



US012183964B2

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

(10) **Patent No.:** **US 12,183,964 B2**
(45) **Date of Patent:** **Dec. 31, 2024**

(54) **MOBILE DEVICE WITH HIGH RADIATION EFFICIENCY**

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

(72) Inventors: **Kun-Sheng Chang**, New Taipei (TW);
Ching-Chi Lin, New Taipei (TW)

(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.: **17/934,606**

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

(65) **Prior Publication Data**
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(30) **Foreign Application Priority Data**
May 25, 2022 (TW) 111119403

(51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01Q 1/48 (2006.01)
H01Q 5/307 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 1/2266** (2013.01); **H01Q 1/22** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/307** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/2266; H01Q 1/48; H01Q 5/307;
H01Q 5/385; H01Q 9/42; H01Q 1/22
See application file for complete search history.

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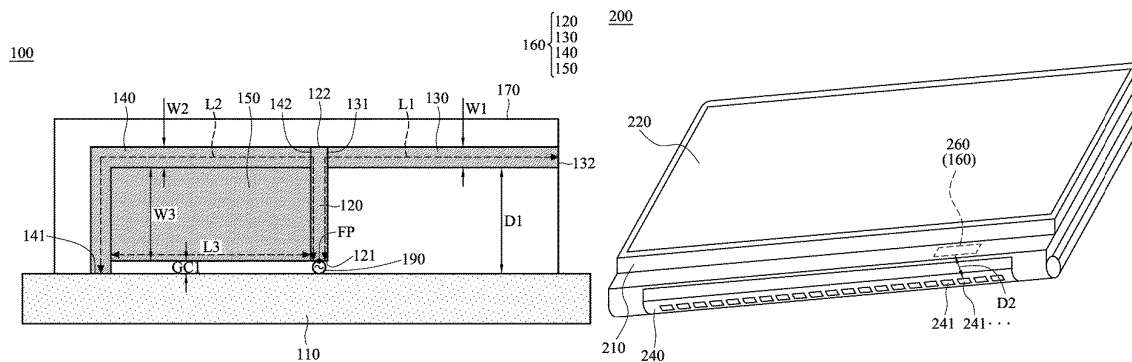
Primary Examiner — Hai V Tran

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

(57) **ABSTRACT**

A mobile device with high radiation efficiency includes a ground element, a first radiation element, a second radiation element, a third radiation element, a fourth radiation element, and a dielectric substrate. The first radiation element has a feeding point. The second radiation element is coupled to the first radiation element. The first radiation element is coupled through the third radiation element to the ground element. The fourth radiation element is coupled between the first radiation element and the third radiation element. The first radiation element, the second radiation element, the third radiation element, and the fourth radiation element are disposed on the dielectric substrate. An antenna structure is formed by the first radiation element, the second radiation element, the third radiation element, and the fourth radiation element.

13 Claims, 4 Drawing Sheets





US012183969B2

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

(10) **Patent No.:** **US 12,183,969 B2**
(45) **Date of Patent:** **Dec. 31, 2024**

(54) **COVER APPARATUS FOR OPTIMAL BEAM IMPLEMENTATION FOR ANTENNA IN WIRELESS COMMUNICATION SYSTEM**

(58) **Field of Classification Search**
CPC H01Q 1/42; H01Q 1/421; H01Q 1/246
See application file for complete search history.

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

(56) **References Cited**

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(72) Inventors: **Sanghoon Park**, Gyeonggi-do (KR);
Juneseok Lee, Gyeonggi-do (KR);
Dohyuk Ha, Gyeonggi-do (KR); **Jinsu Heo**, Gyeonggi-do (KR); **Youngju Lee**,
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 162 days.

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Primary Examiner — Dameon E Levi

Assistant Examiner — Leah Rosenberg

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

(21) Appl. No.: **17/786,870**

(22) PCT Filed: **Dec. 15, 2020**

(86) PCT No.: **PCT/KR2020/018337**

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(2) Date: **Jun. 17, 2022**

(87) PCT Pub. No.: **WO2021/125740**

PCT Pub. Date: **Jun. 24, 2021**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**

H01Q 1/42 (2006.01)

H01Q 1/24 (2006.01)

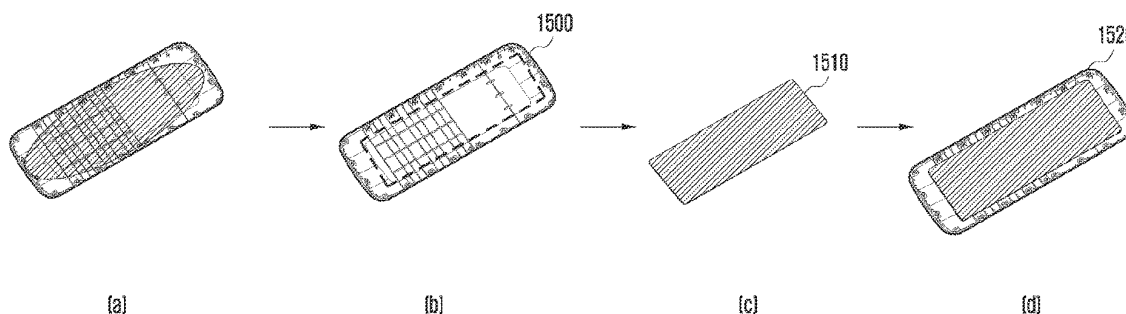
(52) **U.S. Cl.**

CPC **H01Q 1/421** (2013.01); **H01Q 1/246** (2013.01); **H01Q 1/42** (2013.01)

(57) **ABSTRACT**

The present disclosure relates to a communication technique for converging, with IoT technology, a 5G communication system for supporting a higher data transfer rate beyond the 4G system, and a system therefor. The present disclosure may be applied to intelligent services (for example, smart homes, smart buildings, smart cities, smart cars or connected cars, healthcare, digital education, retail businesses, security- and safety-related services, etc.) on the basis of 5G communication technology and IoT-related technology. Disclosed is a cover device for protecting an antenna device which is mounted in an electronic device to radiate a beam in an ultrahigh-frequency band, the cover device comprising: a cover frame including an open window region corresponding to a radiation region of the antenna device; and a

(Continued)





US012183973B2

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

(10) **Patent No.:** **US 12,183,973 B2**
(45) **Date of Patent:** **Dec. 31, 2024**

(54) **ANTENNA DEVICE**

(71) Applicant: **DENSO CORPORATION**, Kariya (JP)

(72) Inventors: **Yuuji Kakuya**, Nisshin (JP); **Masakazu Ikeda**, Nisshin (JP); **Kenichirou Sanji**, Kariya (JP); **Tomokazu Miyashita**, Kariya (JP); **Ryozou Fujii**, Kariya (JP); **Masashi Urabe**, Kariya (JP); **Hiromichi Naitoh**, Kariya (JP)

(73) Assignee: **DENSO CORPORATION**, Kariya (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 123 days.

(21) Appl. No.: **17/972,133**

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

(65) **Prior Publication Data**

US 2023/0039277 A1 Feb. 9, 2023

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2021/021496, filed on Jun. 7, 2021.

(30) **Foreign Application Priority Data**

Jun. 17, 2020 (JP) 2020-104775

(51) **Int. Cl.**
H01Q 13/08 (2006.01)
H01Q 5/328 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 13/08** (2013.01); **H01Q 5/328** (2015.01)

(58) **Field of Classification Search**

CPC H01Q 13/08; H01Q 5/328; H01Q 1/50; H01Q 9/0421

See application file for complete search history.

(56) **References Cited**

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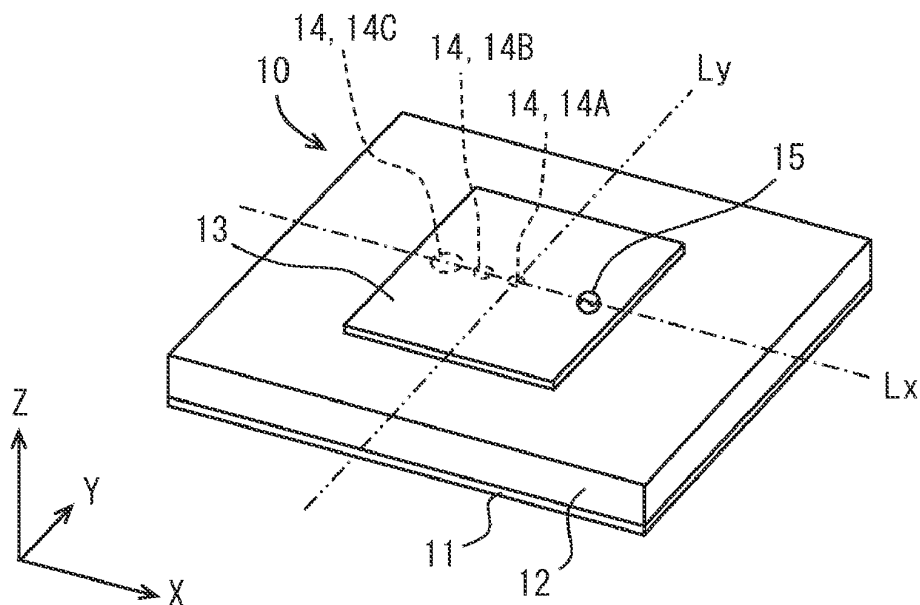
Primary Examiner — Dieu Hien T Duong

(74) *Attorney, Agent, or Firm* — Harness, Dickey & Pierce, P.L.C.

(57) **ABSTRACT**

An antenna device includes a ground plate which is a flat plate-shaped conductor member, an opposing conductive plate which is a flat plate-shaped conductor member installed at a predetermined distance from the ground plate and is electrically connected to a power supply line, and a plurality of short-circuit pins for electrically connecting the opposing conductive plate and the ground plate. One end of a plurality of short-circuit pins extends to a conductive plate plane, which is a plane including the opposing conductive plate, and the other end of the plurality of short-circuit pins extends to the ground plate plane, which is a plane including the ground plate. One or more of the plurality of short-circuit pins connect the opposing conductive plate and the ground plate.

