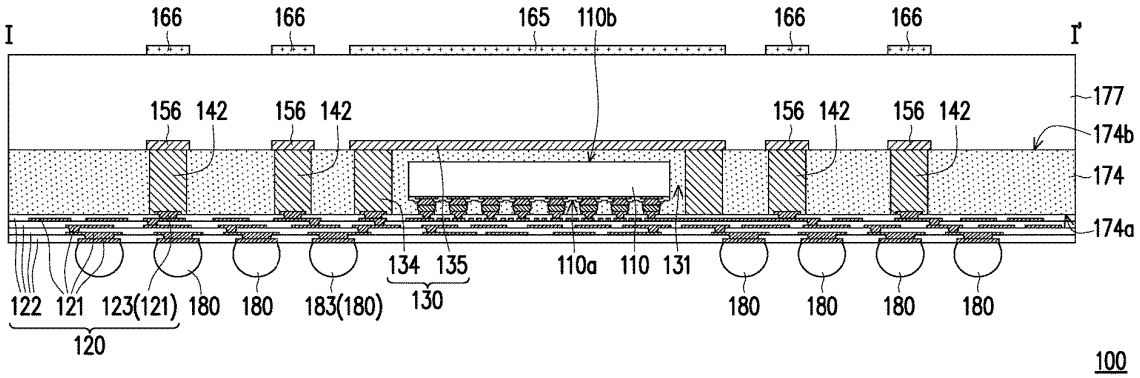
Primary Examiner — Nicholas J Tobergte
(74) *Attorney, Agent, or Firm* — JCIPRNET

(57) **ABSTRACT**

Provided is an integrated antenna package structure including a chip, a circuit structure, a shielding body, an encapsulant, a first antenna layer, a dielectric body, and a second antenna layer. The circuit structure is electrically connected to the chip. The shielding body is disposed on the circuit structure and has an accommodating space. The chip is disposed in the accommodating space of the shielding body. The encapsulant is disposed on the circuit structure and covers the chip. The first antenna layer is disposed on the circuit structure and is electrically connected to the circuit structure. The dielectric body is disposed on the encapsulant. The second antenna layer is disposed on the dielectric body. A manufacturing method of the integrated antenna package structure is also provided.

17 Claims, 7 Drawing Sheets



US012401110B2

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

(10) **Patent No.: US 12,401,110 B2**
(45) **Date of Patent: Aug. 26, 2025**

(54) **ELECTRONIC DEVICE COMPRISING ANTENNA**

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

(72) Inventors: **Gyusub Kim**, Suwon-si (KR); **Jiho Kim**, Suwon-si (KR); **Kyungmoon Seol**, Suwon-si (KR); **Seongyong An**, Suwon-si (KR); **Minkyung Lee**, Suwon-si (KR); **Kyihyun Jang**, Suwon-si (KR); **Myunghun Jeong**, Suwon-si (KR); **Nakchung Choi**, 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 129 days.

(21) Appl. No.: **18/493,239**

(22) Filed: **Oct. 24, 2023**

(65) **Prior Publication Data**

US 2024/0106103 A1 Mar. 28, 2024

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2023/014812, filed on Sep. 26, 2023.

(30) **Foreign Application Priority Data**

Sep. 26, 2022 (KR) 10-2022-0121327
Oct. 27, 2022 (KR) 10-2022-0140147

(51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01Q 1/48 (2006.01)
H01Q 5/40 (2015.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/22*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 5/40*** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/22; H01Q 1/243; H01Q 1/38–48; H01Q 1/52; H01Q 5/30–40
See application file for complete search history.

(56) **References Cited**

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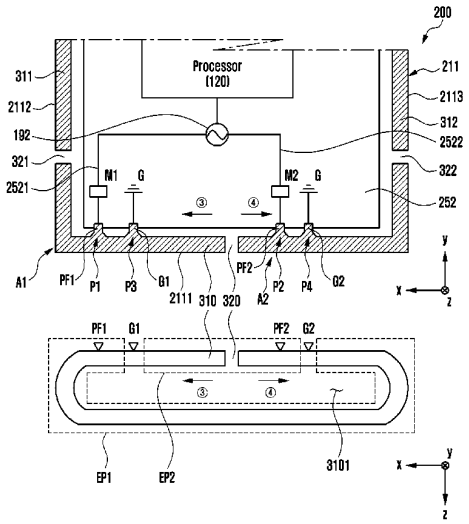
Primary Examiner — Hasan Islam
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

An electronic device is provided. The electronic device includes a housing including a lateral member including a first side surface, a second side surface, and a third side surface, a first conductive portion segmented through a first segmentation portion, a substrate including a ground, and a wireless communication circuit disposed on the substrate, the first conductive portion includes a first power feed unit, a second power feed unit, a first ground part, and a second ground part.

