US011817628B2

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

(10) **Patent No.: US 11,817,628 B2**
(45) **Date of Patent: Nov. 14, 2023**

(54) **DUAL POLARIZED ANTENNA USING SHIFT SERIES FEED**

(71) Applicant: **KMW INC.**, Hwaseong-si (KR)

(72) Inventors: **Su Won Lee**, Yongin-si (KR); **Yong Won Seo**, Daejeon (KR); **Oh Seog Choi**, Hwaseong-si (KR); **Young Chan Moon**, Suwon-si (KR)

(73) Assignee: **KMW INC.**, Hwaseong-si (KR)

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

(21) Appl. No.: **17/528,147**

(22) Filed: **Nov. 16, 2021**

(65) **Prior Publication Data**

US 2022/0077593 A1 Mar. 10, 2022

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2020/005558, filed on Apr. 28, 2020.

(30) **Foreign Application Priority Data**

May 16, 2019 (KR) 10-2019-0057260
Jul. 16, 2019 (KR) 10-2019-0085446

(51) **Int. Cl.**
H01Q 21/06 (2006.01)
H01Q 25/00 (2006.01)
H01Q 21/26 (2006.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 21/062*** (2013.01); ***H01Q 9/0435*** (2013.01); ***H01Q 9/0457*** (2013.01); ***H01Q 21/26*** (2013.01); ***H01Q 25/001*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 21/062; H01Q 21/26; H01Q 25/001; H01Q 9/0457; H01Q 9/0435
See application file for complete search history.

(56) **References Cited**

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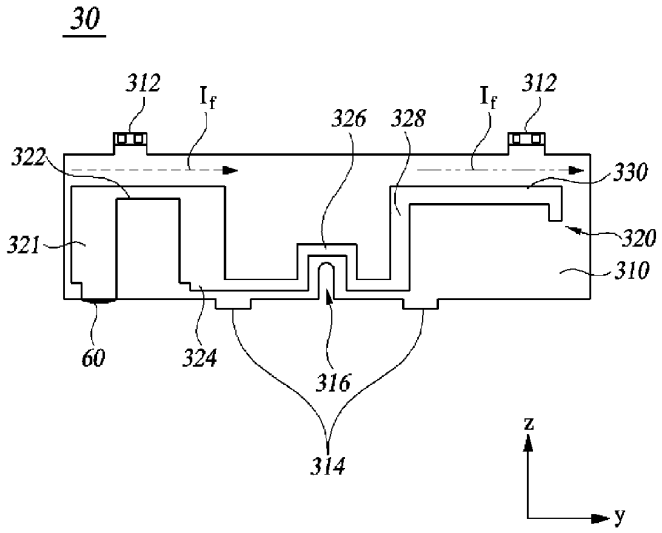
Primary Examiner — Vibol Tan
(74) *Attorney, Agent, or Firm* — INSIGHT LAW GROUP, PLLC; Seung Lee

(57) **ABSTRACT**

The present disclosure provides a dual-polarized antenna, which is advantageous for a reduction in size by significantly reducing the complexity of a structure while satisfying a Cross Polarization ratio (CPR) characteristic and an isolation characteristic, that is, advantages of a dual feed, by enabling a dual feed using a shift series feed even without another structure in one antenna structure.

10 Claims, 11 Drawing Sheets



US011824283B2

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

(10) **Patent No.: US 11,824,283 B2**
(45) **Date of Patent: Nov. 21, 2023**

(54) **ANTENNA ELEMENT AND DISPLAY DEVICE INCLUDING THE SAME**

(71) Applicant: **DONGWOO FINE-CHEM CO., LTD.**, Jeollabuk-do (KR)

(72) Inventors: **Byung Jin Choi**, Incheon (KR); **Young Ju Kim**, Gyeonggi-do (KR); **Dong Pil Park**, Incheon (KR)

(73) Assignee: **DONGWOO FINE-CHEM CO., LTD.**, Jeollabuk-Do (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 140 days.

(21) Appl. No.: **17/524,924**

(22) Filed: **Nov. 12, 2021**

(65) **Prior Publication Data**

US 2022/0158350 A1 May 19, 2022

(30) **Foreign Application Priority Data**

Nov. 13, 2020 (KR) 10-2020-0152042

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

(52) **U.S. Cl.**
CPC ***H01Q 9/0471*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 9/0414*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 9/0414; H01Q 9/045; H01Q 1/38; H01Q 9/0407
See application file for complete search history.

