



US012476345B2

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

(10) **Patent No.:** **US 12,476,345 B2**
(45) **Date of Patent:** **Nov. 18, 2025**

(54) **ANTENNA ASSEMBLY**

(71) Applicant: **Advanced Wireless & Antenna INC.,**
New Taipei (TW)

(72) Inventors: **Ching-Hsiang Huang**, New Taipei
(TW); **Yu-Ting Kao**, New Taipei (TW)

(73) Assignee: **ADVANCED WIRELESS &**
ANTENNA INC., New Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 187 days.

(21) Appl. No.: **18/356,643**

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

(65) **Prior Publication Data**

US 2024/0030587 A1 Jan. 25, 2024

(30) **Foreign Application Priority Data**

Jul. 21, 2022 (TW) 111207886
Sep. 2, 2022 (TW) 111209616

(51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01Q 1/52 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/2266** (2013.01); **H01Q 1/526**
(2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/2266; H01Q 1/526
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2012/0293376 A1 * 11/2012 Hung H01Q 9/42
343/702
2014/0361930 A1 * 12/2014 Liu H01Q 9/42
343/700 MS
2015/0263410 A1 * 9/2015 Hwang H01Q 5/371
343/702
2017/0309993 A1 10/2017 Tu et al.
2020/0014092 A1 1/2020 Wei et al.

* cited by examiner

Primary Examiner — Dameon E Levi

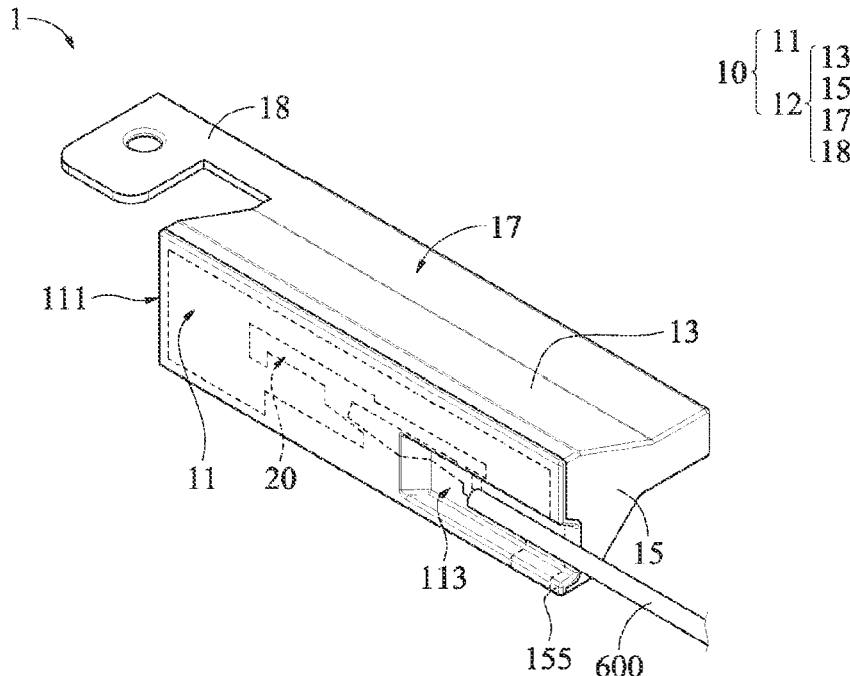
Assistant Examiner — Michael M Bouizza

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

(57) **ABSTRACT**

An antenna assembly adapted to be assembled to a desktop computer includes a shielding body and an antenna body. The shielding body includes a first wall, two first shielding walls, and two second shielding walls. The first wall is connected to the two first shielding walls and the two second shielding walls and faces an outside of the desktop computer. The antenna body is at the first wall of the shielding body, and one or more portion of the antenna body is connected to the first shielding wall or the second shielding wall. The antenna body is operated at a frequency range of 2400 MHz and 2500 MHz or between 5150 MHz and 7125 MHz.

20 Claims, 14 Drawing Sheets





US012476346B2

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

(10) **Patent No.:** **US 12,476,346 B2**
(45) **Date of Patent:** **Nov. 18, 2025**

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

(71) Applicants: **Chih-Heng Lin**, Taipei (TW); **Li-Chun Lee**, Taipei (TW); **Shih-Chia Liu**, Taipei (TW); **Jui-Hung Lai**, Taipei (TW)

(72) Inventors: **Chih-Heng Lin**, Taipei (TW); **Li-Chun Lee**, Taipei (TW); **Shih-Chia Liu**, Taipei (TW); **Jui-Hung Lai**, Taipei (TW)

(73) Assignee: **COMPAL ELECTRONICS, INC.**, Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 209 days.

(21) Appl. No.: **18/447,307**

(22) Filed: **Aug. 10, 2023**

(65) **Prior Publication Data**
US 2024/0283129 A1 Aug. 22, 2024

(30) **Foreign Application Priority Data**
Feb. 22, 2023 (TW) 112106387

(51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01Q 5/307 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 1/2266** (2013.01); **H01Q 5/307** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/2266; H01Q 1/243; H01Q 5/307; H01Q 7/00
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2020/0076061 A1 * 3/2020 Chen H01Q 21/0068
2021/0359410 A1 * 11/2021 Li H01Q 1/246

FOREIGN PATENT DOCUMENTS

TW 201705610 2/2017

OTHER PUBLICATIONS

“Office Action of Taiwan Counterpart Application”, issued on Feb. 6, 2024, p. 1-p. 5.

* cited by examiner

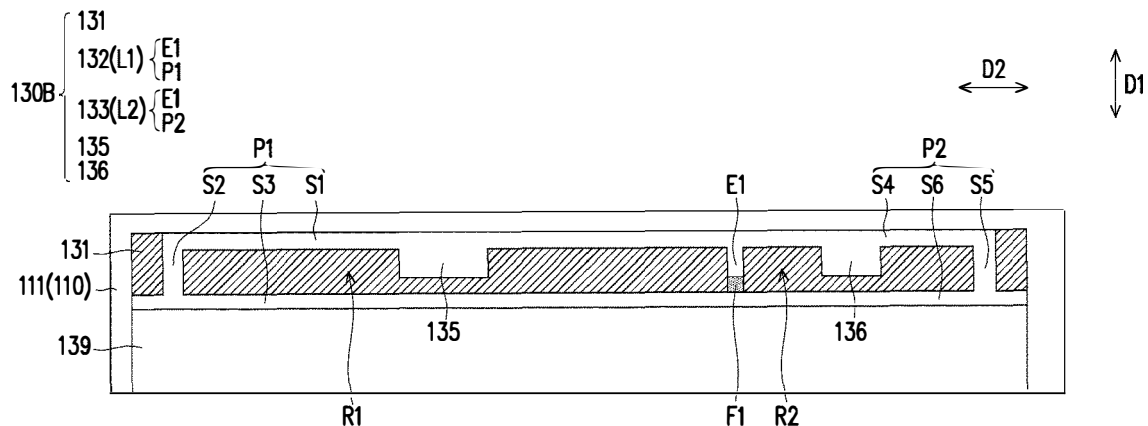
Primary Examiner — Daniel Munoz

(74) Attorney, Agent, or Firm — JCIPRNET

(57) **ABSTRACT**

An antenna module includes a metal cover, a substrate, a first radiating element and a second radiating element. The metal cover has a slot. The substrate is disposed corresponding to the slot. The first radiating element is disposed on the substrate, the first radiating element includes an excited section and a first radiating section connected in sequence, and the excited section has a feeding point. The second radiating element is disposed on the substrate, the second radiating element includes the excited section and a second radiating section connected in sequence, and the excited section is located between the first radiating section and the second radiating section. A length of the first radiating section is greater than a length of the second radiating section, the first radiating element is used to excite a first resonant frequency, and the second radiating element is used to excite a second resonant frequency.

29 Claims, 15 Drawing Sheets





US012476349B2

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

(10) **Patent No.:** **US 12,476,349 B2**
(45) **Date of Patent:** **Nov. 18, 2025**

(54) **WIRELESS COMMUNICATION DEVICE**

(56) **References Cited**

(71) Applicant: **MEDIATEK INC.**, Hsinchu (TW)

U.S. PATENT DOCUMENTS

(72) Inventors: **Shih-Wei Hsieh**, Hsinchu (TW);
Wei-Hsuan Chang, Hsinchu (TW);
Chih-Wei Lee, Hsinchu (TW);
Shyh-Ting Fang, Hsinchu (TW)

2021/0167487 A1 * 6/2021 Varma H01Q 25/005
2022/0217656 A1 * 7/2022 Malik H04B 7/06952
2022/0303368 A1 * 9/2022 Lee H04M 1/185

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

OTHER PUBLICATIONS

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 333 days.

IP.com search History (Year: 2025).*

* cited by examiner

(21) Appl. No.: **18/344,136**

Primary Examiner — Moustapha Diaby

(22) Filed: **Jun. 29, 2023**

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

(65) **Prior Publication Data**

US 2025/0007147 A1 Jan. 2, 2025

(57) **ABSTRACT**

(51) **Int. Cl.**
H01Q 1/00 (2006.01)
H01Q 1/24 (2006.01)
H01Q 1/52 (2006.01)
H04M 1/02 (2006.01)

A wireless communication device is provided. The wireless communication device includes a circuit board, an antenna module, a housing and a metal pattern unit. The antenna module is coupled to the circuit board, wherein the antenna module transmits a wireless signal, the antenna module defines a first FOV area and a second FOV area, and the first FOV area differs from the second FOV area. The housing covers the antenna module, wherein a lid portion of the housing corresponds to the first FOV area, and the lid portion has a first equivalent dielectric constant. The metal pattern unit corresponds to the second FOV area, the metal pattern unit causes a second equivalent dielectric constant, and the first equivalent dielectric constant differs from the second equivalent dielectric constant.

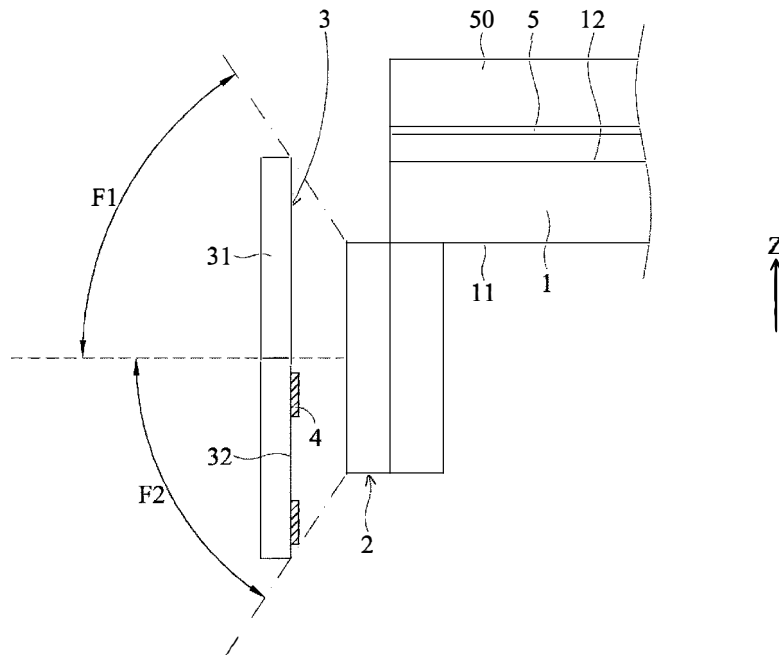
(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/526** (2013.01); **H04M 1/026** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/36; H01Q 1/241;
H01Q 1/38; H01Q 1/42; H01Q 1/526;
H04M 1/026

USPC 455/575.7

See application file for complete search history.

21 Claims, 11 Drawing Sheets





US012476357B2

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

(10) **Patent No.:** **US 12,476,357 B2**
(45) **Date of Patent:** **Nov. 18, 2025**

(54) **ANTENNA ASSEMBLY WITH ISOLATION NETWORK**

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

(72) Inventors: **Maruti Tamrakar**, Tamil Nadu (IN);
Sagar Gupta, Ghaziabad (IN);
Jayprakash Thakur, Bangalore KA (IN); **Rakhi Singh**, Uttar Pradesh (IN)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 921 days.

(21) Appl. No.: **17/129,705**

(22) Filed: **Dec. 21, 2020**

(65) **Prior Publication Data**
US 2021/0111486 A1 Apr. 15, 2021

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

(52) **U.S. Cl.**
CPC **H01Q 1/52** (2013.01); **H01Q 1/2283** (2013.01); **H01Q 1/243** (2013.01); **H03H 7/38** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/52; H01Q 1/2283; H01Q 1/243; H01Q 1/2266; H01Q 5/328; H01Q 5/335;
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,957,827 B1 * 2/2015 Lee H01Q 5/378 343/702
9,413,058 B1 * 8/2016 Kuo H01Q 5/335
(Continued)

FOREIGN PATENT DOCUMENTS

CN 107317103 A * 11/2017 H01Q 1/38
CN 110224226 A 9/2019
(Continued)

OTHER PUBLICATIONS

Extended European Search Report (EESR) received from EP dated Mar. 17, 2022, 12 pages.

(Continued)

Primary Examiner — Dimary S Lopez Cruz

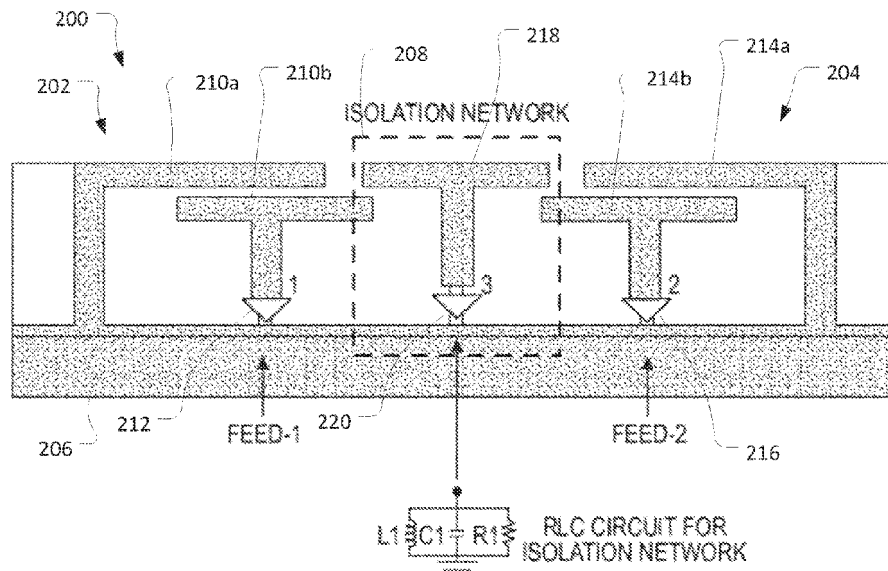
Assistant Examiner — Bamidele A Immanuel

(74) *Attorney, Agent, or Firm* — Schwabe, Williamson & Wyatt, P.C.

(57) **ABSTRACT**

Various embodiments provide an antenna assembly and associated systems, devices, and methods. The antenna assembly may include two or more antennas, including a first antenna and a second antenna, coupled to a ground plane. The antenna assembly may further include an isolation network coupled to the ground plane between the first and second antennas. The isolation network may include a conductive structure between conductive antenna portions of the first and second antennas, and an isolation circuit coupled between the conductive structure and the ground plane. The isolation circuit may include a resistor, an inductor, and/or a capacitor (e.g., coupled in parallel with one another). Other embodiments may be described and claimed.

