US012631937B2

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

(10) **Patent No.: US 12,631,937 B2**
(45) **Date of Patent: May 19, 2026**

(54) **OPTOELECTRONIC EMITTER WITH PHASED-ARRAY ANTENNA COMPRISING A FLARED LASER SOURCE**

(71) Applicant: **COMMISSARIAT A L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES**, Paris (FR)

(72) Inventors: **Daivid Fowler**, Grenoble Cedex (FR); **Sylvain Guerber**, Grenoble Cedex (FR); **Benoit Charbonnier**, Grenoble Cedex (FR)

(73) Assignee: **COMMISSARIAT A L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES**, Paris (FR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 484 days.

(21) Appl. No.: **18/547,607**

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

(86) PCT No.: **PCT/EP2022/054402**
§ 371 (c)(1),
(2) Date: **Mar. 18, 2024**

(87) PCT Pub. No.: **WO2022/180039**
PCT Pub. Date: **Sep. 1, 2022**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Feb. 24, 2021 (FR) 21 01808

(51) **Int. Cl.**
G02F 1/295 (2006.01)
G01S 7/481 (2006.01)

(52) **U.S. Cl.**
CPC ***G02F 1/2955*** (2013.01); ***G01S 7/4817*** (2013.01)

(58) **Field of Classification Search**
CPC G02F 1/2955; G01S 7/4817; G01S 7/4972; G01S 7/4814; G01S 7/4818; G02B 6/42; G02B 6/4212
(Continued)

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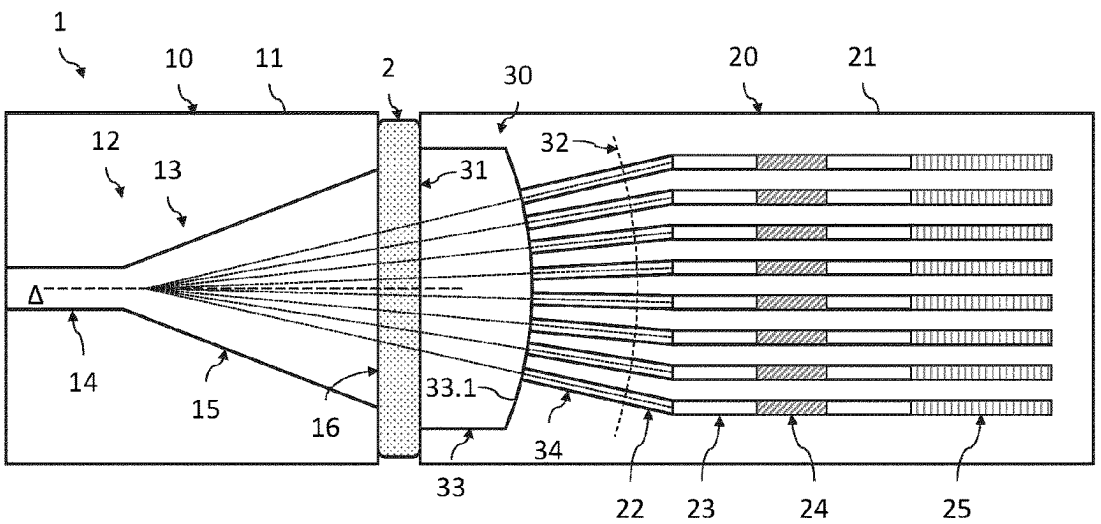
Primary Examiner — Mohammed A Hasan
(74) *Attorney, Agent, or Firm* — Oblon, McClelland, Maier & Neustadt, L.L.P.

(57) **ABSTRACT**

A phased-array optoelectronic emitter includes a laser chip containing a flared laser source and a photonic chip containing phase shifters and elementary transmitters placed in N arms. The photonic chip includes a coupler that ensures optical coupling between the flared laser source and the arms, the coupler having a collection input placed facing the emission surface of the flared laser source and a transmission output comprising N rectilinear waveguides that are coupled to the N arms of the optoelectronic emitter and that are oriented so that their longitudinal axes are secant at a position located in a flared section of the laser source on an optical axis of the laser source.

9 Claims, 4 Drawing Sheets



US012633652B2

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

(10) **Patent No.: US 12,633,652 B2**
(45) **Date of Patent: May 19, 2026**

(54) **ANTENNA DEVICE**

(71) Applicants: **INVENTEC (PUDONG) TECHNOLOGY CORPORATION**, Shanghai (CN); **INVENTEC CORPORATION**, Taipei City (TW)

(72) Inventors: **Chun-An Ko**, Taipei City (TW); **Wen-Lin Gao**, Taipei City (TW); **Yu Shu Tai**, Taipei City (TW); **Hsin-Hung Lin**, Taipei City (TW); **Wei-Chen Cheng**, Taipei City (TW)

(73) Assignees: **INVENTEC (PUDONG) TECHNOLOGY CORPORATION**, Shanghai (CN); **INVENTEC CORPORATION**, Taipei City (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 45 days.

(21) Appl. No.: **18/984,305**

(22) Filed: **Dec. 17, 2024**

(65) **Prior Publication Data**

US 2026/0074420 A1 Mar. 12, 2026

(30) **Foreign Application Priority Data**

Sep. 12, 2024 (CN) 202411281476.7

(51) **Int. Cl.**
H01Q 1/52 (2006.01)
H01Q 1/38 (2006.01)
H01Q 1/48 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/521*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 1/48*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/521; H01Q 1/38; H01Q 1/48
See application file for complete search history.

(56) **References Cited**

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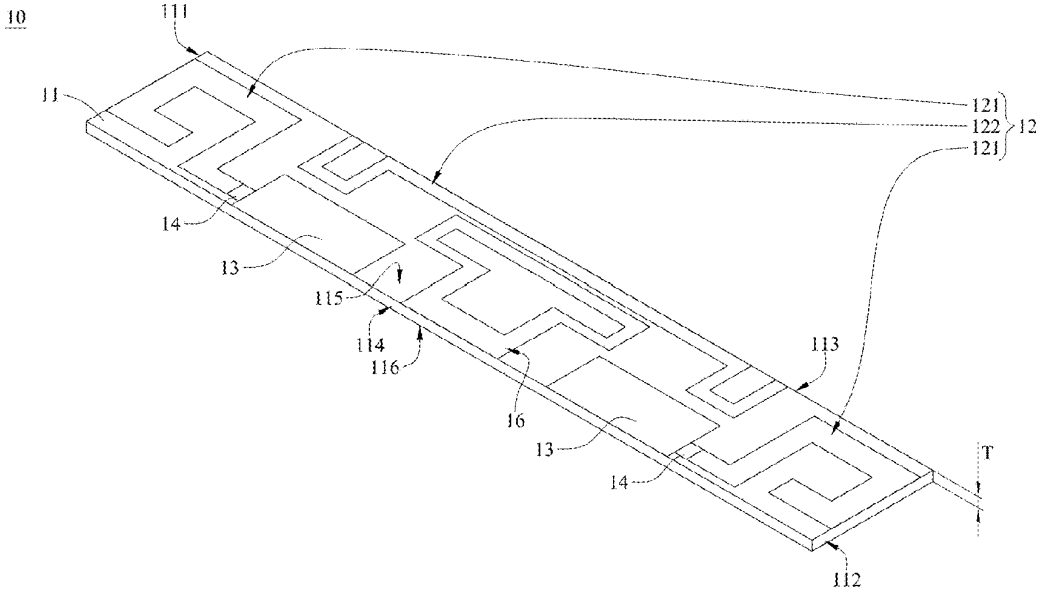
Primary Examiner — Dieu Hien T Duong
(74) *Attorney, Agent, or Firm* — Maschoff Brennan

(57) **ABSTRACT**

An antenna device includes a substrate, an excitation component and a low frequency matching component. The substrate has a first surface and a second surface facing away from each other. The excitation component is disposed on the first surface. The excitation component includes two first excitation portions and a second excitation portion spaced apart from each other. The two first excitation portions are symmetrical. Each of the two first excitation portions includes a first excitation section, a second excitation section, a third excitation section, a fourth excitation section and a fifth excitation section connected to each other. The fourth excitation sections of the two first excitation portions and the second excitation portion are adjacent to different sides of the substrate. A low frequency matching component is disposed on the second surface, and is spaced apart from sides of the substrate.