3 Claims, 5 Drawing Sheets





US012183977B2

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

(10) **Patent No.:** **US 12,183,977 B2**
(45) **Date of Patent:** ***Dec. 31, 2024**

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

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

(72) Inventors: **Jungi Jeong**, Suwon-si (KR); **Chanju
Park**, Suwon-si (KR); **Junhwa Oh**,
Suwon-si (KR); **Sanghyuk Wi**,
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 0 days.

This patent is subject to a terminal dis-
claimer.

(21) Appl. No.: **18/361,369**

(22) Filed: **Jul. 28, 2023**

(65) **Prior Publication Data**
US 2023/0369778 A1 Nov. 16, 2023

Related U.S. Application Data

(63) Continuation of application No. 17/581,044, filed on
Jan. 21, 2022, now Pat. No. 11,742,587.

Foreign Application Priority Data

Feb. 2, 2021 (KR) 10-2021-0014957

(51) **Int. Cl.**
H01Q 21/00 (2006.01)
H01Q 1/22 (2006.01)
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(52) **U.S. Cl.**
CPC **H01Q 21/0025** (2013.01); **H01Q 1/2283**
(2013.01); **H01Q 1/243** (2013.01); **H01Q**
21/064 (2013.01)

(58) Field of Classification Search

CPC H01Q 1/22; H01Q 1/2283; H01Q 1/243;
H01Q 1/38; H01Q 21/0025;

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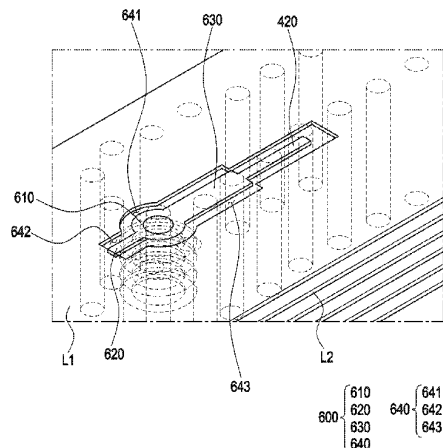
Primary Examiner — Jason M Crawford

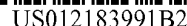
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) ABSTRACT

The disclosure relates to a 5th generation (5G) or 6th generation (6G) communication system for supporting a higher data transfer rate beyond 4th generation (4G) communication such as long-term evolution (LTE). An antenna module is provided. The antenna module includes a communication circuit, an antenna unit comprising multiple antenna elements constituting a subarray, and a network unit disposed beneath the antenna unit in multiple layers, the network unit comprising at least one transmission line configured to be branched to positions of the multiple antenna elements, a via hole extending through the multi-layer, and a stub structure disposed on an area adjacent to the via hole. The open stub structure designed on a first layer forming a ground plane, among the multiple layers, may include a first via pad disposed to be adjacent to the via hole, a first open stub extending from the first via pad in a first

(Continued)





(10) **Patent No.:** US 12,183,991 B2
(45) **Date of Patent:** Dec. 31, 2024

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Primary Examiner — Hai V Tran
Assistant Examiner — Bamidele A Immanuel
(74) Attorney, Agent, or Firm — McClure, Qualey &
Rodack, LLP

(21) Appl. No.: 18/047,301

(22) Filed: **Oct. 18, 2022**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Mar. 8, 2022 (TW) 111108279

(51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01Q 5/307 (2015.01)

(52) **U.S. Cl.**
CPC *H01Q 5/307* (2015.01); *H01Q 1/2283*
(2013.01)

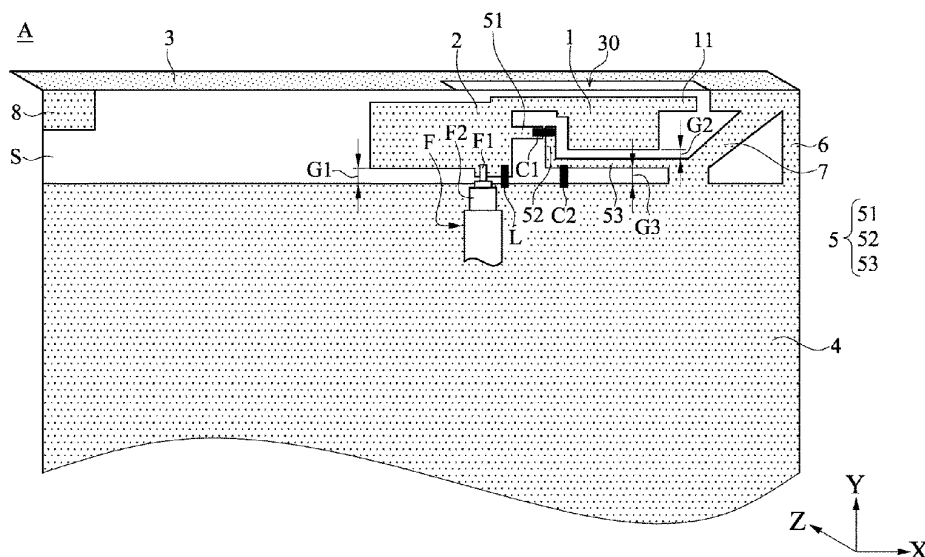
(58) **Field of Classification Search**
CPC H01Q 5/307; H01Q 1/2283; H01Q 1/36;
H01Q 1/2266; H01Q 5/328; H01Q 5/371;
H01Q 1/38; H01Q 1/243; H01Q 1/48;
H01Q 1/50; H01Q 5/314

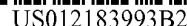
See application file for complete search history.

(57) **ABSTRACT**

An electronic device having an antenna structure is disclosed. The antenna structure includes a substrate, a first radiating portion, a second radiating portion connected to the first radiating portion, a grounding portion, a shorting portion connected between the second radiating portion and the grounding portion, a third radiating portion, a first grounding extension portion connected between the third radiating portion and the grounding portion, and a first capacitive element coupled between a first section and a second section of the shorting portion. The coupling of the shorting portion, the first grounding extension portion, and the third radiating portion generates a first operating frequency band, and the coupling of the first radiating portion, the shorting portion, the first grounding extension portion, and the third radiating portion generates a second operating frequency band, which is higher than the first operating frequency band, through the matching of the first capacitive element.

15 Claims, 5 Drawing Sheets





(10) **Patent No.:** US 12,183,993 B2
(45) **Date of Patent:** Dec. 31, 2024

(56) **References Cited**

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Primary Examiner — Dieu Hien T Duong

(74) *Attorney, Agent, or Firm* — Richard W. James

(57) **ABSTRACT**

A proximity-coupled loop antenna. The proximity-coupled loop antenna includes a dielectric substrate, a ground plane having a direct-fed strip cut therefrom, a radio frequency port, a coupled strip cut therefrom, a first edge cut therefrom parallel the direct-fed strip and a second edge cut therefrom adjacent the first edge situated on the dielectric substrate, the first and second edges of the ground plane having a total length of approximately one-quarter wavelength of the lowest resonant frequency of the antenna and forming a conductive resonant edge.

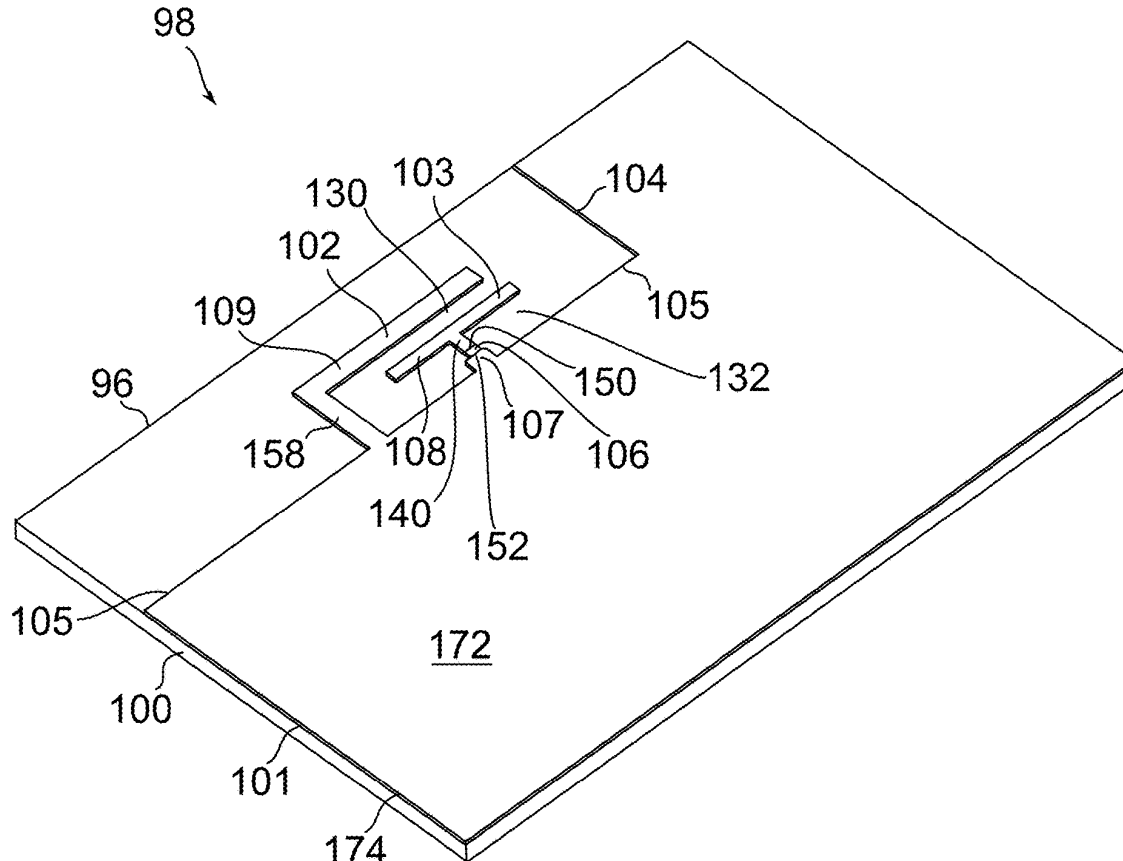
length of approximately one-quarter

17 Claims, 14 Drawing Sheets
(5 of 14 Drawing Sheet(s) Filed in Color)

17 Claims, 14 Drawing Sheets

(5 of 14 Drawing Sheet(s) Filed in Color)

(58) **Field of Classification Search**
CPC H01Q 7/00; H01Q 9/045
See application file for complete search history.