13 Claims, 16 Drawing Sheets





US012476358B2

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

(10) **Patent No.:** **US 12,476,358 B2**
(45) **Date of Patent:** **Nov. 18, 2025**

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

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

(72) Inventors: **Seokwoo Lee**, Suwon-si (KR);
Hyosung Kang, Suwon-si (KR);
Dongryul Shin, Suwon-si (KR); **Jiwoo Lee**, Suwon-si (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 368 days.

(21) Appl. No.: **17/972,551**

(22) Filed: **Oct. 24, 2022**

(65) **Prior Publication Data**
US 2023/0105261 A1 Apr. 6, 2023

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2022/013385, filed on Sep. 6, 2022.

(30) **Foreign Application Priority Data**

Oct. 1, 2021 (KR) 10-2021-0130721

(51) **Int. Cl.**
H01Q 3/24 (2006.01)
H01Q 1/38 (2006.01)
H01Q 13/16 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 3/24** (2013.01); **H01Q 1/38** (2013.01); **H01Q 13/16** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 3/24; H01Q 1/38; H01Q 13/16
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

10,939,539 B2 3/2021 Seo et al.
11,114,741 B2 9/2021 Moon et al.
(Continued)

FOREIGN PATENT DOCUMENTS

JP 2008244581 A 10/2008
KR 20200022161 A 3/2020
(Continued)

OTHER PUBLICATIONS

Extended European Search Report corresponding to Application No. 22876706.7-1201; Dated Jul. 24, 2024.

(Continued)

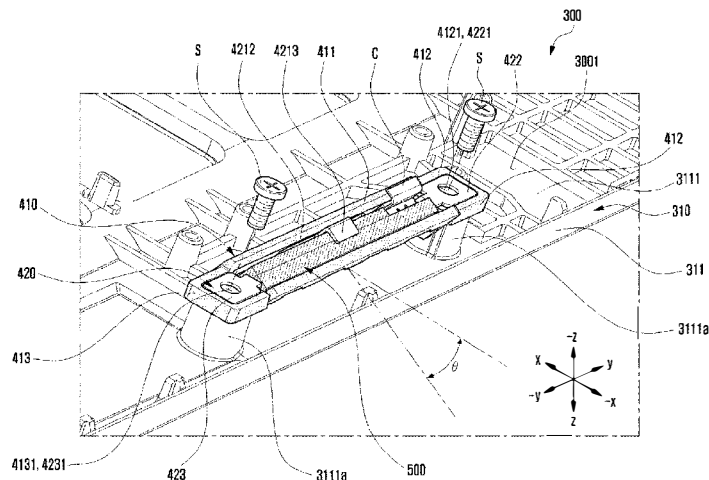
Primary Examiner — Graham P Smith

(74) *Attorney, Agent, or Firm* — CANTOR COLBURN LLP

(57) **ABSTRACT**

An electronic device includes a housing, and an antenna structure disposed in the inner space of the housing. The antenna structure includes a substrate including a first surface, a second surface facing away from the first surface, and side surfaces surrounding a space between the first surface and the second surface. At least one antenna element is disposed to form a beam pattern in a direction in which the first surface is oriented, and at least one bracket is disposed in the inner space and configured to support the substrate such that the first surface is tilted to a predetermined angle with respect to a first direction. A wireless communication circuit is disposed in the inner space and is configured to form, via the at least one antenna element, the beam pattern in the direction in which the first surface is oriented.

16 Claims, 16 Drawing Sheets





US012476366B2

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

(10) **Patent No.:** **US 12,476,366 B2**
(45) **Date of Patent:** **Nov. 18, 2025**

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

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

(72) Inventors: **Yoonjae Lee**, Suwon-si (KR); **Seongyong An**, Suwon-si (KR); **Sangha Lee**, Suwon-si (KR); **Jinwoo Jung**, Suwon-si (KR); **Youngjun Cho**, 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 252 days.

(21) Appl. No.: **18/320,552**

(22) Filed: **May 19, 2023**

(65) **Prior Publication Data**
US 2023/0291101 A1 Sep. 14, 2023

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2021/017067, filed on Nov. 19, 2021.

(30) Foreign Application Priority Data

Nov. 19, 2020 (KR) KR10-2020-0155503
Apr. 29, 2021 (KR) KR10-2021-0055445

(51) **Int. Cl.**
H01Q 5/357 (2015.01)
H01Q 1/24 (2006.01)
H01Q 13/16 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 5/357** (2015.01); **H01Q 1/241** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/24; H01Q 1/241; H01Q 1/243; H01Q 13/10; H01Q 13/12; H01Q 13/16;
(Continued)

(56) References Cited

U.S. PATENT DOCUMENTS

11,470,729 B2 * 10/2022 Kim H04M 1/0237
2006/0097931 A1 5/2006 Kim et al.
(Continued)

FOREIGN PATENT DOCUMENTS

JP 2012156858 A 8/2012
KR 20040110582 A 12/2004
(Continued)

OTHER PUBLICATIONS

International Search Report for PCT/KR2021/017067 mailed Feb. 25, 2022, 5 pages.

(Continued)

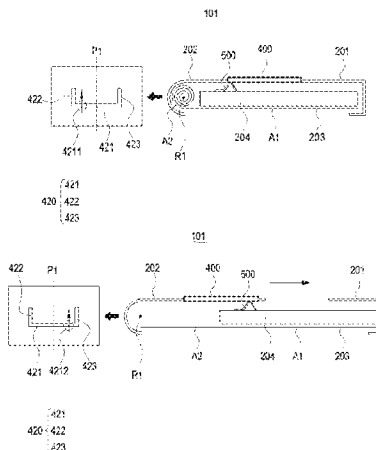
Primary Examiner — Thai Pham

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

(57) ABSTRACT

An electronic device according to various embodiments of the present disclosure may comprise: a first housing; a second housing configured to accommodate at least a portion of the first housing and to guide a sliding motion of the first housing; a flexible display including a first display area connected to the first housing, and a second display area extending from the first display area and capable of bending or rolling; a circuit board disposed in the first housing and movable in response to the sliding motion of the first housing; an antenna structure formed on an outer surface of the second structure, and including a first part and a second part that are symmetrical about a first axis perpendicular to the sliding motion direction; and a feeding structure disposed on the circuit board configured to feed power to the antenna structure. The feeding structure is electrically con-

(Continued)





US012476373B2

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

(10) **Patent No.:** **US 12,476,373 B2**
(45) **Date of Patent:** **Nov. 18, 2025**

(54) **COMMUNICATION DEVICE**

(56)

References Cited

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

U.S. PATENT DOCUMENTS

(72) Inventors: **Yen-Tze Peng**, Hsinchu (TW);
Pao-Chuan Peng, 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 156 days.

(21) Appl. No.: **18/461,775**

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

(65) **Prior Publication Data**

US 2024/0113432 A1 Apr. 4, 2024

(30) **Foreign Application Priority Data**

Sep. 29, 2022 (TW) 111136937

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

(52) **U.S. Cl.**
CPC **H01Q 9/0414** (2013.01); **H01Q 1/2291** (2013.01); **H01Q 9/0421** (2013.01)

(58) **Field of Classification Search**
CPC .. H01Q 9/0414; H01Q 1/2291; H01Q 9/0421; H01Q 5/371; H01Q 1/2258
See application file for complete search history.

10,879,606 B2 12/2020 Ruaro et al.
2011/0006953 A1 * 1/2011 Chiang G06F 1/1698 343/702
2014/0118198 A1 * 5/2014 Kawashimo H01Q 1/42 343/702
2014/0132463 A1 * 5/2014 Hobson H04M 1/0202 343/702
2014/0335785 A1 * 11/2014 Kato H01Q 1/2266 455/41.1
2015/0214620 A1 * 7/2015 Yosui H01Q 1/243 343/702
2015/0364815 A1 * 12/2015 Yong H01Q 1/243 343/702
2018/0101274 A1 * 4/2018 Uttermann G08C 17/02
2019/0074586 A1 * 3/2019 Ruaro H01Q 9/04
2019/0356051 A1 * 11/2019 Barrera H01Q 1/44

FOREIGN PATENT DOCUMENTS

CN 111052498 U 4/2020

* cited by examiner

Primary Examiner — Dameon E Levi

Assistant Examiner — Michael M Bouizza

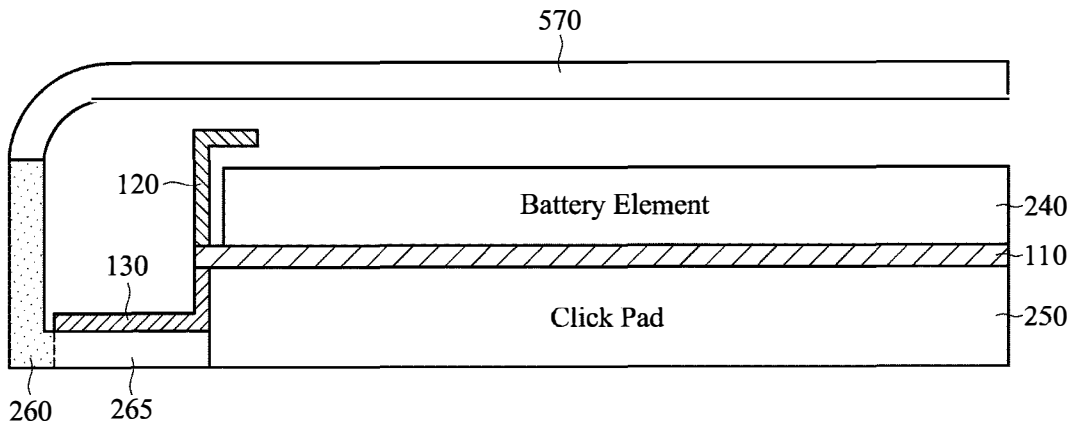
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

A communication device with high radiation efficiency includes a click pad frame, a metal wall, and an antenna structure. The metal wall is coupled to the click pad frame. The antenna structure is coupled to the click pad frame. The click pad frame is disposed between the metal wall and the antenna structure.

20 Claims, 8 Drawing Sheets

500





US012476376B2

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

(10) **Patent No.:** **US 12,476,376 B2**
(45) **Date of Patent:** **Nov. 18, 2025**

(54) **MULTI-FEED ANTENNA ARRANGEMENT
FOR ELECTRONIC APPARATUS**

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

(72) Inventors: **Janne Iivonen**, Helsinki (FI); **Rasmus
Luomanieniemi**, Espoo (FI); **Anu
Lehtovuori**, Espoo (FI); **Ville Viikari**,
Espoo (FI); **Alexander Khripkov**,
Helsinki (FI); **Joonas Krogerus**,
Helsinki (FI); **Riku Kormilainen**,
Espoo (FI)

(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 190 days.

(21) Appl. No.: **18/362,577**

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

(65) **Prior Publication Data**
US 2023/0378654 A1 Nov. 23, 2023

Related U.S. Application Data

(63) Continuation of application No.
PCT/EP2021/052058, filed on Jan. 29, 2021.

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 1/24 (2006.01)
H01Q 1/50 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 9/045** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 1/50** (2013.01); **H01Q**
9/0442 (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 9/045; H01Q 9/0457
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,084,815 B2 8/2006 Phillips et al.
10,290,946 B2 5/2019 Romano et al.
(Continued)

FOREIGN PATENT DOCUMENTS

EP 3168930 A1 5/2017

OTHER PUBLICATIONS

Liu et al., "A Differentially Fed Dual-Polarized Slot Antenna With
High Isolation and Low Profile for Base Station Application," IEEE
Antennas and Wireless Propagation Letters, vol. 18, No. 2, Piscataway,
NJ, US, XP011707813, Total 5 pages, Institute of Electrical and
Electronics Engineers, New York, New York (Feb. 2019).

(Continued)

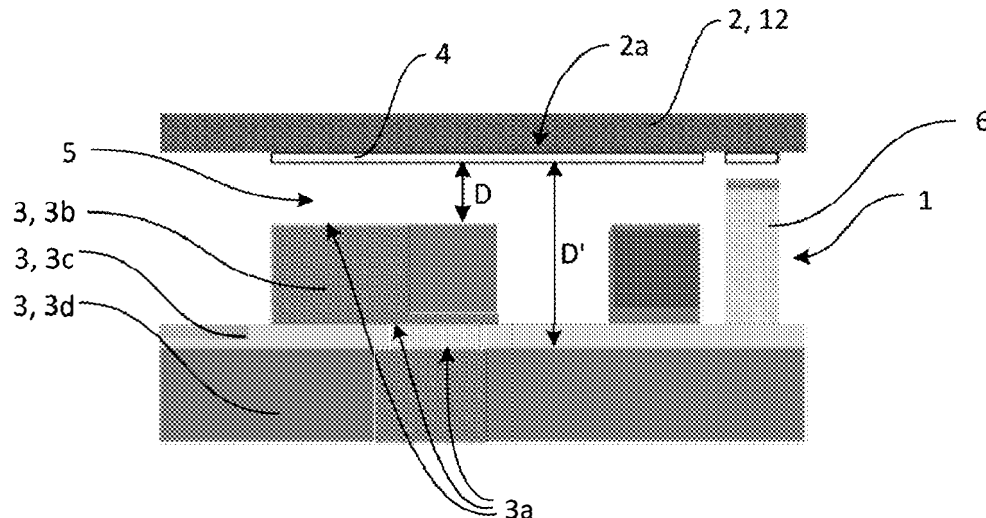
Primary Examiner — Daniel Munoz

(74) *Attorney, Agent, or Firm* — Leydig, Voit & Mayer,
Ltd.

(57) **ABSTRACT**

An antenna arrangement comprising a dielectric element, at
least one conductive element, an antenna radiator, and a
plurality of exciter elements. The antenna radiator arranged
at a first surface of the dielectric element and at a distance
from the conductive element such that a gap is formed
between the antenna radiator and a first surface of the
conductive element. The exciter elements extend at least
partially through a gap and are arranged on or adjacent to the
conductive element. The antenna radiator may comprise a
conductive material and be printed, sintered, painted, lami-
nated, or deposited onto the first surface of the dielectric
element, or molded into the dielectric element.

18 Claims, 4 Drawing Sheets





US012477051B2

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

(10) **Patent No.:** **US 12,477,051 B2**
(45) **Date of Patent:** **Nov. 18, 2025**

(54) **ELECTRONIC DEVICE INCLUDING
ANTENNA AND METHOD FOR
MANUFACTURING THE SAME**

(58) **Field of Classification Search**
CPC H04M 1/02; H04M 1/0249; H04M 1/026
(Continued)

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,929,679 B2 * 3/2018 Asanuma H02N 2/18
10,606,218 B1 3/2020 Ely et al.
(Continued)

FOREIGN PATENT DOCUMENTS

CN 111107205 A 5/2020
KR 10-2019-0011169 A 2/2019
(Continued)

(72) Inventors: **Hyungjin Kim**, Gyeonggi-do (KR);
Jiho Kim, Gyeonggi-do (KR);
Seongyong An, Gyeonggi-do (KR);
Kyihyun Jang, Gyeonggi-do (KR);
Yoonjung Kim, Gyeonggi-do (KR);
Kyungmoon Seol, Gyeonggi-do (KR);
Bumjin Cho, Gyeonggi-do (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 556 days.

OTHER PUBLICATIONS

Extended European Search Report dated Sep. 25, 2024.
International Search Report dated Nov. 16, 2022.
Korean Office Action dated Sep. 9, 2025.

