



US012658560B2

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

(10) **Patent No.:** **US 12,658,560 B2**
(45) **Date of Patent:** **Jun. 16, 2026**

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

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

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

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 467 days.

(21) Appl. No.: **18/038,073**

(22) PCT Filed: **Sep. 9, 2022**

(86) PCT No.: **PCT/CN2022/118237**
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(2) Date: **May 22, 2023**

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

(65) **Prior Publication Data**
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(30) **Foreign Application Priority Data**
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(51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01Q 1/52 (2006.01)
H01Q 13/18 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/2266** (2013.01); **H01Q 1/52** (2013.01); **H01Q 13/18** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/2266; H01Q 1/52; H01Q 13/18; H01Q 13/22
See application file for complete search history.

(56) **References Cited**

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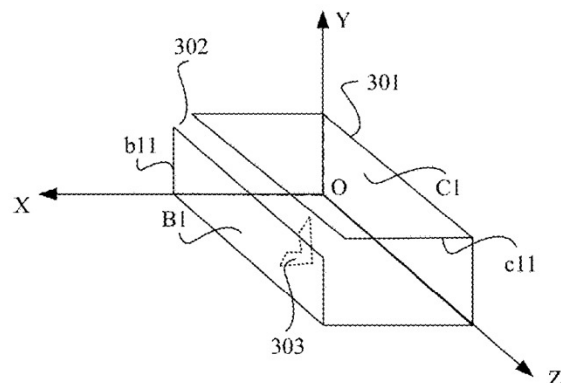
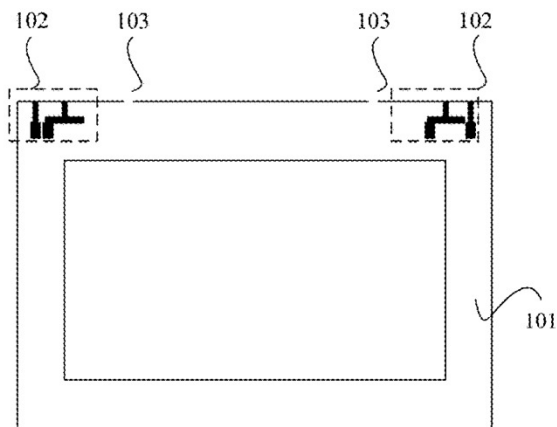
Primary Examiner — Dieu Hien T Duong

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

(57) **ABSTRACT**

This application provides a resonant cavity antenna and an electronic device, and relates to the communications field. The resonant cavity antenna includes an antenna cavity, a first gap, and a feeding part. At least one edge of a first surface of the antenna cavity is parallel to a long edge of a display of an electronic device, at least one edge of a second surface of the antenna cavity is parallel to the long edge of the display, a plane on which the first surface is located intersects a plane on which the second surface is located. The first gap is disposed on the first surface and/or the second surface, and at least a part of the first gap extends in a direction of the long edge of the display. The feeding part

(Continued)





US012658566B2

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

(10) **Patent No.:** **US 12,658,566 B2**
(45) **Date of Patent:** **Jun. 16, 2026**

(54) **ELECTRONIC DEVICE INCLUDING ANTENNA**

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

(72) Inventors: **Jongmin Kim**, Suwon-si (KR); **Eunbae Kwon**, Suwon-si (KR); **Hyoseok Na**, Suwon-si (KR); **Kyonghwan Cho**, Suwon-si (KR); **Sungjae Moon**, Suwon-si (KR); **Wanjae Ju**, 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 40 days.

(21) Appl. No.: **18/786,248**

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

(65) **Prior Publication Data**
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Related U.S. Application Data

(63) Continuation of application No. PCT/KR2024/008981, filed on Jun. 27, 2024.

(30) **Foreign Application Priority Data**

Jun. 27, 2023 (KR) 10-2023-0082973
Sep. 1, 2023 (KR) 10-2023-0116059

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

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H04M 1/0277** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/38; H04M 1/0277
See application file for complete search history.

(56) **References Cited**

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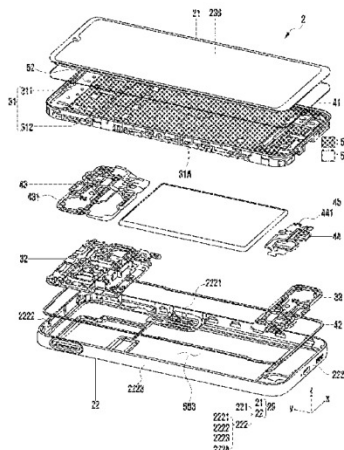
Primary Examiner — David E Lotter

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

(57) **ABSTRACT**

According to an example embodiment of the disclosure, an electronic device is provided. The electronic device includes a front cover forming at least a portion of the front surface of the electronic device, a non-conductive case including a rear portion forming at least a portion of the rear surface of the electronic device and a side portion forming at least a portion of the side surface of the electronic device, a support positioned between the front cover and the non-conductive case and including a first portion and a second portion, wherein the first portion is positioned between the second portion and the side portion, a first conductive pattern disposed between the first portion or the side portion, a second conductive pattern positioned between the second portion and the rear portion and spaced apart from the first conductive pattern, a wireless communication circuit configured to transmit a signal in a designated frequency band through the first conductive pattern and the second conductive pattern.

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US012658579B2

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

(10) **Patent No.:** **US 12,658,579 B2**
(45) **Date of Patent:** **Jun. 16, 2026**

(54) **ANTENNA STRUCTURE**

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

(72) Inventors: **Yi-Ling Tseng**, Taoyuan City (TW); **Chin-Lung Tsai**, Taoyuan City (TW); **Chung-Ting Hung**, Taoyuan City (TW); **Kai-Hsiang Chang**, Taoyuan City (TW); **Yu-Chen Zhao**, Taoyuan City (TW); **Chun-I Cheng**, Taoyuan City (TW)

(73) Assignee: **QUANTA COMPUTER INC.**, 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 59 days.

(21) Appl. No.: **18/979,869**

(22) Filed: **Dec. 13, 2024**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Nov. 5, 2024 (TW) 113211995

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/48 (2006.01)
H01Q 1/50 (2006.01)
H01Q 5/30 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 5/30** (2015.01); **H01Q 1/38** (2013.01); **H01Q 1/50** (2013.01)

(58) **Field of Classification Search**

CPC .. H01Q 1/24; H01Q 1/38; H01Q 1/48; H01Q 1/50; H01Q 5/30

See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Tho G Phan

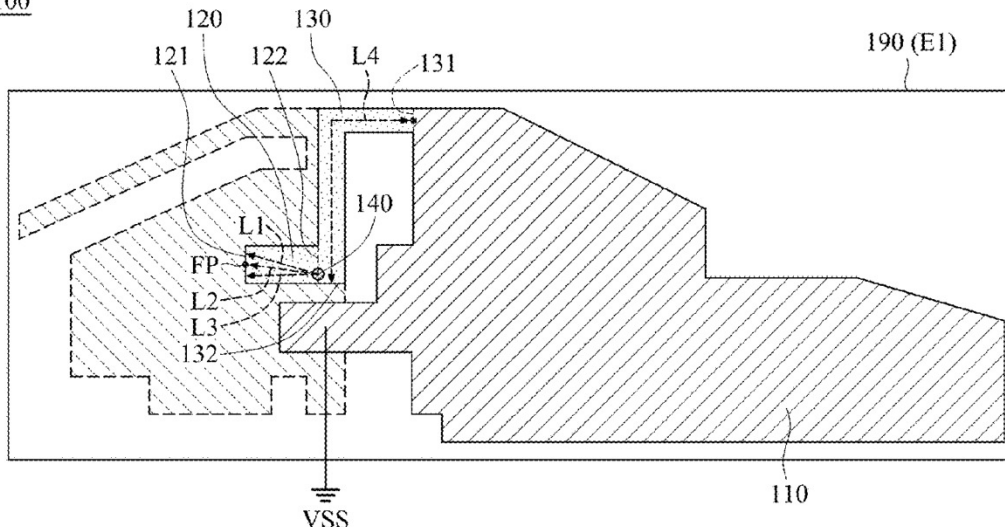
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

An antenna structure includes a ground element, a feeding radiation element, a connection radiation element, a conductive via element, a first radiation element, a second radiation element, a third radiation element, and a nonconductive support element. The feeding radiation element is coupled through the connection radiation element to the ground element. The conductive via element is coupled to the feeding radiation element. The first radiation element, the second radiation element, and the third radiation element are coupled to the conductive via element. A slot is formed between the first radiation element and the second radiation element. The nonconductive support element has a first surface and a second surface which are opposite to each other. The conductive via element penetrates the nonconductive support element. The ground element, the feeding radiation element, and the connection radiation element are disposed on the first surface of the nonconductive support element.

