



US011973260B2

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

(10) **Patent No.:** **US 11,973,260 B2**  
(45) **Date of Patent:** **Apr. 30, 2024**

(54) **ANTENNA**

(71) Applicant: **Industrial Technology Research Institute, Hsinchu (TW)**

(72) Inventors: **Ruo-Lan Chang, New Taipei (TW); Mei-Ju Lee, Hsinchu (TW); Cheng-Hua Tsai, New Taipei (TW); Meng-Hsuan Chen, Taichung (TW); Wei-Chung Chen, Kaohsiung (TW)**

(73) Assignee: **Industrial Technology Research Institute, Hsinchu (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.: **17/984,214**

(22) Filed: **Nov. 9, 2022**

(65) **Prior Publication Data**

US 2023/0163443 A1 May 25, 2023

**Related U.S. Application Data**

(60) Provisional application No. 63/278,071, filed on Nov. 10, 2021.

(30) **Foreign Application Priority Data**

Oct. 3, 2022 (TW) ..... 111137587

(51) **Int. Cl.**

**H01Q 1/12** (2006.01)  
**H01Q 1/00** (2006.01)

(Continued)

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

CPC ..... **H01Q 1/1285** (2013.01); **H01Q 1/007** (2013.01); **H01Q 9/0457** (2013.01); **H01Q 9/065** (2013.01); **H01Q 19/10** (2013.01)

(58) **Field of Classification Search**

CPC ..... H01Q 1/007; H01Q 1/364; H01Q 1/1271; H01Q 1/1278; H01Q 1/1285; H01Q 1/38; (Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,274,334 B2 9/2007 O’Riordan et al.  
2003/0034917 A1 2/2003 Nishizawa et al.  
(Continued)

FOREIGN PATENT DOCUMENTS

CN 203039108 7/2013  
CN 203225336 10/2013  
(Continued)

OTHER PUBLICATIONS

“Office Action of Taiwan Counterpart Application”, dated Aug. 11, 2023, p. 1-p. 3.

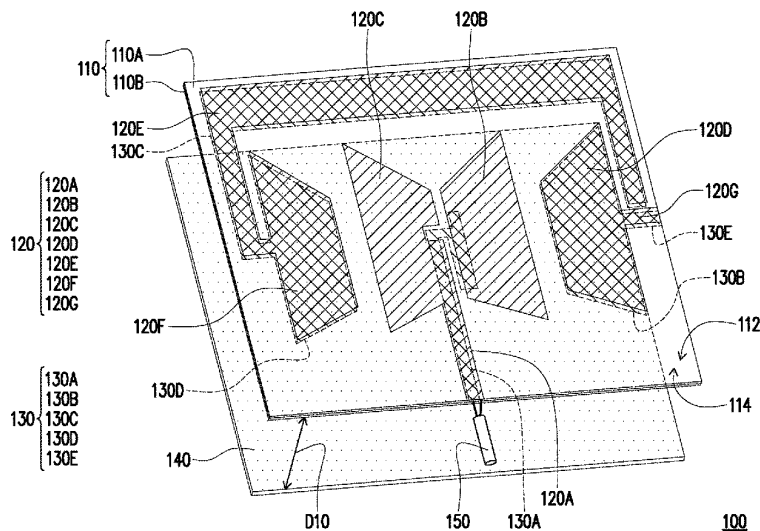
*Primary Examiner* — Robert Karacsony

(74) *Attorney, Agent, or Firm* — JCIPRNET

(57) **ABSTRACT**

A light-transmitting antenna includes a substrate, a first and a second conductive pattern. The first and the second conductive pattern is disposed on a first and a second surface of the substrate respectively. The first conductive pattern includes a first feeder unit, a first and a second radiation unit, a first and a second coupling unit and a first parasitic unit. The first feeder unit is connected to the second radiation unit. The first and the second radiation unit are located between the first and the second coupling unit. One side and the other side of the first parasitic unit is connected to the second coupling unit and adjacent to the first coupling unit respectively. The second conductive pattern includes a second feeder unit, a third coupling unit, a second parasitic unit, and a fourth coupling unit.

**16 Claims, 4 Drawing Sheets**





US011973261B2

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

(10) **Patent No.:** **US 11,973,261 B2**

(45) **Date of Patent:** **Apr. 30, 2024**

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

H01Q 1/242; H01Q 1/36; H01Q 1/48;  
H01Q 1/50; H01Q 1/52; H01Q 5/28;  
H01Q 5/50; H04B 1/006

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

See application file for complete search history.