20 Claims, 37 Drawing Sheets



US012401120B2

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

(10) **Patent No.: US 12,401,120 B2**
(45) **Date of Patent: Aug. 26, 2025**

(54) **ANTENNA MODULE**

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

(72) Inventors: **Chin-Ting Huang**, Taipei (TW); **Hsi-Kai Hung**, Taipei (TW); **Sony Chayadi**, Taipei (TW); **Chun-Kai Wang**, Taipei (TW)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 361 days.

(21) Appl. No.: **18/186,879**

(22) Filed: **Mar. 20, 2023**

(65) **Prior Publication Data**

US 2023/0344127 A1 Oct. 26, 2023

(30) **Foreign Application Priority Data**

Apr. 25, 2022 (TW) 111115609

(51) **Int. Cl.**
H01Q 5/307 (2015.01)
H01Q 1/48 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 5/307*** (2015.01); ***H01Q 1/48*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/22; H01Q 1/243; H01Q 1/32; H01Q 1/52; H01Q 5/30–40; H01Q 1/38–48
See application file for complete search history.

(56) **References Cited**

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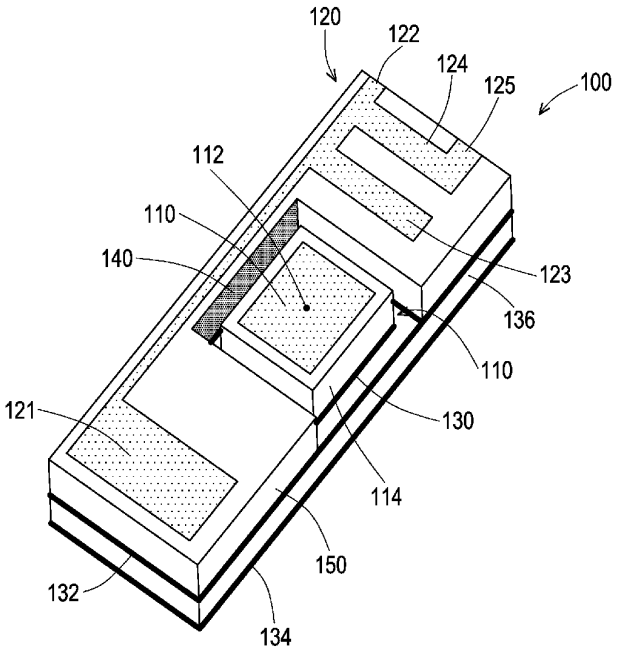
Primary Examiner — Hasan Islam
(74) *Attorney, Agent, or Firm* — J.C. PATENTS

(57) **ABSTRACT**

An antenna module includes a first antenna, a second antenna, a first ground plane, and a second ground plane. The first antenna is used to excite at a first frequency band. The second antenna is disposed beside the first antenna and includes a first radiator with a feeding end, a second radiator connected to the first radiator, and a third radiator connected to the first radiator and including a ground end. The first radiator excites at a second frequency band, and a part of the first radiator and the second radiator excite at a third frequency band. The first ground plane is located below the first antenna and spaced apart from the first antenna. The second ground plane is located below the second antenna and spaced apart from the first ground plane. The ground end is connected to the second ground plane.

10 Claims, 4 Drawing Sheets



US012401130B2

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

(10) **Patent No.: US 12,401,130 B2**
(45) **Date of Patent: Aug. 26, 2025**

(54) **ANTENNA APERTURE HAVING ANTENNA ELEMENTS WITH STATIC CAPACITORS**

(71) Applicant: **Kymeta Corporation**, Redmond, WA (US)

(72) Inventors: **Mohammad Ranjbarnikkhah**, Redmond, WA (US); **Seyed Mohamad Amin Momeni Hasan Abadi**, Redmond, WA (US); **Mohsen Sazegar**, Redmond, WA (US)

(73) Assignee: **KYMETA CORPORATION**, Redmond, WA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 49 days.

