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(19) **United States**

(12) **Patent Application Publication**  
**Wu**

(10) **Pub. No.: US 2024/0063527 A1**

(43) **Pub. Date: Feb. 22, 2024**

(54) **ANTENNA DEVICE AND MOBILE TERMINAL**

**Publication Classification**

(71) Applicant: **GUANGDONG OPPO MOBILE TELECOMMUNICATIONS CORP., LTD.**, Dongguan (CN)

(51) **Int. Cl.**  
*H01Q 1/24* (2006.01)  
*H01Q 5/35* (2006.01)  
*H01Q 1/48* (2006.01)

(72) Inventor: **Xiaopu Wu**, Dongguan (CN)

(52) **U.S. Cl.**  
CPC ..... *H01Q 1/243* (2013.01); *H01Q 5/35* (2015.01); *H01Q 1/48* (2013.01)

(21) Appl. No.: **18/385,051**

(57) **ABSTRACT**

(22) Filed: **Oct. 30, 2023**

Provided is an antenna device. The antenna device includes a first antenna. The first antenna includes a first radiator. The first radiator includes a first branch and a second branch that are connected to each other. The second branch bends and extends from an end of the first branch. The first antenna supports both a first operation mode and a second operation mode. The first antenna covers a bandwidth greater than 190 MHz by using the first operation mode and the second operation mode together. In addition, a mobile terminal is provided.

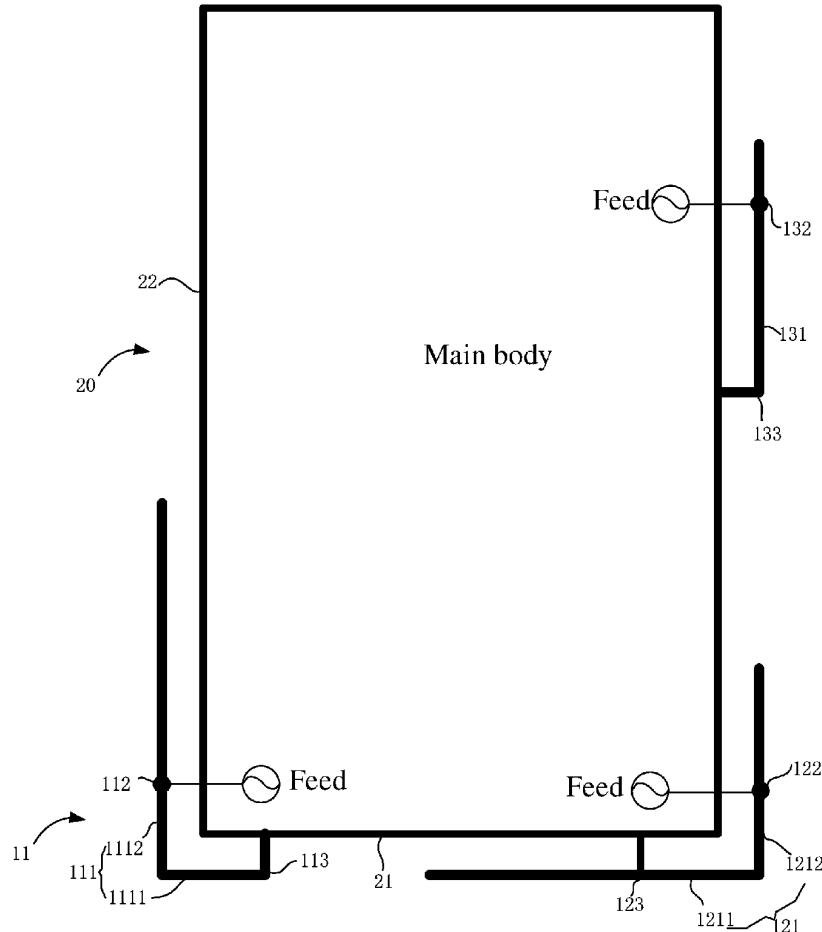
**Related U.S. Application Data**

(63) Continuation of application No. PCT/CN2022/080623, filed on Mar. 14, 2022.

(30) **Foreign Application Priority Data**

Apr. 30, 2021 (CN) ..... 202110484710.6

100





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(12) **Patent Application Publication**  
**SEOL et al.**

(10) **Pub. No.: US 2024/0063528 A1**

(43) **Pub. Date: Feb. 22, 2024**

(54) **ELECTRONIC DEVICE COMPRISING ANTENNA**

**Publication Classification**

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

(51) **Int. Cl.**  
*H01Q 1/24* (2006.01)  
*G09G 3/00* (2006.01)  
*H04M 1/02* (2006.01)

(72) Inventors: **Kyungmoon SEOL**, Suwon-si (KR);  
**Minkyung LEE**, Suwon-si (KR); **Jiho KIM**,  
Suwon-si (KR); **Kyihyun JANG**,  
Suwon-si (KR); **Hyeonuk KANG**,  
Suwon-si (KR); **Seunghwan KIM**,  
Suwon-si (KR); **Gyubok PARK**,  
Suwon-si (KR); **Seongyong AN**,  
Suwon-si (KR)

(52) **U.S. Cl.**  
CPC ..... *H01Q 1/243* (2013.01); *G09G 3/035*  
(2020.08); *H04M 1/0216* (2013.01); *H04M*  
*1/0237* (2013.01); *H04M 1/0269* (2022.02)

(57) **ABSTRACT**

According to an example embodiment of the present disclosure, an electronic device may comprise: a display module comprising a display, a conductive part comprising a conductive material, a wireless communication circuit, and a dielectric. The conductive part may be included in a housing forming the external appearance of the electronic device. The conductive part may include a conductive region which may face and overlap a portion of the front surface of the display module to cover a portion of the front surface of the display module. The wireless communication circuit may be configured to transmit and/or receive a signal in a selected or designated frequency band through the conductive part. The dielectric may be disposed between a portion of the front surface of the display module and the conductive region of the conductive part. An air gap may be provided between the dielectric and a portion of the front surface of the display module or between the dielectric and the conductive region.

