US012046814B2

(12) **United States Patent**
Wakabayashi

(10) **Patent No.: US 12,046,814 B2**
(45) **Date of Patent: Jul. 23, 2024**

(54) **ANTENNA UNIT AND COMMUNICATION EQUIPMENT**

(71) Applicant: **Sony Interactive Entertainment Inc.**, Tokyo (JP)

(72) Inventor: **Minoru Wakabayashi**, Tokyo (JP)

(73) Assignee: **Sony Interactive Entertainment Inc.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 269 days.

(21) Appl. No.: **17/609,815**

(22) PCT Filed: **May 26, 2020**

(86) PCT No.: **PCT/JP2020/020711**
§ 371 (c)(1),
(2) Date: **Nov. 9, 2021**

(87) PCT Pub. No.: **WO2020/241631**
PCT Pub. Date: **Dec. 3, 2020**

(65) **Prior Publication Data**

US 2022/0224004 A1 Jul. 14, 2022

(30) **Foreign Application Priority Data**

May 30, 2019 (JP) 2019-101376

(51) **Int. Cl.**
H01Q 1/52 (2006.01)
H01Q 13/10 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/525*** (2013.01); ***H01Q 13/106*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/106; H01Q 1/241; H01Q 1/525; H01Q 1/2291
See application file for complete search history.

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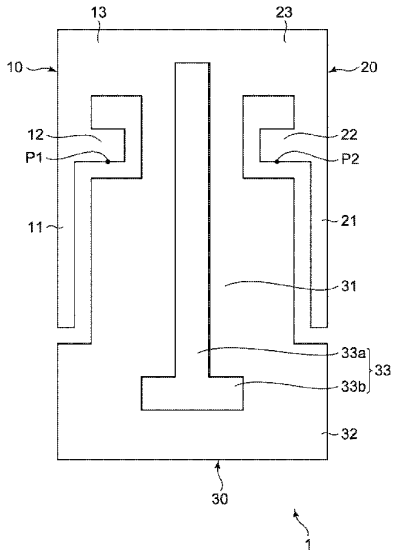
Primary Examiner — Jimmy T Vu
(74) *Attorney, Agent, or Firm* — Matthew B. Dernier, Esq.

(57) **ABSTRACT**

An antenna unit includes a first antenna portion and a second antenna portion that individually transmit or receive a wireless signal, and a ground portion electrically connected to the first antenna portion and the second antenna portion and including a portion positioned between the first antenna portion and the second antenna portion. A through-hole that resonates with a given frequency is provided at a position of the ground portion between the first antenna portion and the second antenna portion.

9 Claims, 5 Drawing Sheets



US012062848B2

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

(10) **Patent No.: US 12,062,848 B2**
(45) **Date of Patent: Aug. 13, 2024**

(54) **ANTENNA APPARATUS**

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

(72) Inventors: **Yuichiro Suzuki**, Tokyo (JP); **Takayoshi Ito**, Tokyo (JP); **Tomihiro Omuro**, Tokyo (JP); **Toru Ozone**, Tokyo (JP); **Jin Sato**, Tokyo (JP); **Yoshiaki Hiraoka**, Tokyo (JP)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 580 days.

(21) Appl. No.: **17/288,922**

(22) PCT Filed: **Nov. 9, 2018**

(86) PCT No.: **PCT/JP2018/041653**
§ 371 (c)(1),
(2) Date: **Apr. 27, 2021**

(87) PCT Pub. No.: **WO2020/095436**
PCT Pub. Date: **May 14, 2020**

(65) **Prior Publication Data**

US 2021/0399428 A1 Dec. 23, 2021

(51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 21/24 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 13/10*** (2013.01); ***H01Q 21/24*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 13/10; H01Q 21/24; H01Q 1/243; H01Q 1/44; H01Q 13/106
See application file for complete search history.

(56) **References Cited**

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(Continued)

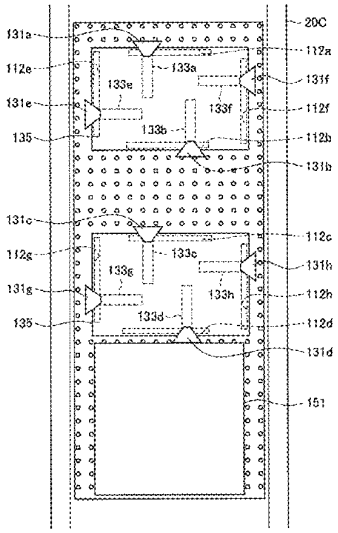
Primary Examiner — Dieu Hien T Duong
(74) *Attorney, Agent, or Firm* — XSENSUS LLP

(57) **ABSTRACT**

To provide a technology that can suppress the reduction of an antenna gain while maintaining the quality of the design of the exterior furnishing of the antenna.

Provided is an antenna apparatus including: an antenna module that includes a first slot antenna that transmits or receives a first wireless signal, a first feed element that supplies power to the first slot antenna, a second slot antenna that transmits or receives a second wireless signal having a polarization direction orthogonal to a polarization direction of the first wireless signal, and a second feed element that supplies power to the second slot antenna; and a metal plate that includes a first slot, and a second slot a longitudinal direction of which is orthogonal to a longitudinal direction of the first slot.

15 Claims, 45 Drawing Sheets



US012068527B2

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

(10) **Patent No.: US 12,068,527 B2**
(45) **Date of Patent: Aug. 20, 2024**

(54) **ANTENNA STRUCTURE AND WIRELESS COMMUNICATION DEVICE USING SAME**

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

(72) Inventors: **Cho-Kang Hsu**, New Taipei (TW); **Min-Hui Ho**, New Taipei (TW); **Te-Chang Lin**, New Taipei (TW)

(73) Assignee: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 338 days.

(21) Appl. No.: **17/136,896**

(22) Filed: **Dec. 29, 2020**

(65) **Prior Publication Data**

US 2021/0210837 A1 Jul. 8, 2021

(30) **Foreign Application Priority Data**

Jan. 6, 2020 (CN) 202010009650.8

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 13/10 (2006.01)
H04B 1/00 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 13/10*** (2013.01); ***H04B 1/006*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 13/10; H01Q 1/42; H01Q 13/16; H01Q 1/38; H01Q 1/48; H01Q 1/50; H01Q 5/35; H04B 1/006
See application file for complete search history.

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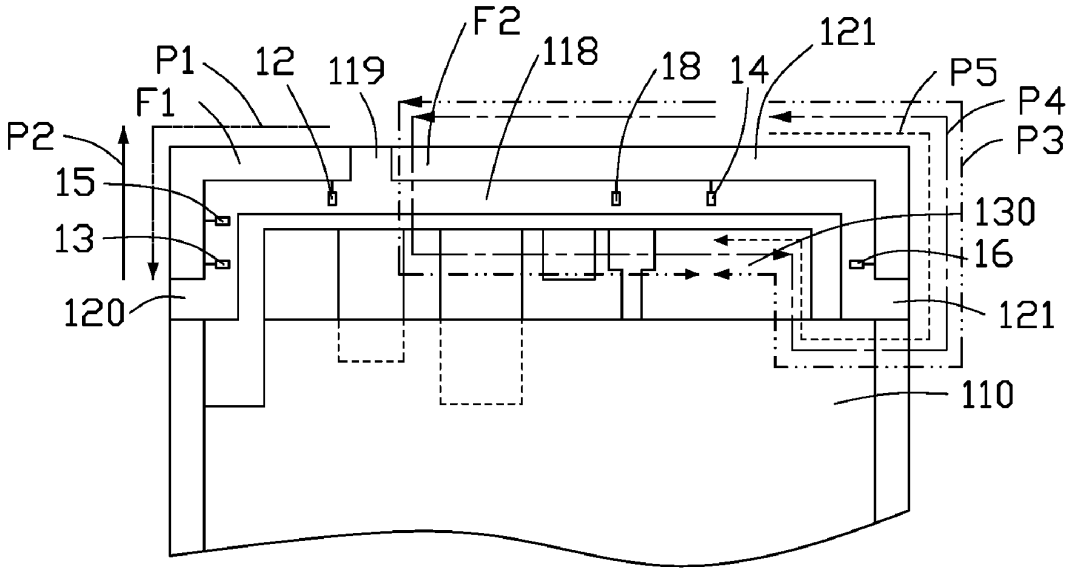
WO WO-2018219112 A1 * 12/2018 ..... H01Q 1/243

Primary Examiner — Hasan Islam
Assistant Examiner — Bamidele A Immanuel
(74) *Attorney, Agent, or Firm* — ScienBiziP, P.C.

(57) **ABSTRACT**

An antenna structure with wide radiation bandwidth in a reduced physical space includes a housing, a first feed portion, and a second feed portion. The housing includes a metallic side frame, a metallic middle frame, and a metallic back board. The metallic side frame defines first and second gaps, and the metallic back board defines a slot. The slot, the first gap, and the second gap divide the metallic side frame to give a first radiation portion. The first and second feed portions are both electrically connected to the first radiation portion. When the first feed portion supplies a current, the current flows through the first radiation portion, toward the second gap to excite a first working mode. When the second feed portion supplies a current, the current flows through the first radiation portion, toward the first gap to excite a second working mode.

9 Claims, 12 Drawing Sheets



US012068528B2

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

(10) **Patent No.: US 12,068,528 B2**
(45) **Date of Patent: Aug. 20, 2024**

(54) **PARASITIC ANTENNA COUPLING IN A PHYSICALLY CONFIGURABLE COMMUNICATION DEVICE**

(71) Applicant: **Microsoft Technology Licensing, LLC**, Redmond, WA (US)

(72) Inventors: **Marc Harper**, Snohomish, WA (US); **Chulmin Han**, Redmond, WA (US)

(73) Assignee: **Microsoft Technology Licensing, LLC**, Redmond, WA (US)

(*) 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.: **17/355,556**

(22) Filed: **Jun. 23, 2021**

(65) **Prior Publication Data**

US 2022/0416404 A1 Dec. 29, 2022

(51) **Int. Cl.**
H01Q 5/378 (2015.01)
H01Q 1/24 (2006.01)
H01Q 21/00 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 21/0025*** (2013.01)

(58) **Field of Classification Search**
CPC ... H01Q 1/243; H01Q 1/2258; H01Q 21/0025
See application file for complete search history.

