



US012586891B2

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

(10) **Patent No.:** **US 12,586,891 B2**
(45) **Date of Patent:** **Mar. 24, 2026**

(54) **ANTENNA DEVICE**

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

(72) Inventors: **Ching-Kuang Clive Tzuang**, New Taipei City (TW); **Tang-Chin Hung**, New Taipei City (TW); **Chia-Chi Lin**, New Taipei City (TW); **Hsien-Te Chen**, Taipei City (TW)

(73) Assignee: **PANELSEMI 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 68 days.

(21) Appl. No.: **18/799,022**

(22) Filed: **Aug. 9, 2024**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Aug. 10, 2023 (TW) 112130105

(51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01L 23/498 (2006.01)
H01L 23/552 (2006.01)
H01L 23/66 (2006.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/2283** (2013.01); **H01L 23/49822** (2013.01); **H01L 23/49838** (2013.01); **H01L 23/552** (2013.01); **H01L 23/66** (2013.01);

H01Q 9/0414 (2013.01); **H01Q 9/0457** (2013.01); **H01L 2223/6616** (2013.01); **H01L 2223/6677** (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

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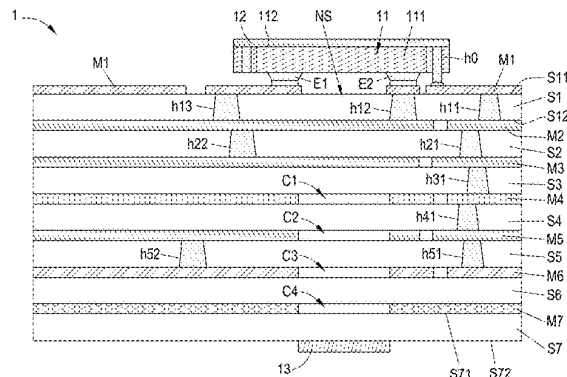
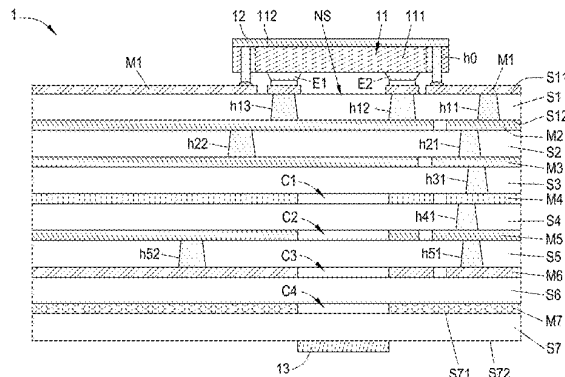
Primary Examiner — Wilson Lee

(74) Attorney, Agent, or Firm — MUNCY, GEISSLER, OLDS & LOWE, P.C.

(57) **ABSTRACT**

An antenna device includes substrate layers, metallic layers, a non-shielding channel, an electronic component, a shielding layer and an antenna unit. The substrate layers include an upper substrate layer and a lower substrate layer located on two sides respectively. The metallic layers are disposed on the substrate layers. The non-shielding channel is at least defined at the upper substrate layer and communicates with the inner and outer surfaces of the upper substrate layer without being interfered by the first metallic layer. The electronic component is disposed on the outer surface of the upper substrate layer and corresponds to and at least partially covers the non-shielding channel. The shielding layer electrically shields the electronic component and is electrically connected to the first metallic layer. The antenna unit is disposed on an outer surface of the lower substrate layer and electrically coupled to the electronic component.

20 Claims, 5 Drawing Sheets





US012586905B2

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

(10) **Patent No.:** **US 12,586,905 B2**
(45) **Date of Patent:** **Mar. 24, 2026**

(54) **ANTENNA AND METHOD FOR
MANUFACTURING THE SAME, AND
ANTENNA SYSTEM**

(58) **Field of Classification Search**
CPC H01Q 9/0407; H01Q 1/38; H01Q 1/48
See application file for complete search history.

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

(56) **References Cited**

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Primary Examiner — Henry Luong

(74) *Attorney, Agent, or Firm* — HOUTTEMAN LAW
LLC

(21) Appl. No.: **17/637,546**

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

(86) PCT No.: **PCT/CN2021/091110**

§ 371 (c)(1),

(2) Date: **Jun. 23, 2023**

(87) PCT Pub. No.: **WO2022/226918**

PCT Pub. Date: **Nov. 3, 2022**

(65) **Prior Publication Data**

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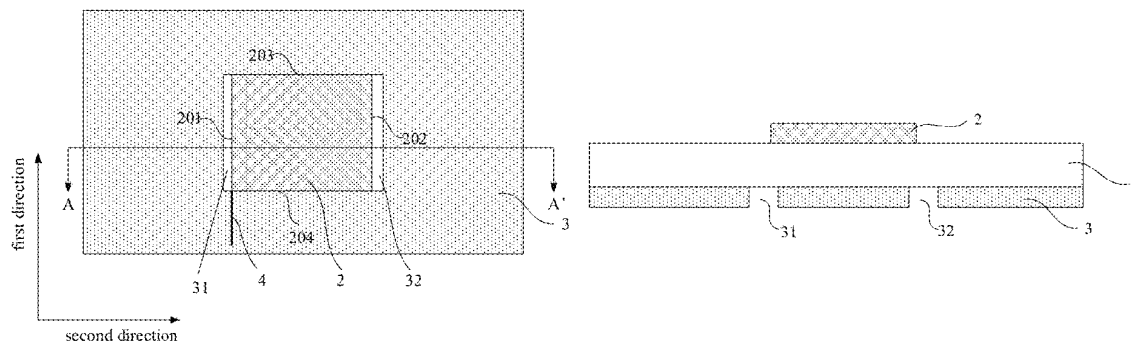
(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/48 (2006.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 9/0407** (2013.01); **H01Q 1/38**
(2013.01); **H01Q 1/48** (2013.01)

(57) **ABSTRACT**

The present disclosure provides an antenna, a method for manufacturing an antenna and an antenna system. The antenna according to the present disclosure includes: a dielectric layer having a first surface and a second surface which are oppositely disposed along a thickness direction of the dielectric layer; a radiation patch disposed on the first surface of the dielectric layer; and a reference electrode layer disposed on the second surface of the dielectric layer and having an orthographic projection on the second surface at least partially overlapping an orthographic projection of the radiation patch on the second surface. The reference electrode layer has an opening penetrating therethrough along a thickness direction of the reference electrode layer, and an orthographic projection of at least a part of a radiation edge

(Continued)





US012586909B2

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

(10) **Patent No.:** **US 12,586,909 B2**
(45) **Date of Patent:** **Mar. 24, 2026**

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

(71) Applicant: **Huawei Technologies Co., Ltd.**,
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(72) Inventors: **Chuanbo Shi**, Shanghai (CN);
Hanyang Wang, Reading (GB);
Pengfei Wu, Shanghai (CN); **Meng Hou**, 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 187 days.

(21) Appl. No.: **18/575,561**

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

(86) PCT No.: **PCT/CN2022/101754**

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(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Jun. 30, 2021 (CN) 202110742500.2

(51) **Int. Cl.**

H01Q 9/04 (2006.01)

H01Q 1/24 (2006.01)

H01Q 5/35 (2015.01)

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

CPC **H01Q 9/045** (2013.01); **H01Q 1/242** (2013.01); **H01Q 5/35** (2015.01)

(58) **Field of Classification Search**

CPC H01Q 9/045; H01Q 1/242; H01Q 5/35;
H01Q 5/364

See application file for complete search history.

(56) **References Cited**

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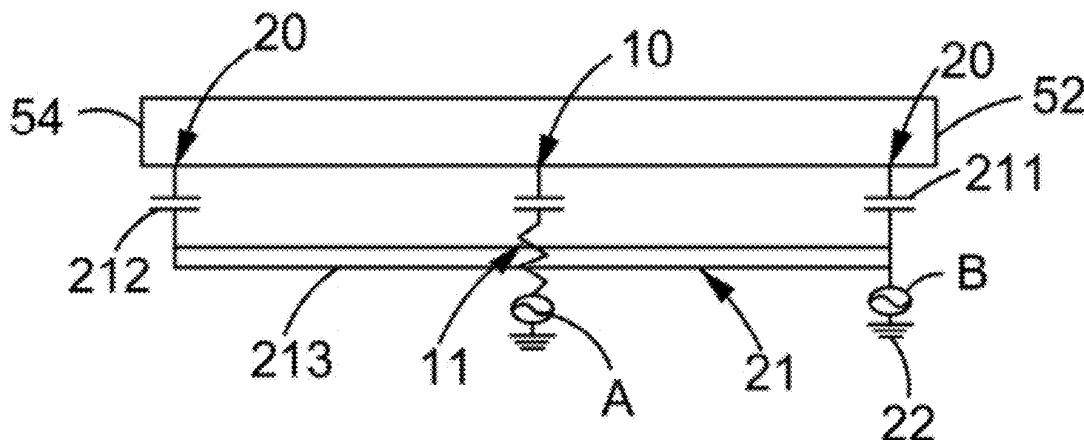
Primary Examiner — Dieu Hien T Duong

(74) Attorney, Agent, or Firm — Slater Matsil, LLP

(57) **ABSTRACT**

A microstrip antenna includes a radiator and a first feed and a second feed that are configured to feed a radio frequency signal, and a first feedpoint and two second feedpoints are disposed on the radiator. The first feedpoint is located at a central position of the radiator, and the first feedpoint is electrically connected to the first feed, and is configured to feed a radio frequency signal into the radiator, to excite the radiator to generate a TM₀₂ mode. The two second feedpoints deviate from the central position of the radiator and are spaced apart from the first feedpoint. The second feed is electrically connected to the second feedpoints through an adjustment circuit. The second feedpoints are configured to feed a radio frequency signal into the radiator, and the

(Continued)





(10) **Patent No.:** US 12,586,910 B2
(45) **Date of Patent:** Mar. 24, 2026

(58) **Field of Classification Search**
CPC .. H01Q 9/0457; H01Q 9/0414; H01Q 21/065;
H01Q 1/38; H01Q 19/005; H01Q 9/0407;
H01Q 1/243; H01Q 1/46
See application file for complete search history.

(56) **References Cited**

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

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(21) Appl. No.: 18/446,906

Translation of CN-110048224-A (Year: 2019).*

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

(65) **Prior Publication Data**
US 2023/0387598 A1 Nov. 30, 2023

Primary Examiner — Renan Luque
(74) Attorney, Agent, or Firm — Jefferson IP Law, LLP

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2022/001926, filed on Feb. 8, 2022.