10 Claims, 8 Drawing Sheets



US012633672B2

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

(10) **Patent No.: US 12,633,672 B2**
(45) **Date of Patent: May 19, 2026**

(54) **ULTRA-WIDE BANDWIDTH LOW-BAND RADIATING ELEMENTS**

(71) Applicant: **Outdoor Wireless Networks LLC**, Claremont, NC (US)

(72) Inventors: **Kumara Swamy Kasani**, Godavari Khani (IN); **Vijay Srinivasan**, Salcette (IN)

(73) Assignee: **Outdoor Wireless Networks LLC**, Richardson, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 647 days.

(21) Appl. No.: **18/051,625**

(22) Filed: **Nov. 1, 2022**

(65) **Prior Publication Data**

US 2023/0114554 A1 Apr. 13, 2023

Related U.S. Application Data

(62) Division of application No. 16/343,587, filed as application No. PCT/US2018/039954 on Jun. 28, 2018, now Pat. No. 11,522,298.
(Continued)

(51) **Int. Cl.**
H01Q 19/10 (2006.01)
H01Q 1/24 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 19/108*** (2013.01); ***H01Q 1/246*** (2013.01); ***H01Q 5/15*** (2015.01); ***H01Q 9/16*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/246; H01Q 5/15; H01Q 9/065; H01Q 9/26; H01Q 9/16; H01Q 9/28;
(Continued)

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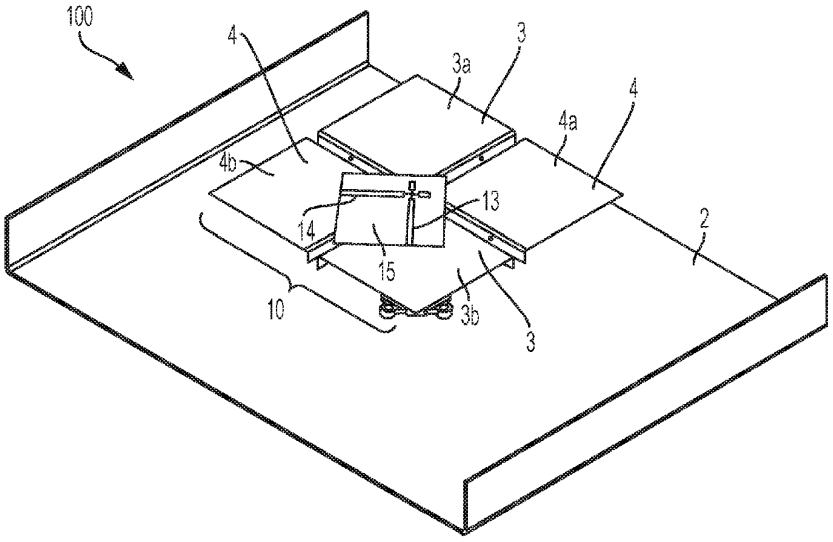
(Continued)

Primary Examiner — Ab Salem Alkassim, Jr.
(74) *Attorney, Agent, or Firm* — Myers Bigel, P.A.

(57) **ABSTRACT**

A dipole antenna includes a reflector, a radiating element, and a feed element. The radiating element includes first and second dipoles above a surface of the reflector. The first and second dipoles respectively include arm segments and are arranged in a crossed dipole arrangement. The feed element includes first and second conductive transmission lines that are electrically isolated from one another and are capacitively coupled to the arm segments of the first and second dipoles, respectively. The arm segments of the first and second dipoles are between the feed element and the surface of the reflector.

14 Claims, 12 Drawing Sheets



US012633955B2

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

(10) **Patent No.: US 12,633,955 B2**
(45) **Date of Patent: May 19, 2026**

(54) **ELECTRONIC DEVICE INCLUDING ANTENNA**

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

(72) Inventors: **Sungsun Kim**, Gyeonggi-do (KR); **Joonwon Jang**, Gyeonggi-do (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 678 days.

(21) Appl. No.: **18/082,138**

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

(65) **Prior Publication Data**

US 2023/0336202 A1 Oct. 19, 2023

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2022/020218, filed on Dec. 13, 2022.

(30) **Foreign Application Priority Data**

Apr. 15, 2022 (KR) 10-2022-0047211
May 9, 2022 (KR) 10-2022-0056658

(51) **Int. Cl.**
H04B 1/40 (2015.01)
H01Q 1/24 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04B 1/40*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/526*** (2013.01); ***H01Q 5/307*** (2015.01)

(58) **Field of Classification Search**
CPC H04B 1/40; H01Q 5/307; H01Q 1/243; H01Q 1/526
See application file for complete search history.

(56) **References Cited**

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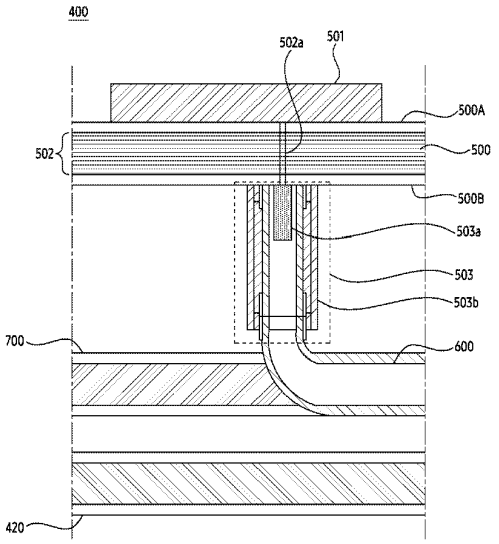
Primary Examiner — Junpeng Chen
(74) *Attorney, Agent, or Firm* — CANTOR COLBURN LLP

(57) **ABSTRACT**

An electronic device according to an embodiment includes a housing including at least one opening; a support member in the housing; a display disposed on the support member; a first printed circuit board including a plurality of layers; a first wireless communication circuit disposed on a first surface of the first printed circuit board; a feeding structure on another surface of the first printed circuit board electrically connected to the first wireless communication circuit; and a waveguide configured to transmit a signal provided from the first wireless communication circuit to an outside of the housing, and the waveguide extends along one surface of the support member from the feeding structure. Other embodiments are possible.

20 Claims, 24 Drawing Sheets



US012640458B2

(12) **United States Patent**
Chen

(10) **Patent No.: US 12,640,458 B2**
(45) **Date of Patent: May 26, 2026**

(54) **ANTENNA MODULE AND FIXED BRACKET THEREOF**

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

(72) Inventor: **Yuan-Yu Chen**, 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 50 days.

(21) Appl. No.: **19/007,692**

(22) Filed: **Jan. 2, 2025**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Mar. 7, 2024 (TW) 113108261

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

(52) **U.S. Cl.**
CPC ***H01Q 1/22*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/22; H01Q 1/1207; B25B 5/006; B25B 5/14; F16M 13/02; F16M 13/022; F16M 11/10; F16M 2200/024; H05K 5/10; H04N 5/64
See application file for complete search history.

(56) **References Cited**

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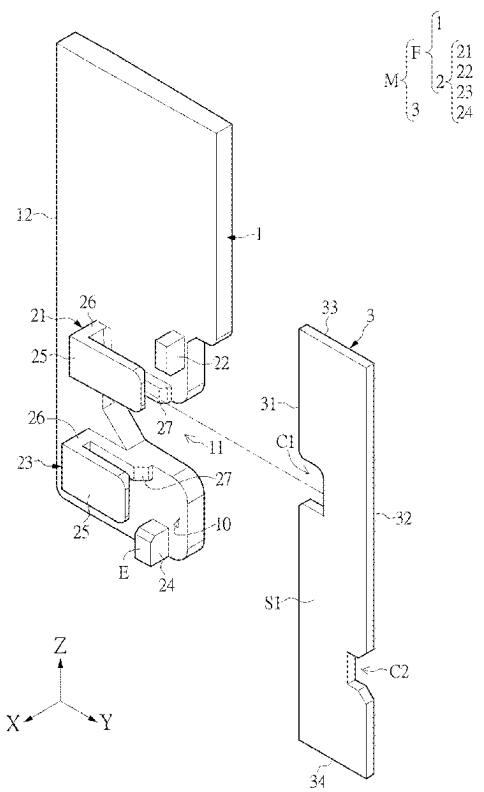
Primary Examiner — David E Lotter
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

An antenna module includes a fixed bracket and an antenna element. The fixed bracket includes a base and a clamping structure disposed on the base. The clamping structure includes a first clamping part, a first retaining wall, a second clamping part, and a second retaining wall. The first clamping part and the second clamping part are arranged along a straight line. A horizontal distance between the first clamping part and the straight line is not equal to a horizontal distance between the second clamping part and the straight line. A horizontal distance between the first retaining wall and the straight line is not equal to a horizontal distance between the second retaining wall and the straight line. The antenna element is detachably engaged with the first clamping part and the second clamping part.