(56) **References Cited**

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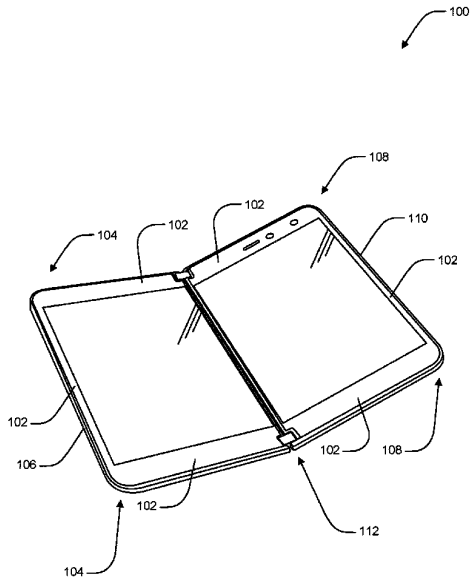
Primary Examiner — Henry Luong
(74) *Attorney, Agent, or Firm* — Holzer Patel Drennan

(57) **ABSTRACT**

A physically configurable communication device includes a conductive chassis. The physically configurable communication device includes a first device portion including one or more electrically driven antennas at least partially formed in the conductive chassis of the physically configurable communication device and an electrical feed in the first device portion connected to the one or more electrically driven antennas. The electrical feed is configured to supply a communication signal to the one or more electrically driven antennas. A second device portion is movably attached to the first device portion. The second device portion includes one or more capacitively coupled antennas at least partially formed in the conductive chassis of the physically configurable communication device, wherein each of the electrically driven antennas in the first device portion capacitively drives at least a corresponding one of the capacitively coupled antennas in the second device portion.

21 Claims, 6 Drawing Sheets



US012068529B2

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

(10) **Patent No.: US 12,068,529 B2**
(45) **Date of Patent: Aug. 20, 2024**

(54) **ELECTRONIC DEVICE HAVING ANTENNA FEED MODULE**

(71) Applicant: **FIH CO., LTD.**, New Taipei (TW)

(72) Inventors: **Cho-Kang Hsu**, New Taipei (TW); **Min-Hui Ho**, New Taipei (TW); **Yen-Hui Lin**, New Taipei (TW); **Wei-Cheng Su**, New Taipei (TW)

(73) Assignee: **FIH CO., LTD.**, New Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 184 days.

(21) Appl. No.: **17/828,306**

(22) Filed: **May 31, 2022**

(65) **Prior Publication Data**

US 2023/0361449 A1 Nov. 9, 2023

(30) **Foreign Application Priority Data**

May 7, 2022 (CN) 202210490818.0

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

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

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

(56) **References Cited**

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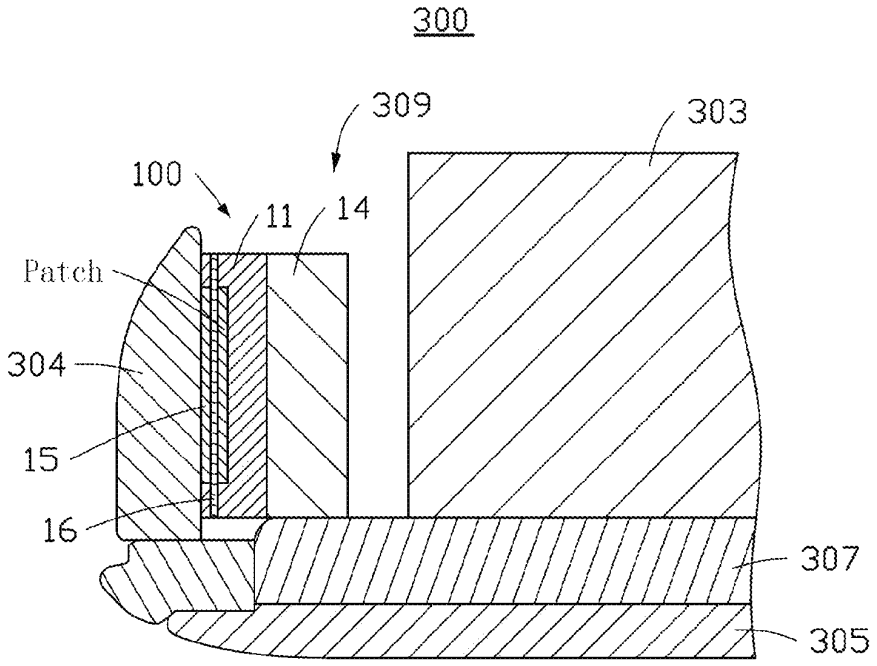
Primary Examiner — Hoang V Nguyen
Assistant Examiner — Brandon Sean Woods
(74) *Attorney, Agent, or Firm* — ScienBiziP, P.C.

(57) **ABSTRACT**

An electronic device includes a metal frame, a middle frame, and at least one antenna feed module. The metal frame includes an upper metal frame, a first side metal frame, a bottom metal frame, and a second side metal frame sequentially connected. The middle frame, spaced apart from the first side metal frame and the second side metal frame, forms a slit, the at least one antenna feed module is received in the slit.

20 Claims, 39 Drawing Sheets



US012068534B2

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

(10) **Patent No.: US 12,068,534 B2**
(45) **Date of Patent: Aug. 20, 2024**

(54) **ANTENNA UNIT, PREPARATION METHOD THEREFOR, AND ELECTRONIC DEVICE**

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

(72) Inventors: **Yali Wang**, Beijing (CN); **Feng Qu**, Beijing (CN)

(73) Assignees: **Beijing BOE Technology Development 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 264 days.

(21) Appl. No.: **17/635,702**

(22) PCT Filed: **Mar. 23, 2021**

(86) PCT No.: **PCT/CN2021/082472**
§ 371 (c)(1),
(2) Date: **Feb. 16, 2022**

(87) PCT Pub. No.: **WO2022/198460**
PCT Pub. Date: **Sep. 29, 2022**

(65) **Prior Publication Data**

US 2023/0344118 A1 Oct. 26, 2023

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

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

(58) **Field of Classification Search**
CPC .. H01Q 1/48; H01Q 1/38; H01Q 1/50; H01Q 1/243; H01Q 13/10
See application file for complete search history.

(56) **References Cited**

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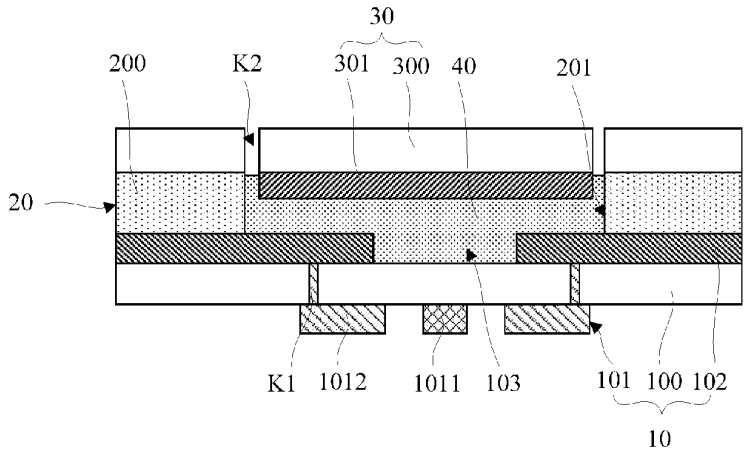
Primary Examiner — Seung H Lee
(74) *Attorney, Agent, or Firm* — Ling Wu; Stephen Yang; Ling and Yang Intellectual Property

(57) **ABSTRACT**

An antenna unit includes: a first substrate, a second substrate, and a third substrate which are stacked. The second substrate has a first slotted area. A liquid crystal layer is arranged in a cavity formed by the first substrate, the first slotted area of the second substrate, and the third substrate. The first substrate includes: a first base substrate, a ground layer on one side of the first base substrate close to the second substrate, and a feed structure layer on one side of the first base substrate away from the second substrate. Orthogonal projections of the ground layer and the feed structure layer on second substrate overlap with an orthogonal projection of first slotted area on the second substrate. The third substrate includes: a third base substrate, and a radiation structure layer on one side of the third base substrate close to the second substrate.

20 Claims, 7 Drawing Sheets



US012068536B2

(12) **United States Patent**
Zhu

(10) **Patent No.: US 12,068,536 B2**
(45) **Date of Patent: Aug. 20, 2024**

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

(71) Applicant: **VIVO MOBILE COMMUNICATION CO., LTD.**, Chang'an Dongguan (CN)

(72) Inventor: **Welcal Zhu**, Chang'an Dongguan (CN)

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

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

(21) Appl. No.: **17/217,666**

(22) Filed: **Mar. 30, 2021**

(65) **Prior Publication Data**

US 2021/0218137 A1 Jul. 15, 2021

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2019/098537, filed on Jul. 31, 2019.

(30) **Foreign Application Priority Data**

Sep. 30, 2018 (CN) 201811159381.2

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

(52) **U.S. Cl.**
CPC ***H01Q 1/521*** (2013.01); ***H01Q 1/24*** (2013.01); ***H01Q 7/00*** (2013.01); ***H01Q 9/42*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/521; H01Q 1/24; H01Q 7/00; H01Q 9/42; H01Q 1/243; H01Q 1/44;
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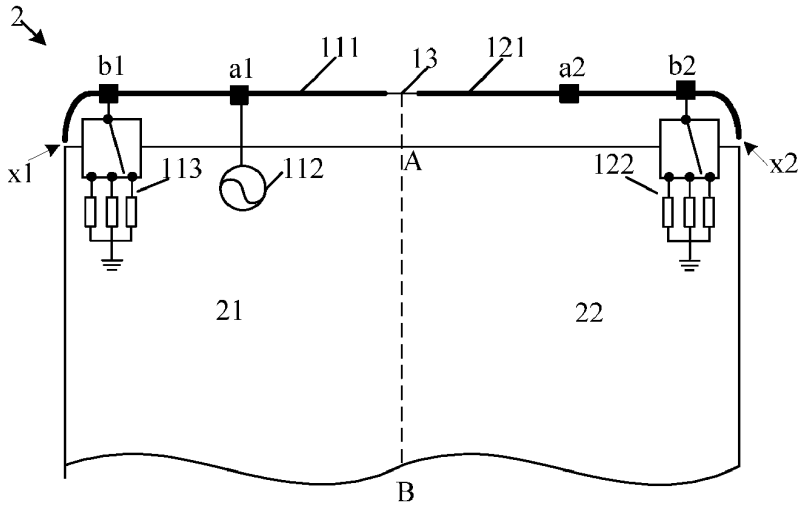
Primary Examiner — Hai V Tran
Assistant Examiner — Michael M Bouizza
(74) *Attorney, Agent, or Firm* — von Briesen & Roper, s.c.

(57) **ABSTRACT**

The present invention provides an antenna unit and a terminal device. The antenna unit includes the first antenna module and the second antenna module, the first antenna module includes the first radiator and the feed connected to the first radiator, and the second antenna module includes the second radiator connected to the first radiator. The first radiator includes the at least one first contact, and the second radiator includes the at least one second contact. When the angle between the first radiator and the second radiator is less than or equal to the first angle, the second radiator is electrically connected to the first radiator in the target manner. The target manner is that N first contacts of the at least one first contact are correspondingly in contact with N second contacts of the at least one second contact, where N is a positive integer.

14 Claims, 7 Drawing Sheets



US012068538B2

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

(10) **Patent No.: US 12,068,538 B2**
(45) **Date of Patent: Aug. 20, 2024**

(54) **DUAL MODE ANTENNA STRUCTURES**

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

(72) Inventors: **Hanyang Wang**, Reading (GB); **Dawei Zhou**, Shenzhen (CN); **Yuanpeng Li**, Shenzhen (CN); **Le Chang**, Shenzhen (CN); **Hai Zhou**, Reading (GB)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 386 days.