(30) **Foreign Application Priority Data**

Feb. 10, 2021 (KR) 10-2021-0019445

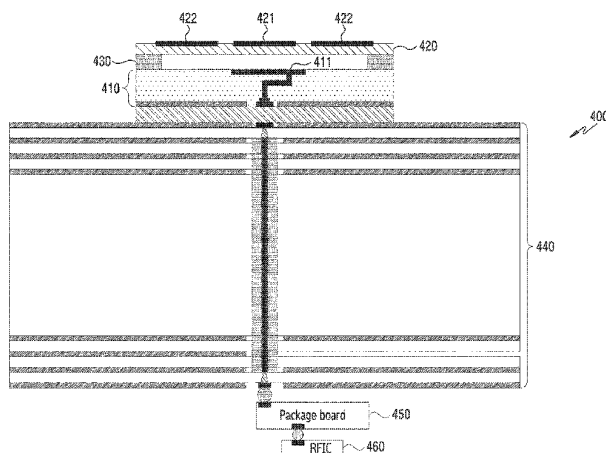
(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 21/06 (2006.01)

(52) **U.S. Cl.**
CPC *H01Q 9/0457* (2013.01); *H01Q 9/0414*
(2013.01); *H01Q 21/065* (2013.01)

(57) **ABSTRACT**

The disclosure relates to a 5th generation (5G) or pre-5G communication system for supporting a data transmission rate higher than that of a 4th generation (4G) communication system such as long term evolution (LTE). An antenna structure of a wireless communication system is provided. The antenna structure includes a first radiator, a first printed circuit board (PCB) in which the first radiator is arranged, a plurality of second radiators, a second PCB in which the plurality of second radiators are arranged, and a frame structure, wherein the frame structure is arranged such that an air layer is formed between the first PCB and the second PCB, and the plurality of second radiators can include a first metal patch arranged in a region corresponding to the first

(Continued)





US012586911B2

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

(10) **Patent No.:** **US 12,586,911 B2**
(45) **Date of Patent:** **Mar. 24, 2026**

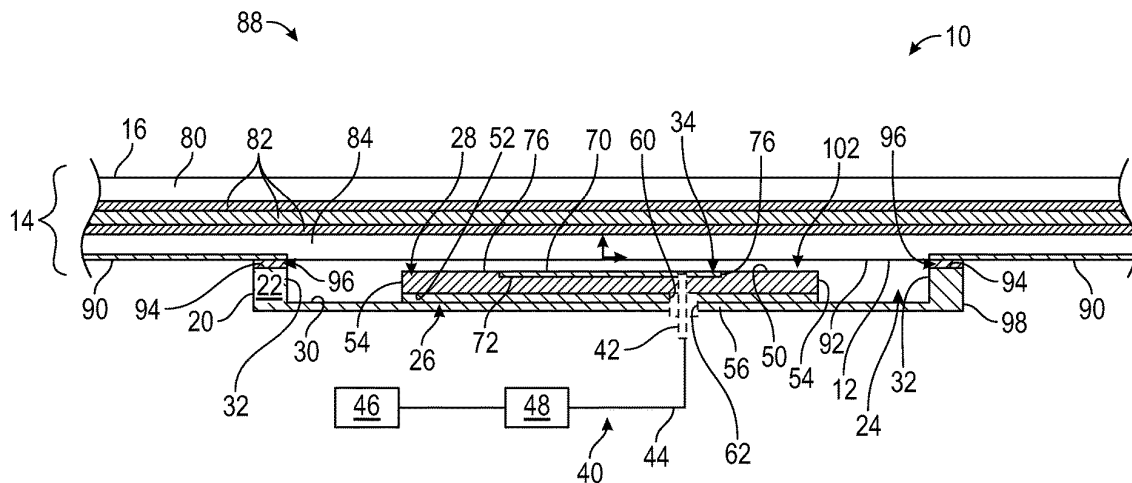
- (54) **ANTENNA ASSEMBLY MOUNTED TO AN INTERIOR SURFACE OF A DIELECTRIC STRUCTURE**
- (71) Applicant: **GM Global Technology Operations LLC**, Detroit, MI (US)
- (72) Inventors: **Gregg R. Kittinger**, Oakland Township, MI (US); **Patrick Edward Leavy**, Akron, MI (US); **Patrick J. Alvarez**, Troy, MI (US); **Duane S. Carper**, Davison, MI (US); **Timothy Brockett**, Malibu, CA (US); **Hyok Jae Song**, Oak Park, CA (US)
- (73) Assignee: **GM GLOBAL TECHNOLOGY OPERATIONS LLC**, Detroit, MI (US)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 105 days.
- (21) Appl. No.: **18/613,837**
- (22) Filed: **Mar. 22, 2024**
- (65) **Prior Publication Data**
US 2025/0300354 A1 Sep. 25, 2025
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H01Q 9/04 (2006.01)
- (52) **U.S. Cl.**
CPC **H01Q 9/0471** (2013.01); **H01Q 9/0485** (2013.01)
- (58) **Field of Classification Search**
CPC H01Q 9/0471; H01Q 9/0485
See application file for complete search history.

- (56) **References Cited**
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- Primary Examiner* — Dameon E Levi
Assistant Examiner — Jordan E. DeWitt
(74) *Attorney, Agent, or Firm* — Vivacqua Crane, PLLC

(57) **ABSTRACT**

An antenna assembly mounted to an interior surface of a dielectric structure includes an antenna including a conductive patch defining an aperture, an upper surface, and a lower surface, where the upper surface of the conductive patch of the antenna faces the interior surface of the dielectric structure. The antenna assembly also includes a conductive enclosure mounted to the interior surface of the dielectric structure. The conductive enclosure includes a main body constructed at least in part of an electrically conductive material, where the main body of the conductive enclosure defines a cavity containing the antenna. The electrically conductive material of the conductive enclosure urges the electromagnetic radiation transmitted from the aperture of the conductive patch of the antenna to a space above the exterior surface of the dielectric structure.

19 Claims, 6 Drawing Sheets





US012586928B2

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

(10) **Patent No.:** **US 12,586,928 B2**
(45) **Date of Patent:** **Mar. 24, 2026**

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

(71) Applicant: **Murata Manufacturing Co., Ltd.**,
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(72) Inventors: **Hideki Ueda**, Nagaokakyo (JP);
Takaya Nemoto, Nagaokakyo (JP);
Kengo Onaka, 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 28 days.

(21) Appl. No.: **18/619,207**

(22) Filed: **Mar. 28, 2024**

(65) **Prior Publication Data**
US 2024/0243488 A1 Jul. 18, 2024

Related U.S. Application Data

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PCT/JP2022/033462, filed on Sep. 6, 2022.

(30) **Foreign Application Priority Data**
Sep. 28, 2021 (JP) 2021-157780

(51) **Int. Cl.**
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H01Q 13/02 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 21/29** (2013.01); **H01Q 13/02**
(2013.01); **H01Q 21/08** (2013.01); **H01Q**
21/24 (2013.01)

(58) **Field of Classification Search**
CPC H01Q 21/29; H01Q 13/02; H01Q 21/08;
H01Q 21/24; H01Q 1/243
See application file for complete search history.

(56) **References Cited**

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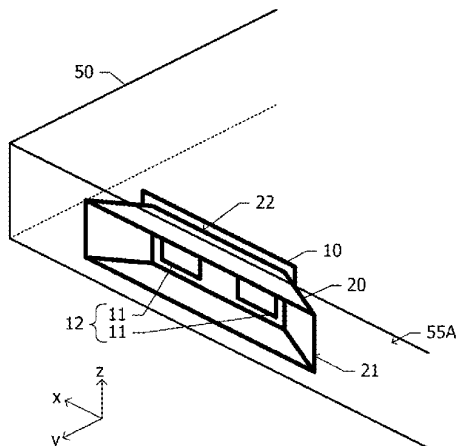
Primary Examiner — Hai V Tran

(74) *Attorney, Agent, or Firm* — XSSENSUS LLP

(57) **ABSTRACT**

An array accommodated in a housing includes multiple antenna elements. The antenna elements face an inside surface of the housing and are arrayed in a first direction at least one-dimensionally. A waveguide is coupled to the antenna elements of the array antenna and extends from the array antenna toward the inside surface of the housing. The waveguide has a housing-side end face facing the inside surface of the housing and an antenna-side end face facing the array antenna. A length from one end to an opposite end of the housing-side end face in the first direction is greater than a length from one end to an opposite end of the antenna-side end face in the first direction. An antenna device that can improve antenna gain without increasing the size of the antenna module is provided.

20 Claims, 17 Drawing Sheets





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

(10) **Patent No.:** **US 12,586,929 B2**
(45) **Date of Patent:** **Mar. 24, 2026**

(54) **DUAL POLARIZATION ANTENNA AND
DUAL POLARIZATION ANTENNA
ASSEMBLY COMPRISING SAME**

(56) **References Cited**

U.S. PATENT DOCUMENTS

(71) Applicant: **KMW INC.**, Hwaseong-si (KR)

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(72) Inventors: **Seong Man Kang**, Hwaseong-si (KR);
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Hun Jung Jung, Hwaseong-si (KR);
Gyo Jin Jo, Yongin-si (KR); **Su Yong**
Lee, Seoul (KR)

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(73) Assignee: **KMW INC.**, Hwaseong-si (KR)

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(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 66 days.

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(21) Appl. No.: **18/540,966**

Primary Examiner — David E Lotter

(22) Filed: **Dec. 15, 2023**

(74) *Attorney, Agent, or Firm* — Insight Law Group,
PLLC; Seung Lee

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

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H01Q 21/24 (2006.01)
H01Q 1/40 (2006.01)

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(52) **U.S. Cl.**
CPC **H01Q 25/001** (2013.01); **H01Q 1/40**
(2013.01); **H01Q 1/38** (2013.01)

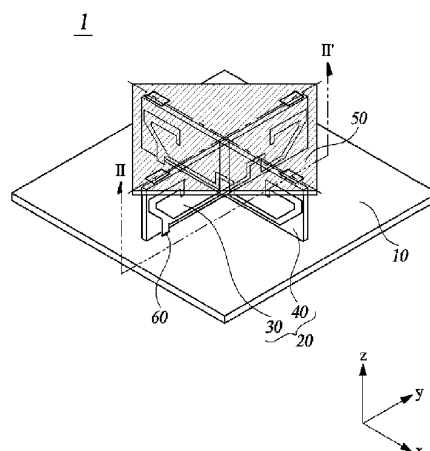
(58) **Field of Classification Search**
CPC .. H01Q 5/25; H01Q 1/32; H01Q 1/38; H01Q
1/1278; H01Q 1/325; H01Q 15/0013;
H01Q 1/1271

See application file for complete search history.