15 Claims, 9 Drawing Sheets



US012640459B1

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

(10) **Patent No.: US 12,640,459 B1**
(45) **Date of Patent: May 26, 2026**

(54) **ANTENNA INSTALLED IN HEAT DISSIPATION VENT**

(71) Applicant: **HONGBO WIRELESS COMMUNICATION TECHNOLOGY CO., LTD.**, Taipei City (TW)

(72) Inventors: **Chia-Tien Li**, Taipei City (TW); **Hong-Fang Yan**, Taipei City (TW)

(73) Assignee: **HONGBO WIRELESS COMMUNICATION TECHNOLOGY CO., LTD.**, Taipei City (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 61 days.

(21) Appl. No.: **18/956,400**

(22) Filed: **Nov. 22, 2024**

(51) **Int. Cl.**

H01Q 1/48	(2006.01)
H01Q 1/22	(2006.01)
H01Q 5/20	(2015.01)
H05K 7/20	(2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/2266*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 5/20*** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/241; H01Q 1/243; H01Q 1/48; H01Q 1/50; H01Q 1/52; H01Q 5/20; H01Q 1/22; H01Q 1/2258; G06F 1/203; H05K 7/20; H05K 7/20154
See application file for complete search history.

(56) **References Cited**

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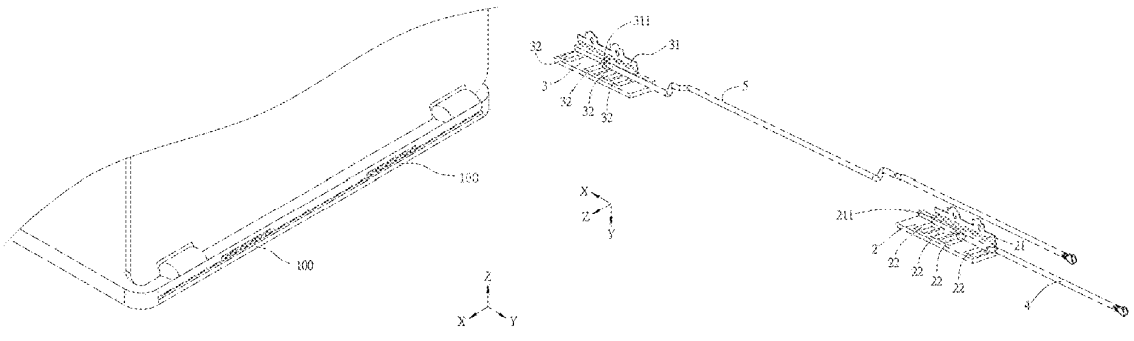
Primary Examiner — Thai Pham
(74) *Attorney, Agent, or Firm* — Li & Cai Intellectual Property (USA) Office

(57) **ABSTRACT**

An antenna installed in a heat dissipation vent includes a heat dissipation frame, a main antenna body, and an auxiliary antenna body. The heat dissipation frame has a plurality of first openings and a plurality of second openings. The main antenna body has a main antenna pattern and a plurality of first alignment openings. The first alignment openings are aligned with the first openings, and are bonded to the heat dissipation frame. The auxiliary antenna body has an auxiliary antenna pattern and a plurality of second alignment openings. The second alignment openings are aligned with the second openings, and are bonded to the heat dissipation frame. Accordingly, an integration degree of a heat sink and an antenna component can be improved.

10 Claims, 11 Drawing Sheets



US012640462B2

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

(10) **Patent No.: US 12,640,462 B2**
(45) **Date of Patent: May 26, 2026**

(54) **ELECTRONIC DEVICE**

(71) Applicant: **Getac Technology Corporation**, New Taipei City (TW)

(72) Inventors: **Shao-Ching Wu**, Taipei City (TW); **Shang-Yi Yang**, Taipei City (TW)

(73) Assignee: **Getac Technology Corporation**, New Taipei City (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 72 days.

(21) Appl. No.: **18/733,004**

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

(65) **Prior Publication Data**

US 2025/0167430 A1 May 22, 2025

(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/38 (2006.01)
H01Q 21/28 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 21/28*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/22; H01Q 1/24; H01Q 1/243; H01Q 1/36; H01Q 1/38; H01Q 5/20; H01Q 21/00; H01Q 21/28
See application file for complete search history.

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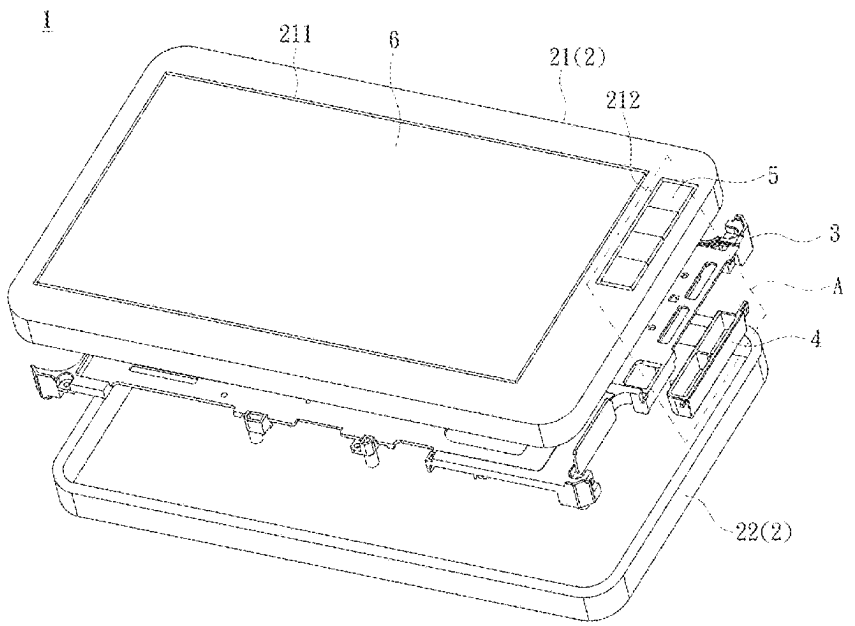
Primary Examiner — Hoang V Nguyen
(74) *Attorney, Agent, or Firm* — COOPER LEGAL GROUP LLC

(57) **ABSTRACT**

An electronic device includes a housing, a metal support plate, a three-dimensional antenna bracket and a side button circuit board. The housing includes an upper housing body and a lower housing body. The metal support plate is arranged in the housing. The three-dimensional antenna bracket is arranged in a first space between the metal support plate and the lower housing body. The side button circuit board is arranged in a second space between the metal support plate and the upper housing body. The area of the three-dimensional antenna bracket and the area of the side button circuit board on the metal support plate overlap with each other. Thus, the electronic device can meet the design requirement for a plurality of antennae, and the three-dimensional antenna bracket and the metal support plate form a radiation cavity to resonate to generate a target antenna frequency band and an available radiation pattern.

20 Claims, 5 Drawing Sheets



US012640479B2

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

(10) **Patent No.: US 12,640,479 B2**
(45) **Date of Patent: May 26, 2026**

(54) **ANTENNA AND ELECTRONIC DEVICE**

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

(72) Inventors: **Xiuyin Zhang**, Guangzhou (CN); **Di Pang**, Guangzhou (CN); **Huafeng Su**, Guangzhou (CN); **Huiliang Xu**, Shenzhen (CN)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 41 days.

(21) Appl. No.: **18/722,569**

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

(86) PCT No.: **PCT/CN2022/138413**
§ 371 (c)(1),
(2) Date: **Jun. 20, 2024**

(87) PCT Pub. No.: **WO2023/134359**
PCT Pub. Date: **Jul. 20, 2023**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

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H01Q 5/328 (2015.01)
H01Q 3/26 (2006.01)
H01Q 13/08 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 5/328*** (2015.01); ***H01Q 3/2611*** (2013.01); ***H01Q 13/08*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/328; H01Q 3/2611; H01Q 13/08
See application file for complete search history.