(21) Appl. No.: **17/883,810**

(22) Filed: **Aug. 9, 2022**

Primary Examiner — Joseph Arevalo

(74) *Attorney, Agent, or Firm* — Cha & Reiter, LLC.

(65) **Prior Publication Data**

US 2023/0038634 A1 Feb. 9, 2023

Related U.S. Application Data

(63) Continuation of application No.
PCT/KR2022/011729, filed on Aug. 8, 2022.

(30) **Foreign Application Priority Data**

Aug. 9, 2021 (KR) 10-2021-0104348

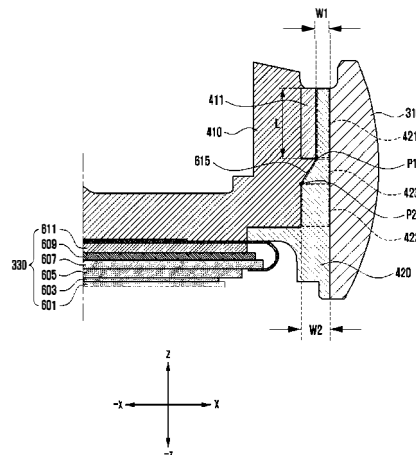
(51) **Int. Cl.**
H04M 1/26 (2006.01)
H01Q 1/24 (2006.01)
H04M 1/02 (2006.01)

(52) **U.S. Cl.**
CPC **H04M 1/026** (2013.01); **H01Q 1/243**
(2013.01)

(57) **ABSTRACT**

An electronic device may include a housing including a front plate, a rear plate, and a side member surrounding a space formed by the front plate and the rear plate, a support member disposed in the space, at least one electronic component disposed in the space, a first non-conductive member disposed on at least a portion of the support member and on the side member, a conductive pattern at least partially disposed between the side member and the first non-conductive member, and a second non-conductive member disposed between the side member and a portion of the conductive pattern and a portion of the first non-conductive member, at least a portion of the conductive pattern may be spaced apart from the at least one electronic component by a predetermined distance, and a first inclined surface may be formed on a portion of the first non-conductive member.

21 Claims, 16 Drawing Sheets





US012482917B2

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

(10) **Patent No.:** **US 12,482,917 B2**
(45) **Date of Patent:** **Nov. 25, 2025**

(54) **ELECTRONIC DEVICE COMPRISING ANTENNA**

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

(72) Inventors: **Dongryul Shin**, Suwon-si (KR);
Seokwoo Lee, Suwon-si (KR); **Jiwoo Lee**, Suwon-si (KR); **Kyungbin Kim**,
Suwon-si (KR)

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

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 82 days.

(21) Appl. No.: **18/606,409**

(22) Filed: **Mar. 15, 2024**

(65) **Prior Publication Data**

US 2024/0250406 A1 Jul. 25, 2024

Related U.S. Application Data

(63) Continuation of application No.
PCT/KR2022/009374, filed on Jun. 30, 2022.

(30) **Foreign Application Priority Data**

Sep. 16, 2021 (KR) 10-2021-0123989

(51) **Int. Cl.**

H01Q 1/22 (2006.01)

G06F 3/044 (2006.01)

G06F 3/0354 (2013.01)

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

CPC **H01Q 1/22** (2013.01); **G06F 3/044**
(2013.01); **G06F 3/03547** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/22; H01Q 1/2266; H01Q 21/08;
H01Q 1/2283; G06F 3/044; G06F
3/03547; G06F 1/1698; G06F 1/16

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,647,519 B1 2/2014 Lin
8,982,001 B2 3/2015 Taniguchi et al.
(Continued)

FOREIGN PATENT DOCUMENTS

EP 3114728 B1 6/2021
JP 2011-002950 A 1/2011
(Continued)

OTHER PUBLICATIONS

International Search Report dated Oct. 14, 2022, issued in Interna-
tional Patent Application No. PCT/KR2022/009374.

(Continued)

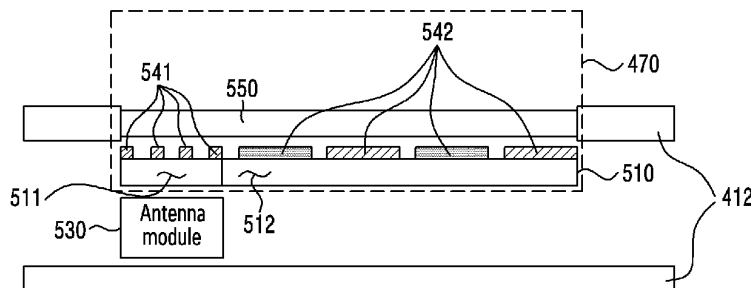
Primary Examiner — David E Lotter

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

(57) **ABSTRACT**

An electronic device is provided. The electronic device includes a housing which forms at least a part of an exterior of the electronic device, an antenna module which is disposed in the housing and includes a first surface facing one surface of the housing and a second surface facing the opposite direction of the first surface, the antenna module including an antenna array disposed on the first surface, a wireless communication circuit electrically connected with the antenna module, an insulation layer which is disposed between the first surface of the antenna module and one surface of the housing, and first pads which are disposed in a first area of the insulation layer that corresponds to the first surface of the antenna module, wherein each of the first pads has a first shape in which at least a part of an area overlapping the antenna array is removed, and wherein the wireless communication circuit feeds power to the antenna array, thereby transmitting and/or receiving a signal of a designated frequency band.

20 Claims, 17 Drawing Sheets



520 { 541
542
510 { 511
512



US012482919B2

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

(10) **Patent No.:** **US 12,482,919 B2**
(45) **Date of Patent:** **Nov. 25, 2025**

(54) **DISPLAY PANEL**

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

(72) Inventors: **Yafei Zhang**, Beijing (CN); **Dongdong Zhang**, Beijing (CN); **Xudong Zhang**, Beijing (CN); **Mengwen Jia**, Beijing (CN); **Mengxia Yu**, Beijing (CN)

(73) Assignee: **Beijing BOE Technology Development Co., Ltd.**, Beijing (CN)

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

(21) Appl. No.: **18/283,505**

(22) PCT Filed: **Feb. 17, 2023**

(86) PCT No.: **PCT/CN2023/076797**

§ 371 (c)(1),

(2) Date: **Sep. 22, 2023**

(87) PCT Pub. No.: **WO2024/168815**

PCT Pub. Date: **Aug. 22, 2024**

(65) **Prior Publication Data**

US 2025/0038396 A1 Jan. 30, 2025

(51) **Int. Cl.**

H01Q 1/22 (2006.01)

H01Q 1/24 (2006.01)

(Continued)

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

CPC **H01Q 1/2283** (2013.01); **H01Q 1/50** (2013.01); **H10K 59/40** (2023.02)

(58) **Field of Classification Search**

CPC H01Q 1/22; H01Q 1/2283; H01Q 1/243; H01Q 1/36; H01Q 1/38; H01Q 1/50; H01Q 21/065; H01Q 21/08

See application file for complete search history.

(56)

References Cited

U.S. PATENT DOCUMENTS

9,905,937 B1 * 2/2018 Chiang H01Q 21/065
2022/0263220 A1 8/2022 Huang et al.
2022/0263238 A1 8/2022 Huang et al.

FOREIGN PATENT DOCUMENTS

CN 111864341 A 10/2020
CN 112306299 A 2/2021

(Continued)

Primary Examiner — Hoang V Nguyen

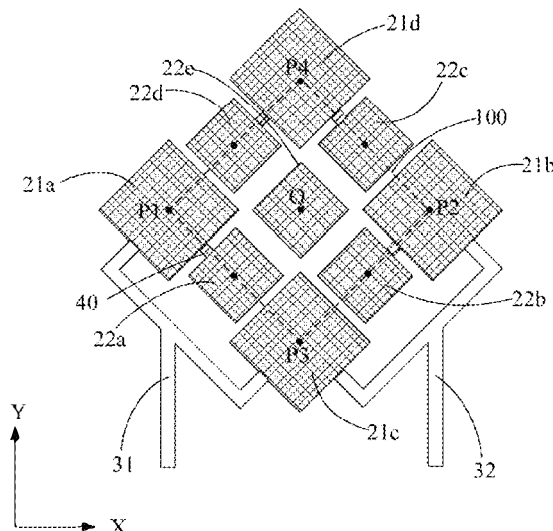
(74) *Attorney, Agent, or Firm* — HOUTTEMAN LAW LLC

(57)

ABSTRACT

The present disclosure provides a display panel, and belongs to the field of display technology. The display panel includes a display module and an antenna module located on a side of a display surface of the display module; the antenna module includes an antenna unit; the antenna unit includes a dielectric substrate, a radiation structure arranged on the dielectric substrate, a first feed line and a second feed line, the first feed line and the second feed line feed the radiation structure and are electrically connected with the radiation structure, and feeding directions of the first feed line and the second feed line are different; the radiation structure includes radiation patches for at least two radiation frequency bands, and the radiation patches are electrically connected.

17 Claims, 18 Drawing Sheets





US012482921B2

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

(10) **Patent No.:** **US 12,482,921 B2**
(45) **Date of Patent:** **Nov. 25, 2025**

(54) **ANTENNA AND TERMINAL**

H01Q 5/50 (2015.01)
H01Q 9/42 (2006.01)

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

(52) **U.S. Cl.**
CPC *H01Q 1/243* (2013.01); *H01Q 5/328*
(2015.01); *H01Q 5/50* (2015.01); *H01Q 9/42*
(2013.01)

(72) Inventors: **Pengfei Wu**, Shanghai (CN); **Lijun Ying**, Shanghai (CN); **Hanyang Wang**, Reading (GB); **Dong Yu**, Shanghai (CN); **Meng Hou**, Shanghai (CN); **Chien-Ming Lee**, Shenzhen (CN)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 5/328; H01Q 5/50; H01Q 9/42
See application file for complete search history.

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 415 days.

10,193,597 B1 * 1/2019 Garrido Lopez H04B 1/38
10,396,438 B1 8/2019 Smith et al.
2005/0280579 A1 12/2005 Liang et al.
(Continued)

(21) Appl. No.: **17/915,763**

FOREIGN PATENT DOCUMENTS

(22) PCT Filed: **Mar. 31, 2021**

CN 103441330 A 12/2013
CN 104115331 A 10/2014
(Continued)

(86) PCT No.: **PCT/CN2021/084786**

§ 371 (c)(1),

(2) Date: **Sep. 29, 2022**

Primary Examiner — Graham P Smith

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

(87) PCT Pub. No.: **WO2021/197399**

PCT Pub. Date: **Oct. 7, 2021**

(57) **ABSTRACT**

An antenna includes a first radiator, a second radiator, and a feed. The first radiator has a first feed point and a first ground point. The second radiator has a second feed point and a second ground point. The antenna further includes a connection line. The connection line has a first end and a second end that are opposite to each other. The first end is coupled to the first feed point of the first radiator, and the second end is coupled to the second feed point of the second radiator. A feeding point is disposed on the connection line, and the feeding point is coupled to the feed.

(65) **Prior Publication Data**

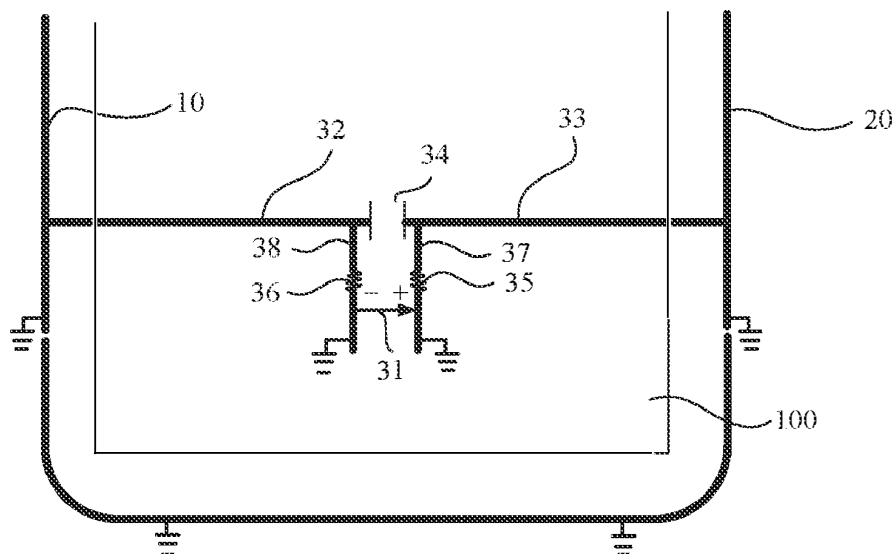
US 2023/0223677 A1 Jul. 13, 2023

(30) **Foreign Application Priority Data**

Mar. 31, 2020 (CN) 202010247465.2

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/328 (2015.01)

20 Claims, 23 Drawing Sheets





US012482923B2

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

(10) **Patent No.:** **US 12,482,923 B2**
(45) **Date of Patent:** **Nov. 25, 2025**

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

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

(72) Inventors: **Chien-Yi Wu**, Taipei (TW); **Chao-Hsu Wu**, Taipei (TW); **Shih-Keng Huang**, Taipei (TW); **Hau Yuen Tan**, Taipei (TW); **Chih-Wei Liao**, Taipei (TW); **Chia-Hung Chen**, Taipei (TW); **Wen-Hgin Chuang**, Taipei (TW); **Chia-Hong Chen**, Taipei (TW); **Lin-Hsu Chiang**, Taipei (TW); **Hsi Yung Chen**, Taipei (TW)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 139 days.

(21) Appl. No.: **18/488,855**

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

(65) **Prior Publication Data**

US 2024/0195083 A1 Jun. 13, 2024

(30) **Foreign Application Priority Data**

Dec. 9, 2022 (TW) 111147315

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/371 (2015.01)

(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 5/371** (2015.01); **H01Q 9/0421** (2013.01);
(Continued)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 1/2266; H01Q 5/30-371; H01Q 13/10; H01Q 21/30
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,405,704 B1 * 7/2008 Lin H01Q 9/42 343/702
7,586,449 B1 * 9/2009 Chen H01Q 1/2266 343/702

(Continued)

FOREIGN PATENT DOCUMENTS

CN 111697351 A * 9/2020 H01Q 1/2258
CN 112928468 6/2021

(Continued)

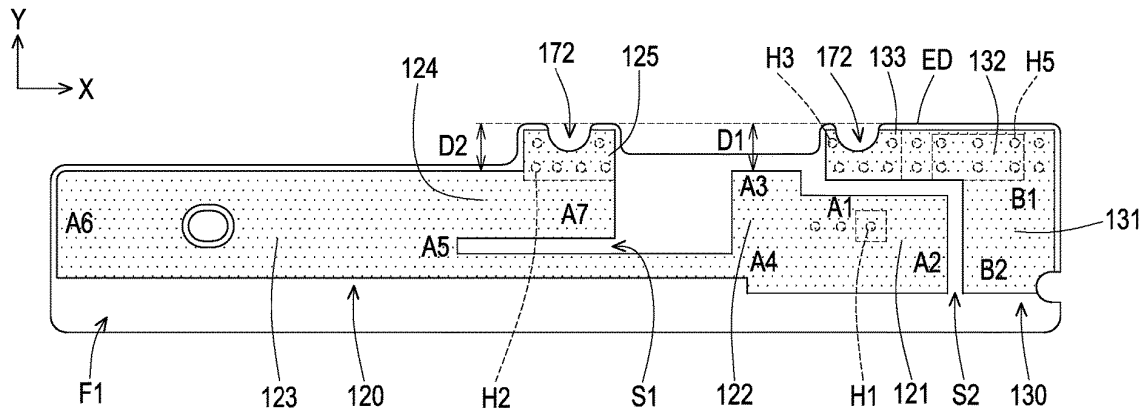
Primary Examiner — Ab Salam Alkassim, Jr.

