



US011652277B2

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

(10) **Patent No.:** **US 11,652,277 B2**
(45) **Date of Patent:** **May 16, 2023**

(54) **PORTABLE ELECTRONIC DEVICE**

(56) **References Cited**

(71) Applicant: **Acer Incorporated**, New Taipei (TW)

U.S. PATENT DOCUMENTS

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Cheng-Nan Ling, New Taipei (TW);
Wen-Chieh Tai, New Taipei (TW)

6,473,296	B2 *	10/2002	Amemiya	G06F 1/1656
					361/740
8,416,561	B2 *	4/2013	Hamada	.....	G06F 1/1681
					361/679.28
9,042,088	B2 *	5/2015	Hamada	.....	G06F 1/1683
					312/223.1
9,107,301	B2 *	8/2015	Pan	.....	G06F 1/1688
10,642,309	B2 *	5/2020	Cheng	.....	G06F 1/203
10,831,245	B1 *	11/2020	Miyamoto	.....	G06F 1/1681
11,221,654	B2 *	1/2022	Chiang	.....	G06F 1/203
2001/0046116	A1 *	11/2001	Amemiya	.....	G06F 1/1616
					361/679.27
2012/0162951	A1 *	6/2012	Hamada	.....	G06F 1/1681
					361/807
2013/0170124	A1 *	7/2013	Pan	.....	H05K 5/0226
					361/679.01

(73) Assignee: **Acer Incorporated**, 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 148 days.

(21) Appl. No.: **17/023,390**

(22) Filed: **Sep. 17, 2020**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Nov. 19, 2019 (TW) 108141974

(51) **Int. Cl.**
G06F 1/16 (2006.01)
H01Q 1/24 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **G06F 1/1616**
(2013.01); **G06F 1/1624** (2013.01); **G06F**
1/1681 (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/084; H01Q 1/2258;
G06F 1/1616; G06F 1/1624; G06F
1/1681; G06F 1/1698

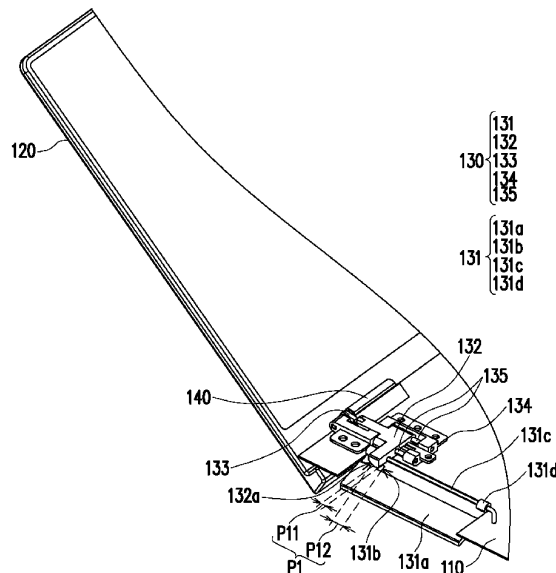
See application file for complete search history.

(Continued)
Primary Examiner — Anthony M Haughton
Assistant Examiner — Theron S Milliser
(74) *Attorney, Agent, or Firm* — JCIPRNET

(57) **ABSTRACT**

A portable electronic device including at least one body, an antenna module, and a rotation mechanism is provided. The antenna module includes an antenna unit, a driving member, and a linking rod. The antenna unit is rotatably disposed on the body, the driving member is slidably disposed on the body and abuts the antenna unit, and a portion of the antenna unit blocks on a sliding path of the driving member, to drive the antenna unit to rotate to open and close relative to the body when the driving member slides. The linking rod has opposite first and second ends. The first end is pivotally connected to the driving member. The rotation mechanism is disposed on the body, the second end is pivotally connected to the rotation mechanism and eccentric to a rotating axis of the rotation mechanism, to slide the driving member when the rotation mechanism rotates.

14 Claims, 13 Drawing Sheets





US011652291B2

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

(10) **Patent No.:** **US 11,652,291 B2**
(45) **Date of Patent:** **May 16, 2023**

(54) **TRI-FREQUENCY MULTI-POLARISATION OMNIDIRECTIONAL ANTENNA**

(71) Applicant: **CITY UNIVERSITY OF HONG KONG, Kowloon (HK)**

(72) Inventors: **Kwok Wa Leung, Kowloon (HK); Peng Fei Hu, Kowloon (HK)**

(73) Assignee: **CITY UNIVERSITY OF HONG KONG, Kowloon (HK)**

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 93 days.