(56) **References Cited**

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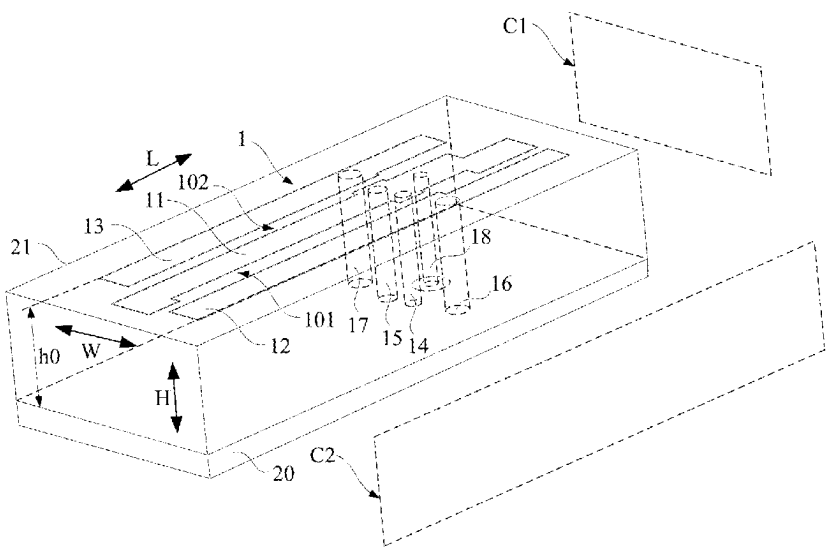
(Continued)

Primary Examiner — Graham P Smith

(57) **ABSTRACT**

An antenna comprises a feeding element and a plurality of radiators including a first radiator, a second radiator, and a third radiator spaced from each other side by side in a first direction on a same plane. One end of the feeding element is connected to a feeding connection point of the first radiator, and the other end is connected to a feeding point. The antenna further includes a first ground element, a second ground element, a third ground element, and a fourth ground element that are spaced from each other in the first direction. A first gap is formed between the second radiator and the first radiator, and a second gap is formed between the third radiator and the first radiator.

18 Claims, 20 Drawing Sheets



US012646822B2

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

(10) **Patent No.: US 12,646,822 B2**
(45) **Date of Patent: Jun. 2, 2026**

(54) **ELECTRONIC DEVICE INCLUDING ANTENNA**

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

(72) Inventors: **Chanhee Oh**, Suwon-si (KR); **Joon Heo**, Suwon-si (KR); **Soon Park**, Suwon-si (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 494 days.

(21) Appl. No.: **18/108,999**

(22) Filed: **Feb. 13, 2023**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. PCT/KR2022/016114, filed on Oct. 21, 2022.

(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/02 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/02*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 1/526*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/02; H01Q 1/526; H01Q 1/38; H01Q 1/52; H01Q 1/24; H04B 5/26; H04B 5/43
See application file for complete search history.

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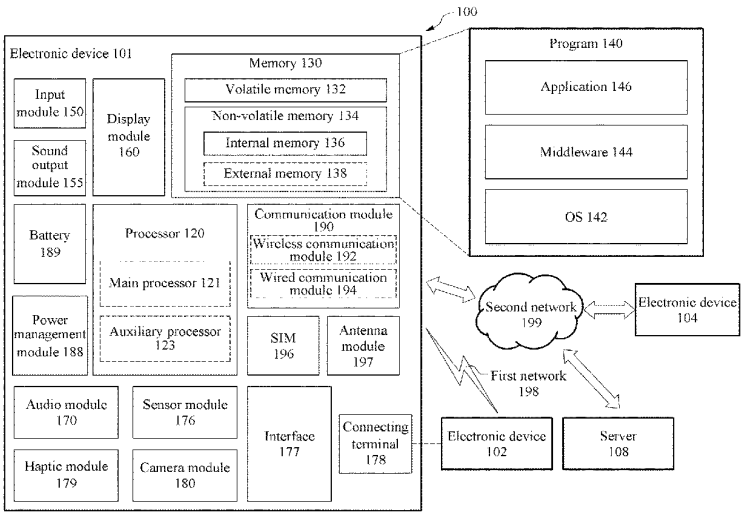
(Continued)

Primary Examiner — Tuan H Nguyen
(74) *Attorney, Agent, or Firm* — Sughrue Mion, PLLC

(57) **ABSTRACT**

An electronic device is provided. The electronic device includes first and second printed circuit boards (PCBs); a flexible PCB (FPCB) connecting the first and second PCBs; and an antenna module between the first and second PCBs. The antenna module includes: a first pattern layer provided on a first substrate surface and forming a first coil pattern; a second pattern layer provided on a second substrate surface and forming a second coil pattern; an overlapping area in which the FPCB is provided between portions of the second pattern layer; and a plurality of pattern areas in which the portions of the second coil pattern are respectively provided.

17 Claims, 27 Drawing Sheets



US012646825B2

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

(10) **Patent No.: US 12,646,825 B2**
(45) **Date of Patent: Jun. 2, 2026**

(54) **ANTENNA AND ANTENNA ARRAY**

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

(72) Inventors: **Sertan Hastürkoglu**, Munich (DE); **Andreas Vollmer**, 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 122 days.

(21) Appl. No.: **18/839,468**

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

(86) PCT No.: **PCT/EP2022/054798**

§ 371 (c)(1),
(2) Date: **Aug. 19, 2024**

(87) PCT Pub. No.: **WO2023/160804**

PCT Pub. Date: **Aug. 31, 2023**

(65) **Prior Publication Data**

US 2025/0174894 A1 May 29, 2025

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

(52) **U.S. Cl.**
CPC ***H01Q 1/246*** (2013.01); ***H01Q 1/521*** (2013.01); ***H01Q 5/42*** (2015.01); ***H01Q 5/48*** (2015.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/246; H01Q 1/52; H01Q 1/521; H01Q 1/523; H01Q 5/40; H01Q 5/42;
(Continued)

(56) **References Cited**

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(Continued)

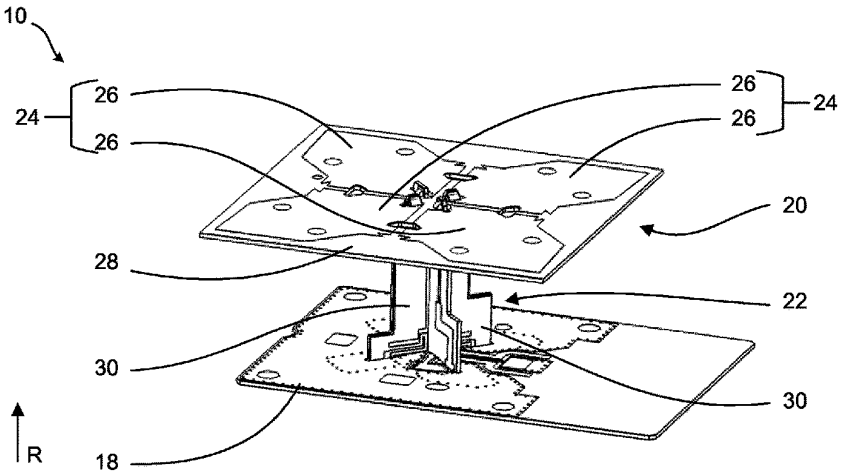
Primary Examiner — Robert Karacsony
(74) *Attorney, Agent, or Firm* — Withrow & Terranova, PLLC

(57) **ABSTRACT**

An antenna has a radiator head, a support, and a reflector, wherein the radiator head comprises at least one radiator, the reflector comprises a ground plane, and the support supports the radiator head. A balun structure having a half for each of the radiation sections is provided, wherein each of the halves of the balun structure comprises a main line, an inductive line and a capacitance. The capacitance comprises a capacitive area, the main line galvanically connects the respective radiation section of the radiator to the capacitive area of the capacitance, and the inductive line extends from the main line and is galvanically connected to the ground plane.

Further, an antenna array and a mobile communication cell site are shown.

18 Claims, 7 Drawing Sheets



US012646829B2

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

(10) **Patent No.: US 12,646,829 B2**
(45) **Date of Patent: Jun. 2, 2026**

(54) **ELECTRONIC DEVICE COMPRISING ANTENNA**

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

(72) Inventors: **Youngjun Cho**, Suwon-si (KR); **Seunghwan Kim**, 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 223 days.

(21) Appl. No.: **18/628,158**

(22) Filed: **Apr. 5, 2024**

(65) **Prior Publication Data**

US 2024/0250418 A1 Jul. 25, 2024

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2022/011564, filed on Aug. 4, 2022.