(74) *Attorney, Agent, or Firm* — J.C. PATENTS

(57) **ABSTRACT**

An antenna module including a first radiator and a second radiator is provided. The first radiator includes a first segment to a fifth segment connected in sequence. A first slot is formed between the second segment and the fourth segment. The second radiator has an edge. A first distance is between the second segment and an extension line. A second distance is between the fourth segment and the extension line. The first segment resonates at a first high frequency band. The first radiator and the first slot resonate at a low frequency band and a second high frequency band. The first distance, the second distance, the second segment, the fourth segment, the fifth segment and the first slot resonate at a third high frequency band. The first segment and the second radiator resonate at a fourth high frequency band. In addition, an electronic device is provided.

10 Claims, 16 Drawing Sheets





US012482930B2

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

(10) **Patent No.:** **US 12,482,930 B2**
(45) **Date of Patent:** **Nov. 25, 2025**

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

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

(72) Inventors: **Chanhee Oh**, Suwon-si (KR); **Sungsoo Kim**, Suwon-si (KR); **Yongyoun Kim**, Suwon-si (KR); **Seyoon Bae**, Suwon-si (KR); **Seungbum Choi**, Suwon-si (KR); **Hyunju Hong**, 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 142 days.

(21) Appl. No.: **18/311,537**

(22) Filed: **May 3, 2023**

(65) **Prior Publication Data**
US 2023/0318173 A1 Oct. 5, 2023

Related U.S. Application Data
(63) Continuation of application No. PCT/KR2021/019422, filed on Dec. 20, 2021.

(30) **Foreign Application Priority Data**
Dec. 21, 2020 (KR) 10-2020-0179908

(51) **Int. Cl.**
H01Q 1/52 (2006.01)
H01Q 7/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/526** (2013.01); **H01Q 7/00** (2013.01); **H04B 5/70** (2024.01); **H05K 1/118** (2013.01); **H05K 1/147** (2013.01)

(58) **Field of Classification Search**
CPC . H01Q 1/526; H01Q 7/00; H04B 5/26; H04B 5/70; H05K 1/118; H05K 1/147
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,246,352 B2 1/2016 Park et al.
9,941,576 B2 4/2018 Ito et al.
(Continued)

FOREIGN PATENT DOCUMENTS

CN 107912075 A 4/2018
EP 3531814 8/2019
(Continued)

OTHER PUBLICATIONS

International Search Report for PCT/KR2021/019422 mailed Apr. 12, 2022, 6 pages.

(Continued)

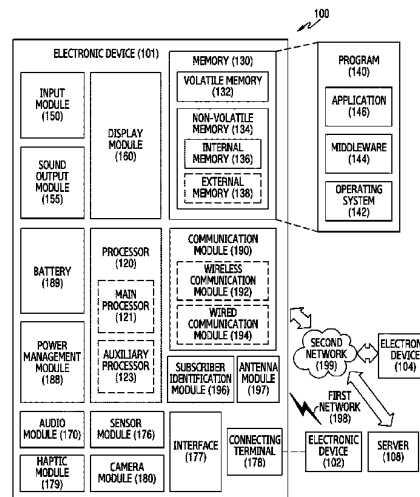
Primary Examiner — Thien M Le

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

(57) **ABSTRACT**

An electronic device, according to various embodiments of the present disclosure, may comprise: a housing, a first circuit board disposed in the housing; flexible circuit boards electrically connected to the first circuit board, coil antennas disposed inside the housing and including a plurality of antennas having conductive patterns provided and configured to generate magnetic fields, a shielding layer disposed below a first antenna from among the plurality of antennas and metal shields disposed about side surfaces of the coil antennas and configured to shield a magnetic field in a first direction from among magnetic fields formed by the coil antennas.

20 Claims, 23 Drawing Sheets





US012482937B2

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

(10) **Patent No.:** **US 12,482,937 B2**
(45) **Date of Patent:** **Nov. 25, 2025**

(54) **ELECTRONIC DEVICE HAVING ANTENNA**

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

(72) Inventors: **Seungmin Woo**, Seoul (KR); **Yusuhk Suh**, Seoul (KR); **Dongik Lee**, Seoul
(KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 180 days.

(21) Appl. No.: **18/564,912**

(22) PCT Filed: **May 31, 2021**

(86) PCT No.: **PCT/KR2021/006756**

§ 371 (c)(1),

(2) Date: **Nov. 28, 2023**

(87) PCT Pub. No.: **WO2022/255503**

PCT Pub. Date: **Dec. 8, 2022**

(65) **Prior Publication Data**

US 2024/0291149 A1 Aug. 29, 2024

(51) **Int. Cl.**

H01Q 5/335 (2015.01)

H01Q 9/40 (2006.01)

H01Q 21/06 (2006.01)

H05K 3/46 (2006.01)

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

CPC **H01Q 5/335** (2015.01); **H01Q 9/40**
(2013.01); **H01Q 21/06** (2013.01); **H05K**
3/4623 (2013.01)

(58) **Field of Classification Search**

CPC H01Q 5/335; H01Q 9/40; H01Q 21/06;
H05K 3/4623

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2020/0328518 A1 * 10/2020 Park H01Q 21/065

2020/0328530 A1 * 10/2020 Park H01Q 1/2283

2020/0388924 A1 * 12/2020 Lee H01Q 9/045

2021/0151899 A1 * 5/2021 Park H01Q 5/385

(Continued)

FOREIGN PATENT DOCUMENTS

KR 10-2012-0134254 12/2012

KR 10-2015-0032972 4/2015

(Continued)

OTHER PUBLICATIONS

PCT International Application No. PCT/KR2021/006756, International Search Report dated Feb. 25, 2022, 5 pages.

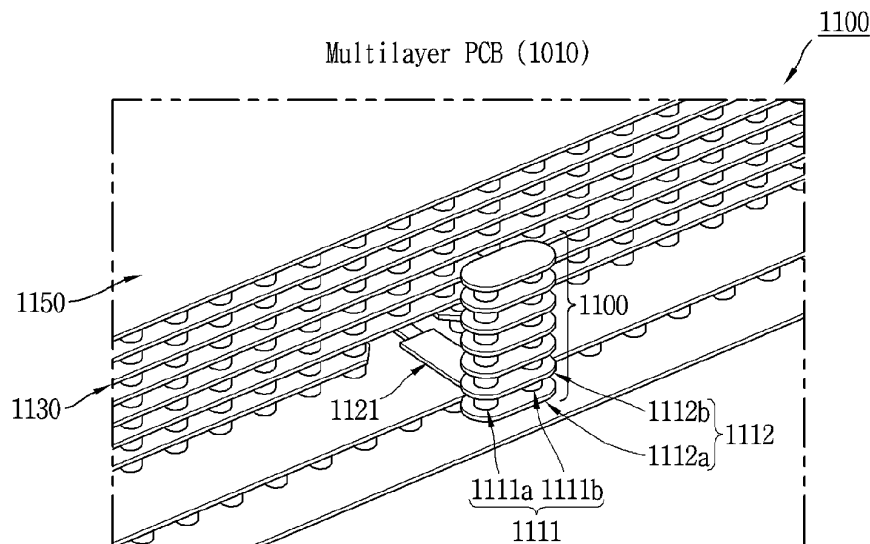
Primary Examiner — Hai V Tran

(74) Attorney, Agent, or Firm — LEE, HONG,
DEGERMAN, KANG & WAIMEY

(57) **ABSTRACT**

Provided is an electronic device having an antenna. The electronic device comprises: a radiator configured by stacking metal patterns on different layers of a multi-layer structure; and an antenna module including a feeding unit disposed on a specific layer of the radiator and having a feeding line configured to be connected to the radiator, wherein the radiator includes a first pad connected to the feeding line and a second pad disposed on the first pad, and the first pad and the second pad are connected to each other by a first connection line and a second connection line.

4 Claims, 26 Drawing Sheets





US012482938B2

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

(10) **Patent No.:** **US 12,482,938 B2**
(45) **Date of Patent:** **Nov. 25, 2025**

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

(71) Applicant: **Beijing Xiaomi Mobile Software Co., Ltd.**, Beijing (CN)

(72) Inventors: **Wei Wang**, Beijing (CN); **Ching-Sung Wang**, Beijing (CN); **Yueliang Li**, Beijing (CN)

(73) Assignee: **Beijing Xiaomi Mobile Software Co., Ltd.**, Beijing (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 167 days.

(21) Appl. No.: **18/456,324**

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

(65) **Prior Publication Data**
US 2024/0283153 A1 Aug. 22, 2024

(30) **Foreign Application Priority Data**
Feb. 22, 2023 (CN) 202310188948.3

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/335 (2015.01)
H01Q 5/357 (2015.01)
H01Q 5/50 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 5/357** (2015.01); **H01Q 1/241** (2013.01); **H01Q 5/50** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/24; H01Q 1/241; H01Q 1/243; H01Q 5/30; H01Q 5/328; H01Q 5/335; H01Q 5/357; H01Q 5/371; H01Q 5/50; H01Q 9/40; H01Q 9/42
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2013/0135150 A1 * 5/2013 Kenoun H01Q 9/0421 343/700 MS
2018/0212313 A1 * 7/2018 Harper H01Q 1/50
2021/0273340 A1 * 9/2021 Sun H01Q 5/10
2022/0407218 A1 * 12/2022 Guo H01Q 5/328

FOREIGN PATENT DOCUMENTS

CN 212033 246 U 11/2020

OTHER PUBLICATIONS

Extended European Search Report mailed Mar. 18, 2024 in corresponding European Patent Application No. 23203996.6, 9 pages.

* cited by examiner

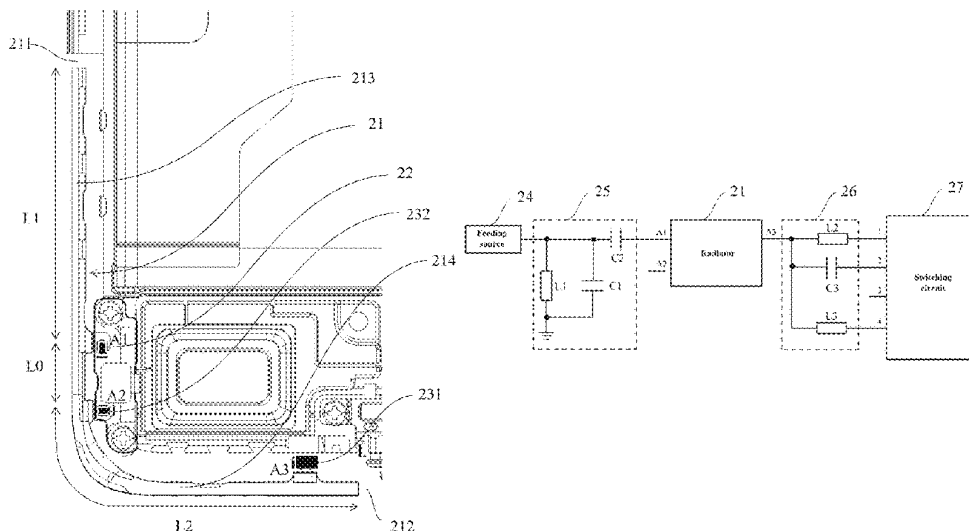
Primary Examiner — Thai Pham

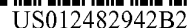
(74) *Attorney, Agent, or Firm* — Oblon, McClelland, Maier & Neustadt, L.L.P.

(57) **ABSTRACT**

An antenna structure and a terminal device are provided. The antenna structure is applied to a terminal device with a curved screen. The antenna structure includes a radiator and a feeding point. The radiator has a first break and a second break located on different sides, the first break is on one curved side edge, and the second break is on one non-curved side edge. The feeding point is electrically connected to the radiator and located between the first break and the second break. A length of a radiation arm between the feeding point and the first break is less than a length of a radiation arm between the feeding point and the second break. The antenna structure has a low-frequency radiation mode that utilizes the radiation arm between the feeding point and the second break for radiation.

19 Claims, 6 Drawing Sheets





(10) **Patent No.:** US 12,482,942 B2
(45) **Date of Patent:** Nov. 25, 2025

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,589,678	B2	9/2009	Perunka et al.	
8,384,604	B2 *	2/2013	Niederkorn	H01Q 1/243 343/702

(Continued)

FOREIGN PATENT DOCUMENTS

CN	109378581	A	2/2019
CN	210489828	U	5/2020

(Continued)

OTHER PUBLICATIONS

Extended European Search Report dated Sep. 19, 2024 issued in
European Patent Application No. 22873097.4.

(Continued)

(21) Appl. No.: 18/299,916

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

Primary Examiner — Dieu Hien T Duong

(65) **Prior Publication Data**

(74) *Attorney, Agent, or Firm* — NIXON & VANDERHYE P.C.

US 2023/0246339 A1 Aug. 3, 2023

(57) **ABSTRACT**

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2022/011512, filed on Aug. 4, 2022.

(30) **Foreign Application Priority Data**

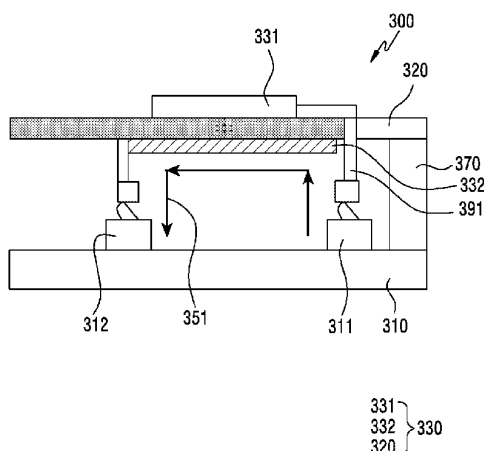
Sep. 27, 2021 (KR) 10-2021-0127326

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 1/42 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 9/0414** (2013.01); **H01Q 1/422**
(2013.01)

(58) **Field of Classification Search**
CPC H01Q 9/0414; H01Q 1/422; H01Q 1/48;
H01Q 1/243

See application file for complete search history.





US012482947B2

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

(10) **Patent No.:** **US 12,482,947 B2**
(45) **Date of Patent:** **Nov. 25, 2025**

(54) **ANTENNA MODULE MOUNTABLE ON A PRINTED CIRCUIT BOARD, AND A SET OF TWO ANTENNA MODULES COMPRISING THE ANTENNA MODULE AND AN AUXILIARY ANTENNA MODULE**

(58) **Field of Classification Search**
CPC H01Q 1/22; H01Q 5/371; H01Q 5/392;
H01Q 9/045; H01Q 9/42
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2005/0270243 A1 * 12/2005 Caimi H01Q 5/321
343/702

2011/0273338 A1 11/2011 Wolf
2012/0182186 A1 7/2012 Yang et al.
2013/0214985 A1 8/2013 Wolf et al.

(Continued)

FOREIGN PATENT DOCUMENTS

EP 1973197 A1 * 9/2008 H01Q 5/385

OTHER PUBLICATIONS

Search Report dated Jan. 21, 2023 issued in corresponding Dutch Application No. 2033403.