ABSTRACT

A dual polarization antenna is disclosed in at least one
embodiment of the present disclosure, including a base
substrate, a power feeding unit supported on the base
substrate, and a radiating plate supported on the power
feeding unit, wherein the first feeding substrate includes a
first insulating substrate supported on the base substrate, and
a first feed line attached to the first insulating substrate and
configured to supply a first reference phase signal to a first
point on the radiating plate and to supply to a second point
on the radiating plate, a first reverse phase signal having a
reverse phase relative to the first reference phase signal, and
wherein the second feeding substrate includes a second
insulating substrate supported on the base substrate, and a
second feed line attached to the first insulating substrate and
configured to supply a second reference phase signal to a
third point on the radiating plate and to supply to a fourth
point on the radiating plate, a second reverse phase signal
having a reverse phase relative to the second reference phase
signal.

7 Claims, 7 Drawing Sheets





US012592474B2

(12) **United States Patent**
Suh

(10) **Patent No.:** **US 12,592,474 B2**
(45) **Date of Patent:** **Mar. 31, 2026**

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

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

(72) Inventor: **Younghoon Suh**, 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 509 days.

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(22) Filed: **Nov. 25, 2022**

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(30) **Foreign Application Priority Data**
Nov. 24, 2021 (KR) 10-2021-0163694

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H01Q 1/24 (2006.01)
(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01)
(58) **Field of Classification Search**
CPC H01Q 1/243
See application file for complete search history.

(56) **References Cited**

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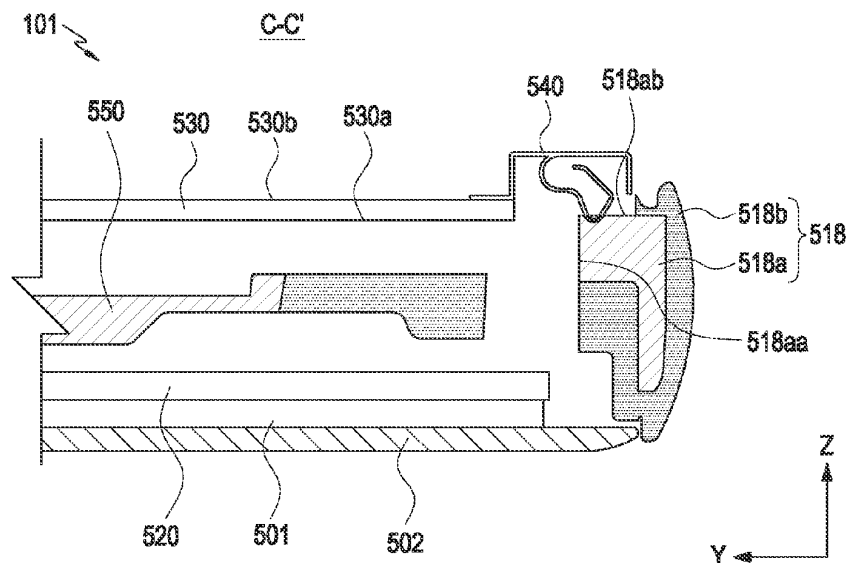
Primary Examiner — Awat M Salih

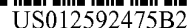
(74) *Attorney, Agent, or Firm* — Sughrue Mion, PLLC

(57) **ABSTRACT**

An electronic device includes a housing including a front surface facing a first direction, a rear surface facing a second direction opposite to the first direction, and a side surface surrounding an inner space between the front surface and the rear surface, where at least part of the side surface includes a conductive portion, a display provided on the front surface of the housing, a printed circuit board (PCB) provided in the inner space, and a coupling member provided on the PCB and coupled to the conductive portion of the side surface, wherein the coupling member contacts the conductive portion of the side surface in the second direction.

11 Claims, 13 Drawing Sheets





(10) **Patent No.:** US 12,592,475 B2
(45) **Date of Patent:** Mar. 31, 2026

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

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/38
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — David E Lotter

(74) *Attorney, Agent, or Firm* — The PL Law Group, PLLC

(65) **Prior Publication Data**

US 2023/0327322 A1 Oct. 12, 2023

(30) **Foreign Application Priority Data**

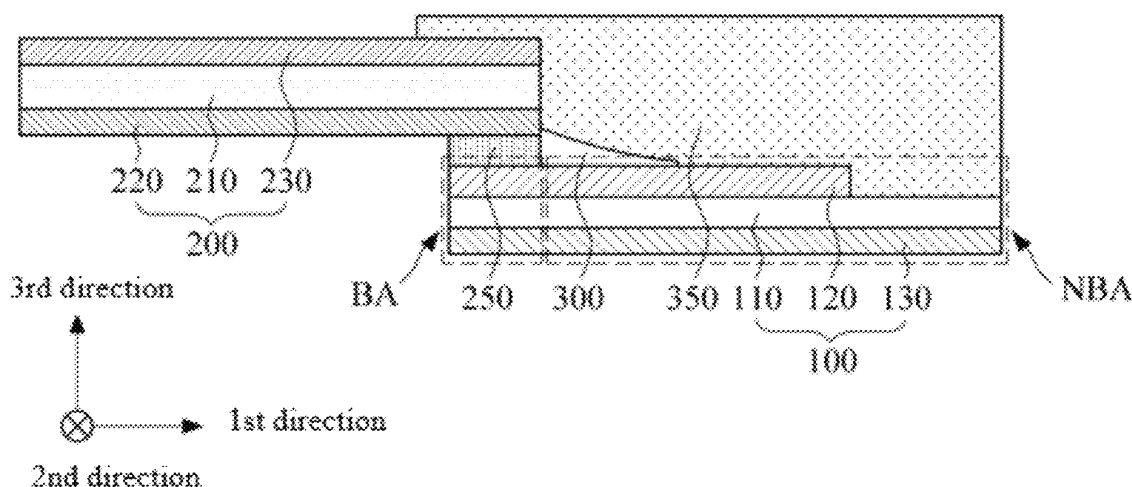
Apr. 8, 2022 (KR) 10-2022-0043922

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

(57) **ABSTRACT**

An antenna structure according to an embodiment includes an antenna device including an antenna unit, a circuit board electrically connected to the antenna unit, an insulating layer covering the antenna device and a portion of the circuit board, and an air layer formed between the antenna device and the insulating layer to partially cover the antenna unit.

17 Claims, 5 Drawing Sheets





US012592487B2

(12) **United States Patent**
Suzuki

(10) **Patent No.:** **US 12,592,487 B2**
(45) **Date of Patent:** **Mar. 31, 2026**

(54) **ANTENNA DEVICE**

(71) Applicant: **Sony Group Corporation**, Tokyo (JP)

(72) Inventor: **Yuichiro Suzuki**, Tokyo (JP)

(73) Assignee: **SONY GROUP CORPORATION**,
Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 30 days.

(21) Appl. No.: **18/841,701**

(22) PCT Filed: **Jan. 31, 2023**

(86) PCT No.: **PCT/JP2023/002963**

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(2) Date:

Aug. 27, 2024

(87) PCT Pub. No.: **WO2023/171180**

PCT Pub. Date: **Sep. 14, 2023**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Mar. 8, 2022 (JP) 2022-035203

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 9/04 (2006.01)
H01Q 1/22 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 9/0407** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 1/2266** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/421; H01Q 1/2266;
H01Q 9/0407; H01Q 13/06; H01Q 19/10;
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Jan. 31, 2023, 09 pages including English Translation.

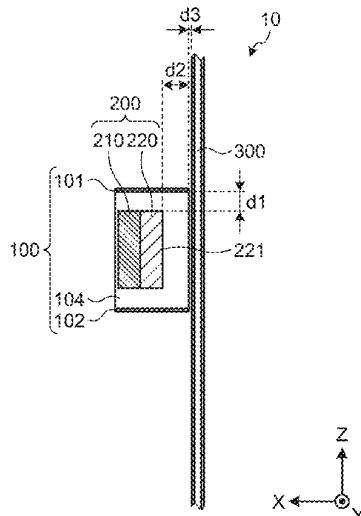
Primary Examiner — Tung X Le

(74) Attorney, Agent, or Firm — XSENSUS LLP

(57) **ABSTRACT**

A device includes a first metal plate and a second metal plate. The first metal plate is arranged to cover at least part of a first side surface in a longitudinal direction of an antenna module having a main radiation unit of substantially rectangular shape. The second metal plate is arranged to cover at least part of a second side surface in the longitudinal direction of the antenna module, the second side surface being different from the first side surface. The antenna module is arranged so that the main radiation unit faces a high dielectric constant member of a housing. A first distance (d3) between an end side of the first metal plate and the high dielectric constant member is smaller than a distance (d2) between the main radiation unit and the high dielectric constant member. A second distance (d3) is smaller than the distance (d2).

12 Claims, 15 Drawing Sheets





US012592489B2

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

(10) **Patent No.:** **US 12,592,489 B2**
(45) **Date of Patent:** **Mar. 31, 2026**

(54) **ANTENNA STRUCTURE**

(56)

References Cited

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

U.S. PATENT DOCUMENTS

(72) Inventors: **Yen-Tze Peng**, Hsinchu (TW);
Meng-Kai Wu, Hsinchu (TW);
Hong-Jun Jian, Hsinchu (TW);
Chia-Hao Chang, Hsinchu (TW)

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343/702
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343/700 MS

(73) Assignee: **WISTRON NEWEB CORP.**, Hsinchu (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 90 days.

(21) Appl. No.: **18/734,096**

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

(65) **Prior Publication Data**

US 2025/0023244 A1 Jan. 16, 2025

(30) **Foreign Application Priority Data**

Jul. 11, 2023 (TW) 112125838

(51) **Int. Cl.**

H01Q 9/04 (2006.01)

H01Q 1/22 (2006.01)

H01Q 5/371 (2015.01)

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

CPC **H01Q 9/0421** (2013.01); **H01Q 1/2266** (2013.01); **H01Q 5/371** (2015.01)

(58) **Field of Classification Search**

CPC H01Q 9/0421; H01Q 1/2266; H01Q 5/371;
H01Q 1/243; H01Q 9/42

See application file for complete search history.