(21) Appl. No.: **18/587,794**

(22) Filed: **Feb. 26, 2024**

(65) **Prior Publication Data**

US 2024/0291158 A1 Aug. 29, 2024

Related U.S. Application Data

(60) Provisional application No. 63/448,875, filed on Feb. 28, 2023.

(51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 1/22 (2006.01)
H01Q 15/00 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 13/10*** (2013.01); ***H01Q 1/2283*** (2013.01); ***H01Q 15/0086*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/2283; H01Q 1/3233; H01Q 13/10; H01Q 13/103; H01Q 15/0066; H01Q 15/0086
See application file for complete search history.

(56) **References Cited**

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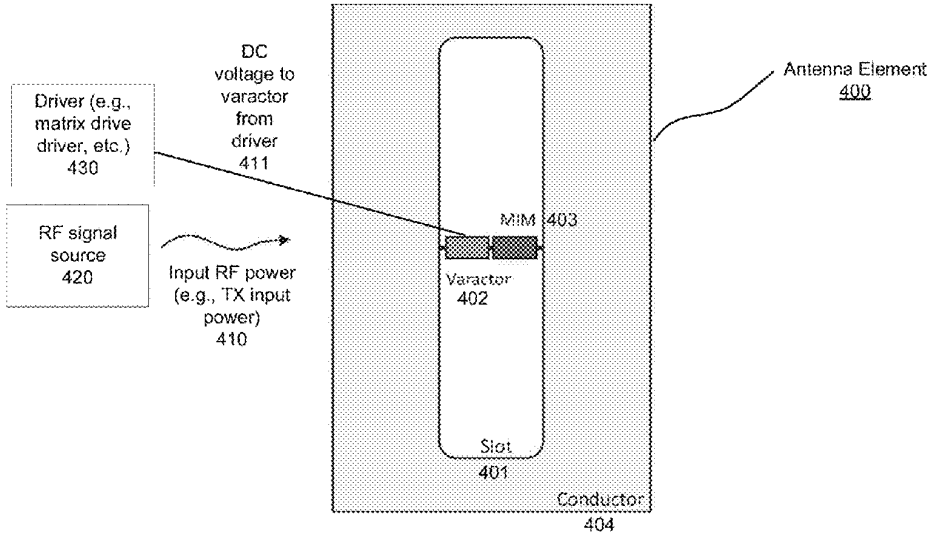
Primary Examiner — Raymond R Chai
(74) *Attorney, Agent, or Firm* — Womble Bond Dickinson (US) LLP

(57) **ABSTRACT**

An antenna having radio-frequency (RF) radiating antenna elements with static capacitors are described. In some embodiments, the antenna has RF signal source; a plurality of radio-frequency (RF) radiating antenna elements coupled to the RF signal source, wherein each of the RF radiating antenna elements comprises a slot, a tuning element coupled to the RF signal source and to tune the slot as part of the RF radiating antenna elements generating beams, and a fixed capacitor coupled to the RF signal source and coupled in series with the tuning element across the slot, the fixed capacitor to mitigate harmonic generation in order to control linear response of the plurality of radio-frequency (RF) radiating antenna elements.

20 Claims, 8 Drawing Sheets



US012401382B2

(12) **United States Patent**
Lin

(10) **Patent No.: US 12,401,382 B2**
(45) **Date of Patent: Aug. 26, 2025**

(54) **CHIP, SYSTEM OF NOISE ANALYSIS AND METHOD OF NOISE ANALYSIS**

(71) Applicant: **Realtek Semiconductor Corporation**, Hsinchu (TW)

(72) Inventor: **Chung Chang Lin**, Hsinchu (TW)

(73) Assignee: **Realtek Semiconductor 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 516 days.

(21) Appl. No.: **18/046,937**

(22) Filed: **Oct. 16, 2022**

(65) **Prior Publication Data**

US 2023/0327692 A1 Oct. 12, 2023

(30) **Foreign Application Priority Data**

Apr. 6, 2022 (TW) 111113082

(51) **Int. Cl.**
H04B 1/10 (2006.01)
H04B 1/40 (2015.01)

(52) **U.S. Cl.**
CPC ***H04B 1/1027*** (2013.01); ***H04B 1/40*** (2013.01)

(58) **Field of Classification Search**
CPC ... H04B 3/02; H04B 3/32; H04B 1/30; H04B 1/006; H04B 5/22; H04B 1/18; H04B 1/0475; H04B 3/487; H04B 5/79; H04B 17/318; H04B 1/16; H04B 10/564; H04B 3/30; H04B 5/263; H04B 1/40; H04B 1/525; H04B 10/40; H04B 2203/5483; H04B 10/50; H04B 10/504
USPC 455/73
See application file for complete search history.

