



US012738655B1

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

(10) **Patent No.:** **US 12,738,655 B1**
(45) **Date of Patent:** **Sep. 15, 2026**

(54) **ANTENNA MODULE**

(71) Applicant: **Murata Manufacturing Co., Ltd.**,
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(72) Inventors: **Toumu Tanabe**, Nagaokakyo (JP);
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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 48 days.

(21) Appl. No.: **18/679,630**

(22) Filed: **May 31, 2024**

Related U.S. Application Data

(63) Continuation of application No.
PCT/JP2022/044158, filed on Nov. 30, 2022.

(30) **Foreign Application Priority Data**

Dec. 22, 2021 (JP) 2021-207801

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

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

(58) **Field of Classification Search**
CPC H01Q 9/0414; H01Q 9/30
See application file for complete search history.

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Primary Examiner — Dameon E Levi

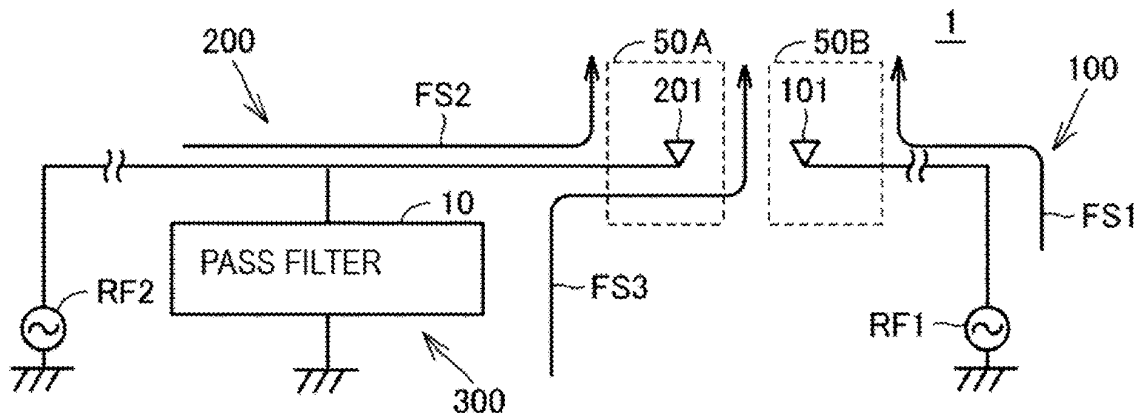
Assistant Examiner — Jordan E. DeWitt

(74) *Attorney, Agent, or Firm* — Keating & Bennett, LLP

(57) **ABSTRACT**

An antenna module includes a first antenna device with a first resonant frequency, a second antenna device with a second resonant frequency, and a pass filter connected between a predetermined position in the second antenna device and the ground. The first antenna device includes a first radiating element connected to a first feed circuit. The second antenna device includes a second radiating element connected to a second feed circuit. The pass filter blocks the second resonant frequency and the first and second radiating

(Continued)





US012725911B2

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

(10) **Patent No.:** **US 12,725,911 B2**
(45) **Date of Patent:** **Sep. 1, 2026**

(54) **ANTENNA STRUCTURE WITH PERIODIC PATTERNS**

(71) Applicants: **ONEWAVE TECHNOLOGY CO., LTD.**, Taipei City (TW); **Yun-Chan Tsai**, Taipei City (TW)

(72) Inventors: **Yun-Chan Tsai**, Taipei City (TW); **Shi-Yu Chiu**, Taipei City (TW); **Shi-Hong Yang**, Taipei City (TW); **Chin-Yun Hsu**, Taipei City (TW); **Chien-Ku Kuo**, Taipei City (TW)

(73) Assignees: **Yun-Chan Tsai**, Taipei City (TW); **ONEWAVE TECHNOLOGY CO., LTD.**, Taipei City (TW)

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

(21) Appl. No.: **19/088,838**

(22) Filed: **Mar. 24, 2025**

(65) **Prior Publication Data**
US 2026/0100498 A1 Apr. 9, 2026

(30) **Foreign Application Priority Data**
Oct. 8, 2024 (TW) 113210867

(51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01Q 5/30 (2015.01)
H01Q 5/50 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 1/2283** (2013.01); **H01Q 5/30** (2015.01); **H01Q 5/50** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/22; H01Q 1/2283; H01Q 1/38; H01Q 1/48; H01Q 5/30; H01Q 5/371; H01Q 5/50; G06K 19/07773
See application file for complete search history.

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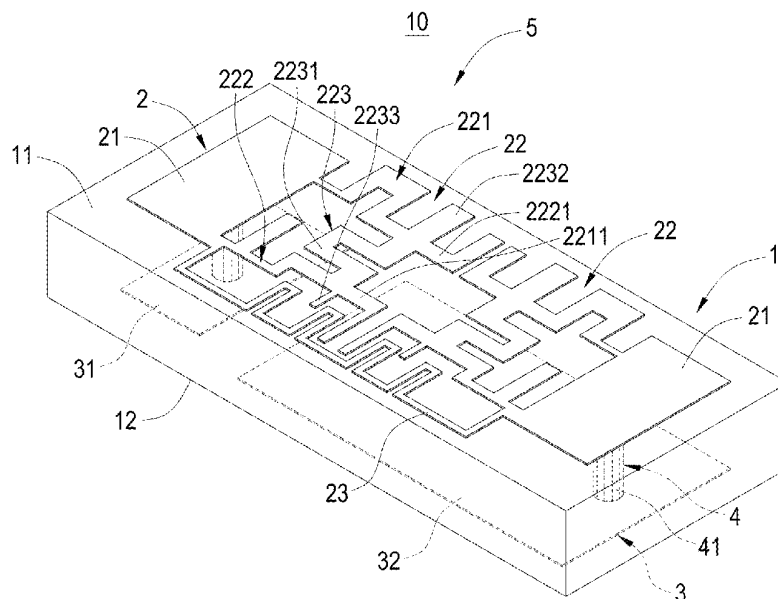
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Primary Examiner — Hasan Islam
(74) *Attorney, Agent, or Firm* — Studebaker Brackett PLLC

(57) **ABSTRACT**

An antenna structure at least includes a chip antenna. The chip antenna includes: a carrier, a first radiating unit, a second radiating unit, and an electric conductor. The first radiating unit is repeatedly designed with two or more periodic pattern layers to increase the bandwidth of the chip antenna and reduce the frequency point of the chip antenna, thereby improving the performance of the antenna. The first radiating unit is arranged on a top surface of the carrier to control the high-frequency band impedance, resonant frequency, and radiation effect, and use two or more periodic pattern layers to generate the frequency multiplication of the low-frequency band and control the frequency offset of the high-frequency band. The second radiating unit on a bottom surface controls the low-frequency band to achieve the predetermined target impedance, resonant frequency, bandwidth, and radiation effect. The size of the antenna is effectively reduced.

12 Claims, 3 Drawing Sheets





US012719181B2

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

(10) **Patent No.:** **US 12,719,181 B2**
(45) **Date of Patent:** **Aug. 25, 2026**

(54) **HIGH-GAIN, OMNI-DIRECTIONAL
ANTENNA SYSTEMS FOR MIMO
TECHNOLOGIES**

(71) Applicant: **Mimosa Networks, Inc.**, Santa Clara,
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(72) Inventors: **John Sanford**, Escondido, CA (US);
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(US); **Justin Lee**, Santa Clara, CA
(US); **Carlos Ramos**, San Jose, CA
(US); **Syed Aon Mujtaba**, Santa Clara,
CA (US)

(73) Assignee: **Mimosa Networks, Inc.**, 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 0 days.

(21) Appl. No.: **18/963,267**

(22) Filed: **Nov. 27, 2024**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. 18/420,616, filed on
Jan. 23, 2024, now Pat. No. 12,212,070, which is a
continuation of application No. 18/107,453, filed on
Feb. 8, 2023, now Pat. No. 11,936,114, which is a
continuation of application No. 17/827,360, filed on
May 27, 2022, now Pat. No. 11,637,384, which is a
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(51) **Int. Cl.**
H01Q 21/20 (2006.01)
H01Q 9/04 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 21/205** (2013.01); **H01Q 9/0428**
(2013.01); **H01Q 21/26** (2013.01); **H04B**
7/0413 (2013.01); **H04B 7/10** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 21/26; H01Q 21/24; H01Q 21/065;
H01Q 21/205; H01Q 25/00; H01Q
9/0428;

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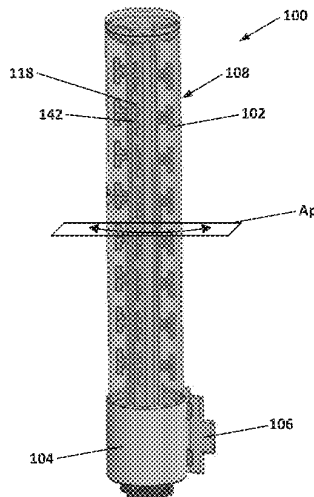
Primary Examiner — Monica C King

(74) *Attorney, Agent, or Firm* — Carr & Ferrell LLP

(57) **ABSTRACT**

High-gain, omni-directional antenna systems for MIMO
technologies are disclosed herein. An example antenna sys-
tem comprises two arrays of horizontally polarized radiating
elements and two arrays of vertically polarized radiating
elements. Each array has a roughly 180-degree radiation
pattern, disposed about a central axis in a common horizon-
tal plane. The horizontally polarized radiating elements
comprise a plurality of slot elements and the vertically
polarized radiating elements comprise a plurality of dipole
elements. Each of the two arrays of horizontally polarized
radiating elements and each of the two arrays of vertically
polarized radiating elements arrays are fed using a corporate
feed. The example antenna system further comprises at least
one printed circuit board that includes a corporate feed that
is fabricated onto the at least one printed circuit board.