(21) Appl. No.: **17/331,388**

(22) Filed: **May 26, 2021**

(65) **Prior Publication Data**

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(51) **Int. Cl.**
H01Q 5/30 (2015.01)
H01Q 7/00 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 5/30** (2015.01); **H01Q 7/00** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/30; H01Q 7/00
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2018/0006355 A1* 1/2018 Qing H01Q 1/38
2020/0136230 A1* 4/2020 Hung H01Q 1/48

2020/0185832 A1* 6/2020 Ross, III H01Q 5/378
2020/0194874 A1* 6/2020 De Sousa H01Q 7/00
2020/0203852 A1* 6/2020 Saitou H01Q 21/06
2020/0251814 A1* 8/2020 Ryu H01Q 7/00
2020/0314566 A1* 10/2020 Perri H01Q 1/273
2020/0335865 A1* 10/2020 Greve H01P 5/12
2020/0343314 A1* 10/2020 Nakamura H01L 27/3276
2020/0381802 A1* 12/2020 Matsushima H01Q 1/2283
2020/0411990 A1* 12/2020 Nakamura H01Q 7/00
2021/0013629 A1* 1/2021 Sharawi H01Q 21/24
2021/0036425 A1* 2/2021 Jain G02C 7/04
2021/0041515 A1* 2/2021 Dolgin H01Q 7/00
2021/0058570 A1* 2/2021 Sato H01Q 7/00
2021/0098879 A1* 4/2021 Takeuchi G06K 7/0004
2021/0104815 A1* 4/2021 Liu H01Q 5/30
2021/0110232 A1* 4/2021 Ueki G06K 19/07771
2021/0152680 A1* 5/2021 Lee H04M 1/0266

* cited by examiner

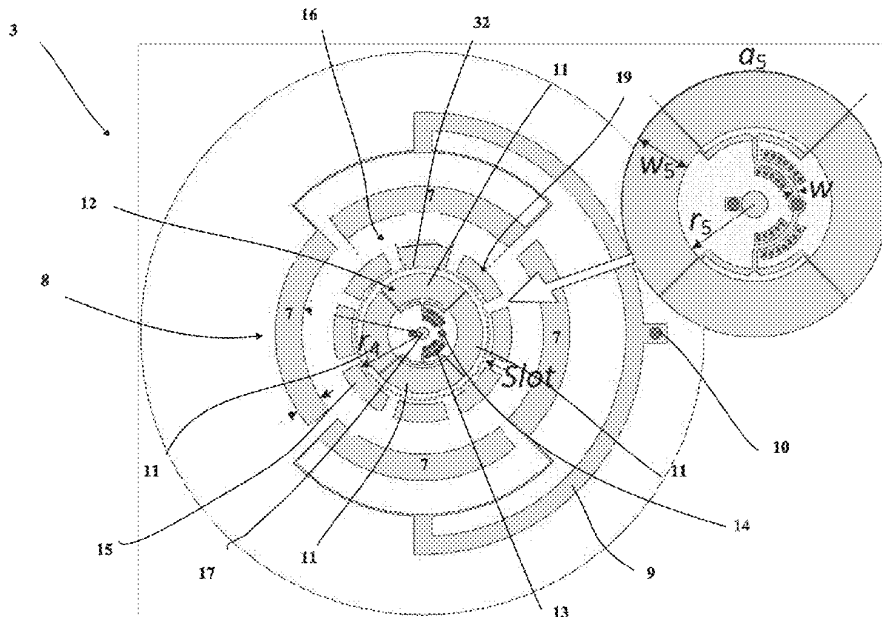
Primary Examiner — Ab Salam Alkassim, Jr.

Assistant Examiner — Bamidele A Jegede

(57) **ABSTRACT**

A tri-frequency multi-polarisation omnidirectional antenna comprising: a first plurality of curved electrically conductive strips arranged on the first face and being arranged to form an outer-loop; second plurality of curved electrically conductive strips arranged on the first face and being arranged to form an inner-loop; third plurality of curved electrically conductive strips arranged on the first face and being arranged to form middle-loop; a first power divider and a second power divider each connected to the strips of the inner-loop; a dielectric resonator comprising a first face, the first face arranged on the first face of the substrate; an electrically conductive probe being arranged at least partially within the dielectric resonator and extending at least part way along the symmetry axis.

16 Claims, 13 Drawing Sheets





US011652292B2

(12) **United States Patent**
Chang

(10) **Patent No.:** **US 11,652,292 B2**

(45) **Date of Patent:** **May 16, 2023**

(54) **DUAL ANTENNA WITH A SHARED RADIATOR**

1/52; H01Q 9/00; H01Q 9/04; H01Q 9/30; H01Q 9/42; H04B 1/00; H04B 1/38; H04B 1/3827; H04B 1/3833; H04B 1/3838

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

USPC 324/600, 649, 658, 686
See application file for complete search history.

