



US012046800B2

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

(10) **Patent No.:** **US 12,046,800 B2**
(45) **Date of Patent:** **Jul. 23, 2024**

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

(71) Applicant: **Samsung Electronics Co., Ltd.**,
Suwon-si (KR)
(72) Inventors: **Sooyoung Jang**, Suwon-si (KR); **Dongryul Shin**, Suwon-si (KR); **Seho Kim**, Suwon-si (KR); **Gyubok 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 194 days.

(21) Appl. No.: **17/574,115**

(22) Filed: **Jan. 12, 2022**

(65) **Prior Publication Data**
US 2022/0223998 A1 Jul. 14, 2022

Related U.S. Application Data
(63) Continuation of application No. PCT/KR2022/000043, filed on Jan. 4, 2022.

(30) **Foreign Application Priority Data**
Jan. 13, 2021 (KR) 10-2021-0004841

(51) **Int. Cl.**
H01Q 1/48 (2006.01)
H01Q 1/24 (2006.01)
H01Q 5/335 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/24** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/335** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/48; H01Q 5/335; H01Q 1/24

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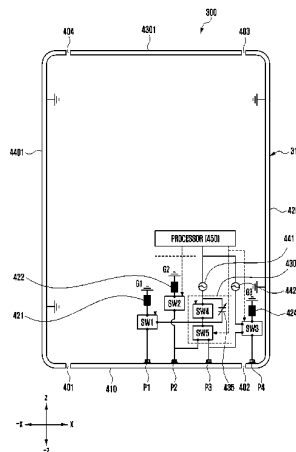
Primary Examiner — Hai V Tran

(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 segment portion and a second segment portion, a first antenna formed between the first segment portion and the second segment portion, and a processor electrically connected to the first antenna, the first antenna includes a first point disposed adjacent to the first segment portion, a third point disposed adjacent to the second segment portion, and a second point disposed between the first point and the third point, and the processor is configured to control feeding signals and/or ground signals of the first point, the second point or the third point, and control the electrical path of the first antenna between the first segment portion and the second segment portion, the first antenna operates in different frequency bands. The first antenna operating at a resonance frequency having the optimum radiation efficiency and performance in a wide-band.

13 Claims, 15 Drawing Sheets





US012046812B2

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

(10) **Patent No.:** **US 12,046,812 B2**
(45) **Date of Patent:** **Jul. 23, 2024**

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

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

(72) Inventors: **Yuanpeng Li**, Shenzhen (CN); **Lanchao Zhang**, Shenzhen (CN); **Jian Luo**, Shenzhen (CN)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 314 days.

(21) Appl. No.: **17/607,331**

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

(86) PCT No.: **PCT/CN2020/086038**

§ 371 (c)(1),

(2) Date: **Oct. 28, 2021**

(87) PCT Pub. No.: **WO2020/221075**

PCT Pub. Date: **Nov. 15, 2020**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Apr. 30, 2019 (CN) 201910360018.5

(51) **Int. Cl.**

H01Q 1/52 (2006.01)

H01Q 1/24 (2006.01)

(Continued)

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

CPC **H01Q 1/521** (2013.01); **H01Q 1/243** (2013.01); **H01Q 5/307** (2015.01); **H01Q 9/045** (2013.01); **H01Q 21/28** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/521; H01Q 5/307; H01Q 1/243; H01Q 9/045; H01Q 21/28

See application file for complete search history.

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Primary Examiner — Graham P Smith

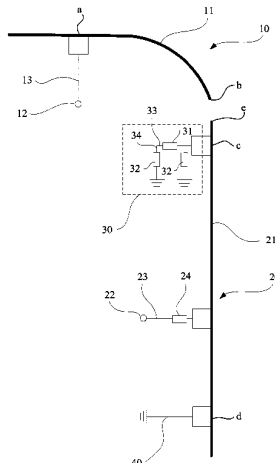
Assistant Examiner — Jordan E. DeWitt

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

(57) **ABSTRACT**

This application provides an antenna assembly. The antenna assembly includes at least a first antenna and a second antenna. The first antenna includes a first feed point and a first radiator connected thereto. The second antenna includes a second feed point and a second radiator connected thereto. There is a gap between the first radiator and the second radiator. An end of the second radiator close to the gap is provided with a first ground wire shared by the first antenna and the second antenna. An end of the second radiator away from the gap is provided with a second ground wire. Because currents excited by the first antenna and the second antenna are orthogonally complementary, crosstalk does not occur between the ground currents of the first antenna and the second antenna.

21 Claims, 8 Drawing Sheets





US012046819B2

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

(10) **Patent No.:** **US 12,046,819 B2**
(45) **Date of Patent:** **Jul. 23, 2024**

(54) **INTEGRATED COMBO SLOT ANTENNAS IN FULL METAL CHASSIS AND ISOLATION IMPROVEMENT TECHNIQUE**

H01Q 1/521; H01Q 13/16; H01Q 21/28; H01Q 1/2266; H01Q 13/10; H01Q 1/242; H01Q 1/52; G06F 1/1658; G06F 1/1698

See application file for complete search history.

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

(56) **References Cited**

(72) Inventors: **Maruti Tamrakar**, Chennai (IN); **Sagar Gupta**, Ghaziabad (IN); **Jayprakash Thakur**, Bangalore (IN); **Prasanna Pichumani**, Bangalore (IN)

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(73) Assignee: **Intel Corporation**, Santa Clara, 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 350 days.

WO WO-2018219070 A1 * 12/2018 H01Q 1/36
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(21) Appl. No.: **17/448,724**