20 Claims, 7 Drawing Sheets





US012719158B2

(12) **United States Patent**
Jo

(10) **Patent No.:** **US 12,719,158 B2**
(45) **Date of Patent:** **Aug. 25, 2026**

(54) **ARTIFICIAL INTELLIGENCE EMPOWERED
MULTI-LAYER COUPLING-CONTROLLED
ANTENNA SYSTEM**

(56) **References Cited**

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(71) Applicant: **SkyMirr, Inc.**, Melbourne, FL (US)

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(72) Inventor: **Youngmin Jo**, Melbourne, FL (US)

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(73) Assignee: **SKYMIRR, INC.**, Melbourne, FL (US)

KR 20230059353 A * 5/2023 H01Q 1/24
WO WO-2022177278 A1 * 8/2022 H04B 1/401

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 120 days.

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(21) Appl. No.: **18/908,282**

Primary Examiner — Hoang V Nguyen

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

(74) *Attorney, Agent, or Firm* — John L. DeAngelis;
Wolter Van Dyke Davis, PLLC

(65) **Prior Publication Data**

US 2025/0300345 A1 Sep. 25, 2025

(57) **ABSTRACT**

Related U.S. Application Data

(60) Provisional application No. 63/542,997, filed on Oct. 6, 2023.

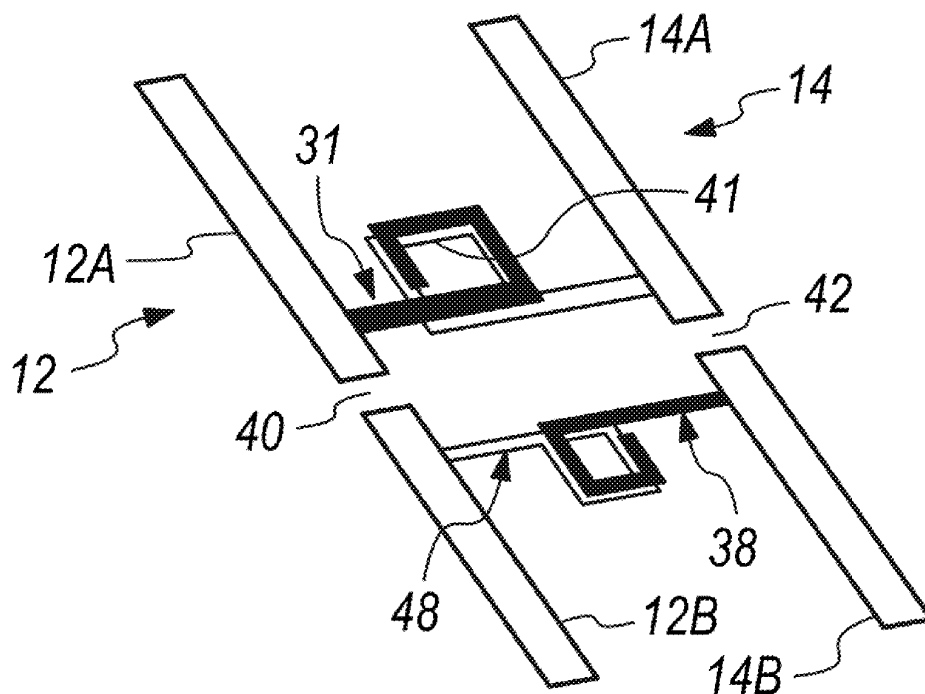
An antenna system. The system comprises first and second spaced-apart antennas each one formed in an upper conductive layer and a lower conductive layer of a printed circuit board. Coupling structures (four coupling structures in one embodiment) disposed between the first and second antennas are formed in either the upper conductive layer or the lower conductive layer and conductively connected to one of the first antenna or the second antenna. The coupling structures formed in the upper conductive layer overlie those formed in the lower conductive layer. The direction of current flow in the coupling structures reduces interference between the electromagnetic fields radiated from the first and the second antennas.

(51) **Int. Cl.**
H01Q 1/52 (2006.01)
H01Q 9/20 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/521** (2013.01); **H01Q 9/20** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/52; H01Q 1/521; H01Q 9/20
See application file for complete search history.

20 Claims, 9 Drawing Sheets





US012719155B2

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

(10) **Patent No.:** **US 12,719,155 B2**
(45) **Date of Patent:** **Aug. 25, 2026**

(54) **MULTI-BAND ANTENNA AND MOBILE COMMUNICATION BASE STATION WITH MODULAR DESIGN**

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

(72) Inventors: **Maximilian Göttl**, Frasdorf (DE);
Florian Leinenbach, Kolbermoor (DE);
Thomas Ettstaller, Bad Aibling (DE);
Christoph Staita, Oberaudorf (DE)

(73) Assignee: **Telefonaktiebolaget LM Ericsson (publ)**, Stockholm (SE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 63 days.

(21) Appl. No.: **18/682,179**

(22) PCT Filed: **Aug. 11, 2021**

(86) PCT No.: **PCT/EP2021/072392**

§ 371 (c)(1),

(2) Date: **Feb. 8, 2024**

(87) PCT Pub. No.: **WO2023/016639**

PCT Pub. Date: **Feb. 16, 2023**

(65) **Prior Publication Data**

US 2024/0380099 A1 Nov. 14, 2024

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/42 (2015.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/246** (2013.01); **H01Q 5/42** (2015.01); **H01Q 5/48** (2015.01); **H01Q 19/108** (2013.01);
(Continued)

(58) **Field of Classification Search**

CPC H01Q 1/246; H01Q 5/40; H01Q 5/42; H01Q 5/48; H01Q 19/10; H01Q 19/108;
(Continued)

(56) **References Cited**

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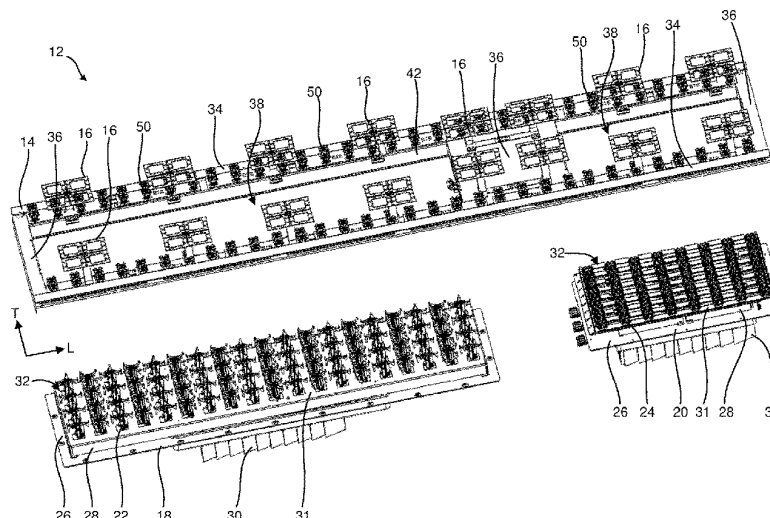
Primary Examiner — Robert Karacsony

(74) *Attorney, Agent, or Firm* — Withrow & Terranova, PLLC

(57) **ABSTRACT**

A multi-band antenna has first radiators, second radiators, a frame and at least one insert. The frame comprises a frame reflector surface, the first radiators are mounted to the frame, and the frame defines at least one window for receiving the at least one insert. The insert comprises a base having an insert reflector surface, the second radiators are mounted to the insert, and the base is located in the at least one window. The frame reflector surface and the insert reflector surface together form a common reflector for the first radiators. Further, a mobile communication base station is shown.

13 Claims, 3 Drawing Sheets





US012719154B2

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

(10) **Patent No.:** **US 12,719,154 B2**
(45) **Date of Patent:** **Aug. 25, 2026**

(54) **ANTENNA AND BASE STATION DEVICE**

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

(72) Inventors: **Chen Huang**, Dongguan (CN); **Dingjiu Daojian**, Dongguan (CN); **Chengdai Xue**, Dongguan (CN); **Chao Ren**, Segrate (IT)

(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 0 days.

(21) Appl. No.: **18/644,115**

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

(65) **Prior Publication Data**
US 2024/0275028 A1 Aug. 15, 2024

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2022/127224, filed on Oct. 25, 2022.