(21) Appl. No.: **17/601,552**

(22) PCT Filed: **May 6, 2019**

(86) PCT No.: **PCT/EP2019/061564**
§ 371 (c)(1),
(2) Date: **Oct. 5, 2021**

(87) PCT Pub. No.: **WO2020/224757**
PCT Pub. Date: **Nov. 12, 2020**

(65) **Prior Publication Data**

US 2022/0181784 A1 Jun. 9, 2022

(51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 1/24 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 13/10*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/521*** (2013.01); ***H01Q 9/26*** (2013.01); ***H01Q 21/28*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/521; H01Q 13/10; H01Q 21/28; H01Q 9/16; H01Q 9/26; H01Q 1/36; H01Q 1/50; H01Q 1/52
See application file for complete search history.

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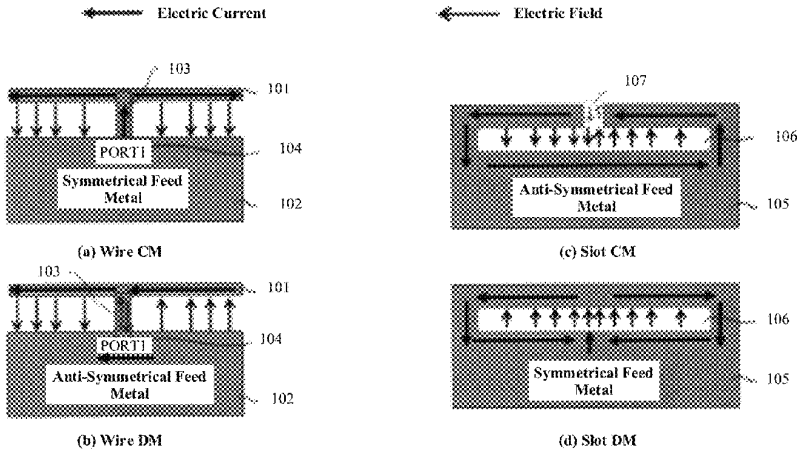
Primary Examiner — Thien M Le
(74) *Attorney, Agent, or Firm* — WOMBLE BOND DICKINSON (US) LLP

(57) **ABSTRACT**

An antenna structure includes a first antenna element connected to a first port, and a second antenna element connected to a second port. The antenna structure is operable to simultaneously transceive: a first signal via electric or magnetic current flow through the first antenna element in a symmetrically excited mode in which current flows symmetrically through the first antenna element and/or an asymmetrically excited mode in which current flows asymmetrically through the first antenna element, the first antenna element resonates at a first resonant frequency; and a second signal via electric or magnetic current flow through the second antenna element in a symmetrically excited mode in which current flows symmetrically through the second antenna element and/or an asymmetrically excited mode in which current flows asymmetrically through the second antenna element, the second antenna element resonates at a second resonant frequency.

19 Claims, 11 Drawing Sheets



US012068549B2

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

(10) **Patent No.: US 12,068,549 B2**
(45) **Date of Patent: Aug. 20, 2024**

(54) **ELECTRONIC DEVICE INCLUDING ANTENNA**

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

(72) Inventors: **Hyunjeong Lee**, Suwon-si (KR); **Himchan Yun**, Suwon-si (KR); **Bomyoung Kim**, Suwon-si (KR); **Sewoong Kim**, Suwon-si (KR); **Soonho Hwang**, Suwon-si (KR); **Jin Kim**, Suwon-si (KR); **Jongoh Lim**, 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 110 days.

(21) Appl. No.: **17/975,085**

(22) Filed: **Oct. 27, 2022**

(65) **Prior Publication Data**

US 2023/0101080 A1 Mar. 30, 2023

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2022/014457, filed on Sep. 27, 2022.

(30) **Foreign Application Priority Data**

Sep. 30, 2021 (KR) 10-2021-0130409
Oct. 29, 2021 (KR) 10-2021-0146313

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 5/35 (2015.01)
H01Q 21/06 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 9/045*** (2013.01); ***H01Q 5/35*** (2015.01); ***H01Q 21/065*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/35; H01Q 21/065; H01Q 1/52; H01Q 1/243
See application file for complete search history.

(56) **References Cited**

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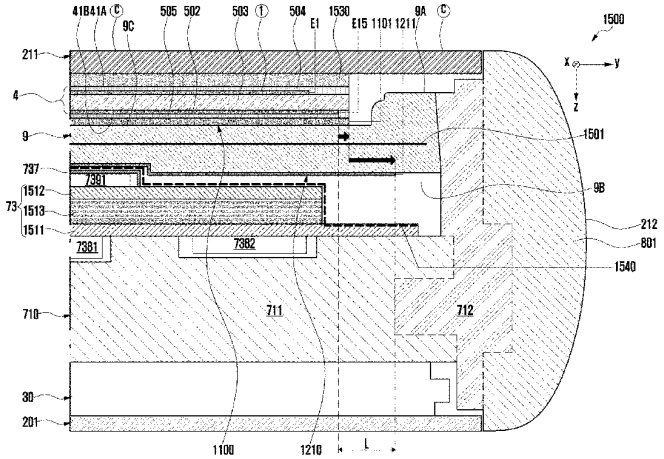
Primary Examiner — Dieu Hien T Duong
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

An electronic device is provided. The electronic device includes a housing, an antenna structure, a first conductive material, and a second conductive material. The housing may be configured to provide a front surface and a rear surface of the electronic device. The antenna structure includes a printed circuit board positioned in the housing. The printed circuit board includes a first surface configured to face the front surface or the rear surface and a second surface configured to face a direction opposite to the first surface. The printed circuit board includes a first conductive layer, a second conductive layer, and a dielectric. The first conductive layer includes a first antenna element and a second antenna element which are configured so as not to overlap each other when viewed from above the first surface.

20 Claims, 26 Drawing Sheets



US012068810B2

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

(10) **Patent No.: US 12,068,810 B2**
(45) **Date of Patent: Aug. 20, 2024**

(54) **ELECTRONIC DEVICE HAVING TRANSPARENT ANTENNA**

(71) Applicants: **LG ELECTRONICS INC.**, Seoul (KR); **KOREA ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY**, Daejeon (KR)

(72) Inventors: **Kukheon Choi**, Seoul (KR); **Ilnam Cho**, Seoul (KR); **Seungmin Woo**, Seoul (KR); **Byeongyong Park**, Seoul (KR); **Jeongwook Kim**, Daejeon (KR); **Jongwon Yu**, Daejeon (KR); **Kwangseok Kim**, Daejeon (KR)

(73) Assignees: **LG ELECTRONICS INC.**, Seoul (KR); **KOREA ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY**, Daejeon (KR)

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

(21) Appl. No.: **17/758,815**

(22) PCT Filed: **Mar. 6, 2020**

(86) PCT No.: **PCT/KR2020/003154**
§ 371 (c)(1),
(2) Date: **Jul. 14, 2022**

(87) PCT Pub. No.: **WO2021/177490**
PCT Pub. Date: **Sep. 10, 2021**

(65) **Prior Publication Data**

US 2023/0041218 A1 Feb. 9, 2023

(51) **Int. Cl.**
H04B 7/0413 (2017.01)
H01Q 1/24 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04B 7/0413*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/3291*** (2013.01); ***H01Q 1/48*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 9/045; H01Q 9/40
See application file for complete search history.

(56) **References Cited**

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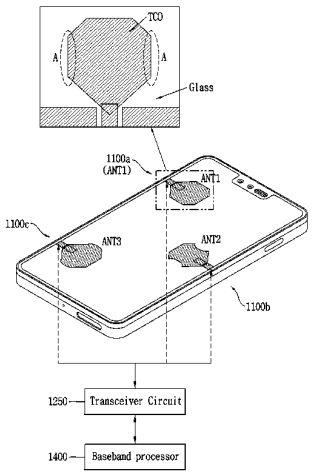
Primary Examiner — AB Salam Alkassim, Jr.
(74) *Attorney, Agent, or Firm* — LEE, HONG, DEGERMAN, KANG & WAIMEY

(57) **ABSTRACT**

Provided according to the present invention is an electronic device having an antenna. The electronic device may comprise: a transparent antenna built into a display and configured to emit a signal to the front of the display; and a transmission line for feeding the transparent antenna. The transparent antenna is configured as a rectangular patch rotated at a predetermined angle, and a portion of the left and right-side areas of the rectangular patch may be formed as vertical lines.

13 Claims, 19 Drawing Sheets



US012069801B2

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

(10) **Patent No.: US 12,069,801 B2**
(45) **Date of Patent: Aug. 20, 2024**

(54) **PHASE SHIFTER, ANTENNA, AND BASE STATION**

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

(72) Inventors: **Xinming Liu**, Xi'an (CN); **Junfeng Lu**, Xi'an (CN); **Zhenxing Wan**, Xi'an (CN); **Weimin Li**, 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 311 days.

(21) Appl. No.: **17/479,397**

(22) Filed: **Sep. 20, 2021**

(65) **Prior Publication Data**

US 2022/0007503 A1 Jan. 6, 2022

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2020/080360, filed on Mar. 20, 2020.

(30) **Foreign Application Priority Data**

Mar. 20, 2019 (CN) 201910213308.7

(51) **Int. Cl.**
H05K 1/02 (2006.01)
H01P 1/18 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H05K 1/0271*** (2013.01); ***H01P 1/18*** (2013.01); ***H01Q 1/12*** (2013.01); ***H05K 1/0243*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H05K 1/0271; H05K 1/0243; H05K 2201/068; H05K 2201/10098; H01P 1/18; H01Q 1/12; H01R 12/55
See application file for complete search history.

(56) **References Cited**

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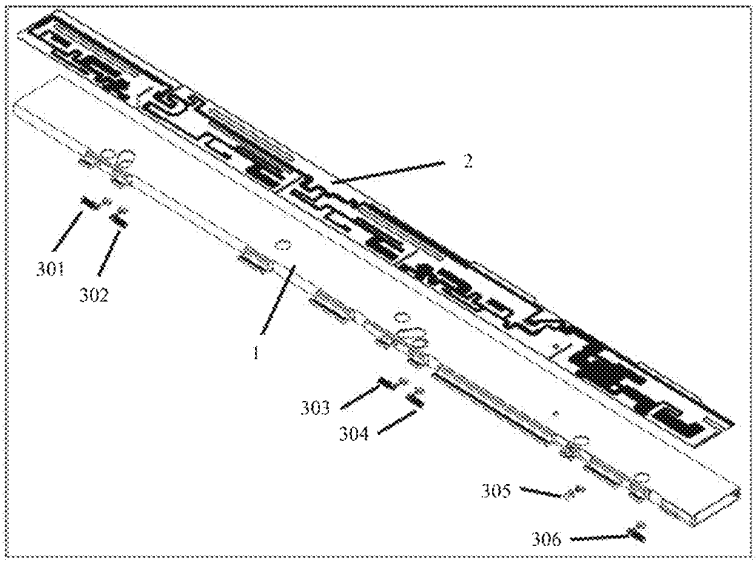
(Continued)

Primary Examiner — Keith Ferguson
(74) *Attorney, Agent, or Firm* — Fish & Richardson P.C.