10 Claims, 4 Drawing Sheets

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US012658582B2

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

(10) **Patent No.:** **US 12,658,582 B2**
(45) **Date of Patent:** **Jun. 16, 2026**

(54) **ANTENNA STRUCTURE AND ELECTRONIC DEVICE USING THE SAME**

H01Q 9/42; H01Q 13/10; H01Q 1/243;
H01Q 5/20; H01Q 1/002; H01Q 1/36;
H01Q 25/04; H01Q 5/357

(71) Applicant: **Chiun Mai Communication Systems, Inc.,** New Taipei (TW)

See application file for complete search history.

(56)

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Primary Examiner — Dameon E Levi

Assistant Examiner — Jordan E. DeWitt

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 186 days.

(21) Appl. No.: **18/094,495**

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

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Jan. 21, 2022 (CN) 202210084178.3

(51) **Int. Cl.**
H01Q 5/48 (2015.01)
H01Q 1/52 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 5/48** (2015.01); **H01Q 1/526** (2013.01)

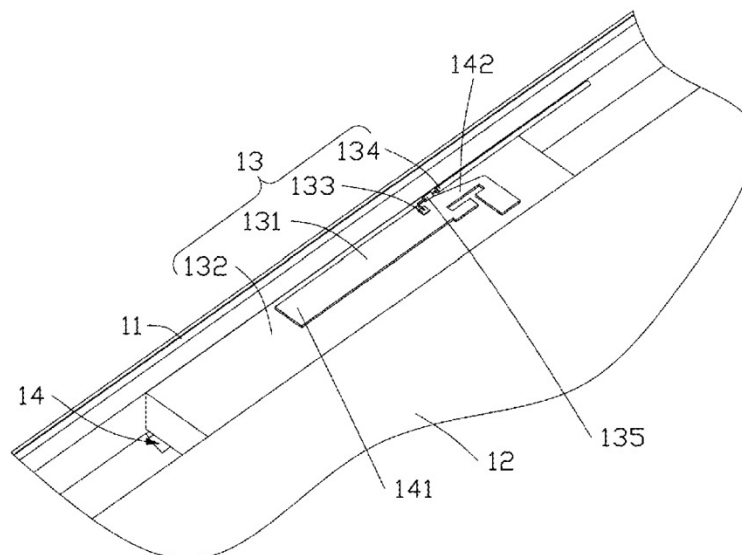
(58) **Field of Classification Search**
CPC H01Q 5/48; H01Q 1/526; H01Q 5/371;

(57)

ABSTRACT

An antenna structure for a metal-cased electronic device includes a radiator, a feed portion, and a slit. The feed portion can feed signals into the radiator, the radiator includes a first end and a second end, the first end disposes a first radiation portion, the second end disposes a second radiation portion and a third radiation portion, the second radiation portion and the third radiation portion are coupled to each other to radiate a radiation signal at a first frequency band, the slit and the radiator is spaced at intervals, and the slit is coupled to the first radiation portion to radiate the radiation signal at a second frequency band. The present disclosure also provides an electronic device with the antenna structure.

18 Claims, 12 Drawing Sheets





US012663841B2

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

(10) **Patent No.:** **US 12,663,841 B2**
(45) **Date of Patent:** **Jun. 23, 2026**

(54) **INTEGRATED CLICK PAD FRAME WIFI ANTENNA**

(56) **References Cited**

U.S. PATENT DOCUMENTS

(71) Applicant: **DELL PRODUCTS L.P.**, Round Rock, TX (US)

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(72) Inventors: **Sumana Pallampati**, Austin, TX (US); **Chin-Ming Chang**, New Taipei City (TW); **Ching Wei Chang**, Cedar Park, TX (US); **Changsoo Kim**, Cedar Park, TX (US)

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(73) Assignee: **Dell Products L.P.**, Round Rock, TX (US)

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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 167 days.

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(21) Appl. No.: **18/522,779**

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

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(65) **Prior Publication Data**

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US 2025/0172977 A1 May 29, 2025

7,554,498 B1 * 6/2009 Lee H01Q 5/371 343/702

(51) **Int. Cl.**

G06F 1/16 (2006.01)
G06F 3/0354 (2013.01)
H01Q 1/22 (2006.01)

(Continued)

Primary Examiner — Adrian S Wilson

(74) Attorney, Agent, or Firm — Larson Newman, LLP

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

CPC **G06F 1/169** (2013.01); **G06F 1/1698** (2013.01); **G06F 3/03547** (2013.01); **H01Q 1/2266** (2013.01)

(57) **ABSTRACT**

A click pad frame is provided for holding a click pad device in an information handling system. The click pad frame includes a click pad device retainer portion and an antenna portion. The click pad device retainer portion and the antenna portion are fabricated from a single piece of sheet metal.

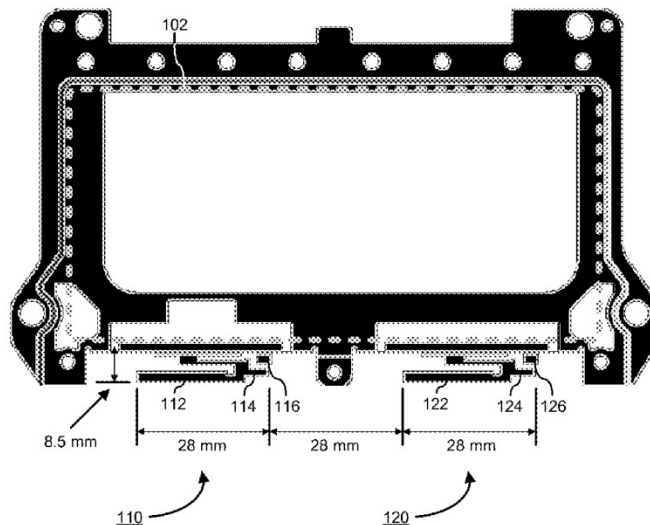
(58) **Field of Classification Search**

CPC G06F 1/1656; G06F 1/169; G06F 1/1692; G06F 1/1698; H01Q 1/2266; H01Q 1/2291

See application file for complete search history.

18 Claims, 4 Drawing Sheets

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US012665293B2

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

(10) **Patent No.:** **US 12,665,293 B2**
(45) **Date of Patent:** **Jun. 23, 2026**

(54) **ANTENNA STRUCTURE**

(56)

References Cited

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

U.S. PATENT DOCUMENTS

(72) Inventors: **Yuan-Lung Lee**, Taoyuan City (TW);
Chih-Chun Lin, Taoyuan City (TW)

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(73) Assignee: **QUANTA COMPUTER INC.**,
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 623 days.

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(21) Appl. No.: **18/182,752**

CN 113381184 A * 9/2021 H01Q 1/2258

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

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(65) **Prior Publication Data**

US 2024/0213666 A1 Jun. 27, 2024

Primary Examiner — Alexander H Taningco

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

(30) **Foreign Application Priority Data**

Dec. 22, 2022 (TW) 111214208

(57)

ABSTRACT

(51) **Int. Cl.**
H01Q 1/52 (2006.01)
H01Q 5/307 (2015.01)
H01Q 9/04 (2006.01)

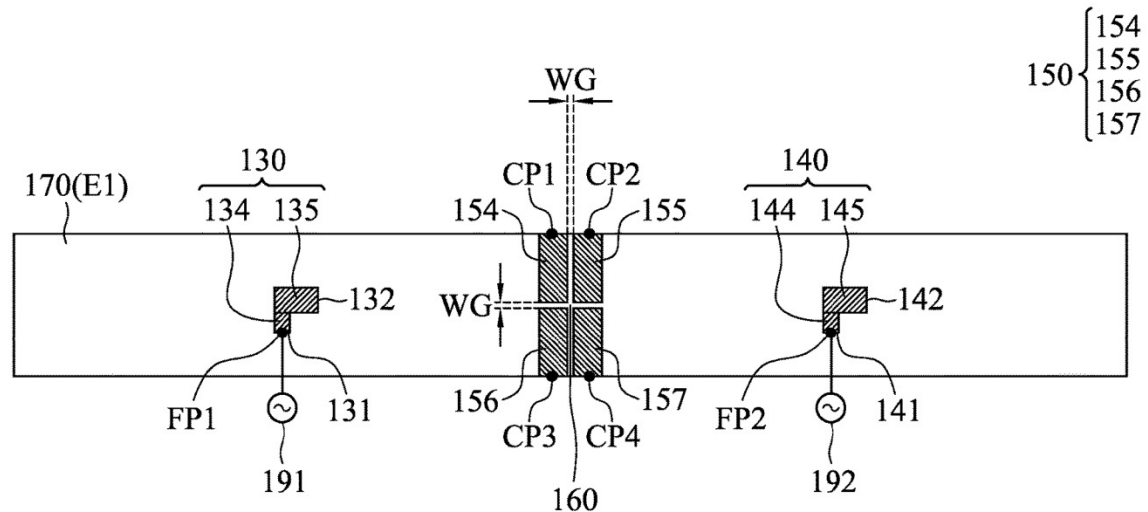
An antenna structure includes a metal mechanism element, a first radiation element, a second radiation element, an impedance element, and a dielectric substrate. The metal mechanism element has a slot. The first radiation element has a first feeding point. The second radiation element has a second feeding point. The impedance element is coupled to the metal mechanism element. The impedance element is disposed between the first radiation element and the second radiation element. The dielectric substrate is adjacent to the slot of the metal mechanism element. The first radiation element, the second radiation element, and the impedance element are disposed on the dielectric substrate. The impedance element is configured to increase the isolation between the first radiation element and the second radiation element.

