



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**

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**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)

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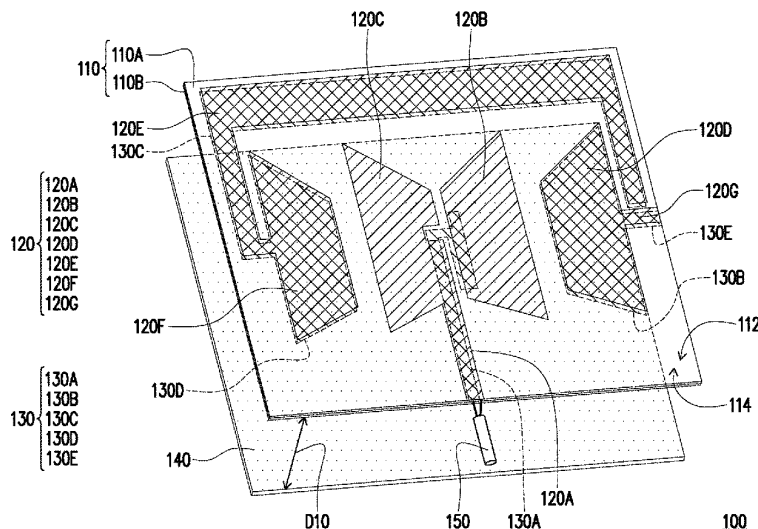
*Primary Examiner* — Robert Karacsony

(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)

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

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|              |      |        |       |       | 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.

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

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

(Continued)

(65) **Prior Publication Data**

US 2021/0226319 A1 Jul. 22, 2021

*Primary Examiner* — Hai V Tran

*Assistant Examiner* — Bamidele A Immanuel

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

(30) **Foreign Application Priority Data**

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

(57) **ABSTRACT**

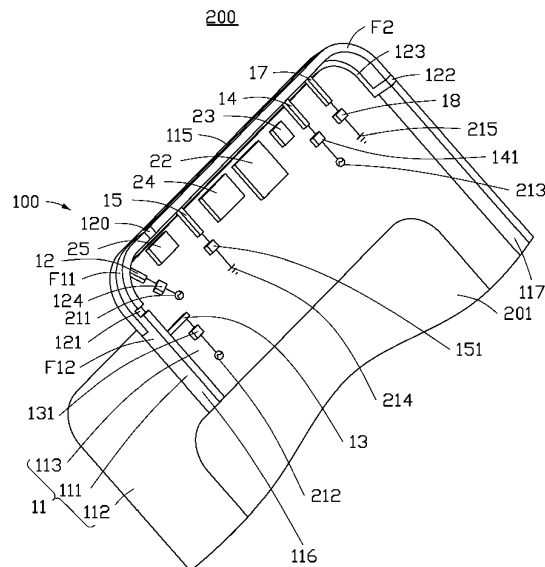
(51) **Int. Cl.**  
**H01Q 1/24** (2006.01)  
**H01Q 13/10** (2006.01)  
**H04B 1/00** (2006.01)

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.

(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)

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(73) Assignee: **Samsung Electronics Co., Ltd** (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 296 days.

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

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

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

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(65) **Prior Publication Data**

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**Related U.S. Application Data**

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

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

*Primary Examiner* — Hai V Tran

(30) **Foreign Application Priority Data**

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

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

(57) **ABSTRACT**

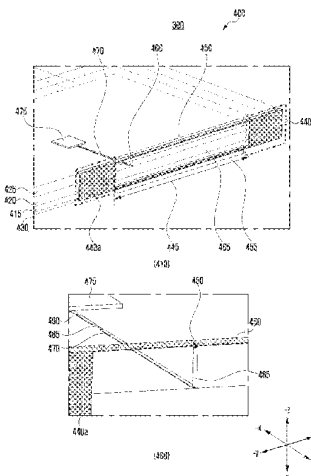
(51) **Int. Cl.**  
**H01Q 1/24** (2006.01)  
**H01Q 1/38** (2006.01)  
**H01Q 9/04** (2006.01)  
**H01Q 13/10** (2006.01)

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**





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(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**

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**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.