(57) **ABSTRACT**

The present disclosure relates to phase shifters, antennas, and base stations. One example phase shifter includes a cavity, a built-in printed circuit board (PCB), and a stress relief portion. The stress relief portion is connected to the PCB, and the stress relief portion is configured to reduce a stress generated due to different coefficients of thermal expansion (CTE) of the cavity and the PCB.

9 Claims, 5 Drawing Sheets



US012074362B2

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

(10) **Patent No.: US 12,074,362 B2**
(45) **Date of Patent: Aug. 27, 2024**

(54) **ELECTRONIC DEVICE COMPRISING ANTENNA**

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

(72) Inventors: **Sungsoo Kim**, Suwon-si (KR); **Jaehoon Jo**, Suwon-si (KR); **Yongyoun Kim**, Suwon-si (KR); **Dongyoung Lee**, Suwon-si (KR); **Woomin Jang**, Suwon-si (KR); **Seungbum 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 112 days.

(21) Appl. No.: **17/980,128**

(22) Filed: **Nov. 3, 2022**

(65) **Prior Publication Data**

US 2023/0198126 A1 Jun. 22, 2023

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2022/014212, filed on Sep. 23, 2022.

(30) **Foreign Application Priority Data**

Dec. 17, 2021 (KR) 10-2021-0181503
Jan. 14, 2022 (KR) 10-2022-0005883

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
G01D 5/24 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***G01D 5/24*** (2013.01); ***G01L 1/142*** (2013.01); ***H01Q 9/0407*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 9/0407; H01Q 5/40; H01Q 9/0414; H01Q 21/08; G01D 5/24; G01L 1/142
See application file for complete search history.

(56) **References Cited**

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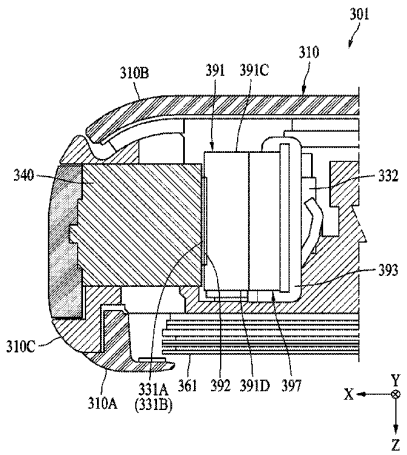
Primary Examiner — Seung H Lee
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

An electronic device is provided. The electronic device includes a housing including a first surface, a second surface opposite to the first surface, and a side surface between the first surface and the second surface, an antenna including a carrier including a first carrier surface facing the side surface, a second carrier surface opposite to the first carrier surface and a plurality of side carrier surfaces between the first carrier surface and the second carrier surface, and a patch positioned on the first carrier surface, a first capacitive sensor positioned between the first carrier surface and the side surface, and a filler positioned between the side surface and the first carrier surface.

20 Claims, 24 Drawing Sheets



US012074369B2

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

(10) **Patent No.: US 12,074,369 B2**
(45) **Date of Patent: Aug. 27, 2024**

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

(71) Applicant: **GUANGZHOU SHIYUAN ELECTRONIC TECHNOLOGY COMPANY LIMITED**, Guangzhou (CN)

(72) Inventors: **Bingjie Deng**, Guangzhou (CN); **Guofeng Hong**, Guangzhou (CN)

(73) Assignee: **GUANGZHOU SHIYUAN ELECTRONIC TECHNOLOGY COMPANY LIMITED**, Guangzhou (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 147 days.

(21) Appl. No.: **17/846,308**

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

(65) **Prior Publication Data**

US 2022/0320724 A1 Oct. 6, 2022

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2020/128393, filed on Nov. 12, 2020.

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

(52) **U.S. Cl.**
CPC ***H01Q 1/526*** (2013.01); ***H01Q 1/2283*** (2013.01); ***H01Q 1/528*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/526; H01Q 1/2283; H01Q 1/528; H01Q 1/2266; H01Q 1/523; H01Q 5/371;
(Continued)

(56) **References Cited**

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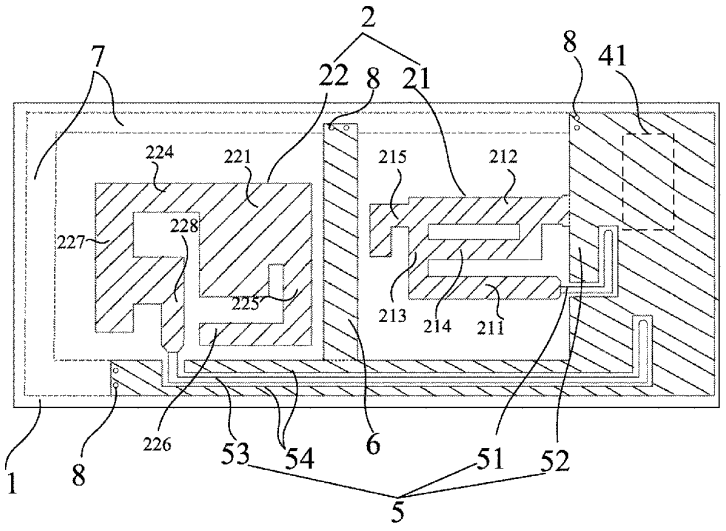
Primary Examiner — Jany Richardson
(74) *Attorney, Agent, or Firm* — BAYES PLLC

(57) **ABSTRACT**

An antenna assembly and an electronic device are provided. The antenna assembly comprises a dielectric substrate; an antenna unit, arranged on a surface of the dielectric substrate; a radio frequency chip, arranged on a surface of the dielectric substrate, and connected with the antenna unit; and a metal shielding cover, arranged on another surface of the dielectric substrate facing away from the antenna unit, and coving the antenna unit. The electromagnetic interference to antenna unit caused by other electronic devices of electronic equipment can be isolated through the metal shielding cover, and the antenna unit and the radio frequency chip of the antenna assembly can be arranged on the same dielectric substrate, avoiding the use of a coaxial cable to connect the antenna unit and the radio frequency chip, thereby solving the problem of electromagnetic interference to and ensuring the radiation performance of the antenna unit.

20 Claims, 12 Drawing Sheets



US012087995B2

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

(10) **Patent No.: US 12,087,995 B2**
(45) **Date of Patent: Sep. 10, 2024**

(54) **ANTENNA FOR AN ELECTRONIC DEVICE, AN ELECTRONIC DEVICE, A MOBILE DEVICE, A HINGE STRUCTURE, AND A METHOD FOR SELECTING AN ANTENNA**

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

(72) Inventors: **Jayprakash Thakur**, Bangalore (IN); **Prasanna Pichumani**, Bangalore (IN); **Maruti Tamrakar**, Tamil Nadu (IN); **Doddi Raghavendra**, Bangalore (IN); **Sagar Gupta**, Ghaziabad (IN)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 264 days.

(21) Appl. No.: **17/455,928**

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

(65) **Prior Publication Data**

US 2022/0200123 A1 Jun. 23, 2022

(30) **Foreign Application Priority Data**

Dec. 23, 2020 (EP) 20216823

(51) **Int. Cl.**
H01Q 1/02 (2006.01)
H01Q 1/12 (2006.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/02*** (2013.01); ***H01Q 1/12*** (2013.01); ***H01Q 9/04*** (2013.01); ***H01Q 9/0407*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/02; H01Q 1/12; H01Q 9/0407; H01Q 9/04
See application file for complete search history.

(56) **References Cited**

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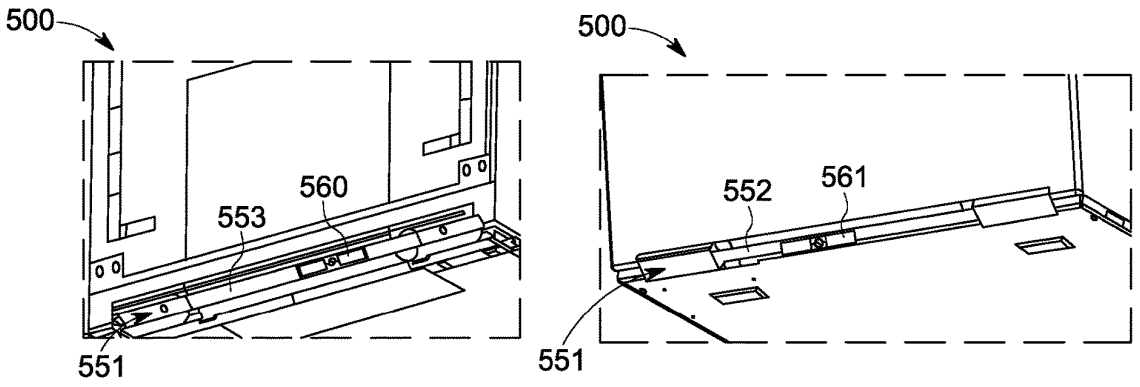
Primary Examiner — Hai V Tran
(74) *Attorney, Agent, or Firm* — 2SPL Patent Attorneys PartG mbB; Kieran O'Leary

(57) **ABSTRACT**

Examples relate to concepts for antenna arrangement and particular to an antenna for an electronic device. An electronic device comprises, a case, a lid and a heat spreading structure. Further, an electronic device comprises a hinge arrangement between the case and the lid. The hinge arrangement comprises at least one hinge structure connecting the lid to the case. Further, the electronic device comprises an antenna. The antenna is arranged in an area of the hinge arrangement. The heat spreading structure extends from the case through the area of the hinge arrangement to the lid.

16 Claims, 17 Drawing Sheets



US012088002B2

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

(10) **Patent No.: US 12,088,002 B2**
(45) **Date of Patent: Sep. 10, 2024**

(54) **ELECTRONIC DEVICE COMPRISING ANTENNA AND HOUSING INCLUDING NON-METALLIC MATERIAL**

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

(72) Inventors: **Jigu Jang**, Suwon-si (KR); **Hoyoung Lee**, Suwon-si (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 129 days.

(21) Appl. No.: **17/976,597**

(22) Filed: **Oct. 28, 2022**

(65) **Prior Publication Data**

US 2023/0055951 A1 Feb. 23, 2023

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2021/003572, filed on Mar. 23, 2021.

(30) **Foreign Application Priority Data**

Apr. 28, 2020 (KR) 10-2020-0051529

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

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/38*** (2013.01); ***H04M 1/026*** (2013.01); *H01Q 1/48* (2013.01)

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

(56) **References Cited**

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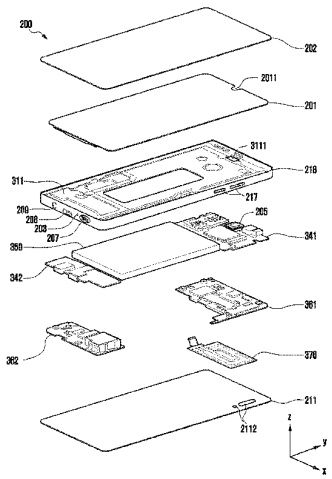
Primary Examiner — Wilson Lee
(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye, P.C.