(52) **U.S. Cl.**
CPC **H01Q 1/521** (2013.01); **H01Q 5/307** (2015.01); **H01Q 9/0407** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/22; H01Q 1/52; H01Q 1/243; H01Q 5/30–50

See application file for complete search history.

9 Claims, 7 Drawing Sheets





US012665294B2

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

(10) **Patent No.:** **US 12,665,294 B2**
(45) **Date of Patent:** **Jun. 23, 2026**

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

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

(72) Inventors: **Liang Xue**, Shanghai (CN); **Yiwen Gong**, Shanghai (CN); **Wei Wu**,
Shanghai (CN); **Jiaming Wang**,
Shanghai (CN); **Fangchao Zhao**,
Shanghai (CN)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 193 days.

(21) Appl. No.: **18/579,689**

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

(86) PCT No.: **PCT/CN2022/105631**

§ 371 (c)(1),

(2) Date: **Jan. 16, 2024**

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PCT Pub. Date: **Jan. 19, 2023**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

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H01Q 1/24 (2006.01)

(Continued)

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

CPC **H01Q 1/521** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 1/48** (2013.01); **H01Q 9/42**
(2013.01); **H01Q 25/04** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/521; H01Q 1/243; H01Q 1/48;
H01Q 9/42; H01Q 25/04
See application file for complete search history.

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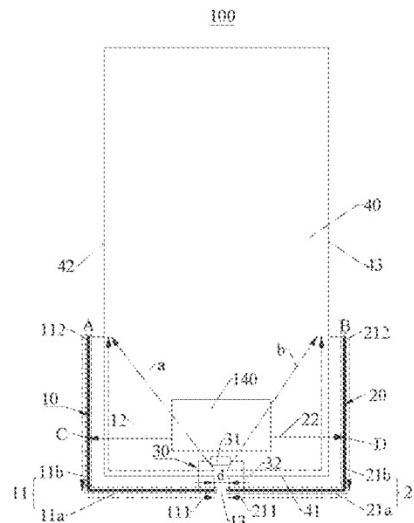
Primary Examiner — Graham P Smith

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

(57) **ABSTRACT**

An antenna structure includes a first radiator and a second radiator, and a first open end of the first radiator is opposite to and spaced from a second open end of the second radiator. A decoupling circuit is connected between the first open end and the second open end. The first radiator includes a first section and a second section that intersect, and the first section and the second section are respectively located on two adjacent sides of a ground.

20 Claims, 40 Drawing Sheets





US012665301B2

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

(10) **Patent No.:** **US 12,665,301 B2**
(45) **Date of Patent:** **Jun. 23, 2026**

(54) **ANTENNA STRUCTURE**

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

(72) Inventors: **Yu-Chen Zhao**, Taoyuan City (TW); **Chung-Ting Hung**, Taoyuan City (TW); **Chin-Lung Tsai**, Taoyuan City (TW); **Yi-Ling Tseng**, Taoyuan City (TW); **Kai-Hsiang Chang**, Taoyuan City (TW); **Chun-I Cheng**, Taoyuan City (TW)

(73) Assignee: **QUANTA COMPUTER INC.**, 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 113 days.

(21) Appl. No.: **18/410,057**

(22) Filed: **Jan. 11, 2024**

(65) **Prior Publication Data**

US 2025/0174900 A1 May 29, 2025

(30) **Foreign Application Priority Data**

Nov. 29, 2023 (TW) 112213015

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/50 (2006.01)
H01Q 7/00 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 7/00** (2013.01); **H01Q 1/38** (2013.01); **H01Q 1/50** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 7/00; H01Q 1/38; H01Q 1/50
See application file for complete search history.

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Primary Examiner — Dimary S Lopez Cruz

Assistant Examiner — Bamidele A Immanuel

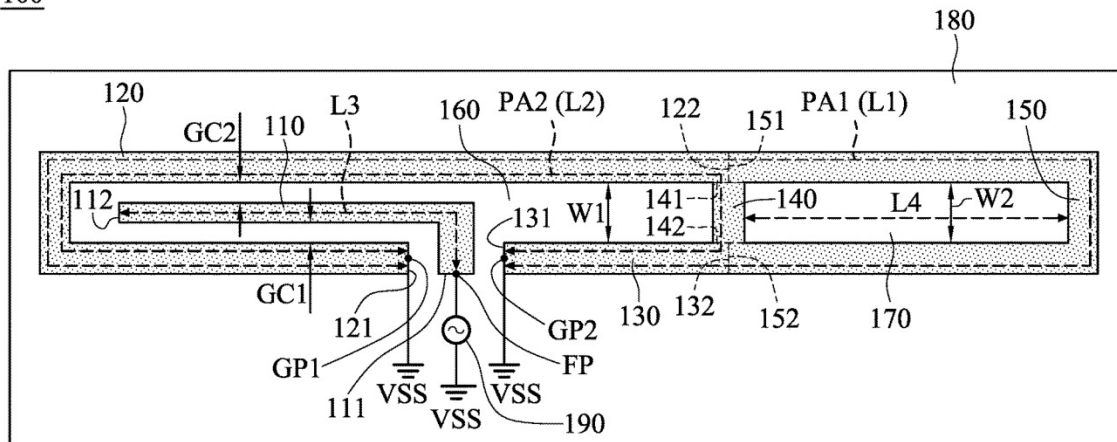
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

An antenna structure includes a feeding radiation element, a first grounding radiation element, a second grounding radiation element, a connection radiation element, an extension radiation element, and a dielectric substrate. The feeding radiation element has a feeding point. The first grounding radiation element has a first grounding point. The first grounding radiation element is adjacent to the feeding radiation element. The second grounding radiation element has a second grounding point. The connection radiation element is coupled between the first grounding radiation element and the second grounding radiation element. The extension radiation element is coupled to the connection radiation element. A closed slot is surrounded by the connection radiation element and the extension radiation element. The feeding radiation element, the first grounding radiation element, the second grounding radiation element, the connection radiation element, and the extension radiation element are all disposed on the dielectric substrate.

12 Claims, 3 Drawing Sheets

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US012665306B1

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

(10) **Patent No.:** **US 12,665,306 B1**
(45) **Date of Patent:** **Jun. 23, 2026**

(54) **COMMUNICATION DEVICE**

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

(72) Inventors: **Hung-Chi Chang**, Taoyuan City (TW);
Chun-I Lin, Taoyuan City (TW)

(73) Assignee: **QUANTA COMPUTER INC.**,
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 35 days.

(21) Appl. No.: **19/015,072**

(22) Filed: **Jan. 9, 2025**

(30) **Foreign Application Priority Data**

Dec. 23, 2024 (TW) 113150168

(51) **Int. Cl.**
H01Q 1/48 (2006.01)
H01Q 1/27 (2006.01)
H01Q 5/20 (2015.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 9/0421** (2013.01); **H01Q 1/27** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/20** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/22; H01Q 1/243; H01Q 1/38;
H01Q 1/48; H01Q 9/0421; H01Q
5/30-392

See application file for complete search history.