(56) **References Cited**

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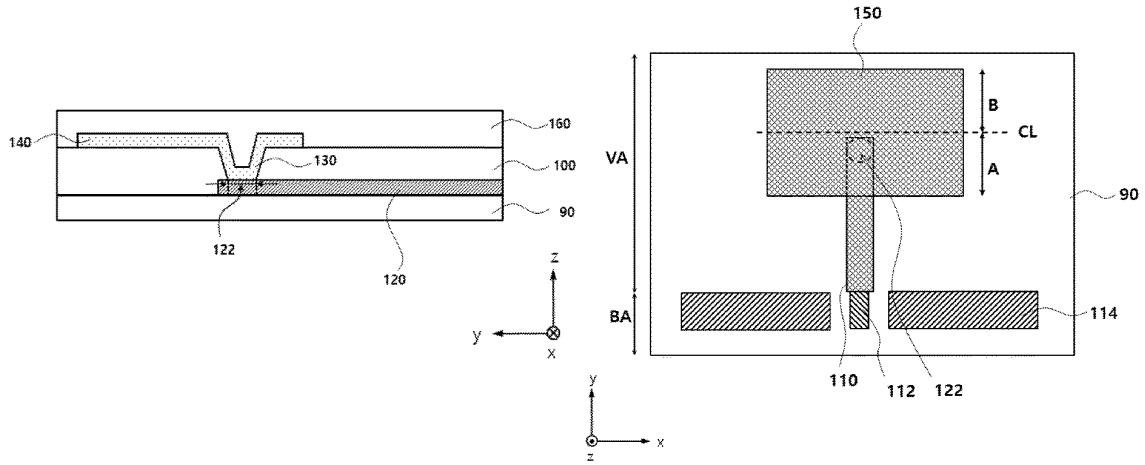
Primary Examiner — Dimary S Lopez Cruz
Assistant Examiner — Aladdin Abdulbaki
(74) *Attorney, Agent, or Firm* — The PL Law Group, PLLC

(57) **ABSTRACT**

An antenna element according to an embodiment of the present invention includes a radiation body including a contact part which is concave toward the transmission line, a transmission line disposed on a different layer from the radiation body and connected to the radiation body through the contact part, and a signal pad connected to an end of the transmission line.

9 Claims, 4 Drawing Sheets



US011824568B2

(12) **United States Patent**
Wei

(10) **Patent No.: US 11,824,568 B2**
(45) **Date of Patent: Nov. 21, 2023**

(54) **ANTENNA STRUCTURE**

(71) Applicant: **Wistron NeWeb Corp.**, Hsinchu (TW)

(72) Inventor: **Shih-Chiang Wei**, Hsinchu (TW)

(73) Assignee: **WISTRON NEWEB CORP.**, Hsinchu (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 29 days.

(21) Appl. No.: **17/480,200**

(22) Filed: **Sep. 21, 2021**

(65) **Prior Publication Data**

US 2022/0399907 A1 Dec. 15, 2022

(30) **Foreign Application Priority Data**

Jun. 11, 2021 (TW) 110121414

(51) **Int. Cl.**
H04B 1/00 (2006.01)
H01Q 1/38 (2006.01)
H01Q 1/48 (2006.01)
H01Q 1/24 (2006.01)

(52) **U.S. Cl.**
CPC ***H04B 1/0053*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 1/48*** (2013.01); *H01Q 1/243* (2013.01)

(58) **Field of Classification Search**
CPC H04B 1/0053; H01Q 1/38; H01Q 1/48; H01Q 1/243; H01Q 5/392; H01Q 5/40
See application file for complete search history.

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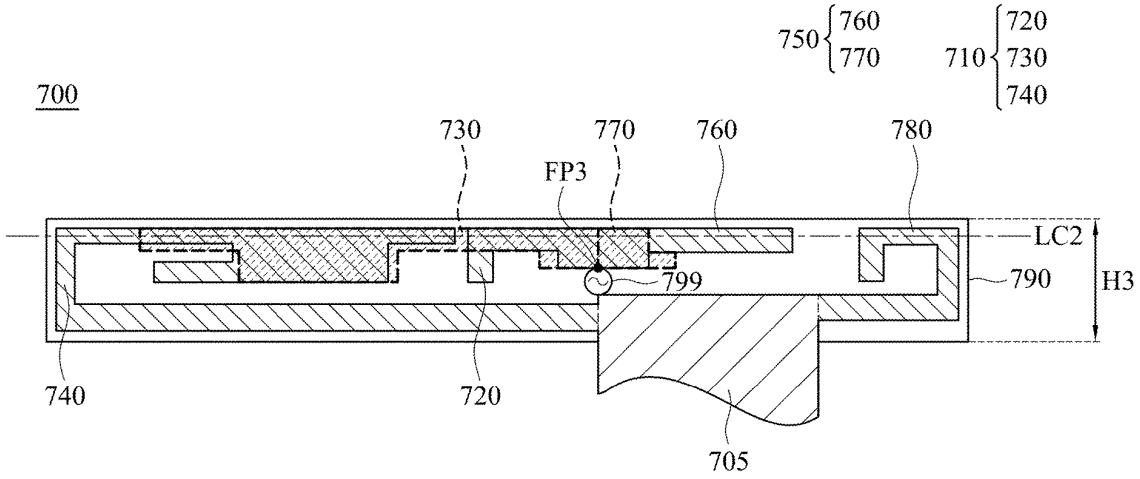
Primary Examiner — Dimary S Lopez Cruz
Assistant Examiner — Jordan E. DeWitt
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

An antenna structure includes a ground element, a first radiation element, a second radiation element, a third radiation element, and a dielectric substrate. The first radiation element has a feeding point. The first radiation element is coupled to a first grounding point on the ground element. The second radiation element is coupled to the feeding point. The third radiation element is coupled to a second grounding point on the ground element. The third radiation element is adjacent to the second radiation element. The ground element, the first radiation element, the second radiation element, and the third radiation element are all disposed on the dielectric substrate.