(30) **Foreign Application Priority Data**

Oct. 7, 2021 (KR) 10-2021-0133368

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/46 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 1/46*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 5/335*** (2015.01); ***H04R 1/025*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/46; H01Q 1/00; H01Q 1/243; H01Q 5/335; H01Q 5/321; H01Q 5/371;
(Continued)

(56) **References Cited**

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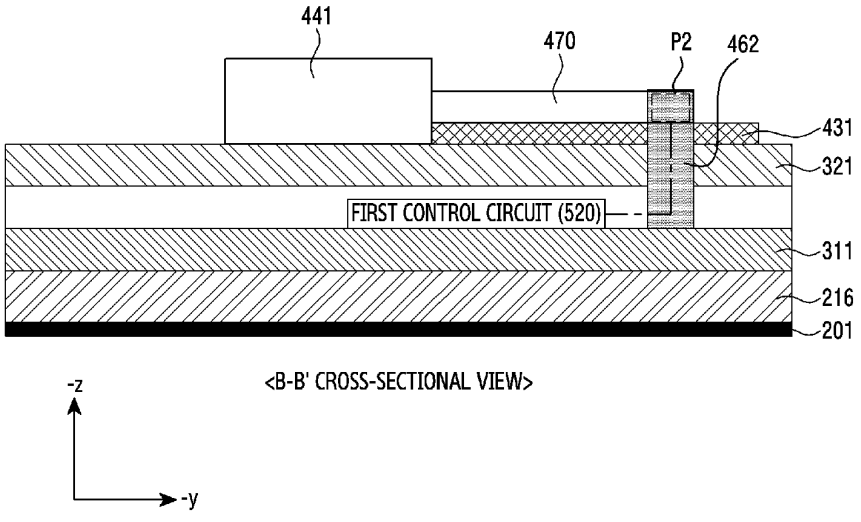
(Continued)

Primary Examiner — David E Lotter
(74) *Attorney, Agent, or Firm* — Sughrue Mion, PLLC

(57) **ABSTRACT**

An electronic device includes a first frame, a speaker module, a wireless communication circuit, a conductive connection member which is connected to the wireless communication circuit via a first capacitor, a conductive pattern which is connected at a first point to the conductive connection member, and includes a first portion extending from the first point and connected to the speaker module and a second portion extending from the first point, and a control circuit, wherein the first portion includes a first inductor, and the wireless communication circuit may transmit or receive a first signal in a first frequency band via a first electrical path including the first capacitor, the conductive connection member, and the second portion of the conductive pattern.

20 Claims, 18 Drawing Sheets



US012646837B2

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

(10) **Patent No.: US 12,646,837 B2**
(45) **Date of Patent: Jun. 2, 2026**

(54) **ELECTRONIC DEVICE**

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

(72) Inventors: **Zipeng Hou**, Guangdong (CN); **Zhengping Hu**, Guangdong (CN)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 153 days.

(21) Appl. No.: **18/647,937**

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

(65) **Prior Publication Data**

US 2024/0275046 A1 Aug. 15, 2024

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2022/128378, filed on Oct. 28, 2022.

(30) **Foreign Application Priority Data**

Oct. 28, 2021 (CN) 202111267203.3

(51) **Int. Cl.**
H01Q 5/10 (2015.01)
H01Q 5/328 (2015.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 5/10*** (2015.01); ***H01Q 5/35*** (2015.01); *H01Q 1/241* (2013.01); *H01Q 1/36* (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/24; H01Q 1/241; H01Q 1/243; H01Q 1/273; H01Q 1/52; H01Q 5/10;
(Continued)

(56) **References Cited**

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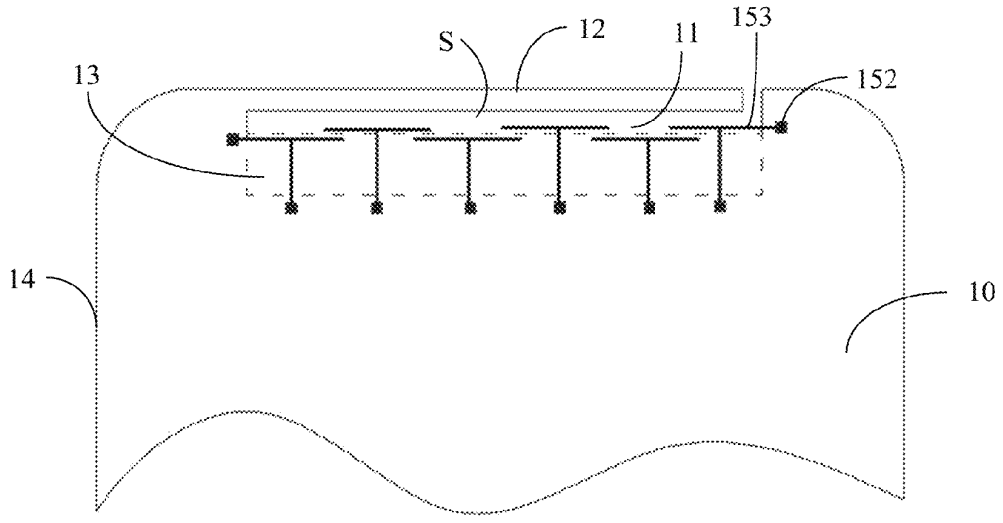
Primary Examiner — Thai Pham
(74) *Attorney, Agent, or Firm* — BROOKS KUSHMAN P.C.

(57) **ABSTRACT**

An electronic device, and the electronic device includes: a frame body, a display, and an antenna coupling structure. The display is disposed on the frame body, and a display control line is disposed on a side, close to the frame body, of the display. An antenna resonant arm is disposed on the frame body, and the antenna resonant arm includes a first antenna and a second antenna. Operating frequency bands of the first antenna and the second antenna are different, and a gap is formed between the antenna resonant arm and the display control line. A clearance area is provided at a position, close to the gap, on the frame body, the antenna coupling structure is disposed in the clearance area, and the antenna coupling structure is coupled to an antenna reference ground on the frame body.

11 Claims, 2 Drawing Sheets



US012646844B2

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

(10) **Patent No.: US 12,646,844 B2**
(45) **Date of Patent: Jun. 2, 2026**

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

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

(72) Inventors: **Dong Yu**, Shanghai (CN); **Zhijun Huang**, Shanghai (CN); **Kexin Liu**, Shanghai (CN); **Fangchao Zhao**, Shanghai (CN); **Peng Huang**, Shanghai (CN); **Hanyang Wang**, Reading (GB)

(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 300 days.

(21) Appl. No.: **18/254,992**

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

(86) PCT No.: **PCT/CN2021/134016**
§ 371 (c)(1),
(2) Date: **May 30, 2023**

(87) PCT Pub. No.: **WO2022/111687**
PCT Pub. Date: **Jun. 2, 2022**

(65) **Prior Publication Data**

US 2024/0021993 A1 Jan. 18, 2024

(30) **Foreign Application Priority Data**

Nov. 30, 2020 (CN) 202011380031.6

(51) **Int. Cl.**
H01Q 9/42 (2006.01)
H01Q 1/22 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 9/0407*** (2013.01); ***H01Q 1/22*** (2013.01); ***H01Q 5/35*** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/22; H01Q 1/243; H01Q 1/521; H01Q 5/35; H01Q 5/50; H01Q 5/28;
(Continued)

(56) **References Cited**

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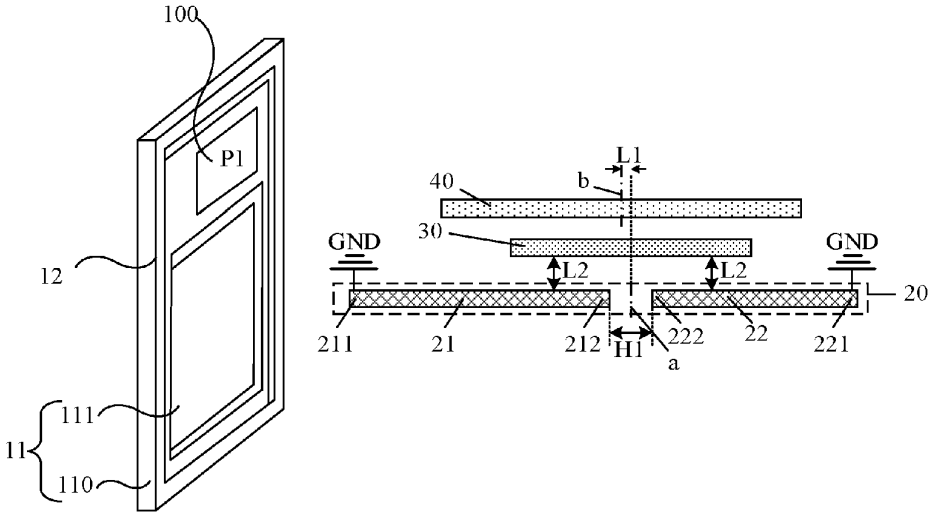
Primary Examiner — Dimary S Lopez Cruz
Assistant Examiner — Marin Stoytchev Stoytchev
(74) *Attorney, Agent, or Firm* — Conley Rose, P.C.