(21) Appl. No.: **18/488,573**

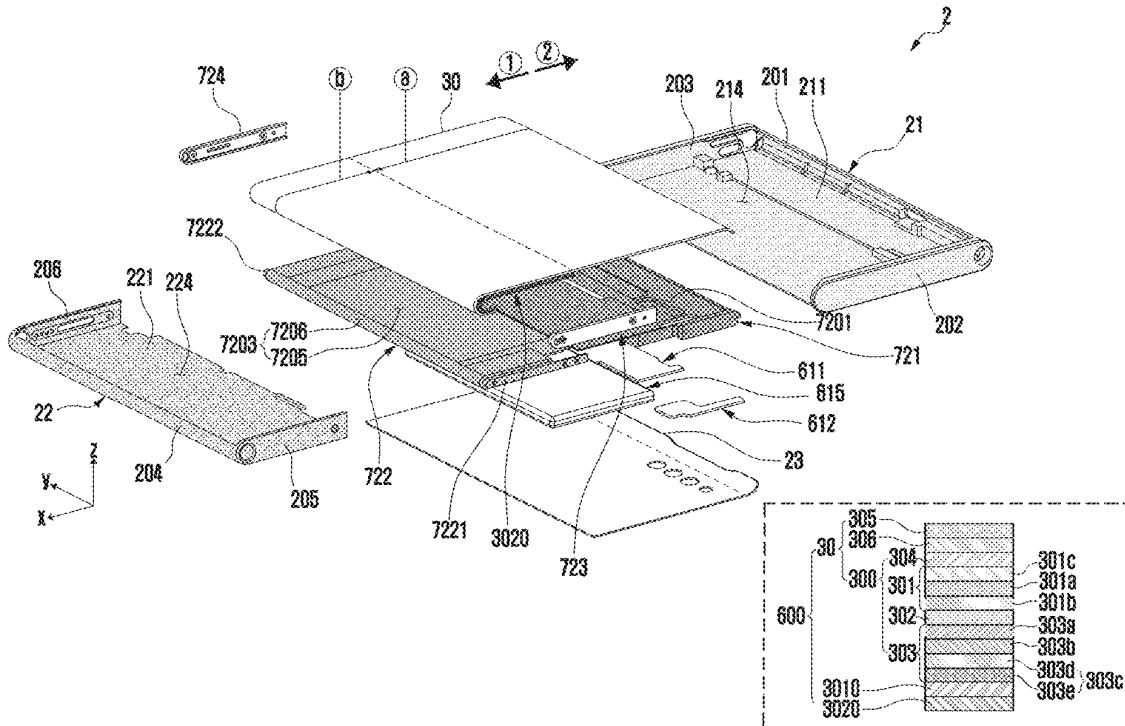
(22) Filed: **Oct. 17, 2023**

**Related U.S. Application Data**

(63) Continuation of application No. PCT/KR2022/018081, filed on Nov. 16, 2022.

(30) **Foreign Application Priority Data**

Nov. 16, 2021 (KR) ..... 10-2021-0157659  
Dec. 9, 2021 (KR) ..... 10-2021-0175992  
Nov. 16, 2022 (KR) ..... 10-2022-0153369





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(19) **United States**

(12) **Patent Application Publication**  
SU et al.

(10) **Pub. No.: US 2024/0063535 A1**

(43) **Pub. Date: Feb. 22, 2024**

(54) **WIDEBAND ANTENNA SYSTEM**

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

(71) Applicant: **ASUSTeK COMPUTER INC.**, Taipei (TW)

CPC ..... **H01Q 1/50** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/50** (2015.01)

(72) Inventors: **Chun-Chieh SU**, Taipei (TW);  
**Wei-Cheng LO**, Taipei (TW);  
**Chien-Ming HSU**, Taipei (TW);  
**Che-Yen LIN**, Taipei (TW);  
**Chuan-Chien HUANG**, Taipei (TW)

(57) **ABSTRACT**

(21) Appl. No.: **18/180,974**

A wideband antenna system includes a first metal radiation portion, having a coupling distance with a second metal radiation portion; a first feeding contact and a second feeding contact, electrically connected to the first metal radiation portion and the second metal radiation portion respectively, and close to the coupling distance; a first ground contact, electrically connected to the second metal radiation portion; a second ground contact, electrically connected to the first metal radiation portion; an impedance tuner, electrically connected to the first feeding contact, the second feeding contact, the first ground contact, the second ground contact, and a radio frequency signal source, to switch the first metal radiation portion and the second metal radiation portion; an aperture contact, electrically connected to the first metal radiation portion; and an aperture tuner, electrically connected to the aperture contact.