(Continued)

Primary Examiner — Dameon E Levi

Assistant Examiner — Jordan E. DeWitt

(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

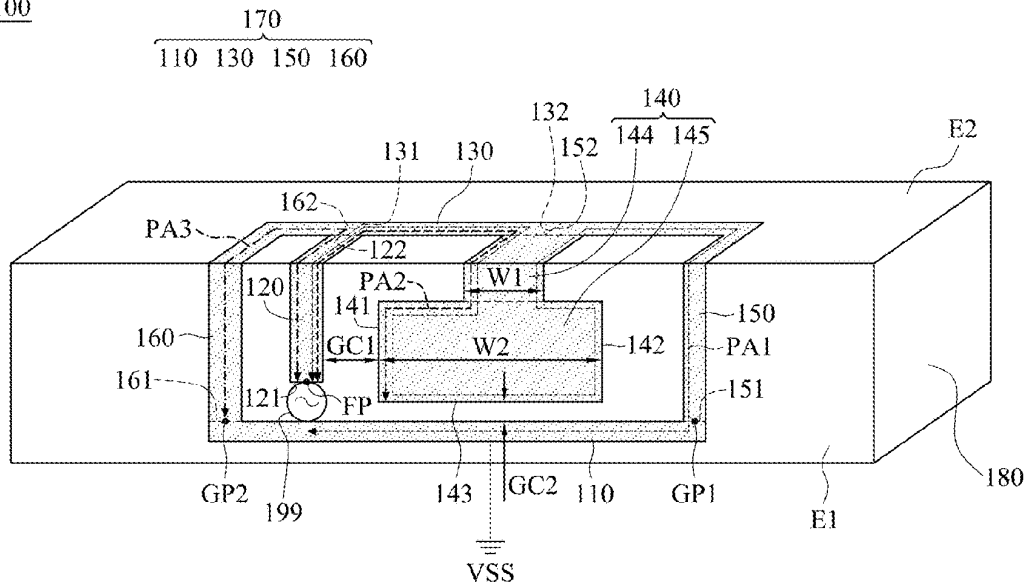
(57)

ABSTRACT

An antenna structure includes a ground element, a feeding radiation element, a connection radiation element, a coupling radiation element, a first shorting radiation element, and a second shorting radiation element. The feeding radiation element has a feeding point. The coupling radiation element is coupled through the connection radiation element to the feeding radiation element. The coupling radiation element is also coupled through the first shorting radiation element to a first grounding point on the ground element. The feeding radiation element is also coupled through the second shorting radiation element to a second grounding point on the ground element. A loop structure is formed by the ground element, the connection radiation element, the first shorting radiation element, and the second shorting radiation element.

17 Claims, 7 Drawing Sheets

100





US012592491B2

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

(10) **Patent No.:** **US 12,592,491 B2**
(45) **Date of Patent:** **Mar. 31, 2026**

(54) **SELF-DECOUPLING WIDEBAND ANTENNA SYSTEM AND TERMINAL DEVICE**

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

(72) Inventors: **Hang Meng**, Shenzhen (CN); **Chao Guo**, Shenzhen (CN); **Yufei Zhang**, Shenzhen (CN); **Xuan Zhai**, Shenzhen (CN); **Hao Guo**, 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 188 days.

(21) Appl. No.: **18/579,020**

(22) PCT Filed: **Aug. 23, 2022**

(86) PCT No.: **PCT/CN2022/114301**

§ 371 (c)(1),

(2) Date: **Jan. 12, 2024**

(87) PCT Pub. No.: **WO2023/098162**

PCT Pub. Date: **Jun. 8, 2023**

(65) **Prior Publication Data**

US 2024/0322439 A1 Sep. 26, 2024

(30) **Foreign Application Priority Data**

Nov. 30, 2021 (CN) 202111446807.4

(51) **Int. Cl.**

H01Q 21/28 (2006.01)

H01Q 5/378 (2015.01)

(Continued)

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

CPC **H01Q 9/42** (2013.01); **H01Q 5/378** (2015.01); **H01Q 5/50** (2015.01); **H01Q 21/28** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 5/35; H01Q 5/50; H01Q 5/328; H01Q 5/335; H01Q 5/378; H01Q 9/42; H01Q 21/28

See application file for complete search history.

(56)

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Primary Examiner — Tung X Le

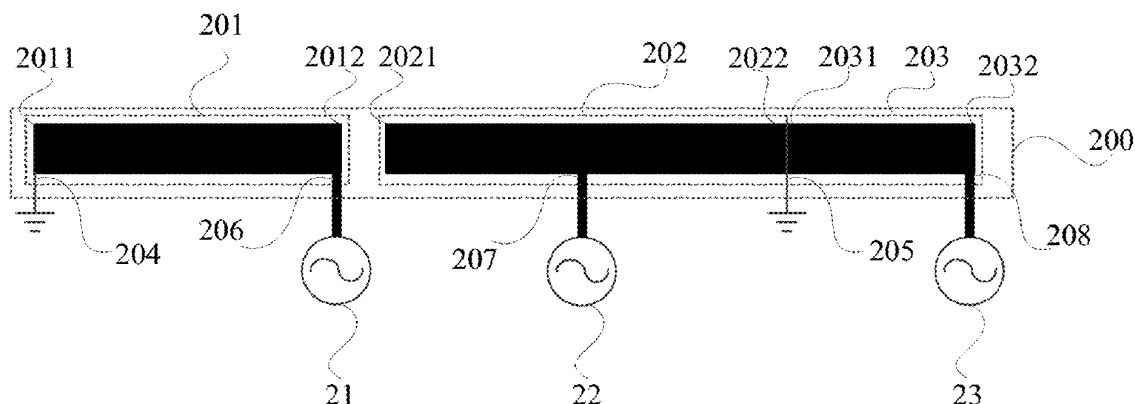
(74) *Attorney, Agent, or Firm* — Conley Rose, P.C.

(57)

ABSTRACT

A self-decoupling wideband antenna system and a terminal device, including: a first end of a first radiation stub that is connected to a first ground point, and the first radiation stub is further connected to a first feed point; a first end of a second radiation stub and a first end of a third radiation stub are connected to a second ground point, and a slot is provided between a second end of the second radiation stub and a second end of the first radiation stub. A distance between the second end of the second radiation stub and the second end of the first radiation stub is less than a distance between the first end of the second radiation stub and the second end of the first radiation stub.

20 Claims, 24 Drawing Sheets





US012592492B2

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

(10) **Patent No.:** **US 12,592,492 B2**
(45) **Date of Patent:** **Mar. 31, 2026**

(54) **LOCATING ANTENNAS IN AN APPARATUS**

(56)

References Cited

(71) Applicant: **Nokia Technologies Oy**, Espoo (FI)

U.S. PATENT DOCUMENTS

(72) Inventors: **Harri Arttur Varheenmaa**, Helsinki (FI); **Pasi Yla-Oijala**, Vantaa (FI); **Anu Kristiina Lehtovuori**, Espoo (FI); **Ville Viikari**, Espoo (FI)

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343/700 MS

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(73) Assignee: **Nokia Technologies Oy**, Espoo (FI)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 56 days.

FOREIGN PATENT DOCUMENTS

(21) Appl. No.: **18/594,667**

CN 106921023 A 7/2017

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

Primary Examiner — Dameon E Levi

Assistant Examiner — Jordan E. DeWitt

(65) **Prior Publication Data**

US 2024/0305004 A1 Sep. 12, 2024

(74) *Attorney, Agent, or Firm* — McCarter & English LLP

(30) **Foreign Application Priority Data**

Mar. 9, 2023 (EP) 23160874

(57)

ABSTRACT

(51) **Int. Cl.**

H01Q 13/10 (2006.01)

H01Q 21/06 (2006.01)

H01Q 21/30 (2006.01)

An antenna module includes: a dielectric substrate including upper and lower edges, opposing side edges, and interior and exterior faces, the substrate being placed in an aperture of a rim of a device such that the upper edge of the substrate is aligned with an upper edge of the rim, the opposing side edges of the substrate are adjacent opposing side edges of the aperture of the rim, and the lower edge of the substrate is adjacent a lower edge of the aperture of the rim; one or more antenna elements positioned adjacent the exterior face of the substrate and fed through apertures in the substrate; and one or more conductive portions shaped to define at least a part of a perimeter of a slot of a slot antenna fed separately to the antenna elements. The antenna elements wholly overlap the conductive portions and do not overlap the slot.

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

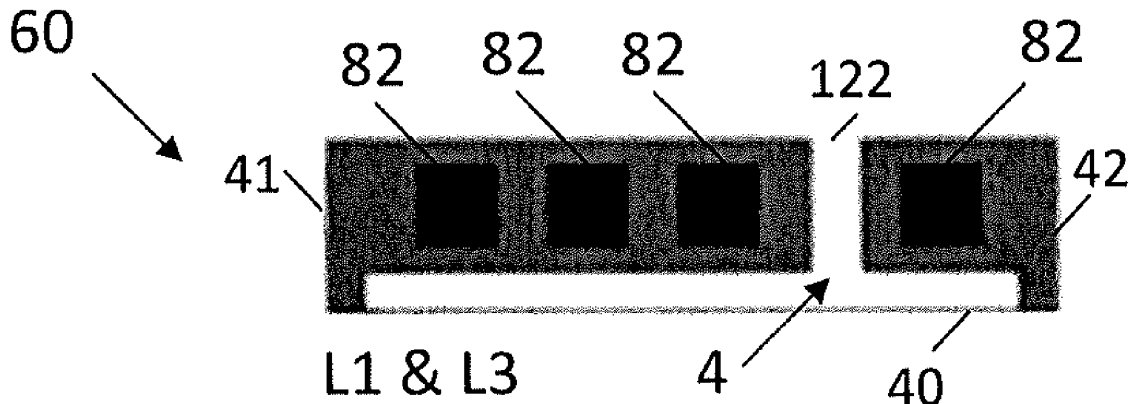
CPC **H01Q 13/10** (2013.01); **H01Q 21/064** (2013.01); **H01Q 21/30** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 13/10; H01Q 21/064; H01Q 21/30; H01Q 5/40; H01Q 13/16; H01Q 5/371; H01Q 9/0407; H01Q 13/106; H01Q 21/28; H01Q 1/22; H01Q 1/36; H01Q 1/12; H01Q 1/48; H01Q 1/50; H01Q 21/00; H01Q 21/06

See application file for complete search history.

14 Claims, 7 Drawing Sheets





US012592498B2

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

(10) **Patent No.:** **US 12,592,498 B2**
(45) **Date of Patent:** **Mar. 31, 2026**

(54) **ARRAY ANTENNA WITH DUAL
POLARIZATION**

(71) Applicant: **SAAB AB**, Linköping (SE)

(72) Inventors: **Nicklas Billström**, Lindome (SE);
Andreas Wikström, Lindome (SE);
Kenneth J-O Svensson, Gothenburg
(SE); **Max Wallén**, Mölnlycke (SE)

(73) Assignee: **SAAB AB**, Linköping (SE)

(*) 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.: **18/555,882**

(22) PCT Filed: **Apr. 4, 2022**

(86) PCT No.: **PCT/SE2022/050331**

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PCT Pub. Date: **Oct. 27, 2022**

(65) **Prior Publication Data**

US 2024/0204422 A1 Jun. 20, 2024

(30) **Foreign Application Priority Data**

Apr. 23, 2021 (SE) 2100064-1

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

(Continued)

(52) **U.S. Cl.**
CPC **H01Q 21/24** (2013.01); **H01Q 1/38**
(2013.01); **H01Q 9/42** (2013.01); **H01Q**
13/085 (2013.01)

(58) **Field of Classification Search**

CPC H01Q 21/24; H01Q 1/38; H01Q 9/42;
H01Q 13/085

See application file for complete search history.