Primary Examiner — Raymond R Chai

(74) *Attorney, Agent, or Firm* — Nath, Goldberg & Meyer; Joshua B. Goldberg

(57) **ABSTRACT**

An antenna module is provided which is mountable on a surface of a printed circuit board which contains an electrically conductive layer that constitutes a ground plane for the antenna module. The antenna module is embodied as a planar body having a top surface and a bottom surface, wherein the bottom surface is configured to be mounted on the printed circuit board and the top surface is facing away from the bottom surface. The planar body is a layered structure comprising a central planar layer, a first circuitry, a second circuitry, and a plurality of vias. The antenna module is an electrically active component and the first circuitry includes a feeding strip of electrically conductive material that is connected to at least some of the vias.

27 Claims, 5 Drawing Sheets

(71) Applicant: **THE ANTENNA COMPANY INTERNATIONAL N.V.**, Willemstad (CW)

(72) Inventors: **Sung Bin Mun**, Eindhoven (NL); **Diego Caratelli**, Eersel (NL); **Javier Armando Arrincon Rodriguez**, Eindhoven (NL)

(73) Assignee: **THE ANTENNA COMPANY INTERNATIONAL N.V.**, Willemstad (CW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 196 days.

(21) Appl. No.: **18/495,319**

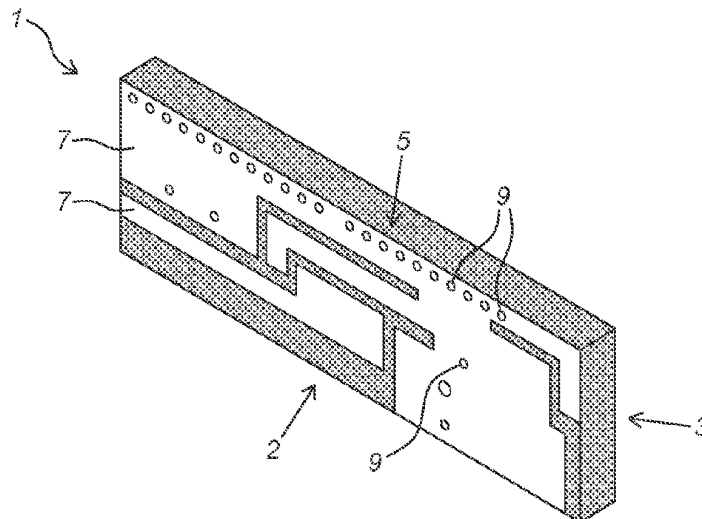
(22) Filed: **Oct. 26, 2023**

(65) **Prior Publication Data**
US 2024/0145925 A1 May 2, 2024

(30) **Foreign Application Priority Data**
Oct. 27, 2022 (NL) 2033403

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

(52) **U.S. Cl.**
CPC **H01Q 9/045** (2013.01); **H01Q 1/22** (2013.01)





US012482950B2

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

(10) **Patent No.:** **US 12,482,950 B2**
(45) **Date of Patent:** **Nov. 25, 2025**

(54) **DEVICE AND A METHOD FOR AN ANTENNA WITH A CAVITY EXTENSION**

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

(72) Inventors: **Ruiyuan Tian**, Helsinki (FI); **Joonas Krogerus**, Helsinki (FI); **Dong Liu**, Dongguan (CN); **Zlatoljub Milosavljevic**, Helsinki (FI)

(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 160 days.

(21) Appl. No.: **18/296,263**

(22) Filed: **Apr. 5, 2023**

(65) **Prior Publication Data**

US 2023/0246343 A1 Aug. 3, 2023

Related U.S. Application Data

(63) Continuation of application No. PCT/EP2020/078082, filed on Oct. 7, 2020.

(51) **Int. Cl.**
H01Q 13/18 (2006.01)
H01Q 15/14 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 13/18** (2013.01); **H01Q 15/14** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 15/14; H01Q 1/2266; H01Q 1/243; H01Q 5/40; H01Q 13/18; G06F 1/1616; G06F 1/1641; G06F 1/1677
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

12,119,549 B2 *	10/2024	Barrera		H04R 1/02
2004/0085248 A1 *	5/2004	Onaka		H01Q 9/42
				343/702
2006/0061512 A1 *	3/2006	Asano		H01Q 9/42
				343/702
2007/0200771 A1 *	8/2007	Schack		H01Q 1/243
				343/702
2010/0013720 A1	1/2010	Sakata et al.		
2010/0231481 A1 *	9/2010	Chiang		H01Q 9/42
				343/702
2012/0105294 A1 *	5/2012	Chiang		H01Q 1/2266
				343/789
2013/0050032 A1 *	2/2013	Shiu		H01Q 1/2258
				343/702
2018/0294576 A1	10/2018	Niakan et al.		
2020/0195336 A1	6/2020	Raghavan et al.		
2023/0246343 A1 *	8/2023	Tian		H01Q 1/2266
				343/702
2024/0030607 A1 *	1/2024	Zhou		G06F 1/1698

FOREIGN PATENT DOCUMENTS

CN 209029529 U 6/2019

* cited by examiner

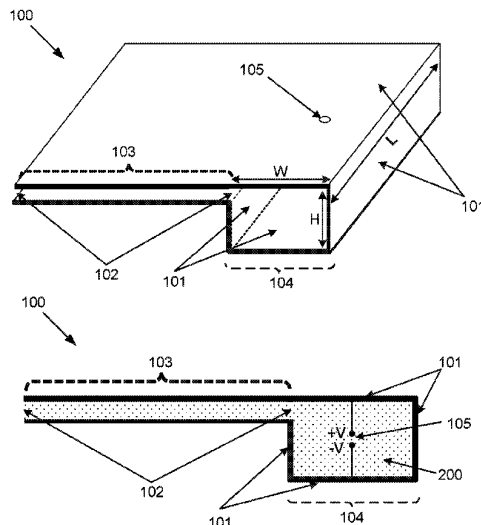
Primary Examiner — Jason M Crawford

(74) *Attorney, Agent, or Firm* — Leydig, Voit & Mayer, Ltd.

(57) **ABSTRACT**

A foldable mobile device is provided. The device includes an antenna cavity substantially enclosed by at least four conductor walls, and a gap between two substantially perpendicular conductor walls at a first side of the antenna cavity. The device further includes a cavity extension extending at a direction substantially perpendicular to the first side of the cavity and aligned with the gap. Devices, methods, and a non-transitory computer-readable medium are disclosed.

15 Claims, 5 Drawing Sheets





US012489196B2

(12) **United States Patent**
Li

(10) **Patent No.:** **US 12,489,196 B2**
(45) **Date of Patent:** **Dec. 2, 2025**

(54) **ANTENNA STRUCTURE AND MOBILE
DEVICE HAVING THE SAME**

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

(72) Inventor: **Jian-De Li**, 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 95 days.

(21) Appl. No.: **18/399,986**

(22) Filed: **Dec. 29, 2023**

(65) **Prior Publication Data**
US 2024/0235006 A1 Jul. 11, 2024

(30) **Foreign Application Priority Data**
Jan. 5, 2023 (TW) 112100291

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

(52) **U.S. Cl.**
CPC **H01Q 1/2266** (2013.01); **H01Q 9/0421**
(2013.01)

(58) **Field of Classification Search**
CPC H01F 1/14708; H01F 1/15308; H01F
17/0013; H01F 17/04; H01F 2017/048;
H01F 27/255; H01F 27/292
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2010/0295737 A1 * 11/2010 Milosavljevic H01Q 5/371
343/702
2011/0037680 A1 * 2/2011 Chiu H01Q 9/0421
343/893
2016/0365640 A1 * 12/2016 Minard H01Q 1/38
2021/0242567 A1 * 8/2021 Wang H01Q 1/245
2022/0311126 A1 * 9/2022 Hou H01Q 1/243
2023/0198150 A1 * 6/2023 Feng H01Q 9/42
343/702
2023/0402737 A1 * 12/2023 Lai H01Q 5/385

(Continued)

FOREIGN PATENT DOCUMENTS

TW 201703350 A 1/2017
TW 202023113 A 6/2020

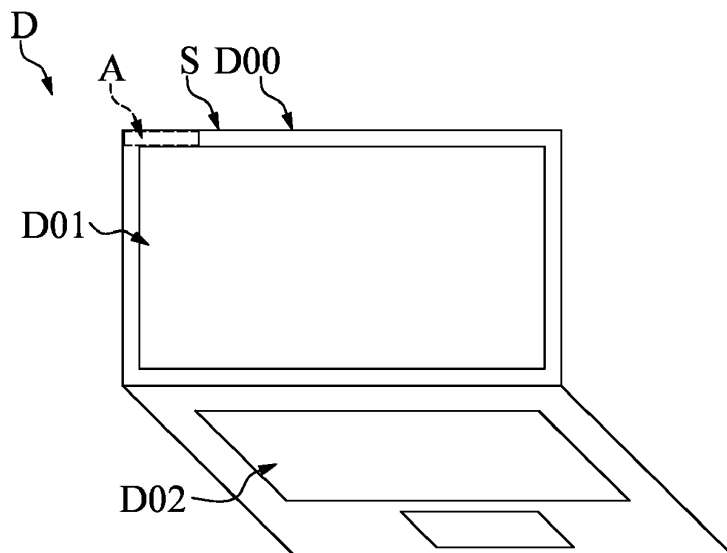
Primary Examiner — Thien M Le

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

(57) **ABSTRACT**

An antenna structure is arranged on a metal back cover. The metal back cover has an L-shaped slot, which has first and second partitions respectively arranged along a first direction and a second direction that are perpendicular to one another. The antenna structure includes an L-shaped radiating element that partially overlaps with the second partition and includes a first radiating portion, a second radiating portion, and a grounded radiating portion. The first radiating portion and the second radiating portion extend along the second direction. One end of the second radiating portion is connected to the first radiating portion. A first feeding point is disposed between the first radiating portion and the second radiating portion. The grounded radiating portion is extended along the first direction and connected to another end of the second radiating portion. The grounded radiating portion has a first grounded side grounded through a capacitive element.

20 Claims, 8 Drawing Sheets





US012489203B2

(12) **United States Patent**
Yamakawa

(10) **Patent No.:** **US 12,489,203 B2**
(45) **Date of Patent:** **Dec. 2, 2025**

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

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

(72) Inventor: **Yuri Yamakawa**, Kyoto (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 198 days.

(21) Appl. No.: **18/337,432**

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

(65) **Prior Publication Data**
US 2023/0352824 A1 Nov. 2, 2023

Related U.S. Application Data
(63) Continuation of application No.
PCT/JP2021/044261, filed on Dec. 2, 2021.

(30) **Foreign Application Priority Data**
Dec. 23, 2020 (JP) 2020-213397

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

(52) **U.S. Cl.**
CPC **H01Q 1/38** (2013.01); **H01Q 1/2283**
(2013.01); **H01Q 1/48** (2013.01); **H01Q 1/50**
(2013.01); **H01Q 5/378** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/38; H01Q 1/2283; H01Q 1/48;
H01Q 1/50; H01Q 5/378; H01Q 1/40;
H01Q 9/0414; H01Q 21/08; H01Q 21/24
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

11,527,816 B2 * 12/2022 Sudo H01Q 9/0414
2020/0119453 A1 * 4/2020 Takayama H01Q 1/243

FOREIGN PATENT DOCUMENTS

JP 2003-158410 A 5/2003
JP 6798656 B1 12/2020
(Continued)

OTHER PUBLICATIONS

International Search Report and Written Opinion mailed on Feb. 15,
2022, received for PCT Application PCT/JP2021/044261, filed on
Dec. 2, 2021, 11 pages including English Translation.

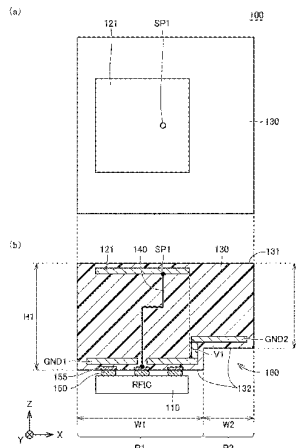
Primary Examiner — Seung H Lee

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

(57) **ABSTRACT**

An antenna module includes a dielectric substrate, a radiating element, and grounding electrodes. The dielectric substrate has a first surface facing a second surface, and includes a plate-shaped first portion and a plate-shaped second portion which has a thickness less than that of the first portion. The radiating element is disposed in the first portion. The grounding electrode is disposed in the first portion at a position, which is located apart from the radiating element in the direction from the radiating element to the second surface, so as to face the radiating element. The grounding electrode is disposed between the first surface and the second surface in the second portion, and is electrically connected to the grounding electrode. The second surface in an area of the second portion includes a recess disposed at an end of the first dielectric substrate.

19 Claims, 12 Drawing Sheets





US012489210B2

(12) **United States Patent**
Chang

(10) **Patent No.:** **US 12,489,210 B2**
(45) **Date of Patent:** **Dec. 2, 2025**

(54) **MULTI-FEED ANTENNA WITH A SHARED RADIATOR**

(71) Applicant: **NANJING SILERGY MICRO (HK) CO., LIMITED**, Causeway Bay (HK)

(72) Inventor: **Chia-Lin Chang**, Taipei (TW)

(73) Assignee: **Nanjing Silergy Micro (HK) Co., Ltd.**, Nanjing (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 168 days.

(21) Appl. No.: **17/876,619**

(22) Filed: **Jul. 29, 2022**

(65) **Prior Publication Data**
US 2023/0052735 A1 Feb. 16, 2023

(30) **Foreign Application Priority Data**
Aug. 10, 2021 (CN) 202110911864.9

(51) **Int. Cl.**
H01Q 5/378 (2015.01)
H01Q 9/04 (2006.01)
H01Q 9/30 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 5/378** (2015.01); **H01Q 9/045** (2013.01); **H01Q 9/30** (2013.01)

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

(56) **References Cited**
U.S. PATENT DOCUMENTS

12,317,475 B2 5/2025 Sakui et al.
2017/0244818 A1* 8/2017 Kim H01Q 1/243
2019/0041929 A1* 2/2019 Bologna G05B 15/02

2020/0021029 A1* 1/2020 Chou H01Q 9/0421
2020/0119429 A1* 4/2020 Park H01Q 5/335
2022/0223998 A1* 7/2022 Jang H01Q 5/328
2023/0318180 A1* 10/2023 Lan H01Q 1/243
343/702
2023/0344152 A1* 10/2023 Wu H01Q 5/35
2023/0352852 A1* 11/2023 Wu H01Q 1/241
2023/0361467 A1* 11/2023 Wu H01Q 5/40
2024/0072418 A1* 2/2024 Wu H04B 1/0064

FOREIGN PATENT DOCUMENTS

CN 104183914 A 12/2014
CN 112490626 A * 3/2021 H01Q 1/22
TW 201818612 A 8/2018
WO WO-2022247378 A1 * 12/2022

* cited by examiner

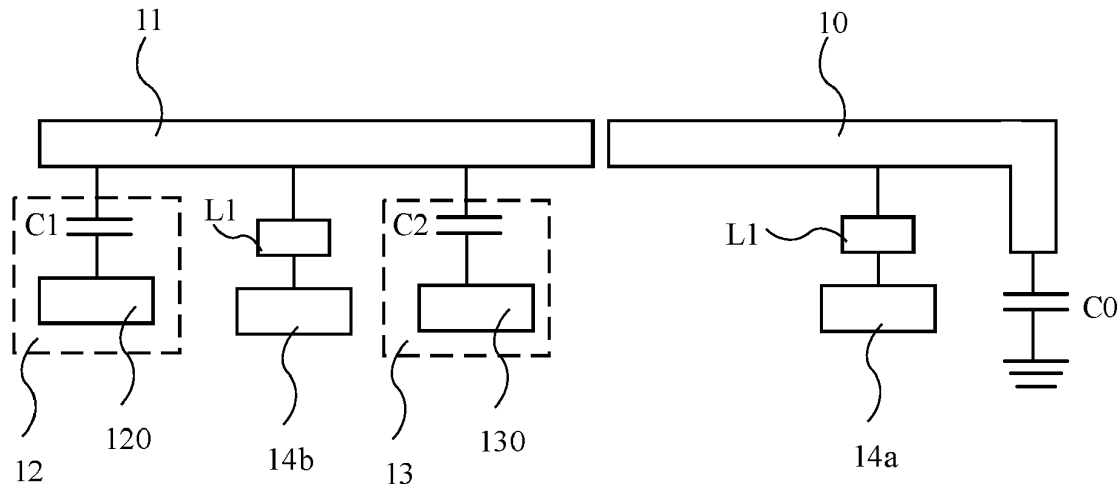
Primary Examiner — Dameon E Levi

Assistant Examiner — Anh N Ho

(57) **ABSTRACT**

A multi-feed antenna with a shared radiator comprises a ground capacitor, a first antenna module, a second antenna module, a first feed-in module, a second feed-in module and at least one sensing module. The first antenna module is grounded through the ground capacitor. The second antenna module is coupled with the first antenna module. The first feed-in module and the second feed-in module are connected with the second antenna module, and the first feed-in module and the second feed-in module are used to receive or send radio frequency signals through the first antenna module and the second antenna module. The at least one sensing module is connected with the first antenna module or the second antenna module, and the at least one sensing module is used to sense a capacitance value of a parasitic capacitance of the first antenna module or the second antenna module.