(57) **ABSTRACT**

An electronic device, according to an embodiment of the present disclosure, may comprise: a front plate; a rear plate positioned on an opposite side of the front plate; a side member including a side surface surrounding at least a part of a space between the front plate and the rear plate, and including a non-conductive material; a non-conductive member comprising a non-conductive material positioned in the space alongside the side member; an adhesive positioned between the side member and the non-conductive member; at least one antenna positioned in the space and spaced apart from the side member and having the non-conductive member therebetween, the at least one antenna is coupled to the non-conductive member; and a communication circuit configured to transmit and/or receive a signal in a selected or designated frequency band by means of the at least one antenna.

20 Claims, 20 Drawing Sheets



US012088014B2

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

(10) **Patent No.: US 12,088,014 B2**
(45) **Date of Patent: Sep. 10, 2024**

(54) **ELECTRONIC DEVICE INCLUDING ANTENNA STRUCTURE FOR UWB-BASED POSITIONING**

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

(72) Inventors: **Youngsuk Yoo**, Suwon-si (KR); **Woosup Lee**, Suwon-si (KR); **Sukgi Hong**, Suwon-si (KR); **Dongyeon Kim**, Suwon-si (KR); **Jungsik Park**, Suwon-si (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 170 days.

(21) Appl. No.: **17/829,813**

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

(65) **Prior Publication Data**

US 2022/0393367 A1 Dec. 8, 2022

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2022/007252, filed on May 20, 2022.

(30) **Foreign Application Priority Data**

Jun. 3, 2021 (KR) 10-2021-0072216

(51) **Int. Cl.**
H01Q 21/06 (2006.01)
H01Q 1/24 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 21/065*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 5/25*** (2015.01); ***H01Q 9/045*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 5/25; H01Q 9/045; H01Q 21/065
See application file for complete search history.

(56) **References Cited**

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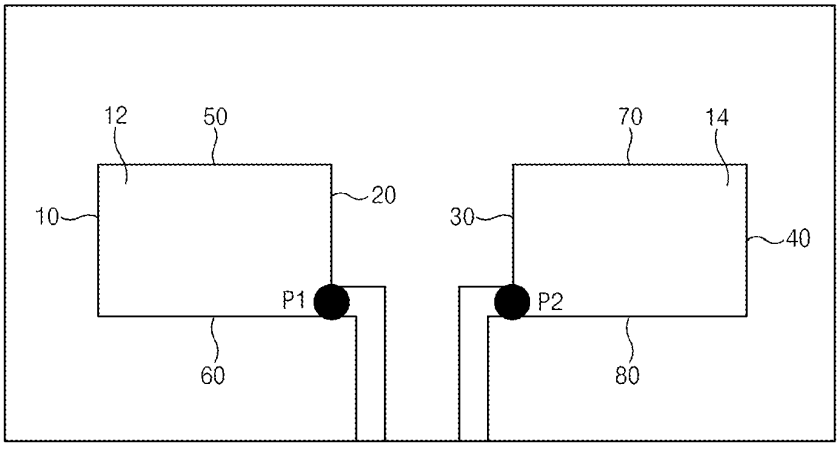
Search Report dated Sep. 13, 2022 issued in International Patent Application No. PCT/KR2022/007252.

Primary Examiner — Dameon E Levi
Assistant Examiner — Leah Rosenberg
(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye, P.C.

(57) **ABSTRACT**

Disclosed is an electronic device. The electronic device includes: an antenna structure including at least one antenna and at least one processor operatively connected with the antenna structure. The antenna structure includes: a first conductive patch including a first edge and a second edge parallel to the first edge, a first transmission line electrically connected to a first point of the first conductive patch, a second conductive patch spaced apart from the first conductive patch by a specified distance and including a third edge at least partially facing the second edge of the first conductive patch and a fourth edge parallel to the third edge, and a second transmission line electrically connected to a second point of the second conductive patch. The first point of the first conductive patch and the second point of the second conductive patch are located on the second edge of the first
(Continued)



US012088019B2

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

(10) **Patent No.: US 12,088,019 B2**
(45) **Date of Patent: Sep. 10, 2024**

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

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

(72) Inventors: **Shih-Chiang Wei**, Hsinchu (TW); **Yung-Chieh Yu**, Hsinchu (TW); **Hsieh-Chih Lin**, 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 130 days.

(21) Appl. No.: **18/152,833**

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

(65) **Prior Publication Data**

US 2024/0014555 A1 Jan. 11, 2024

(30) **Foreign Application Priority Data**

Jul. 6, 2022 (TW) 111125249

(51) **Int. Cl.**

H01Q 5/10	(2015.01)
H01Q 1/22	(2006.01)
H01Q 1/48	(2006.01)
H01Q 5/307	(2015.01)
H01Q 9/04	(2006.01)

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

CPC ***H01Q 5/10*** (2015.01); ***H01Q 1/2266*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 5/307*** (2015.01); ***H01Q 9/045*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 5/371; H01Q 9/42; H01Q 5/328; H01Q 1/48; H01Q 5/378; H01Q 1/2266

See application file for complete search history.

(56) **References Cited**

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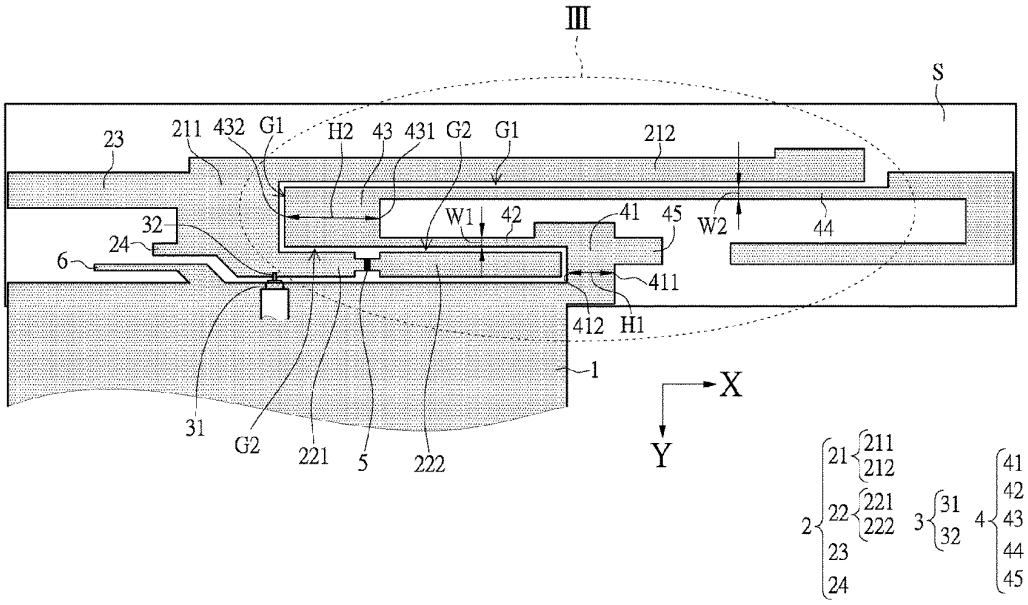
Primary Examiner — Wei (Victor) Y Chan

(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 the antenna structure disposed therein. The antenna structure includes a grounding element, a feeding radiation element, a feeding element and a first grounding radiation element. The feeding radiation element includes a first radiating portion, a second radiating portion and a third radiating portion. The first radiating portion and the second radiating portion jointly surround the first grounding radiation element. The first radiating portion is spaced apart from and coupled with the first grounding radiation element to generate a first operating frequency band. The second radiating portion is spaced apart from and coupled with the first grounding radiation element to generate a second operating frequency band. The first operating frequency band is lower than the second operating frequency band.

18 Claims, 9 Drawing Sheets



US012094645B2

(12) **United States Patent**
Nasu

(10) **Patent No.: US 12,094,645 B2**
(45) **Date of Patent: Sep. 17, 2024**

(54) **ANTENNA COUPLING ELEMENT, ANTENNA DEVICE, AND COMMUNICATION TERMINAL DEVICE**

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

(72) Inventor: **Takafumi Nasu**, Nagaokakyo (JP)

(73) Assignee: **MURATA MANUFACTURING CO., LTD.**, Kyoto (JP)

(*) 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.: **16/992,193**

(22) Filed: **Aug. 13, 2020**

(65) **Prior Publication Data**

US 2020/0373083 A1 Nov. 26, 2020

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2019/016120, filed on Apr. 15, 2019.

(30) **Foreign Application Priority Data**

Apr. 25, 2018 (JP) 2018-084211
Feb. 19, 2019 (JP) 2019-027731

(51) **Int. Cl.**
H01Q 1/50 (2006.01)
H01F 38/14 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01F 38/14*** (2013.01); ***H01Q 1/50*** (2013.01); ***H01Q 5/307*** (2015.01); ***H01Q 21/30*** (2013.01)

(58) **Field of Classification Search**
CPC H01F 38/14; H01F 2027/2809; H01F 27/2804; H01F 19/04; H01Q 1/50;
(Continued)

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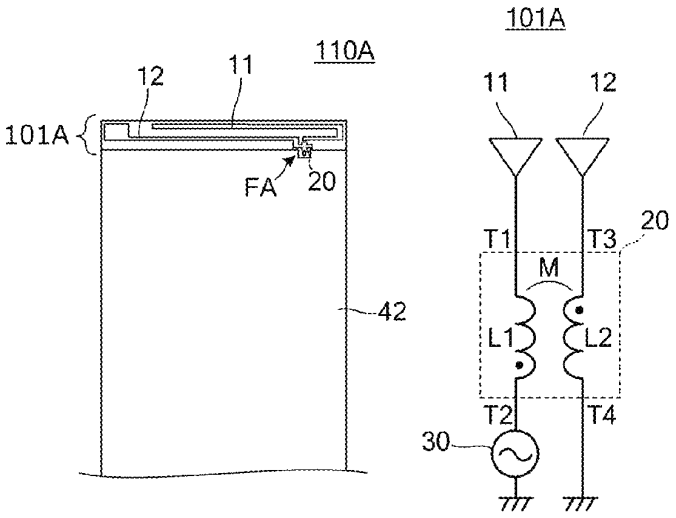
Primary Examiner — Hai V Tran
(74) *Attorney, Agent, or Firm* — Keating & Bennett, LLP

(57) **ABSTRACT**

An antenna coupling element includes a first coil connected to a first radiating element and a feeder circuit and a second coil connected to a second radiating element and electromagnetically coupled to the first coil. The first and second coils have a relationship in which a direction of a magnetic field generated in the first coil when a current flows from the first coil toward the first radiating element and a direction of a magnetic field generated in the second coil when a current flows from the second coil toward the second radiating element are opposite to each other. The first and second coils are set such that a resonant frequency of a fundamental wave of the second radiating element with a transformer defined by the first coil and the second coil is lower than a resonant frequency of a fundamental wave of the first radiating element.