(30) **Foreign Application Priority Data**
Nov. 3, 2021 (CN) 202111294511.5

(51) **Int. Cl.**
H01P 1/00 (2006.01)
H01Q 1/24 (2006.01)
H01Q 19/10 (2006.01)
H01Q 21/00 (2006.01)
H01Q 21/06 (2006.01)

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

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(58) **Field of Classification Search**

None
See application file for complete search history.

(56) **References Cited**

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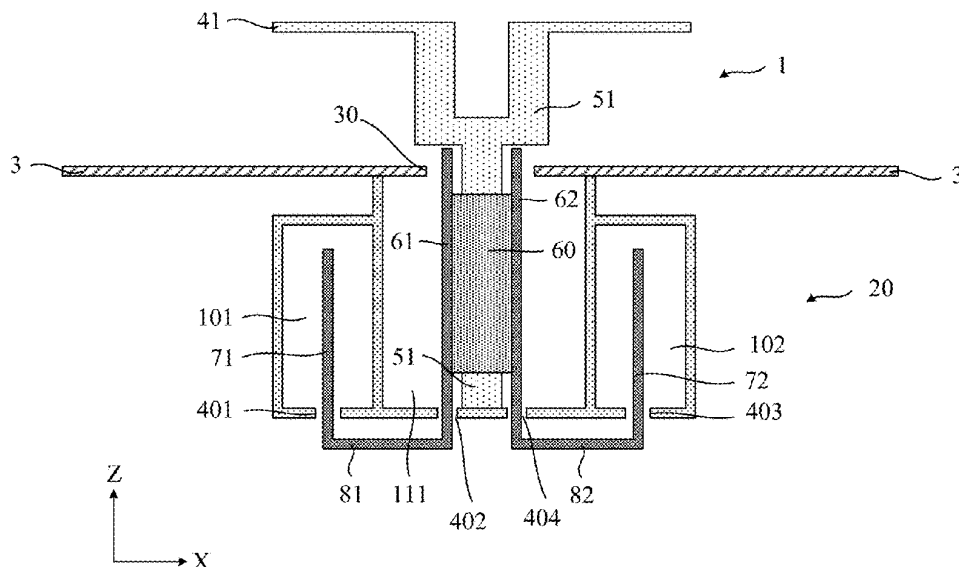
Primary Examiner — Dameon E Levi

Assistant Examiner — Anh Ho

(57) **ABSTRACT**

This disclosure provides an antenna and a base station device. The antenna includes: a plurality of first frequency band antenna groups; a plurality of second frequency band radiating elements; and a reflection plate on which a reflection plate through hole is provided. Each first frequency band radiating element includes: a first balun structure and a first signal transmission structure, which pass through the reflection plate through hole. A phase shifter includes a first phase shifter cavity, a choke cavity, and a first feed network signal transmission structure located in the first phase shifter cavity. A part that is of the first balun structure and that is located on a second side of the reflection plate is located in the choke cavity.

18 Claims, 15 Drawing Sheets





US012719153B2

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

(10) **Patent No.:** **US 12,719,153 B2**
(45) **Date of Patent:** **Aug. 25, 2026**

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

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

(72) Inventors: **Mincheol Seo**, Suwon-si (KR);
Hoonsang Yoo, Suwon-si (KR);
Sunghyup Lee, Suwon-si (KR);
Woosuk Kang, Suwon-si (KR); **Yunsik**
Kim, Suwon-si (KR); **Changha Yu**,
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
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(21) Appl. No.: **18/628,014**

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

(65) **Prior Publication Data**
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H01Q 1/50 (2006.01)

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

(58) **Field of Classification Search**
None

See application file for complete search history.

(56) **References Cited**

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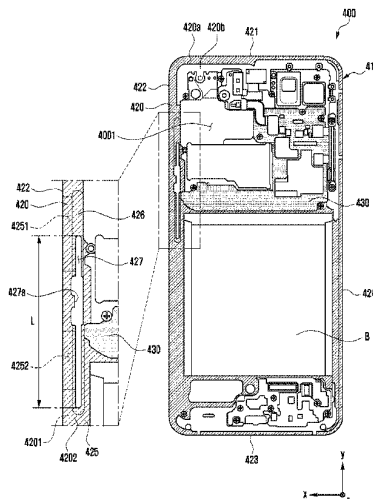
Primary Examiner — Crystal L Hammond

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

(57) **ABSTRACT**

An electronic device according to various embodiments may comprise: a housing comprising a conductive portion; at least one electronic part arranged in an internal space of the housing; a slot formed to have a designated length on the conductive portion, within a specified distance of the at least one electronic part; an electric connection structure arranged to correspond to the slot at least partially, and electrically connects the at least one electronic part and a device substrate arranged in the internal space; a conductive contact for electrically connecting the electric connection structure and the conductive portion, using a method of crossing the slot; and a wireless communication circuit arranged on the device substrate and configured to transmit and/or receive a wireless signal in a designated frequency band, via the slot and at least a portion of the conductive portion.

20 Claims, 13 Drawing Sheets





US012719148B2

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

(10) **Patent No.:** **US 12,719,148 B2**
(45) **Date of Patent:** **Aug. 25, 2026**

(54) **GNSS ANTENNA**

(71) Applicant: **u-blox AG**, Thalwil (CH)

(72) Inventors: **Thomas Kaufmann**, Zurich (CH);
Seyedali Malakooti, Payneham (AU);
Christophe Fumeaux, Large Bay (AU)

(73) Assignee: **u-blox AG**, Thalwil (CH)

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

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(65) **Prior Publication Data**

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Related U.S. Application Data

(62) Division of application No. 17/100,086, filed on Nov. 20, 2020, now Pat. No. 11,929,541.

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H01Q 1/36 (2006.01)
H01Q 1/48 (2006.01)
H01Q 9/04 (2006.01)
H01Q 5/30 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 1/1271** (2013.01); **H01Q 1/36** (2013.01); **H01Q 1/48** (2013.01); **H01Q 9/0435** (2013.01); **H01Q 5/30** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/1271; H01Q 1/36; H01Q 1/48;
H01Q 9/0435; H01Q 5/30; H01Q 5/28;
H01Q 5/35; H01Q 9/0428; H01Q 1/38;
H01Q 1/3233; H01Q 1/325; H01Q 1/50;
B60J 1/20; B60J 7/00

See application file for complete search history.

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Primary Examiner — Dameon E Levi

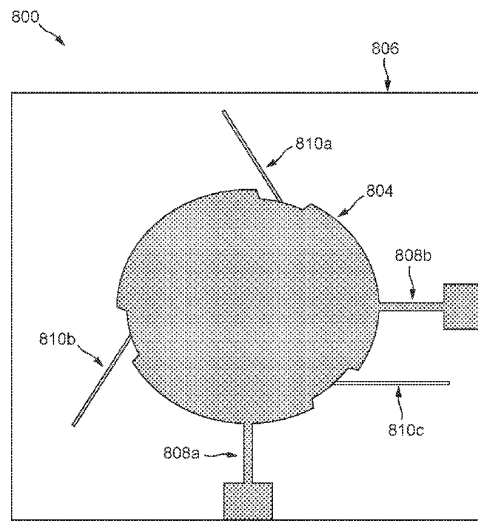
Assistant Examiner — Jordan E. DeWitt

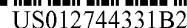
(74) *Attorney, Agent, or Firm* — FINNEGAN,
HENDERSON, FARABOW, GARRETT & DUNNER
LLP

(57) **ABSTRACT**

An antenna includes an optically transparent substrate layer having a first surface and an opposing second surface; a radiating element having a first mesh structure and disposed on the first surface of the substrate layer; a ground plane having a second mesh structure formed on the second surface of the substrate layer; at least two feed lines configured to connect the radiating element to an external circuit; and at least two stubs connected to the radiating element.

4 Claims, 14 Drawing Sheets





(10) **Patent No.:** US 12,744,331 B2
(45) **Date of Patent:** Sep. 22, 2026

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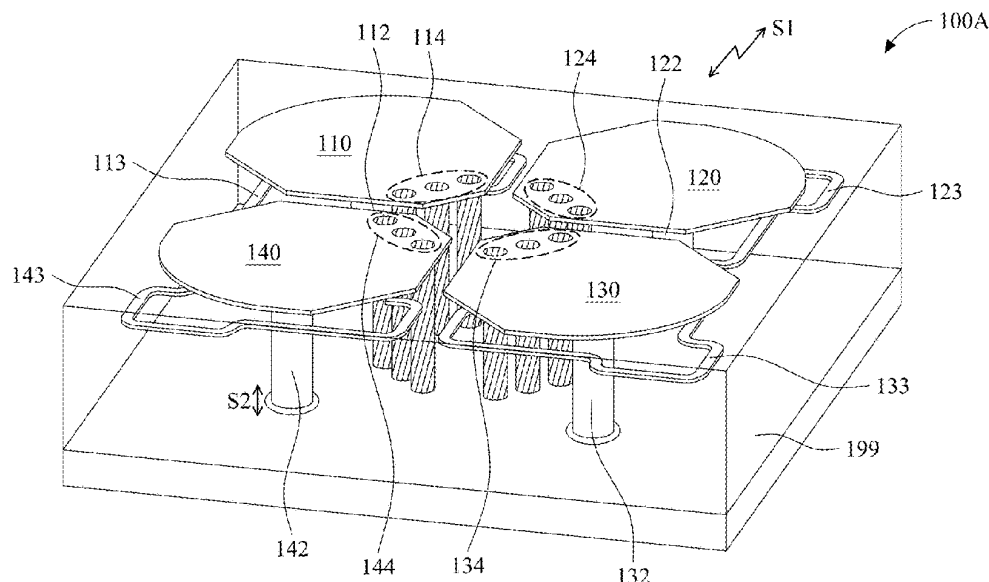
Primary Examiner — Hoang V Nguyen

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

(57) **ABSTRACT**

A MIMO (multiple input and multiple output) antenna system is provided. The MIMO antenna system includes a dielectric substrate, a first MIMO antenna, and a second MIMO antenna. The first MIMO antennas is mounted on the dielectric substrate. The second MIMO antenna is mounted on the dielectric substrate and located beside the first MIMO antenna. The first MIMO antenna and the second MIMO antenna are configured to wirelessly access a set of first signals.