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Primary Examiner — Hasan Islam

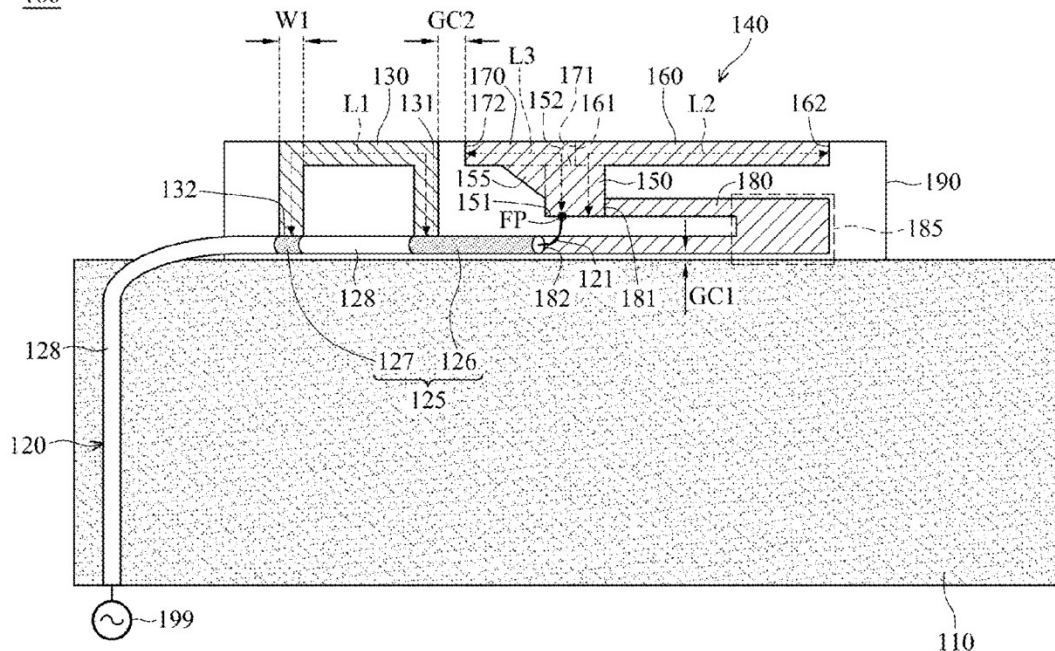
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

A communication device includes a ground plane, an antenna structure, a cable, a connection metal element, and a dielectric substrate. The antenna structure has a feeding point. The cable includes a feeding conductor and a grounding conductor. The feeding conductor is coupled to the feeding point. The grounding conductor includes a first conductive region and a second conductive region. The connection metal element is coupled between the first conductive region and the second conductive region of the grounding conductor. The antenna structure and the connection metal element are disposed on the dielectric substrate. The cable is adjacent to the ground plane. Neither the first conductive region nor the second conductive region of the grounding conductor is coupled to the ground plane.

10 Claims, 3 Drawing Sheets

100





US012666528B2

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

(10) **Patent No.:** **US 12,666,528 B2**
(45) **Date of Patent:** **Jun. 23, 2026**

(54) **MULTI-CONFIGURABLE ANTENNA TUNER
CIRCUIT BOARD**

(71) Applicant: **DELL PRODUCTS L.P.**, Round Rock,
TX (US)

(72) Inventors: **Changsoo Kim**, Cedar Park, TX (US);
Yun-Tsan Lee, East District (TW);
Ching Wei Chang, Cedar Park, TX
(US); **Sumana Pallampati**, Austin, TX
(US)

(73) Assignee: **Dell Products L.P.**, Round Rock, TX
(US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 239 days.

(21) Appl. No.: **18/496,869**

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

(65) **Prior Publication Data**
US 2025/0142714 A1 May 1, 2025

(51) **Int. Cl.**
H05K 1/02 (2006.01)
H01Q 1/22 (2006.01)
H05K 1/11 (2006.01)
H05K 3/303 (2026.01)

(52) **U.S. Cl.**
CPC **H05K 1/0243** (2013.01); **H01Q 1/22**
(2013.01); **H05K 1/111** (2013.01); **H05K**
3/303 (2013.01); **H05K 1/0277** (2013.01);
H05K 2201/10015 (2013.01); **H05K**
2201/10022 (2013.01); **H05K 2201/1003**
(2013.01); **H05K 2201/10098** (2013.01)

(58) **Field of Classification Search**

CPC H05K 1/0243; H05K 1/111; H05K 3/303;
H05K 1/0277; H05K 2201/10015; H05K
2201/10022; H05K 2201/1003; H05K
2201/10098; H01Q 1/22; H01Q 1/241;
H01Q 1/38; H01Q 5/335

See application file for complete search history.

(56) **References Cited**

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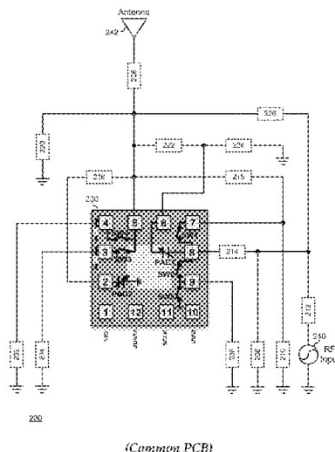
Primary Examiner — Renan Luque

(74) *Attorney, Agent, or Firm* — Larson Newman, LLP

(57) **ABSTRACT**

A printed circuit board includes an antenna and a plurality of component pads. The printed circuit board is configured to provide an antenna tuner for a mobile data communication network. Each component pad is configured, when populated with an electrical component, to couple the electrical component to the printed circuit board to form an antenna tuner circuit for the antenna. When a first set of the component pads are populated with electrical components, the antenna tuner circuit is configured as an aperture tuner for the antenna. When a second set of the component pads are populated with electrical components, the antenna tuner circuit is configured as an impedance tuner for the antenna.

14 Claims, 10 Drawing Sheets





US012671163B2

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

(10) **Patent No.:** **US 12,671,163 B2**
(45) **Date of Patent:** **Jun. 30, 2026**

(54) **ANTENNA MODULE**

(71) Applicant: **AMONSENSE CO., LTD**, Cheonan-si (KR)

(72) Inventors: **Kyung Hyun Ryu**, Cheonan-si (KR);
Se Ho Lee, Cheonan-si (KR); **Hyung Il Baek**, Cheonan-si (KR)

(73) Assignee: **AMONSENSE CO., LTD**, Cheonan-si (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 418 days.

(21) Appl. No.: **18/258,802**

(22) PCT Filed: **Dec. 8, 2021**

(86) PCT No.: **PCT/KR2021/018516**

§ 371 (c)(1),

(2) Date: **Jun. 21, 2023**

(87) PCT Pub. No.: **WO2022/145785**

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

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Dec. 28, 2020 (KR) 10-2020-0184513

Dec. 8, 2021 (KR) 10-2021-0174475

(51) **Int. Cl.**

H01Q 1/02 (2006.01)

H01Q 1/38 (2006.01)

H01Q 9/04 (2006.01)

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

CPC **H01Q 1/02** (2013.01); **H01Q 1/38** (2013.01); **H01Q 9/0407** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/2283; H01Q 9/0414; H01Q 9/045;
H01Q 21/065; H04B 1/0057; H01P
1/20327; H01P 1/2135; H03H 7/12

See application file for complete search history.

(56) **References Cited**

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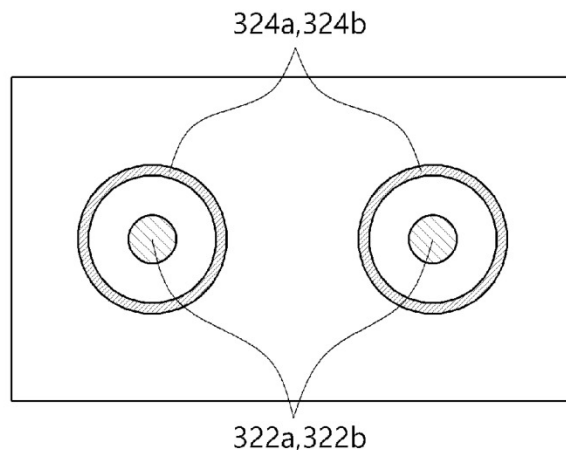
Primary Examiner — Alexander H Taningco

(74) Attorney, Agent, or Firm — BROADVIEW IP LAW, PC

(57) **ABSTRACT**

An antenna module is provided. An antenna module includes a radiation pattern that functions as an antenna; a base layer disposed on one side of the radiation pattern and implemented by stacking a plurality of low-temperature co-fired ceramic (LTCC) substrates to have a connection pattern electrically connected to the radiation pattern; an RF chipset electrically connected to the radiation pattern through the connection pattern to generate an RF signal to be transmitted from the radiation pattern or to process an RF signal received from the antenna; a thermal interface material (TIM) disposed at one side of the RF chipset to transfer heat generated from the RF chipset; a heat sink disposed at one side of the TIM to spread heat transferred from the TIM;

(Continued)





(10) **Patent No.:** US 12,671,164 B2
(45) **Date of Patent:** Jun. 30, 2026

None

See application file for complete search history.

(56)

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Primary Examiner — Dameon E Levi
Assistant Examiner — Anh Ho

(57)

ABSTRACT

An electronic device includes a metal back cover, a metal frame, a first antenna module and a second antenna module. The metal frame includes a first and a second disconnection portion, a first and a second connection portion. The first and the second connection portion are connected to the metal back cover. The first disconnection portion is separated from the first connection portion, the metal back cover and the second disconnection portion to form a first slot. The second disconnection portion is connected to the second connection portion and is separated from the metal back cover to form a second slot. The first antenna module is connected to the first disconnection portion, and forms a first antenna path. The second antenna module is connected to the second disconnection portion, and forms a second and a third antenna path with the second disconnection portion and the metal back cover.