(56) **References Cited**

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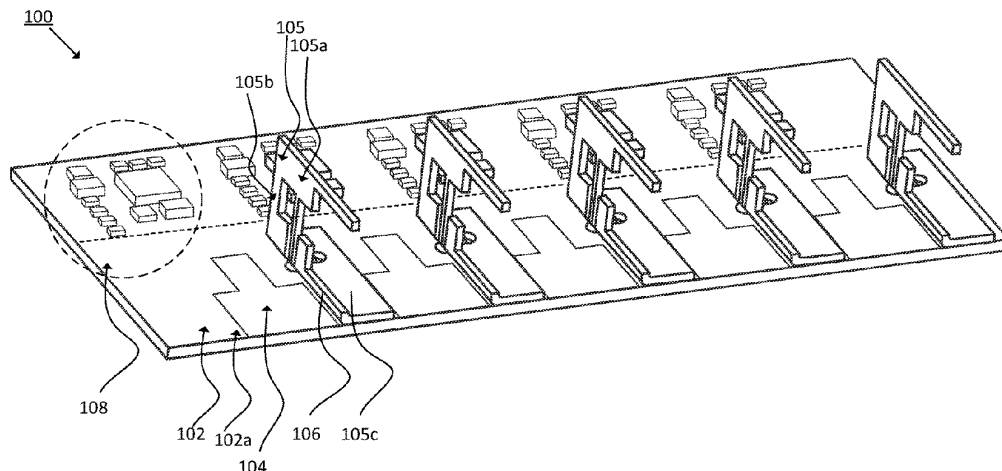
Primary Examiner — Hai V Tran

(74) *Attorney, Agent, or Firm* — Sage Patent Group

(57) **ABSTRACT**

Provided is an Active Electronically Scanned Array (AESA) including at least one planar Printed Circuit Board (PCB), a first set of first notch antenna elements arranged on the PCB, and a second set of second antenna elements; wherein the first and second antenna elements are interleaved, wherein each first antenna element is configured to transmit and/or receive, a signal having a first direction of polarization, and wherein each second antenna element is configured to transmit and/or receive, a signal having a second direction of polarization, which is different from the first direction of polarization, characterized in that each second antenna element is a notch antenna element which is included in a surface mounted element on the PCB, and wherein the first direction of polarization and the second direction of polarization is separated by at least 45°.

12 Claims, 8 Drawing Sheets





US012597699B2

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

(10) **Patent No.:** **US 12,597,699 B2**
(45) **Date of Patent:** **Apr. 7, 2026**

(54) **ELECTRONIC DEVICE INCLUDING ANTENNA**

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

(72) Inventors: **Sumin Yun**, Suwon-si (KR); **Hosaeng Kim**, Suwon-si (KR); **Seongjin Park**, Suwon-si (KR); **Hyunjeong Lee**, Suwon-si (KR); **Hyunjoo 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 43 days.

(21) Appl. No.: **18/819,286**

(22) Filed: **Aug. 29, 2024**

(65) **Prior Publication Data**
US 2025/0030151 A1 Jan. 23, 2025

Related U.S. Application Data

(63) Continuation of application No.
PCT/KR2024/010166, filed on Jul. 16, 2024.

(30) **Foreign Application Priority Data**

Jul. 18, 2023 (KR) 10-2023-0092952
Jul. 19, 2023 (KR) 10-2023-0093909

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/38 (2006.01)
H01Q 9/04 (2006.01)
H04M 1/02 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 9/0492** (2013.01); **H04M 1/0216** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/24; H01Q 1/243; H01Q 1/523;
H01Q 5/25; H01Q 5/42; H01Q 9/0428;
(Continued)

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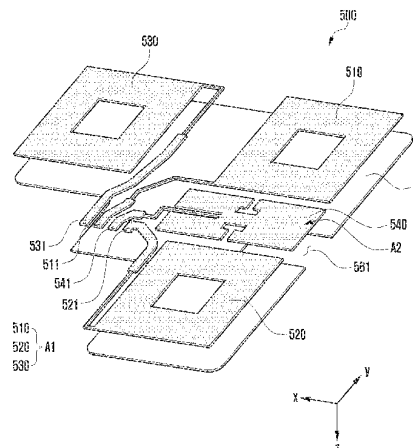
Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

An electronic device is provided. The electronic device includes a housing, an antenna structure disposed in the housing, wherein the antenna structure includes a substrate including a first substrate surface, a second substrate surface facing away from the first substrate surface, and a ground layer disposed between the first substrate surface and the second substrate surface, a first conductive patch including a plurality of sub-patches arranged to correspond to the ground layer, and a second conductive patch disposed between a first sub-patch and a second sub-patch among the plurality of sub-patches of the first conductive patch when viewed from above the first substrate surface, and a wireless communication circuit configured to transmit or receive a first wireless signal in a first frequency band through the plurality of sub-patches of the first conductive patch and to transmit or receive a second wireless signal in a second frequency band through the second conductive patch. The

(Continued)





US012597704B2

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

(10) **Patent No.:** **US 12,597,704 B2**
(45) **Date of Patent:** **Apr. 7, 2026**

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

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

(72) Inventors: **Sujin Cho**, Suwon-si (KR); **Kihwan
Kwon**, Suwon-si (KR); **Byungjoon
Kim**, Suwon-si (KR); **Heejin 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 38 days.

(21) Appl. No.: **18/658,094**

(22) Filed: **May 8, 2024**

(65) **Prior Publication Data**
US 2025/0023230 A1 Jan. 16, 2025

Related U.S. Application Data
(63) Continuation of application No.
PCT/KR2024/004357, filed on Apr. 3, 2024.

(30) **Foreign Application Priority Data**
Jul. 10, 2023 (KR) 10-2023-0089453
Jul. 20, 2023 (KR) 10-2023-0094942
(Continued)

(51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01Q 3/06 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 3/06** (2013.01); **H01Q 1/2291**
(2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/22; H01Q 1/243; H01Q 1/52;
H01Q 21/06; H01Q 21/0025
See application file for complete search history.

(56) **References Cited**

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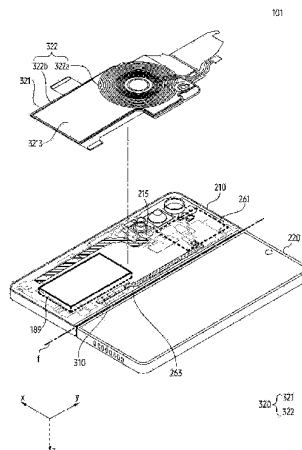
Primary Examiner — Hasan Islam

(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

An electronic device is provided. The electronic device includes a housing including a support, a printed circuit board disposed in the housing, at least one processor disposed on the printed circuit board, a first antenna module spaced apart from the printed circuit board in the housing, a flexible printed circuit board disposed in the housing, and coupled to the printed circuit board and the first antenna module, to electrically connect the printed circuit board and the first antenna module, a second antenna module disposed in the housing, and including a base substrate and a conductive pattern disposed on the base substrate, and a conductive sheet, wherein the flexible printed circuit board is at least partially overlapped with the second antenna module in a direction of a rear surface of the housing, between the printed circuit board and the first antenna module, and wherein at least a portion of the conductive sheet is disposed between the second antenna module and the flexible printed circuit board at a portion where the second antenna module and the flexible printed circuit board overlap.

20 Claims, 23 Drawing Sheets





US012597707B2

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

(10) **Patent No.:** **US 12,597,707 B2**
(45) **Date of Patent:** **Apr. 7, 2026**

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

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

(72) Inventors: **Chun-Hsien Chang**, Kaohsiung City (TW); **Yu-Tsung Huang**, Taoyuan City (TW)

(73) Assignee: **AUDEN TECHNO CORP.**, Taoyuan 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.: **18/669,600**

(22) Filed: **May 21, 2024**

(65) **Prior Publication Data**

US 2025/0364720 A1 Nov. 27, 2025

(51) **Int. Cl.**
H01Q 9/42 (2006.01)
H01Q 1/22 (2006.01)
H01Q 5/357 (2015.01)
H01Q 1/38 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 5/357** (2015.01); **H01Q 1/2283** (2013.01); **H01Q 1/38** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/357; H01Q 1/2283; H01Q 1/38
See application file for complete search history.

(56) **References Cited**

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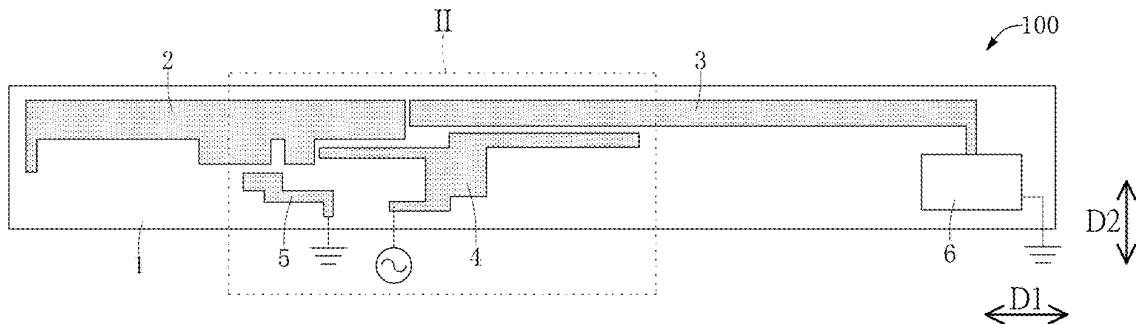
Primary Examiner — David E Lotter

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

(57) **ABSTRACT**

An antenna module and an electronic device are provided. The antenna module includes a substrate, a floating radiating unit, a low-frequency radiating unit, and a feed unit. The substrate has a first and a second direction that are not parallel to each other. The floating radiating unit is spaced apart from the low-frequency radiating unit along the first direction, and the floating radiating unit and the low-frequency radiating unit have a common side in the second direction. The feed unit is located on the common side, and is spaced apart from the floating radiating unit and the low-frequency radiating unit along the second direction. A projection path of the feed unit along the second direction passes through the floating radiating unit and the low-frequency radiating unit, and the feed unit is coupled with the floating radiating unit and the low-frequency radiating unit.

8 Claims, 10 Drawing Sheets





US012598246B2

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

(10) **Patent No.:** **US 12,598,246 B2**
(45) **Date of Patent:** **Apr. 7, 2026**

(54) **ELECTRONIC DEVICE INCLUDING ANTENNA**

(56) **References Cited**

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

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(72) Inventors: **Yongyoun Kim**, Suwon-si (KR);
Myunghoon Kwak, Suwon-si (KR);
Raetae Kim, Suwon-si (KR); **Gisoo Lim**, Suwon-si (KR); **Byounguk Yoon**, Suwon-si (KR); **Hyunju Hong**, Suwon-si (KR)

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

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 670 days.