(56) **References Cited**

(72) Inventors: **Kun-Lin Sung**, New Taipei (TW);  
**Yung-Chin Chen**, New Taipei (TW);  
**Yi-Chieh Lee**, New Taipei (TW)

U.S. PATENT DOCUMENTS

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

11,342,653 B2 \* 5/2022 Hsu ..... H01Q 1/243  
11,349,199 B2 \* 5/2022 Hsu ..... H01Q 1/243  
2014/0218244 A1 \* 8/2014 Chang ..... H01Q 1/243  
343/702  
2016/0056531 A1 \* 2/2016 Lee ..... H01Q 1/243  
343/702

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 486 days.

(Continued)

FOREIGN PATENT DOCUMENTS

(21) Appl. No.: **17/150,214**

CN 205543232 U 8/2016  
CN 109921176 A 6/2019

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

(Continued)

(65) **Prior Publication Data**

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

US 2021/0226319 A1 Jul. 22, 2021

(30) **Foreign Application Priority Data**

(57) **ABSTRACT**

Jan. 17, 2020 (CN) ..... 202010051202.4

An antenna structure with wide radiation bandwidth in a reduced physical space includes a metallic housing, a first feed portion, and a second feed portion. The metallic housing includes a metallic side frame and a metallic back board. The metallic side frame defines a slot, and first and second gaps. The metallic side frame between the first gap and one end of the slot forms a first radiation portion. The second gap divides the first radiation portion into first and second radiation sections. The first feed portion feeds current and signal to the first radiation section, and the first radiation section works in a GPS mode and a WIFI 2.4 GHz mode. The second feed portion feeds current and signal to the second radiation section, and the second radiation section works in a WIFI 5 GHz mode.

(51) **Int. Cl.**

**H01Q 1/24** (2006.01)  
**H01Q 13/10** (2006.01)  
**H04B 1/00** (2006.01)

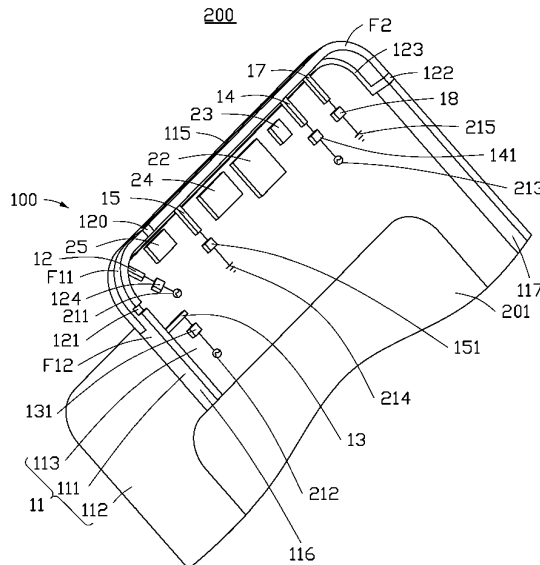
(52) **U.S. Cl.**

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 1/44;  
H01Q 5/328; H01Q 5/335; H01Q 9/42;

**14 Claims, 13 Drawing Sheets**





US011973262B2

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

(10) **Patent No.:** **US 11,973,262 B2**  
(45) **Date of Patent:** **Apr. 30, 2024**

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

USPC ..... 343/770  
See application file for complete search history.

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

(56) **References Cited**

(72) Inventors: **Woongsun Hong**, Gyeonggi-do (KR);  
**Hongil Kwon**, Gyeonggi-do (KR)

U.S. PATENT DOCUMENTS

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

9,627,769 B2 4/2017 Koo et al.  
10,455,065 B2 10/2019 Lee et al.  
10,709,043 B2 7/2020 Yun et al.  
2019/0165470 A1 5/2019 Jeon  
2019/0327834 A1 10/2019 Kim et al.  
2019/0386378 A1 12/2019 Lee et al.

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 296 days.

(Continued)

(21) Appl. No.: **17/570,029**

FOREIGN PATENT DOCUMENTS

(22) Filed: **Jan. 6, 2022**

KR 10-1944340 1/2019  
KR 1020190038264 4/2019

(65) **Prior Publication Data**

US 2022/0231403 A1 Jul. 21, 2022

(Continued)

**Related U.S. Application Data**

OTHER PUBLICATIONS

(63) Continuation of application No. PCT/KR2021/020060, filed on Dec. 28, 2021.

International Search Report dated Mar. 30, 2022 issued in counter-part application No. PCT/KR2021/020060, 9 pages.

(30) **Foreign Application Priority Data**

Jan. 18, 2021 (KR) ..... 10-2021-0007044

*Primary Examiner* — Hai V Tran

(74) *Attorney, Agent, or Firm* — The Farrell Law Firm, P.C.