(72) Inventor: **Chia-Lin Chang**, Causeway Bay (HK)

(56) **References Cited**

(73) Assignee: **NANJING SILERGY MICRO (HK) CO., LIMITED**, Causeway Bay (HK)

U.S. PATENT DOCUMENTS

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

6,049,314 A * 4/2000 Munson H01Q 9/0471 343/846
2015/0234019 A1* 8/2015 Biber G01R 33/3415 324/322

(21) Appl. No.: **17/396,824**

FOREIGN PATENT DOCUMENTS

(22) Filed: **Aug. 9, 2021**

CN 106299604 A * 1/2017 H01Q 1/242
CN 110911842 B * 5/2021 H01Q 1/2258
CN 114122716 A * 3/2022 H01Q 1/36

(65) **Prior Publication Data**

US 2022/0069466 A1 Mar. 3, 2022

* cited by examiner

(30) **Foreign Application Priority Data**

Aug. 25, 2020 (CN) 202010863280.4

Primary Examiner — Hoai-An D. Nguyen

(74) *Attorney, Agent, or Firm* — Amin, Turocy & Watson, LLP

(51) **Int. Cl.**

H01Q 5/314 (2015.01)

G01D 5/24 (2006.01)

(57) **ABSTRACT**

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

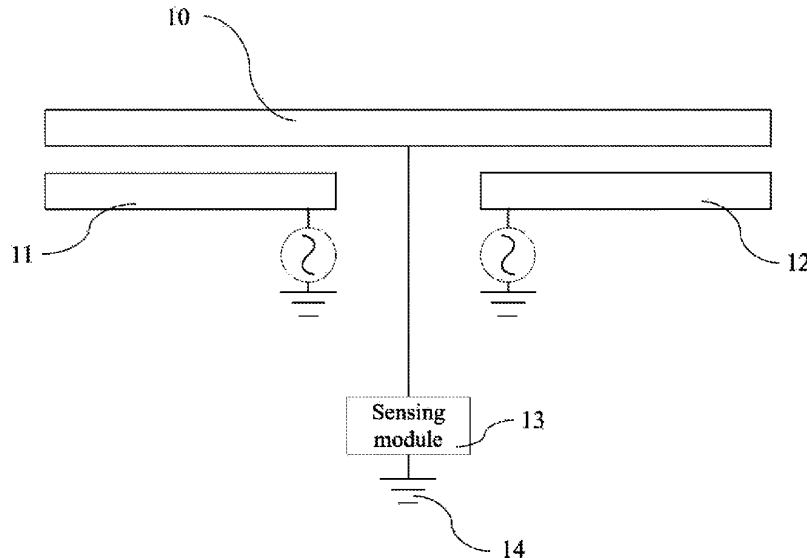
CPC **H01Q 5/314** (2015.01); **G01D 5/24** (2013.01)

A dual antenna with a shared radiator includes a radiator unit, a first feed-in unit, a second feed-in unit, a sensing module and a ground unit. The first feed-in unit and the second feed-in unit are respectively coupled with the radiator unit. The sensing module is connected to a substantial center of the radiator unit and used for sensing a distance between the radiator unit and an external object through the radiator unit. The ground unit is connected to the sensing module. The first feed-in unit is used to send or receive a first radio frequency signal together with the radiator unit, and the second feed-in unit is used to send or receive a second radio frequency signal together with the radiator unit.

(58) **Field of Classification Search**

CPC .. G01D 5/00; G01D 5/12; G01D 5/14; G01D 5/24; H01Q 5/00; H01Q 5/30; H01Q 5/307; H01Q 5/314; H01Q 1/00; H01Q 1/12; H01Q 1/22; H01Q 1/24; H01Q 1/241; H01Q 1/242; H01Q 1/245; H01Q 1/36; H01Q 1/48; H01Q 1/50; H01Q

10 Claims, 7 Drawing Sheets





US011652296B2

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

(10) **Patent No.:** **US 11,652,296 B2**
(45) **Date of Patent:** **May 16, 2023**

(54) **MICROSTRIP ANTENNA AND MICROSTRIP ANTENNA MODULE INCLUDING THE SAME**

(58) **Field of Classification Search**
CPC H01Q 9/045; H01Q 1/48; H01Q 9/16
See application file for complete search history.