US012183994B2

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

(10) **Patent No.:** **US 12,183,994 B2**
(45) **Date of Patent:** **Dec. 31, 2024**

(54) **ANTENNA STRUCTURE**

(56)

References Cited

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

U.S. PATENT DOCUMENTS

(72) Inventors: **Ying-Cong Deng**, Taoyuan (TW);
Chung-Ting Hung, Taoyuan (TW);
Chin-Lung Tsai, Taoyuan (TW);
Yi-Ling Tseng, Taoyuan (TW);
Yu-Chen Zhao, Taoyuan (TW);
Yi-Chih Lo, Taoyuan (TW)

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(73) Assignee: **QUANTA COMPUTER INC.**,
Taoyuan (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 170 days.

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(21) Appl. No.: **18/153,730**

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(22) Filed: **Jan. 12, 2023**

Primary Examiner — Daniel Munoz

(65) **Prior Publication Data**

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

(30) **Foreign Application Priority Data**

Dec. 7, 2022 (TW) 111146916

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H01Q 5/371 (2015.01)

H01Q 1/48 (2006.01)

H01Q 7/00 (2006.01)

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

CPC **H01Q 7/00** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/371** (2015.01)

(58) **Field of Classification Search**

CPC H01Q 5/364; H01Q 5/371

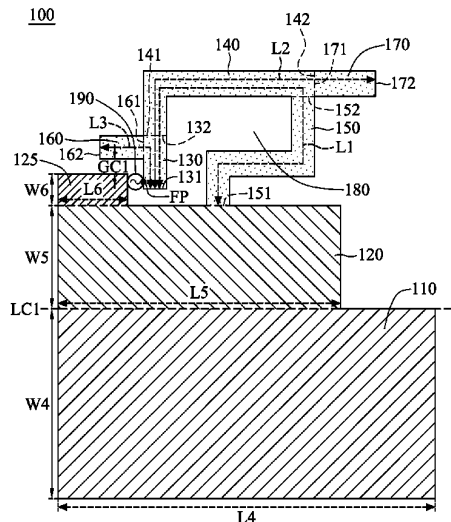
See application file for complete search history.

(57)

ABSTRACT

An antenna structure includes a main ground plane, a protruding ground plane, a feeding radiation element, a connection radiation element, a shorting radiation element, a first radiation element, and a second radiation element. The protruding ground plane is coupled to the main ground plane. The feeding radiation element has a feeding point. The connection radiation element is coupled to the feeding radiation element. The connection radiation element is further coupled through the shorting radiation element to the protruding ground plane. The first radiation element is coupled to the feeding radiation element. The second radiation element is coupled to the connection radiation element. The protruding ground plane further includes an extension portion. The first radiation element is adjacent to the extension portion of the protruding ground plane.

9 Claims, 2 Drawing Sheets





US012183995B2

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

(10) **Patent No.:** **US 12,183,995 B2**
(45) **Date of Patent:** **Dec. 31, 2024**

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

(71) Applicants: **Ta-Hong Cheng**, Taipei (TW);
Yen-Hao Yu, Taipei (TW); **Shih-Chia Liu**, Taipei (TW); **Po-Hsuan Chen**, Taipei (TW); **Jui-Hung Lai**, Taipei (TW)

(72) Inventors: **Ta-Hong Cheng**, Taipei (TW);
Yen-Hao Yu, Taipei (TW); **Shih-Chia Liu**, Taipei (TW); **Po-Hsuan Chen**, Taipei (TW); **Jui-Hung Lai**, Taipei (TW)

(73) Assignee: **COMPAL ELECTRONICS, 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 203 days.

(21) Appl. No.: **17/959,303**

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

(65) **Prior Publication Data**

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Related U.S. Application Data

(60) Provisional application No. 63/257,562, filed on Oct. 19, 2021.

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 1/48 (2006.01)
H01Q 17/00 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 9/0407** (2013.01); **H01Q 1/48** (2013.01); **H01Q 17/00** (2013.01)

(58) **Field of Classification Search**
None

See application file for complete search history.

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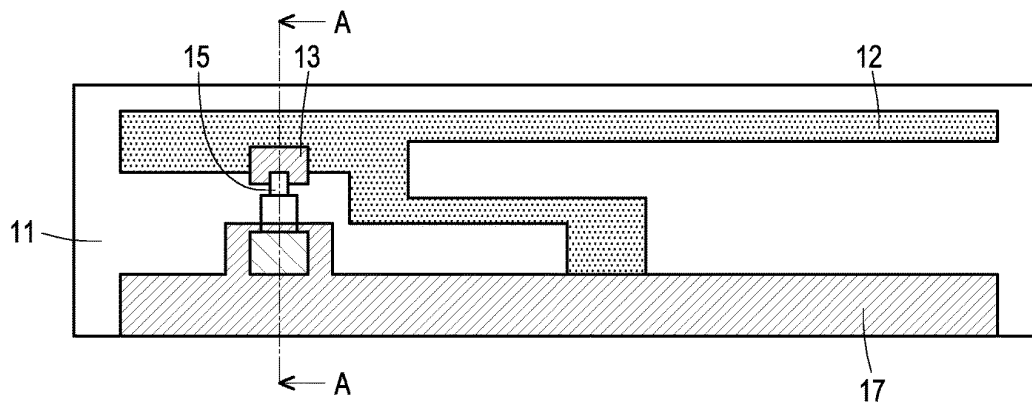
Primary Examiner — Wilson Lee

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

(57) **ABSTRACT**

An antenna structure and an electronic apparatus are provided. The antenna structure includes a substrate, a first radiation part, and a second radiation part. The substrate has a first surface and a second surface opposite to each other. The first radiation part is disposed on the first surface. The first radiation part is an absorber material. The second radiation part is disposed on the second surface. The second radiation part is coupled to a feeding part. There is a distance between the second radiation part and the first radiation part, so as to excite a first resonance mode through the coupling of the second radiation part to the first radiation part. Accordingly, the specific absorption rate (SAR) value of the electromagnetic wave is reduced.

19 Claims, 9 Drawing Sheets





US012183996B2

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

(10) **Patent No.:** **US 12,183,996 B2**
(45) **Date of Patent:** **Dec. 31, 2024**

(54) **ELECTRONIC DEVICE INCLUDING ANTENNA**

(71) Applicant: **Samsung Electronics Co., Ltd.**,
Suwon-si (KR)
(72) Inventors: **Sumin Yun**, Suwon-si (KR);
Soonheung Kwon, Suwon-si (KR);
Hosaeng Kim, Suwon-si (KR);
Hyungjoo Lee, Suwon-si (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 135 days.

(21) Appl. No.: **18/173,337**

(22) Filed: **Feb. 23, 2023**

(65) **Prior Publication Data**
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(63) Continuation of application No. PCT/KR2023/000587, filed on Jan. 12, 2023.

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Feb. 18, 2022 (KR) 10-2022-0021601

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H01Q 1/24 (2006.01)
(52) **U.S. Cl.**
CPC **H01Q 9/0407** (2013.01); **H01Q 1/243** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 9/0407; H01Q 1/243; H01Q 5/25;
H01Q 9/0435; H01Q 21/065; H01Q 25/001

See application file for complete search history.

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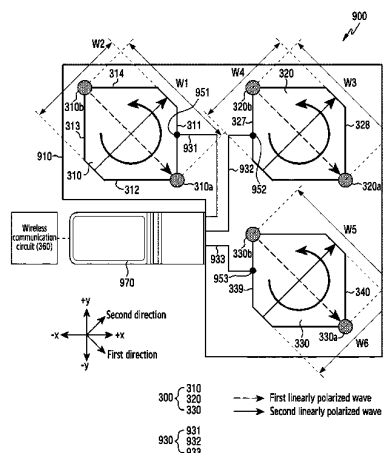
Primary Examiner — Seung H Lee

(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

An electronic device is provided. The electronic device includes a first conductive patch, a second conductive patch, a third conductive patch, and a wireless communication circuit. The first conductive patch includes a first edge facing the second conductive patch, a second edge perpendicularly meeting the first edge at a first corner, a third edge parallel to the first edge, and a fourth edge that is parallel to the second edge and perpendicularly meets the third edge at a second corner. The second conductive patch and the third conductive patch each have a shape identical to that of the first conductive patch. The wireless communication circuit feed power to a first point of the first edge, a second point of a fifth edge of the second conductive patch, and a third point of a sixth edge of the third conductive patch.

20 Claims, 22 Drawing Sheets





US012184312B2

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

(10) **Patent No.:** **US 12,184,312 B2**
(45) **Date of Patent:** ***Dec. 31, 2024**

(54) **ANTENNA BANDWIDTH ENHANCEMENT
FOR AN ELECTRONIC DEVICE**

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

(72) Inventors: **Simon Svendsen**, Aalborg (DK); **Ole Jagielski**, Viborg (DK)

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

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

This patent is subject to a terminal dis-
claimer.