15 Claims, 12 Drawing Sheets





US012744320B2

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

(10) **Patent No.:** **US 12,744,320 B2**
(45) **Date of Patent:** **Sep. 22, 2026**

(54) **OPEN LOOP ANTENNA AND ELECTRONIC DEVICE**

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

(72) Inventors: **Hao-Yu Wang**, Hsinchu (TW); **Pei Siou Luo**, 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 291 days.

(21) Appl. No.: **18/151,499**

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

(65) **Prior Publication Data**
US 2024/0063543 A1 Feb. 22, 2024

(30) **Foreign Application Priority Data**
Aug. 17, 2022 (TW) 111131016

(51) **Int. Cl.**
H01Q 7/00 (2006.01)
H01Q 5/35 (2015.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 7/00** (2013.01); **H01Q 5/35** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 7/00; H01Q 5/407; H01Q 9/26; H01Q 9/42; H01Q 5/307; H01Q 5/35; H01Q 5/378; H01Q 5/371; H01Q 5/40; H01Q 1/48; H01Q 1/243; H01Q 1/38; H01Q 5/328

See application file for complete search history.

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Primary Examiner — Dameon E Levi

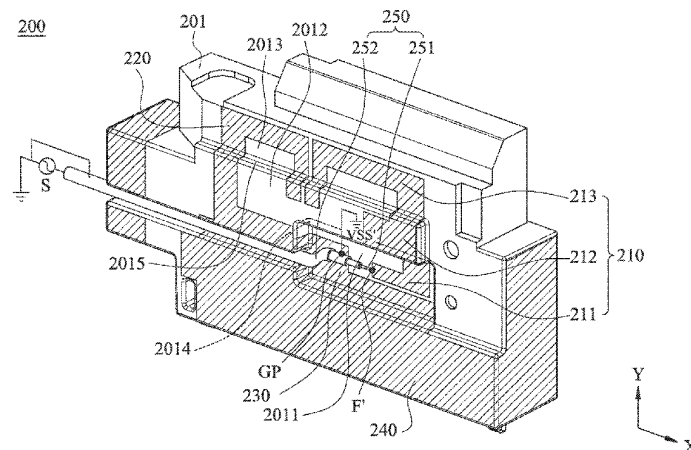
Assistant Examiner — Gurbir Singh

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

(57) **ABSTRACT**

An open loop antenna includes a base, a first radiating section disposed on the base, a second radiating section spaced apart from the first radiating section to form an open loop, and a grounding section spaced apart from the first radiating section and connected to the second radiating section and a ground voltage. The first radiating section includes a feeding segment connected to a feeding point, an extending segment connected to the feeding segment and excited to generate a first frequency band, and a high-frequency coupling segment connected to the extending segment and excited to generate a second frequency band. The second radiating section is coupled with the first radiating section to generate a third frequency band. The first frequency band is higher than the second frequency band. The second frequency band is higher than the third frequency band.

19 Claims, 8 Drawing Sheets





US012744319B2

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

(10) **Patent No.:** **US 12,744,319 B2**
(45) **Date of Patent:** **Sep. 22, 2026**

(54) **ANTENNA STRUCTURE**

(56)

References Cited

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

U.S. PATENT DOCUMENTS

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

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

Primary Examiner — Dameon E Levi

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 79 days.

Assistant Examiner — Anh Ho

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

(21) Appl. No.: **18/923,203**

(57)

ABSTRACT

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

(65) **Prior Publication Data**

US 2026/0066537 A1 Mar. 5, 2026

(30) **Foreign Application Priority Data**

Aug. 27, 2024 (TW) 113209250

(51) **Int. Cl.**
H01Q 5/357 (2015.01)
H01Q 1/24 (2006.01)
H01Q 1/38 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 5/357** (2015.01); **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01)

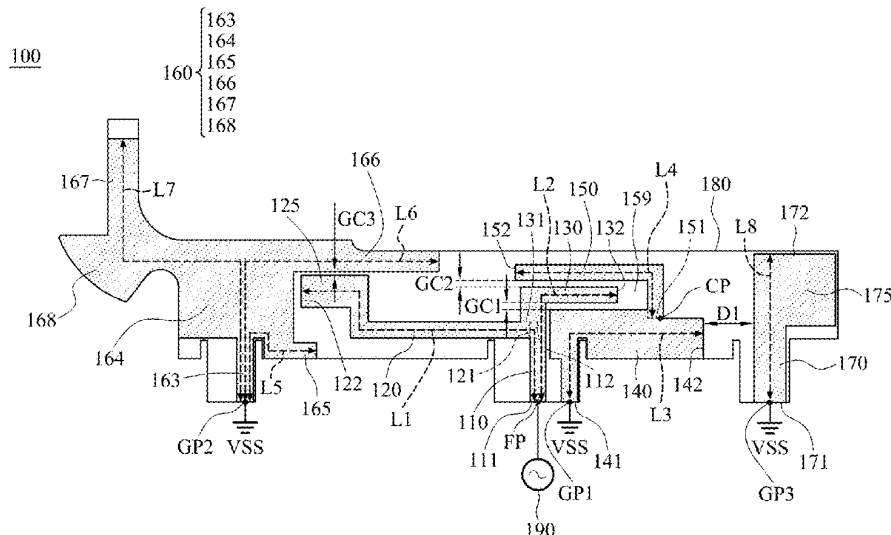
(58) **Field of Classification Search**

None

See application file for complete search history.

An antenna structure includes a feeding radiation element, a first radiation element, a second radiation element, a third radiation element, a fourth radiation element, a fifth radiation element, and a sixth radiation element. The first radiation element is coupled to the feeding radiation element. The second radiation element is coupled to the feeding radiation element. The first radiation element and the second radiation element substantially extend in opposite directions. The third radiation element is coupled to a first grounding point. The fourth radiation element is coupled to the third radiation element. Both the third radiation element and the fourth radiation element are adjacent to the second radiation element. The fifth radiation element is coupled to a second grounding point. The fifth radiation element is adjacent to the first radiation element. The sixth radiation element is coupled to a third grounding point.

9 Claims, 2 Drawing Sheets





(10) **Patent No.:** US 12,738,659 B2
(45) **Date of Patent:** Sep. 15, 2026

(56) **References Cited**

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				343/702

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Primary Examiner — David E Lotter

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

(57) **ABSTRACT**

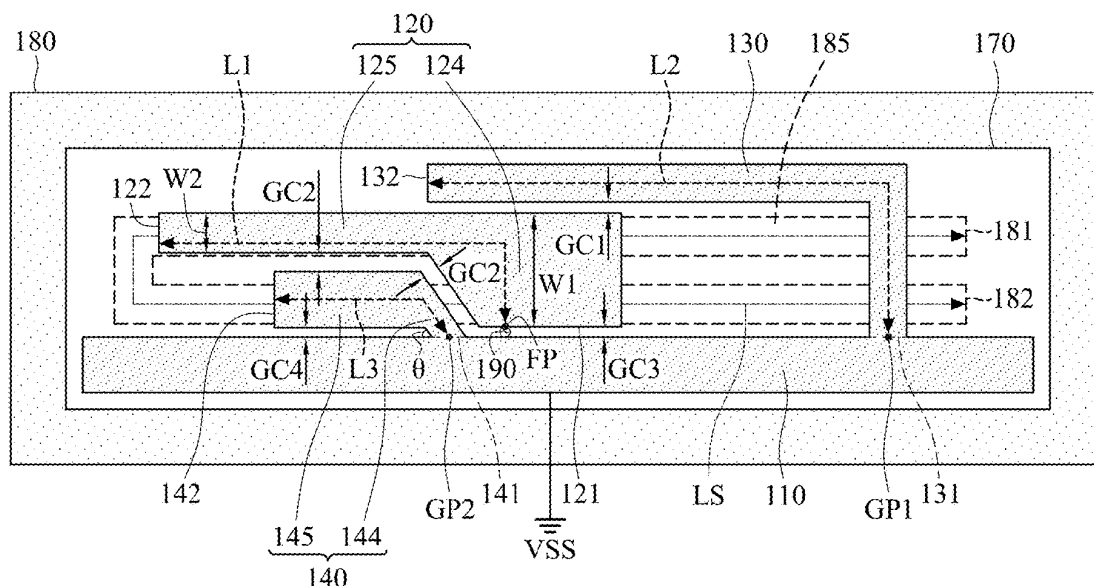
An antenna structure includes a ground element, a first radiation element, a second radiation element, a third radiation element, a nonconductive support element, and a metal mechanism element. The first radiation element has a feeding point. The second radiation element is coupled to a first grounding point on the ground element and adjacent to the first radiation element. The third radiation element is coupled to a second grounding point on the ground element. The third radiation element is adjacent to the first radiation element. The first radiation element is between the second radiation element and the third radiation element. The ground element, the first radiation element, the second radiation element, and the third radiation element are disposed on the nonconductive support element. The metal mechanism element has a slot.