14 Claims, 7 Drawing Sheets





US012489220B2

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

(10) **Patent No.:** **US 12,489,220 B2**
(45) **Date of Patent:** ***Dec. 2, 2025**

(54) **TERMINAL ANTENNA**

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

(72) Inventors: **Kunpeng Wei**, Shenzhen (CN); **Qiao Guan**, Shenzhen (CN)

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

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

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **18/272,281**

(22) PCT Filed: **Dec. 8, 2022**

(86) PCT No.: **PCT/CN2022/137638**

§ 371 (c)(1),

(2) Date: **Jul. 13, 2023**

(87) PCT Pub. No.: **WO2023/173835**

PCT Pub. Date: **Sep. 21, 2023**

(65) **Prior Publication Data**

US 2024/0388008 A1 Nov. 21, 2024

(30) **Foreign Application Priority Data**

Mar. 18, 2022 (CN) 202210271441.X

(51) **Int. Cl.**

H01Q 21/06 (2006.01)

H01Q 1/38 (2006.01)

H01Q 15/24 (2006.01)

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

CPC **H01Q 21/062** (2013.01); **H01Q 1/38** (2013.01); **H01Q 15/24** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 21/062; H01Q 1/38; H01Q 15/24;
H01Q 7/00; H01Q 21/28; H01Q 1/2291;
H01Q 1/241; H01Q 1/50

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,365,698 B2 4/2008 Dwyer et al.

8,125,391 B2 2/2012 Knudsen

(Continued)

FOREIGN PATENT DOCUMENTS

CN 101257143 A 9/2008

CN 101794934 A 8/2010

(Continued)

OTHER PUBLICATIONS

Tian et al: "Design of dual-frequency and dual-polarization CTS array antenna based on parallel plate waveguide", Journal of Telemetry, Tracking and Command, vol. 44, No. 2, Mar. 2023, pp. 112-122.

(Continued)

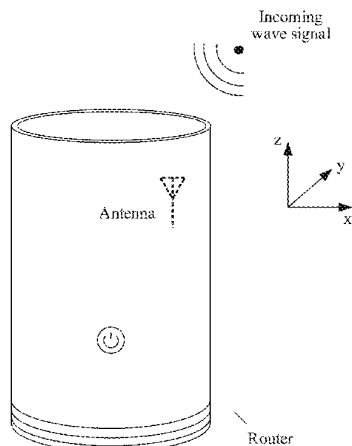
Primary Examiner — Seung H Lee

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

(57) **ABSTRACT**

Embodiments of this application disclose a terminal antenna, and relate to the field of antenna technologies. The terminal antenna includes a first radiator and a second radiator, the first radiator is in a ring structure, the second radiator is disposed inside the first radiator, the first radiator and the second radiator are not directly connected, and the first radiator and the second radiator are located on a same plane. The terminal antenna further includes at least two inductor components, one end of the inductor component is connected to the first radiator, and the other end of the inductor component is connected to the second radiator. A feed is further disposed on the terminal antenna, one end of

(Continued)





US012489222B2

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

(10) **Patent No.:** **US 12,489,222 B2**
(45) **Date of Patent:** **Dec. 2, 2025**

(54) **ANTENNA DEVICE**

(71) Applicants: **DENSO CORPORATION**, Kariya (JP); **TOYOTA JIDOSHA KABUSHIKI KAISHA**, Toyota (JP); **MIRISE Technologies Corporation**, Nisshin (JP)

(72) Inventors: **Jungaun Lee**, Nisshin (JP); **Toshifumi Shirosaki**, Nisshin (JP); **Takahiro Kato**, Nisshin (JP); **Hirokazu Oyabu**, Nisshin (JP); **Toshihiko Takahata**, Nisshin (JP)

(73) Assignees: **DENSO CORPORATION**, Kariya (JP); **TOYOTA JIDOSHA KABUSHIKI KAISHA**, Toyota (JP); **MIRISE Technologies Corporation**, Nisshin (JP)

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

(21) Appl. No.: **18/394,770**

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

(65) **Prior Publication Data**

US 2024/0291160 A1 Aug. 29, 2024

(30) **Foreign Application Priority Data**

Feb. 23, 2023 (JP) 2023-026805

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

(52) **U.S. Cl.**
CPC **H01Q 21/064** (2013.01); **H01Q 21/0006** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/2283; H01Q 1/3233; H01Q 1/36; H01Q 1/38; H01Q 13/0233; H01Q 21/0006; H01Q 21/0037; H01Q 21/0043; H01Q 21/005; H01Q 21/064; H01Q 21/0087; H01P 11/02

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,568,160 A * 10/1996 Collins H01Q 21/24 343/778
6,101,705 A * 8/2000 Wolfson H01P 11/002 29/600
10,224,617 B2 3/2019 Chen et al.
2018/0034140 A1 * 2/2018 Chen H01Q 9/0485

* cited by examiner

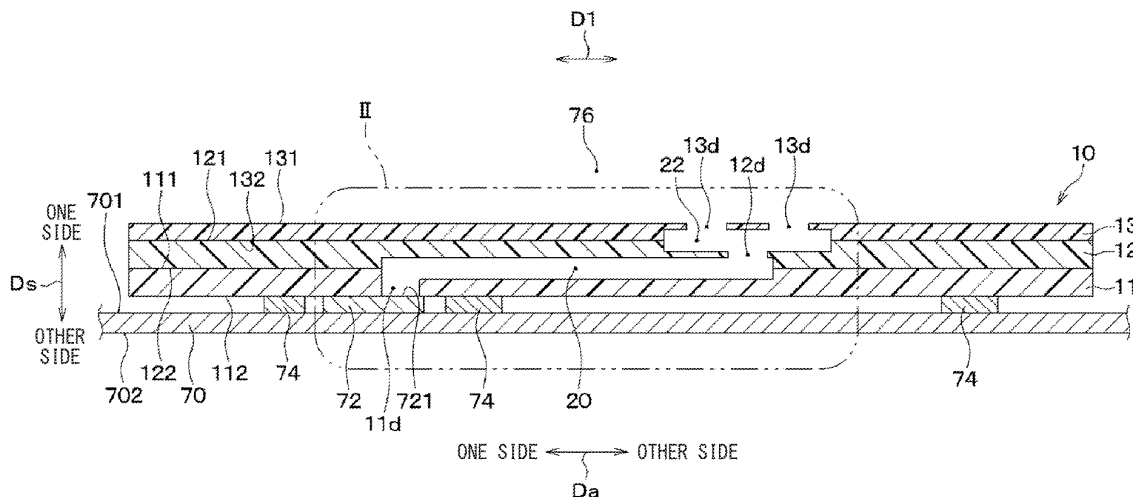
Primary Examiner — Robert Karacsony

(74) *Attorney, Agent, or Firm* — Posz Law Group, PLC

(57) **ABSTRACT**

Each of first, second, and third stacked parts includes a resin member a conductive film that covers the resin member. The first, second, and third stacked parts are stacked on one another. The first stacked part has an external port to propagate radio waves to an external device. The second stacked part has an intermediate passage to propagate the radio waves therethrough. The third stacked part has antenna radiating elements to propagate the radio waves to an external space. The first stacked part and the second stacked part are stacked to form a waveguide that is extended. The waveguide is connected to the external port of the first stacked part and to one end of the intermediate passage to propagate the radio waves therethrough. The antenna radiating elements are coupled to the one end of the intermediate passage.

6 Claims, 13 Drawing Sheets





US012494582B2

(12) **United States Patent**
Yang

(10) **Patent No.:** **US 12,494,582 B2**
(45) **Date of Patent:** **Dec. 9, 2025**

(54) **ANTENNA STRUCTURE AND ANTENNA SYSTEM**

(71) Applicant: **TP-LINK CORPORATION LIMITED**, Hong Kong (CN)

(72) Inventor: **Junyu Yang**, Sichuan (CN)

(73) Assignee: **TP-LINK CORPORATION LIMITED**, Hong Kong (CN)

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

(21) Appl. No.: **18/703,317**

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

(86) PCT No.: **PCT/CN2022/141678**

§ 371 (c)(1),

(2) Date: **Apr. 19, 2024**

(87) PCT Pub. No.: **WO2023/134429**

PCT Pub. Date: **Jul. 20, 2023**

(65) **Prior Publication Data**

US 2025/0239775 A1 Jul. 24, 2025

(30) **Foreign Application Priority Data**

Jan. 13, 2022 (CN) 202210039312.8

Jan. 30, 2022 (CN) 202210114584.X

(51) **Int. Cl.**
H01Q 9/16 (2006.01)

H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 9/16** (2013.01); **H01Q 9/0421** (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,866,689 B2 * 10/2014 Islam H01Q 21/30

2015/0349418 A1 12/2015 Patron et al. 343/810

(Continued)

FOREIGN PATENT DOCUMENTS

CN 102629708 A 8/2012

CN 104993254 A 10/2015

(Continued)

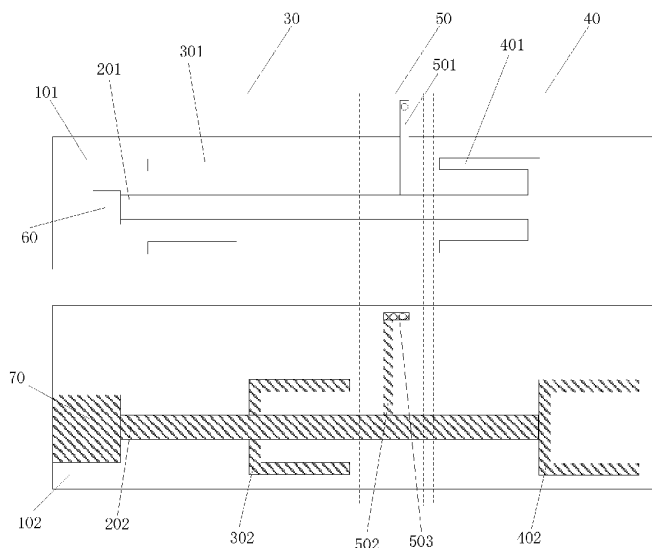
Primary Examiner — Wilson Lee

(74) *Attorney, Agent, or Firm* — The Sun IP Law

(57) **ABSTRACT**

Provided are an antenna structure and an antenna system. The antenna structure includes a dielectric substrate, a two-wire parallel line, a first dipole antenna, a second dipole antenna and a reconfiguration structure; where the dielectric substrate includes a front surface and a back surface that are opposite each other; the two-wire parallel line includes a front conductor and a back conductor that are parallel to each other; the first dipole antenna includes a first radiation arm and a second radiation arm, and the second dipole antenna includes a third radiation arm and a fourth radiation arm; the reconfiguration structure includes a front unit, a back unit and a switching device; two ends of the switching device are connected to the front unit and the back unit respectively; and the two-wire parallel line is configured to transmit a radio frequency signal and a control signal.

20 Claims, 4 Drawing Sheets





US012494584B2

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

(10) **Patent No.:** **US 12,494,584 B2**
(45) **Date of Patent:** **Dec. 9, 2025**

- (54) **TERMINAL MONOPOLE ANTENNA**
- (71) Applicant: **Honor Device Co., Ltd.**, Shenzhen (CN)
- (72) Inventors: **Dawei Zhou**, Shenzhen (CN);
Yuanpeng Li, Shenzhen (CN)
- (73) Assignee: **HONOR DEVICE CO., LTD.**, Shenzhen (CN)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.
- (21) Appl. No.: **18/279,525**
- (22) PCT Filed: **Aug. 17, 2022**
- (86) PCT No.: **PCT/CN2022/113116**
§ 371 (c)(1),
(2) Date: **Aug. 30, 2023**
- (87) PCT Pub. No.: **WO2023/030015**
PCT Pub. Date: **Mar. 9, 2023**
- (65) **Prior Publication Data**
US 2024/0313410 A1 Sep. 19, 2024
- (30) **Foreign Application Priority Data**
Sep. 3, 2021 (CN) 202111034604.4
- (51) **Int. Cl.**
H01Q 9/42 (2006.01)
H01Q 1/24 (2006.01)
- (52) **U.S. Cl.**
CPC **H01Q 9/42** (2013.01); **H01Q 1/24** (2013.01)
- (58) **Field of Classification Search**
CPC H01Q 9/42; H01Q 1/24; H01Q 5/335;
H01Q 7/00; H01Q 1/243; H01Q 5/20;
(Continued)

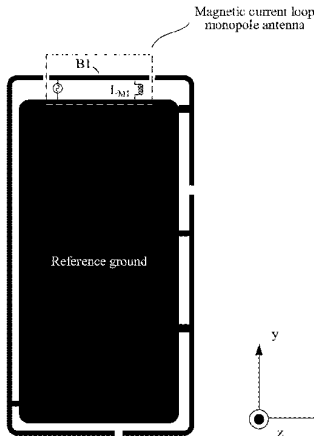
- (56) **References Cited**
- U.S. PATENT DOCUMENTS
- 5,521,607 A * 5/1996 Deasy H01Q 9/145 343/750
- 6,873,291 B2 3/2005 Aoyama et al.
(Continued)
- FOREIGN PATENT DOCUMENTS
- CN 1407832 A 4/2003
CN 104471789 A 3/2015
(Continued)

- OTHER PUBLICATIONS
- Liu Yiming, et al: “An Inductor—Loaded Broadband Electrical Small Planar Monopole for Mobile Terminal Applications”, Electronic Information Warfare Technology, 2014 , 29(4), Jul. 15, 2014, total 5 pages.
- Primary Examiner — Hai V Tran
- (74) Attorney, Agent, or Firm — Slater Matsil, LLP

- (57) **ABSTRACT**
- Embodiments of this application disclose a terminal monopole antenna, relating to the technical field of antennas. The antenna includes a radiation branch, the radiation branch includes at least one radiator, and a first end of the radiator is electrically connected to a reference ground through a first inductor. When the terminal monopole antenna is directly fed by a feeding point, a second end of the radiator is electrically connected to the feeding point. When the terminal monopole antenna is coupled and fed, the second end is electrically connected to the reference ground through a second inductor. The terminal monopole antenna further includes a feeding branch, the feeding branch is configured to perform coupled feeding to the radiation branch. A length of the radiation branch is less than a quarter of an operating wavelength of the terminal monopole antenna.