(21) Appl. No.: **18/492,951**

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

(65) **Prior Publication Data**

US 2024/0154631 A1 May 9, 2024

Related U.S. Application Data

(63) Continuation of application No. 16/926,971, filed on
Jul. 13, 2020, now Pat. No. 11,799,505, which is a
(Continued)

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/38 (2006.01)
H01Q 5/321 (2015.01)
H01Q 5/335 (2015.01)
H01Q 5/50 (2015.01)
H01Q 9/30 (2006.01)

(Continued)

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

CPC **H04B 1/0064** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 1/38** (2013.01); **H01Q 5/321**
(2015.01); **H01Q 5/335** (2015.01); **H01Q 5/50**
(2015.01); **H01Q 9/30** (2013.01); **H01Q 21/28**
(2013.01); **H04B 1/3888** (2013.01); **H04B**
1/401 (2013.01)

(58) **Field of Classification Search**

CPC **H04B 1/0064**; **H04B 1/3888**; **H04B 1/401**;
H01Q 1/243; **H01Q 1/38**; **H01Q 5/321**;
H01Q 5/335; **H01Q 5/50**; **H01Q 9/30**;
H01Q 21/28

See application file for complete search history.

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Primary Examiner — Hai V Tran

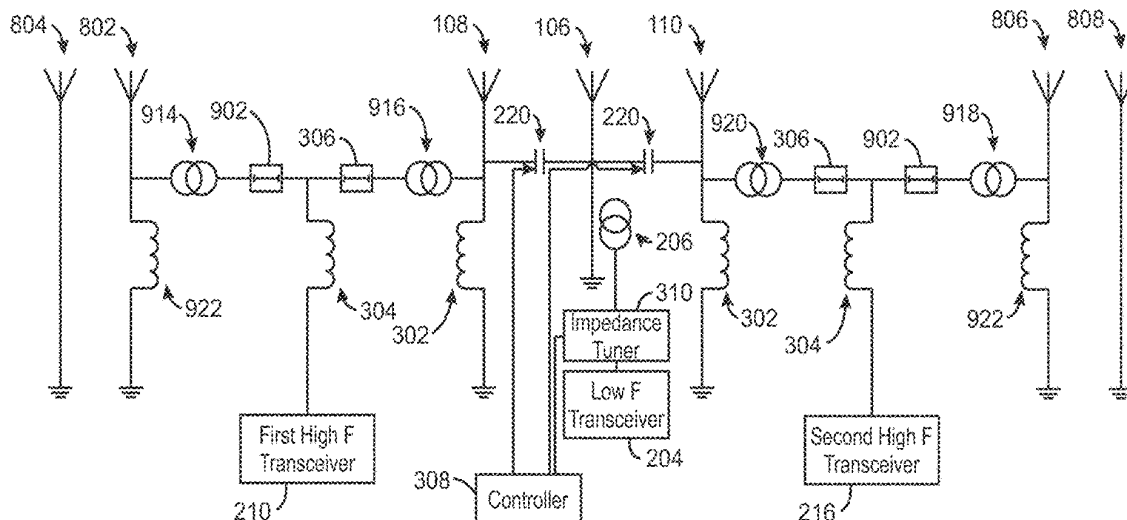
Assistant Examiner — Michael M Bouizza

(74) *Attorney, Agent, or Firm* — Banner & Witcoff Ltd.

(57) **ABSTRACT**

Techniques are disclosed for configuring a broadband antenna system. An example electronic device includes a first antenna operating at a first frequency range and coupled to a first transceiver via a first signal path comprising a first indirect feed. The electronic device also includes a second antenna operating at a second frequency range and coupled to a second transceiver via a second signal path comprising a second indirect feed, wherein the first frequency range is lower than the first frequency range. The electronic device also includes a third antenna operating at the second frequency range and coupled to a third transceiver via a second signal path comprising a third indirect feed. Additionally, the first antenna is coupled to the first antenna and the second antenna by a capacitive coupling element.

31 Claims, 14 Drawing Sheets





US012185253B2

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

(10) **Patent No.:** **US 12,185,253 B2**
(45) **Date of Patent:** **Dec. 31, 2024**

(54) **ELECTRONIC DEVICE AND METHOD FOR ADJUSTING OUTPUT POWER OF RADIO FREQUENCY SIGNAL TO BE OUTPUT TO ANTENNA**

(56) **References Cited**

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

(72) Inventors: **Byunggil Jeon**, Gyeonggi-do (KR);
Jongbok Jang, Gyeonggi-do (KR);
Eunsik Jang, Gyeonggi-do (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 358 days.

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Primary Examiner — Myron Wyche

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

(21) Appl. No.: **17/743,883**

(22) Filed: **May 13, 2022**

(65) **Prior Publication Data**

US 2022/0369234 A1 Nov. 17, 2022

Related U.S. Application Data

(63) Continuation of application No.
PCT/KR2022/003476, filed on Mar. 11, 2022.

(30) **Foreign Application Priority Data**

May 17, 2021 (KR) 10-2021-0063513

(51) **Int. Cl.**
H04W 52/06 (2009.01)
H04B 1/04 (2006.01)

(Continued)

(52) **U.S. Cl.**
CPC **H04W 52/06** (2013.01); **H04B 1/04**
(2013.01); **H04B 17/102** (2015.01); **H04B**
17/13 (2015.01); **H04B 2001/0408** (2013.01)

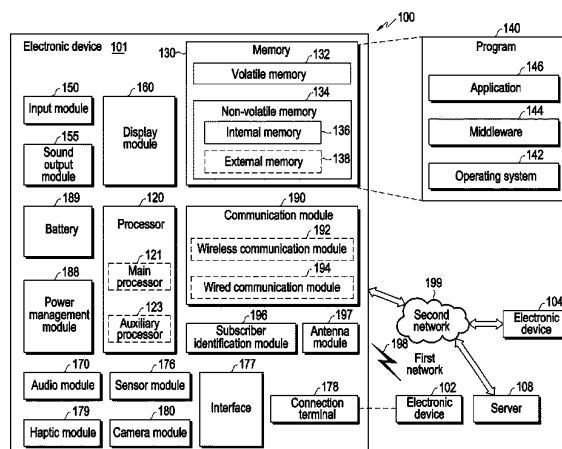
(58) **Field of Classification Search**
CPC H04W 52/06; H01Q 1/50; H04B 1/04;
H04B 17/13; H04B 17/102

See application file for complete search history.

(57) **ABSTRACT**

A method and electronic device are provided for adjusting an output power of an RF signal to be output to an antenna, based on a proximity of an object and a shape (or configuration) of the electronic device. The electronic device may include a proximity sensor, an antenna corresponding to the proximity sensor, a power amplifier corresponding to the antenna, and a processor configured to control the power amplifier to output a first RF signal having a first output power to the antenna, identify the antenna corresponding to the proximity sensor, based on proximity of an object being detected by the proximity sensor, identify, using a power table configured for the antenna, a second output power corresponding to a shape of the electronic device and the proximity of the object being detected, wherein the second output power is different from the first output power, and control the power amplifier to output a second RF signal having the second output power, to the antenna.

12 Claims, 5 Drawing Sheets





US012191568B2

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

(10) **Patent No.:** **US 12,191,568 B2**
(45) **Date of Patent:** **Jan. 7, 2025**

(54) **SLOT ANTENNAS FOR ELECTRONIC USER DEVICES AND RELATED METHODS**

1/1616 (2013.01); *G06F 1/1662* (2013.01);
H01Q 1/243 (2013.01); *H01Q 5/15* (2015.01);
H01Q 13/16 (2013.01)

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

(58) **Field of Classification Search**

CPC *H01Q 13/10*; *H01Q 1/2266*; *H01Q 1/44*;
H01Q 5/00; *H01Q 21/064*; *H01Q 1/213*
See application file for complete search history.

(72) Inventors: **Jayprakash Thakur**, Bangalore (IN);
Prakash Kurma Raju, Bangalore (IN);
Gustavo Fricke, San Jose, CA (US)

(56) **References Cited**

(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 273 days.

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(21) Appl. No.: **17/732,895**

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

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(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. 16/716,919, filed on Dec. 17, 2019, now Pat. No. 11,322,849.

Primary Examiner — Joseph J Lauture

(74) Attorney, Agent, or Firm — Hanley, Flight & Zimmerman, LLC

(51) **Int. Cl.**

<i>H01Q 13/10</i>	(2006.01)
<i>H01Q 1/22</i>	(2006.01)
<i>H01Q 1/44</i>	(2006.01)
<i>H01Q 5/00</i>	(2015.01)
<i>H01Q 21/06</i>	(2006.01)
<i>G06F 1/16</i>	(2006.01)
<i>H01Q 1/24</i>	(2006.01)
<i>H01Q 5/15</i>	(2015.01)
<i>H01Q 13/16</i>	(2006.01)

(57)

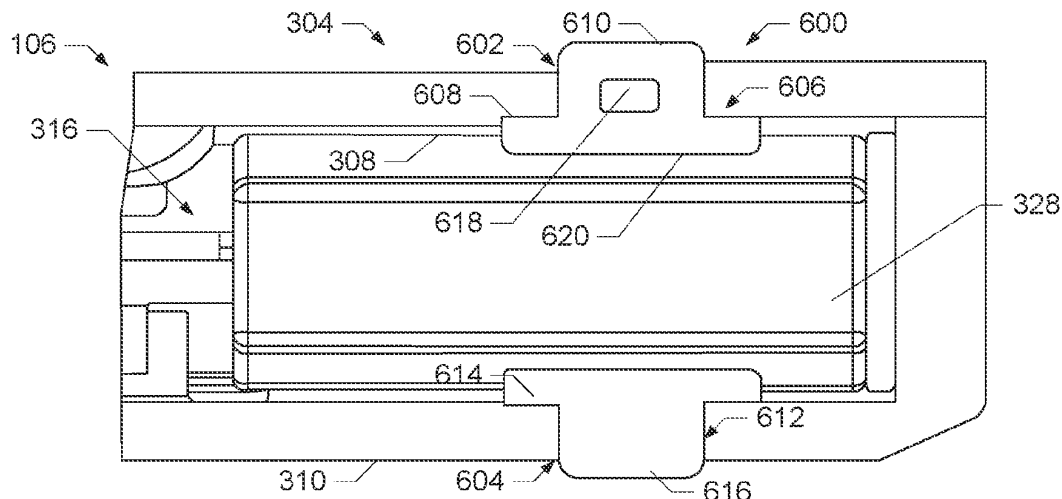
ABSTRACT

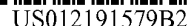
Example slot antennas for electronic user device and related methods are disclosed herein. An example electronic user device includes a first housing; a second housing rotatably coupled to the first housing; a display screen carried by the second housing; a dual-band antenna carried by the second housing; and a bezel about the display screen, the bezel to cover the dual-band antenna.