20 Claims, 6 Drawing Sheets

(51)	Int. Cl. <i>H01Q 1/48</i> (2006.01) <i>H01Q 13/16</i> (2006.01)
(52)	U.S. Cl. CPC <i>H01Q 13/16</i> (2013.01); <i>H01Q 1/48</i> (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/48; H01Q 1/38; H01Q 5/371;
H01Q 9/42; H01Q 1/2266; H01Q 13/16
See application file for complete search history.

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US012738652B2

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

(10) **Patent No.:** **US 12,738,652 B2**
(45) **Date of Patent:** **Sep. 15, 2026**

(54) **ANTENNA STRUCTURE**

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

(72) Inventors: **Yi-Che Tsai**, Hsinchu (TW); **Ci-Jin Huang**, Hsinchu (TW); **Chin-Yang Chen**, Hsinchu (TW)

(73) Assignee: **WISTRON NEWEB CORPORATION**, Hsinchu (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 75 days.

(21) Appl. No.: **18/919,494**

(22) Filed: **Oct. 18, 2024**

(65) **Prior Publication Data**
US 2025/0141106 A1 May 1, 2025

(30) **Foreign Application Priority Data**
Nov. 1, 2023 (TW) 112142127

(51) **Int. Cl.**
H01Q 5/50 (2015.01)
H01Q 1/48 (2006.01)
H01Q 5/15 (2015.01)
H01Q 5/328 (2015.01)
(52) **U.S. Cl.**
CPC **H01Q 5/50** (2015.01); **H01Q 1/48** (2013.01); **H01Q 5/15** (2015.01); **H01Q 5/328** (2015.01)

(58) **Field of Classification Search**

CPC H01Q 1/246; H01Q 1/38; H01Q 1/48; H01Q 1/52; H01Q 5/30-50; H01Q 21/065; H01Q 21/26-30
See application file for complete search history.

(56) **References Cited**

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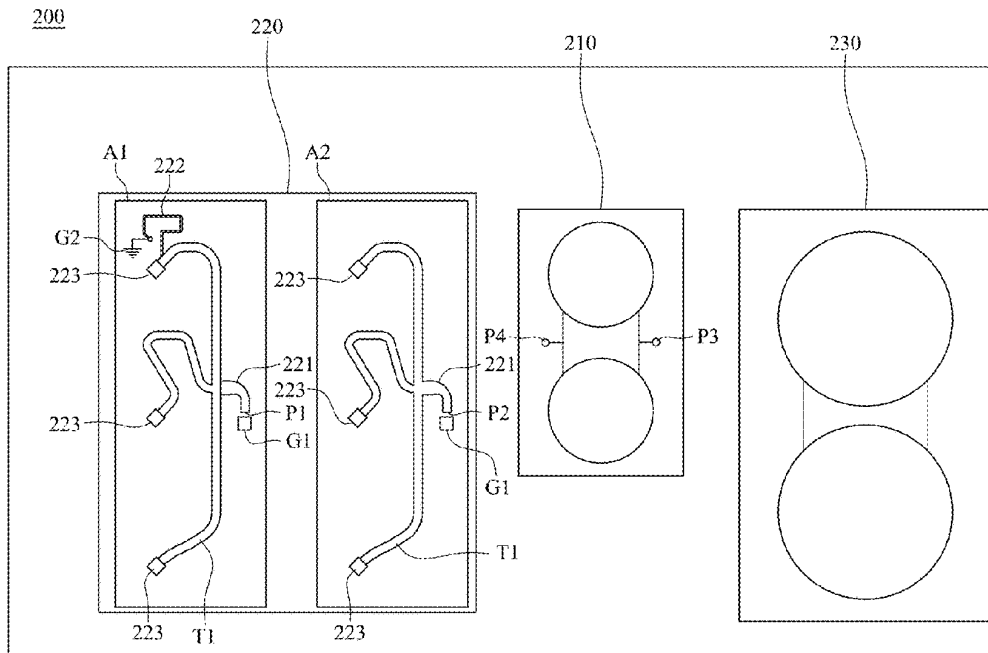
Primary Examiner — Hasan Islam

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

(57) **ABSTRACT**

An antenna structure includes a first frequency band antenna and a second frequency band antenna. The first frequency band antenna is operated at a first frequency band. The second frequency band antenna is operated at a second frequency band, and includes a feeding portion, a balun and at least one antenna unit. The balun is connected to the feeding portion. The at least one antenna unit is connected to the balun. The first frequency band is different from the second frequency band.

17 Claims, 11 Drawing Sheets





US012738638B2

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

(10) **Patent No.:** **US 12,738,638 B2**
(45) **Date of Patent:** **Sep. 15, 2026**

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

(71) Applicant: **JRD COMMUNICATION
(SHENZHEN) LTD.**, Shenzhen (CN)

(72) Inventors: **Yongyi Yan**, Shenzhen (CN); **Xinrong
An**, Shenzhen (CN)

(73) Assignee: **JRD COMMUNICATION
(SHENZHEN) 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 184 days.

(21) Appl. No.: **18/254,860**

(22) PCT Filed: **Dec. 10, 2020**

(86) PCT No.: **PCT/CN2020/135454**

§ 371 (c)(1),

(2) Date: **May 28, 2023**

(87) PCT Pub. No.: **WO2022/110316**

PCT Pub. Date: **Jun. 2, 2022**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Nov. 27, 2020 (CN) 202011364945.3

(51) **Int. Cl.**

H01Q 1/42 (2006.01)

H01Q 1/22 (2006.01)

H01Q 1/38 (2006.01)

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

CPC **H01Q 1/42** (2013.01); **H01Q 1/22**
(2013.01); **H01Q 1/38** (2013.01)

(58) **Field of Classification Search**

CPC .. H01Q 1/42; H01Q 1/22; H01Q 1/38; H01Q
1/243; H01Q 5/328

See application file for complete search history.

(56) **References Cited**

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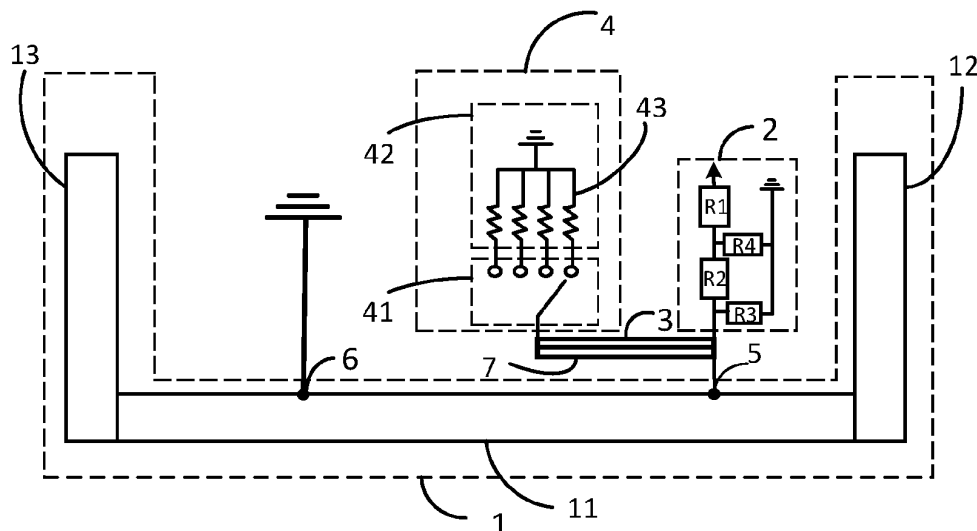
Primary Examiner — Seokjin Kim

(74) *Attorney, Agent, or Firm* — PV IP PC; Wei Te
Chung

(57) **ABSTRACT**

Disclosed are an antenna assembly and a mobile terminal. The antenna assembly comprises a metal frame, a matching circuit, an antenna wiring and a tuning module. The metal frame is provided with a feed point, and the matching circuit is connected to the feed point on the metal frame. One end of the antenna wiring is connected to the feed point, and the other end of the antenna wiring is connected to the tuning module. The connection of the antenna wiring and the tuning module is equivalent to addition of an impedance-adjustable parallel circuit at the feed point.