18 Claims, 15 Drawing Sheets



US011831076B2

(12) **United States Patent**
Yoshikawa

(10) **Patent No.: US 11,831,076 B2**
(45) **Date of Patent: Nov. 28, 2023**

(54) **ANTENNA, WIRELESS COMMUNICATION MODULE, AND WIRELESS COMMUNICATION DEVICE**

(71) Applicant: **KYOCERA Corporation**, Kyoto (JP)

(72) Inventor: **Hiromichi Yoshikawa**, Yokohama (JP)

(73) Assignee: **KYOCERA CORPORATION**, Kyoto (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 385 days.

(21) Appl. No.: **17/288,914**

(22) PCT Filed: **Oct. 25, 2019**

(86) PCT No.: **PCT/JP2019/042058**
§ 371 (c)(1),
(2) Date: **Apr. 27, 2021**

(87) PCT Pub. No.: **WO2020/090691**
PCT Pub. Date: **May 7, 2020**

(65) **Prior Publication Data**

US 2021/0399435 A1 Dec. 23, 2021

(30) **Foreign Application Priority Data**

Oct. 31, 2018 (JP) 2018-206002

(51) **Int. Cl.**
H01Q 21/00 (2006.01)
H01Q 13/08 (2006.01)
H01Q 1/48 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 21/0006*** (2013.01); ***H01Q 13/08*** (2013.01); *H01Q 1/48* (2013.01)

(58) **Field of Classification Search**
CPC H01Q 21/0006; H01Q 13/08; H01Q 1/48; H01Q 1/38; H01Q 1/521; H01Q 9/0442;
(Continued)

(56) **References Cited**

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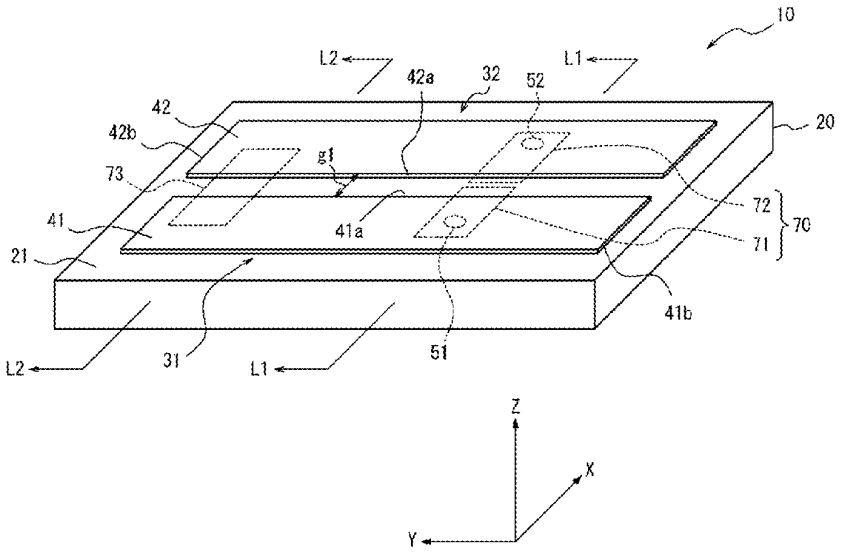
Primary Examiner — Seung H Lee
(74) *Attorney, Agent, or Firm* — HAUPTMAN HAM, LLP

(57) **ABSTRACT**

An antenna includes first and second antenna elements and first and second couplers. The first antenna element includes a first radiation conductor and a first feeder line. The second antenna element includes a second radiation conductor and a second feeder line. The second feeder line is coupled to the first feeder line such that a first component, which is a capacitance component or an inductance component, is dominant. The first coupler couples the first and second feeder lines such that a second component is dominant. The first radiation conductor and the second radiation conductor are arranged at an interval of ½ or less of a resonance wavelength. The second radiation conductor is coupled to the first radiation conductor with a first coupling method in which a capacitive coupling or a magnetic field coupling is dominant. The second coupler couples the first and second radiation conductors with a second coupling method.