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

CPC *H01Q 13/10* (2013.01); *H01Q 1/2266* (2013.01); *H01Q 1/44* (2013.01); *H01Q 5/00* (2013.01); *H01Q 21/064* (2013.01); *G06F*

20 Claims, 10 Drawing Sheets







US012191583B2

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

(10) **Patent No.:** **US 12,191,583 B2**
(45) **Date of Patent:** **Jan. 7, 2025**

(54) **ELECTRONIC DEVICE INCLUDING ANTENNA**

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

(72) Inventors: **Kyoungmok Kim**, Suwon-si (KR); **Sungjun Lee**, Suwon-si (KR); **Sanggon Shin**, Suwon-si (KR); **Oleg Feygenson**, Suwon-si (KR); **Chaup Yoo**, Suwon-si (KR); **Soonho Hwang**, 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 182 days.

(21) Appl. No.: **18/086,070**

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

(65) **Prior Publication Data**
US 2023/0170618 A1 Jun. 1, 2023

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2022/018403, filed on Nov. 21, 2022.

(30) **Foreign Application Priority Data**

Nov. 29, 2021 (KR) 10-2021-0167271
Jan. 26, 2022 (KR) 10-2022-0011766

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

(Continued)

(52) **U.S. Cl.**
CPC **H01Q 9/0442** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/328** (2015.01)

(58) **Field of Classification Search**

CPC .. H01Q 1/24; H01Q 1/38; H01Q 1/46; H01Q 1/48; H01Q 1/243; H01Q 5/328;
(Continued)

(56) **References Cited**

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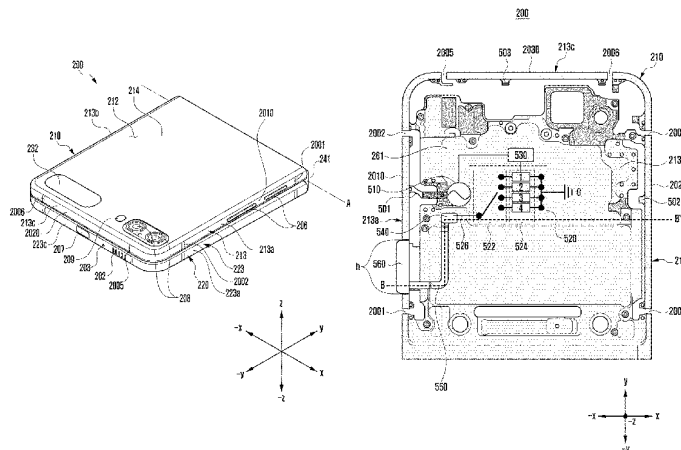
Primary Examiner — Tung X Le

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

(57) **ABSTRACT**

An electronic device may include a housing including a first side surface, a first conductive portion disposed between at least a first segmenting portion and a second segmenting portion formed in the first side surface, and including a first feeding point, a printed circuit board disposed inside the housing and including a ground, a first electronic component disposed adjacent to the first conductive portion, a first conductive connection member electrically connected to the first electronic component, a first wireless communication circuit electrically connected to the first feeding point, a processor electrically connected to the first wireless communication circuit, and a matching circuit electrically connected to the first conductive connection member and the ground, and configured to electrically connect or disconnect the first conductive connection member and the ground

(Continued)





US012191585B2

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

(10) **Patent No.:** **US 12,191,585 B2**
(45) **Date of Patent:** **Jan. 7, 2025**

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

(71) Applicants: **DONGWOO FINE-CHEM CO.,
LTD.**, Jeollabuk-do (KR); **POSTECH
RESEARCH AND BUSINESS
DEVELOPMENT FOUNDATION**,
Gyeongsangbuk-do (KR)

(72) Inventors: **Byung Jin Choi**, Incheon (KR); **Ho
Dong Yoon**, Gyeonggi-do (KR); **Won
Hee Lee**, Incheon (KR); **Won Bin
Hong**, Seoul (KR)

(73) Assignees: **DONGWOO FINE-CHEM CO.,
LTD.**, Jeollabuk-Do (KR); **POSTECH
RESEARCH AND BUSINESS
DEVELOPMENT FOUNDATION**,
Gyeongsangbuk-Do (KR)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 42 days.

(21) Appl. No.: **17/981,580**

(22) Filed: **Nov. 7, 2022**

(65) **Prior Publication Data**
US 2023/0058014 A1 Feb. 23, 2023

Related U.S. Application Data
(63) Continuation of application No.
PCT/KR2021/005637, filed on May 6, 2021.

(30) **Foreign Application Priority Data**
May 7, 2020 (KR) 10-2020-0054546

(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); **H01Q 1/48** (2013.01); **H01Q 21/08**
(2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/242; H01Q 1/243; H01Q 1/364;
H01Q 1/48; H01Q 1/50; H01Q 1/521;
(Continued)

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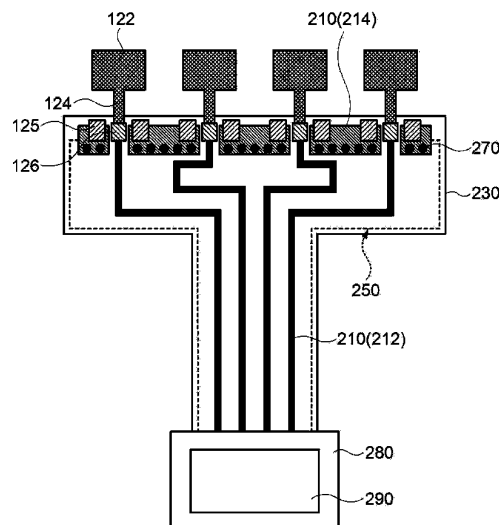
Primary Examiner — Hoang V Nguyen

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

(57) **ABSTRACT**

An antenna package according to an embodiment includes
an antenna unit, and a circuit board electrically connected to
the antenna unit. The circuit board may include a core layer,
a signal transmission wiring disposed on one surface of the
core layer, the signal transmission wiring having one end
portion connected to the antenna unit, a ground layer dis-
posed on an opposite surface facing the one surface of the
core layer, and a first via structure formed through the core
layer and arranged around the one end portion of the signal
transmission wiring to be in contact with the ground layer.

15 Claims, 6 Drawing Sheets





US012199327B2

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

(10) **Patent No.:** **US 12,199,327 B2**
(45) **Date of Patent:** **Jan. 14, 2025**

(54) **POWER DIVIDER AND BASE STATION ANTENNA**

- (71) Applicant: **Outdoor Wireless Networks LLC**,
Claremont, NC (US)
- (72) Inventors: **Jianpeng Lu**, Suzhou (CN); **Changfu Chen**, Suzhou (CN); **Fei Li**, Suzhou (CN)
- (73) Assignee: **Outdoor Wireless Networks LLC**,
Claremont, NC (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 301 days.

(21) Appl. No.: **17/813,705**

(22) Filed: **Jul. 20, 2022**

(65) **Prior Publication Data**
US 2023/0059701 A1 Feb. 23, 2023

(30) **Foreign Application Priority Data**
Aug. 20, 2021 (CN) 202110958676.1

- (51) **Int. Cl.**
H01P 5/16 (2006.01)
H01P 3/08 (2006.01)
H04B 1/04 (2006.01)
- (52) **U.S. Cl.**
CPC **H01P 5/16** (2013.01); **H01P 3/08** (2013.01); **H04B 1/04** (2013.01)
- (58) **Field of Classification Search**
CPC H01P 5/16; H01P 3/08; H04B 1/04
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Andrea Lindgren Baltzell

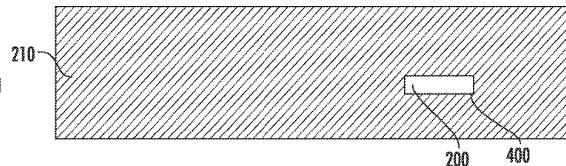
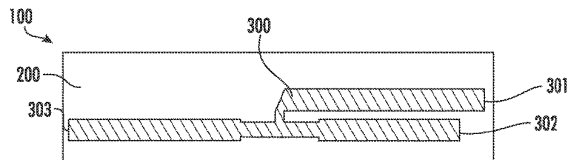
Assistant Examiner — Timothy F. Bardo

(74) *Attorney, Agent, or Firm* — Myers Bigel, P.A.

(57) **ABSTRACT**

A power divider includes: a dielectric substrate; a transmission line circuit on a first surface of the dielectric substrate, the transmission line circuit including an input trace, a first output trace and a second output trace. The transmission line circuit is configured to split a signal received at the input trace into a first sub-component that is output on the first output trace and a second sub-component that is output on the second output trace; and a reference potential layer, set on a second surface opposite the first surface of the dielectric substrate, where the reference potential layer is provided with a decoupling window that exposes a part of the dielectric substrate to reduce coupling in the transmission line circuit.

20 Claims, 5 Drawing Sheets





US012199334B2

(12) **United States Patent**
Chen

(10) **Patent No.:** **US 12,199,334 B2**
(45) **Date of Patent:** **Jan. 14, 2025**

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

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

(72) Inventor: **Jia Chen**, Dongguan (CN)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 216 days.

(21) Appl. No.: **17/965,572**

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

(65) **Prior Publication Data**

US 2023/0030798 A1 Feb. 2, 2023

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2021/085810, filed on Apr. 7, 2021.

(30) **Foreign Application Priority Data**

Apr. 13, 2020 (CN) 202010283862.5

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 9/04 (2006.01)
H01Q 19/10 (2006.01)
H01Q 21/08 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/24** (2013.01); **H01Q 9/0414** (2013.01); **H01Q 19/10** (2013.01); **H01Q 21/08** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/24; H01Q 19/10; H01Q 21/08;
H01Q 21/28; H01Q 9/0407; H01Q
9/0414

See application file for complete search history.