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

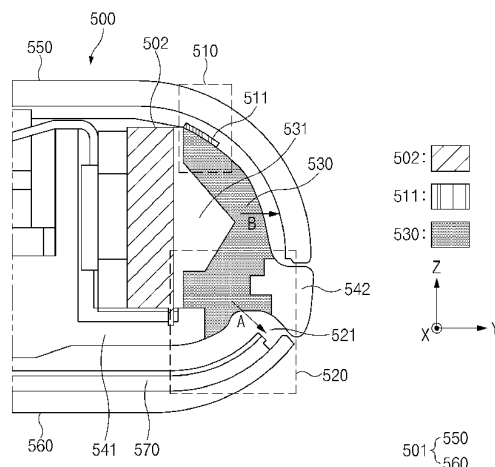
*Assistant Examiner* — Leah Rosenberg

(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 belonging 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**

(71) Applicant: **Huawei Technologies Co., Ltd.**,  
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(72) Inventors: **Ning Ma**, Shenzhen (CN); **Ben Lai**,  
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(73) Assignee: **HUAWEI TECHNOLOGIES CO., LTD.**,  
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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 176 days.

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

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

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

§ 371 (c)(1),

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

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

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

(65) **Prior Publication Data**

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(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)

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

CPC ..... **H01Q 9/0414** (2013.01); **H01Q 1/48**  
(2013.01); **H01Q 9/045** (2013.01)

(58) **Field of Classification Search**

CPC ..... H01Q 1/24; H01Q 1/243; H01Q 1/38;  
H01Q 1/48; H01Q 21/28; H01Q 9/04;  
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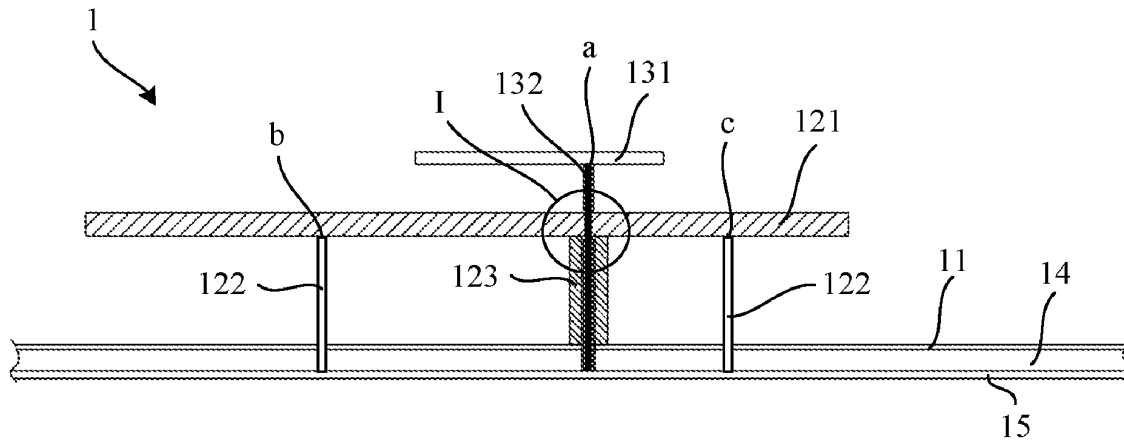
*Primary Examiner* — Tho G Phan

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

(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.

**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);  
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(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**  
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**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.

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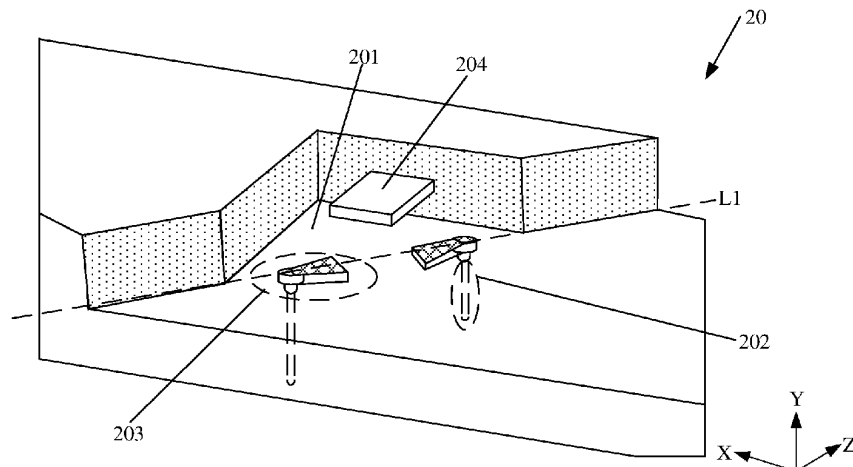
*Primary Examiner* — Wei (Victor) Y Chan

(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**





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(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**