(57) **ABSTRACT**

An antenna apparatus includes a first branch, a frame branch, and a second branch. The frame branch is provided with a first gap, and the frame branch is divided into a first frame branch and a second frame branch by the first gap. The first branch, the second branch, the first frame branch and the second frame branch are conductive, not in contact with each other and are insulated from each other A first feeding circuit is electrically connected to the second frame branch, configured to transmit a first excitation signal to the second frame branch, and excite the second frame branch to radiate a first radio wave. A second feeding circuit is electrically connected to the second branch, configured to transmit a second excitation signal to the second branch, and excite the second branch to radiate a second radio wave.

20 Claims, 16 Drawing Sheets



US012651822B2

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

(10) **Patent No.: US 12,651,822 B2**
(45) **Date of Patent: Jun. 9, 2026**

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

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

(72) Inventors: **Han Sub Ryu**, Gyeongsangbuk-do (KR); **Yu Mi Ahn**, Daegu (KR); **Ho Dong Yoon**, Gyeonggi-do (KR); **Won Hee Lee**, Incheon (KR); **Jae Hyun Lee**, Gyeonggi-do (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 146 days.

(21) Appl. No.: **17/884,966**

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

(65) **Prior Publication Data**

US 2022/0393335 A1 Dec. 8, 2022

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2021/001639, filed on Feb. 8, 2021.

(30) **Foreign Application Priority Data**

Feb. 10, 2020 (KR) 10-2020-0015473
Feb. 20, 2020 (KR) 10-2020-0020767

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/22 (2006.01)
H01Q 1/36 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/22*** (2013.01); ***H01Q 1/36*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/22; H01Q 1/36; H01Q 9/045; H01Q 1/1271; H01Q 1/243; H01Q 1/38; H01Q 1/40; G02B 5/30; G06F 3/041; G06F 3/0412
See application file for complete search history.

(56) **References Cited**

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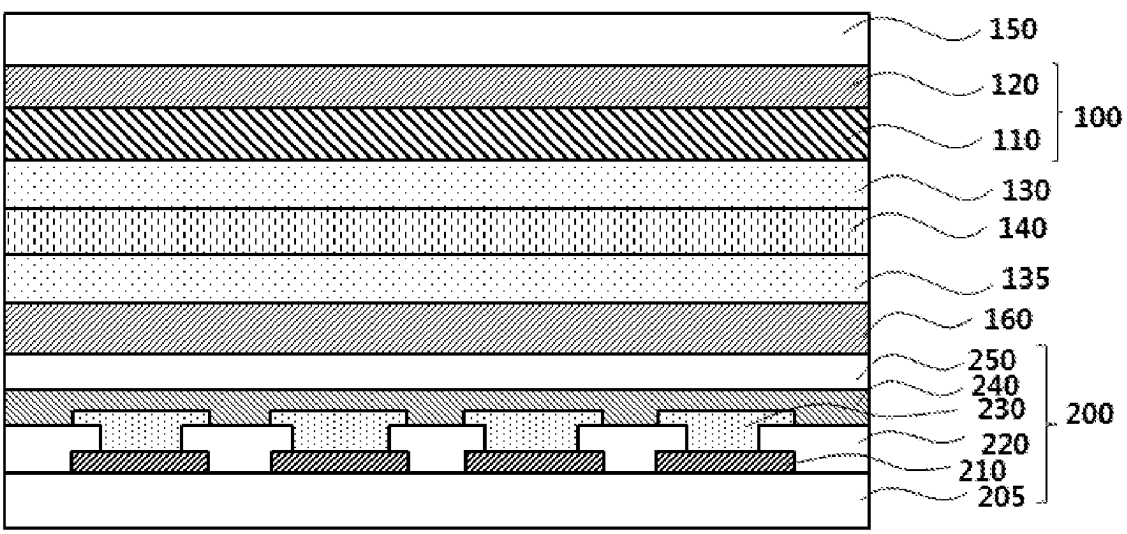
Primary Examiner — Dimary S Lopez Cruz
Assistant Examiner — Bamidele A Immanuel
(74) *Attorney, Agent, or Firm* — The PL Law Group, PLLC

(57) **ABSTRACT**

An antenna stack structure according to an embodiment includes a protective layer, and an antenna electrode layer formed directly on a surface of the protective layer. The antenna electrode layer includes a first electrode layer and a second electrode layer having a lower reflectance than that of the first electrode layer. A visual recognition of electrode are prevented by the second electrode layer.

18 Claims, 5 Drawing Sheets



US012651825B2

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

(10) **Patent No.: US 12,651,825 B2**
(45) **Date of Patent: Jun. 9, 2026**

(54) **ELECTRONIC DEVICE**

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

(72) Inventors: **Jiaming Wang**, Shanghai (CN); **Dong Yu**, Shanghai (CN); **Fangchao Zhao**, 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 77 days.

(21) Appl. No.: **18/692,697**

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

(86) PCT No.: **PCT/CN2022/118906**
§ 371 (c)(1),
(2) Date: **Mar. 15, 2024**

(87) PCT Pub. No.: **WO2023/040928**
PCT Pub. Date: **Mar. 23, 2023**

(65) **Prior Publication Data**

US 2025/0141089 A1 May 1, 2025

(30) **Foreign Application Priority Data**

Sep. 18, 2021 (CN) 202111111392.5

(51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01Q 1/48 (2006.01)
H01Q 5/30 (2015.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/2266*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 5/30*** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/22; H01Q 1/52; H01Q 1/243; H01Q 5/30–50
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

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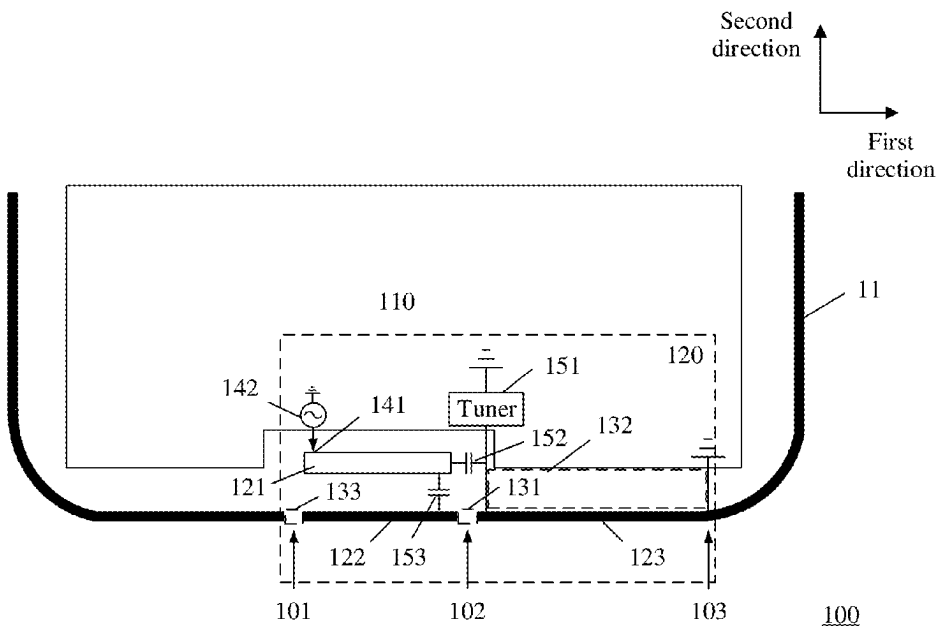
(Continued)

Primary Examiner — Hasan Islam
(74) *Attorney, Agent, or Firm* — Slater Matsil, LLP

(57) **ABSTRACT**

An electronic device including an antenna structure is provided. A side frame between a first position and a second position of the electronic device is configured as a first radiator of the antenna structure. A side frame between the second position and a third position of the electronic device is configured as a second radiator of the antenna structure. A first slot is provided at the second position of the side frame. A second slot is formed between the second radiator and a ground. The first radiator extends in a first direction, and is spaced from the third radiator in a second direction. Projections of the third radiator and the first radiator in the second direction at least partially overlap. A first feed point is disposed on the third radiator or the first radiator, and the first feed point is configured to feed the antenna structure.