Primary Examiner — David E Lotter

(22) Filed: **Sep. 24, 2021**

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

(65) **Prior Publication Data**

US 2022/0200165 A1 Jun. 23, 2022

(57) **ABSTRACT**

(30) **Foreign Application Priority Data**

Dec. 18, 2020 (EP) 20215444

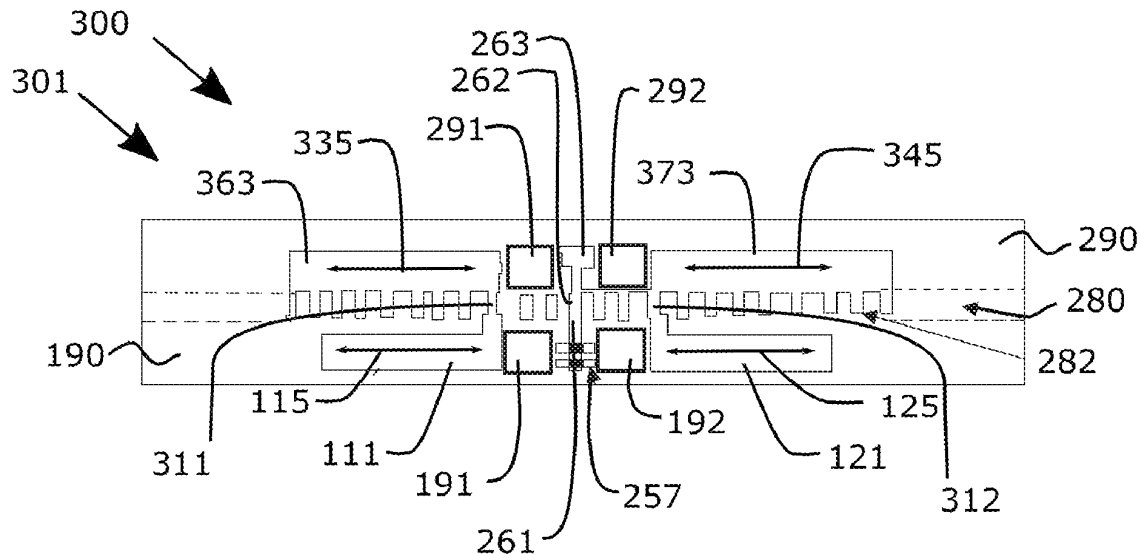
A slot antenna assembly for a portable electronic device is disclosed. The assembly includes a first slot antenna having a first slot through a substrate from an outer surface of the substrate to an inner surface of the substrate. The assembly also includes a second slot antenna including a second slot through the substrate from the outer surface of the substrate to the inner surface of the substrate. An isolator includes at least one of an isolation slot and a conductor. The isolator includes a substrate isolation slot which extends through the substrate between the first and second slot antennas; and a conductor. The conductor connects the inner surface of the substrate between the first and second antennas to an opposite inner surface of an opposite substrate opposite the inner surface between the first and second antennas.

(51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01Q 1/38 (2006.01)
H01Q 13/10 (2006.01)
H01Q 21/06 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 21/064** (2013.01); **H01Q 1/38** (2013.01); **H01Q 13/106** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 21/064; H01Q 1/38; H01Q 13/106;

24 Claims, 7 Drawing Sheets





US012046836B2

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

(10) **Patent No.:** **US 12,046,836 B2**
(45) **Date of Patent:** **Jul. 23, 2024**

(54) **ANTENNA STRUCTURE AND IMAGE DISPLAY DEVICE INCLUDING THE SAME**

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

(71) Applicants: **DONGWOO FINE-CHEM CO., LTD.**, Jeollabuk-do (KR); **KREEMO INC.**, Seoul (KR)

(56) **References Cited**

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Primary Examiner — Ab Salam Alkassim, Jr.

Assistant Examiner — Anh N Ho

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

(72) Inventors: **Won Hee Lee**, Gyeonggi-do (KR); **Dong Pil Park**, Incheon (KR); **Young Sub Son**, Seoul (KR); **In Seok Jang**, Gyeonggi-do (KR); **Beak Jun Seong**, Gyeonggi-do (KR); **Jung Woo Lee**, Seoul (KR); **Seong Tae Jeong**, Gyeonggi-do (KR); **In Kyung Hong**, Seoul (KR); **John Joonho Park**, Gyeonggi-do (KR)

(73) Assignees: **DONGWOO FINE-CHEM CO., LTD.**, Jeollabuk-Do (KR); **KREEMO INC.**, Seoul (KR)

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

(21) Appl. No.: **17/857,672**

(22) Filed: **Jul. 5, 2022**

(65) **Prior Publication Data**

US 2023/0006349 A1 Jan. 5, 2023

(30) **Foreign Application Priority Data**

Jul. 5, 2021 (KR) 10-2021-0087566

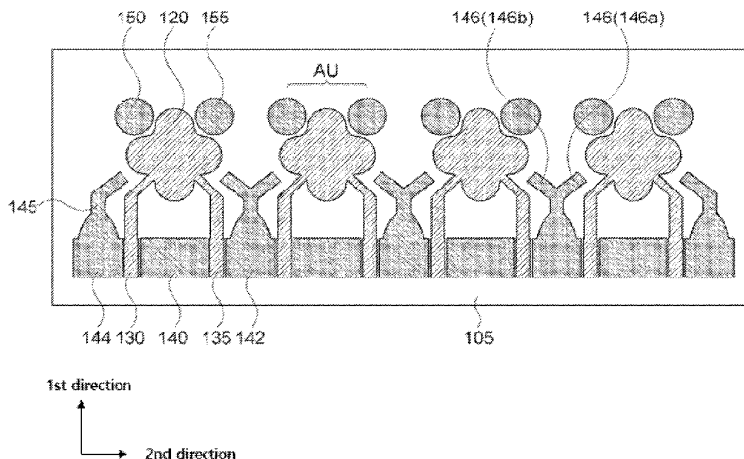
(51) **Int. Cl.**
H01Q 5/378 (2015.01)
H01Q 1/24 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 5/378** (2015.01); **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 9/045** (2013.01); **H01Q 9/40** (2013.01); **H01Q 21/0025** (2013.01)

(57) **ABSTRACT**

An antenna structure according to an embodiment of the present disclosure includes an antenna unit array including a plurality of antenna units, and a parasitic element disposed to be adjacent to the antenna units and to be electrically and physically separated from the antenna units. Each of the antenna units includes a radiator, and a transmission line including a first transmission line and a second transmission line connected to the radiator in different directions. The parasitic element includes a first parasitic element disposed between the first transmission line and the second transmission line included in the same antenna unit, and a second parasitic element disposed between the first transmission line and the second transmission line included in different neighboring antenna units. The second parasitic element includes a branched portion including a first branched portion and a second branched portion bent in different directions.

19 Claims, 9 Drawing Sheets





US012046837B2

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

(10) **Patent No.:** **US 12,046,837 B2**
(45) **Date of Patent:** **Jul. 23, 2024**

(54) **COMMUNICATION DEVICE**
(71) Applicant: **Wistron Corp.**, New Taipei (TW)
(72) Inventors: **Cheng-Chieh Yang**, New Taipei (TW);
Yi Shien Chen, New Taipei (TW)
(73) Assignee: **WISTRON CORP.**, 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 0 days.