14 Claims, 3 Drawing Sheets





US012738633B2

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

(10) **Patent No.:** **US 12,738,633 B2**
(45) **Date of Patent:** **Sep. 15, 2026**

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

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

(72) Inventors: **Chung-Che Lien**, Hsinchu (TW);
Tzu-Kuan Sun, Hsinchu (TW);
Ting-Han Shih, Hsinchu (TW);
Chia-Hao Chang, 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 98 days.

(21) Appl. No.: **18/763,353**

(22) Filed: **Jul. 3, 2024**

(65) **Prior Publication Data**

US 2025/0125517 A1 Apr. 17, 2025

(30) **Foreign Application Priority Data**

Oct. 17, 2023 (TW) 112139478

(51) **Int. Cl.**
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H01Q 1/27 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/2266** (2013.01); **H01Q 1/27**
(2013.01); **H01Q 1/42** (2013.01); **H01Q 9/16**
(2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/2266; H01Q 1/27; H01Q 1/42;
H01Q 9/16; H01Q 5/378; H01Q 1/22;
H01Q 5/371; H01Q 9/42

See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Dameon E Levi

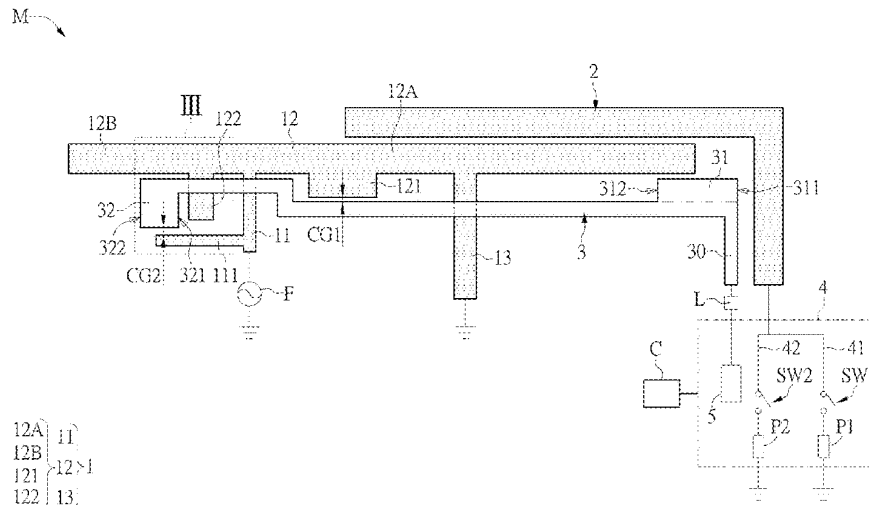
Assistant Examiner — Jose A. Miranda Gonzalez

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

(57) **ABSTRACT**

An electronic device includes a housing and an antenna module. The antenna module is disposed in the housing. The antenna module includes a first radiating element, a switching circuit, a proximity sensing circuit, a second radiating element, and a third radiating element. The first radiating element includes a feeding portion, a radiating portion, and a grounding portion. The feeding portion and the grounding portion are connected to the radiating portion. The second radiating element is electrically connected to the switching circuit. The second radiating element and the radiating portion are separated from and coupled with each other. The third radiating element is electrically connected to the proximity sensing circuit. The third radiating element and the second radiating element are separated from each other, and the third radiating element and the radiating portion are separated from and coupled with each other.

19 Claims, 8 Drawing Sheets





US012738632B2

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

(10) **Patent No.:** **US 12,738,632 B2**
(45) **Date of Patent:** **Sep. 15, 2026**

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

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

(72) Inventors: **De-Shao Yao**, Hsinchu (TW);
Chih-Feng Tai, 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 52 days.

(21) Appl. No.: **18/650,543**

(22) Filed: **Apr. 30, 2024**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Oct. 11, 2023 (TW) 112138655

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

(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/2266** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/307** (2015.01); **H01Q 13/10** (2013.01); **H01Q 21/06** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/48; H01Q 1/2266; H01Q 5/307; H01Q 13/10; H01Q 21/06; H01Q 9/42; H01Q 1/22; H01Q 5/371; H01Q 13/106; H01Q 1/38; H01Q 1/243; H01Q 1/2258; H01Q 13/16; H01Q 21/064

See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Dameon E Levi

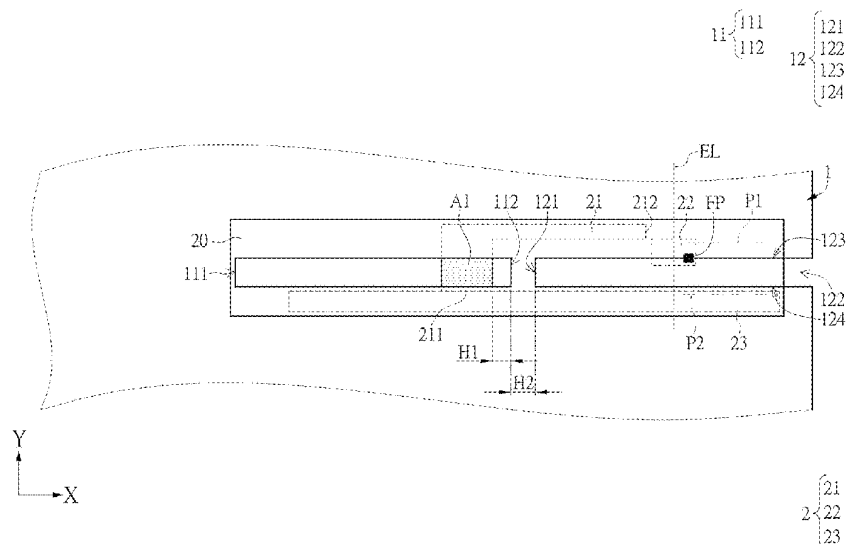
Assistant Examiner — Gurbir Singh

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

(57) **ABSTRACT**

An electronic device includes a housing and an antenna structure. The housing includes a first slot and a second slot. The first slot and the second slot extend along a same direction. The first slot has a first closed end and a second closed end. The second slot has a third closed end and an open end. The antenna structure is disposed in the housing. The antenna structure includes a grounding element, a first radiating element, and a second radiating element. The first radiating element has a first end and a second end, the first end is connected to the grounding element, and the second end is located between the third closed end and the open end. An orthogonal projection of the first radiating element that is projected onto the housing overlaps with and crosses on the first slot.

16 Claims, 7 Drawing Sheets





US012737014B2

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

(10) **Patent No.:** **US 12,737,014 B2**
(45) **Date of Patent:** **Sep. 15, 2026**

(54) **ELECTRONIC DEVICE HAVING CLUTCH
BARREL ANTENNA SLOT**

(56) **References Cited**

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(71) Applicant: **Apple Inc.**, Cupertino, CA (US)
(72) Inventors: **Trevor J Edmonds**, San Francisco, CA (US); **Michael J Williams**, Campbell, CA (US); **Nikolaos Chiotellis**, San Jose, CA (US); **Joel D Barrera**, Cedar Park, TX (US); **Marc Soriano Baliarda**, San Jose, CA (US); **Ayoub Yari Boroujeni**, Redwood City, CA (US); **Jerzy S Guterman**, Sunnyvale, CA (US); **Mahmoud R Amini**, Redwood City, CA (US); **Kevin M Robinson**, Sunnyvale, CA (US)

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U.S. Appl. No. 17/832,465, filed Jun. 3, 2022.

Primary Examiner — Mahendra R Patel

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

(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 397 days.

(21) Appl. No.: **18/477,202**

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

(65) **Prior Publication Data**
US 2025/0110531 A1 Apr. 3, 2025

(51) **Int. Cl.**
G06F 1/16 (2006.01)
H01Q 13/10 (2006.01)

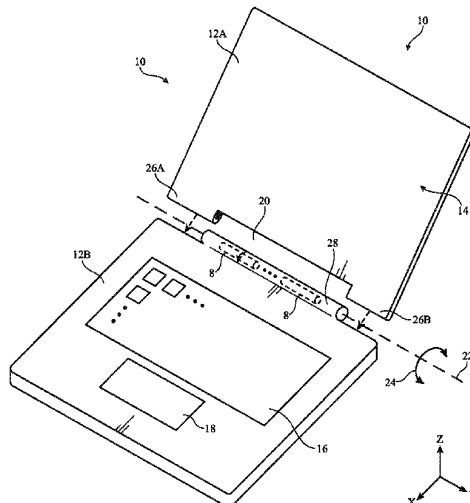
(52) **U.S. Cl.**
CPC **G06F 1/1681** (2013.01); **H01Q 13/10** (2013.01)

(58) **Field of Classification Search**
CPC G06F 1/1681; G06F 1/1616; H01Q 13/10; H01Q 1/2266
USPC 455/575.7
See application file for complete search history.