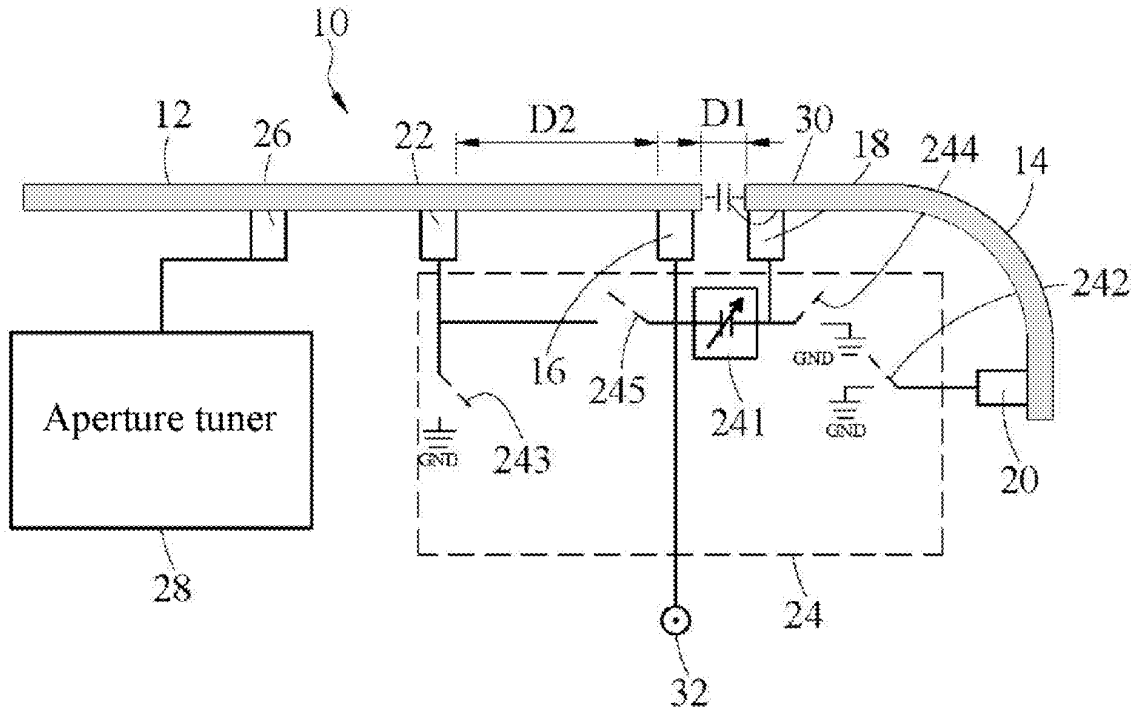
(22) Filed: **Mar. 9, 2023**

(30) **Foreign Application Priority Data**

Aug. 22, 2022 (TW) ..... 111131574

**Publication Classification**

(51) **Int. Cl.**  
**H01Q 1/50** (2006.01)  
**H01Q 1/48** (2006.01)  
**H01Q 5/50** (2006.01)





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(12) **Patent Application Publication**  
**WANG et al.**

(10) **Pub. No.: US 2024/0063543 A1**

(43) **Pub. Date: Feb. 22, 2024**

(54) **OPEN LOOP ANTENNA AND ELECTRONIC DEVICE**

(52) **U.S. Cl.**  
CPC ..... **H01Q 7/00** (2013.01); **H01Q 5/35** (2015.01)

(71) Applicant: **Wistron NeWeb Corporation**, Hsinchu (TW)

(57) **ABSTRACT**

(72) Inventors: **Hao-Yu WANG**, Hsinchu (TW); **Pei Siou LUO**, Hsinchu (TW)

An open loop antenna includes a base, a first radiating section disposed on the base, a second radiating section spaced apart from the first radiating section to form an open loop, and a grounding section spaced apart from the first radiating section and connected to the second radiating section and a ground voltage. The first radiating section includes a feeding segment connected to a feeding point, an extending segment connected to the feeding segment and excited to generate a first frequency band, and a high-frequency coupling segment connected to the extending segment and excited to generate a second frequency band. The second radiating section is coupled with the first radiating section to generate a third frequency band. The first frequency band is higher than the second frequency band. The second frequency band is higher than the third frequency band.