(21) Appl. No.: **17/582,224**
(22) Filed: **Jan. 24, 2022**

(65) **Prior Publication Data**
US 2023/0178893 A1 Jun. 8, 2023

(30) **Foreign Application Priority Data**
Dec. 7, 2021 (TW) 110145601

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/27 (2006.01)
H01Q 1/38 (2006.01)
H01Q 5/50 (2015.01)
H01Q 9/32 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 5/50** (2015.01); **H01Q 1/241** (2013.01); **H01Q 1/38** (2013.01); **H01Q 9/32** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/24; H01Q 1/241; H01Q 1/27; H01Q 1/273; H01Q 5/30; H01Q 5/321; H01Q 5/335; H01Q 5/371; H01Q 5/50; H01Q 9/32; H01Q 9/40
See application file for complete search history.

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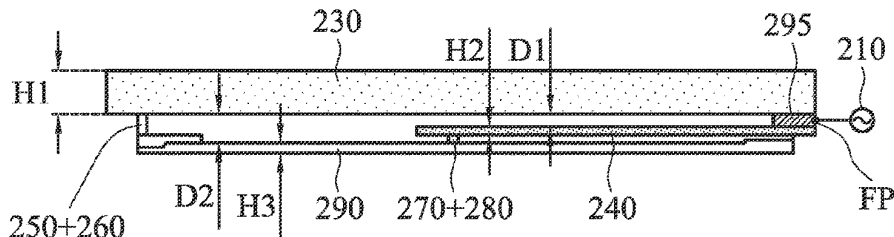
Primary Examiner — Thai Pham
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**
A communication device includes an RF (Radio Frequency) module, an antenna structure, a first switch element, a second switch element, a plurality of first impedance elements, and a plurality of second impedance elements. The antenna structure is coupled to the RF module. The antenna structure includes a first radiation element and a second radiation element. The first switch element is coupled to the first radiation element. The first switch element is switchable between the first impedance elements. The second switch element is coupled to the second radiation element. The second switch element is switchable between the second impedance elements.

17 Claims, 10 Drawing Sheets

200

220 { 230
240
295





US012046838B2

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

(10) **Patent No.:** **US 12,046,838 B2**
(45) **Date of Patent:** **Jul. 23, 2024**

(54) **MULTILAYER BOARD**

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

(72) Inventors: **Koji Kamada**, Nagaokakyo (JP);
Kunihiro Komaki, Nagaokakyo (JP);
Masahiro Izawa, Nagaokakyo (JP);
Ryo Komura, 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 139 days.

(21) Appl. No.: **17/901,018**

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

(65) **Prior Publication Data**
US 2022/0416425 A1 Dec. 29, 2022

Related U.S. Application Data

(63) Continuation of application No.
PCT/JP2021/009016, filed on Mar. 8, 2021.

(30) **Foreign Application Priority Data**

Apr. 14, 2020 (JP) 2020-072089
Sep. 10, 2020 (JP) 2020-151833

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 1/48 (2006.01)
H05K 1/16 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 9/0407** (2013.01); **H01Q 1/48**
(2013.01); **H05K 1/162** (2013.01); **H05K**
2201/09672 (2013.01); **H05K 2201/10098**
(2013.01)

(58) **Field of Classification Search**

CPC H01Q 9/0407; H01Q 9/0414; H01Q 1/48
See application file for complete search history.

(56) **References Cited**

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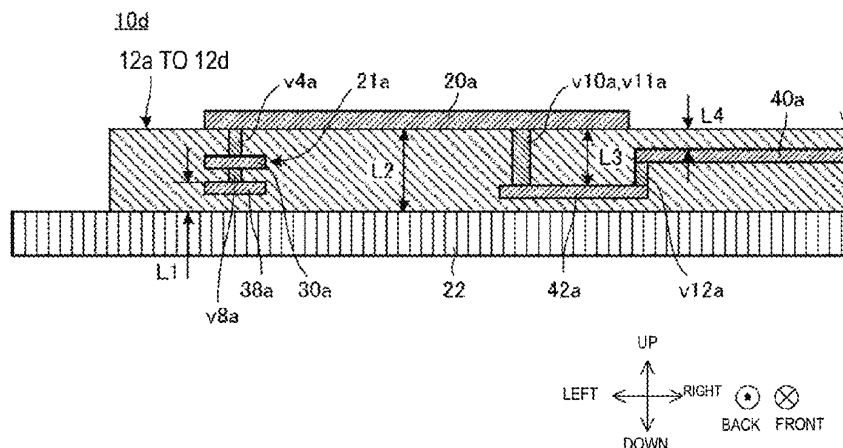
Primary Examiner — Awat M Salih

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

(57) **ABSTRACT**

An element assembly has a structure in which insulator
layers including first and second insulator layers are lami-
nated in an up-down direction. The first insulator layer is
above the second insulator layer. A radiant conductor layer
is on an upper surface of the first insulator layer. A first
capacitance defining portion includes a first interlayer con-
nection conductor passing through one or more of the
insulator layers in the up-down direction. The first interlayer
connection conductor is electrically connected to the radiant
conductor layer. The radiant conductor layer, a ground
conductor, and the first capacitance defining portion define
and function as a patch antenna. When the first interlayer
connection conductor is electrically connected to the radiant
conductor layer, a distance from a lower end of the first
interlayer connection conductor to the ground conductor in

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US012046839B2

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

(10) **Patent No.:** **US 12,046,839 B2**
(45) **Date of Patent:** **Jul. 23, 2024**

(54) **ANTENNA STRUCTURE 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); **Biqi Li**, 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 270 days.

(21) Appl. No.: **17/629,417**

(22) PCT Filed: **Apr. 12, 2021**

(86) PCT No.: **PCT/CN2021/086406**

§ 371 (c)(1),

(2) Date: **Jan. 24, 2022**

(87) PCT Pub. No.: **WO2022/217400**

PCT Pub. Date: **Oct. 20, 2022**

(65) **Prior Publication Data**

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(51) **Int. Cl.**

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H01Q 1/48 (2006.01)

(Continued)

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

CPC **H01Q 9/0421** (2013.01); **H01Q 1/22** (2013.01); **H01Q 1/48** (2013.01); **H01Q 1/50** (2013.01); **H01Q 9/04** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 9/0421; H01Q 1/48; H01Q 1/50; H01Q 1/22; H01Q 5/364

See application file for complete search history.