(65) **Prior Publication Data**

US 2024/0072411 A1 Feb. 29, 2024

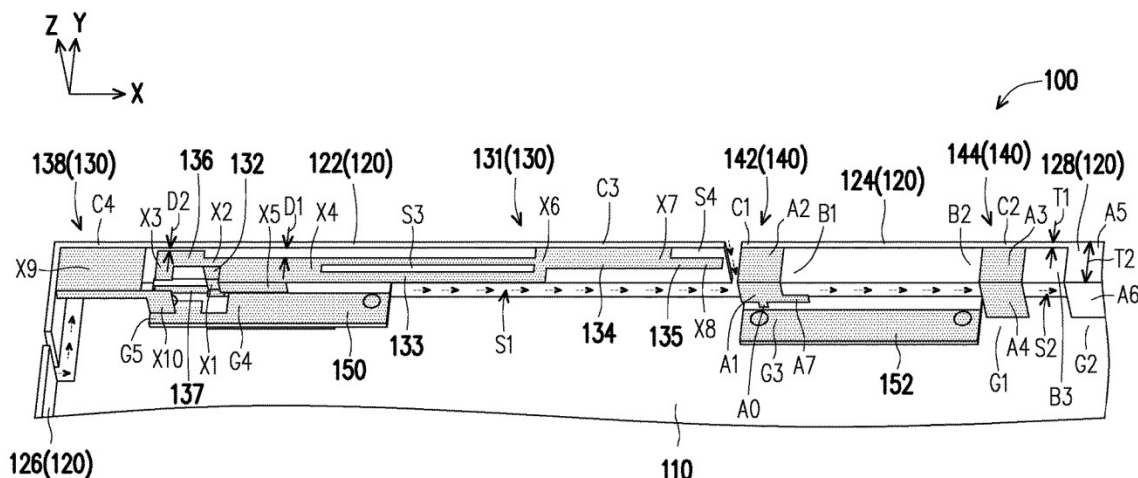
(30) **Foreign Application Priority Data**

Aug. 24, 2022 (TW) 111131820

(51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01Q 5/40 (2015.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/22** (2013.01); **H01Q 5/40**
(2015.01); **H01Q 9/045** (2013.01)

12 Claims, 7 Drawing Sheets





US012671169B2

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

(10) **Patent No.:** **US 12,671,169 B2**
(45) **Date of Patent:** **Jun. 30, 2026**

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

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

(72) Inventors: **Yen-Tze Peng**, Hsinchu (TW);
Chun-Hsiang Chuang, 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 577 days.

(21) Appl. No.: **18/054,202**

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

(65) **Prior Publication Data**
US 2023/0411828 A1 Dec. 21, 2023

(30) **Foreign Application Priority Data**
Jun. 21, 2022 (TW) 111122963

(51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01Q 5/35 (2015.01)
H01Q 5/378 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 1/2291** (2013.01); **H01Q 1/2266** (2013.01); **H01Q 5/35** (2015.01); **H01Q 5/378** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/2291; H01Q 1/2266; H01Q 5/35; H01Q 5/378
See application file for complete search history.

(56) **References Cited**

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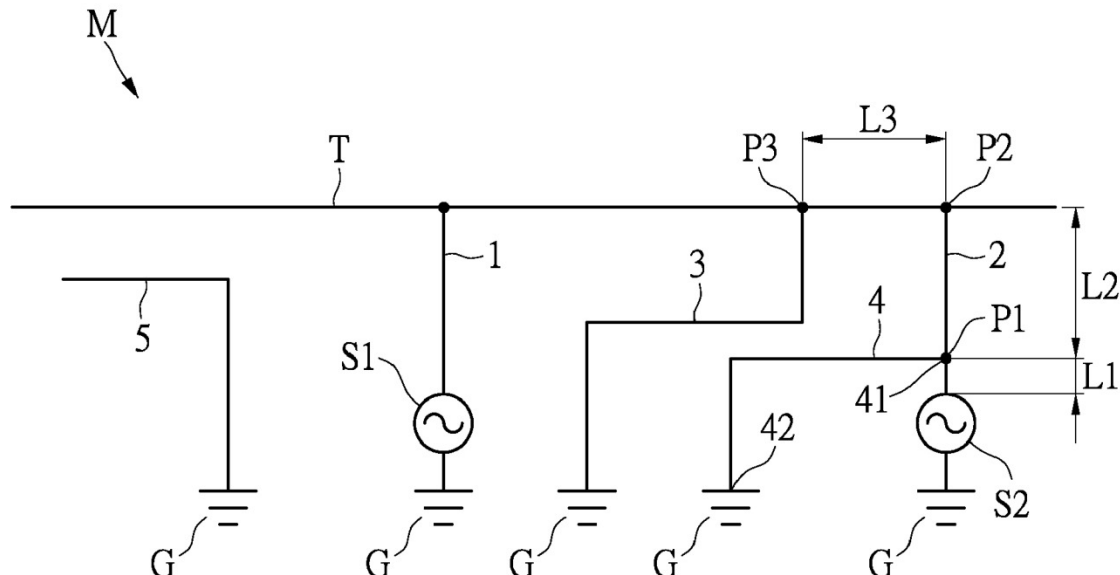
Primary Examiner — Alexander H Taningco

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

(57) **ABSTRACT**

An antenna structure and an electronic device are provided. The electronic device includes a housing and an antenna structure disposed in the housing. The antenna structure includes a radiating element, a first feeding element with a first feeding portion connected to the radiating element, a second feeding element with a second feeding portion connected to the radiating element, a grounding element connected to the radiating element and located between the first feeding element and the second feeding element, and a grounding branch with a first end connected to the second feeding portion and a second end connected to a ground plane. The first feeding element and the second feeding element are used for feeding respective signals to excite the radiating element to respectively generate a first radiation pattern and a second radiation pattern. The first radiation pattern is different from the second radiation pattern.

14 Claims, 8 Drawing Sheets





US012671170B2

(12) **United States Patent**
Fabrega Sanchez et al.

(10) **Patent No.:** **US 12,671,170 B2**
(45) **Date of Patent:** **Jun. 30, 2026**

(54) **MULTI-BAND ANTENNA SUPPORT**

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

(72) Inventors: **Jorge Fabrega Sanchez**, San Diego, CA (US); **Chinmaya Mishra**, San Diego, CA (US); **Darryl Sheldon Jessie**, San Diego, CA (US); **Bhushan Shanti Asuri**, San Diego, CA (US); **Allen Minh-Triet Tran**, Rancho Santa Fe, CA (US); **Mohammad Ali Tassoudji**, San Diego, CA (US); **Jeongil Jay Kim**, San Diego, CA (US); **Gurkanwal Singh Sahota**, Rancho Santa Fe, CA (US); **Kevin Hsi-Huai Wang**, San Diego, CA (US)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 345 days.

(21) Appl. No.: **18/321,879**

(22) Filed: **May 23, 2023**

(65) **Prior Publication Data**
US 2024/0396205 A1 Nov. 28, 2024

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

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 5/307** (2015.01); **H01Q 9/0421** (2013.01); **H01Q 21/08** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 5/307; H01Q 5/42; H01Q 1/2283; H01Q 9/0407; H01Q 9/0421; H01Q 9/42; H01Q 21/08; H01Q 21/24

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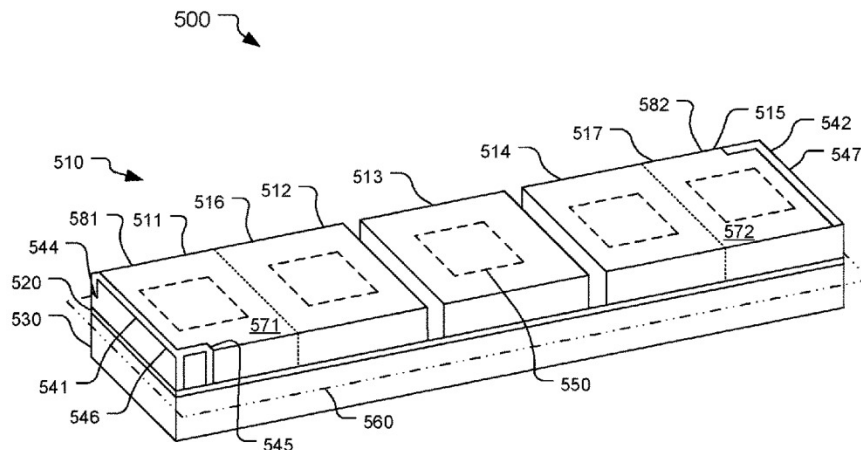
Primary Examiner — Moustapha Diaby