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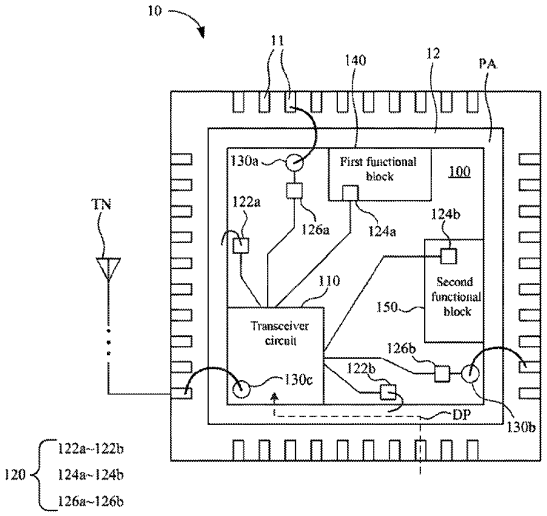
Primary Examiner — Ajibola A Akinyemi
(74) *Attorney, Agent, or Firm* — CKC & Partners Co., LLC

(57) **ABSTRACT**

A chip comprises a plurality of signal receiving circuits, a transceiver circuit and a memory circuit. The plurality of signal receiving circuits are set at different locations on the chip. The transceiver circuit includes a dynamic switch circuit and a baseband processor. The dynamic switch circuit is configured to output a to-be-analyzed signal from the one of the plurality of signal receiving circuits. The baseband processor is configured to obtain a frequency spectrum and magnitude of the to-be-analyzed signal, and obtain a data packet of an input radio-frequency signal received by an external antenna. The memory circuit is configured to store the frequency spectrum and magnitude of the to-be-analyzed signal, and transmit the frequency spectrum and magnitude to an external computing device, so as to determine an interference path, an interference source or a combination thereof of an interference signal of the transceiver circuit through the external computing device.

20 Claims, 5 Drawing Sheets



US012401431B2

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

(10) **Patent No.: US 12,401,431 B2**
(45) **Date of Patent: Aug. 26, 2025**

(54) **JOINT PHASE AND GAIN CALIBRATION FOR MILLIMETER WAVE BEAMFORMING**

(71) Applicant: **QUALCOMM Incorporated**, San Diego, CA (US)

(72) Inventors: **Vasanthan Raghavan**, West Windsor Township, NJ (US); **Kobi Ravid**, Closter, NJ (US); **Junyi Li**, Fairless Hills, PA (US)

(73) Assignee: **QUALCOMM Incorporated**, San Diego, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 376 days.

(21) Appl. No.: **18/172,269**

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

(65) **Prior Publication Data**

US 2024/0283548 A1 Aug. 22, 2024

(51) **Int. Cl.**

H04B 17/11	(2015.01)
H04B 17/12	(2015.01)
H04B 17/14	(2015.01)
H04B 17/21	(2015.01)
H04L 5/00	(2006.01)

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

CPC ***H04B 17/11*** (2015.01); ***H04B 17/12*** (2015.01); ***H04B 17/14*** (2015.01); ***H04B 17/21*** (2015.01); ***H04L 5/0055*** (2013.01)

(58) **Field of Classification Search**

CPC H04B 17/11; H04B 17/21; H04B 17/12; H04B 17/14; H04L 5/0055

See application file for complete search history.