(57) **ABSTRACT**

An electronic device such as a laptop computer may have an upper housing and a lower housing. The lower housing may have a clutch barrel. The upper housing may be coupled to the clutch barrel by a hinge. The lower housing may have an upper metal wall separated from the upper housing by a first gap and a lower metal wall separated from the upper housing by a second gap. The clutch barrel may include a conductor. An antenna may be formed from a radiating slot in the conductor. The radiating slot may have a tunnel extending from a first opening to a second opening in the conductor across a diameter of the conductor. The tunnel may be linear or non-linear. The tunnel may have a uniform or tapered width. The radiating slot may convey radio-frequency signals through both gaps regardless of the orientation of the upper housing.

20 Claims, 9 Drawing Sheets





US012731914B2

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

(10) **Patent No.:** **US 12,731,914 B2**
(45) **Date of Patent:** **Sep. 8, 2026**

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

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

(72) Inventors: **Dooseok Choi**, Suwon-si (KR); **Kyeol
Kwon**, Suwon-si (KR); **Youngki Lee**,
Suwon-si (KR); **Dongkwon Choi**,
Suwon-si (KR)

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

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 301 days.

(21) Appl. No.: **18/511,376**

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

(65) **Prior Publication Data**

US 2024/0347931 A1 Oct. 17, 2024

(30) **Foreign Application Priority Data**

Apr. 17, 2023 (KR) 10-2023-0050336

(51) **Int. Cl.**
H01Q 21/29 (2006.01)
H01Q 3/06 (2006.01)
H01Q 21/08 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 21/293** (2013.01); **H01Q 3/06**
(2013.01); **H01Q 21/08** (2013.01)

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

(56) **References Cited**

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Primary Examiner — Dimary S Lopez Cruz

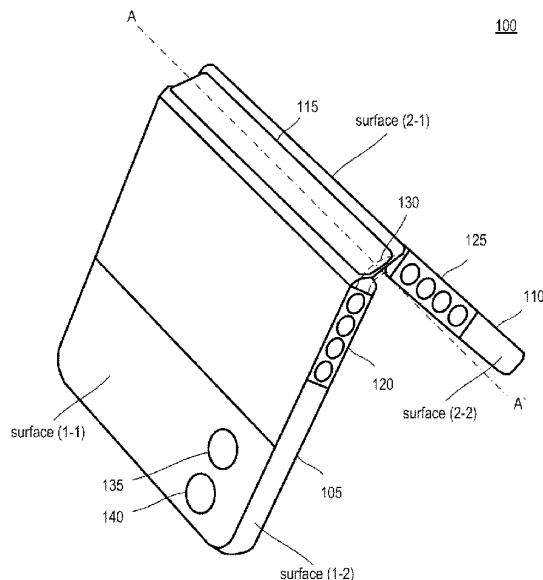
Assistant Examiner — Brandon Sean Woods

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

(57) **ABSTRACT**

An electronic device includes: a first housing including a first surface and a second surface connected to the first surface and having an area that is smaller than an area of the first surface; a second housing including a third surface and a fourth surface connected to the third surface and having an area that is smaller than an area of the third surface; a hinge structure connecting the first housing and the second housing to be foldable relative to each other at a folding axis between a folded state of the electronic device and an unfolded state of the electronic device; a first antenna array provided at the first surface; and a second antenna array provided at the fourth surface; and a flexible board connecting the first antenna array and the second antenna array, wherein the first antenna array and the second antenna array are configured to form a third antenna array and to form a fourth antenna array, according to whether the electronic device is in the unfolded state or in the folded state.

14 Claims, 14 Drawing Sheets





US012731896B2

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

(10) **Patent No.:** **US 12,731,896 B2**
(45) **Date of Patent:** **Sep. 8, 2026**

(54) **ANTENNA STRUCTURE**

(56) **References Cited**

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(72) Inventors: **An-Chun Liu**, Taoyuan City (TW);
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(73) Assignee: **QISDA CORPORATION**, 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 145 days.

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(21) Appl. No.: **18/800,221**

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(22) Filed: **Aug. 12, 2024**

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(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Sep. 4, 2023 (CN) 202311130845.3

Primary Examiner — Dameon E Levi
Assistant Examiner — Jordan E. DeWitt

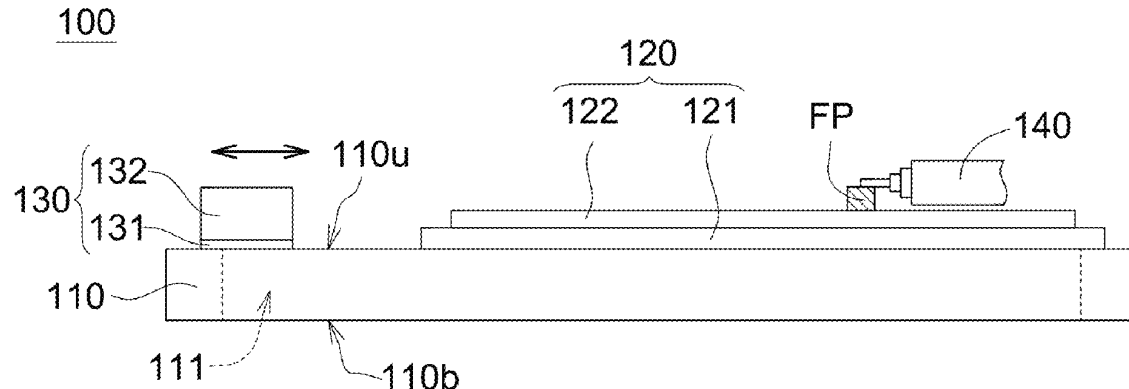
(51) **Int. Cl.**
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H01Q 1/52 (2006.01)
(52) **U.S. Cl.**
CPC **H01Q 5/30** (2015.01); **H01Q 1/526** (2013.01)

(57) **ABSTRACT**

An antenna structure is provided. The antenna structure includes a conductor substrate, a coupling feed-in element and a shielding element. The conductor substrate has a slot. The coupling feed-in element, partly overlapping the slot, is disposed on the conductor substrate. The shielding element, partly overlapping the slot, is separated from the coupling feed-in element and disposed on the conductor substrate, wherein the shielding element is movable along the slot.

(58) **Field of Classification Search**
CPC H01Q 5/30; H01Q 1/526; H01Q 5/50;
H01Q 13/106; H01Q 13/103; H01Q 5/10;
H01Q 1/241; H01Q 5/20
See application file for complete search history.

14 Claims, 7 Drawing Sheets





US012731895B2

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

(10) **Patent No.:** **US 12,731,895 B2**
(45) **Date of Patent:** **Sep. 8, 2026**

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

1/48; H01Q 1/50; H01Q 1/52; H01Q
1/521; H01Q 5/10; H01Q 5/20; H01Q
5/378; H01Q 9/40; H01Q 9/04; H01Q
9/0407

(71) Applicant: **Shenzhen Fulian Fugui Precision Industry Co., Ltd.**, Shenzhen (CN)

See application file for complete search history.

(72) Inventors: **Shiou-Jen Lin**, New Taipei (TW);
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(56) **References Cited**

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(73) Assignee: **Shenzhen Fulian Fugui Precision Industry 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 60 days.

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(22) Filed: **Dec. 31, 2024**

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(65) **Prior Publication Data**

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Primary Examiner — Tho G Phan

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

(51) **Int. Cl.**
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H01Q 1/00 (2006.01)
H01Q 1/22 (2006.01)
H01Q 1/38 (2006.01)
H01Q 1/48 (2006.01)
H01Q 1/52 (2006.01)

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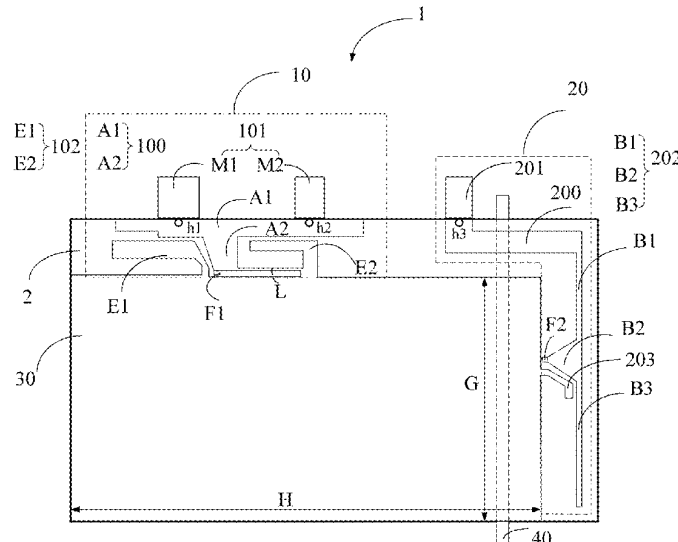
(52) **U.S. Cl.**
CPC **H01Q 5/20** (2015.01); **H01Q 1/002**
(2013.01); **H01Q 1/22** (2013.01); **H01Q 1/48**
(2013.01); **H01Q 1/521** (2013.01); **H01Q 5/10**
(2015.01); **H01Q 9/0407** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/00; H01Q 1/002; H01Q 1/22;
H01Q 1/24; H01Q 1/243; H01Q 1/38;
H01Q

(57) **ABSTRACT**

An antenna structure includes a first antenna and a second antenna, the first antenna includes: a first radiation part arranged on a first surface of a mainboard; a first external metal strip with one end fixed on a second surface of the mainboard to excite a first operating frequency band; a first grounding extension part with one end connected to metal grounding plane to excite a second operating frequency band and a third operating frequency band; the second antenna includes: a second radiation part arranged on the first surface; a second external metal strip with one end fixed on the second surface to excite the first operating frequency band; a third radiation part with one end connected to the second radiation part; a second grounding extension part with one end connected to the metal grounding plane to excite the second operating frequency band and the third operating frequency band.