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

(72) Inventors: **Sanghyun Kim**, Suwon-si (KR);
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4,095,227 A * 6/1978 Kaloj H01Q 9/0421
343/700 MS

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

5,703,600 A 12/1997 Burrell et al.
7,522,105 B1 4/2009 LaComb
2018/0062263 A1* 3/2018 Ueda H01Q 21/06

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 58 days.

FOREIGN PATENT DOCUMENTS

JP 2007-142570 A 6/2007
JP 2007274317 A * 10/2007

(21) Appl. No.: **17/224,331**

OTHER PUBLICATIONS

(22) Filed: **Apr. 7, 2021**

Johnson, Richard, C., "Antenna Engineering Handbook," McGraw-Hill, Inc., 1992 (pp. 1-47).

(65) **Prior Publication Data**

US 2022/0181780 A1 Jun. 9, 2022

* cited by examiner

(30) **Foreign Application Priority Data**

Dec. 3, 2020 (KR) 10-2020-0167486

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

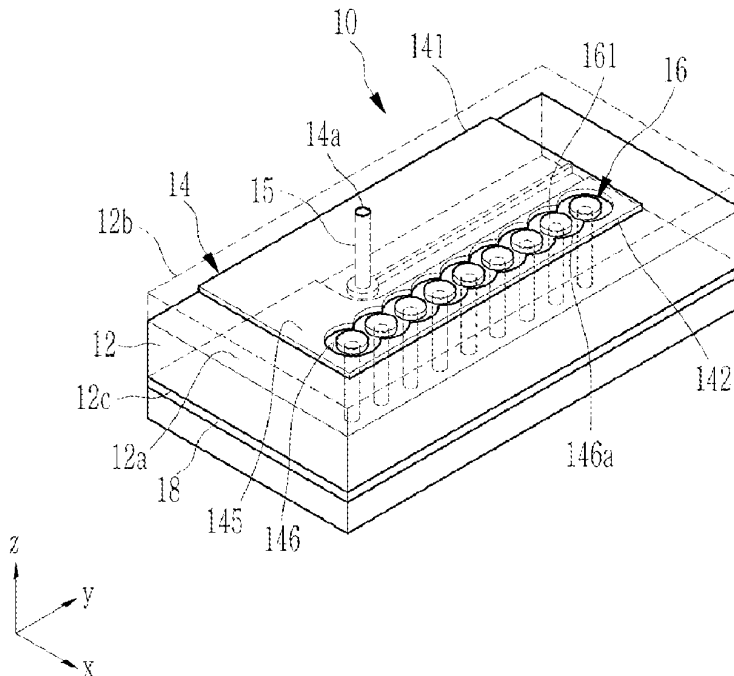
(51) **Int. Cl.**
H01Q 1/48 (2006.01)
H01Q 9/04 (2006.01)
H01Q 9/16 (2006.01)

(57) **ABSTRACT**

An antenna including a substrate, a radiation portion connected to a feed line, disposed on a layer of the substrate, and including a conductor having an opening, and a coupling member connected to a ground portion and disposed within the opening spaced apart from the conductor by a gap.

(52) **U.S. Cl.**
CPC **H01Q 9/045** (2013.01); **H01Q 1/48** (2013.01); **H01Q 9/16** (2013.01)

30 Claims, 19 Drawing Sheets





US011652301B2

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

(10) **Patent No.:** **US 11,652,301 B2**
(45) **Date of Patent:** **May 16, 2023**

(54) **PATCH ANTENNA ARRAY**
(71) Applicant: **QUALCOMM Incorporated**, San Diego, CA (US)
(72) Inventors: **Taesik Yang**, San Diego, CA (US); **Jorge Fabrega Sanchez**, San Diego, CA (US); **Mohammad Ali Tassoudji**, San Diego, CA (US); **Kevin Hsi Huai Wang**, San Diego, CA (US); **Jeongil Jay Kim**, San Diego, CA (US)
(73) Assignee: **QUALCOMM Incorporated**, San Diego, CA (US)

(56) **References Cited**
U.S. PATENT DOCUMENTS
4,755,821 A 7/1988 Itoh et al.
5,231,406 A * 7/1993 Sreenivas H01Q 21/065
343/700 MS

(Continued)

FOREIGN PATENT DOCUMENTS

CN 102324620 A 1/2012
CN 103531891 A 1/2014

(Continued)

OTHER PUBLICATIONS

Alatan L., et al., "Dual Frequency Bi-Orthogonally Polarized Antenna for GPS Applications", Melecon 2000. 10th. Mediterranean Electro technical Conference, Lemesos, Cyprus, May 29-31, 2000; [Melecon Conferences], New York, NY: IEEE, US, vol. Conf. 10, May 29, 2000 (May 29, 2000), pp. 652-655, XP000988136, ISBN: 978-0-7803-6291-8.