20 Claims, 11 Drawing Sheets



US012651826B2

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

(10) **Patent No.: US 12,651,826 B2**
(45) **Date of Patent: Jun. 9, 2026**

(54) **ELECTRONIC DEVICE WITH FOLDED ANTENNA MODULE**

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

(72) Inventors: **Alden T Rush**, San Diego, CA (US); **Salih Yarga**, San Jose, CA (US); **Joel Ravi**, San Francisco, CA (US); **Woonyong Bae**, San Jose, CA (US); **Laura M Burke**, Los Gatos, CA (US); **Bhaskara R Rupakula**, San Jose, CA (US); **Haozhan Tian**, San Jose, CA (US); **Erdinc Irci**, Sunnyvale, CA (US); **Hongfei Hu**, Cupertino, CA (US); **Carlo Di Nallo**, Belmont, 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 317 days.

(21) Appl. No.: **18/464,969**

(22) Filed: **Sep. 11, 2023**

(65) **Prior Publication Data**

US 2025/0087868 A1 Mar. 13, 2025

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 3/36 (2006.01)
H01Q 5/25 (2015.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 3/36*** (2013.01); ***H01Q 5/25*** (2015.01)

(58) **Field of Classification Search**
USPC 343/702
See application file for complete search history.

(56) **References Cited**

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WO 2022235071 A1 11/2022

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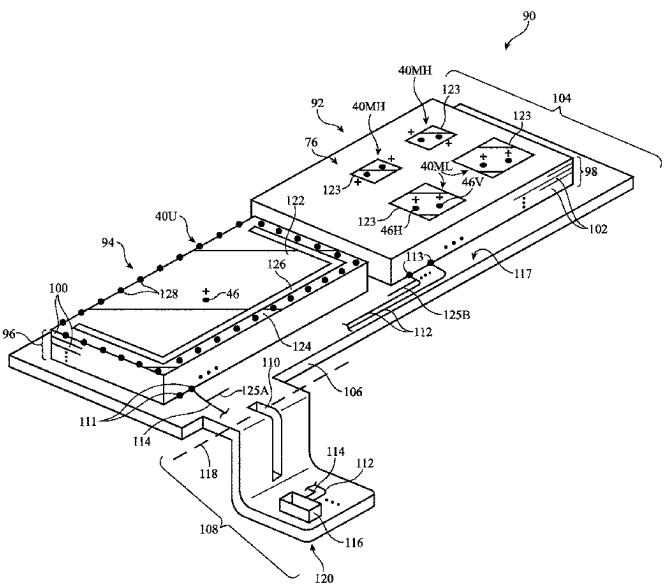
U.S. Appl. No. 17/730,039, filed Apr. 26, 2022.

Primary Examiner — Dimary S Lopez Cruz
Assistant Examiner — Brandon Sean Woods
(74) *Attorney, Agent, or Firm* — Treyz Law Group, P.C.; Michael H. Lyons

(57) **ABSTRACT**

An electronic device may be provided with a housing having sidewalls, a dielectric cover, and a conductive plate. A display may be mounted to the sidewalls opposite the dielectric cover. A logic board may be interposed between the display and the plate. The device may include a phased antenna array on a first module and an ultra-wideband (UWB) on a second module. The first and second modules may be surface-mounted to the main body of a flexible printed circuit between the plate and the dielectric cover. The UWB antenna and the array may convey radio-frequency signals through the dielectric cover. The flexible printed circuit may have a tail that carries the transmission lines for the UWB antenna and the array. The tail may be folded through a hole in the mid-chassis and coupled to a radio-frequency connector on the logic board.

20 Claims, 11 Drawing Sheets



US012651827B2

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

(10) **Patent No.: US 12,651,827 B2**
(45) **Date of Patent: Jun. 9, 2026**

(54) **ELECTRONIC DEVICE INCLUDING ANTENNA**

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

(72) Inventors: **Youngsub Kim**, Suwon-si (KR); **Juneseok Lee**, Suwon-si (KR); **Kwanghyun Baek**, Suwon-si (KR); **Jungyub Lee**, Suwon-si (KR); **Dohyuk Ha**, 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 237 days.

(21) Appl. No.: **18/384,156**

(22) Filed: **Oct. 26, 2023**

(65) **Prior Publication Data**

US 2024/0266716 A1 Aug. 8, 2024

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2023/015656, filed on Oct. 11, 2023.

(30) **Foreign Application Priority Data**

Feb. 8, 2023 (KR) 10-2023-0016848

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/22 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 1/246*** (2013.01); ***H01Q 1/2283*** (2013.01); ***H01Q 9/16*** (2013.01); ***H01Q 21/062*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/2283; H01Q 1/246; H01Q 1/38; H01Q 9/0414; H01Q 9/06; H01Q 9/065;
(Continued)

(56) **References Cited**

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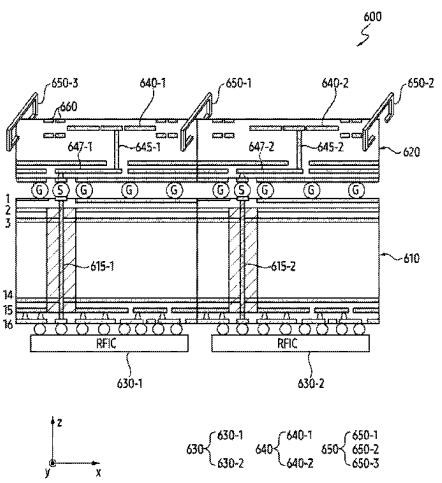
Primary Examiner — Jason M Crawford
(74) *Attorney, Agent, or Firm* — Sughrue Mion, PLLC

(57) **ABSTRACT**

A radio unit (RU) module may include: a first substrate comprising a first surface and a second surface opposite to the first surface; a radio frequency integrated circuit (RFIC); a second substrate comprising a plurality of layers that comprises a plurality of second layers that comprises at least one first layer; a plurality of antenna elements comprising a first antenna element and a second antenna element; and a plurality of conductivity members comprising a conductivity member. The RFIC may be coupled to the first surface of the first substrate. The second substrate may be coupled to the second surface of the first substrate. The plurality of antenna elements may be disposed on the at least one first layer of the second substrate. The plurality of conductivity
(Continued)



US012651844B2

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

(10) **Patent No.: US 12,651,844 B2**
(45) **Date of Patent: Jun. 9, 2026**

(54) **ELECTRONIC DEVICE INCLUDING EMI ABSORBER**

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

(72) Inventors: **Eunbae Kwon**, Suwon-si (KR); **Changrim Yu**, Suwon-si (KR); **Jongmin Kim**, Suwon-si (KR); **Joseph Kang**, Suwon-si (KR); **Kwonsik Min**, Suwon-si (KR); **Jihwan Oh**, Suwon-si (KR); **Kyonghwan Cho**, Suwon-si (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 350 days.

(21) Appl. No.: **18/332,322**

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

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. PCT/KR2023/005494, filed on Apr. 21, 2023.

(30) **Foreign Application Priority Data**

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Jun. 10, 2022 (KR) 10-2022-0070924

(51) **Int. Cl.**
H01Q 17/00 (2006.01)
H01Q 1/52 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 17/007*** (2013.01); ***H01Q 1/52*** (2013.01); ***H04M 1/02*** (2013.01); ***H04M 1/0264*** (2013.01);
(Continued)

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

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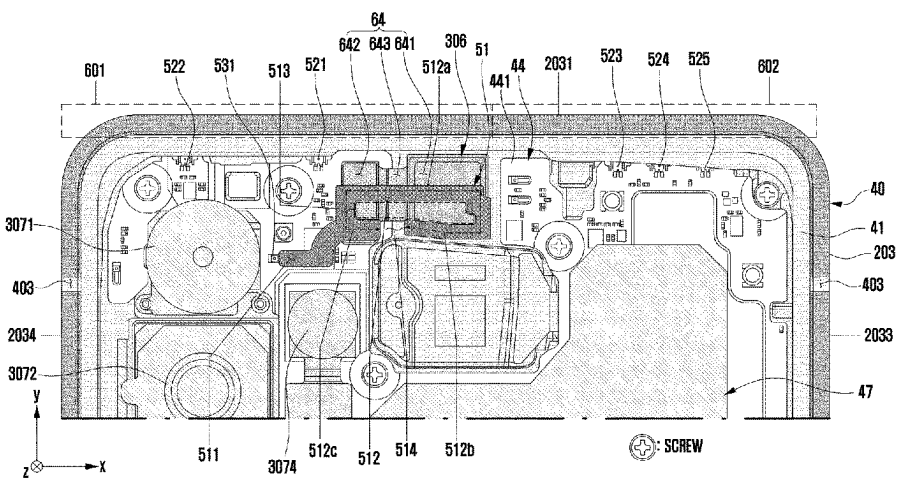
Primary Examiner — Vladimir Magloire
Assistant Examiner — Ashley Brown Raynal
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

An electronic device is provided. The electronic device includes a housing including a front surface plate, a rear surface plate, and a side surface portion providing a side surface, a first support positioned between the front surface plate and the rear surface plate and connected to the side surface portion, a display, a wireless communication circuit configured to transmit or receive a signal through an antenna radiator, camera circuitry positioned between the first support and the rear surface plate, and a conductive pattern positioned between the first support and the rear surface plate and at least partially overlapping with the camera circuitry when viewed from a top of the rear surface plate, and electrically connected to a ground of the electronic device.