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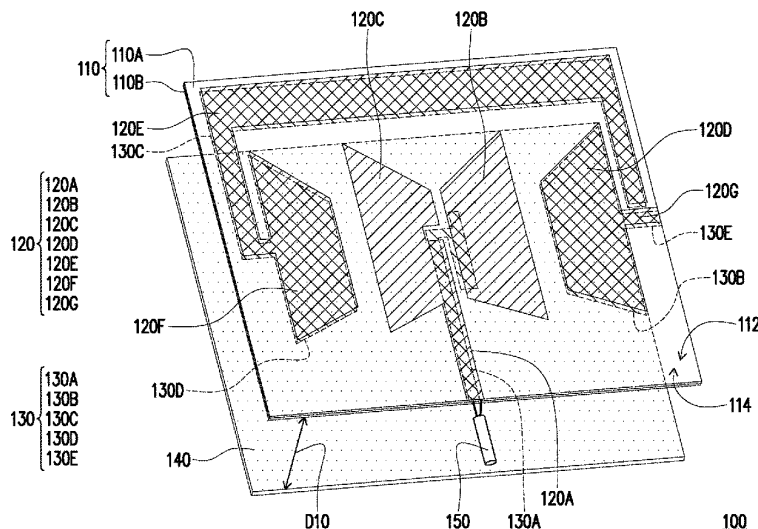
*Primary Examiner* — Robert Karacsony

(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)

(72) Inventor: **Xiaolin Hou**, 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 353 days.

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

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

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

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

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

(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)

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

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.

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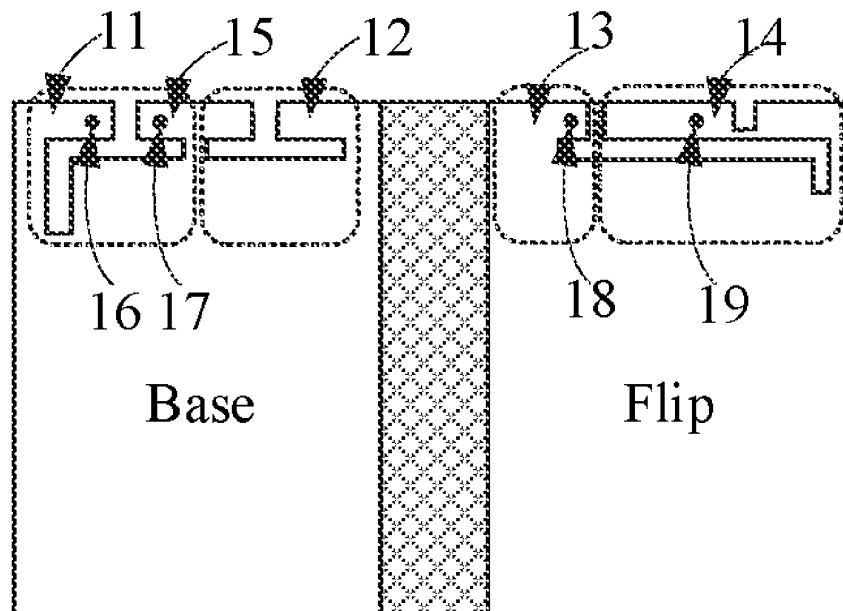
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(57) **ABSTRACT**

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.

**18 Claims, 2 Drawing Sheets**







US011984646B2

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

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(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.

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**H01Q 1/42** (2006.01)

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

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(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)

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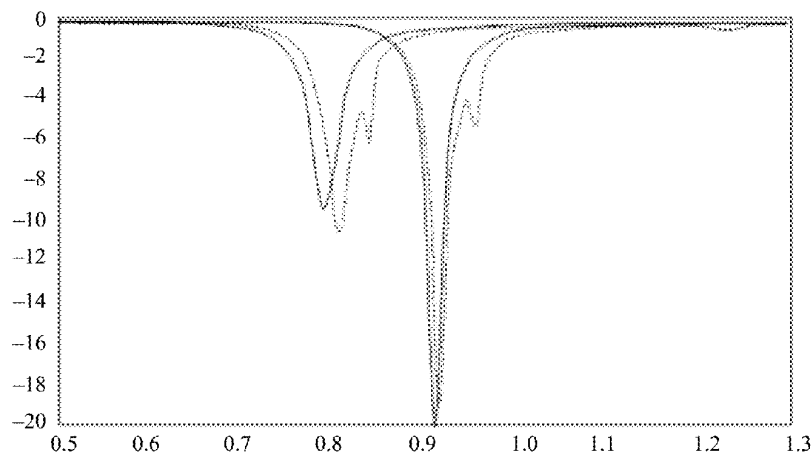
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(57) **ABSTRACT**

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.**

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(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  
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**H04M 1/02** (2006.01)

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(2013.01); **H04M 1/0266** (2013.01); **H04M**  
**1/0277** (2013.01)

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H01Q 1/44; H01Q 1/46; H01Q 5/35;  
H01Q 5/371;

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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**