(Continued)

Primary Examiner — Hasan Islam
(74) *Attorney, Agent, or Firm* — Qualcomm Incorporated

(57) **ABSTRACT**

Methods, systems, and devices for wireless communication are described. According to one or more aspects, the described apparatus includes one or more stacks of patch radiators (such as patch antennas) comprising at least a first patch radiator and a second patch radiator. The first patch radiator is associated with a low-band frequency; the second patch radiator is associated with a high-band frequency. The first patch radiator and the second patch radiator may overlap a ground plane, which may be asymmetric. Some or all patch radiators in a stack may be rotated relative to the ground plane, such that some or all edge of a patch radiator may be nonparallel with one or more edges of the ground plane. Further, each patch radiator stack may include separate feeds for each of at least two frequencies and two

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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 384 days.

(21) Appl. No.: **16/379,553**

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(65) **Prior Publication Data**
US 2019/0319364 A1 Oct. 17, 2019

Related U.S. Application Data

(60) Provisional application No. 62/785,636, filed on Dec. 27, 2018, provisional application No. 62/656,181, filed on Apr. 11, 2018.

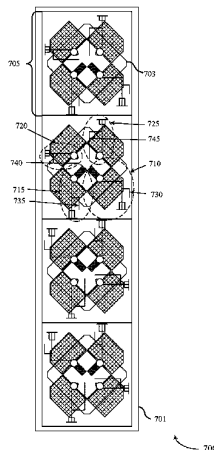
(51) **Int. Cl.**
H01Q 21/06 (2006.01)
H01Q 1/22 (2006.01)

(Continued)

(52) **U.S. Cl.**
CPC **H01Q 21/065** (2013.01); **H01Q 1/2283** (2013.01); **H01Q 5/364** (2015.01); **H01Q 5/385** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/38; H01Q 21/065; H01Q 5/30-5/392

See application file for complete search history.





US011659649B2

(12) **United States Patent**
Li

(10) **Patent No.:** **US 11,659,649 B2**
(45) **Date of Patent:** **May 23, 2023**

(54) **ELECTRONIC DEVICE**

(71) Applicant: **BEIJING XIAOMI MOBILE SOFTWARE CO., LTD.**, Beijing (CN)

(72) Inventor: **Yueliang Li**, Beijing (CN)

(73) Assignee: **BEIJING XIAOMI MOBILE SOFTWARE CO., LTD.**, Beijing (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 60 days.

(21) Appl. No.: **17/241,667**

(22) Filed: **Apr. 27, 2021**

(65) **Prior Publication Data**
US 2022/0039251 A1 Feb. 3, 2022

(30) **Foreign Application Priority Data**
Jul. 30, 2020 (CN) 202010751661.3

(51) **Int. Cl.**
H01R 13/658 (2011.01)
H05K 1/02 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H05K 1/0243** (2013.01); **H01R 13/6466** (2013.01); **H01R 13/6581** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01R 12/724; H01R 13/6581; H01R 13/6582; H01R 13/6585; H01R 13/6658; H01R 13/6471; H01R 12/721; H01R 13/6466; H01R 13/6691; H01R 2201/16; H05K 1/0215; H05K 1/0218; H05K 2201/0715; H05K 5/0026; H05K 1/0243; H05K 1/111; H05K 2201/1006; H05K 2201/10098; H05K 1/0213; H05K 1/0216;

(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,139,364 A * 10/2000 Beutler H04M 1/0274
439/607.01
9,544,405 B1 * 1/2017 Kodama H04B 3/56
2010/0164835 A1 7/2010 Tai et al.
2013/0257659 A1 * 10/2013 Darnell H05K 1/028
343/702
2015/0263458 A1 * 9/2015 Guo H01R 12/724
29/883

(Continued)

FOREIGN PATENT DOCUMENTS

JP H0472982 B2 11/1992
JP 2018063889 A 4/2018
KR 20190020971 A 3/2019

OTHER PUBLICATIONS

Indian Patent Application No. 202144019301, Office Action dated Feb. 17, 2022, 5 pages.
Japanese Patent Application No. 2021-075787, Office Action dated Apr. 26, 2022, 4 pages.
Japanese Patent Application No. 2021-075787, English translation of Office Action dated Apr. 26, 2022, 4 pages.