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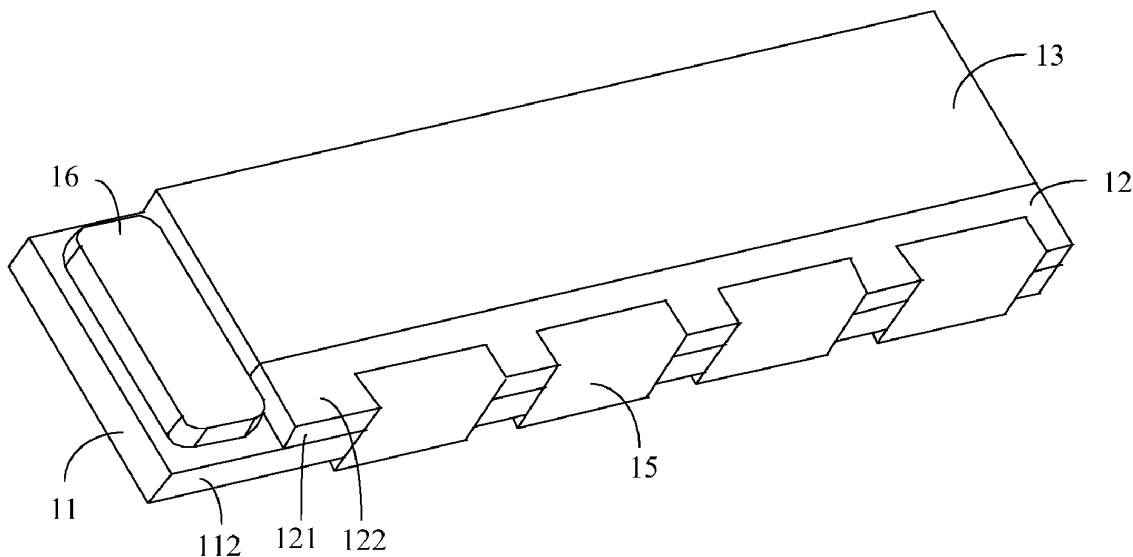
Primary Examiner — Thien M Le

(74) *Attorney, Agent, or Firm* — The Webb Law Firm

(57) **ABSTRACT**

An antenna module includes a first substrate, a second substrate, and a signal processing chip. The second substrate and the signal processing chip are located on a same side of the first substrate. A side of the first substrate that faces away from the second substrate is provided with a first antenna array, and the second substrate bears a second antenna array.

16 Claims, 3 Drawing Sheets





US012199335B2

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

(10) **Patent No.:** **US 12,199,335 B2**
(45) **Date of Patent:** **Jan. 14, 2025**

(54) **ELECTRONIC DEVICE COMPRISING AN ANTENNA**

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

(72) Inventors: **Youngjoon Lim**, Suwon-si (KR);
Haeyeon Kim, Suwon-si (KR); **Shinho Yoon**, Suwon-si (KR); **Soonho Hwang**,
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 117 days.

(21) Appl. No.: **17/994,147**

(22) Filed: **Nov. 25, 2022**

(65) **Prior Publication Data**

US 2023/0092046 A1 Mar. 23, 2023

Related U.S. Application Data

(63) Continuation of application No.
PCT/KR2022/008563, filed on Jun. 16, 2022.

(30) **Foreign Application Priority Data**

Jun. 16, 2021 (KR) 10-2021-0078157

(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 1/24**
(2013.01); **H01Q 1/42** (2013.01); **H01Q 1/422**
(2013.01); **H01Q 9/0407** (2013.01); **H01Q**
21/08 (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 1/24; H01Q 1/422;
H01Q 1/42; H01Q 21/08; H01Q 9/0407
See application file for complete search history.

(56) **References Cited**

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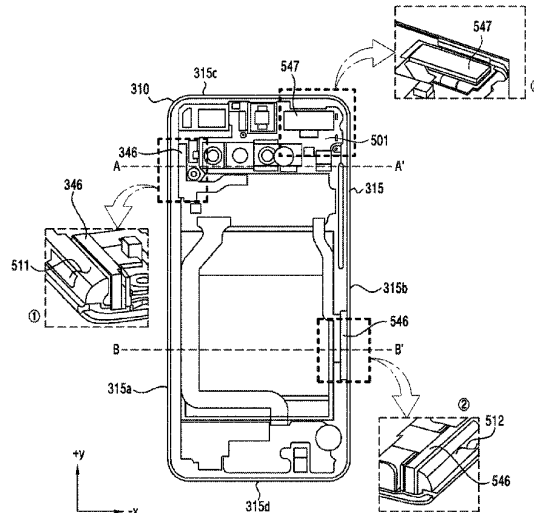
Primary Examiner — Hai V Tran

(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

An electronic device is provided. The electronic device includes a first frame, a first opening formed in a first area of the first frame, a first antenna module, a cover that includes a first dielectric material and a second dielectric material and is disposed in the first area of the first frame, and a first wireless communication circuit. The first dielectric material includes an engagement groove, and the second dielectric material includes a protrusion corresponding to the engagement groove. The first dielectric material and the second dielectric material may come into contact as the protrusion of the second dielectric material engages with the engagement groove of the first dielectric material.

20 Claims, 20 Drawing Sheets





US012199341B2

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

(10) **Patent No.:** **US 12,199,341 B2**
(45) **Date of Patent:** **Jan. 14, 2025**

(54) **ANTENNA DEVICE**

(71) Applicant: **TMY Technology Inc.**, Taipei (TW)

(72) Inventors: **Chun-Cheng Chan**, Taipei (TW);
Jiun-Wei Wu, Taipei (TW); **Su-Wei Chang**, Taipei (TW)

(73) Assignee: **TMY Technology Inc.**, New Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 156 days.

(21) Appl. No.: **17/893,188**

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

(65) **Prior Publication Data**
US 2023/0223682 A1 Jul. 13, 2023

Related U.S. Application Data

(60) Provisional application No. 63/298,188, filed on Jan. 10, 2022.

(30) **Foreign Application Priority Data**
Jun. 7, 2022 (TW) 111121098

(51) **Int. Cl.**
H01Q 1/50 (2006.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/50** (2013.01); **H01Q 9/0414** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/38; H01Q 1/50; H01Q 9/0414; H01Q 9/28
See application file for complete search history.

(56) **References Cited**

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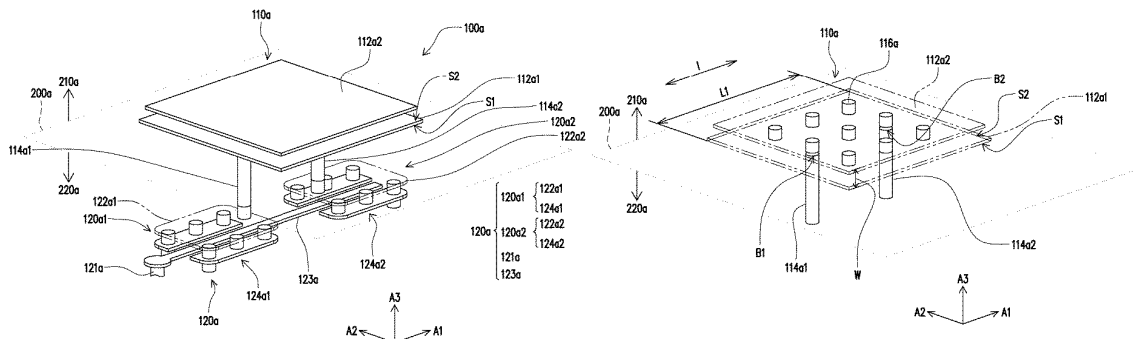
Primary Examiner — Thien M Le

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

(57) **ABSTRACT**

An antenna device includes a differential antenna and a first balun. The differential antenna includes a first radiator, a first antenna port and a second antenna port connected to a first surface of the first radiator. Orthographic projections of the first antenna port and the second antenna port projected to the first radiator are symmetrical to a midpoint of the first radiator. The first balun is located on one side of the first surface of the first radiator, and its orthographic projection on the first plane where the first surface is located overlaps the first surface. The first balun includes a first port, a first wiring, a first coupling structure electrically connected to the first antenna port, and a second coupling structure electrically connected to the second antenna port. Neither the first coupling structure nor the second coupling structure directly contacts the first wiring.

17 Claims, 27 Drawing Sheets





US012199344B2

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

(10) **Patent No.:** **US 12,199,344 B2**
(45) **Date of Patent:** **Jan. 14, 2025**

(54) **ANTENNA MODULE**

(71) Applicant: **AMONSENSE CO., LTD.**, Cheonan-si (KR)

(72) Inventors: **Hongdae Jung**, Cheonan-si (KR); **Scho Lee**, Cheonan-si (KR); **Kyunghyun Ryu**, Cheonan-si (KR); **Hyungil Baek**, Cheonan-si (KR)

(73) Assignee: **AMONSENSE CO., LTD.**, Cheonan-si (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 259 days.