(74) *Attorney, Agent, or Firm* — Smith Tempel Blaha LLC/Qualcomm

(57) **ABSTRACT**

A method of transducing signals includes: transducing first signals, of frequencies above at least 24 GHz, between first wireless signals and first guided signals, using a plurality of first antenna elements comprising at least one first substrate and at least one ground conductor; and transducing second signals, of frequencies within at least a portion of a frequency range between 8 GHz and 24 GHz, between second wireless signals and second guided signals, using at least one second antenna element each comprising a transducer disposed on a second substrate that at least partially overlaps an active component set and the at least one first substrate, or disposed on at least one of the at least one first substrate, the active component set being configured to provide signals for

(Continued)





US012671179B2

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

(10) **Patent No.:** **US 12,671,179 B2**
(45) **Date of Patent:** **Jun. 30, 2026**

(54) **ELECTRONIC DEVICE WITH REAR WALL ANTENNA PARASITIC**

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

(72) Inventors: **Dingliang Wen**, Shenzhen (CN); **Yuan Tao**, Santa Clara, CA (US); **Junying Liu**, Shanghai (CN); **Lu Zhang**, Shanghai (CN); **Yiren Wang**, Cupertino, CA (US); **Tao Wang**, Cupertino, CA (US); **Nikolaj P Kammersgaard**, Copenhagen (DK); **Erda Wen**, San Diego, CA (US); **Hao Xu**, Cupertino, CA (US); **Hongfei Hu**, Cupertino, CA (US); **Carlo Di Nallo**, Belmont, CA (US); **Mattia Pascolini**, San Francisco, CA (US); **Aditya Gupta**, Cupertino, CA (US); **Elisabeth A Lang**, San Francisco, CA (US)

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

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

(21) Appl. No.: **18/645,322**

(22) Filed: **Apr. 24, 2024**

(65) **Prior Publication Data**

US 2025/0337164 A1 Oct. 30, 2025

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

(52) **U.S. Cl.**
CPC **H01Q 5/378** (2015.01); **H01Q 1/241** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 5/378; H01Q 1/241; H01Q 9/42;
H01Q 1/243; H01Q 1/36; H01Q 1/22;
H01Q 1/44; H01Q 1/50

See application file for complete search history.

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Primary Examiner — Dameon E Levi

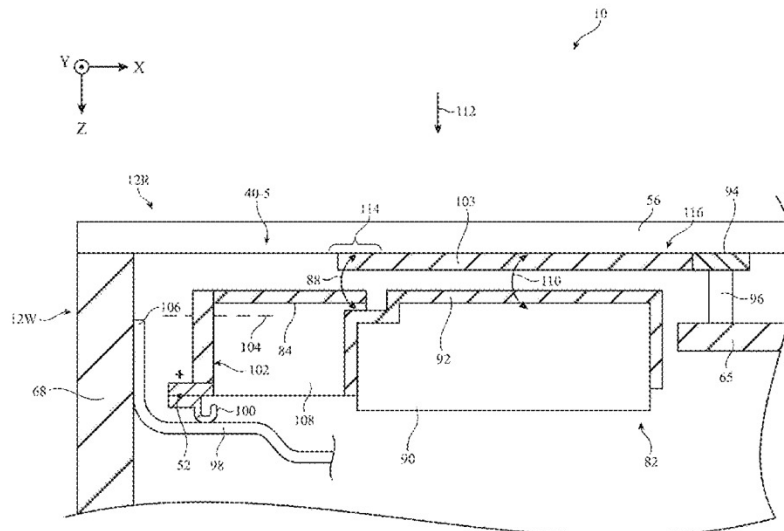
Assistant Examiner — Jordan E. DeWitt

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

(57) **ABSTRACT**

An electronic device may be provided with peripheral conductive housing structures, a rear wall, and a vent that includes a conductive cowling. The device may include an antenna having an antenna arm coupled to a positive antenna feed terminal and having a parasitic element. The parasitic element may be formed from a conductive trace that is layered onto the rear wall, that is indirectly fed by the antenna arm, and that overlaps a portion of the conductive cowling. The parasitic element may be shorted to a conductive bracket on the rear wall or may be separated from the bracket by a gap. If desired, the conductive cowling may form some or all of a parasitic element for the antenna. The conductive cowling may be indirectly fed by the conductive trace and/or may include an extension that is indirectly fed by the antenna arm.

20 Claims, 13 Drawing Sheets





US012671181B2

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

(10) **Patent No.:** **US 12,671,181 B2**
(45) **Date of Patent:** **Jun. 30, 2026**

(54) **ULTRA-WIDEBAND ANTENNA MATCHING**

(56)

References Cited

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

U.S. PATENT DOCUMENTS

(72) Inventors: **Han Wang**, Campbell, CA (US); **Jingni Zhong**, Santa Clara, CA (US); **Alden T Rush**, San Diego, CA (US); **Ming Chen**, Cupertino, CA (US); **Yiren Wang**, Cupertino, CA (US); **Yuan Tao**, Santa Clara, CA (US); **Hao Xu**, Cupertino, CA (US); **Hongfei Hu**, Cupertino, CA (US); **Mattia Pascolini**, San Francisco, CA (US)

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

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KR-20100066265-A Translation (Year: 2010).*
KR-20100066265-A (Year: 2010).*

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 192 days.

Primary Examiner — Dameon E Levi

Assistant Examiner — Gurbir Singh

(21) Appl. No.: **18/458,893**

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

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

(65) **Prior Publication Data**

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Related U.S. Application Data

(60) Provisional application No. 63/403,637, filed on Sep. 2, 2022.

(51) **Int. Cl.**
H01Q 5/50 (2015.01)
H01P 3/08 (2006.01)
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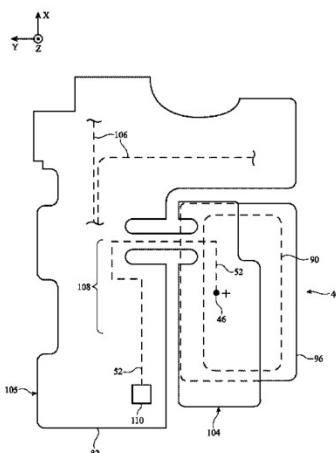
(52) **U.S. Cl.**
CPC **H01Q 5/50** (2015.01); **H01P 3/08**
(2013.01); **H01Q 1/243** (2013.01); **H01Q 5/25**
(2015.01)

(58) **Field of Classification Search**
CPC H01P 3/08; H01P 5/085; H01Q 1/243;
H01Q 1/2283; H01Q 5/25; H01Q 1/38;
H01Q 5/50; H01Q 5/335; H01Q 1/241
See application file for complete search history.

(57) **ABSTRACT**

An electronic device may be provided with an antenna resonating element on a first substrate that is mounted to a second substrate. A signal conductor may be coupled to a feed terminal on the antenna resonating element. The signal conductor may include impedance matching structures for the antenna. The impedance matching structures may include an open transmission line stub, a grounded transmission line stub, and a phase shifting segment. The impedance matching structures may configure the antenna to exhibit a wide bandwidth in an ultra-wideband (UWB) frequency band. If desired, the signal conductor may have a phase-shifting segment configured to match a non-50 Ohm impedance of a radio-frequency front end coupled to the signal conductor.

17 Claims, 15 Drawing Sheets





US012676402B2

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

(10) **Patent No.:** **US 12,676,402 B2**
(45) **Date of Patent:** **Jul. 7, 2026**

(54) **ELECTRONIC DEVICE INCLUDING ANTENNA**

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

(72) Inventors: **Hyungjoo Lee**, Suwon-si (KR);
Soonheung Kwon, Suwon-si (KR);
Hosaeng Kim, Suwon-si (KR); **Sumin Yun**, Suwon-si (KR)

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

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

(21) Appl. No.: **18/484,059**

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

(65) **Prior Publication Data**
US 2024/0079762 A1 Mar. 7, 2024

Related U.S. Application Data

(63) Continuation of application No.
PCT/KR2023/012901, filed on Aug. 30, 2023.

(30) **Foreign Application Priority Data**

Sep. 6, 2022 (KR) 10-2022-0112776
Oct. 18, 2022 (KR) 10-2022-0133922

(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 9/045**
(2013.01); **H01Q 21/24** (2013.01); **H04M 1/026** (2013.01)

(58) **Field of Classification Search**
CPC ... H04B 1/40; H04B 5/43; H04B 7/02; H04B 7/04; H04B 7/0404
See application file for complete search history.