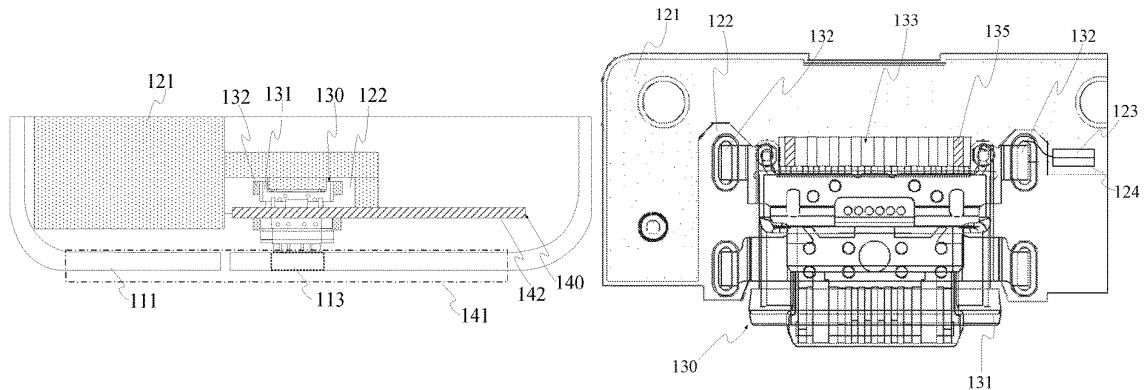
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Primary Examiner — Steven T Sawyer
(74) *Attorney, Agent, or Firm* — Cozen O'Connor

(57) **ABSTRACT**

An electronic device includes a housing, a circuit board, a charging interface and an antenna unit. The housing is provided with an external interface. The circuit board is arranged in the housing and includes a grounding metal. The charging interface is arranged in the housing and in communication with the external interface. The charging interface includes a metal casing. The metal casing is provided with a plurality of grounding solder pads, and the grounding solder pads are arranged to be separated from the grounding metal. The antenna unit is coupled with the charging interface.

18 Claims, 4 Drawing Sheets





US011664579B2

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

(10) **Patent No.:** **US 11,664,579 B2**
(45) **Date of Patent:** **May 30, 2023**

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

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

(72) Inventors: **Jonghyuck Lee**, Suwon-si (KR); **Taeik Kim**, Suwon-si (KR); **Haeyeon Kim**, Suwon-si (KR); **Sehyun Park**, Suwon-si (KR); **Dongjun Oh**, Suwon-si (KR); **Shinho Yoon**, Suwon-si (KR); **Myeongsu Oh**, 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 862 days.

(21) Appl. No.: **16/655,969**

(22) Filed: **Oct. 17, 2019**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Oct. 24, 2018 (KR) 10-2018-0127259

(51) **Int. Cl.**
H01Q 1/22 (2006.01)
G06F 1/16 (2006.01)

(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/2266** (2013.01); **G06F 1/1616** (2013.01); **H01Q 1/2291** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/2266; H01Q 1/2291; H01Q 1/243; H01Q 1/44; H01Q 5/314; H01Q 9/14;
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

2003/0129950 A1 7/2003 Kwak
2010/0317415 A1 12/2010 Lee et al.
(Continued)

FOREIGN PATENT DOCUMENTS

EP 3 343 693 A1 7/2018
JP 2006-157787 A 6/2006
(Continued)

OTHER PUBLICATIONS

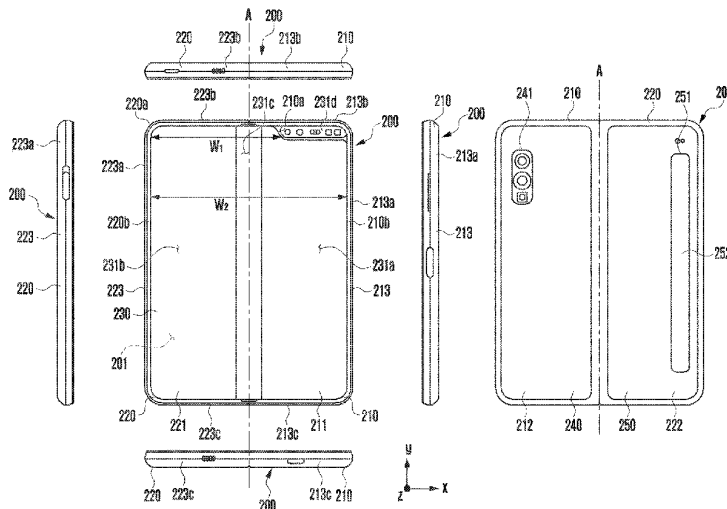
International Search Report dated Jan. 23, 2020, issued in International Patent Application No. PCT/KR2019/013630.
(Continued)

Primary Examiner — Andrea Lindgren Baltzell
Assistant Examiner — Yonchan J Kim
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

An electronic device is provided. The electronic device includes a foldable housing, a flexible display, at least one printed circuit board (PCB), and a wireless communication circuit. The foldable housing includes a hinge structure, a first housing structure connected to the hinge structure and including a first surface facing in a first direction, a second surface facing in a direction opposite to the first direction, and a first lateral member surrounding a first space between the first surface and the second surface, and a second housing structure connected to the hinge structure and including a third surface facing in a second direction, a fourth surface facing in a direction opposite to the second direction, and a second lateral member surrounding a second space between the third surface and the fourth surface.