Communication dated Mar. 10, 2024, issued by the Korean Intellectual Property Office in Korean Patent Application No. 10-2020-0062175.

(Continued)

(21) Appl. No.: **17/993,423**

Primary Examiner — Angelica Perez

(22) Filed: **Nov. 23, 2022**

(74) *Attorney, Agent, or Firm* — Sughrue Mion, PLLC

(65) **Prior Publication Data**

US 2023/0092831 A1 Mar. 23, 2023

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2021/004909, filed on Apr. 20, 2021.

(30) **Foreign Application Priority Data**

May 25, 2020 (KR) 10-2020-0062175

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

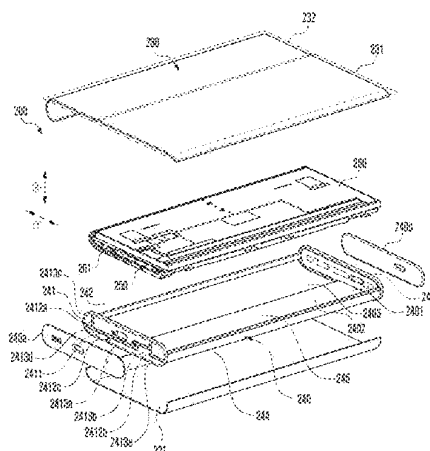
(52) **U.S. Cl.**
CPC **H04M 1/0235** (2013.01); **H04M 1/0268** (2013.01)

(58) **Field of Classification Search**
CPC .. H04M 1/0235; H04M 1/0268; H04M 1/026; H04M 1/0237; H04M 1/0239;
(Continued)

(57) **ABSTRACT**

An electronic device may include: a housing which is at least partially made of a conductive material, and has a first surface facing a first direction, a second surface facing a second direction opposite to the first surface, and at least one side surface surrounding a space between the first surface and the second surface; a slide plate coupled to the housing so as to be slidable in a third direction perpendicular to the first direction; a flexible display which is disposed to be at least partially supported by the slidable plate; multiple conductive parts formed to be electrically segmented by at least one first non-conductive part formed on the at least one side surface along the third direction, and at least one second non-conductive part formed to cross over the first non-conductive part; a substrate disposed in the space; and a wireless communication circuit disposed on the substrate and configured to transmit and receive a wireless signal through the multiple conductive parts in at least one frequency band.

15 Claims, 31 Drawing Sheets





US012602562B1

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

(10) **Patent No.:** **US 12,602,562 B1**
(45) **Date of Patent:** **Apr. 14, 2026**

(54) **MEDIA PROCESSING DEVICES WITH
2-DIMENSIONAL ARTICULABLE RF
ANTENNA**

(71) Applicant: **Zebra Technologies Corporation**,
Lincolnshire, IL (US)

(72) Inventors: **Wai Kean Tham**, Gopeng (MY);
Yuming Zhang, Singapore (SG)

(73) Assignee: **Zebra Technologies Corporation**,
Lincolnshire, IL (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.: **19/177,113**

(22) Filed: **Apr. 11, 2025**

(51) **Int. Cl.**
G06K 19/02 (2006.01)
G06K 19/077 (2006.01)

(52) **U.S. Cl.**
CPC **G06K 19/025** (2013.01); **G06K 19/07722**
(2013.01); **G06K 19/07779** (2013.01)

(58) **Field of Classification Search**
CPC G06K 19/025; G06K 19/07722; G06K
19/07779 235/492
USPC 235/492
See application file for complete search history.

(56) **References Cited**

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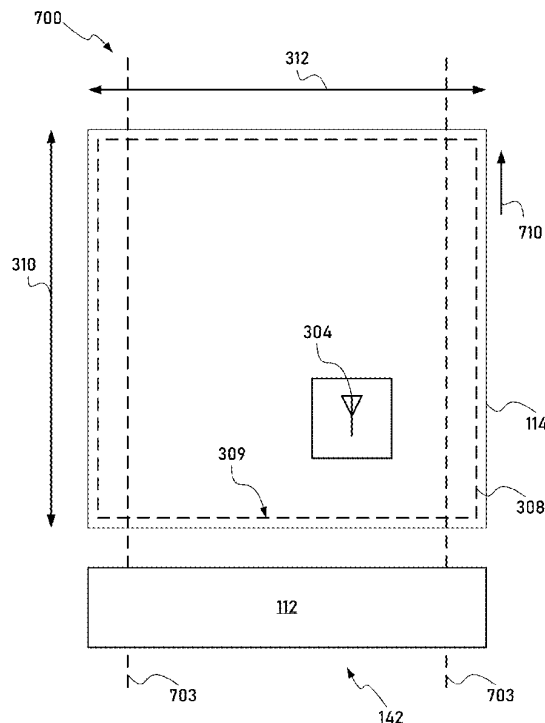
Primary Examiner — Michael G Lee

Assistant Examiner — David Tardif

(57) **ABSTRACT**

Media processing devices with two-dimensional articulatable RF antennas are disclosed herein. An example media processing device with a two-dimensional articulatable RF antenna includes a media process path having a feed direction; an RF encoder disposed at a point along the media process path, comprising a programming region; an RF antenna configured to program RF tags; and a driver configured to articulate the RF antenna in a first direction perpendicular to the feed direction and within the programming region, and articulate the RF antenna in a second direction, parallel with the feed direction and within the programming region.

16 Claims, 10 Drawing Sheets





US012603412B2

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

(10) **Patent No.:** **US 12,603,412 B2**
(45) **Date of Patent:** **Apr. 14, 2026**

(54) **MOBILE DEVICE SUPPORTING WIDEBAND OPERATION**

(71) Applicant: **Acer Incorporated**, New Taipei City (TW)

(72) Inventors: **Kun-Sheng Chang**, New Taipei City (TW); **Ching-Chi Lin**, New Taipei City (TW); **Chuan-Chun Wang**, New Taipei City (TW)

(73) Assignee: **ACER INCORPORATED**, 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 217 days.

(21) Appl. No.: **18/535,305**

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

(65) **Prior Publication Data**

US 2025/0125515 A1 Apr. 17, 2025

(30) **Foreign Application Priority Data**

Oct. 17, 2023 (TW) 112139511

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

(52) **U.S. Cl.**
CPC **H01Q 1/2266** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/20** (2015.01); **H01Q 5/35** (2015.01); **H01Q 13/10** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/2266; H01Q 1/2258; H01Q 13/10; H01Q 5/20; H01Q 21/30; H01Q 1/48; H01Q 5/35
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Hoang V Nguyen

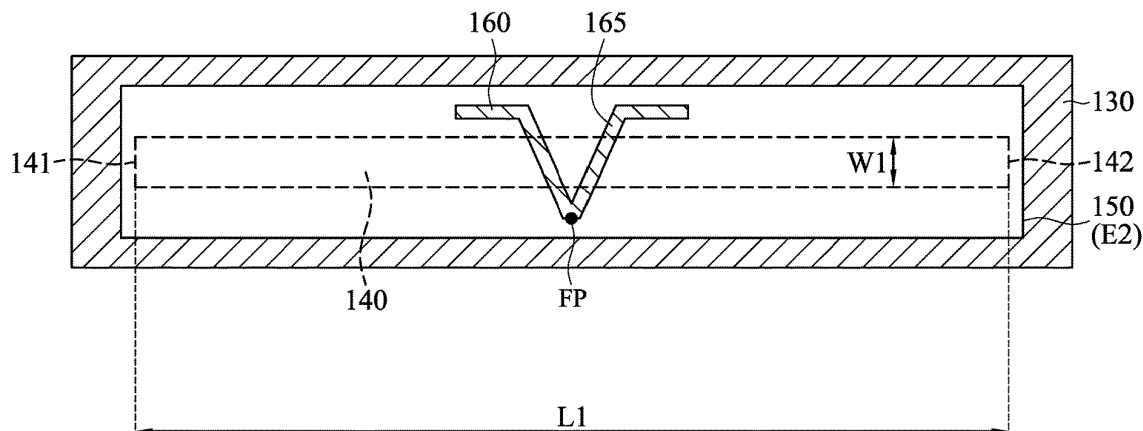
Assistant Examiner — Anna N Hamadyk

(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

A mobile device supporting wideband operations includes a first metal mechanism element, a dielectric substrate, a first feeding radiation element, a second feeding radiation element, a ground element, and a second metal mechanism element. The first metal mechanism element includes a main portion and a sidewall portion. The sidewall portion of the first metal mechanism element has a first slot. Both the first feeding radiation element and the second feeding radiation element extend across the first slot of the first metal mechanism element. An antenna structure is formed by the first slot of the first metal mechanism element, the dielectric substrate, the first feeding radiation element, the second feeding radiation element, and the ground element. The second metal mechanism element is disposed opposite to the main portion of the first metal mechanism element. The second metal mechanism element has a second slot.

17 Claims, 7 Drawing Sheets





US012603413B2

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

(10) **Patent No.:** **US 12,603,413 B2**
(45) **Date of Patent:** **Apr. 14, 2026**

(54) **ELECTRONIC APPARATUS INCLUDING ANTENNA**

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

(72) Inventors: **Youngjun Cho**, Suwon-si (KR); **Seongyong An**, Suwon-si (KR); **Sangha Lee**, Suwon-si (KR); **Yoonjae Lee**, Suwon-si (KR); **Jinwoo Jung**, Suwon-si (KR); **Jaebong Chun**, Suwon-si (KR); **Sangmin Han**, 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 307 days.

(21) Appl. No.: **18/318,445**

(22) Filed: **May 16, 2023**

(65) **Prior Publication Data**
US 2023/0307820 A1 Sep. 28, 2023

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2021/016744, filed on Nov. 16, 2021.

(30) **Foreign Application Priority Data**

Nov. 16, 2020 (KR) 10-2020-0152870
Apr. 2, 2021 (KR) 10-2021-0043169

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/50 (2006.01)
H04M 1/02 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/50** (2013.01); **H04M 1/0237** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/50; H01Q 1/0237; H01Q 1/0268; H01Q 1/026
See application file for complete search history.