(21) Appl. No.: **17/778,099**

(22) PCT Filed: **Nov. 12, 2020**

(86) PCT No.: **PCT/KR2020/015878**

§ 371 (c)(1),

(2) Date: **May 19, 2022**

(87) PCT Pub. No.: **WO2021/107468**

PCT Pub. Date: **Jun. 3, 2021**

(65) **Prior Publication Data**

US 2023/0026240 A1 Jan. 26, 2023

(30) **Foreign Application Priority Data**

Nov. 29, 2019 (KR) 10-2019-0156912

(51) **Int. Cl.**
H01Q 5/30 (2015.01)
H01Q 13/10 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 13/10** (2013.01); **H01Q 5/30** (2015.01)

(58) **Field of Classification Search**

CPC H01Q 13/10; H01Q 5/30; H01Q 5/364; H01Q 9/0421

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

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Primary Examiner — Hai V Tran

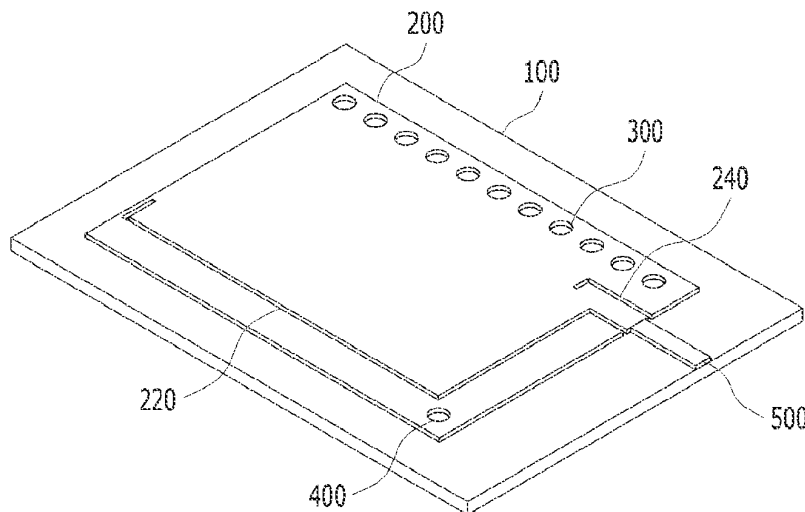
Assistant Examiner — Bamidele A Immanuel

(74) *Attorney, Agent, or Firm* — Maschoff Brennan

(57) **ABSTRACT**

An antenna module is proposed in which a slit and a through-hole for grounding are additionally formed in a single radiator such that the antenna module resonates in two frequency bands or expands the bandwidth around a reference resonant frequency. The proposed antenna module includes a radiator having a first slit, and the radiator is divided into a first region and a second region with respect to the first slit, wherein a plurality of first through-holes and a second slit are formed in the first region, a second through-hole is formed in the second region, and a power feeding pattern is connected to a region between the first slit and the second slit in the first region.

6 Claims, 4 Drawing Sheets





US012199353B2

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

(10) **Patent No.:** **US 12,199,353 B2**
(45) **Date of Patent:** ***Jan. 14, 2025**

(54) **MULTI-BAND ANTENNA AND MOBILE
TERMINAL**

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

(72) Inventors: **Liang Xue**, Shanghai (CN); **Dong Yu**,
Shanghai (CN); **Lijun Ying**, Shanghai
(CN); **Meng Hou**, Shanghai (CN);
Jiaqing You, Shanghai (CN)

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

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

This patent is subject to a terminal dis-
claimer.

(21) Appl. No.: **18/181,296**

(22) Filed: **Mar. 9, 2023**

(65) **Prior Publication Data**

US 2023/0216196 A1 Jul. 6, 2023

Related U.S. Application Data

(63) Continuation of application No. 16/957,492, filed as
application No. PCT/CN2018/124026 on Dec. 26,
2018, now Pat. No. 11,626,662.

(30) **Foreign Application Priority Data**

Dec. 28, 2017 (WO) PCT/CN2017/119444

(51) **Int. Cl.**
H01Q 5/25 (2015.01)

H01Q 5/335 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 5/335** (2015.01); **H01Q 5/25**
(2015.01)

(58) **Field of Classification Search**

CPC H01Q 5/335; H01Q 5/25; H01Q 1/44;
H01Q 1/52; H01Q 5/392; H01Q 9/42;
(Continued)

(56) **References Cited**

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Primary Examiner — Hai V Tran

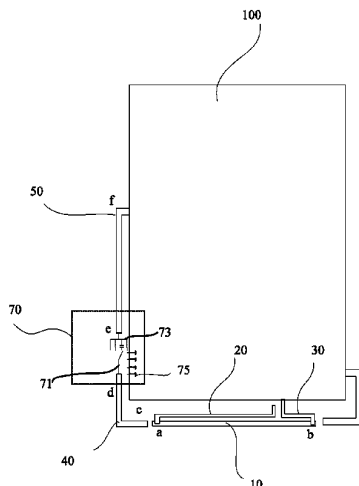
Assistant Examiner — Michael M Bouizza

(74) *Attorney, Agent, or Firm* — Rimon PC

(57) **ABSTRACT**

This application provides a multi-band antenna. The antenna
includes a feeder and a radiating element connected to the
feeder, and further includes: a first notch structure, where the
first notch structure is located on a side of the radiating
element and is coupled to the radiating element; and a
second notch structure, where the second notch structure is
located on a far side of the first notch structure from the
radiating element, and a far end of the second notch structure
from the radiating element is grounded. The first notch
structure may be selectively connected to the ground or to
the second notch structure.

18 Claims, 13 Drawing Sheets





US012199355B2

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

(10) **Patent No.:** **US 12,199,355 B2**
(45) **Date of Patent:** **Jan. 14, 2025**

(54) **ANTENNA FOR USE IN A RADIO COMMUNICATION TERMINAL**

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

(72) Inventors: **Kun Zhao**, Malmö (SE); **Zhinong Ying**, Lund (SE)

(73) Assignee: **Sony Group Corporation**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 88 days.

(21) Appl. No.: **17/642,192**

(22) PCT Filed: **Jun. 30, 2020**

(86) PCT No.: **PCT/EP2020/068428**

§ 371 (c)(1),

(2) Date: **Mar. 10, 2022**

(87) PCT Pub. No.: **WO2021/058153**

PCT Pub. Date: **Apr. 1, 2021**

(65) **Prior Publication Data**

US 2022/0302591 A1 Sep. 22, 2022

(30) **Foreign Application Priority Data**

Sep. 27, 2019 (SE) 1951096-5

(51) **Int. Cl.**

H01Q 5/40 (2015.01)

H01Q 1/24 (2006.01)

H01Q 1/48 (2006.01)

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

CPC **H01Q 5/40** (2015.01); **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/48; H01Q 1/243; H01Q 5/40
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Ricardo I Magallanes

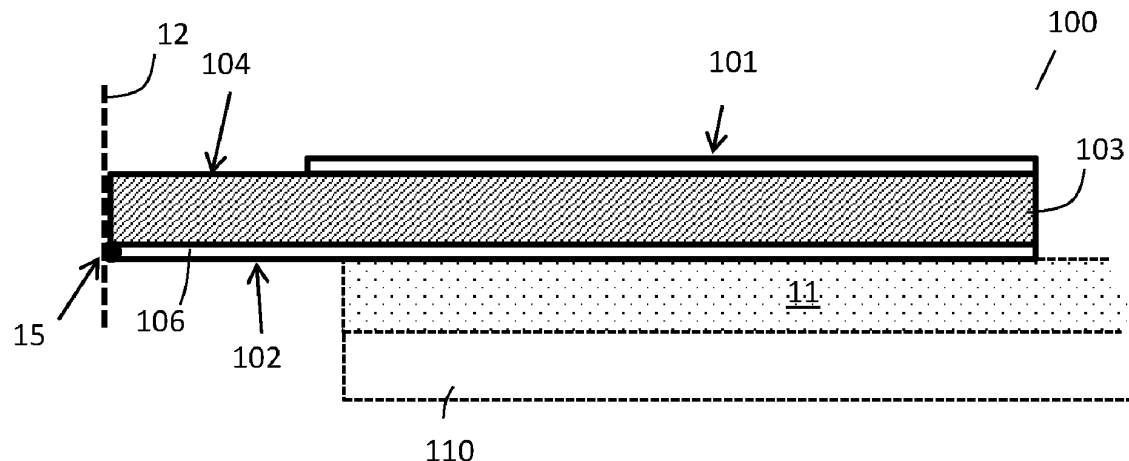
Assistant Examiner — Jordan E. DeWitt

(74) *Attorney, Agent, or Firm* — Tucker Ellis LLP

(57) **ABSTRACT**

Antenna (1), for use in a wireless terminal including a ground plane (11) and a metal frame (12) encompassing the ground plane with a gap (13) between the metal frame and the ground plane; wherein said antenna is configured to form a grounding connection (15) between the ground plane and the metal frame for operation in a first frequency range (FR1); and wherein the antenna comprises an open cavity structure (100) for a second frequency range (FR2).

19 Claims, 9 Drawing Sheets





US012199363B2

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

(10) **Patent No.:** **US 12,199,363 B2**
(45) **Date of Patent:** **Jan. 14, 2025**

(54) **ANTENNA MODULE**
(71) Applicant: **TDK Corporation**, Tokyo (JP)
(72) Inventors: **Yasuyuki Hara**, Tokyo (JP); **Yuta Ashida**, Tokyo (JP)
(73) Assignee: **TDK Corporation**, Tokyo (JP)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 149 days.

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(21) Appl. No.: **17/900,155**

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

(65) **Prior Publication Data**
US 2023/0060223 A1 Mar. 2, 2023

(30) **Foreign Application Priority Data**
Sep. 1, 2021 (JP) 2021-142392

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
(52) **U.S. Cl.**
CPC **H01Q 9/045** (2013.01); **H01Q 9/0414** (2013.01)

(58) **Field of Classification Search**
CPC H01P 1/203; H01Q 21/065; H01Q 21/24;
H01Q 9/0414; H01Q 9/045; H01Q 9/0457
See application file for complete search history.

(56) **References Cited**

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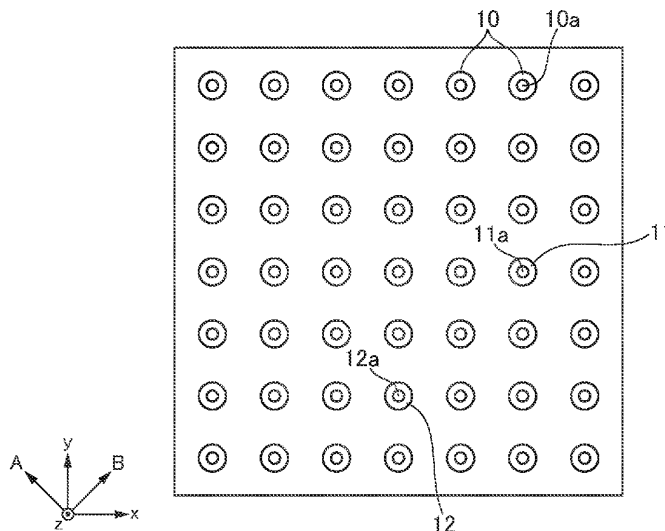
JP 2020-057920 A 4/2020
JP 2020-088493 A 6/2020
WO 2019/054063 A1 9/2020

Primary Examiner — Thien M Le
(74) *Attorney, Agent, or Firm* — Rimon P.C.