(56) **References Cited**

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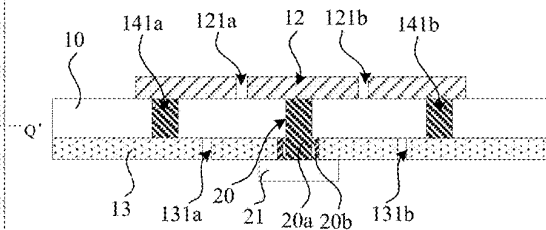
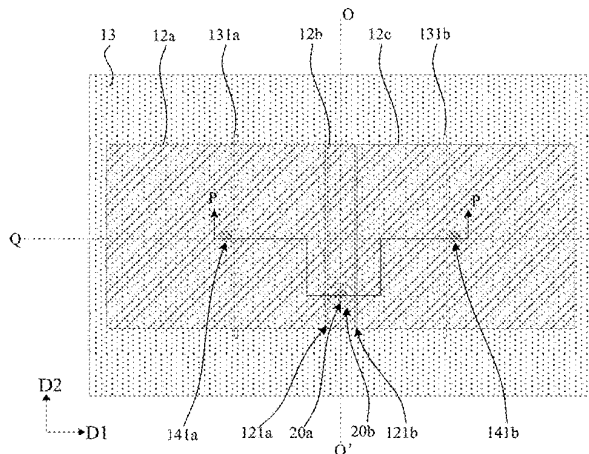
Primary Examiner — Hai V Tran

(74) *Attorney, Agent, or Firm* — Ling Wu; Stephen Yang; Ling and Yang Intellectual Property

(57) **ABSTRACT**

An antenna structure includes a dielectric substrate, a ground layer and a radiation layer located at two opposite sides of the dielectric substrate. The ground layer has two first gaps which are symmetrical about a central axis of the antenna structure in a first direction to introduce a radiation zero. The radiation layer has two second gaps which are symmetrical about the central axis, edges of the two second gaps are aligned with edges of the radiation layer in a second direction to introduce another radiation zero. The second direction is perpendicular to the first direction.

10 Claims, 10 Drawing Sheets





US012047524B2

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

(10) **Patent No.:** **US 12,047,524 B2**
(45) **Date of Patent:** **Jul. 23, 2024**

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

(71) Applicant: **Samsung Electronics Co., Ltd.**,
Gyeonggi-do (KR)
(72) Inventors: **Suyang Park**, Gyeonggi-do (KR);
Myeongkoo Kang, Gyeonggi-do (KR);
Minjae Kim, Gyeonggi-do (KR);
Jaehyeok Shin, Gyeonggi-do (KR);
Sungmin Lee, 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 411 days.

(21) Appl. No.: **17/554,100**

(22) Filed: **Dec. 17, 2021**

(65) **Prior Publication Data**
US 2022/0210256 A1 Jun. 30, 2022

Related U.S. Application Data
(63) Continuation of application No. PCT/KR2021/018957, filed on Dec. 14, 2021.

(30) **Foreign Application Priority Data**
Dec. 24, 2020 (KR) 10-2020-0183275

(51) **Int. Cl.**
H04M 1/02 (2006.01)
(52) **U.S. Cl.**
CPC **H04M 1/0277** (2013.01); **H04M 1/0249** (2013.01); **H04M 1/0264** (2013.01); **H04M 1/0266** (2013.01)

(58) **Field of Classification Search**
CPC H04M 1/0277; H04M 1/0249; H04M 1/0264; H04M 1/0266; H04M 1/026
See application file for complete search history.

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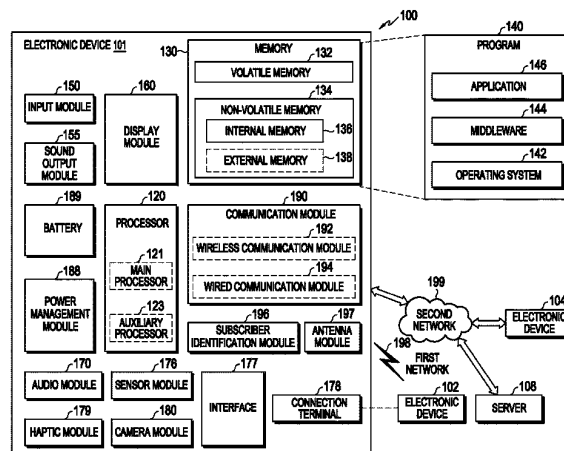
Primary Examiner — Ankur Jain

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

(57) **ABSTRACT**

According to various embodiments of the disclosure, an electronic device may comprise a housing including a conductive portion, a wireless communication circuit electrically connected with the conductive portion, a first camera module disposed in a first area of the housing proximate to the conductive portion and including a first camera assembly and a flexible circuit board extending from the first camera assembly, a second camera module disposed in a second area of the housing, spaced apart from the first camera module, and including a second camera assembly and a camera bracket covering the second camera assembly and forming at least a partial surface of the housing, and a conductive pattern having at least a portion disposed between the first area and the second area and including a first portion coupled with the first camera module and a second portion coupled with the camera bracket. Other various embodiments are possible.

19 Claims, 11 Drawing Sheets





US012051851B2

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

(10) **Patent No.:** **US 12,051,851 B2**
(45) **Date of Patent:** **Jul. 30, 2024**

(54) **ELECTRONIC DEVICE INCLUDING ANTENNA INCLUDING COUPLING-FEEDING STRUCTURE**

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

(72) Inventors: **Jaehyung Kim**, Suwon-si (KR); **Hakjin Kim**, Suwon-si (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 134 days.

(21) Appl. No.: **17/946,681**

(22) Filed: **Sep. 16, 2022**

(65) **Prior Publication Data**
US 2023/0014260 A1 Jan. 19, 2023

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2021/003172, filed on Mar. 15, 2021.

(30) **Foreign Application Priority Data**
Mar. 17, 2020 (KR) 10-2020-0032875

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/307 (2015.01)
H01Q 21/06 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 5/307** (2015.01); **H01Q 21/06** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 5/307; H01Q 21/06; H01Q 5/357; H01Q 9/42; H01Q 21/28;
(Continued)

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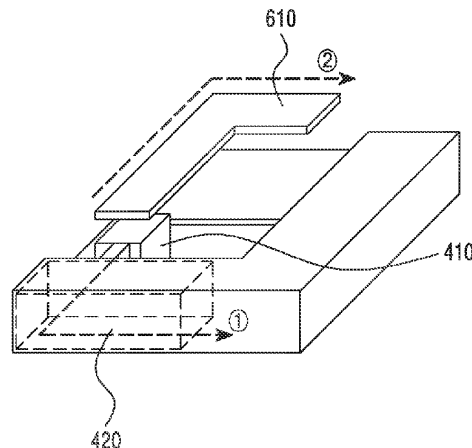
International Search Report for PCT/KR2021/003172 dated Jun. 25, 2021, 5 pages.
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Primary Examiner — Daniel D Chang
(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye, P.C.