(21) Appl. No.: **18/151,499**

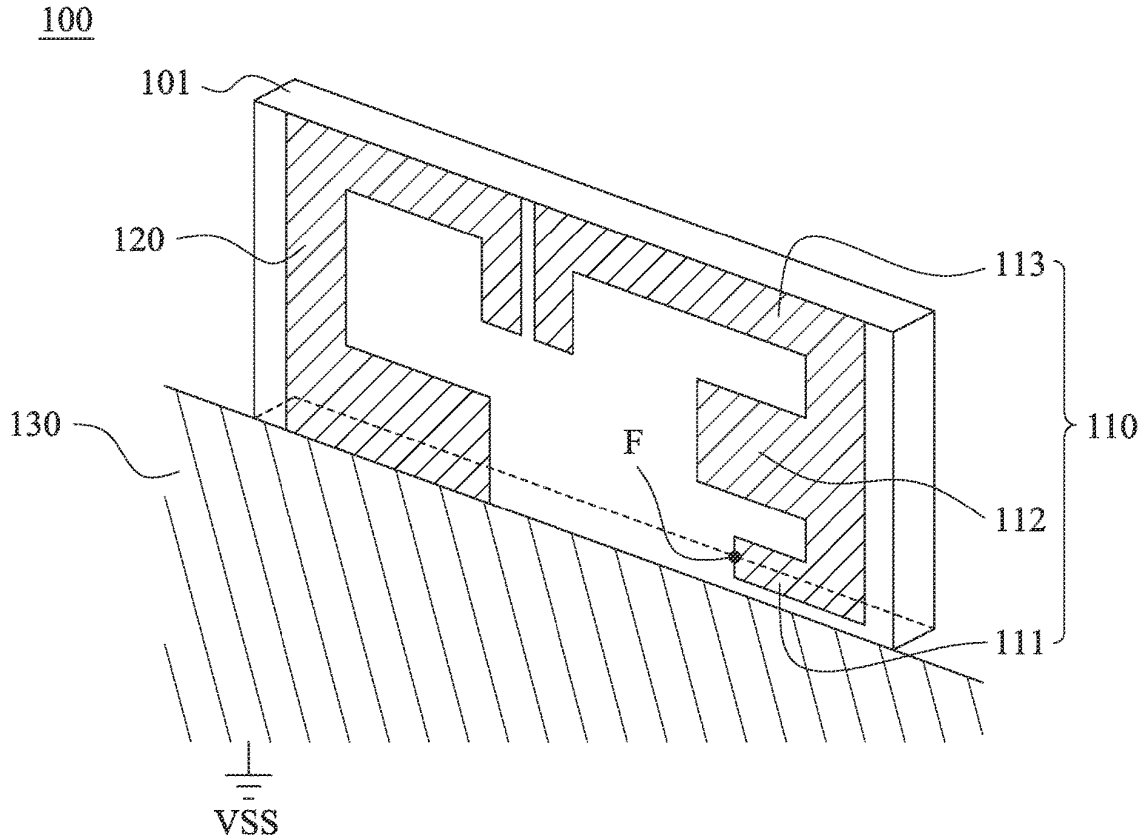
(22) Filed: **Jan. 9, 2023**

(30) **Foreign Application Priority Data**

Aug. 17, 2022 (TW) ..... 111131016

**Publication Classification**

(51) **Int. Cl.**  
**H01Q 7/00** (2006.01)  
**H01Q 5/35** (2006.01)





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(19) **United States**

(12) **Patent Application Publication**  
**HWANG et al.**

(10) **Pub. No.: US 2024/0072416 A1**

(43) **Pub. Date: Feb. 29, 2024**

(54) **ELECTRONIC DEVICE INCLUDING ANTENNA**

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

(72) Inventors: **Soonho HWANG**, Suwon-si (KR);  
**Kyungjae LEE**, Suwon-si (KR);  
**Sungkoo PARK**, Suwon-si (KR);  
**Himchan YUN**, Suwon-si (KR);  
**Kookjoo LEE**, Suwon-si (KR);  
**Donguk CHOI**, Suwon-si (KR);  
**Seunghwan KIM**, Suwon-si (KR);  
**Jaebong CHUN**, Suwon-si (KR)

(73) Assignee: **SAMSUNG ELECTRONICS CO., LTD.**, Suwon-si (KR)

(21) Appl. No.: **18/381,741**

(22) Filed: **Oct. 19, 2023**

**Related U.S. Application Data**

(63) Continuation of application No. PCT/KR2023/010751, filed on Jul. 25, 2023.

(30) **Foreign Application Priority Data**

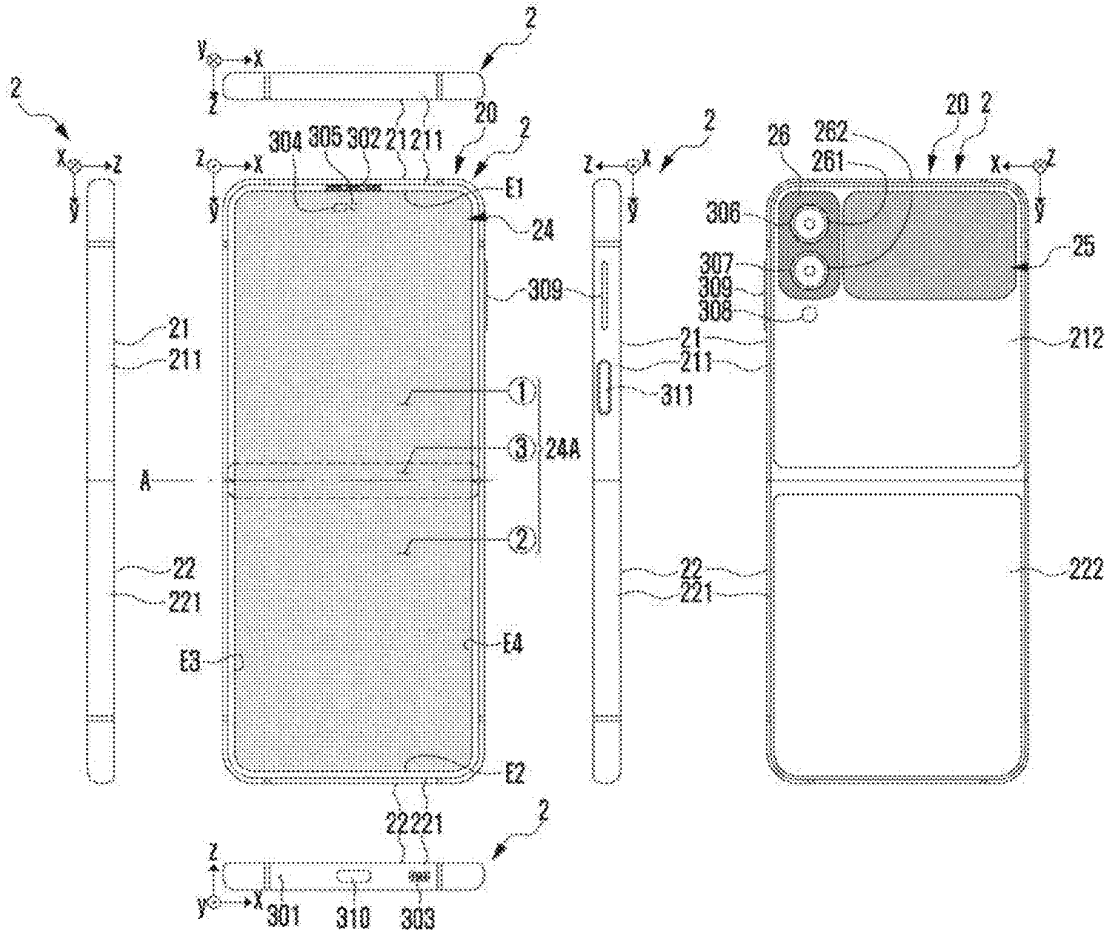
Jul. 29, 2022 (KR) ..... 10-2022-0094349  
Aug. 9, 2022 (KR) ..... 10-2022-0099540