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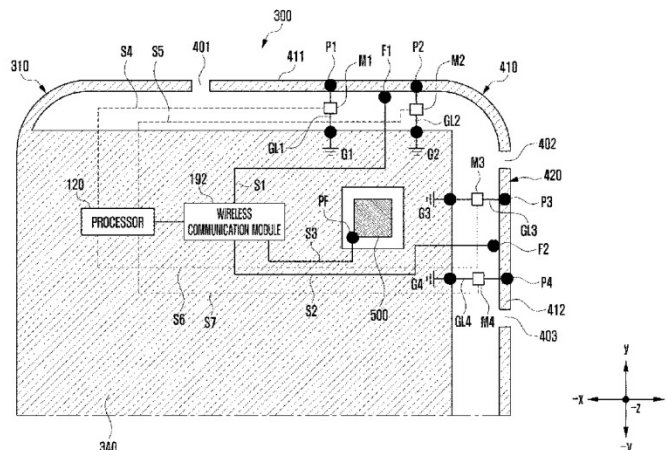
Primary Examiner — Wen W Huang

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

(57) **ABSTRACT**

An electronic device is provided. The electronic device includes a housing including a lateral member, a printed circuit board disposed inside the housing and including a first ground point and a second ground point electrically connected to a first point and a second point of a first conductive part of the lateral member, a first antenna including a first feeding point disposed between the first point and the second point, and configured to transmit and/or receive a first polarization signal, a patch antenna including a first feeder point and configured to transmit and/or receive a first polarization signal, a wireless communication module electrically connected to the first feeding point and the first feeder point, and a processor electrically connected to the wireless communication module and configured to transmit

(Continued)





US012676419B2

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

(10) **Patent No.:** **US 12,676,419 B2**
(45) **Date of Patent:** **Jul. 7, 2026**

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

(58) **Field of Classification Search**

CPC H01Q 13/10; H01Q 5/328; H01Q 1/241;
H01Q 1/243; H01Q 5/378; H01Q 9/42;
(Continued)

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

(72) Inventors: **Chang Qin**, Shenzhen (CN); **Tiezhu Liang**, Shenzhen (CN); **Chao Feng**, Shenzhen (CN); **Guannan Chen**, Shenzhen (CN); **Yihang Hao**, Shenzhen (CN)

(56)

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

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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 51 days.

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(21) Appl. No.: **18/838,877**

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(22) PCT Filed: **May 10, 2023**

Nasimuddin et al., "A Wideband High Gain Circularly Polarized Antenna for Satellite Applications," 2019 IEEE Asia-Pacific Microwave Conference (APMC), Singapore, pp. 234-236 (Dec. 10-13, 2019).

(86) PCT No.: **PCT/CN2023/093185**

§ 371 (c)(1),

(2) Date: **Aug. 15, 2024**

Primary Examiner — Dimary S Lopez Cruz

Assistant Examiner — Bamidele A Immanuel

(87) PCT Pub. No.: **WO2024/027258**

PCT Pub. Date: **Feb. 8, 2024**

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

(65) **Prior Publication Data**

US 2025/0158287 A1 May 15, 2025

(57)

ABSTRACT

(30) **Foreign Application Priority Data**

Aug. 3, 2022 (CN) 202210926634.4

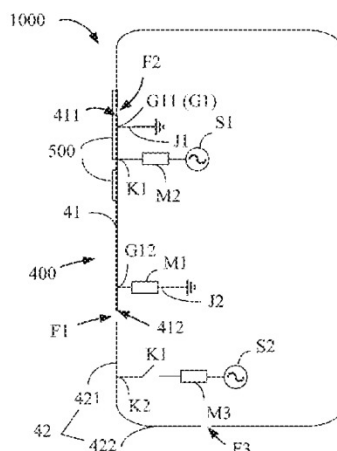
Embodiments of this application provide an antenna structure. The antenna structure includes a first radiation stub, a second radiation stub, and a first feed. The first radiation stub includes two grounding points and a first feed point. The first feed point is located between the two grounding points, and the two grounding points are configured for grounding. The first radiation stub is spaced apart from a ground connected to the two grounding points to form a slot, and the first radiation stub forms a slot antenna. The second radiation stub has a gap with the first radiation stub, and the second radiation stub is coupled to the first radiation stub through the gap. The first feed is electrically connected to the first

(Continued)

(51) **Int. Cl.**
H01Q 1/36 (2006.01)
H01Q 5/328 (2015.01)

(Continued)

(52) **U.S. Cl.**
CPC **H01Q 13/10** (2013.01); **H01Q 5/328** (2015.01); **H01Q 1/241** (2013.01)





US012683266B2

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

(10) **Patent No.:** **US 12,683,266 B2**
(45) **Date of Patent:** ***Jul. 14, 2026**

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

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

(72) Inventors: **Qiao Sun**, Xi'an (CN); **Kun Li**, Xi'an (CN); **Liang Lu**, 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 120 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **18/649,166**

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

(65) **Prior Publication Data**
US 2024/0283137 A1 Aug. 22, 2024

Related U.S. Application Data
(63) Continuation of application No. 17/432,731, filed as application No. PCT/CN2020/074608 on Feb. 10, 2020, now Pat. No. 12,003,017.

(30) **Foreign Application Priority Data**
Feb. 27, 2019 (CN) 201910146738.1
Apr. 4, 2019 (CN) 201910278901.X

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

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/35** (2015.01); **H01Q 9/42** (2013.01); **H04M 1/0281** (2013.01)

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

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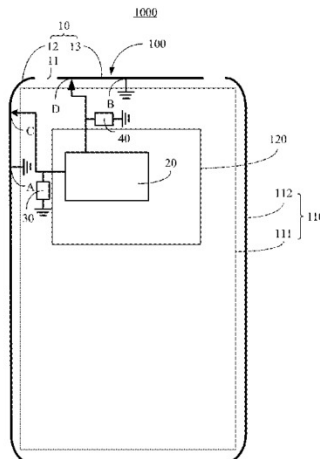
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Primary Examiner — Hasan Islam
(74) *Attorney, Agent, or Firm* — Conley Rose, P.C.

(57) **ABSTRACT**
A terminal device includes a radiator sharing antenna. The radiator sharing antenna includes a radiator that is divided into a first sub-radiator and a second sub-radiator through a gap, a first feeding point located on the first sub-radiator, and a second feeding point located on the second sub-radiator. The first feeding point is configured to pass a first radio frequency signal through resonance of the first sub-radiator and through parasitic resonance of the second sub-radiator, and the second feeding point is configured to pass a second radio frequency signal through resonance of the second sub-radiator and through parasitic resonance of the first sub-radiator.

24 Claims, 10 Drawing Sheets





US012683280B2

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

(10) **Patent No.:** **US 12,683,280 B2**
(45) **Date of Patent:** **Jul. 14, 2026**

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

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

(72) Inventors: **Lu Chen**, Beijing (CN); **Yiming Wang**, Beijing (CN); **Xiaoqiang Yang**, Beijing (CN); **Wei Zhao**, Beijing (CN); **Mengjiao Li**, Beijing (CN); **Zhifeng Zhang**, Beijing (CN)

(73) Assignees: **Beijing BOE Sensor Technology Co., Ltd.**, Beijing (CN); **BOE Technology Group Co., Ltd.**, Beijing (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 92 days.

(21) Appl. No.: **18/635,116**

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

(65) **Prior Publication Data**
US 2024/0356230 A1 Oct. 24, 2024

Related U.S. Application Data
(63) Continuation of application No. PCT/CN2023/089417, filed on Apr. 20, 2023.

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

(52) **U.S. Cl.**
CPC **H01Q 9/0442** (2013.01); **H01Q 9/045** (2013.01); **H01Q 9/285** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 9/0442; H01Q 9/045; H01Q 9/285
See application file for complete search history.

(56) **References Cited**

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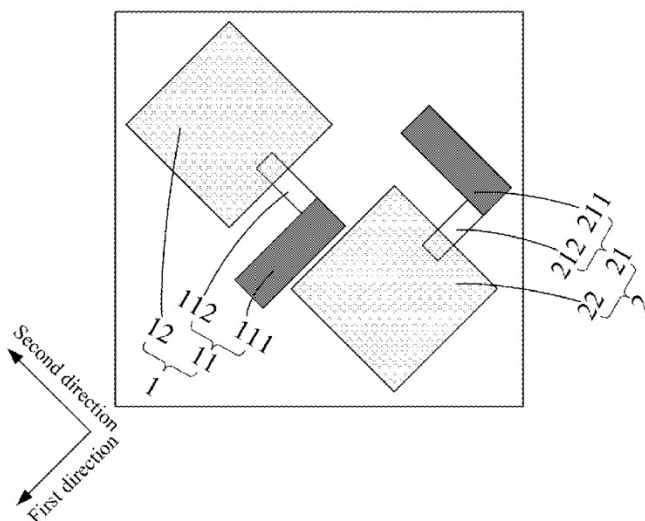
Primary Examiner — Thien M Le

(74) *Attorney, Agent, or Firm* — IPPro, PLLC

(57) **ABSTRACT**

Provided is an antenna. The antenna includes: a first antenna unit and a second antenna unit, wherein the first antenna unit includes a first phase-tuning structure and a first radiation structure, and the second antenna unit includes a second phase-tuning structure and a second radiation structure; wherein a first feed terminal of the first phase-tuning structure is electrically connected to the first radiation structure, and a first feed terminal of the second phase-tuning structure is electrically connected to the second radiation structure; and a feed direction of the first feed terminal of the first phase-tuning structure to the first radiation structure is a first direction, and a feed direction of the first feed terminal of the second phase-tuning structure to the second radiation structure is a second direction, the first direction being different from the second direction.