20 Claims, 13 Drawing Sheets





US011664601B2

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

(10) **Patent No.:** **US 11,664,601 B2**
(45) **Date of Patent:** **May 30, 2023**

(54) **ELECTRONIC DEVICES WITH COEXISTING ANTENNAS**
(71) Applicant: **Apple Inc.**, Cupertino, CA (US)
(72) Inventors: **Erdinc Irci**, Sunnyvale, CA (US); **Bilgehan Avser**, San Bruno, CA (US); **Han Wang**, Campbell, CA (US); **Harish Rajagopalan**, San Jose, CA (US); **Hongfei Hu**, Cupertino, CA (US); **Jingni Zhong**, Santa Clara, CA (US); **Ming Chen**, Cupertino, CA (US); **Nanbo Jin**, San Jose, CA (US); **Yijun Zhou**, Mountain View, CA (US)

(58) **Field of Classification Search**
CPC H01Q 1/241-243; H01Q 1/52; H01Q 1/48-50; H01Q 3/26-30; H01Q 13/10; H01Q 5/30-50; H01Q 5/378-385
See application file for complete search history.

(56) **References Cited**
U.S. PATENT DOCUMENTS
8,179,322 B2 5/2012 Nissinen
9,577,331 B2* 2/2017 Tseng H01Q 21/28
9,768,507 B2 9/2017 Rajgopal et al.
10,530,042 B2* 1/2020 Avser H01Q 5/50
2010/0073241 A1 3/2010 Ayala Vazquez et al.
2013/0293424 A1 11/2013 Zhu et al.
2020/0153082 A1 5/2020 Mangrum
2020/0266539 A1 8/2020 Cooper et al.

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

* cited by examiner
Primary Examiner — Hasan Islam
(74) *Attorney, Agent, or Firm* — Treyz Law Group, P.C.; Tianyi He

(21) Appl. No.: **17/032,843**

(22) Filed: **Sep. 25, 2020**

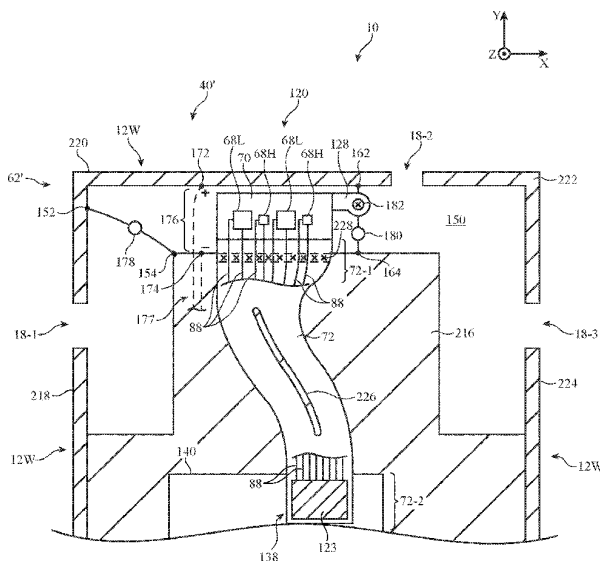
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H01Q 1/24 (2006.01)
H01Q 13/10 (2006.01)
H01Q 1/52 (2006.01)
H01Q 3/30 (2006.01)
H01Q 1/48 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 13/10** (2013.01); **H01Q 1/48** (2013.01); **H01Q 1/526** (2013.01); **H01Q 3/30** (2013.01)

(57) **ABSTRACT**
An electronic device may be provided with an antenna module. A phased antenna array of dielectric resonator antennas may be disposed within the antenna module. The dielectric resonator antennas may include dielectric columns excited by feed probes. A flexible printed circuit may include transmission lines coupled to the feed probes. The flexible printed circuit may have a first end coupled to the antenna module and extending towards peripheral conductive housing structures forming an additional antenna and a second end coupled to transceiver circuitry. Ground traces on the flexible printed circuit may be shorted to ground structures at the first and second ends to improve the antenna efficiency of the additional antenna. The flexible printed circuit may include an elongated slot with overlapping conductive structures and laterally surrounded by a fence of conductive vias to improve the flexibility of the flexible printed circuit while providing satisfactory antenna performance.