**Publication Classification**

(51) **Int. Cl.**  
**H01Q 1/24** (2006.01)  
**H01Q 1/50** (2006.01)  
**H01Q 1/52** (2006.01)  
(52) **U.S. Cl.**  
CPC ..... **H01Q 1/243** (2013.01); **H01Q 1/50**  
(2013.01); **H01Q 1/526** (2013.01); **H04M**  
**1/0214** (2013.01)

(57) **ABSTRACT**

An electronic device includes: a housing forming an exterior of the electronic device; a first display; a second display facing in a direction different from that of the first display, wherein the second display may include a conductive pattern; a metal part electrically connected to the conductive pattern; and a wireless communication circuit electrically connected to at least one of the metal part or the conductive pattern.





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(19) **United States**

(12) **Patent Application Publication**  
**Edwards et al.**

(10) **Pub. No.: US 2024/0072417 A1**

(43) **Pub. Date: Feb. 29, 2024**

(54) **ELECTRONIC DEVICE ANTENNA ARRAYS MOUNTED AGAINST A DIELECTRIC LAYER**

*H01Q 3/26* (2006.01)  
*H01Q 9/04* (2006.01)  
*H01Q 21/06* (2006.01)  
*H01Q 21/22* (2006.01)

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

(52) **U.S. Cl.**  
CPC ..... *H01Q 1/243* (2013.01); *H01Q 1/38* (2013.01); *H01Q 3/26* (2013.01); *H01Q 3/2605* (2013.01); *H01Q 3/2658* (2013.01); *H01Q 9/0414* (2013.01); *H01Q 21/061* (2013.01); *H01Q 21/065* (2013.01); *H01Q 21/22* (2013.01)

(72) Inventors: **Jennifer M. Edwards**, San Francisco, CA (US); **Harish Rajagopalan**, San Jose, CA (US); **Simone Paulotto**, Redwood City, CA (US); **Bilgehan Avser**, Pacifica, CA (US); **Hao Xu**, Cupertino, CA (US); **Rodney A. Gomez Angulo**, Santa Clara, CA (US); **Siwen Yong**, San Francisco, CA (US); **Matthew A. Mow**, Los Altos, CA (US); **Mattia Pascolini**, San Francisco, CA (US)

(57) **ABSTRACT**

An electronic device may be provided with a dielectric cover layer, a dielectric substrate, and a phased antenna array on the dielectric substrate for conveying millimeter wave signals through the dielectric cover layer. The array may include conductive traces mounted against the dielectric layer. The conductive traces may form patch elements or parasitic elements for the phased antenna array. The dielectric layer may have a dielectric constant and a thickness selected to form a quarter wave impedance transformer for the array at a wavelength of operation of the array. The substrate may include fences of conductive vias that laterally surround each of the antennas within the array. When configured in this way, signal attenuation, destructive interference, and surface wave generation associated with the presence of the dielectric layer over the phased antenna array may be minimized.