(56) **References Cited**

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(Continued)

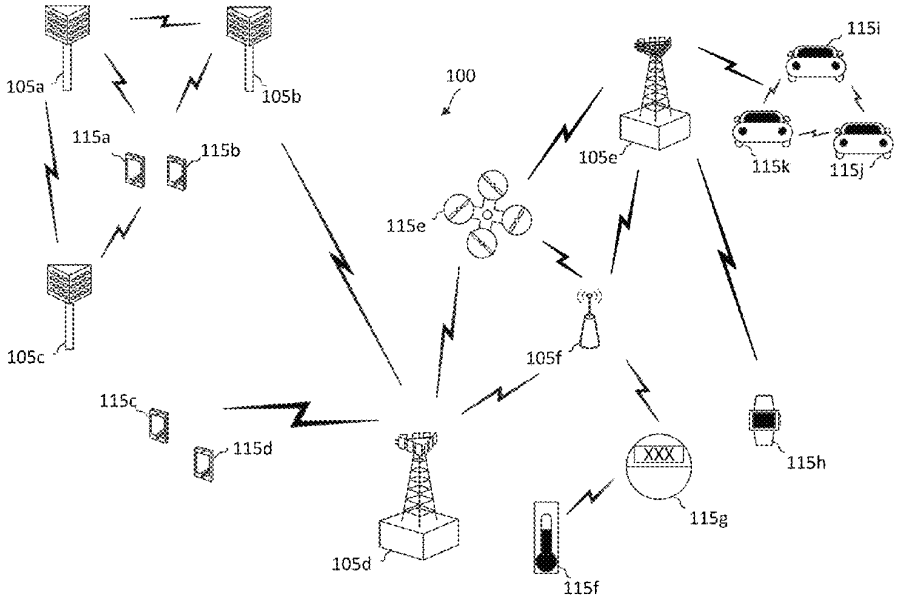
Primary Examiner — Dominic E Rego

(74) *Attorney, Agent, or Firm* — Haynes and Boone, LLP

(57) **ABSTRACT**

Wireless communications systems, apparatuses, and methods are provided. A method of wireless communication performed by a user equipment (UE) includes transmitting, to a network unit, a plurality of reference signals, wherein the plurality of reference signals is associated with a first set of phase and gain values to be used with a first antenna array at the UE for uplink transmissions, receiving, from the network unit, signals used to determine calibration coefficients associated with the first set of phase and gain values for the first antenna array, and transmitting, to the network unit, a communication signal based on the calibration coefficients associated with the first set of phase/gain values and calibration coefficients associated with a second set of phase/gain values, wherein the calibration coefficients associated with the second set of phase/gain values are interpolated from the calibration coefficients associated with the first set of phase/gain values.

30 Claims, 10 Drawing Sheets



US012401485B2

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

(10) **Patent No.: US 12,401,485 B2**
(45) **Date of Patent: Aug. 26, 2025**

(54) **NETWORK COMMUNICATION APPARATUS AND NETWORK COMMUNICATION MONITORING METHOD THEREOF HAVING FULL BAND MONITORING MECHANISM**

(71) Applicant: **REALTEK SEMICONDUCTOR CORPORATION**, Hsinchu (TW)

(72) Inventors: **Kun-Chien Hung**, Hsinchu (TW); **Tai-I Huang**, Hsinchu (TW)

(73) Assignee: **REALTEK SEMICONDUCTOR 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 468 days.

(21) Appl. No.: **17/970,386**

(22) Filed: **Oct. 20, 2022**

(65) **Prior Publication Data**

US 2023/0145509 A1 May 11, 2023

(30) **Foreign Application Priority Data**

Nov. 10, 2021 (TW) 110141906

(51) **Int. Cl.**
H04L 5/00 (2006.01)
H04W 24/08 (2009.01)

(52) **U.S. Cl.**
CPC ***H04L 5/006*** (2013.01); ***H04W 24/08*** (2013.01)

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

(56) **References Cited**

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Primary Examiner — Saad Khawar
(74) *Attorney, Agent, or Firm* — WPAT, PC

(57) **ABSTRACT**

The present invention discloses a network communication apparatus having full band monitoring mechanism. An antenna circuit receives a set of wireless signals in a full band. A receiving circuit includes receivers to receive the set of wireless signals to generate a set of received signals. A first part of the receivers operate in a service mode to perform data receiving on corresponding operation frequency sub-bands, and a second part of the receivers operate in a monitoring mode to perform interference signal monitoring on monitoring frequency sub-bands in the full band. The sub-band filtering circuits filters one of the received signals generated by one of the receivers operated in the monitoring mode to generate a filtered signal. The monitoring circuits perform monitoring on the filtered signal generated by the sub-band filtering circuits to generate signal parameter statistical data.

20 Claims, 5 Drawing Sheets