(56) **References Cited**

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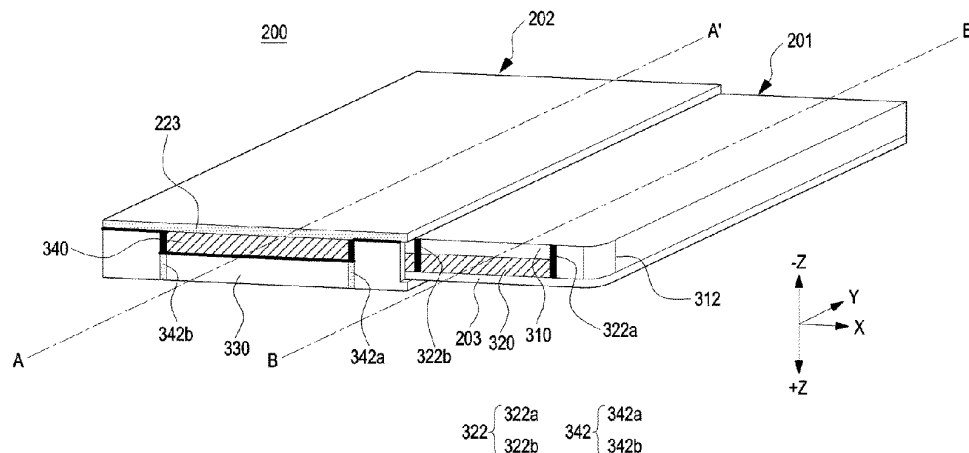
Primary Examiner — David Tung

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

(57) **ABSTRACT**

According to various embodiments disclosed herein, an electronic apparatus comprises: a first housing including a first metal area and a first non-metal area; a second housing configured to accommodate at least a portion of the first housing and to guide a slide movement of the first housing, the second housing including a second metal area and a second non-metal area; and a display including a first display region connected with the first housing and a second display region extending from the first display region. In a state in which the first housing is accommodated in the second housing, the first metal area may face at least a portion of the second non-metal area, and the first non-metal area may face at least a portion of the second metal area.

15 Claims, 16 Drawing Sheets





US012603430B2

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

(10) **Patent No.:** **US 12,603,430 B2**
(45) **Date of Patent:** **Apr. 14, 2026**

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

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

(72) Inventors: **Guan-Ren Su**, Hsinchu (TW);
Meng-Kai Wu, Hsinchu (TW);
Hsieh-Chih Lin, Hsinchu (TW)

(73) Assignee: **WISTRON NEWEB CORP.**, Hsinchu (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 318 days.

(21) Appl. No.: **18/451,391**

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

(65) **Prior Publication Data**

US 2024/0088562 A1 Mar. 14, 2024

(30) **Foreign Application Priority Data**

Sep. 14, 2022 (TW) 111134673

(51) **Int. Cl.**
H01Q 5/328 (2015.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 5/328** (2015.01); **H01Q 9/0442** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/328; H01Q 9/0442; H01Q 5/25;
H01Q 5/371; H01Q 1/243; H01Q 5/378;
H01Q 9/42

See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Dimary S Lopez Cruz

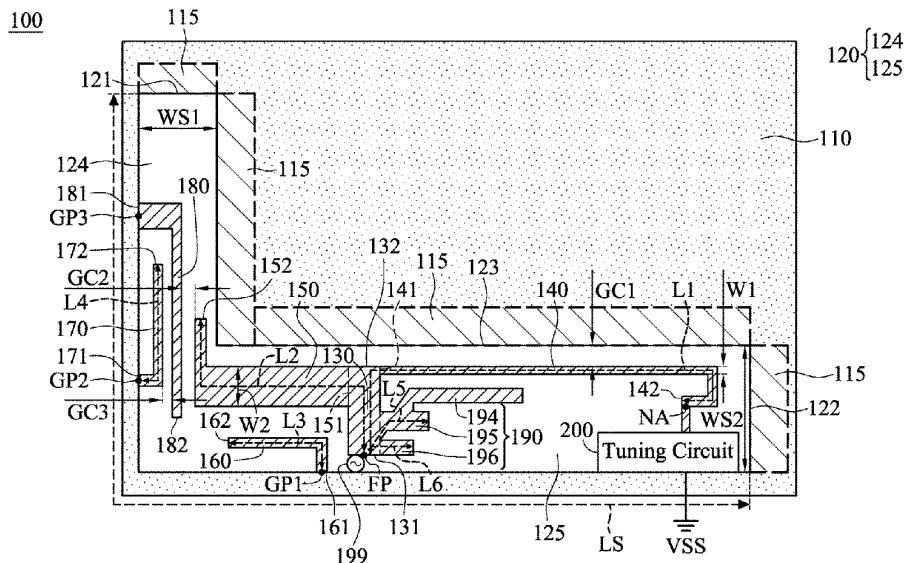
Assistant Examiner — Michael M Bouizza

(74) Attorney, Agent, or Firm — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

An antenna structure includes a metal mechanism element, a feeding radiation element, a first radiation element, a second radiation element, a third radiation element, a fourth radiation element, a fifth radiation element, a sixth radiation element, and a tuning circuit. A slot is formed in the metal mechanism element. The first radiation element is coupled to the feeding radiation element. The tuning circuit is coupled to the first radiation element. The second radiation element is coupled to the feeding radiation element. The third radiation element is coupled to a first grounding point on the metal mechanism element. The fourth radiation element is coupled to a second grounding point on the metal mechanism element. The fifth radiation element is coupled to a third grounding point on the metal mechanism element.

20 Claims, 4 Drawing Sheets





US012603435B2

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

(10) **Patent No.:** **US 12,603,435 B2**
(45) **Date of Patent:** **Apr. 14, 2026**

(54) **ANTENNA STRUCTURE**

(71) Applicant: **Wistron NeWeb Corporation**, Hsinchu (TW)

(72) Inventors: **Kuo Jen Lai**, Hsinchu (TW);
Chin-Lien Huang, 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 447 days.

(21) Appl. No.: **18/061,010**

(22) Filed: **Dec. 2, 2022**

(65) **Prior Publication Data**

US 2024/0014560 A1 Jan. 11, 2024

(30) **Foreign Application Priority Data**

Jul. 6, 2022 (TW) 111125410

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 21/28 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 9/0421** (2013.01); **H01Q 21/28** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 9/0421; H01Q 21/28; H01Q 9/04;
H01Q 9/0407; H01Q 9/0442
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Jimmy T Vu

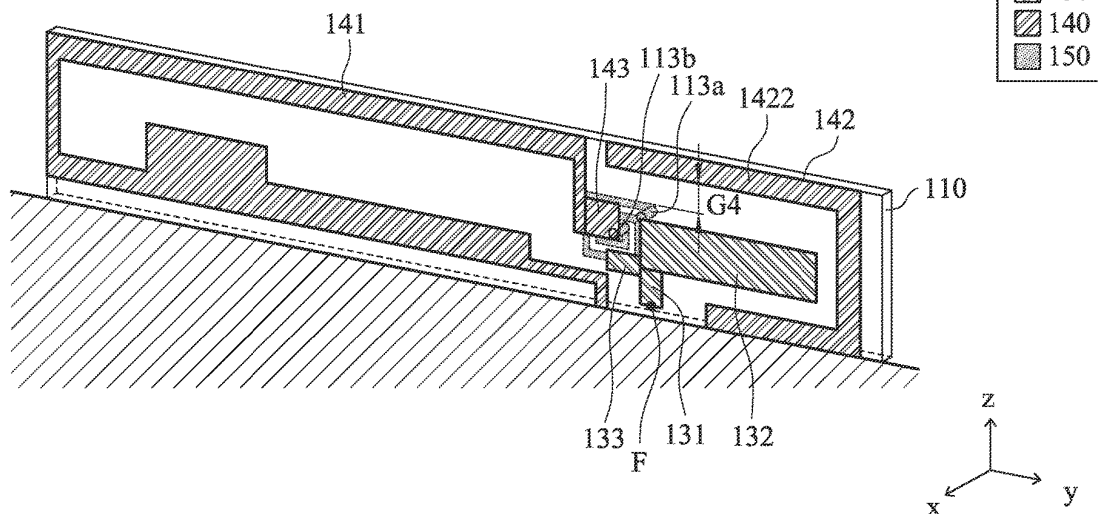
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

The antenna structure includes a substrate, a ground layer, a feeding unit, an antenna unit, and an inductive element. The ground layer is disposed on the substrate. The feeding unit is disposed on the substrate. The antenna unit is disposed on the substrate and connected to the ground layer. The feeding unit and the antenna unit are indirectly connected. One end of the inductive element is electrically connected to the feeding unit, and another end of the inductive element is electrically connected to the antenna unit.

18 Claims, 6 Drawing Sheets

100





US012603444B2

(12) **United States Patent**
Minamitani

(10) **Patent No.:** **US 12,603,444 B2**
(45) **Date of Patent:** **Apr. 14, 2026**

(54) **ANTENNA MODULE AND COMMUNICATION DEVICE INCLUDING THE SAME**

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

(72) Inventor: **Natsumi Minamitani**, 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 124 days.

(21) Appl. No.: **18/793,992**

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

(65) **Prior Publication Data**

US 2025/0007182 A1 Jan. 2, 2025

Related U.S. Application Data

(63) Continuation of application No.
PCT/JP2022/040889, filed on Nov. 1, 2022.

(30) **Foreign Application Priority Data**

Feb. 16, 2022 (JP) 2022-022338

(51) **Int. Cl.**
H01Q 21/28 (2006.01)
H01Q 5/307 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 21/28** (2013.01); **H01Q 5/307**
(2015.01)

(58) **Field of Classification Search**
CPC H01Q 21/28; H01Q 5/307
See application file for complete search history.

(56) **References Cited**

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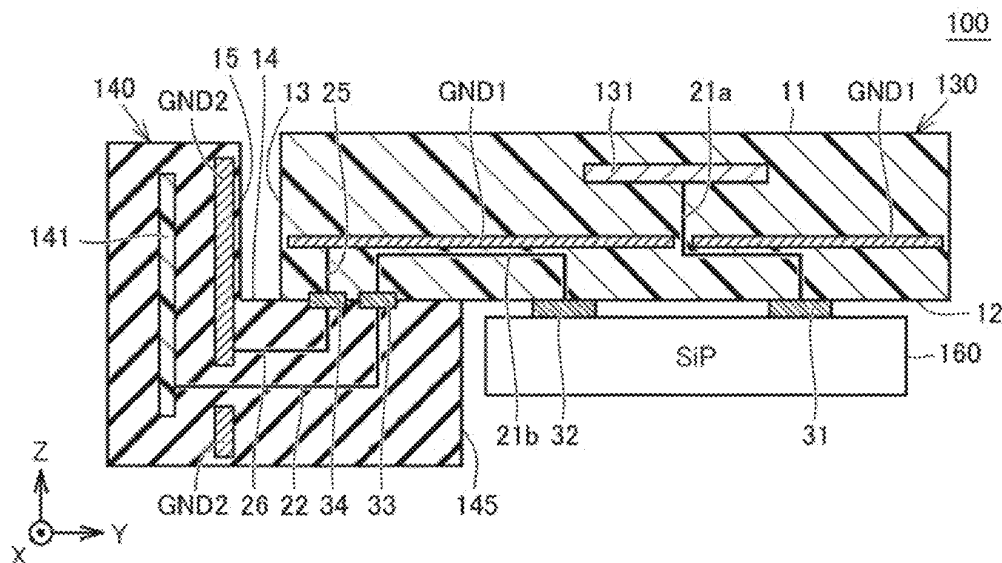
Primary Examiner — Graham P Smith

(74) *Attorney, Agent, or Firm* — XSENSUS LLP

(57) **ABSTRACT**

An antenna module includes first and second radiating elements, and a substrate including a first main surface facing away from a second main surface. The first radiating element is closer to the first main surface than to the second main surface. The second radiating element is in a first antenna disposition member. A feed circuit supplies high-frequency signals to the first and second radiating elements. The first antenna disposition member has a first disposition surface on which the substrate is disposed and a first intersecting surface intersecting the first disposition surface. The second main surface is joined to the first disposition surface, and a feed wiring line electrically connecting the first radiating element or the second radiating element to the feed circuit includes a wiring line spanning the substrate and the first antenna disposition member in a first joint portion between the second main surface and the first disposition surface.