(57) **ABSTRACT**

According to various embodiments, an electronic device includes: a housing; a first conductive member comprising a conductive material corresponding to a portion of the housing; a second conductive member comprising a conductive material arranged inside the housing; a printed circuit board arranged inside the housing; a wireless communication circuit arranged on the printed circuit board; and a conductive connection member comprising a conductive material electrically connected to the wireless communication circuit. The conductive connection member includes an elastic portion and at least one of a first surface, a second surface, a third surface, and a fourth surface. The elastic portion of the conductive connection member is in contact with the first conductive member, and the at least one of the first surface, the second surface, the third surface, and the fourth surface of the conductive connection member is spaced apart, by a gap, from a portion of the second conductive member. The wireless communication circuit may be configured to: receive a signal in a first frequency band by directly feeding

(Continued)





US012051862B2

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

(10) **Patent No.:** **US 12,051,862 B2**
(45) **Date of Patent:** **Jul. 30, 2024**

(54) **ANTENNA UNIT AND WIRELESS COMMUNICATION DEVICE INCLUDING THE SAME**

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

(72) Inventors: **Shota Taki**, Kyoto (JP); **Masahiro Izawa**, Kyoto (JP); **Yasuo Tanbo**, Kyoto (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 202 days.

(21) Appl. No.: **17/657,367**

(22) Filed: **Mar. 31, 2022**

(65) **Prior Publication Data**
US 2022/0224015 A1 Jul. 14, 2022

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2020/037890, filed on Oct. 6, 2020.

(30) **Foreign Application Priority Data**

Oct. 30, 2019 (JP) 2019-197528

(51) **Int. Cl.**
H01Q 9/40 (2006.01)
H01Q 5/25 (2015.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 9/40** (2013.01); **H01Q 5/25** (2015.01); **H01Q 5/364** (2015.01); **H01Q 9/0421** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/36; H01Q 9/0421; H01Q 9/16-48
See application file for complete search history.

(56) **References Cited**

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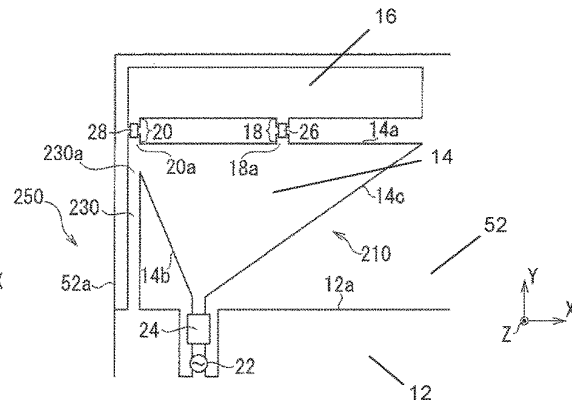
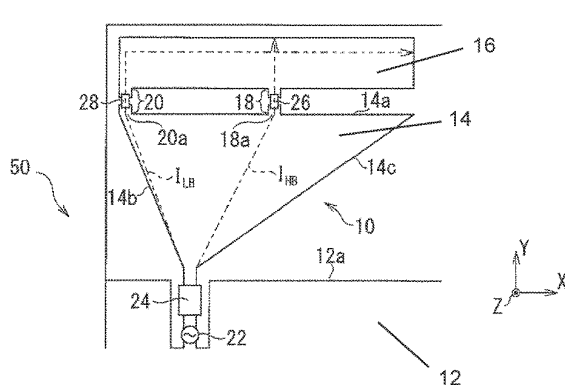
Primary Examiner — Ab Salam Alkassim, Jr.

(74) *Attorney, Agent, or Firm* — Pearne & Gordon LLP

(57) **ABSTRACT**

An antenna unit includes a feed point, a first antenna conductor extending from the feed point and having a width that expands as a distance from the feed point increases, a second antenna conductor facing a top end edge of the first antenna conductor with a gap formed therebetween, a first connection part connecting the top end edge of the first antenna conductor and the second antenna conductor via a capacitor, and a second connection part connecting the top end edge of the first antenna conductor and the second antenna conductor via an inductor or a zero-ohm resistor. A first connection point between the first connection part and the first antenna conductor is closer to a center of the top end edge of the first antenna conductor compared with a second connection point between the second connection part and the first antenna conductor.

9 Claims, 8 Drawing Sheets





US012057621B2

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

(10) **Patent No.:** **US 12,057,621 B2**
(45) **Date of Patent:** **Aug. 6, 2024**

(54) **ELECTRONIC DEVICE AND METHOD FOR ANTENNA COUPLING**

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

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

(56) **References Cited**

(72) Inventors: **Pilwon Seo**, Gyeonggi-do (KR); **Bomi Lee**, Gyeonggi-do (KR); **Sangil Im**, Gyeonggi-do (KR); **Ilseub Kim**, Gyeonggi-do (KR); **Heedong Kim**, Gyeonggi-do (KR); **Yeonkwan Seo**, Gyeonggi-do (KR)

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

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 397 days.

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Korean Office Action dated Feb. 13, 2023.

(21) Appl. No.: **17/475,507**

Primary Examiner — Graham P Smith
(74) *Attorney, Agent, or Firm* — Cha & Reiter, LLC

(22) Filed: **Sep. 15, 2021**

(65) **Prior Publication Data**
US 2022/0102839 A1 Mar. 31, 2022

(57) **ABSTRACT**

Related U.S. Application Data

An electronic device and method are disclosed. The electronic device includes a first antenna configured to communicate using a first frequency band group, a ground switch coupled to the first antenna, a second antenna configured to communicate using a second frequency band group, wherein the second antenna overlaps the first antenna, a band selection switch configured to select one of multiple radio frequency (RF) paths for the second frequency band group, and a processor. The processor implements the method, including determining a communication frequency band, when the communication frequency band is unsupported by the second antenna, identifying an RF path corresponding to the communication frequency band from among the multiple RF paths, and controlling the band selection switch to select the identified RF path for operative connection to the second antenna.