(51) **Int. Cl.**

**H01Q 1/24** (2006.01)  
**H01Q 1/38** (2006.01)  
**H01Q 9/04** (2006.01)  
**H01Q 13/10** (2006.01)

(57) **ABSTRACT**

An electronic device is provided and includes a housing, a first substrate disposed in an inner space of the housing, a second substrate disposed on a first surface of the first substrate, a third substrate disposed on a first surface of the second substrate, a first conductive patch attached to at least a partial region of the side surfaces of the first substrate, the second substrate, and the third substrate, and a second conductive patch attached to at least another partial region of the side surfaces of the first substrate, the second substrate, and the third substrate.

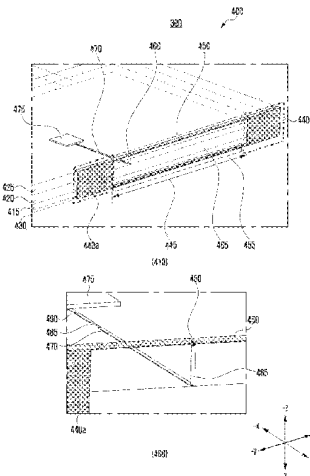
(52) **U.S. Cl.**

CPC ..... **H01Q 1/243** (2013.01); **H01Q 1/24** (2013.01); **H01Q 1/38** (2013.01); **H01Q 9/04** (2013.01); **H01Q 9/0407** (2013.01); **H01Q 13/10** (2013.01)

(58) **Field of Classification Search**

CPC ..... H01Q 1/243; H01Q 1/24; H01Q 1/38; H01Q 9/0407; H01Q 9/04; H01Q 13/10

**20 Claims, 18 Drawing Sheets**





US011973263B2

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

(10) **Patent No.:** **US 11,973,263 B2**  
(45) **Date of Patent:** **Apr. 30, 2024**

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

(71) Applicant: **Samsung Electronics Co., Ltd.**,  
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(72) Inventors: **Mincheol Seo**, Gyeonggi-do (KR);  
**Donghun Shin**, Gyeonggi-do (KR);  
**Yonghyun Yoon**, Gyeonggi-do (KR);  
**Gyusub Kim**, Gyeonggi-do (KR);  
**Seongjin Park**, Gyeonggi-do (KR);  
**Myunghun Jeong**, 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 119 days.

(21) Appl. No.: **17/839,671**

(22) Filed: **Jun. 14, 2022**

(65) **Prior Publication Data**

US 2022/0311128 A1 Sep. 29, 2022

**Related U.S. Application Data**

(63) Continuation of application No.  
PCT/KR2020/013530, filed on Oct. 6, 2020.

(30) **Foreign Application Priority Data**

Dec. 20, 2019 (KR) ..... 10-2019-0172324

(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); **H01Q 1/526** (2013.01); **H01Q**  
**5/307** (2015.01); **H01Q 5/378** (2015.01);  
**H01Q 19/22** (2013.01)

(58) **Field of Classification Search**

CPC ..... H01Q 1/243; H01Q 1/38; H01Q 1/526;  
H01Q 5/307; H01Q 5/378; H01Q 19/22  
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

10,826,159 B2 \* 11/2020 Kim ..... B29C 45/14655  
10,992,028 B2 \* 4/2021 Moon ..... G06F 1/1656  
(Continued)

FOREIGN PATENT DOCUMENTS

KR 10-2017-0025846 A 3/2017  
KR 10-2018-0021432 A 3/2018  
(Continued)

OTHER PUBLICATIONS

Korean Office Action dated Jan. 3, 2024.

*Primary Examiner* — A B Salam Alkassim, Jr.

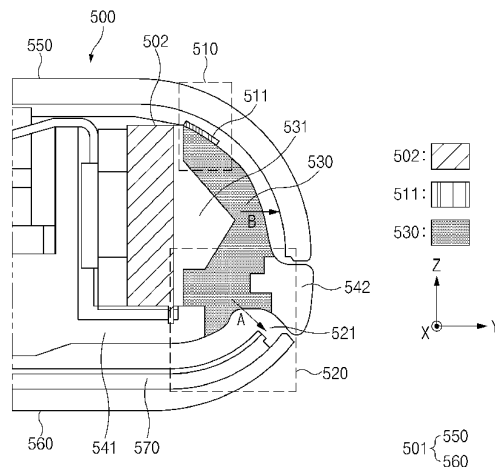
*Assistant Examiner* — Leah Rosenberg

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

(57) **ABSTRACT**

An electronic device according to a certain embodiments  
comprises: a housing including a front plate, a rear plate, and  
a side member surrounding a space between the front plate  
and the rear plate; an antenna module disposed in the space,  
and configured to transmit and receive first signals belong-  
ing to a first frequency band using at least one antenna  
element; a nonconductive member disposed to face at least  
one surface of the antenna module; and a conductive pattern  
being closer to the rear plate than to the at front plate and  
disposed between the nonconductive member and the rear  
plate, wherein the conductive pattern is configured to:  
change a radiation direction of at least a portion of the first  
signal and transmit and receive a second signal belonging to  
a second frequency band.