20 Claims, 22 Drawing Sheets



US011831086B2

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

(10) **Patent No.: US 11,831,086 B2**
(45) **Date of Patent: Nov. 28, 2023**

(54) **ANTENNA STRUCTURE**

(71) Applicant: **Wistron NeWeb Corp.**, Hsinchu (TW)

(72) Inventors: **Po-Yen Chen**, Hsinchu (TW); **Kuan-Hung Li**, Hsinchu (TW)

(73) Assignee: **WISTRON NEWEB CORP.**, 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.: **17/370,181**

(22) Filed: **Jul. 8, 2021**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Oct. 27, 2020 (TW) 109137217

(51) **Int. Cl.**

H01Q 5/10	(2015.01)
H01Q 1/48	(2006.01)
H01Q 13/10	(2006.01)
H01Q 9/42	(2006.01)
H01Q 5/364	(2015.01)

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

CPC ***H01Q 5/10*** (2015.01); ***H01Q 1/48*** (2013.01); ***H01Q 5/364*** (2015.01); ***H01Q 9/42*** (2013.01); ***H01Q 13/10*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 13/10; H01Q 5/357; H01Q 13/106; H01Q 5/10; H01Q 1/48; H01Q 5/364; H01Q 9/42

See application file for complete search history.

(56) **References Cited**

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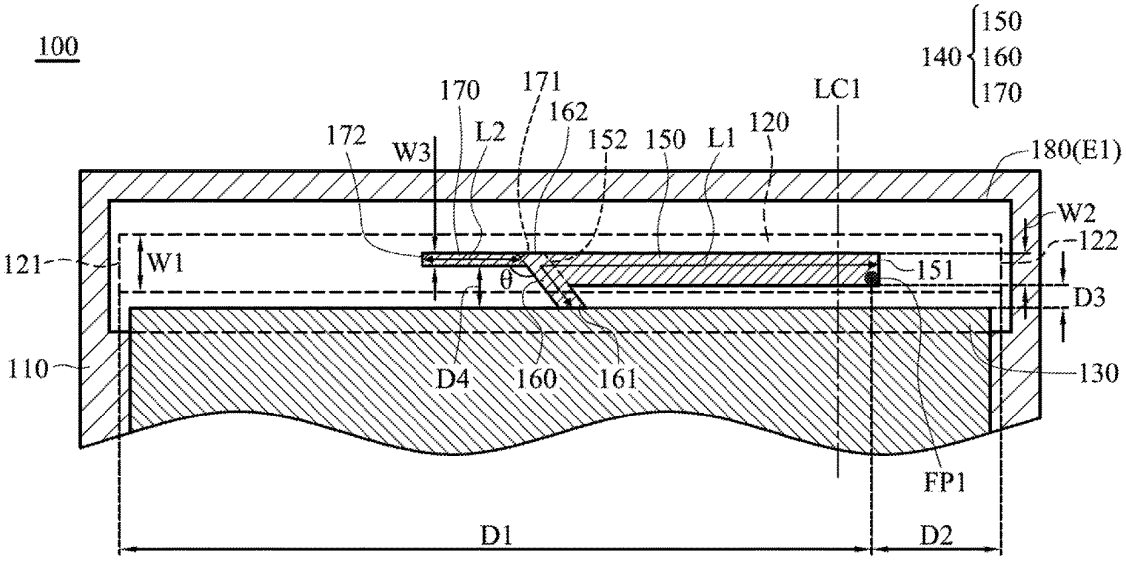
Primary Examiner — Ricardo I Magallanes
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

An antenna structure includes a metal mechanism element, a ground element, a feeding radiation element, and a dielectric substrate. The metal mechanism element has a slot. The slot has a first closed end and a second closed end. The ground element is coupled to the metal mechanism element. The feeding radiation element has a feeding point. The feeding radiation element is coupled to the ground element. The dielectric substrate has a first surface and a second surface which are opposite to each other. The feeding radiation element is disposed on the first surface of the dielectric substrate. The second surface of the dielectric substrate is adjacent to the metal mechanism element. The slot of the metal mechanism element is excited to generate a first frequency band and a second frequency band. The feeding radiation element is excited to generate a third frequency band.

9 Claims, 6 Drawing Sheets



US011831089B2

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

(10) **Patent No.: US 11,831,089 B2**
(45) **Date of Patent: Nov. 28, 2023**

(54) **ANTENNA SUBSTRATE AND ANTENNA MODULE COMPRISING THE SAME**

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

(72) Inventors: **Moon Hee Yi**, Suwon-si (KR); **Tae Seong Kim**, Suwon-si (KR)

(73) Assignee: **SAMSUNG ELECTRO-MECHANICS 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 358 days.

(21) Appl. No.: **16/789,039**

(22) Filed: **Feb. 12, 2020**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Dec. 10, 2019 (KR) 10-2019-0163278

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 9/04 (2006.01)
H01Q 1/24 (2006.01)
H01Q 1/42 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 9/045*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/422*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 9/045; H01Q 1/243; H01Q 1/422; H01Q 23/00; H01Q 19/005; H01Q 15/10; H01Q 15/08; H01Q 1/38; H01Q 9/065; H01Q 21/08; H01Q 25/00; H01Q 9/0414
See application file for complete search history.