18 Claims, 11 Drawing Sheets





US012683294B2

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

(10) **Patent No.:** **US 12,683,294 B2**
(45) **Date of Patent:** **Jul. 14, 2026**

(54) **TERMINAL ANTENNA AND HIGH ISOLATION ANTENNA SYSTEM**

(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 299 days.

(21) Appl. No.: **18/258,285**

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

(86) PCT No.: **PCT/CN2022/137647**

§ 371 (c)(1),

(2) Date: **Jun. 19, 2023**

(87) PCT Pub. No.: **WO2023/207117**

PCT Pub. Date: **Nov. 2, 2023**

(65) **Prior Publication Data**

US 2024/0388011 A1 Nov. 21, 2024

(30) **Foreign Application Priority Data**

Apr. 29, 2022 (CN) 202210474925.4

(51) **Int. Cl.**

H01Q 5/35 (2015.01)

H01Q 1/52 (2006.01)

H01Q 5/307 (2015.01)

H01Q 5/342 (2015.01)

H01Q 5/357 (2015.01)

(Continued)

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

CPC **H01Q 21/28** (2013.01); **H01Q 1/521** (2013.01); **H01Q 7/00** (2013.01); **H01Q 9/0414** (2013.01); **H01Q 9/065** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/52; H01Q 1/521; H01Q 5/35; H01Q 5/342; H01Q 5/357; H01Q 7/00; H01Q 9/065; H01Q 9/20; H01Q 9/42; H01Q 21/28

See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Dimary S Lopez Cruz

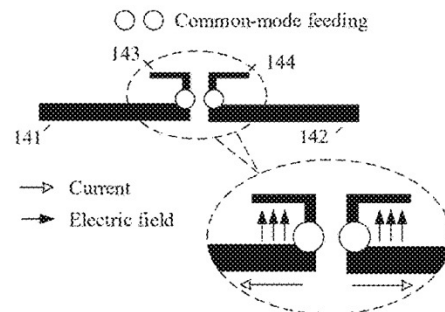
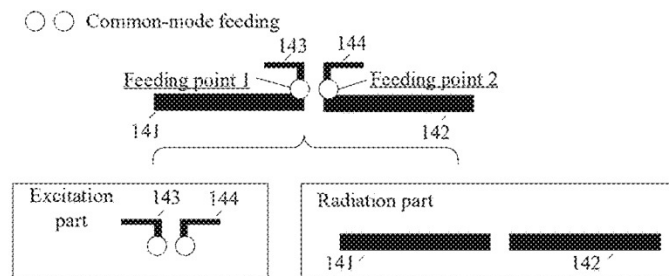
Assistant Examiner — Marin Stoytchev Stoytchev

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

(57) **ABSTRACT**

A terminal antenna includes a first excitation part and a first radiation part, and the first excitation part is disposed at a middle location of the first radiation part. A common-mode feed is disposed on the first excitation part, and the common-mode feed is disposed between the first radiation part and the first excitation part. The common-mode feed is one or two feeds disposed between the first excitation part and the first radiation part.

20 Claims, 44 Drawing Sheets





US012683295B2

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

(10) **Patent No.:** **US 12,683,295 B2**
(45) **Date of Patent:** **Jul. 14, 2026**

(54) **ELECTRONIC DEVICE COMPRISING ANTENNA**

(71) Applicants: **Samsung Electronics Co., Ltd.**,
Suwon-si (KR); **POSTECH RESEARCH AND BUSINESS DEVELOPMENT FOUNDATION**,
Pohang-si (KR)

(72) Inventors: **Wonbin Hong**, Pohang-si (KR); **Sumin Yun**, Suwon-si (KR); **Jachoon Jo**,
Suwon-si (KR); **Dongkwon Choi**,
Pohang-si (KR); **Hosaeng Kim**,
Suwon-si (KR)

(73) Assignees: **Samsung Electronics Co., Ltd.**,
Suwon-si (KR); **POSTECH RESEARCH AND BUSINESS DEVELOPMENT FOUNDATION**,
Pohang-si (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 87 days.

(21) Appl. No.: **18/507,641**

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

(65) **Prior Publication Data**
US 2024/0088575 A1 Mar. 14, 2024

Related U.S. Application Data
(63) Continuation of application No.
PCT/KR2022/006937, filed on May 13, 2022.

(30) **Foreign Application Priority Data**
May 13, 2021 (KR) 10-2021-0062047

(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 1/38** (2013.01); **H01Q 3/30**
(2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/38; H01Q 1/46;
H01Q 3/24; H01Q 3/26; H01Q 3/30;
H01Q 19/32; H01Q 21/205; H01Q 21/28
See application file for complete search history.

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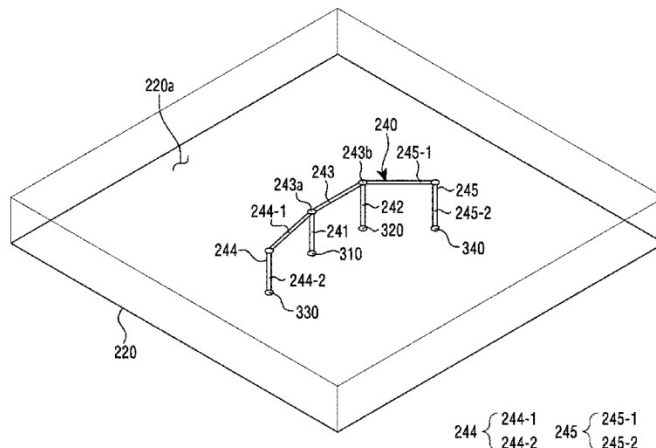
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Primary Examiner — Alexander H Tanningco
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**
An electronic device is provided. The electronic device includes a wireless communication circuit, a plurality of antennas, and a processor, a first antenna including a first conductive portion, a second conductive portion, a third conductive portion, a first conductive stub including a first portion extending in a direction parallel to a printed circuit board (PCB) with the third conductive portion at a first end of the third conductive portion contacting a first conductive portion and a portion bending at one end of the first portion
(Continued)





US012683296B2

(12) **United States Patent**
McGough

(10) **Patent No.:** **US 12,683,296 B2**
(45) **Date of Patent:** **Jul. 14, 2026**

(54) **VERTICALLY-POLARIZED
OMNIDIRECTIONAL ANTENNA WITH
BROADBAND AMPLITUDE TAPER**

(71) Applicant: **PCTEL, Inc.**, Bloomington, IL (US)

(72) Inventor: **Erin Patrick McGough**, Seven Hills,
OH (US)

(73) Assignee: **PCTEL, INC.**, Bloomington, IL (US)

(*) 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.: **18/761,851**

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

(65) **Prior Publication Data**

US 2026/0011931 A1 Jan. 8, 2026

(51) **Int. Cl.**
H01Q 21/29 (2006.01)
H01Q 1/42 (2006.01)

(Continued)

(52) **U.S. Cl.**
CPC **H01Q 21/29** (2013.01); **H01Q 1/42**
(2013.01); **H01Q 1/50** (2013.01); **H01Q 9/20**
(2013.01); **H01Q 13/10** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 21/29; H01Q 1/42; H01Q 1/50;
H01Q 9/20; H01Q 13/10
See application file for complete search history.

(56) **References Cited**

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vol. 61, No. 9, pp. 4538-4548, Sep. 2013, doi: 10.1109/TAP.2013.
2267199. (Year: 2013).*

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Primary Examiner — Regis J Betsch

Assistant Examiner — Jose A. Miranda Gonzalez

(74) *Attorney, Agent, or Firm* — Husch Blackwell LLP

(57) **ABSTRACT**

A vertically-polarized omnidirectional antenna, including: a
body including: a host printed circuit board (PCB) includ-
ing: first and second slots, and a metal flooded ground plane,
first and second antenna PCBs forming four dipole pairs, the
first and second antenna PCBs mounted to the host PCB,
respective first to third ground connection fillet tabs, the first
and second tabs being on an opposite side of the host PCB
from the third tab, the first to third tabs being on a same side
of its antenna PCB, an amplitude taper on each antenna PCB
at transitions between the host and antenna PCBs, including:
a first transmission line splitting off into a second transmis-
sion line and a third transmission line, the second transmis-
sion line feeding two antennas to form one dipole pair, the
third transmission line stepping down using a quarter-wave
transformer, and a radio frequency (RF) connector to receive a
power supply.

19 Claims, 29 Drawing Sheets