**20 Claims, 25 Drawing Sheets**





US011973278B2

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

(10) **Patent No.:** **US 11,973,278 B2**  
(45) **Date of Patent:** **Apr. 30, 2024**

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

(52) **U.S. Cl.**  
CPC ..... **H01Q 9/0414** (2013.01); **H01Q 1/48** (2013.01); **H01Q 9/045** (2013.01)

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

(58) **Field of Classification Search**  
CPC ..... H01Q 1/24; H01Q 1/243; H01Q 1/38; H01Q 1/48; H01Q 21/28; H01Q 9/04; (Continued)

(72) Inventors: **Ning Ma**, Shenzhen (CN); **Ben Lai**, Wuhan (CN); **Xin Pan**, Shenzhen (CN)

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

(56) **References Cited**

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 176 days.

9,209,515 B2\* 12/2015 Lin ..... H01Q 1/084  
9,444,128 B2\* 9/2016 Lee ..... H01Q 21/28  
(Continued)

(21) Appl. No.: **17/765,113**

FOREIGN PATENT DOCUMENTS

(22) PCT Filed: **Jul. 27, 2020**

CN 103259085 A 8/2013  
CN 103746192 A 4/2014

(86) PCT No.: **PCT/CN2020/104911**

(Continued)

§ 371 (c)(1),

(2) Date: **Mar. 30, 2022**

*Primary Examiner* — Tho G Phan

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

(87) PCT Pub. No.: **WO2021/063094**

PCT Pub. Date: **Apr. 8, 2021**

(57) **ABSTRACT**

An electronic device comprising an antenna structure including a signal reference ground, a first antenna, and a second antenna. The first antenna includes a first radiator and a first feeding line, where the first radiator has a first feeding point, is fed from the first feeding point through the first feeding line, and is electrically coupled to the signal reference ground. The second antenna includes a second radiator and a second feeding line, where the second radiator has a second feeding point and is fed from the second feeding point through the second feeding line, and the second feeding line includes a signal transmission line and a signal reference ground line that is electrically coupled to the first radiator.

(65) **Prior Publication Data**

US 2022/0399648 A1 Dec. 15, 2022

(30) **Foreign Application Priority Data**

Sep. 30, 2019 (CN) ..... 201910947978.1

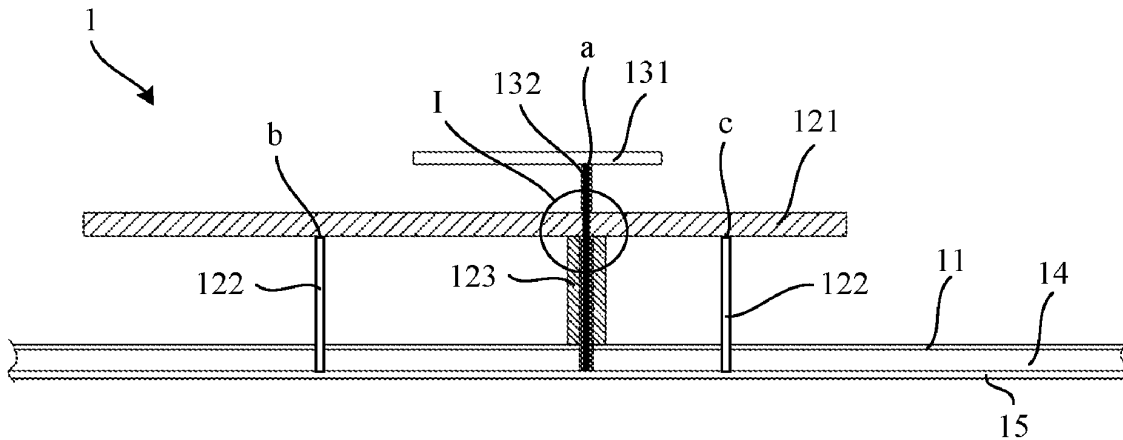
(51) **Int. Cl.**

**H01Q 1/24** (2006.01)

**H01Q 1/48** (2006.01)

**H01Q 9/04** (2006.01)

**20 Claims, 10 Drawing Sheets**





US011973280B2

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

(10) **Patent No.:** **US 11,973,280 B2**  
(45) **Date of Patent:** **Apr. 30, 2024**