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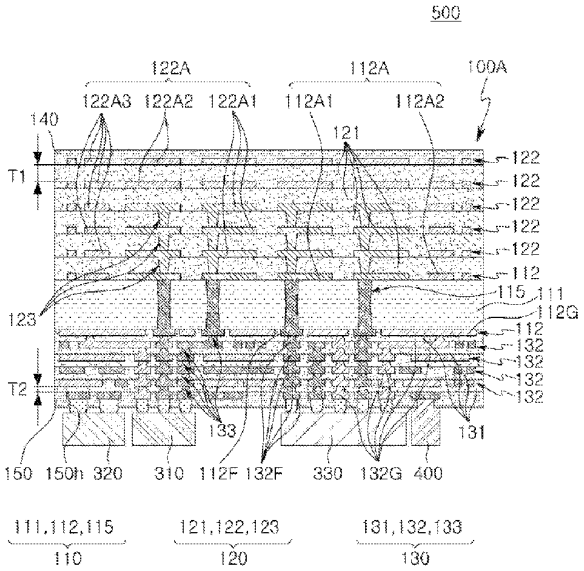
Primary Examiner — Hai V Tran
Assistant Examiner — Bamidele A Jegede
(74) *Attorney, Agent, or Firm* — Morgan, Lewis & Bockius LLP

(57) **ABSTRACT**

An antenna substrate and an antenna module including the same are provided. The antenna substrate includes an antenna unit including first and second pattern layers adjacent to each other and disposed on different levels and a first insulating layer providing a first insulating region between the first and second pattern layers, and a feed unit including third and fourth pattern layers adjacent to each other and disposed on different levels and a second insulating layer providing a second insulating region between the third and fourth pattern layers. Each of the first and second pattern layers includes an antenna pattern, and each of the third and fourth pattern layers includes a feed pattern. The antenna unit is disposed on the feed unit. The first insulating region is thicker than the second insulating region.

20 Claims, 10 Drawing Sheets



US011831090B2

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

(10) **Patent No.: US 11,831,090 B2**
(45) **Date of Patent: Nov. 28, 2023**

(54) **ELECTRONIC DEVICES WITH DISPLAY-OVERLAPPING ANTENNAS**

(71) Applicant: **Apple Inc.**, Cupertino, CA (US)

(72) Inventors: **Forhad Hasnat**, Cupertino, CA (US); **David Garrido Lopez**, Campbell, CA (US); **Harish Rajagopalan**, San Jose, CA (US); **Mikal Askarian Amiri**, Tempe, AZ (US); **Rodney A. Gomez Angulo**, Santa Clara, CA (US); **Lu Zhang**, Shanghai (CN)

(73) Assignee: **Apple Inc.**, Cupertino, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 351 days.

(21) Appl. No.: **16/903,198**

(22) Filed: **Jun. 16, 2020**

(65) **Prior Publication Data**

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(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 9/40	(2006.01)
H01Q 7/00	(2006.01)
H01Q 13/22	(2006.01)

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

CPC ***H01Q 9/40*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 7/00*** (2013.01); ***H01Q 13/22*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 9/40; H01Q 1/243; H01Q 7/00; H01Q 13/22; H01Q 13/18; H01Q 9/42

See application file for complete search history.

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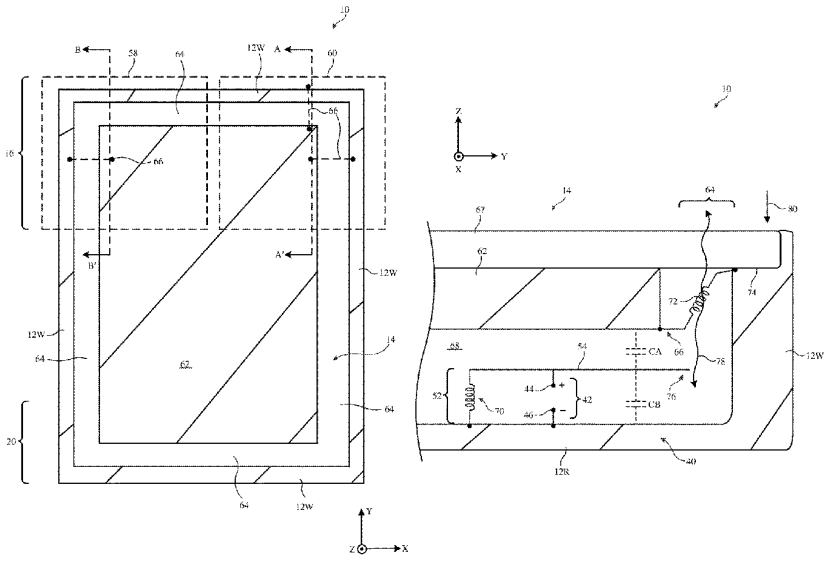
Primary Examiner — Hai V Tran
Assistant Examiner — Bamidele A Jegede
(74) *Attorney, Agent, or Firm* — Treyz Law Group, P.C.; Michael H. Lyons; Tianyi He