18 Claims, 5 Drawing Sheets





US012725930B2

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

(10) **Patent No.:** **US 12,725,930 B2**
(45) **Date of Patent:** **Sep. 1, 2026**

(54) **HYBRID ANTENNA STRUCTURE**

(56) **References Cited**

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

U.S. PATENT DOCUMENTS

(72) Inventors: **Li-Kai Kuo**, Hsinchu (TW); **Jun-Yan Chen**, Hsinchu (TW)

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

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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 98 days.

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(22) Filed: **Aug. 6, 2024**

Primary Examiner — Alexander H Taningco
Assistant Examiner — Marin Stoytchev Stoytchev
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**

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H01Q 5/364 (2015.01)

(Continued)

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

CPC **H01Q 9/0442** (2013.01); **H01Q 9/0414**
(2013.01); **H01Q 9/0457** (2013.01); **H01Q**
21/30 (2013.01)

(58) **Field of Classification Search**

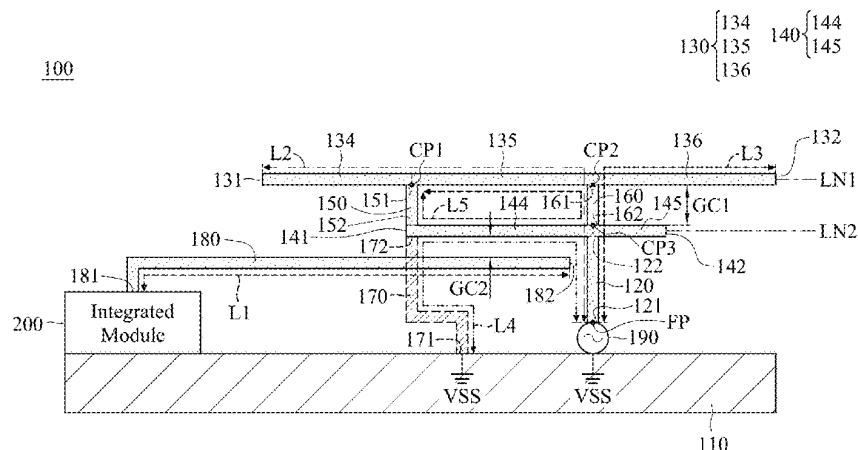
CPC H01Q 5/328; H01Q 5/364; H01Q 5/378;
H01Q 9/0414; H01Q 9/0442; H01Q
9/0457; H01Q 9/42; H01Q 21/30

See application file for complete search history.

(57) **ABSTRACT**

A hybrid antenna structure includes a ground element, a feeding radiation element, a first radiation element, a second radiation element, a first connection radiation element, a second connection radiation element, a shorting radiation element, a third radiation element, and an integrated module. The ground element provides a ground voltage. The feeding radiation element has a feeding point. The second radiation element is coupled to the feeding radiation element. The first radiation element is coupled through the first connection radiation element and the second connection radiation element to the second radiation element. The second radiation element is also coupled through the shorting radiation element to the ground voltage. The third radiation element is adjacent to the second radiation element. The integrated module is coupled to the third radiation element. The integrated module has the functions of circuit adjustment and proximity sense.

21 Claims, 4 Drawing Sheets





US012725925B2

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

(10) **Patent No.:** **US 12,725,925 B2**
(45) **Date of Patent:** **Sep. 1, 2026**

(54) **ANTENNA STRUCTURE**

(56)

References Cited

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

U.S. PATENT DOCUMENTS

(72) Inventors: **Cheng-Wei Chiang**, Hsinchu (TW);
Jian-Zhong Chen, Hsinchu (TW);
Jun-Yan Chen, Hsinchu (TW);
Ching-Wen Chen, Hsinchu (TW)

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

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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 7 days.

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Primary Examiner — Hai V Tran

(21) Appl. No.: **19/175,198**

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

(22) Filed: **Apr. 10, 2025**

(57)

ABSTRACT

(65) **Prior Publication Data**

US 2026/0163235 A1 Jun. 11, 2026

An antenna structure includes the following. A first radiation element has a feeding point. A second radiation element is coupled to the feeding point. A third radiation element is coupled through a capacitive element to the second radiation element. A fourth radiation element is coupled through a tunable circuit to a ground element. The fourth radiation element is adjacent to the first radiation element. A fifth radiation element is coupled to the fourth radiation element. A nonconductive support element has a first surface and a second surface which are opposite to each other. The first radiation element, the second radiation element, the capacitive element, the third radiation element, and the fourth radiation element are disposed on the first surface. The fifth radiation element is disposed on the second surface.

(30) **Foreign Application Priority Data**

Dec. 9, 2024 (TW) 113147703

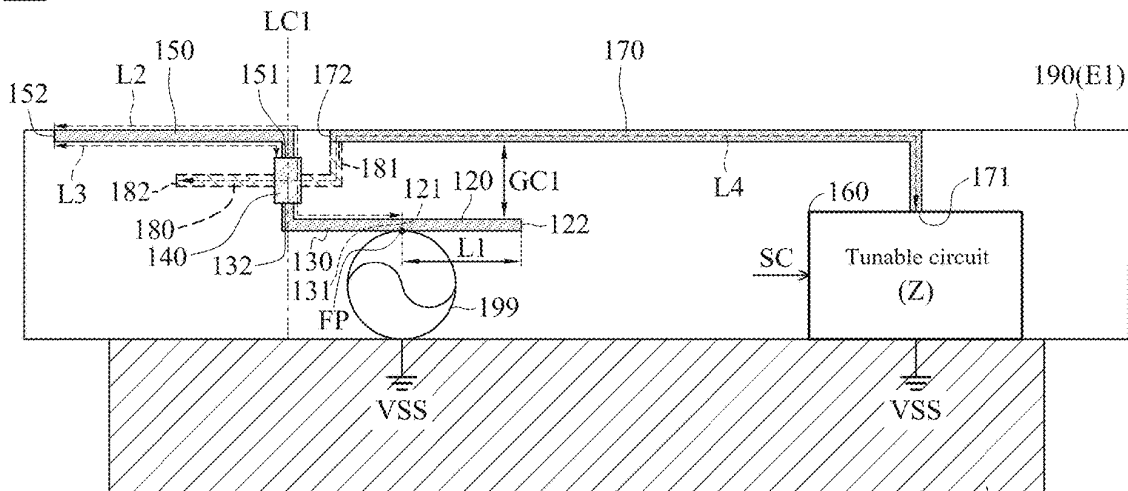
20 Claims, 6 Drawing Sheets

(51) **Int. Cl.**
H01Q 5/321 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 5/321** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 5/321
See application file for complete search history.

100



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US012725909B2

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

(10) **Patent No.:** **US 12,725,909 B2**
(45) **Date of Patent:** **Sep. 1, 2026**

(54) **MESHED PATCH ANTENNA ARRAY**

(56)

References Cited

(71) Applicant: **Google LLC**, Mountain View, CA (US)

U.S. PATENT DOCUMENTS

(72) Inventors: **Mohammad Reza Ghajar**, Redwood City, CA (US); **Eddie Charles Burgess**, Chicago, IL (US); **Ali Molaei**, Chicago, IL (US)

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(73) Assignee: **Google LLC**, Mountain View, CA (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 67 days.

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(22) PCT Filed: **Oct. 27, 2023**

(86) PCT No.: **PCT/US2023/078054**

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Primary Examiner — Hoang V Nguyen

(87) PCT Pub. No.: **WO2025/090092**

(74) *Attorney, Agent, or Firm* — Shumaker & Sieffert, P.A.

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H01Q 1/24 (2006.01)

H01Q 9/04 (2006.01)

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

CPC **H01Q 1/2266** (2013.01); **H01Q 9/0407** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/2266; H01Q 1/243; H01Q 9/0407; H01Q 21/065; H01Q 21/28

See application file for complete search history.

(57)

ABSTRACT

An example mobile computing device includes a main logic board (MLB); a first antenna array positioned on the MLB and configured to transmit signals in a first direction, the first antenna array comprising one or more planes; and a second antenna array positioned on the MLB and configured to transmit signals in a second direction, the second, direction being different than the first direction, the second antenna array comprising one or more planes and the second direction being different than the first direction, wherein at least one of the one or more of the planes in the first antenna array or at least one of the one or more of the pianos in the second antenna array comprises a meshed patch structure.

11 Claims, 5 Drawing Sheets