(21) Appl. No.: **18/502,979**

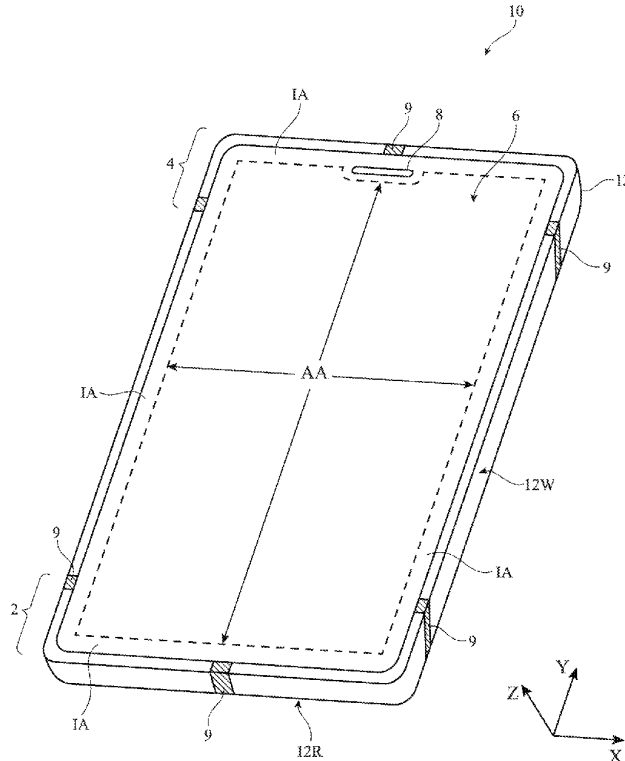
(22) Filed: **Nov. 6, 2023**

**Related U.S. Application Data**

(63) Continuation of application No. 17/314,740, filed on May 7, 2021, now Pat. No. 11,811,133, which is a continuation of application No. 15/950,677, filed on Apr. 11, 2018, now Pat. No. 11,139,588.

**Publication Classification**

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





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(19) **United States**

(12) **Patent Application Publication**  
**WU**

(10) **Pub. No.: US 2024/0072418 A1**

(43) **Pub. Date: Feb. 29, 2024**

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

*H03H 7/38* (2006.01)

*H04B 1/00* (2006.01)

(71) Applicant: **GUANGDONG OPPO MOBILE TELECOMMUNICATIONS CORP., LTD.**, Dongguan (CN)

(52) **U.S. Cl.**  
CPC ..... *H01Q 1/243* (2013.01); *H01Q 5/335* (2015.01); *H03H 7/38* (2013.01); *H04B 1/0064* (2013.01)

(72) Inventor: **Xiaopu WU**, Dongguan (CN)

(57) **ABSTRACT**

(21) Appl. No.: **18/503,330**

(22) Filed: **Nov. 7, 2023**

**Related U.S. Application Data**

(63) Continuation of application No. PCT/CN2022/086365, filed on Apr. 12, 2022.

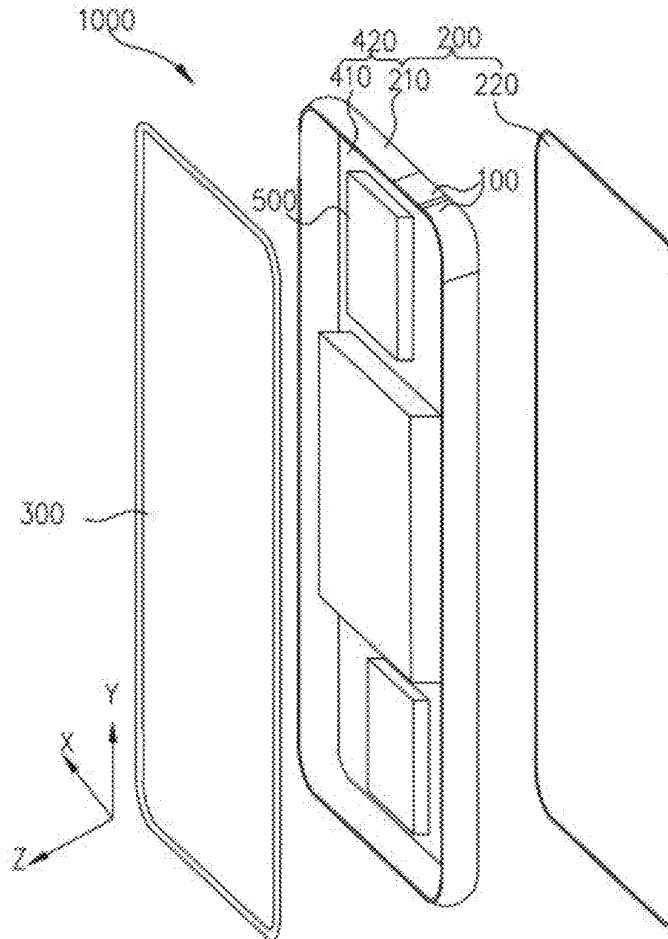
(30) **Foreign Application Priority Data**

May 26, 2021 (CN) ..... 202110582433.2

**Publication Classification**

(51) **Int. Cl.**  
*H01Q 1/24* (2006.01)  
*H01Q 5/335* (2006.01)

Provided are an antenna assembly and an electronic device. The antenna assembly includes a first radiator, a second radiator, a first matching module, a first feeding module, a second matching module, and a second feeding module. The first radiator has a first ground end, a first coupling end, and a first feeding point. The second radiator has a second coupling end, a second ground end, and a second feed point. A first coupling gap is defined between the second coupling end and the first coupling end. The first matching module is electrically connected between the first feeding point and the first feeding module. The second matching module is electrically connected between the second feeding point and the second feeding module. The first radiator and the second radiator support multiple resonant modes, where at least one resonant mode is a  $1/8$  to  $1/4$  wavelength mode.