20 Claims, 64 Drawing Sheets

Setting illustration of a magnetic current loop monopole antenna in an electronic device





US012494590B2

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

(10) **Patent No.:** **US 12,494,590 B2**
(45) **Date of Patent:** **Dec. 9, 2025**

(54) **ANTENNA ARRAY**

2018/0226713 A1* 8/2018 Lerner H01Q 1/38
2023/0288529 A1* 9/2023 Raz G01S 13/02

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

FOREIGN PATENT DOCUMENTS

(72) Inventors: **Chi-Hsuan Lee**, Taoyuan (TW);
Tsung-Ying Hsieh, Taoyuan (TW)

CN	104124517	A	10/2014
CN	106486785	A	3/2017
CN	111033893	A	4/2020
CN	113555678	A	10/2021
TW	201101586	A	1/2011
TW	M491965	U	12/2014

(73) Assignee: **QUANTA COMPUTER INC.**,
Taoyuan (TW)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 195 days.

OTHER PUBLICATIONS

(21) Appl. No.: **18/405,127**

Chinese language office action dated Apr. 16, 2025, issued in
application No. TW 112142201.

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

Chinese language office action dated Dec. 19, 2024, issued in
application No. TW 112142201.

(65) **Prior Publication Data**
US 2025/0149803 A1 May 8, 2025

* cited by examiner

(30) **Foreign Application Priority Data**
Nov. 2, 2023 (TW) 112142201

Primary Examiner — Daniel Munoz

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

(51) **Int. Cl.**
H01Q 21/06 (2006.01)
H01Q 1/48 (2006.01)
H01Q 21/00 (2006.01)

(57) **ABSTRACT**

(52) **U.S. Cl.**
CPC **H01Q 21/065** (2013.01); **H01Q 1/48**
(2013.01); **H01Q 21/0006** (2013.01)

An antenna array includes a glass plate, a ground element, a first radiation element, a second radiation element, a third radiation element, a fourth radiation element, and a feeding network. The glass plate has a first surface and a second surface which are opposite to each other. The ground element is disposed on the second surface of the glass plate. The feeding network has a feeding port. The feeding network is coupled to the first radiation element, the second radiation element, the third radiation element, and the fourth radiation element. The first radiation element, the second radiation element, the third radiation element, the fourth radiation element, and the feeding network are disposed on the first surface of the glass plate.

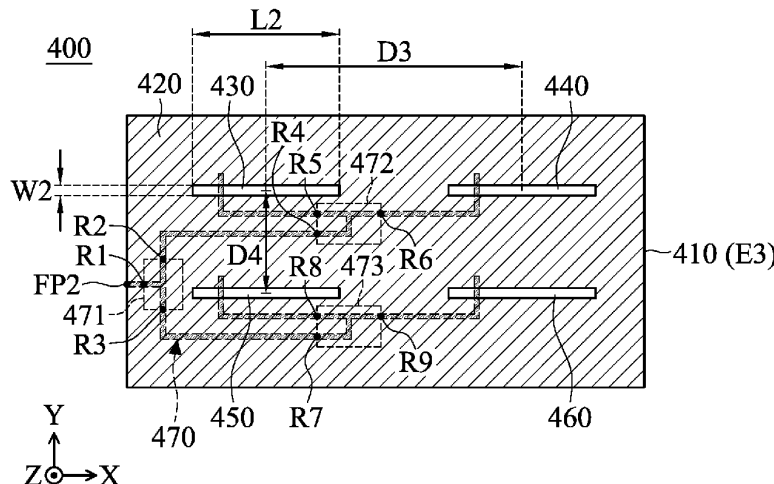
(58) **Field of Classification Search**
CPC .. H01Q 21/0006; H01Q 21/065; H01Q 1/243;
H01Q 1/48
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,388,621 B1* 5/2002 Lynch H01Q 21/065
343/770
11,165,155 B2 11/2021 Huh

8 Claims, 5 Drawing Sheets





US012499342B2

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

(10) **Patent No.:** **US 12,499,342 B2**
(45) **Date of Patent:** **Dec. 16, 2025**

(54) **TIKI-SHAPED ANTENNA SYSTEM**

(71) Applicant: **Williot, Ltd.**, Caesarea (IL)

(72) Inventors: **Michael Shvabsky**, Tirat Carmel (IL);
Alon Yehezckely, Haifa (IL); **Oleg**
Becker, Holon (IL); **Keren**
Barkai-Alon, Beit Hashmonai (IL)

(73) Assignee: **Williot, Ltd.**, Caesarea (IL)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 71 days.

(21) Appl. No.: **18/350,456**

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

(65) **Prior Publication Data**

US 2025/0021782 A1 Jan. 16, 2025

(51) **Int. Cl.**
G06K 19/07 (2006.01)
H01Q 1/22 (2006.01)
H01Q 7/00 (2006.01)
H01Q 23/00 (2006.01)

(52) **U.S. Cl.**
CPC **G06K 19/0724** (2013.01); **H01Q 1/2225**
(2013.01); **H01Q 7/00** (2013.01); **H01Q 23/00**
(2013.01)

(58) **Field of Classification Search**

CPC G06K 19/0724; H01Q 1/2225; H01Q 7/00;
H01Q 23/00

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2021/0288395 A1 * 9/2021 Yehezckely H04W 4/70
2022/0391658 A1 * 12/2022 Shimada H01Q 9/24

FOREIGN PATENT DOCUMENTS

KR 20140134407 A * 11/2014

* cited by examiner

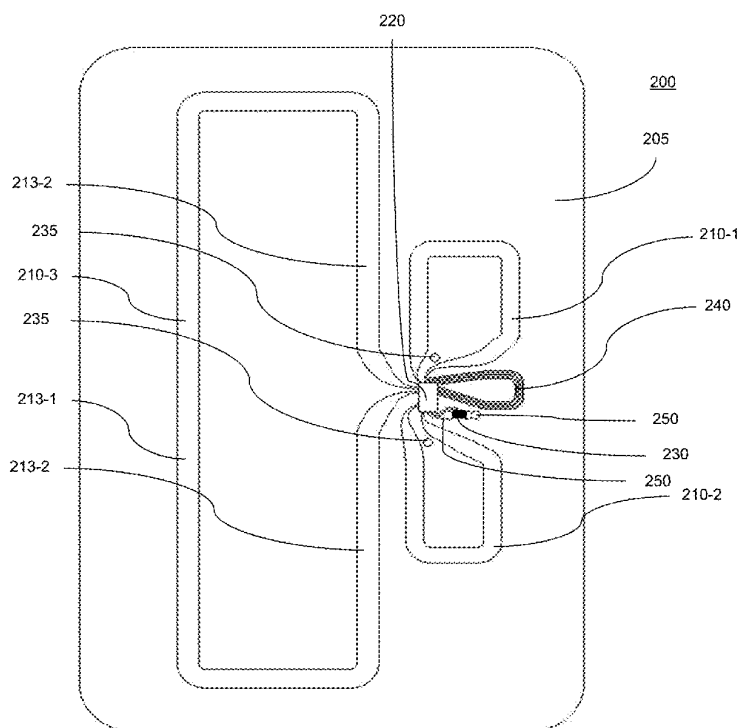
Primary Examiner — Laura A Gudorf

(74) *Attorney, Agent, or Firm* — M&B IP Analysts, LLC

(57) **ABSTRACT**

A tag, comprises: a first loop antenna connected to a chip for harvesting energy at a first frequency and being located on a first side of the chip; a second loop antenna connected to the chip for use in wireless communication using a frequency range and being located on a side of the chip opposite the first side; and a third loop antenna connected to the chip for harvesting energy at a frequency lower than the first frequency and the frequency range and having a portion of its loop (i) proximal to a portion of both the first and second antennas and (ii) extends parallel to a side of the chip perpendicular to the first side, and having a portion that is parallel to the first chip side; wherein a circumference of the third antenna is greater than a greatest circumference of the first and second antennas.

24 Claims, 6 Drawing Sheets





US012500330B2

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

(10) **Patent No.:** **US 12,500,330 B2**
(45) **Date of Patent:** **Dec. 16, 2025**

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

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

(72) Inventors: **Weibo Peng**, Shenzhen (CN); **Xin Xu**,
Shenzhen (CN); **Linsheng Li**, Shenzhen
(CN); **Timofey Kamyshev**, Shenzhen
(CN); **Wei Shan**, Shanghai (CN);
Yongchao Wang, Xi'an (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 250 days.

(21) Appl. No.: **18/259,966**

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

(86) PCT No.: **PCT/CN2021/142515**

§ 371 (c)(1),

(2) Date: **Jun. 29, 2023**

(87) PCT Pub. No.: **WO2022/143777**

PCT Pub. Date: **Jul. 7, 2022**

(65) **Prior Publication Data**

US 2024/0072415 A1 Feb. 29, 2024

(30) **Foreign Application Priority Data**

Dec. 31, 2020 (CN) 202011644200.2

Mar. 16, 2021 (CN) 202110283703.X

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 9/04 (2006.01)

(Continued)

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

CPC **H01Q 1/243** (2013.01); **H01Q 9/0407**
(2013.01); **H01Q 15/24** (2013.01); **H01Q**
21/065 (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 15/0086; H01Q 15/24;
H01Q 19/005; H01Q 21/065;
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

10,497,605 B2 * 12/2019 Parkhe H01L 21/68721
10,742,315 B1 * 8/2020 Li H01Q 13/08

(Continued)

FOREIGN PATENT DOCUMENTS

CN 103534875 A 1/2014

CN 106384882 A 2/2017

(Continued)

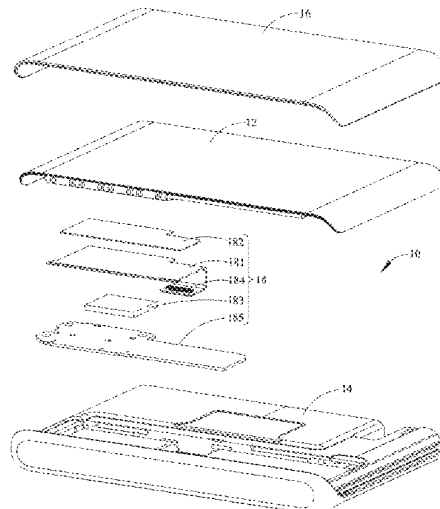
Primary Examiner — Thien M Le

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

(57) **ABSTRACT**

A patch antenna includes a plurality of patch units, a first feeding branch, and a second feeding branch. The plurality of patch units is symmetric relative to a virtual symmetry axis. The plurality of patch units is arranged at intervals. A gap is formed between adjacent patch units, and the adjacent patch units are coupled through the gap. The first feeding branch and the second feeding branch are symmetric relative to the symmetry axis, and each of the first feeding branch and the second feeding branch is electrically connected to at least one patch unit of the plurality of patch units. The first feeding branch is configured for a first polarization of the patch antenna, and the second feeding branch is configured for a second polarization of the patch antenna.

20 Claims, 15 Drawing Sheets





US012500339B2

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

(10) **Patent No.:** **US 12,500,339 B2**
(45) **Date of Patent:** **Dec. 16, 2025**

(54) **ANTENNA AND ELECTRONIC DEVICE**

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

(72) Inventors: **Dong Yu**, Shanghai (CN); **Jiaming Wang**, Shanghai (CN); **Liang Xue**,
Shanghai (CN); **Yuanpeng Li**,
Shenzhen (CN); **Hanyang Wang**,
Reading (GB); **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 208 days.

(21) Appl. No.: **18/264,859**

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

(86) PCT No.: **PCT/CN2021/137028**

§ 371 (c)(1),

(2) Date: **Aug. 9, 2023**

(87) PCT Pub. No.: **WO2022/170842**

PCT Pub. Date: **Aug. 18, 2022**

(65) **Prior Publication Data**

US 2024/0106119 A1 Mar. 28, 2024

(30) **Foreign Application Priority Data**

Feb. 10, 2021 (CN) 202110185331.7

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

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

(58) **Field of Classification Search**

CPC H01Q 5/364; H01Q 9/42; H01Q 1/243;
H01Q 1/48; H01Q 9/0421; H01Q 9/0457;
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,061,025 A * 5/2000 Jackson H01Q 9/0421
343/745
10,218,082 B2 * 2/2019 Zhao G03H 5/00
(Continued)

FOREIGN PATENT DOCUMENTS

CN 110190381 A 8/2019
CN 209487711 U * 10/2019
(Continued)

OTHER PUBLICATIONS

Hu et al., Design of a Frequency and Polarization Reconfigurable Patch Antenna With a Stable Gain, 2018, IEEE vol. 6, pp. 68169-68175 (Year: 2018).*

(Continued)

Primary Examiner — Dameon E Levi

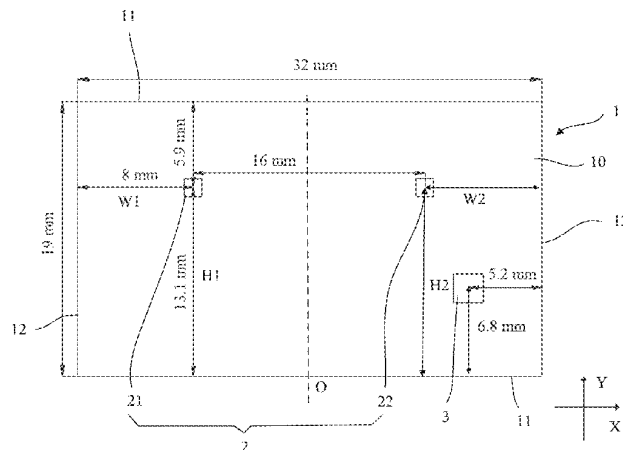
Assistant Examiner — Jordan E. DeWitt

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

(57) **ABSTRACT**

An antenna includes a patch radiator, a feed point, a first ground point, and a second ground point. The patch radiator has a first side edge and an intersecting second side edge, and a first coupling contact and a second coupling contact. The patch radiator is coupled to the first ground point and the second ground point through the first coupling contact and the second coupling contact, and is biased coupled to the feed point. A distance between the first coupling contact and the first side edge, a distance between the first coupling contact and the second side edge, a distance between the second coupling contact and the first side edge, and a distance between the second coupling contact and the sec-

(Continued)





US012500341B2

(12) **United States Patent**
Hamabe

(10) **Patent No.:** **US 12,500,341 B2**
(45) **Date of Patent:** **Dec. 16, 2025**

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

(56) **References Cited**

(71) Applicant: **Panasonic Intellectual Property Management Co., Ltd.**, Osaka (JP)

U.S. PATENT DOCUMENTS

(72) Inventor: **Taichi Hamabe**, Osaka (JP)

11,245,188 B2 * 2/2022 Chiang H01Q 9/26
2023/0163466 A1 * 5/2023 Yu H01Q 9/42
343/702

(73) Assignee: **PANASONIC INTELLECTUAL PROPERTY MANAGEMENT CO., LTD.**, Osaka (JP)

FOREIGN PATENT DOCUMENTS

JP 2005-20289 1/2005
JP 4976511 7/2012
WO 2021/213125 10/2021

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 199 days.