19 Claims, 13 Drawing Sheets



US012095141B2

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

(10) **Patent No.: US 12,095,141 B2**
(45) **Date of Patent: Sep. 17, 2024**

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

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

(72) Inventors: **Meng-Kai Wu**, Hsinchu (TW); **Hong-Jun Jian**, Hsinchu (TW); **Hsieh-Chih Lin**, 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 176 days.

(21) Appl. No.: **18/064,987**

(22) Filed: **Dec. 13, 2022**

(65) **Prior Publication Data**

US 2023/0411825 A1 Dec. 21, 2023

(30) **Foreign Application Priority Data**

Jun. 17, 2022 (TW) 111122539

(51) **Int. Cl.**

H01Q 1/22	(2006.01)
H01Q 1/48	(2006.01)
H01Q 3/18	(2006.01)
H01Q 5/30	(2015.01)
H01Q 9/04	(2006.01)
H01Q 13/10	(2006.01)

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

CPC ***H01Q 1/2266*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 3/18*** (2013.01); ***H01Q 5/30*** (2015.01); ***H01Q 9/0457*** (2013.01); ***H01Q 13/10*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/2266; H01Q 1/48; H01Q 3/10; H01Q 3/18; H01Q 5/30; H01Q 9/0457

See application file for complete search history.

(56) **References Cited**

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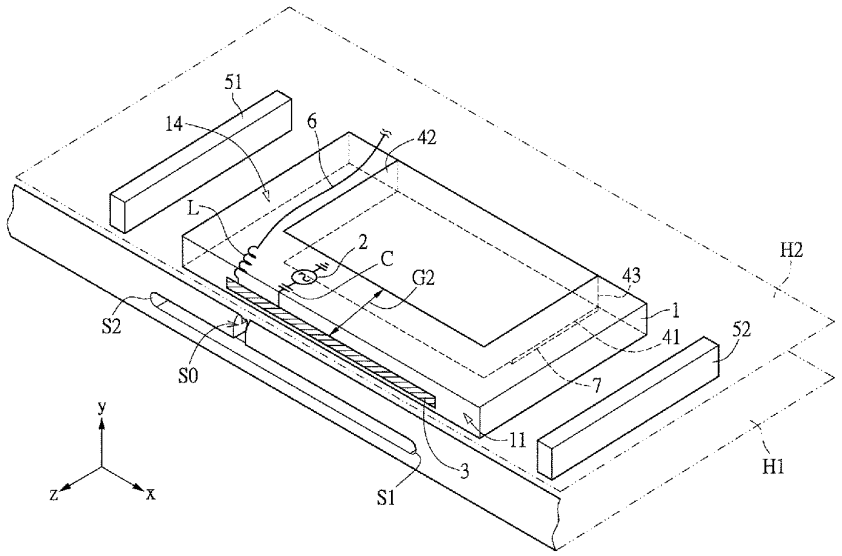
Primary Examiner — Graham P Smith
Assistant Examiner — Amal Patel
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

An electronic device and an antenna module are provided. The electronic device includes a metal housing and the antenna module disposed. The metal housing has a slot, and the slot has an open end. The antenna module includes a carrier, a feeding element, a radiating element connected to the feeding element, and a grounding element. The radiating element is disposed on a first surface of the carrier. An orthogonal projection of the radiating element that is projected onto the metal housing at least partially overlaps with the slot. The grounding element includes a first grounding portion and a second grounding portion electrically connected to each other. The radiating element and the first grounding portion are spaced apart from each other by a first coupling gap, and the radiating element and the second grounding portion are spaced apart from each other by a second coupling gap.

17 Claims, 8 Drawing Sheets



US012095143B2

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

(10) **Patent No.: US 12,095,143 B2**
(45) **Date of Patent: Sep. 17, 2024**

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

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

(72) Inventors: **Li-Kai Kuo**, Hsinchu (TW); **Chun-Hsiang Chuang**, Hsinchu (TW); **Ri-Chang Wang**, 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 167 days.

(21) Appl. No.: **18/066,376**

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

(65) **Prior Publication Data**

US 2023/0378635 A1 Nov. 23, 2023

(30) **Foreign Application Priority Data**

May 18, 2022 (TW) 111118488

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/22 (2006.01)
H01Q 1/38 (2006.01)
H01Q 1/50 (2006.01)

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

(58) **Field of Classification Search**
CPC H01Q 1/2283; H01Q 1/38; H01Q 1/50; H01Q 5/321; H01Q 5/328; H01Q 5/378; H01Q 1/245
See application file for complete search history.

(56) **References Cited**

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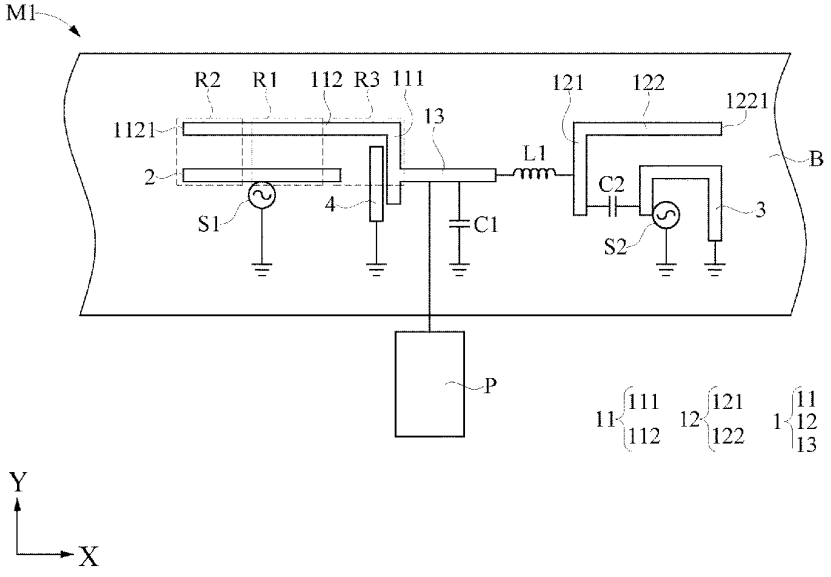
Primary Examiner — David E Lotter
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

An antenna module and an electronic device including the antenna module are provided. The antenna module includes a radiating element, a first inductive element, a first capacitive element, a first feeding radiating element and a second feeding radiating element. The radiating element includes a first radiating branch, a second radiating branch and a third radiating branch, and the third radiating branch is connected between the first and second radiating branches. The first inductive element is connected between the second radiating branch and the third radiating branch. One end of the first capacitive element connected to the third radiating branch, and another end thereof is grounded. The first feeding radiation element is adjacent to the first radiating branch. The second feeding radiation element is adjacent to the second radiating branch. The first feeding radiation element and the first radiating branch are used to generate the first operating frequency band.

15 Claims, 6 Drawing Sheets



US012095146B2

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

(10) **Patent No.: US 12,095,146 B2**
(45) **Date of Patent: Sep. 17, 2024**

(54) **ELECTRONIC DEVICE**

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

(72) Inventors: **Chien-Yi Wu**, Taipei (TW); **Hau Yuen Tan**, Taipei (TW); **Chao-Hsu Wu**, Taipei (TW); **Cheng-Hsiung Wu**, Taipei (TW); **Chen-Kuang Wang**, Taipei (TW); **Shih-Keng Huang**, Taipei (TW); **Chia-Hung Chen**, Taipei (TW); **Sheng-Chin Hsu**, Taipei (TW); **Hao-Hsiang Yang**, Taipei (TW)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 91 days.

(21) Appl. No.: **17/746,863**

(22) Filed: **May 17, 2022**

(65) **Prior Publication Data**

US 2023/0033219 A1 Feb. 2, 2023

(30) **Foreign Application Priority Data**

Jul. 29, 2021 (TW) 110127964

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

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

(58) **Field of Classification Search**
CPC H01Q 1/2291; H01Q 5/364; H01Q 9/0421; H01Q 1/24
See application file for complete search history.

(56) **References Cited**

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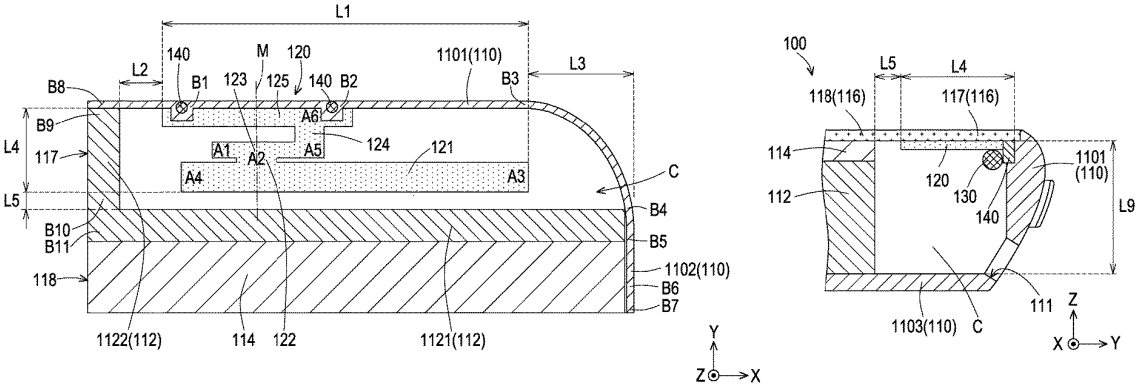
Primary Examiner — Hai V Tran
Assistant Examiner — Michael M Bouizza
(74) *Attorney, Agent, or Firm* — J.C. PATENTS

(57) **ABSTRACT**

An electronic device, including a metal back cover, a front cover, a metal wall, and at least one antenna radiator, is provided. The front cover covers the metal back cover and includes a frame area. The metal wall is disposed between the metal back cover and the front cover, and forms a metal cavity corresponding to the frame area together with the metal back cover. Each of the at least one antenna radiator is disposed in the metal cavity, is connected to a first side wall of the metal back cover, and is spaced apart from the metal wall by a distance.

11 Claims, 5 Drawing Sheets



US012095153B2

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

(10) **Patent No.: US 12,095,153 B2**
(45) **Date of Patent: Sep. 17, 2024**

(54) **ANTENNA STRUCTURE**

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

(72) Inventors: **Chun-I Chen**, Taoyuan (TW); **Chun-Yuan Wang**, Taoyuan (TW); **Chung-Ting Hung**, Taoyuan (TW)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 208 days.

(21) Appl. No.: **17/935,144**

(22) Filed: **Sep. 26, 2022**

(65) **Prior Publication Data**

US 2024/0047864 A1 Feb. 8, 2024

(30) **Foreign Application Priority Data**

Aug. 5, 2022 (TW) 111129635

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 5/307 (2015.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/38*** (2013.01); ***H01Q 5/307*** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/38; H01Q 5/307; H01Q 5/371; H01Q 5/378; H01Q 9/42
See application file for complete search history.