(57) **ABSTRACT**

An antenna module includes first and second signal pads, an antenna element, and first and second filters. The first signal pad is coupled to the antenna element through the first to fourth conductor patterns of the first filter. The second signal pad is coupled to the antenna element through the fifth to eighth conductor patterns of the first filter. The second, third, sixth and seventh conductor patterns extend along the diagonal line of the antenna element. The second and sixth conductor patterns face each other with the diagonal line interposed therebetween. The third and seventh conductor patterns face each other with the diagonal line interposed therebetween. The first, fourth, fifth and eighth conductor patterns extend in the second direction, respectively with respect to the second, third, sixth and seventh conductor patterns.

8 Claims, 5 Drawing Sheets





US012199654B2

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

(10) **Patent No.:** **US 12,199,654 B2**
(45) **Date of Patent:** **Jan. 14, 2025**

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

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

(72) Inventors: **Shinho Yoon**, Gyeonggi-do (KR);
Taeyoon Seo, Gyeonggi-do (KR);
Myeongjun Kong, Gyeonggi-do (KR);
Taeik Kim, Gyeonggi-do (KR); **Donjun**
Oh, Gyeonggi-do (KR); **Soonho**
Hwang, Gyeonggi-do (KR)

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

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 333 days.

(21) Appl. No.: **17/721,581**

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

(65) **Prior Publication Data**
US 2022/0329278 A1 Oct. 13, 2022

Related U.S. Application Data
(63) Continuation of application No.
PCT/KR2022/005184, filed on Apr. 11, 2022.

(30) **Foreign Application Priority Data**
Apr. 12, 2021 (KR) 10-2021-0047267

(51) **Int. Cl.**
H04B 1/38 (2015.01)
H04B 1/3827 (2015.01)

(52) **U.S. Cl.**
CPC **H04B 1/3838** (2013.01)

(58) **Field of Classification Search**
CPC .. G09F 9/30; G09F 9/301; H01Q 1/24; H01Q
1/243; H01Q 1/38; H04B 1/005; H04B
1/3838; H04B 7/0408

See application file for complete search history.

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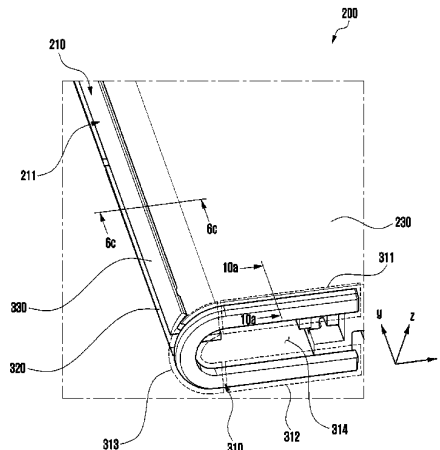
Primary Examiner — Siu M Lee

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

(57) **ABSTRACT**

An antenna and an electronic device including the same are provided. The electronic device includes a first housing including a first conductive portion through a portion of a side surface and including a first space, a second housing slidable along a first direction from the first housing, a flexible display including at least a partially variable display area when transitioning from a slide-in state to a slide-out state, and a wireless communication circuit disposed in the first space and configured to transmit or receive a wireless signal in a frequency band through the first conductive portion. The first conductive portion includes a first portion having a first length along the first direction, a second portion spaced apart from the first portion at a predetermined interval and having a second length in the first direction, and a third portion connecting to a first end of the first portion and a first end of the second portion. The frequency band is determined based on a third length extending from the first portion, through the third portion, to the second portion.

17 Claims, 31 Drawing Sheets





US012200152B2

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

(10) **Patent No.:** **US 12,200,152 B2**
(45) **Date of Patent:** **Jan. 14, 2025**

(54) **ELECTRONIC DEVICE HAVING ANTENNAS**

(56) **References Cited**

(71) Applicant: **LG ELECTRONICS INC.**, Seoul (KR)

U.S. PATENT DOCUMENTS

(72) Inventors: **Dongjin Kim**, Seoul (KR); **Youngebae Kwon**, Seoul (KR); **Sungwon Kim**, Seoul (KR); **Byungwoon Jung**, Seoul (KR); **Jihun Ha**, Seoul (KR)

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(73) Assignee: **LG ELECTRONICS INC.**, Seoul (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 0 days.

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(21) Appl. No.: **18/556,637**

PCT International Application No. PCT/KR2021/004997, International Search Report dated Jan. 14, 2022, 2 pages.

(22) PCT Filed: **Apr. 21, 2021**

(Continued)

(86) PCT No.: **PCT/KR2021/004997**

§ 371 (c)(1),
(2) Date: **Oct. 20, 2023**

Primary Examiner — Yuwen Pan

Assistant Examiner — Fatuma G Sherif

(87) PCT Pub. No.: **WO2022/225079**

(74) Attorney, Agent, or Firm — LEE, HONG,
DEGERMAN, KANG & WAIMEY

PCT Pub. Date: **Oct. 27, 2022**

(57) **ABSTRACT**

(65) **Prior Publication Data**

US 2024/0267444 A1 Aug. 8, 2024

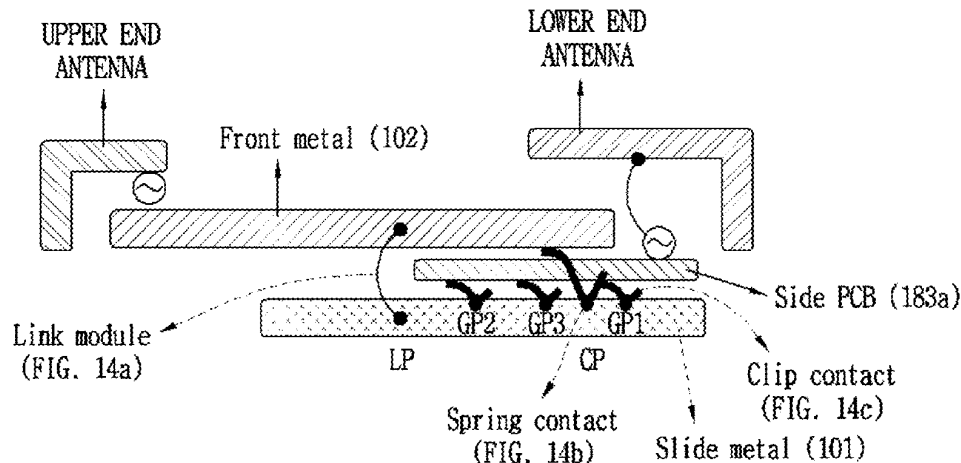
Provided is a mobile terminal changing in size according to one embodiment. The mobile terminal comprises: a slide metal part; a front metal part formed to be coupled to the slide metal part; and a coupling link formed to couple the slide metal part and the front metal part in a folded state or an extended state. A plurality of antennas are disposed on the left surface, the right surface and the lower surface of the slide metal part, and at least one surface of the slide metal part is ground-connected to a PCB, which is accommodated in the slide metal part, at a plurality of points, and thus a difference in the lengths of ground paths is reduced in accordance with a relative movement to reduce a change in antenna performance of the plurality of antennas due to the relative movement.

(51) **Int. Cl.**
H04M 1/02 (2006.01)
H01Q 1/24 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H04M 1/0235** (2013.01); **H01Q 1/243** (2013.01); **H01Q 21/28** (2013.01); **H04B 1/401** (2013.01); **H04M 1/0249** (2013.01)

(58) **Field of Classification Search**
CPC .. H04M 1/0235; H04M 1/0249; H01Q 1/243; H01Q 21/28; H04B 1/401
See application file for complete search history.

20 Claims, 44 Drawing Sheets





US012200866B2

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

(10) **Patent No.:** **US 12,200,866 B2**
(45) **Date of Patent:** **Jan. 14, 2025**

(54) **ELECTRONIC DEVICE INCLUDING ANTENNA**

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

(72) Inventors: **Kyonghwan Cho**, Suwon-si (KR);
Jongmin Kim, Suwon-si (KR);
Youngjung Kim, Suwon-si (KR);
Sangho Hong, 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 367 days.

(21) Appl. No.: **17/860,781**

(22) Filed: **Jul. 8, 2022**

(65) **Prior Publication Data**
US 2023/0038214 A1 Feb. 9, 2023

Related U.S. Application Data
(63) Continuation of application No. PCT/KR2022/009624, filed on Jul. 4, 2022.

(30) **Foreign Application Priority Data**
Jul. 13, 2021 (KR) 10-2021-0091765

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

(52) **U.S. Cl.**
CPC **H05K 1/145** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01R 12/721** (2013.01);
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(58) **Field of Classification Search**
CPC H01Q 1/24; H01Q 1/243; H01Q 1/38
See application file for complete search history.

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Primary Examiner — Hoang V Nguyen
(74) *Attorney, Agent, or Firm* — Sughrue Mion, PLLC

(57) **ABSTRACT**
An electronic device may include a printed circuit board including a connector configured to move between a first position and a second position on the printed circuit board; an antenna; a support member that is disposed between the printed circuit board and the antenna in a direction in which the printed circuit board, the support member, and the antenna are stacked; a signal connection member that is electrically connected to the connector of the printed circuit board; and a conductive member disposed between the printed circuit board and the support member, and aligned to cover the first position and the second position of the printed circuit board.

20 Claims, 23 Drawing Sheets