OTHER PUBLICATIONS

Extended European Search Report issued Oct. 11, 2023 in corresponding European Patent Application No. 23159556.2.
K. Sakaguchi et al., "A Small Antenna Consisting of Short-Ended Parallel Stubs and Capacitors", Electronics and Communications in Japan, Part 1., vol. 80, No. 4, pp. 83-95, Nov. 4, 1997.

(21) Appl. No.: **18/207,863**

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

* cited by examiner

(65) **Prior Publication Data**
US 2023/0402753 A1 Dec. 14, 2023

Primary Examiner — Minh Tran
(74) *Attorney, Agent, or Firm* — Wenderoth, Lind & Ponack, L.L.P.

(30) **Foreign Application Priority Data**
Jun. 10, 2022 (JP) 2022-094626

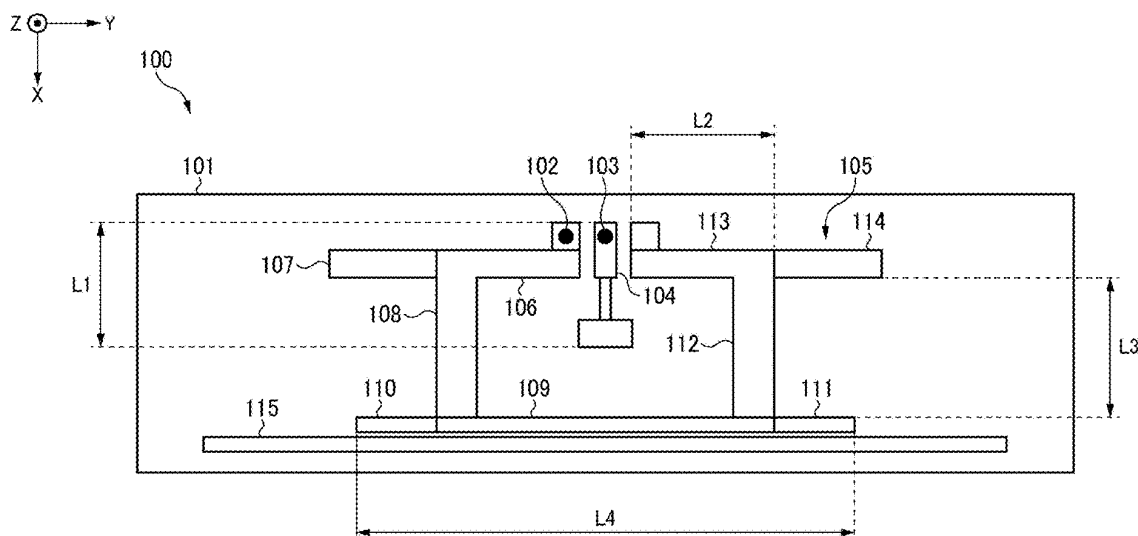
(57) **ABSTRACT**

There are provided an antenna device and a communication device including: a feed antenna connected to a feed point and extending from the feed point, the feed antenna corresponding to a first frequency; a loop antenna connected to a ground and arranged to surround the feed antenna, the loop antenna corresponding to a second frequency lower than the first frequency; and a resonator arranged outside the loop antenna in a direction in which the feed antenna extends, the resonator corresponding to the second frequency. The loop antenna includes an extending portion that extends to protrude outward on a side where the resonator is arranged with respect to the feed point.

(51) **Int. Cl.**
H01Q 5/378 (2015.01)
H01Q 7/00 (2006.01)
(52) **U.S. Cl.**
CPC **H01Q 5/378** (2015.01); **H01Q 7/00** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/378; H01Q 7/00; H01Q 1/2291;
H01Q 9/40; H01Q 5/385
See application file for complete search history.

4 Claims, 4 Drawing Sheets





US012500343B2

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

(10) **Patent No.:** **US 12,500,343 B2**
(45) **Date of Patent:** **Dec. 16, 2025**

(54) **TERMINAL MONOPOLE ANTENNA BASED ON COUPLED FEEDING**

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

(72) Inventors: **Dawei Zhou**, Shenzhen (CN);
Yuanpeng Li, 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 114 days.

(21) Appl. No.: **18/550,035**

(22) PCT Filed: **May 5, 2022**

(86) PCT No.: **PCT/CN2022/091007**

§ 371 (c)(1),
(2) Date: **Sep. 11, 2023**

(87) PCT Pub. No.: **WO2023/020019**

PCT Pub. Date: **Feb. 23, 2023**

(65) **Prior Publication Data**

US 2024/0154311 A1 May 9, 2024

(30) **Foreign Application Priority Data**

Aug. 20, 2021 (CN) 202110961752.4

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

(52) **U.S. Cl.**
CPC **H01Q 9/0421** (2013.01); **H01Q 1/243** (2013.01); **H01Q 9/0442** (2013.01); **H01Q 9/0457** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/24; H01Q 9/04; H01Q 9/042;
H01Q 9/0421; H01Q 9/0442;

(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,030,833 B2 4/2006 Ohara et al.

11,949,177 B2 4/2024 Wang et al.

(Continued)

FOREIGN PATENT DOCUMENTS

CN 1599130 A 3/2005

CN 102570039 A 7/2012

(Continued)

OTHER PUBLICATIONS

Yang Hong, Hou Chunpen, "Design of a multi-band single-plane monopole mobile phone antenna", Digital Technology and Application, 2017, (01), pp. 145-146, Jan. 15, 2017.

(Continued)

Primary Examiner — Thai Pham

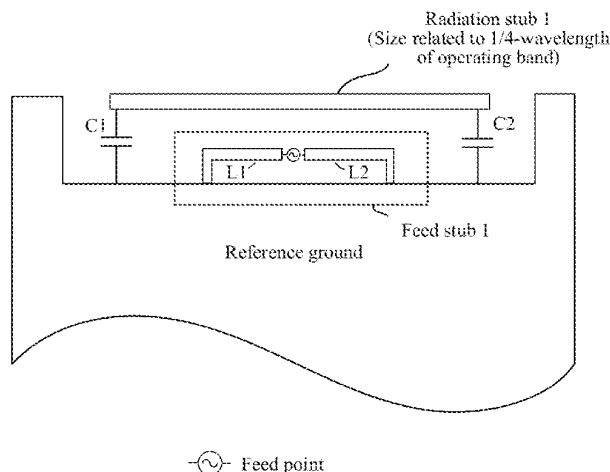
(74) *Attorney, Agent, or Firm* — Slater Matsil, LLP

(57) **ABSTRACT**

Embodiments of this application disclose a terminal monopole antenna based on coupled feeding, relate to the technical field of antennas. The antenna includes a feed stub and a radiation stub. The radiation stub includes at least one radiator. Ends on two sides of the radiator are coupled to a reference ground through a first capacitor and a second capacitor. The feed stub is not connected to the radiation stub. The feed stub is arranged between the radiation stub and the reference ground. A feed point is provided on the feed stub. The feed stub is used to perform coupled feeding on the radiation stub.

20 Claims, 40 Drawing Sheets

Current loop monopole antenna





US012500344B2

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

(10) **Patent No.:** **US 12,500,344 B2**
(45) **Date of Patent:** **Dec. 16, 2025**

(54) **WIDEBAND ANTENNA ARRANGED ON VEHICLE**

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

(72) Inventors: **Changwon Yun**, Seoul (KR); **Changil Kim**, Seoul (KR); **Yeomin Youn**, Seoul (KR)

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

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

(21) Appl. No.: **18/698,194**

(22) PCT Filed: **Oct. 6, 2021**

(86) PCT No.: **PCT/KR2021/013703**

§ 371 (c)(1),

(2) Date: **Apr. 3, 2024**

(87) PCT Pub. No.: **WO2023/058788**

PCT Pub. Date: **Apr. 13, 2023**

(65) **Prior Publication Data**

US 2024/0322436 A1 Sep. 26, 2024

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 1/32 (2006.01)

(Continued)

(52) **U.S. Cl.**
CPC **H01Q 9/0421** (2013.01); **H01Q 1/32** (2013.01); **H01Q 1/42** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/371** (2015.01); **H01Q 25/00** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 9/0421; H01Q 1/32; H01Q 1/42; H01Q 1/48; H01Q 5/371; H01Q 25/00;
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,339,406 B1 1/2002 Nesic et al.
2006/0109179 A1 5/2006 Humpfer et al.
(Continued)

FOREIGN PATENT DOCUMENTS

KR 10-0363303 11/2002
KR 10-1152217 6/2012
(Continued)

OTHER PUBLICATIONS

PCT International Application No. PCT/KR2021/013507, International Search Report dated Jun. 29, 2022, 4 pages.

(Continued)

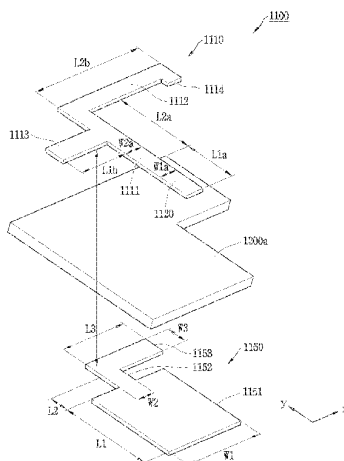
Primary Examiner — Seung H Lee

(74) *Attorney, Agent, or Firm* — LEE, HONG, DEGERMAN, KANG & WAIMEY

(57) **ABSTRACT**

The antenna module comprises: a PCB on which a transmission line is formed; and an antenna PCB coupled to the PCB, having a feeding line and an antenna pattern formed on a first surface thereof, and having a ground pattern formed on a second surface thereof. The ground pattern can comprise: a first ground pattern formed to have a first width, which is greater than the width of the feeding line in a region in which the feeding line is formed; and a second ground pattern, which extends from one end portion of the first ground pattern so as to be formed with a second width in a first axial direction and with a second length in a second axial direction. The ground pattern can further comprise a third ground pattern, which extends from one end portion of the second ground pattern to be bent so as to be formed with a third width in the second axial direction and with a third length in the first axial direction.

20 Claims, 23 Drawing Sheets





US012500356B2

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

(10) **Patent No.:** **US 12,500,356 B2**
(45) **Date of Patent:** **Dec. 16, 2025**

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

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

(72) Inventors: **Kaiming Dong**, Shenzhen (CN); **Wei
Xiong**, 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 189 days.

(21) Appl. No.: **18/277,285**

(22) PCT Filed: **May 6, 2022**

(86) PCT No.: **PCT/CN2022/091301**

§ 371 (c)(1),

(2) Date: **Aug. 15, 2023**

(87) PCT Pub. No.: **WO2023/020023**

PCT Pub. Date: **Feb. 23, 2023**

(65) **Prior Publication Data**

US 2024/0136736 A1 Apr. 25, 2024

US 2024/0235063 A9 Jul. 11, 2024

(30) **Foreign Application Priority Data**

Aug. 17, 2021 (CN) 202110945168.X

(51) **Int. Cl.**

H01Q 21/28 (2006.01)

H01Q 1/24 (2006.01)

(Continued)

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

CPC **H01Q 21/28** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 1/521** (2013.01); **H01Q**
5/328 (2015.01); **H01Q 5/364** (2015.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 1/521; H01Q 5/328;
H01Q 5/364; H01Q 21/28
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

10,763,571 B2 9/2020 Chen et al.

10,819,013 B2 10/2020 Lin

(Continued)

FOREIGN PATENT DOCUMENTS

CN 107394347 A 11/2017

CN 107437661 A 12/2017

(Continued)

Primary Examiner — Daniel Munoz

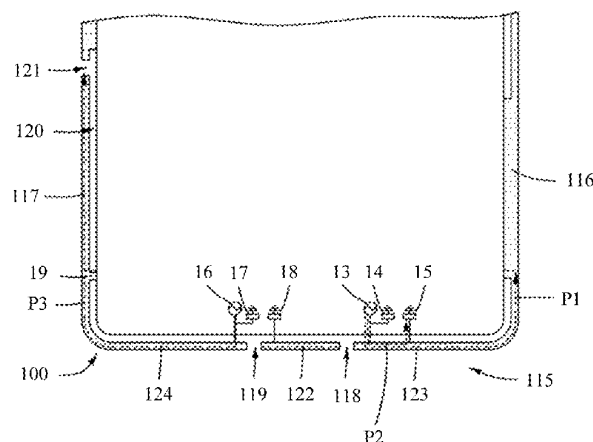
(74) Attorney, Agent, or Firm — WOMBLE BOND
DICKINSON (US) LLP

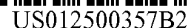
(57) **ABSTRACT**

This application provides a terminal antenna and a mobile terminal device. The terminal antenna includes a frame, a first feed, and a second feed. A part of the frame on a side of the first gap away from the second gap forms the first conductor, a part of the frame on a side of the second gap away from the first gap forms the second conductor, and the frame between the first gap and the second gap forms the third conductor. The first feed is electrically connected to the first conductor, so that the first conductor radiates a signal, and the second feed is electrically connected to the second conductor, so that the second conductor radiates a signal in a low band.

20 Claims, 12 Drawing Sheets

200





(10) **Patent No.:** US 12,500,357 B2
(45) **Date of Patent:** Dec. 16, 2025

(56) **References Cited**

U.S. PATENT DOCUMENTS

2016/0352014 A1 12/2016 Chen et al.
2022/0344823 A1 * 10/2022 Panther H01Q 21/26
(Continued)

FOREIGN PATENT DOCUMENTS

CN	106790795	A	5/2017
CN	109103569	A	12/2018

(Continued)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 85 days.

OTHER PUBLICATIONS

WIPO, International Search Report for PCT Application No. PCT/CN2022/114648, Nov. 21, 2022.

(21) Appl. No.: 18/435,826

(Continued)

(22) Filed: **Feb. 7, 2024**

Primary Examiner — Thien M Le

(65) **Prior Publication Data**

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

US 2024/0178577 A1 May 30, 2024

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2022/114648, filed on Aug. 25, 2022.

(30) **Foreign Application Priority Data**

Sep. 13, 2021 (CN) 202111069517.2

(51) **Int. Cl.**
H01Q 21/28 (2006.01)
H01O 1/24 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 21/28** (2013.01); **H01Q 1/241**
(2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/241; H01Q 1/243; H01Q 21/28;
H01Q 21/29; H01Q 21/30; H01Q 5/307;
H01Q 9/0421; H01Q 9/42

See application file for complete search history.

20 Claims, 8 Drawing Sheets

(57) **ABSTRACT**

Provided are an antenna assembly and an electronic device. The antenna assembly includes a housing, a radio frequency circuit, a first antenna, a second antenna, and a third antenna. The first, second and third antennas are provided on the housing. The first antenna radiates a first radio frequency signal at a GPS frequency band L1, and each of the second and third antennas radiates a second radio frequency signal at a GPS frequency band L5. A first GPS module of the radio frequency circuit is connected with the first antenna and supports receipt and transmission of the first radio frequency signal. A second GPS module of the radio frequency circuit is selectively connected to one of the second and third antennas, and switch, based on network information of a received second radio frequency signal, between being connected to the second antenna and being connected to the third antenna.