(54) **ANTENNA ELEMENT AND TERMINAL DEVICE**  
(71) Applicant: **VIVO MOBILE COMMUNICATION CO.,LTD.**, Guangdong (CN)  
(72) Inventors: **Yijin Wang**, Guangdong (CN);  
**Huan-Chu Huang**, Guangdong (CN);  
**Xianjing Jian**, Guangdong (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 295 days.

(21) Appl. No.: **17/530,375**

(22) Filed: **Nov. 18, 2021**

(65) **Prior Publication Data**  
US 2022/0077582 A1 Mar. 10, 2022

**Related U.S. Application Data**  
(63) Continuation of application No. PCT/CN2020/090101, filed on May 13, 2020.

(30) **Foreign Application Priority Data**  
May 22, 2019 (CN) ..... 201910430963.8

(51) **Int. Cl.**  
**H01Q 9/04** (2006.01)  
**H01Q 1/24** (2006.01)  
(Continued)

(52) **U.S. Cl.**  
CPC ..... **H01Q 9/045** (2013.01); **H01Q 1/243** (2013.01)

(58) **Field of Classification Search**  
CPC ..... H01Q 21/26; H01Q 1/38; H01Q 1/246; H01Q 1/243; H01Q 21/24; H01Q 1/50  
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2014/0176378 A1 6/2014 Yu et al.  
2015/0130682 A1 5/2015 Jung et al.  
(Continued)

FOREIGN PATENT DOCUMENTS

CN 101834345 A 9/2010  
CN 102870276 A 1/2013  
(Continued)

OTHER PUBLICATIONS

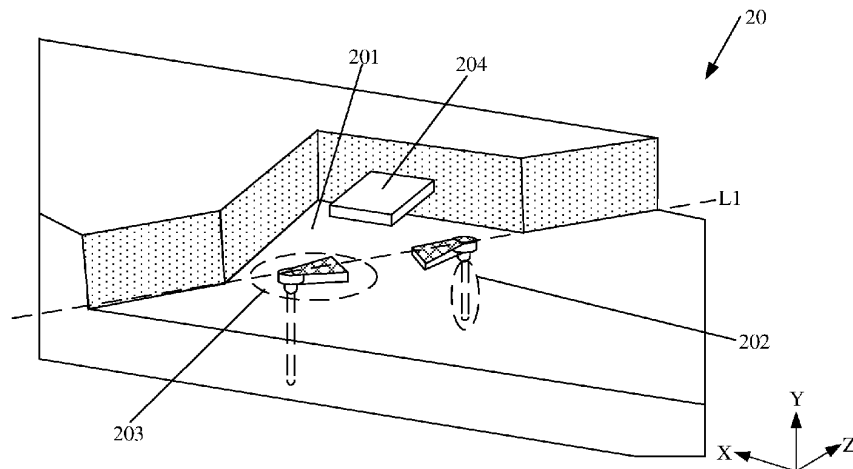
International Search Report of International Application No. PCT/CN2020/090101 dated Aug. 3, 2020.  
(Continued)

*Primary Examiner* — Wei (Victor) Y Chan  
(74) *Attorney, Agent, or Firm* — IP & T GROUP LLP

(57) **ABSTRACT**

An antenna element includes: a target metal groove, M feeding components disposed at the bottom of the target metal groove, M feeding arms and a first insulator disposed in the target metal groove, and a target radiator carried by the first insulator. Each feeding component of the M feeding components is electrically connected to a feeding arm, and the M feeding components are isolated from the target metal groove. The M feeding arms are located between the bottom of the target metal groove and the first insulator, and the M feeding arms is distributed along the diagonal direction of the target metal groove. Each feeding arm of the M feeding arms is coupled to the target radiator and the target metal groove, and a resonance frequency of the target radiator is different from a resonance frequency of the target metal groove, and M is a positive integer.