(57) **ABSTRACT**

An electronic device may include a conductive housing with a rear wall and a sidewall. A display may be mounted to the sidewall and may include a conductive display structure separated from the sidewall by a slot. An antenna arm may be interposed between the conductive display structure and the rear wall. A first inductor may couple the conductive display structure to the housing and may compensate for a distributed capacitance between the antenna arm and the conductive display structure. A second inductor may couple the antenna arm to the rear wall and may compensate for a distributed capacitance between the antenna arm and the rear wall. A speaker may be co-located with the antenna. A third inductor may couple the antenna arm to the rear wall to allow antenna currents to bypass the speaker.

20 Claims, 9 Drawing Sheets



US011837777B2

(12) **United States Patent**
Zeng

(10) **Patent No.: US 11,837,777 B2**
(45) **Date of Patent: Dec. 5, 2023**

(54) **ANTENNA ASSEMBLY AND TERMINAL**

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

(72) Inventor: **Lun Zeng**, 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 335 days.

(21) Appl. No.: **17/446,294**

(22) Filed: **Aug. 28, 2021**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Dec. 28, 2020 (CN) 202011580679.8

(51) **Int. Cl.**
H05K 1/18 (2006.01)
H01Q 1/24 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); *H05K 1/181* (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H05K 1/181
See application file for complete search history.

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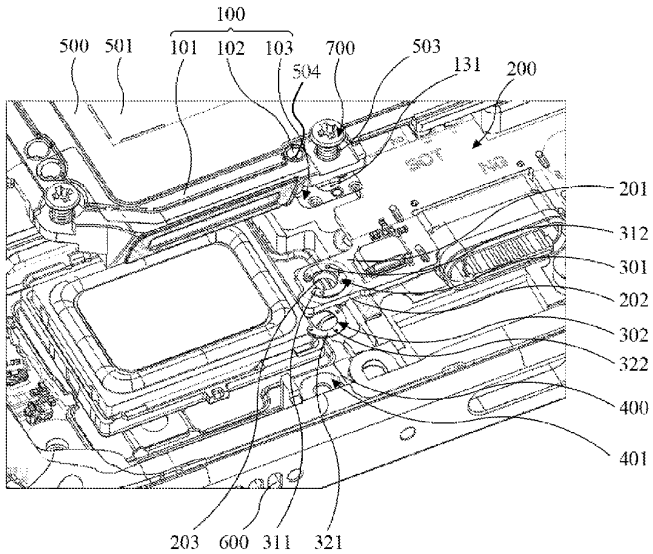
Primary Examiner — Krystal Robinson
(74) *Attorney, Agent, or Firm* — SYNCODA LLC; Feng Ma

(57) **ABSTRACT**

A antenna assembly includes: a first antenna disposed on the first support provided with a first through hole, wherein the first antenna includes a first part disposed on an upper surface of the first support, a second part disposed inside the first through hole, and a third part disposed on a lower surface of the first support; a first connecting plate, an upper surface of which abuts against the third part, and lower surface is attached to an upper surface of the circuit board; a second connecting plate, an upper surface of which is attached to a lower surface of the circuit board; and a second antenna disposed on a middle frame of the terminal and connected to a lower surface of the second connecting plate, the first antenna being connected to a feed point of the second antenna through the first connecting plate and the second connecting plate.

17 Claims, 5 Drawing Sheets



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(12) **United States Patent**
Nasu

(10) **Patent No.: US 11,837,800 B2**
(45) **Date of Patent: Dec. 5, 2023**

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

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

(72) Inventor: **Takafumi Nasu**, Nagaokakyo (JP)

(73) Assignee: **MURATA MANUFACTURING CO., LTD.**, Kyoto (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 364 days.

(21) Appl. No.: **17/356,570**

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

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. PCT/JP2020/030063, filed on Aug. 5, 2020.

(30) **Foreign Application Priority Data**

Aug. 27, 2019 (JP) 2019-154827
Sep. 9, 2019 (JP) 2019-163567

(51) **Int. Cl.**
H01Q 5/371 (2015.01)
H01Q 5/378 (2015.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 5/371*** (2015.01); ***H01Q 1/243*** (2013.01); ***H01Q 5/378*** (2015.01); ***H01Q 7/00*** (2013.01); ***H04W 72/044*** (2013.01)

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

(56) **References Cited**

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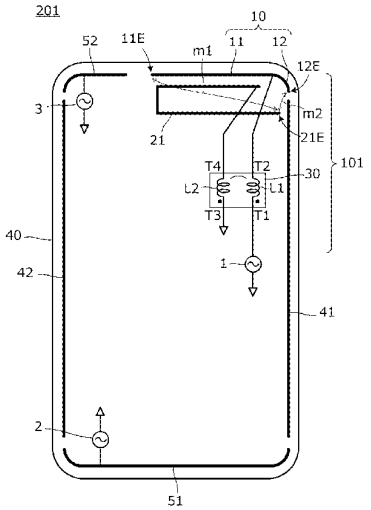
Primary Examiner — Jany Richardson
(74) *Attorney, Agent, or Firm* — Keating & Bennett, LLP