13 Claims, 12 Drawing Sheets



US012651845B2

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

(10) **Patent No.: US 12,651,845 B2**
(45) **Date of Patent: Jun. 9, 2026**

(54) **ELECTRONIC DEVICE WITH MILLIMETER WAVE ANTENNA MODULE**

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

(72) Inventors: **Yu Wang**, Shenzhen (CN); **Zengchao Qu**, 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 162 days.

(21) Appl. No.: **18/255,284**

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

(86) PCT No.: **PCT/CN2022/114633**
§ 371 (c)(1),
(2) Date: **May 31, 2023**

(87) PCT Pub. No.: **WO2023/045688**
PCT Pub. Date: **Mar. 30, 2023**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**
H01Q 19/10 (2006.01)
H01Q 1/24 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 19/10*** (2013.01); ***H01Q 1/243*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/24; H01Q 1/243; H01Q 1/22; H01Q 1/2291; H01Q 1/42; H01Q 3/32; H01Q 3/46; H01Q 15/0006; H01Q 15/0013; H01Q 15/0026; H01Q 19/06; H01Q 19/10; H01Q 21/08
See application file for complete search history.

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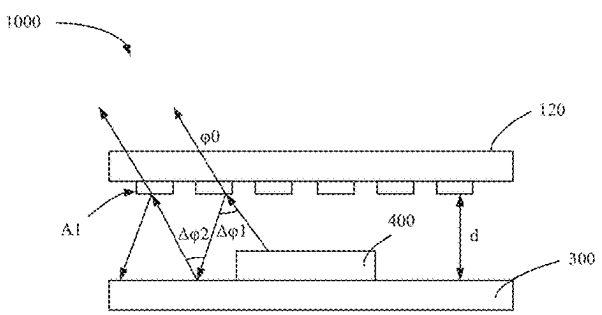
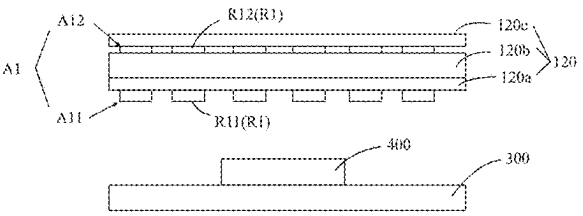
Primary Examiner — Thai Pham
(74) *Attorney, Agent, or Firm* — Conley Rose, P.C.

(57) **ABSTRACT**

An electronic device, including a circuit board, a back cover, and a millimeter wave antenna module. The millimeter wave antenna module is disposed on a surface of the circuit board facing the back cover and is configured to send a millimeter wave signal. At least one of the back cover and the circuit board is disposed with an in-phase reflection structure. According to this application, the phases of the millimeter wave signal reaching the back cover each time are the same when the millimeter wave signal is reflected the plurality of times between the circuit board and the back cover in a shorter distance. This reduces a thickness of the whole electronic device and improves radiation performance of an antenna.

19 Claims, 10 Drawing Sheets





US012651848B2

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

(10) **Patent No.: US 12,651,848 B2**
(45) **Date of Patent: Jun. 9, 2026**

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

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(72) Inventors: **Jin Hao**, Houston, TX (US); **Yu-Yuan Guo**, New Taipei (TW); **Kai-Hao Chen**, New Taipei (TW); **Liang-Hsien Hung**, New Taipei (TW)

(73) Assignee: **Nanning FuLian FuGui Precision Industrial Co., Ltd.**, Nanning (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 134 days.

(21) Appl. No.: **18/646,599**

(22) Filed: **Apr. 25, 2024**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Sep. 12, 2023 (CN) 202311171409.5

(51) **Int. Cl.**
H01Q 21/06 (2006.01)
H01Q 9/04 (2006.01)
H04B 7/0413 (2017.01)

(52) **U.S. Cl.**
CPC ***H01Q 21/065*** (2013.01); ***H01Q 9/0414*** (2013.01); ***H04B 7/0413*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 21/065; H01Q 9/0414; H01Q 1/521; H01Q 21/205; H01Q 21/28; H04B 7/0413
See application file for complete search history.

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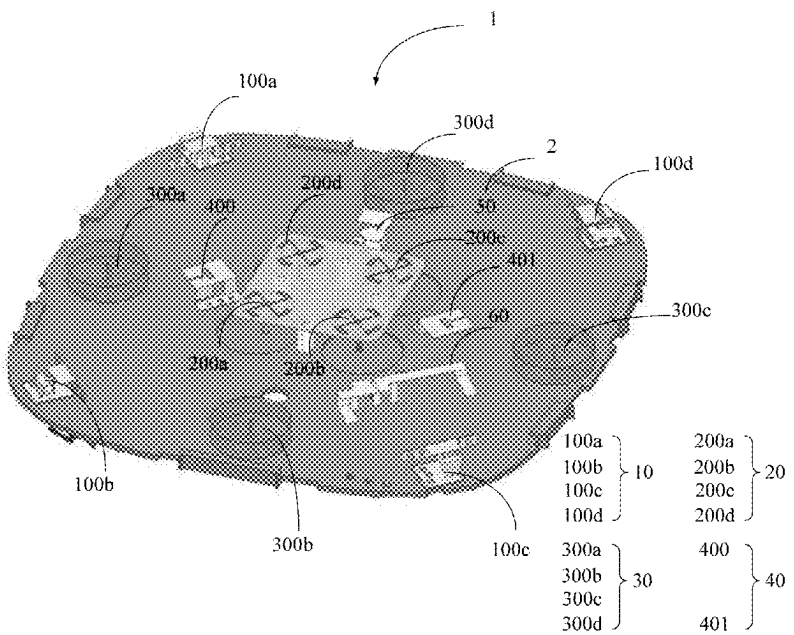
Primary Examiner — Regis J Betsch
Assistant Examiner — Jose A. Miranda Gonzalez
(74) *Attorney, Agent, or Firm* — ScienBiziP, P.C.

(57) **ABSTRACT**

An antenna system, installed on a base, includes: a first group of MIMO antennas, including multiple first MIMO antennas, and each first MIMO antenna is provide with a grounding structure and a fence like structure perpendicular to the base; a second group of MIMO antennas, comprising multiple second MIMO antennas, and each second MIMO antenna is a planar structure, arranged on a substrate, and the substrate is fixed to the base through a support column and the substrate is parallel to the base; a third group of MIMO antennas, comprising multiple third MIMO antennas, and each third MIMO antenna includes a dielectric structure and a wire structure perpendicular to the base, and the wire structure excites the dielectric structure; an AUX antenna, provided with a T-shaped slot parallel to the base.

16 Claims, 18 Drawing Sheets



US012651851B2

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

(10) **Patent No.: US 12,651,851 B2**
(45) **Date of Patent: Jun. 9, 2026**

(54) **ANTENNA AND TERMINAL DEVICE**

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

(72) Inventors: **Qing Liu**, Shenzhen (CN); **Qi Shi**, Shenzhen (CN)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 274 days.

(21) Appl. No.: **18/552,845**

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

(86) PCT No.: **PCT/CN2022/083410**
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(87) PCT Pub. No.: **WO2022/206682**
PCT Pub. Date: **Oct. 6, 2022**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**
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H01Q 1/32 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 21/30*** (2013.01); ***H01Q 1/3275*** (2013.01); ***H01Q 1/521*** (2013.01); ***H01Q 5/378*** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 21/30; H01Q 1/3275; H01Q 1/521; H01Q 5/378; H01Q 5/307; H01Q 5/371;
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Primary Examiner — Dameon E Levi
Assistant Examiner — Anh N Ho
(74) *Attorney, Agent, or Firm* — WOMBLE BOND DICKINSON (US) LLP

(57) **ABSTRACT**

An antenna comprises a first radiator, a second radiator, a third radiator located on a printed circuit board PCB. Operating frequency bands of the first radiator and the second radiator comprise a first frequency band, a resonance frequency band generated by the third radiator comprises the first frequency band. A current on the first radiator is orthogonal to a current on the second radiator, and a distance between the first radiator, the second radiator, and the third
(Continued)