**17 Claims, 5 Drawing Sheets**





US011973260B2

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

(10) **Patent No.:** **US 11,973,260 B2**  
(45) **Date of Patent:** **Apr. 30, 2024**

(54) **ANTENNA**

(71) Applicant: **Industrial Technology Research Institute, Hsinchu (TW)**

(72) Inventors: **Ruo-Lan Chang, New Taipei (TW); Mei-Ju Lee, Hsinchu (TW); Cheng-Hua Tsai, New Taipei (TW); Meng-Hsuan Chen, Taichung (TW); Wei-Chung Chen, Kaohsiung (TW)**

(73) Assignee: **Industrial Technology Research Institute, Hsinchu (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.: **17/984,214**

(22) Filed: **Nov. 9, 2022**

(65) **Prior Publication Data**

US 2023/0163443 A1 May 25, 2023

**Related U.S. Application Data**

(60) Provisional application No. 63/278,071, filed on Nov. 10, 2021.

(30) **Foreign Application Priority Data**

Oct. 3, 2022 (TW) ..... 111137587

(51) **Int. Cl.**

**H01Q 1/12** (2006.01)  
**H01Q 1/00** (2006.01)

(Continued)

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

CPC ..... **H01Q 1/1285** (2013.01); **H01Q 1/007** (2013.01); **H01Q 9/0457** (2013.01); **H01Q 9/065** (2013.01); **H01Q 19/10** (2013.01)

(58) **Field of Classification Search**

CPC ..... H01Q 1/007; H01Q 1/364; H01Q 1/1271; H01Q 1/1278; H01Q 1/1285; H01Q 1/38;  
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,274,334 B2 9/2007 O’Riordan et al.  
2003/0034917 A1 2/2003 Nishizawa et al.  
(Continued)

FOREIGN PATENT DOCUMENTS

CN 203039108 7/2013  
CN 203225336 10/2013  
(Continued)

OTHER PUBLICATIONS

“Office Action of Taiwan Counterpart Application”, dated Aug. 11, 2023, p. 1-p. 3.

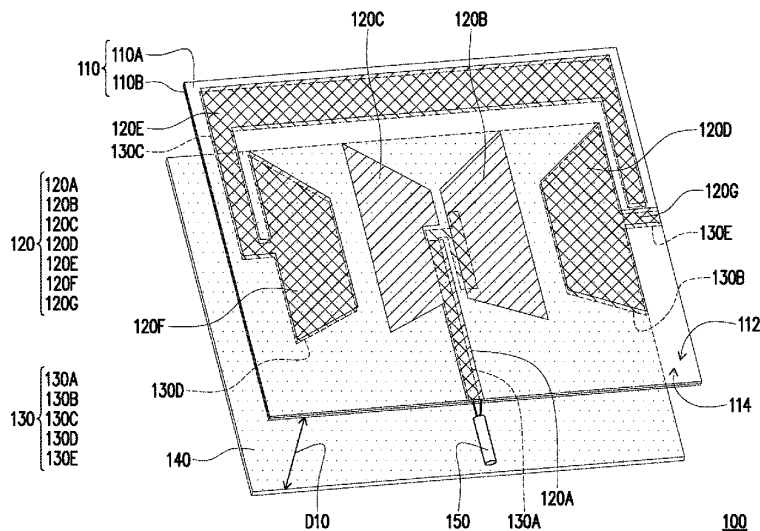
*Primary Examiner* — Robert Karacsony

(74) *Attorney, Agent, or Firm* — JCIPRNET

(57) **ABSTRACT**

A light-transmitting antenna includes a substrate, a first and a second conductive pattern. The first and the second conductive pattern is disposed on a first and a second surface of the substrate respectively. The first conductive pattern includes a first feeder unit, a first and a second radiation unit, a first and a second coupling unit and a first parasitic unit. The first feeder unit is connected to the second radiation unit. The first and the second radiation unit are located between the first and the second coupling unit. One side and the other side of the first parasitic unit is connected to the second coupling unit and adjacent to the first coupling unit respectively. The second conductive pattern includes a second feeder unit, a third coupling unit, a second parasitic unit, and a fourth coupling unit.

**16 Claims, 4 Drawing Sheets**





US011984643B2

(12) **United States Patent**  
**Hou**

(10) **Patent No.:** **US 11,984,643 B2**  
(45) **Date of Patent:** **May 14, 2024**

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

H01Q 1/242; H01Q 1/36; H01Q 13/106;  
H01Q 1/24; H01Q 1/46; H04M 1/0216;  
H04M 1/0268; H04M 1/026; H03H 7/383  
See application file for complete search history.

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

(56) **References Cited**

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 353 days.