(57) **ABSTRACT**

An antenna unit includes a coupling element including first and second coils, a feeding radiating element, and a parasitic radiating element. A series circuit including the first coil and a feeder circuit is connected to the feeding radiating element, and the parasitic radiating element is connected to the second coil. A distance between open ends of the parasitic radiating element and a short portion of the feeding radiating element is shorter than a distance between open ends of the parasitic radiating element and a long portion the feeding radiating element. The antenna unit is an antenna for a first frequency band with fundamental wave resonance of the long portion and fundamental wave resonance of the parasitic radiating element, and a second frequency band with higher-order resonance of the parasitic radiating element and resonance of the short portion, the second frequency band being higher than the first frequency band.

20 Claims, 16 Drawing Sheets



US011843183B2

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

(10) **Patent No.: US 11,843,183 B2**
(45) **Date of Patent: Dec. 12, 2023**

(54) **MULTI-BAND ANTENNA STRUCTURE**

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

(72) Inventors: **Bing Luo**, Chengdu (CN); **Weihong Xiao**, Dongguan (CN); **Wenfei Qin**, Chengdu (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 358 days.

(21) Appl. No.: **17/358,417**

(22) Filed: **Jun. 25, 2021**

(65) **Prior Publication Data**

US 2021/0320409 A1 Oct. 14, 2021

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2019/125826, filed on Dec. 17, 2019.

(30) **Foreign Application Priority Data**

Dec. 27, 2018 (CN) 201811615844.1

(51) **Int. Cl.**
H01Q 5/30 (2015.01)
H01Q 1/36 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 5/30*** (2015.01); ***H01Q 1/36*** (2013.01); ***H01Q 15/00*** (2013.01); ***H01Q 19/10*** (2013.01); ***H01Q 21/30*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/30; H01Q 1/36; H01Q 15/00; H01Q 19/10; H01Q 21/30
See application file for complete search history.

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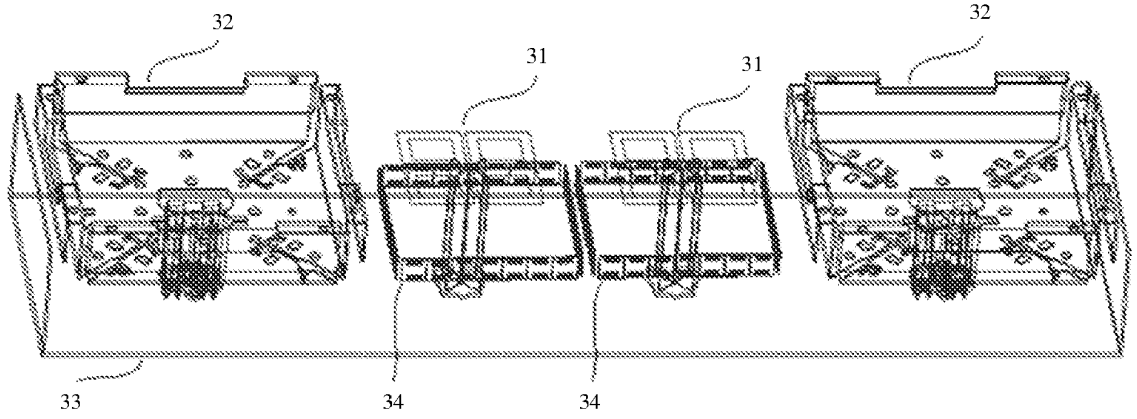
Primary Examiner — Graham P Smith
(74) *Attorney, Agent, or Firm* — SLATER MATSIL, LLP

(57) **ABSTRACT**

A multi-band antenna structure, including a first antenna element, a second antenna element, a reflection panel, and a first parasitic structure of the first antenna element. A distance between the reflection panel and an antenna element with a higher operating frequency band is less than a distance between the reflection panel and an antenna element with a lower operating frequency band. A distance between the first antenna element and the second antenna element is less than 0.5 times a vacuum wavelength corresponding to a lower frequency bands. A distance between the first antenna element and the first parasitic structure is less than 0.5 times a vacuum wavelength corresponding to an operating frequency band of the first antenna element. A distance between the second antenna element and the first parasitic structure is less than 0.5 times a vacuum wavelength corresponding to an operating frequency band of the second antenna element.

20 Claims, 15 Drawing Sheets



US011843185B2

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

(10) **Patent No.: US 11,843,185 B2**
(45) **Date of Patent: Dec. 12, 2023**

(54) **DISTRIBUTED, TUNABLE RADIATING ELEMENT**

(71) Applicant: **Dell Products L.P.**, Round Rock, TX (US)

(72) Inventors: **Suresh Ramasamy**, Cedar Park, TX (US); **Changsoo Kim**, Cedar Park, TX (US); **Sumana Pallampati**, Nagpur (IN); **Anthony J. Sanchez**, Pflugerville, TX (US)

(73) Assignee: **Dell Products L.P.**, Round Rock, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 11 days.