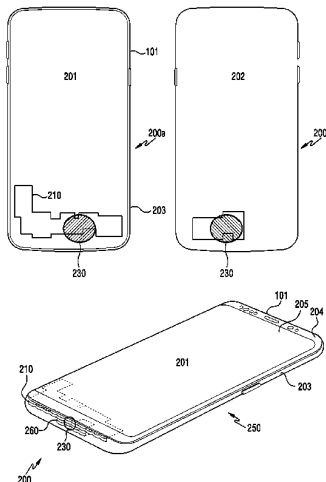
(63) Continuation of application No. PCT/KR2020/003557, filed on Mar. 13, 2020.

(30) **Foreign Application Priority Data**
Mar. 15, 2019 (KR) 10-2019-0029690

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/48 (2006.01)
H04B 1/00 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01); **H04B 1/0057** (2013.01)

20 Claims, 6 Drawing Sheets





US012057634B2

(12) **United States Patent**
Jeon

(10) **Patent No.:** **US 12,057,634 B2**
(45) **Date of Patent:** **Aug. 6, 2024**

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

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

(72) Inventor: **Seunggil Jeon**, 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 216 days.

(21) Appl. No.: **17/699,412**

(22) Filed: **Mar. 21, 2022**

(65) **Prior Publication Data**

US 2022/0216613 A1 Jul. 7, 2022

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2020/013795, filed on Oct. 8, 2020.

(30) **Foreign Application Priority Data**

Oct. 11, 2019 (KR) 10-2019-0126341

(51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 1/02 (2006.01)
H01Q 1/38 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 13/10** (2013.01); **H01Q 1/02** (2013.01); **H01Q 1/38** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 13/10; H01Q 1/02; H01Q 1/38; H01Q 1/243; H01Q 1/12

See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Ricardo I Magallanes

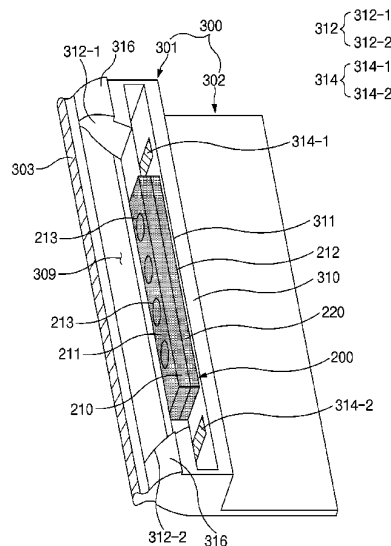
Assistant Examiner — Jordan E. DeWitt

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

(57) **ABSTRACT**

An electronic device according to certain embodiments, comprises a bracket defining a portion of a surface of the electronic device, the bracket including metal and having a recess formed therein, wherein the recess is formed by an inner wall including a resting region and an inclined region facing a different direction from the inner wall; and an antenna substrate including a conductive pattern, a first surface including a radiation area configured to radiate an RF signal from the conductive pattern, and a second surface opposite the first surface, wherein the antenna substrate is disposed in an interior of the recess such that the first surface faces an opened portion of the recess, the second surface faces the inner wall.

20 Claims, 10 Drawing Sheets





US012062844B2

(12) **United States Patent**
Lee

(10) **Patent No.:** **US 12,062,844 B2**

(45) **Date of Patent:** **Aug. 13, 2024**

(54) **ANTENNA SYSTEM AND ANTENNA COMBINATION ARCHITECTURE**

H01Q 1/2266; H01Q 13/18; H01Q 5/10;
H01Q 5/20; H05K 9/0073; H05K 9/0081;
H05K 9/0084; H01L 24/10-17; H01L
23/535; H01L 21/74; H01L 23/12-15
(Continued)

(71) Applicant: **ASUSTeK COMPUTER INC.**, Taipei (TW)

(72) Inventor: **Cheng-Tse Lee**, Taipei (TW)

(56) **References Cited**

U.S. PATENT DOCUMENTS

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(73) Assignee: **ASUSTEK COMPUTER INC.**, Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 197 days.

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(21) Appl. No.: **17/887,626**

AU 2010202586 A1 * 1/2011 G06F 1/1616
CN 201623261 U 11/2010
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(22) Filed: **Aug. 15, 2022**

(65) **Prior Publication Data**

US 2023/0077329 A1 Mar. 16, 2023

(30) **Foreign Application Priority Data**

Sep. 13, 2021 (TW) 110134113

Primary Examiner — Dameon E Levi

Assistant Examiner — Tan Minh Nguyen

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

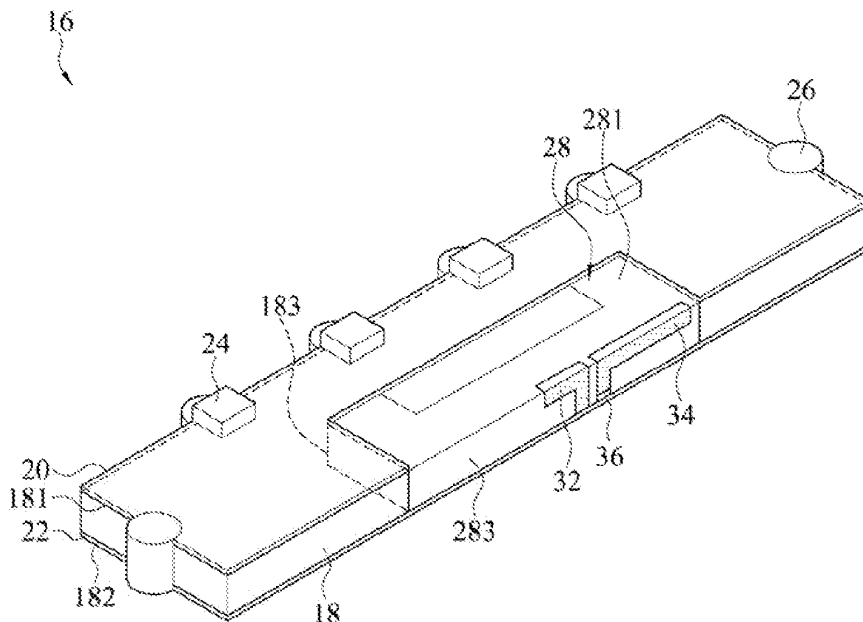
(51) **Int. Cl.**
H01Q 1/42 (2006.01)
H01L 23/00 (2006.01)
(Continued)

(57) **ABSTRACT**

An antenna system is on a first conductor, spaced apart from a second conductor and includes a first dielectric substrate, and a first metal layer and a second metal layer. Many first conductive structures are connected to the first metal layer and the second conductor. Many second conductive structures are connected to the first metal layer and the second metal layer. A second dielectric substrate includes a third horizontal surface, a first vertical surface and a second vertical surface. A frequency adjustment portion is on the
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/422** (2013.01); **H01L 23/481** (2013.01); **H01L 23/535** (2013.01); **H01L 24/10** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/422; H01Q 1/38; H01Q 9/42;





US012062847B2

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

(10) **Patent No.:** **US 12,062,847 B2**
(45) **Date of Patent:** **Aug. 13, 2024**

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

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

(72) Inventors: **Bing Luo**, Chengdu (CN); **Jianping Li**,
Shenzhen (CN); **Wenfei Qin**, Chengdu
(CN)

(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 143 days.