U.S. PATENT DOCUMENTS

11,056,768 B2\* 7/2021 Kim ..... H01Q 21/00  
2020/0411957 A1 12/2020 Zhu et al.  
2021/0318720 A1\* 10/2021 Lin ..... H01Q 1/36  
2022/0115768 A1\* 4/2022 Oh ..... H01Q 9/42

(21) Appl. No.: **17/443,568**

CN 109728412 A 5/2019  
KR 20200100986 A 8/2020

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

FOREIGN PATENT DOCUMENTS

(65) **Prior Publication Data**

US 2022/0311126 A1 Sep. 29, 2022

OTHER PUBLICATIONS

European Patent Application No. 21188109.9, Search and Opinion dated Jan. 26, 2022, 8 pages.

(30) **Foreign Application Priority Data**

Mar. 23, 2021 (CN) ..... 202110309966.3

\* cited by examiner

(51) **Int. Cl.**  
**H01Q 1/24** (2006.01)  
**H01Q 5/335** (2015.01)  
**H01Q 13/16** (2006.01)  
**H04M 1/02** (2006.01)

*Primary Examiner* — Hai V Tran  
*Assistant Examiner* — Michael M Bouizza  
(74) *Attorney, Agent, or Firm* — COZEN O'CONNOR

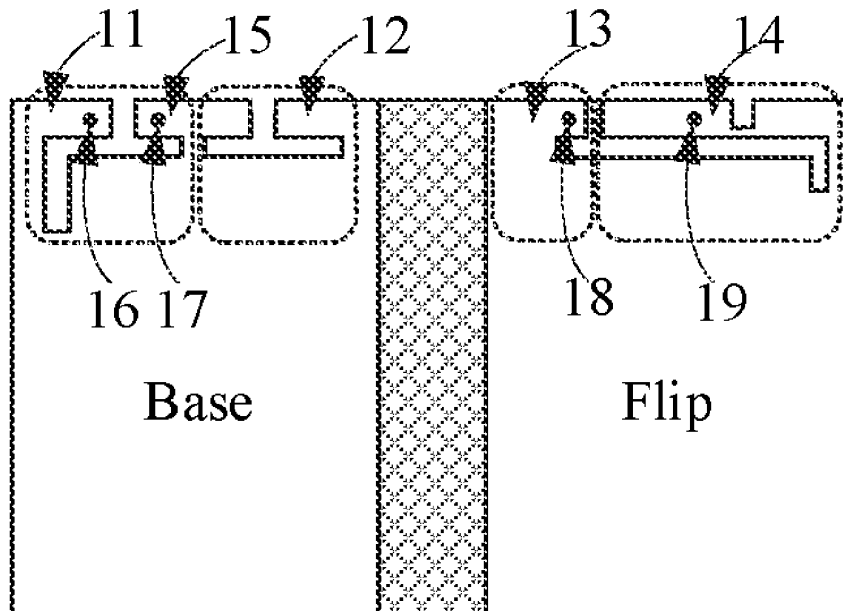
(52) **U.S. Cl.**  
CPC ..... **H01Q 1/243** (2013.01); **H01Q 5/335** (2015.01); **H01Q 13/16** (2013.01); **H04M 1/0216** (2013.01); **H04M 1/0268** (2013.01)

(57) **ABSTRACT**

Provided is an electronic device. The electronic device includes a base and a flip. The flip is rotatable around a rotation axis to bring the electronic device into a closed state. The base is provided with a first antenna including a first slot, and the flip is provided with a second antenna including a groove. In the closed state, the first slot in the first antenna is opposite to the groove in the second antenna.

(58) **Field of Classification Search**  
CPC ..... H01Q 1/243; H01Q 5/335; H01Q 13/16; H01Q 1/2266; H01Q 5/35; H01Q 21/28;

**18 Claims, 2 Drawing Sheets**







US011984646B2

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

(10) **Patent No.:** **US 11,984,646 B2**  
(45) **Date of Patent:** **May 14, 2024**

(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 224 days.

(21) Appl. No.: **17/610,846**  
(22) PCT Filed: **May 12, 2020**  
(86) PCT No.: **PCT/CN2020/089827**  
§ 371 (c)(1),  
(2) Date: **Nov. 12, 2021**  
(87) PCT Pub. No.: **WO2020/228703**  
PCT Pub. Date: **Nov. 19, 2020**

(65) **Prior Publication Data**  
US 2022/0223999 A1 Jul. 14, 2022

(30) **Foreign Application Priority Data**  
May 13, 2019 (CN) ..... 201910393785.6  
May 23, 2019 (CN) ..... 201910435969.4

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

(52) **U.S. Cl.**  
CPC ..... **H01Q 1/243** (2013.01); **H01Q 1/42** (2013.01); **H04M 1/0216** (2013.01); **H04M 1/0268** (2013.01); **H05K 1/118** (2013.01)