(21) Appl. No.: **17/340,398**

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

(65) **Prior Publication Data**

US 2022/0393350 A1 Dec. 8, 2022

(51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01Q 5/328 (2015.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 5/328*** (2015.01); ***H01Q 1/2291*** (2013.01); ***H01Q 9/0414*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/328; H01Q 1/2291; H01Q 9/0414; H01Q 5/314; H01Q 5/378; H01Q 5/50; H01Q 9/42
See application file for complete search history.

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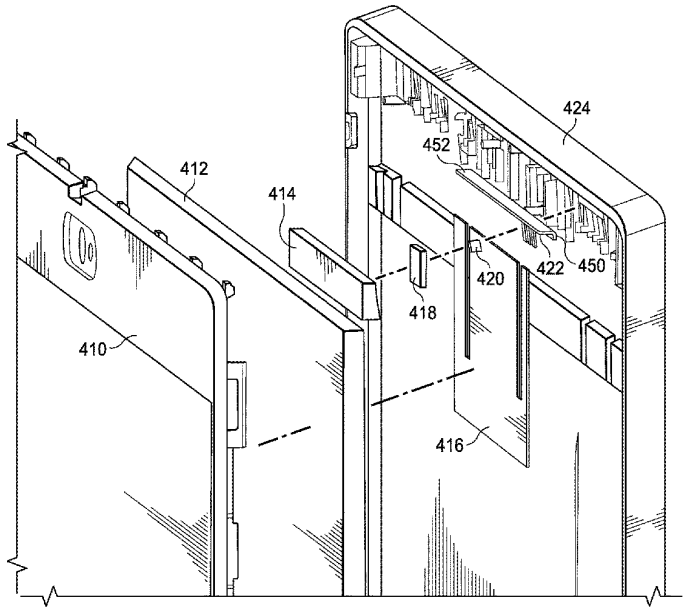
Primary Examiner — Hai V Tran
Assistant Examiner — Michael M Bouizza
(74) *Attorney, Agent, or Firm* — Terrile, Cannatti & Chambers; Stephen A. Terrile

(57) **ABSTRACT**

An information handling system (IHS) includes an antenna system. The antenna system includes an antenna; a radiating element, the radiating element being capacitively coupled with the antenna; and, a tuner module electrically coupled to the antenna and the radiating element, the tuner module tuning the antenna and the radiating element.

12 Claims, 9 Drawing Sheets



US011843186B2

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

(10) **Patent No.: US 11,843,186 B2**
(45) **Date of Patent: Dec. 12, 2023**

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

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

(72) Inventors: **Hau Yuen Tan**, Taipei (TW); **Chao-Hsu Wu**, Taipei (TW); **Chien-Yi Wu**, Taipei (TW); **Shih-Keng Huang**, Taipei (TW); **Cheng-Hsiung Wu**, Taipei (TW)

(73) Assignee: **PEGATRON CORPORATION**, Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 114 days.

(21) Appl. No.: **17/691,973**

(22) Filed: **Mar. 10, 2022**

(65) **Prior Publication Data**

US 2022/0344814 A1 Oct. 27, 2022

(30) **Foreign Application Priority Data**

Apr. 23, 2021 (TW) 110114719

(51) **Int. Cl.**

H01Q 5/35	(2015.01)
H01Q 1/48	(2006.01)
H01Q 1/36	(2006.01)
H01Q 1/50	(2006.01)
H01Q 21/24	(2006.01)
H01Q 9/42	(2006.01)

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

CPC ***H01Q 5/35*** (2015.01); ***H01Q 1/48*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 9/42; H01Q 1/243; H01Q 21/28; H01Q 1/38; H01Q 5/378; H01Q 5/371; H01Q 1/48; H01Q 5/328; H01Q 5/35

See application file for complete search history.

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Primary Examiner — Wei (Victor) Y Chan

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

(57) **ABSTRACT**

An antenna module includes first, second, third antenna radiators, and first, second, third ground radiators. The first antenna radiator includes a first feeding terminal. The second antenna radiator extends from the first antenna radiator. The third antenna radiator extends from the first feeding terminal. The first ground radiator is disposed beside the first and second antenna radiators. A first coupling gap exists between the first ground radiator and the first and second antenna radiators. The second ground radiator is disposed beside the second antenna radiator. A second coupling gap exists between the second ground radiator and the second antenna radiator. The third ground radiator is disposed beside the first and second antenna radiators. A third coupling gap exists between the third ground radiator and the first antenna radiator. A fourth coupling gap exists between the third ground radiator and the second antenna radiator.

10 Claims, 9 Drawing Sheets