(56) **References Cited**

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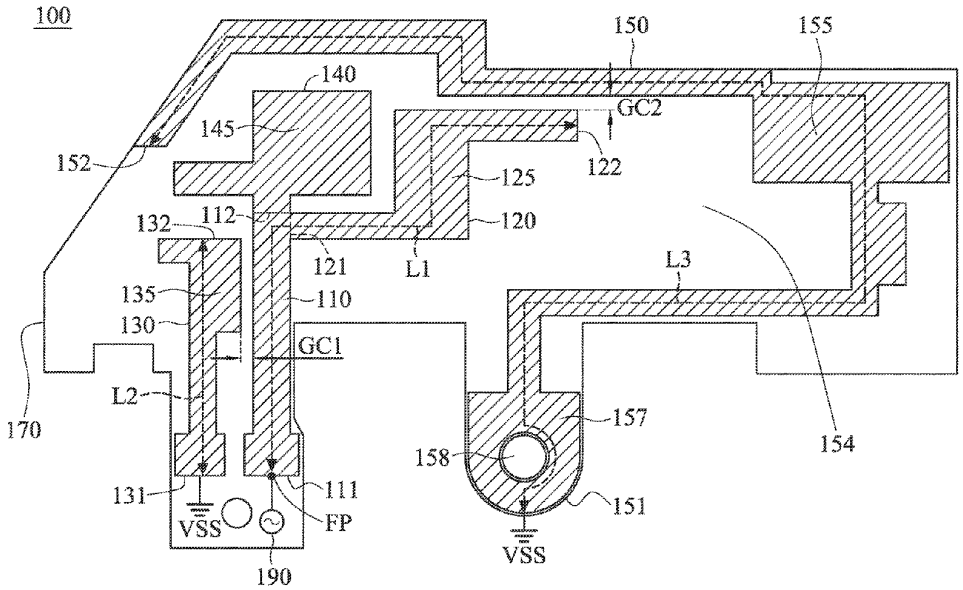
* cited by examiner

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

(57) **ABSTRACT**

An antenna structure includes a first radiation element, a second radiation element, a third radiation element, a fourth radiation element, a fifth radiation element, and a nonconductive support element. The first radiation element has a feeding point. The second radiation element is coupled to the first radiation element. The third radiation element is coupled to a ground voltage and adjacent to the first radiation element. The fourth radiation element is coupled to the first radiation element. The fifth radiation element is coupled to the ground voltage and adjacent to the second radiation element. The first radiation element, the second radiation element, the third radiation element, and the fourth radiation element are at least partially surrounded by the fifth radiation element. The first radiation element, the second radiation element, the third radiation element, the fourth radiation element, and the fifth radiation element are disposed on the nonconductive support element.

10 Claims, 3 Drawing Sheets



US012095159B2

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

(10) **Patent No.: US 12,095,159 B2**
(45) **Date of Patent: Sep. 17, 2024**

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

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

(72) Inventors: **Laiwei Shen**, Shanghai (CN); **Liang Xue**, Shanghai (CN); **Jiaqing You**, 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 394 days.

(21) Appl. No.: **17/420,609**

(22) PCT Filed: **Jan. 4, 2019**

(86) PCT No.: **PCT/CN2019/070437**
§ 371 (c)(1),
(2) Date: **Jul. 2, 2021**

(87) PCT Pub. No.: **WO2020/140275**
PCT Pub. Date: **Jul. 9, 2020**

(65) **Prior Publication Data**

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(51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 1/24 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 13/103*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/44*** (2013.01); ***H01Q 5/378*** (2015.01); ***H01Q 21/28*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/44; H01Q 1/243; H01Q 1/521; H01Q 5/328; H01Q 5/378; H01Q 13/16; H01Q 13/103; H01Q 9/42; H01Q 21/28
See application file for complete search history.

(56) **References Cited**

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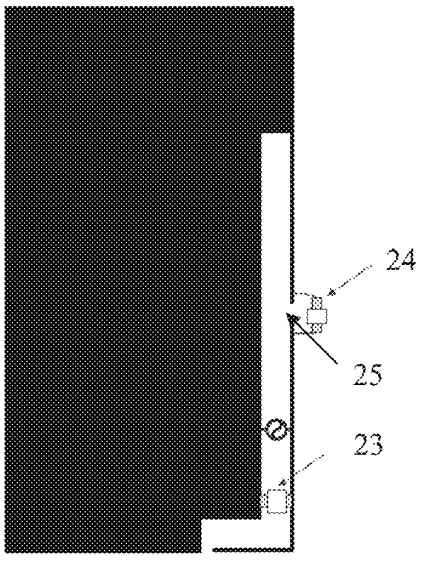
(Continued)

Primary Examiner — Tung X Le
(74) *Attorney, Agent, or Firm* — Conley Rose, P.C.

(57) **ABSTRACT**

An antenna system having a first antenna that includes a metal middle frame, a first metal frame, and a second metal frame. The middle frame is a ground of the first antenna. The first and second metal frames are side edges of the mobile terminal. A first gap is formed by the first, the second metal frames, and the middle frame. A first end of the first metal frame is connected to the middle frame by a first connection point, and a second end of the first metal frame is connected to a first end of the second metal frame. A first slit is located between a second end of the second metal frame and the middle frame. The first feed point on the first metal frame is connected to the middle frame. A length of the first metal frame is greater than a length of the second metal frame.

20 Claims, 9 Drawing Sheets



US012095173B2

(12) **United States Patent**
Hwang

(10) **Patent No.: US 12,095,173 B2**
(45) **Date of Patent: Sep. 17, 2024**

(54) **UWB ANTENNA MODULE**

(71) Applicant: **AMOTECH CO., LTD.**, Incheon (KR)

(72) Inventor: **Chul Hwang**, Incheon (KR)

(73) Assignee: **AMOTECH CO., LTD.**, Incheon (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 238 days.

(21) Appl. No.: **17/622,682**

(22) PCT Filed: **Jun. 23, 2020**

(86) PCT No.: **PCT/KR2020/008173**
§ 371 (c)(1),
(2) Date: **Dec. 23, 2021**

(87) PCT Pub. No.: **WO2020/262942**
PCT Pub. Date: **Dec. 30, 2020**

(65) **Prior Publication Data**

US 2022/0255225 A1 Aug. 11, 2022

(30) **Foreign Application Priority Data**

Jun. 25, 2019 (KR) 10-2019-0075759

(51) **Int. Cl.**
H01Q 5/25 (2015.01)
H01Q 1/48 (2006.01)
H01Q 15/00 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 5/25*** (2015.01); ***H01Q 1/48*** (2013.01); ***H01Q 15/004*** (2013.01)

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

(56) **References Cited**

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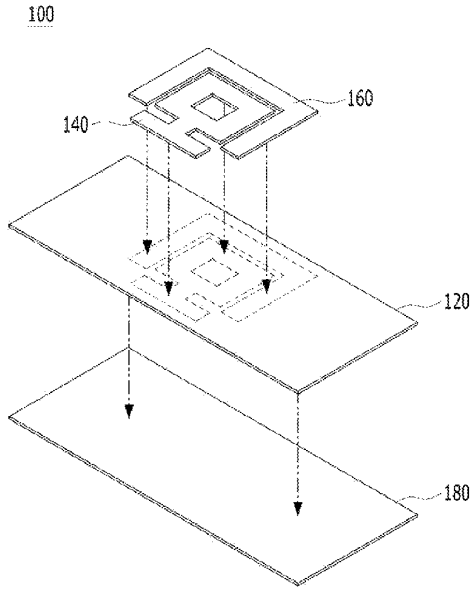
Primary Examiner — Hoang V Nguyen
Assistant Examiner — Brandon Sean Woods
(74) *Attorney, Agent, or Firm* — Maschoff Brennan

(57) **ABSTRACT**

Presented is a UWB antenna module configured to implement omni-directional characteristics with respect to bearings even when mounted on a metal ground plane. The presented UWB antenna module comprises: a base sheet; a radiation pattern formed on a front surface of the base sheet; and a ground pattern formed on the front surface of the base sheet and arranged to surround the radiation pattern.

10 Claims, 15 Drawing Sheets



US012095176B2

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

(10) **Patent No.: US 12,095,176 B2**
(45) **Date of Patent: Sep. 17, 2024**

(54) **ELECTRONIC DEVICE INCLUDING ANTENNA FEEDING UNIT**

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

(72) Inventors: **Sanghue Hong**, Suwon-si (KR); **Jaewan Park**, Suwon-si (KR); **Minsung Koo**, Suwon-si (KR); **Minsoo Sohn**, Suwon-si (KR); **Woosung Lee**, Suwon-si (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 319 days.

(21) Appl. No.: **17/682,615**

(22) Filed: **Feb. 28, 2022**

(65) **Prior Publication Data**

US 2022/0302588 A1 Sep. 22, 2022

Related U.S. Application Data

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(30) **Foreign Application Priority Data**

Mar. 16, 2021 (KR) 10-2021-0033978

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

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

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/32; H01Q 1/3233; H01Q 5/335
See application file for complete search history.

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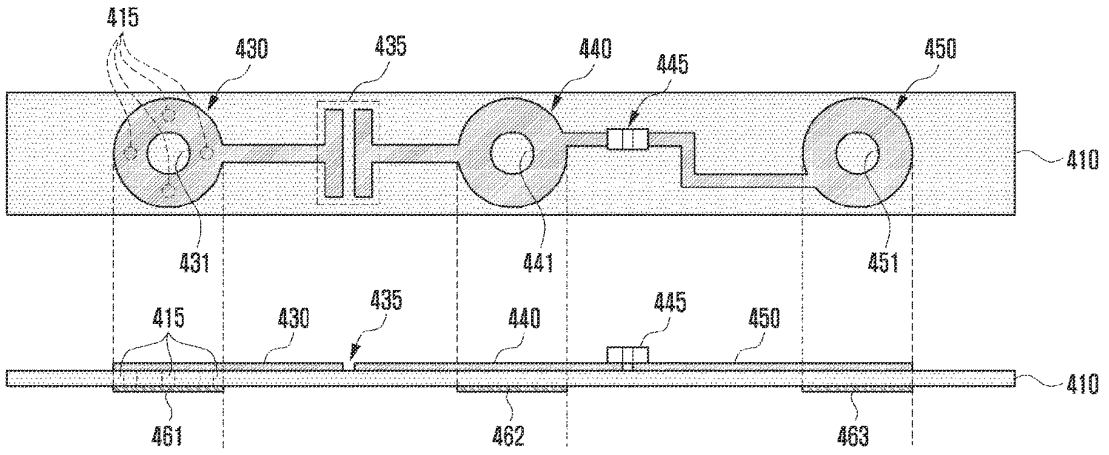
International Search Report dated Jun. 7, 2022, issued in an international Application No. PCT/KR2022/002819.

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

(57) **ABSTRACT**

An electronic device is provided. The electronic device includes an antenna, a wireless communication module electrically connected to the antenna, a flexible printed circuit board (FPCB) including a first feeding element and a second feeding element which are electrically connected to the wireless communication module, a substrate disposed above the first feeding element and the second feeding element, a first conductive pattern including a first coupling hole and a second conductive pattern including a second coupling hole, which are formed on the upper surface of the substrate, a first coupling fastener configured to penetrate the first coupling hole and the first feeding element and electrically connect the first conductive pattern and the first feeding element, and a second coupling fastener configured to penetrate the second coupling hole and the second feeding element and electrically connect the second conductive pattern and the second feeding element.