20 Claims, 11 Drawing Sheets





US011670853B2

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

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(45) **Date of Patent:** **Jun. 6, 2023**

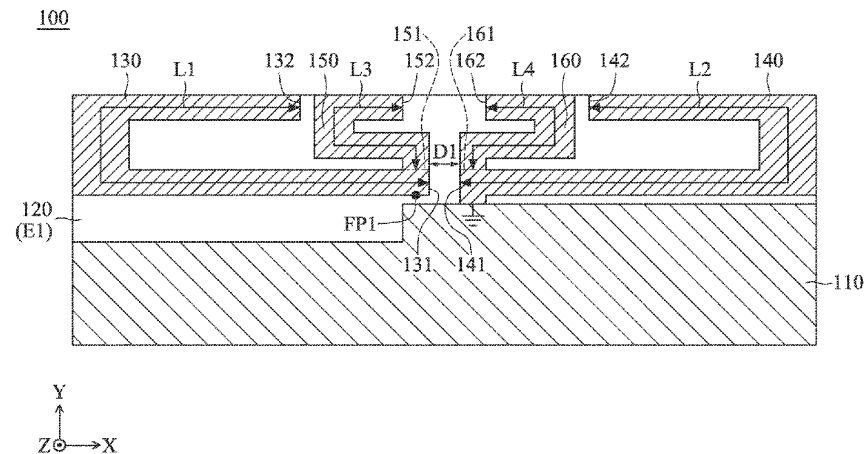
- (54) **ANTENNA STRUCTURE**
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- (73) Assignee: **WISTRON CORP.**, New Taipei (TW)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 184 days.
- (21) Appl. No.: **17/208,243**
- (22) Filed: **Mar. 22, 2021**
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- (52) **U.S. Cl.**
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- (58) **Field of Classification Search**
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(Continued)

- (56) **References Cited**
U.S. PATENT DOCUMENTS
6,906,678 B2 * 6/2005 Chen H01Q 1/243
343/700 MS
8,866,689 B2 * 10/2014 Islam H01Q 21/30
343/810
(Continued)
FOREIGN PATENT DOCUMENTS
CN 208548451 U 2/2019
TW 200414603 A 8/2004
TW 200835055 A 8/2008
OTHER PUBLICATIONS
Chinese language office action dated Sep. 13, 2021, issued in application No. TW 110104923.
(Continued)

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(57) **ABSTRACT**
An antenna structure includes a ground element, a dielectric substrate, a first radiation element, a second radiation element, a third radiation element, a fourth radiation element, a fifth radiation element, a sixth radiation element, and a seventh radiation element. The dielectric substrate has a first surface and a second surface. The first radiation element and the third radiation element are coupled to a first feeding point. The second radiation element and the fourth radiation element are coupled to the ground element. The first radiation element, the second radiation element, the third radiation element, and the fourth radiation element are on the first surface. The fifth radiation element is coupled to a second feeding point. The sixth radiation element and the seventh radiation element are coupled to the fifth radiation element. The fifth radiation element, the sixth radiation element, and the seventh radiation element are on the second surface.

20 Claims, 18 Drawing Sheets





US011677137B2

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Lo et al.

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(45) **Date of Patent:** **Jun. 13, 2023**

- (54) **ELECTRONIC DEVICE**
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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 0 days.
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- (22) Filed: **Feb. 21, 2022**
- (65) **Prior Publication Data**
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- (30) **Foreign Application Priority Data**
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- (51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 13/10 (2006.01)
H01Q 1/38 (2006.01)
- (52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/38**
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- (58) **Field of Classification Search**
CPC H01Q 1/24; H01Q 1/38; H01Q 13/106
See application file for complete search history.
- (56) **References Cited**
U.S. PATENT DOCUMENTS
10,542,130 B1* 1/2020 Lo H04M 1/026
FOREIGN PATENT DOCUMENTS
TW I688159 B 3/2020
OTHER PUBLICATIONS
Chinese language office action dated Aug. 15, 2022, issued in application No. TW 110133950.
* cited by examiner
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(57) **ABSTRACT**
An electronic device is provided, including a housing, a first slot, a second slot, and a circuit board. The first and second slots are formed on the housing and spaced apart from each other. The circuit board is disposed in the housing and includes a first antenna structure and a second antenna structure. The first antenna structure has a Z-shaped conductive body, and the second antenna structure includes a microstrip portion and a base portion. The base portion is electrically connected to the conductive body, and the microstrip portion is spaced apart from the base portion.

10 Claims, 5 Drawing Sheets