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(19) **United States**

(12) **Patent Application Publication**  
**HWANG**

(10) **Pub. No.: US 2024/0072444 A1**

(43) **Pub. Date: Feb. 29, 2024**

(54) **MULTIBAND PATCH ANTENNA**

**Publication Classification**

(71) Applicant: **AMOTECH CO., LTD.**, Incheon (KR)

(51) **Int. Cl.**  
**H01Q 9/04** (2006.01)  
**H01Q 5/25** (2006.01)

(72) Inventor: **Chul HWANG**, Incheon (KR)

(52) **U.S. Cl.**  
CPC ..... **H01Q 9/0407** (2013.01); **H01Q 5/25** (2015.01)

(73) Assignee: **AMOTECH CO., LTD.**, Incheon (KR)

(57) **ABSTRACT**

(21) Appl. No.: **18/272,487**

This disclosure presents a multiband patch antenna which resonates in a second frequency band as well as in a first frequency band, i.e., a GNSS frequency band, by adding an antenna pin to a patch antenna. The presented multiband patch antenna includes a base substrate, an upper patch disposed on an upper surface of the base substrate, a lower patch disposed on a lower surface of the base substrate, a feed pin which passes through the base substrate, the upper patch, and the lower patch, and an antenna pin which is spaced apart from the feed pin and passes through the base substrate and the lower patch.

(22) PCT Filed: **Jan. 13, 2022**

(86) PCT No.: **PCT/KR2022/000636**

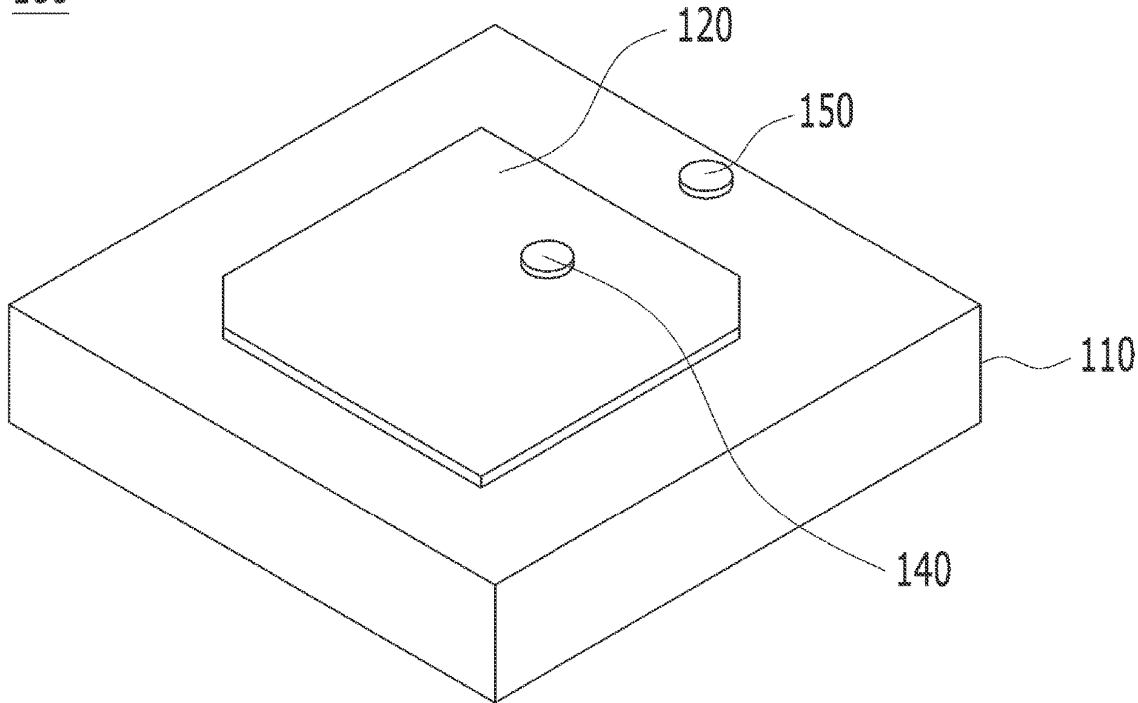
§ 371 (c)(1),

(2) Date: **Jul. 14, 2023**

(30) **Foreign Application Priority Data**

Jan. 15, 2021 (KR) ..... 10-2021-0005908

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(19) **United States**

(12) **Patent Application Publication**  
TAI et al.

(10) **Pub. No.: US 2024/0072445 A1**

(43) **Pub. Date: Feb. 29, 2024**

(54) **ANTENNA STRUCTURE**

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

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

CPC ..... **H01Q 9/0421** (2013.01); **H01Q 1/48**  
(2013.01); **H01Q 5/307** (2015.01)

(72) Inventors: **Chih-Feng TAI**, Hsinchu (TW);  
**Tzu-Chi LU**, Hsinchu (TW)