18 Claims, 8 Drawing Sheets



US012095179B2

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

(10) **Patent No.: US 12,095,179 B2**
(45) **Date of Patent: Sep. 17, 2024**

(54) **ELECTRONIC DEVICE**

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

(72) Inventors: **Chien-Yi Wu**, Taipei (TW); **Chao-Hsu Wu**, Taipei (TW); **Hau Yuen Tan**, Taipei (TW); **Cheng-Hsiung Wu**, Taipei (TW); **Chen-Kuang Wang**, Taipei (TW); **Tse-Hsuan Wang**, Taipei (TW); **Sheng-Chin Hsu**, Taipei (TW); **Shih-Keng Huang**, Taipei (TW); **Chia-Hung Chen**, Taipei (TW)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 155 days.

(21) Appl. No.: **17/898,341**

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

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Oct. 5, 2021 (TW) 110137082

(51) **Int. Cl.**

H01Q 5/50	(2015.01)
G06F 1/16	(2006.01)
H01Q 1/22	(2006.01)
H01Q 1/48	(2006.01)
H01Q 13/10	(2006.01)

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

CPC ***H01Q 5/50*** (2015.01); ***G06F 1/1626*** (2013.01); ***H01Q 1/2291*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 13/106*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 5/371; H01Q 7/00; H01Q 1/38

See application file for complete search history.

(56) **References Cited**

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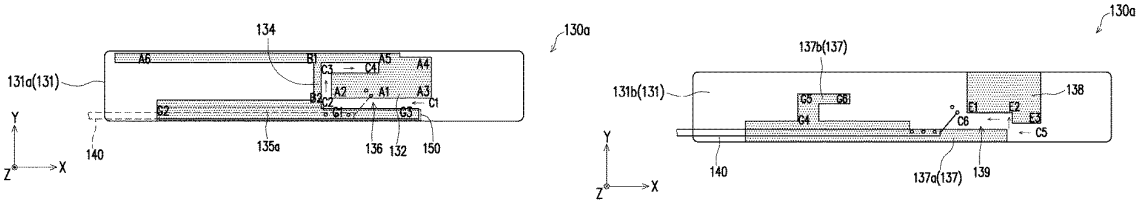
Primary Examiner — Ricardo I Magallanes
Assistant Examiner — Aladdin Abdulbaki
(74) *Attorney, Agent, or Firm* — J.C. PATENTS

(57) **ABSTRACT**

An electronic device includes a metal back cover and an antenna module. The metal back cover includes a slit. The antenna module is separated from the metal back cover and disposed far away from the slit. The antenna module includes an antenna radiator, a first ground radiator, and a connection radiator. The antenna radiator includes a first section, a second section, and a third section that are sequentially connected and form bends, and the first section has a feeding end. A first slot is formed between the first ground radiator, the first section, the second section, and a part of the third section. A width and length of the first slot are associated with a center frequency and impedance matching of a high frequency band.

10 Claims, 10 Drawing Sheets



US012095182B2

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

(10) **Patent No.: US 12,095,182 B2**
(45) **Date of Patent: Sep. 17, 2024**

(54) **CIRCUIT INTEGRATED ANTENNA**

(71) Applicant: **Nippon Telegraph and Telephone Corporation**, Tokyo (JP)

(72) Inventors: **Go Itami**, Tokyo (JP); **Hiroshi Hamada**, Tokyo (JP); **Hideyuki Nosaka**, Tokyo (JP)

(73) Assignee: **Nippon Telegraph and Telephone Corporation**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 145 days.

(21) Appl. No.: **17/912,218**

(22) PCT Filed: **Apr. 20, 2020**

(86) PCT No.: **PCT/JP2020/017022**
§ 371 (c)(1),
(2) Date: **Sep. 16, 2022**

(87) PCT Pub. No.: **WO2021/214815**
PCT Pub. Date: **Oct. 28, 2021**

(65) **Prior Publication Data**

US 2023/0130741 A1 Apr. 27, 2023

(51) **Int. Cl.**
H01Q 13/08 (2006.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 9/045*** (2013.01); ***H01Q 13/08*** (2013.01)

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

(56) **References Cited**

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Lin et al., "A Compact Edge-Fed Filtering Microstrip Antenna with 0.2 dB Equal-Ripple Response," Proceedings of the 39th European Microwave Conference, 29 Sep.-Oct. 1, 2009, Rome, Italy, pp. 378-380.

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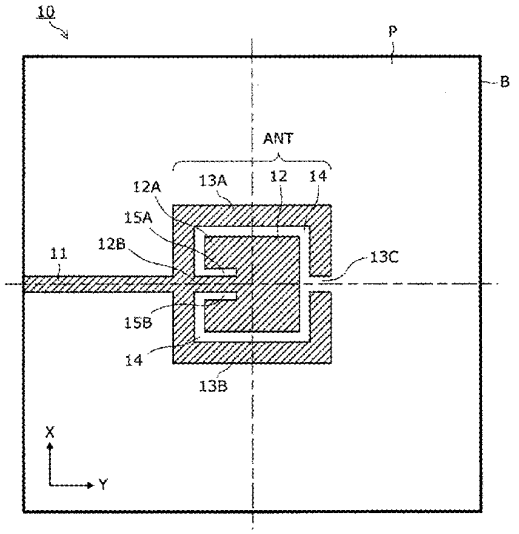
Primary Examiner — Dameon E Levi
Assistant Examiner — Anh N Ho
(74) *Attorney, Agent, or Firm* — Slater Matsil, LLP

(57) **ABSTRACT**

Stub conductors are disposed so as to surround an outer periphery of a patch conductor and be spaced from the patch conductor with a gap positioned between the stub conductors and the patch conductor.

12 Claims, 17 Drawing Sheets



US012095514B2

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

(10) **Patent No.: US 12,095,514 B2**
(45) **Date of Patent: Sep. 17, 2024**

(54) **ELECTRONIC APPARATUS INCLUDING ANTENNA AND AUDIO INTERFACE**

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

(72) Inventors: **Bonam Lee**, Suwon-si (KR); **Hosan Baek**, Suwon-si (KR); **Seongkyoo Byeon**, Suwon-si (KR); **Junyoung Yang**, Suwon-si (KR); **Cheungwon Ryu**, 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 232 days.

(21) Appl. No.: **17/584,934**

(22) Filed: **Jan. 26, 2022**

(65) **Prior Publication Data**

US 2022/0247500 A1 Aug. 4, 2022

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2022/000597, filed on Jan. 13, 2022.

(30) **Foreign Application Priority Data**

Jan. 29, 2021 (KR) 10-2021-0013428

(51) **Int. Cl.**
H04B 15/02 (2006.01)
G06F 3/16 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04B 15/02*** (2013.01); ***G06F 3/16*** (2013.01); ***H01Q 5/25*** (2015.01); ***H04L 12/66*** (2013.01); ***H04R 3/00*** (2013.01)

(58) **Field of Classification Search**
CPC H04L 65/752; H04L 65/80; H04L 65/612; H04L 65/613; H04L 65/762; H04L 65/61;
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(56) **References Cited**

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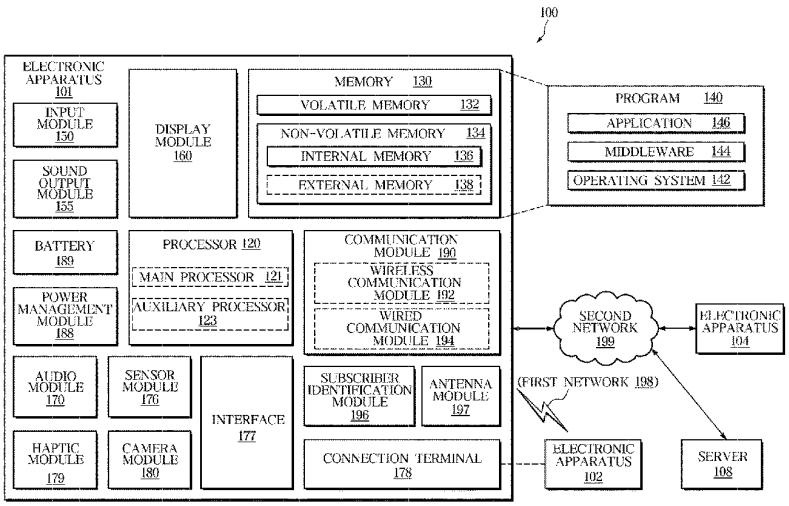
International Search Report dated May 9, 2022, issued in International Application No. PCT/KR2022/000597.

Primary Examiner — Lun-See Lao
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

An electronic apparatus is provided. The electronic apparatus includes a housing having a first surface, an antenna formed on the first surface, an interface that is connectable to an external terminal of an external apparatus via an audio connector formed on the first surface and configured to provide a detection signal indicating whether a connection with the external terminal is made, a processor configured to process an audio signal received from the external terminal of the external apparatus via the interface, a signal line extending from the interface, a noise filter connected to the processor, a matching element, and a switch configured to electrically connect one of the noise filter or the matching element to the signal line, based on the detection signal.

11 Claims, 15 Drawing Sheets



US012095531B2

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

(10) **Patent No.: US 12,095,531 B2**
(45) **Date of Patent: Sep. 17, 2024**

(54) **ELECTRONIC DEVICE COMPRISING ANTENNA**

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

(72) Inventors: **Jongwon Lee**, Gyeonggi-do (KR); **Daehee Park**, Gyeonggi-do (KR); **Chonghwa Seo**, Gyeonggi-do (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 6 days.

(21) Appl. No.: **18/125,867**

(22) Filed: **Mar. 24, 2023**

(65) **Prior Publication Data**

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Related U.S. Application Data

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(30) **Foreign Application Priority Data**

Aug. 12, 2021 (KR) 10-2021-0106836

(51) **Int. Cl.**
H04B 7/06 (2006.01)

(52) **U.S. Cl.**
CPC ***H04B 7/0608*** (2013.01); ***H04B 7/066*** (2013.01)

(58) **Field of Classification Search**
CPC H04B 7/0608; H04B 7/066
USPC 375/262
See application file for complete search history.

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Primary Examiner — Leila Malek
(74) *Attorney, Agent, or Firm* — Cha & Reiter, LLC

(57) **ABSTRACT**

An electronic device according to various embodiments may include a plurality of antennas including a first antenna group and a second antenna group and a wireless communication circuit, and the wireless communication circuit may control the first antenna group to receive a first signal by establishing a first wireless communication channel of the first frequency band with an external device, measure a first channel capacity, select at least one antenna from the second antenna group based on correlation, identify a second channel capacity of a second wireless communication channel of the first frequency band which is able to be established using some of the first antenna group and the selected at least one antenna of the second antenna group, and control to receive the signal of the first frequency band by using some of the first antenna group and the selected at least one antenna.

20 Claims, 15 Drawing Sheets