(21) Appl. No.: **17/687,422**

(22) Filed: **Mar. 4, 2022**

(65) **Prior Publication Data**

US 2022/0190472 A1 Jun. 16, 2022

Related U.S. Application Data

(63) Continuation of application No.
PCT/CN2020/100490, filed on Jul. 6, 2020.

(30) **Foreign Application Priority Data**

Sep. 5, 2019 (CN) 201910837849.7

(51) **Int. Cl.**
H01Q 1/52 (2006.01)
H01Q 21/06 (2006.01)
H01Q 21/30 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/523** (2013.01); **H01Q 21/062**
(2013.01); **H01Q 21/30** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/523; H01Q 21/062; H01Q 21/30;
H01Q 1/521; H01Q 5/42; H01Q 9/285;
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(56) **References Cited**

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Primary Examiner — Dimary S Lopez Cruz

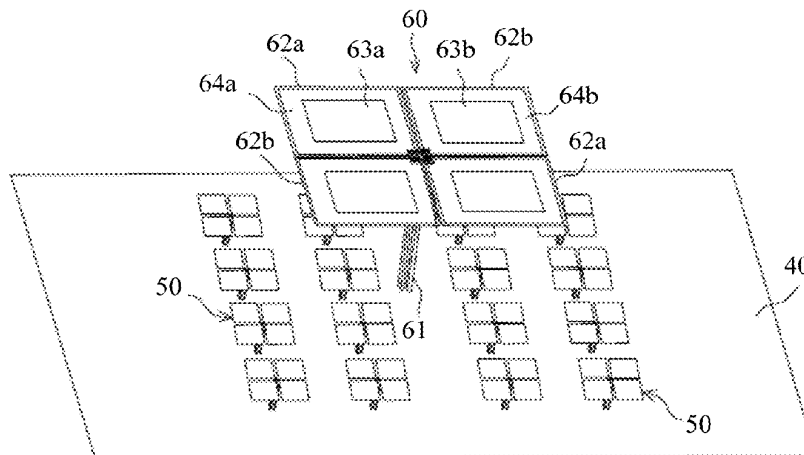
Assistant Examiner — Austin M Back

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

(57) **ABSTRACT**

This application discloses an antenna, an antenna array, and
a communications device. The antenna includes a radiation
part and a feeding part. The feeding part is coupled to the
radiation part, so that the radiation part radiates a low-frequency
signal outward. The radiation part includes one or more
frequency selection units with a bandpass characteristic, and
the radiation part is a structure that is capable of exciting,
when a high-frequency signal passes through, coupling
currents. When the high-frequency signal passes through the
radiation part, each pair of coupling currents excited on the
radiation part appear in pairs and can cancel each other. This
can reduce or even completely eliminate a high-frequency
induced current with the same frequency as the high-
frequency signal on the radiation part.

20 Claims, 24 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**

(56) **References Cited**

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

U.S. PATENT DOCUMENTS

(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)

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(73) Assignee: **SONY GROUP CORPORATION**, Tokyo (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 580 days.

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

International Search Report and Written Opinion mailed on Jan. 15, 2019, received for PCT Application PCT/JP2018/041653, Filed on Nov. 9, 2018, 7 pages including English Translation.

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

(Continued)

(86) PCT No.: **PCT/JP2018/041653**

§ 371 (c)(1),

(2) Date: **Apr. 27, 2021**

Primary Examiner — Dieu Hien T Duong

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

(87) PCT Pub. No.: **WO2020/095436**

PCT Pub. Date: **May 14, 2020**

(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.

(65) **Prior Publication Data**

US 2021/0399428 A1 Dec. 23, 2021

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.

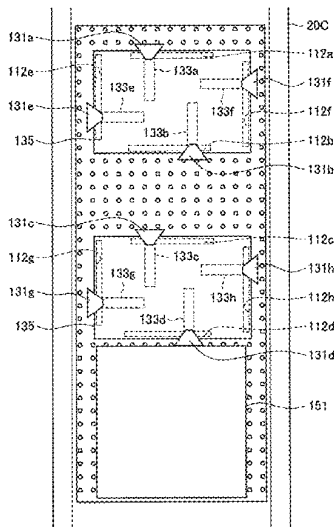
(51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 21/24 (2006.01)

(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.

15 Claims, 45 Drawing Sheets





US012062856B2

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

(10) **Patent No.:** **US 12,062,856 B2**

(45) **Date of Patent:** **Aug. 13, 2024**

(54) **ANTENNA COUPLED FEED MODULE AND ELECTRONIC DEVICE WITH SAME**

(58) **Field of Classification Search**

CPC H01Q 21/28; H01Q 1/38; H01Q 9/0407; H01Q 1/243

See application file for complete search history.

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

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

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2020/0212584 A1* 7/2020 Park H01Q 13/16

(73) Assignee: **FIH CO., LTD.**, New Taipei (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 305 days.

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(21) Appl. No.: **17/828,315**

Primary Examiner — David E Lotter

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

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

(65) **Prior Publication Data**

US 2023/0361487 A1 Nov. 9, 2023

(57) **ABSTRACT**

An antenna coupled feed module is received in a slit formed between a metal frame and at least one electronic component of an electronic device. The antenna coupled feed module includes a substrate, at least one coupled feed portion, an active circuit, a metal layer, and a non-conductive layer. The coupled feed portion and the active circuit are disposed on opposite surfaces of the substrate; the coupled feed portion couples the electrical signals to the metal layer, the metal layer conducts the electrical signals to the metal frame to radiate wireless signals; the non-conductive layer is arranged between the metal layer and the at least one coupled feed portion, and covers the coupled feed portion; the active circuit switches the electrical signals fed to the coupled feed portion. An electronic device with the antenna coupled feed module is also provided.