(57) **ABSTRACT**

(21) Appl. No.: **18/354,940**

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

(22) Filed: **Jul. 19, 2023**

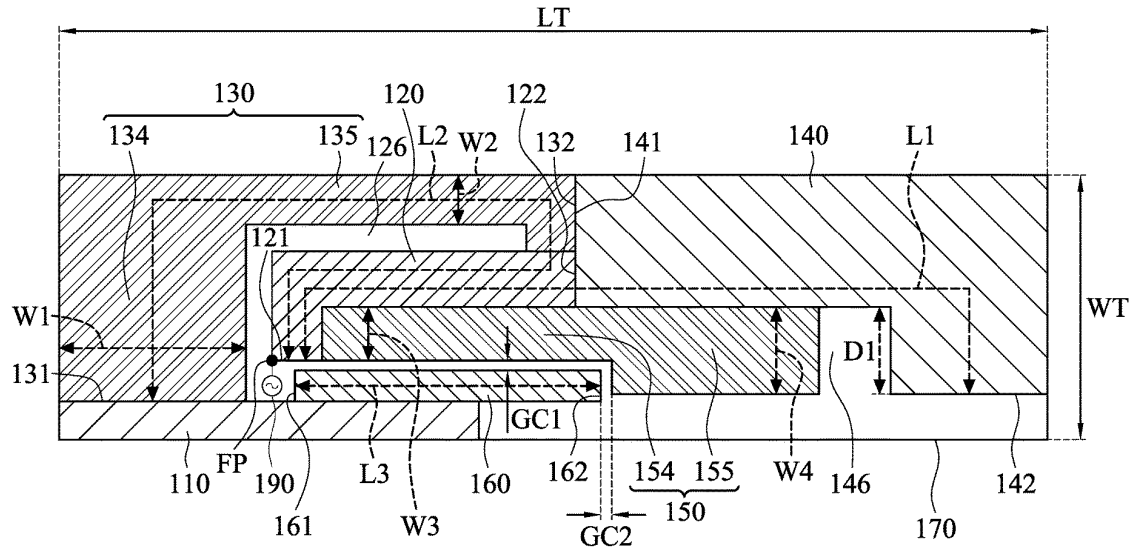
(30) **Foreign Application Priority Data**

Aug. 23, 2022 (TW) ..... 111131589

**Publication Classification**

(51) **Int. Cl.**  
**H01Q 9/04** (2006.01)  
**H01Q 1/48** (2006.01)  
**H01Q 5/307** (2006.01)

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(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2024/0088541 A1**

**Li et al.** (43) **Pub. Date: Mar. 14, 2024**

(54) **ELECTRONIC DEVICE**

**Publication Classification**

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

(51) **Int. Cl.**  
**H01Q 1/24** (2006.01)  
**H01Q 5/321** (2006.01)  
**H01Q 5/335** (2006.01)

(72) Inventors: **Yuanpeng Li**, Shenzhen (CN);  
**Hanyang Wang**, Reading (GB); **Dawei Zhou**, Shenzhen (CN)

(52) **U.S. Cl.**  
CPC ..... **H01Q 1/243** (2013.01); **H01Q 5/321**  
(2015.01); **H01Q 5/335** (2015.01)

(21) Appl. No.: **18/259,909**

(57) **ABSTRACT**

(22) PCT Filed: **Dec. 22, 2021**

An electronic device includes an antenna structure having an antenna radiator, a first circuit, a first feeding element, and a second feeding element. The first circuit comprises feeding input ports configured to input electrical signals of the first feeding element and the second feeding element, and feeding output ports configured to feed processed electrical signals to the antenna radiator. The electrical signal of the first feeding element has a same phase on the feeding input ports. The electrical signal of the second feeding element has opposite phases on the feeding input ports.

(86) PCT No.: **PCT/CN2021/140289**

§ 371 (c)(1),

(2) Date: **Jun. 29, 2023**

(30) **Foreign Application Priority Data**

Dec. 30, 2020 (CN) ..... 202011611722.2  
Mar. 19, 2021 (CN) ..... 202110296431.7



US 20240088543A1

(19) **United States**

(12) **Patent Application Publication**  
**Koul et al.**

(10) **Pub. No.: US 2024/0088543 A1**

(43) **Pub. Date: Mar. 14, 2024**

(54) **CONFORMAL ANTENNA MODULE WITH 3D-PRINTED RADOME**

**Publication Classification**

(71) Applicant: **Synergy Microwave Corporation**, Paterson, NJ (US)

(51) **Int. Cl.**  
*H01Q 1/24* (2006.01)  
*H01Q 1/42* (2006.01)  
*H01Q 3/30* (2006.01)  
*H01Q 9/04* (2006.01)

(72) Inventors: **Shiban K. Koul**, Delhi (IN); **Ajay Kumar Poddar**, Elmwood Park, NJ (US); **Karthikeya Gulur Sadananda**, New Delhi (IN); **Ulrich L. Rohde**, Upper Saddle River, NJ (US)

(52) **U.S. Cl.**  
CPC ..... *H01Q 1/243* (2013.01); *H01Q 1/42* (2013.01); *H01Q 3/30* (2013.01); *H01Q 9/0407* (2013.01)

(73) Assignee: **Synergy Microwave Corporation**, Paterson, NJ (US)

(57) **ABSTRACT**

(21) Appl. No.: **18/508,553**

The present disclosure provides several embodiments of integrated conformal antennas that are designed to be integrated into handheld devices and support operation at millimeter-wave operating frequency band that includes 28 GHz. The antennas have low mutual coupling despite close proximity, and maintain a front-to-back radiation ratio of 10 dB or better within the operating frequency band. The integrated conformal antennas are further capable of supporting operation of the device in different orientations, different forward gains, or a combination thereof.

(22) Filed: **Nov. 14, 2023**

**Related U.S. Application Data**

(62) Division of application No. 17/221,965, filed on Apr. 5, 2021, now Pat. No. 11,876,284.

(60) Provisional application No. 63/033,884, filed on Jun. 3, 2020.