20 Claims, 17 Drawing Sheets





US012603950B2

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

(10) **Patent No.:** **US 12,603,950 B2**
(45) **Date of Patent:** **Apr. 14, 2026**

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

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

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(Continued)

(72) Inventors: **Himchan Yun**, Suwon-si (KR);
Sungkoo Park, Suwon-si (KR);
Kyungjae Lee, Suwon-si (KR); **Soonho
Hwang**, Suwon-si (KR)

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

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(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 320 days.

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(21) Appl. No.: **18/303,274**

(22) Filed: **Apr. 19, 2023**

(65) **Prior Publication Data**
US 2023/0262151 A1 Aug. 17, 2023

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

Related U.S. Application Data

(63) Continuation of application No.
PCT/KR2021/014486, filed on Oct. 18, 2021.

(57) **ABSTRACT**

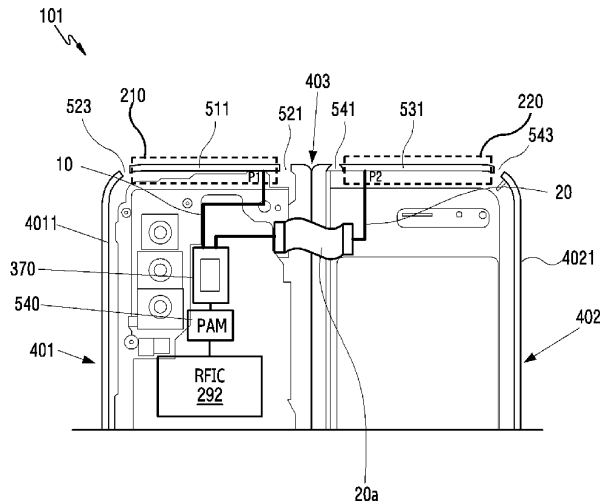
(30) **Foreign Application Priority Data**

Oct. 21, 2020 (KR) 10-2020-0136855

An electronic device is provided. The electronic device includes a housing, a first antenna including a first portion of a first part, a second antenna including a second portion of a second part, a power distribution circuit electrically connected to the first antenna through a first path and electrically connected to the second antenna through a second path longer than the first path, a wireless communication circuit. The housing comprises the first part, the second part, and a connecting part disposed between the first part and the second part, wherein the first part is coupled to the connecting part so as to be rotatable with respect to the second part, and in a state where the housing is folded, a first point of the first antenna may correspond to a second point of the second antenna.

(51) **Int. Cl.**
H04M 1/02 (2006.01)
H01Q 1/24 (2006.01)
(52) **U.S. Cl.**
CPC **H04M 1/026** (2013.01); **H01Q 1/243**
(2013.01); **H04M 1/0216** (2013.01)
(58) **Field of Classification Search**
CPC H04M 1/026; H04M 1/0216; H01Q 1/243;
H01Q 5/30; H01Q 3/30; H01Q 21/29;
H01Q 1/2225; H01Q 1/38; H03H 7/0115
See application file for complete search history.

20 Claims, 23 Drawing Sheets





US0D1119875S

(12) **United States Design Patent** (10) **Patent No.:** **US D1,119,875 S**
Forster et al. (45) **Date of Patent:** **** Mar. 24, 2026**

(54) **ANTENNA**
(71) Applicant: **Avery Dennison Retail Information Services LLC**, Mentor, OH (US)
(72) Inventors: **Ian J. Forster**, Chelmsford (GB); **Norman A. Howard**, Ilford (GB); **Panagiotis Petridis**, Chelmsford (GB); **Achimugu A. Atojoko**, Chelmsford (GB); **Muhammad Rizwan**, Chelmsford (GB)
(73) Assignee: **Avery Dennison Retail Information Services LLC**, Mentor, OH (US)

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(**) Term: **15 Years**

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(21) Appl. No.: **29/979,854**

CN 203398282 U 1/2014
CN 219149519 U 6/2023

(Continued)

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

(51) **LOC (15) Cl.** **14-03**

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

USPC **D14/230**

(58) **Field of Classification Search**

USPC D14/496, 217, 230, 233, 234, 343;
D19/9, 10; D20/22, 27, 28

CPC H01Q 9/285; H01Q 9/16; H01Q 9/065;
H01Q 9/0407; H01Q 9/04; H01Q 9/00

See application file for complete search history.

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Primary Examiner — Michelle E. Wilson

Assistant Examiner — Benjamin L. Gray

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(57) **CLAIM**

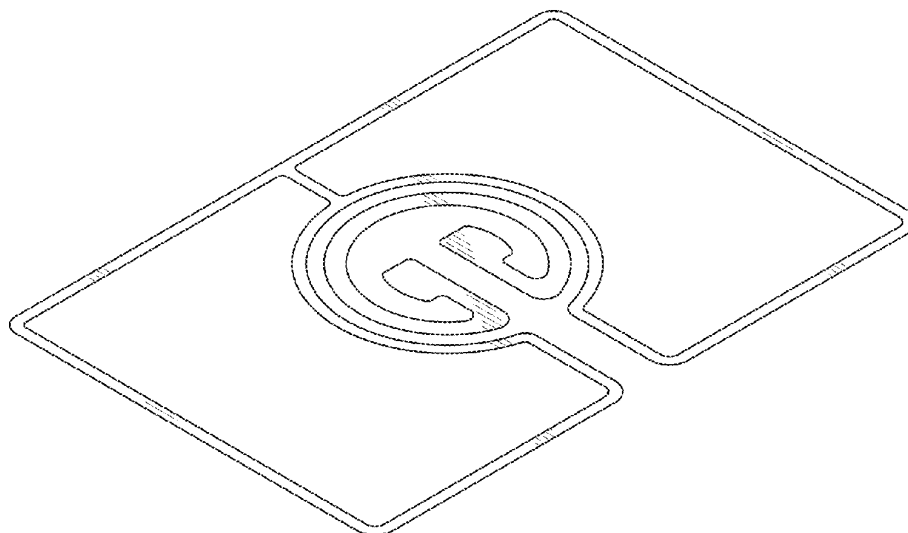
The ornamental design for an antenna as shown and described.

DESCRIPTION

FIG. 1 is an isometric view of an antenna in accordance with the design; and,

FIG. 2 is a top plan view thereof.

1 Claim, 2 Drawing Sheets





US0D1119876S

(12) **United States Design Patent** (10) **Patent No.:** **US D1,119,876 S**
Forster et al. (45) **Date of Patent:** **** Mar. 24, 2026**

(54) **ANTENNA**
(71) Applicant: **Avery Dennison Retail Information Services LLC**, Mentor, OH (US)
(72) Inventors: **Ian J. Forster**, Chelmsford (GB); **Norman A. Howard**, Ilford (GB); **Panagiotis Petridis**, Chelmsford (GB); **Achimugu A. Atojoko**, Chelmsford (GB); **Muhammad Rizwan**, Chelmsford (GB)
(73) Assignee: **Avery Dennison Retail Information Services LLC**, Mentor, OH (US)

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D543,976 S 6/2007 Oliver
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H01Q 9/0407; H01Q 9/04; H01Q 9/00

See application file for complete search history.

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(57) **CLAIM**

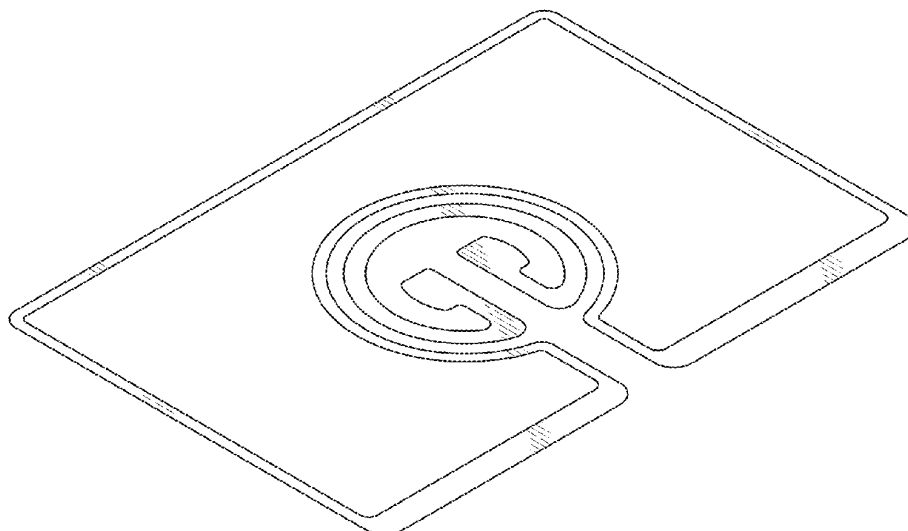
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1 Claim, 2 Drawing Sheets





US0D1119877S

(12) **United States Design Patent** (10) **Patent No.:** **US D1,119,877 S**
Forster et al. (45) **Date of Patent:** **** Mar. 24, 2026**

(54) **ANTENNA**
(71) Applicant: **Avery Dennison Retail Information Services LLC**, Mentor, OH (US)
(72) Inventors: **ian J. Forster**, Chelmsford (GB); **Norman A. Howard**, Ilford (GB); **Panagiotis Petridis**, Chelmsford (GB); **Achimugu A. Atojoko**, Chelmsford (GB); **Muhammad Rizwan**, Chelmsford (GB)
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(**) Term: **15 Years**

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CN 219149519 U 6/2023

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H01Q 9/0407; H01Q 9/04; H01Q 9/00

See application file for complete search history.

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Primary Examiner — Michelle E. Wilson

Assistant Examiner — Benjamin L. Gray

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6,147,604 A 11/2000 Wiklof et al.
6,147,662 A 11/2000 Grabau et al.
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(57)

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