(30) **Foreign Application Priority Data**

May 7, 2022 (CN) 202210490801.5

20 Claims, 12 Drawing Sheets

(51) **Int. Cl.**

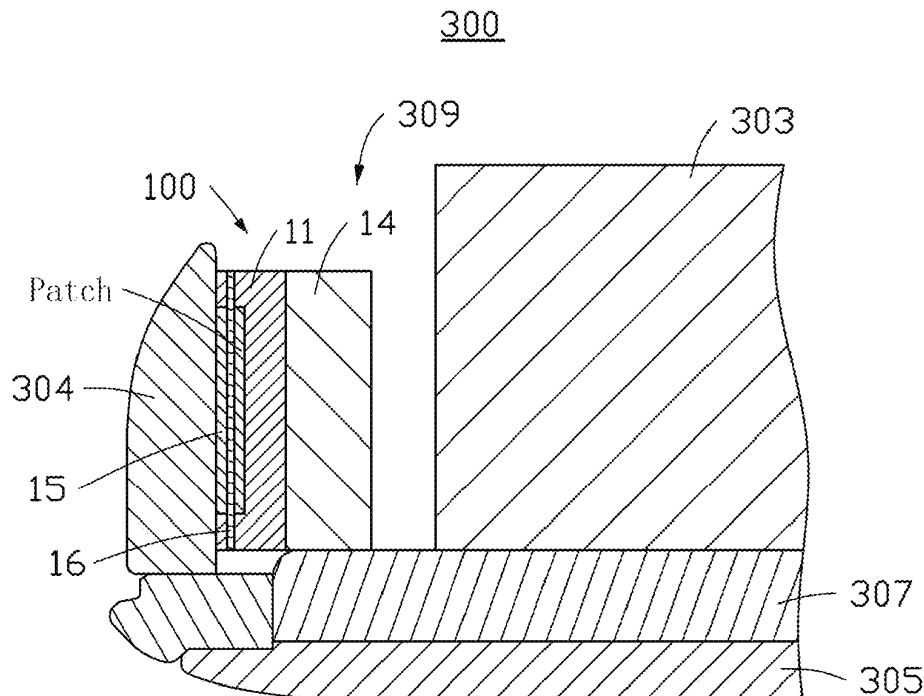
H01Q 1/38 (2006.01)

H01Q 9/04 (2006.01)

H01Q 21/28 (2006.01)

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

CPC **H01Q 21/28** (2013.01); **H01Q 1/38** (2013.01); **H01Q 9/0407** (2013.01)





US012062857B2

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

(10) **Patent No.:** **US 12,062,857 B2**
(45) **Date of Patent:** **Aug. 13, 2024**

(54) **THREE-DIMENSIONAL ANTENNA MODULE**

(56) **References Cited**

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

U.S. PATENT DOCUMENTS

(72) Inventors: **Chin-Ting Huang**, Taipei (TW); **Hsi-Kai Hung**, Taipei (TW); **Chun-Kai Wang**, Taipei (TW); **Sony Chayadi**, Taipei (TW)

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(73) Assignee: **PEGATRON CORPORATION**, Taipei (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 137 days.

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TW 201635643 10/2016

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(21) Appl. No.: **17/952,145**

Primary Examiner — Hoang V Nguyen

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

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

(65) **Prior Publication Data**

US 2023/0155304 A1 May 18, 2023

(30) **Foreign Application Priority Data**

Nov. 18, 2021 (TW) 110143062

(57) **ABSTRACT**

(51) **Int. Cl.**
H01Q 25/00 (2006.01)
H01Q 1/52 (2006.01)
H01Q 1/22 (2006.01)

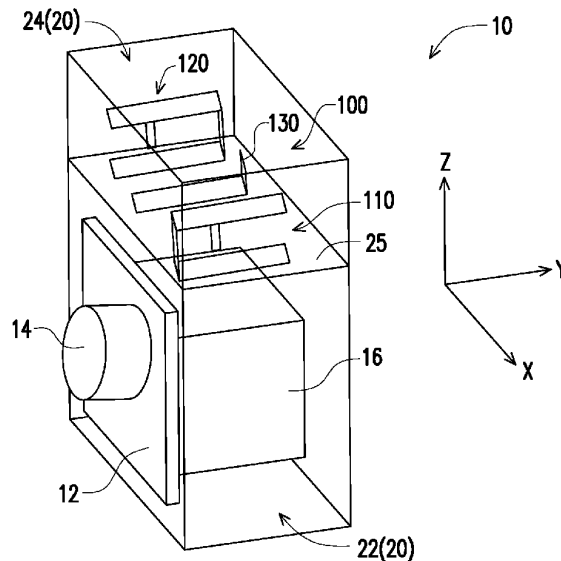
A three-dimensional antenna module includes a first antenna, a second antenna, and a conductor. The first antenna includes a first main radiator and a first feeding section connected to the first main radiator. The first main radiator includes a first open end and a second open end. The first main radiator is bent to form a first opening. The second antenna includes a second main radiator and a second feeding section connected to the second main radiator. The second main radiator includes a third open end and a fourth open end. The second main radiator is bent to form a second opening. A direction the first opening faces is different from a direction the second opening faces. The conductor is disposed between the first antenna and the second antenna.

(52) **U.S. Cl.**
CPC **H01Q 25/005** (2013.01); **H01Q 1/521** (2013.01); **H01Q 1/2291** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/22; H01Q 1/2291; H01Q 1/36; H01Q 1/50; H01Q 1/52; H01Q 1/521; H01Q 9/26; H01Q 21/00; H01Q 21/28; H01Q 25/005

See application file for complete search history.

10 Claims, 4 Drawing Sheets





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(54) **ELECTRONIC DEVICE WITH SWITCHABLE ANTENNA LOOP PATH**

(58) **Field of Classification Search**
USPC 343/702
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(56) **References Cited**

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(57) **ABSTRACT**

An electronic device may be provided with peripheral conductive housing structures having first and second segments. The device may include an antenna having a resonating arm formed from the first segment, an antenna ground, and a tuning element. The first terminal may have first, second, and third terminals. The first terminal may be coupled to the second segment. The antenna may have a switchable loop path that includes a first path from the second terminal to the first segment, a second path from first segment to a first point on the antenna ground, a portion of the antenna ground from the first point to a second point, and a third path from the second point to the third terminal. The tuning element may selectively activate the switchable loop path to boost performance of the antenna in a frequency band between 3300 MHz and 5000 MHz when needed.

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

(65) **Prior Publication Data**

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H01Q 1/24 (2006.01)
H01Q 5/364 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 3/247** (2013.01); **H01Q 1/243** (2013.01); **H01Q 5/364** (2015.01)

20 Claims, 7 Drawing Sheets