(58) **Field of Classification Search**  
CPC ..... H01Q 1/243; H01Q 1/42; H01Q 5/40; H01Q 5/378; H01Q 1/22; H01Q 1/2266;  
(Continued)

(56) **References Cited**  
U.S. PATENT DOCUMENTS

5,561,436 A 10/1996 Phillips  
2008/0300028 A1 12/2008 Uejima et al.  
(Continued)

FOREIGN PATENT DOCUMENTS

CN 102037604 A 4/2011  
CN 102544699 A 7/2012  
(Continued)

OTHER PUBLICATIONS

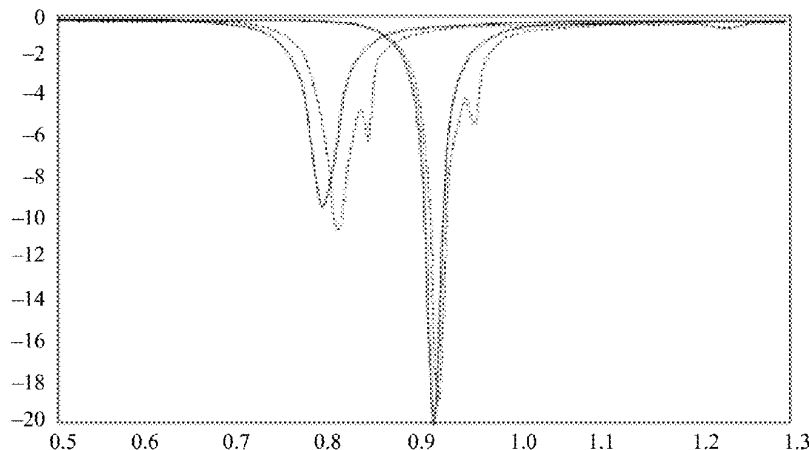
Li Chuan, Multi-antenna System for 5G Multi-mode Terminal, University of Electronic Science and Technology, Feb. 2017, 2 pages(abstract).

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(57) **ABSTRACT**

An electronic device includes a first part and a second part that can be folded or expanded relative to each other. The electronic device has a closed state and an open state. When the electronic device is in the closed state, a frame of the first part and a frame of the second part partially or totally overlap. The first part includes a first feeding antenna. The second part includes a first parasitic antenna, and when the electronic device is in the closed state, the first parasitic antenna is not grounded and can be coupled to the first feeding antenna.

**20 Claims, 26 Drawing Sheets**





US011984667B2

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

(10) **Patent No.:** **US 11,984,667 B2**  
(45) **Date of Patent:** **May 14, 2024**

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

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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 323 days.

(21) Appl. No.: **17/406,672**

(22) Filed: **Aug. 19, 2021**

(65) **Prior Publication Data**  
US 2021/0384630 A1 Dec. 9, 2021

**Related U.S. Application Data**

(63) Continuation of application No.  
PCT/KR2020/002378, filed on Feb. 19, 2020.

(30) **Foreign Application Priority Data**  
Feb. 19, 2019 (KR) ..... 10-2019-0019541

(51) **Int. Cl.**  
**H01Q 5/50** (2015.01)  
**H01Q 1/24** (2006.01)  
**H04M 1/02** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **H01Q 5/50** (2015.01); **H01Q 1/243**  
(2013.01); **H04M 1/0266** (2013.01); **H04M**  
**1/0277** (2013.01)

(58) **Field of Classification Search**  
CPC ..... H01Q 1/243; H01Q 1/38;  
H01Q 1/44; H01Q 1/46; H01Q 5/35;  
H01Q 5/371;

(Continued)

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

10,075,569 B2 9/2018 Kim et al.  
10,306,029 B1 \* 5/2019 Hwang ..... H04M 1/0202  
(Continued)

**FOREIGN PATENT DOCUMENTS**

KR 10-2017-0119392 4/2016  
KR 10-2018-0108147 10/2018  
WO WO 2018/139692 8/2018

**OTHER PUBLICATIONS**

Korean Office Action dated Feb. 24, 2023 issued in counterpart  
application No. 10-2019-0019541, 11 pages.

(Continued)

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(57) **ABSTRACT**

An electronic device including an improved antenna structure is provided. The electronic device includes an antenna structure including a side surface member including first to fifth conductive parts, a first to fifth insulation part between the conductive parts. The electronic device includes a display and a wireless communication circuit electrically connected with the first to the fifth conductive parts, and configured to transceive in a designated frequency band. The second conductive part includes a feeding structure that at least partially overlaps the display in within a predetermined distance of the first insulation part, and is electrically connected with the wireless communication circuit.

**16 Claims, 30 Drawing Sheets**

