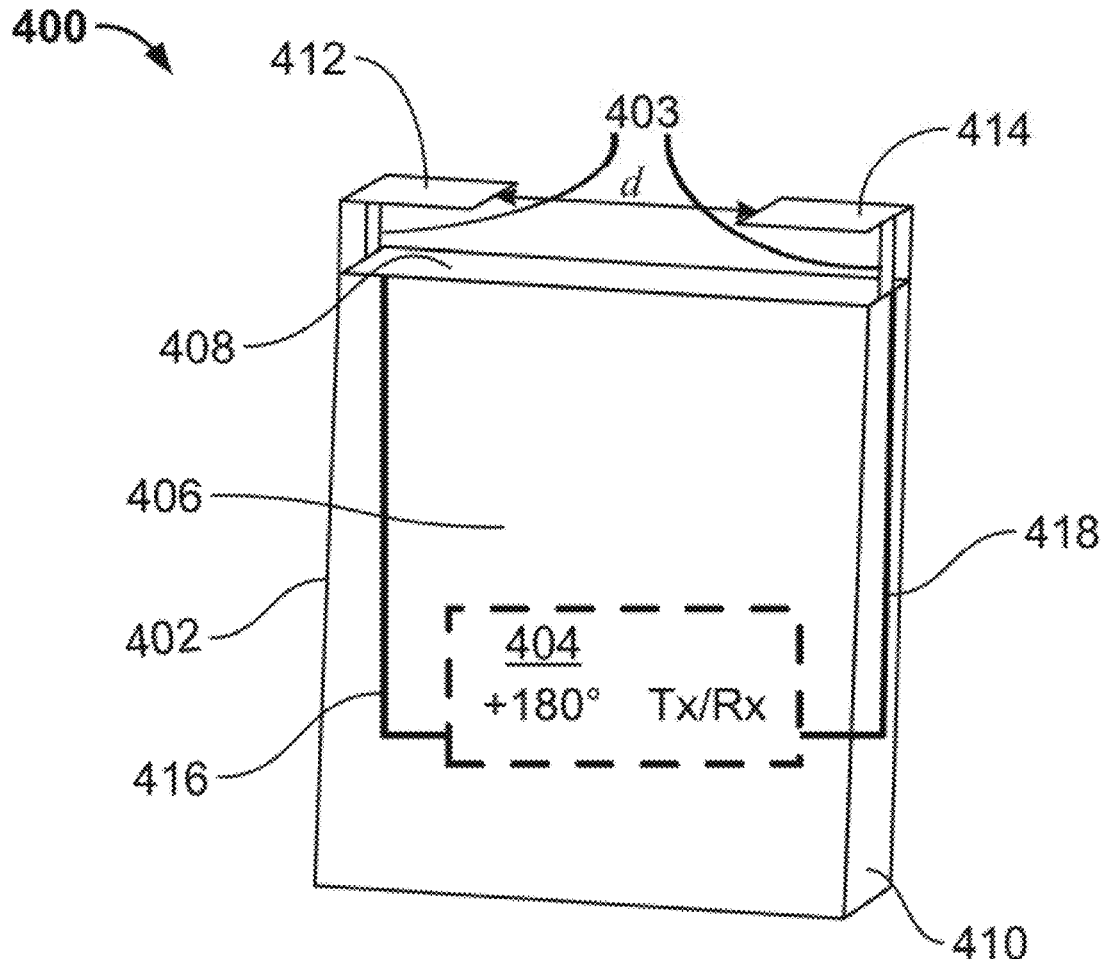


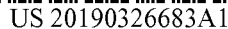


US 20190326673A1

(19) **United States**(12) **Patent Application Publication****Jones, III**(10) **Pub. No.: US 2019/0326673 A1**(43) **Pub. Date: Oct. 24, 2019**(54) **DUAL SMALL ANTENNAS WITH FEED
POINTS FED OUT OF PHASE**(52) **U.S. Cl.**
CPC **H01Q 9/0421** (2013.01); **H01Q 1/243**
(2013.01)(71) Applicant: **SPAWAR Systems Center Pacific**, San
Diego, CA (US)(72) Inventor: **Thomas O. Jones, III**, San Diego, CA
(US)(73) Assignee: **United States of America as
represented by Secretary of the Navy**,
San Diego, CA (US)(21) Appl. No.: **15/956,873**(22) Filed: **Apr. 19, 2018****Publication Classification**(51) **Int. Cl.**
H01Q 9/04 (2006.01)(57) **ABSTRACT**

A system includes a rectangular parallelepiped, a first and second antenna and a driving component. The rectangular parallelepiped has a front surface, a back surface, a first side surface a second side surface, a top surface and a bottom surface. The front surface is parallel with the back surface, the first side surface is parallel with the second side surface and the top surface is parallel with the bottom surface. The first antenna and the second antenna are disposed at the top surface and are separated by a distance, d . The driving component drives the first antenna at a frequency f and at a first phase φ , and drives the second antenna at the frequency f and at a second phase $\varphi+180^\circ$, wherein $d < \lambda$, and wherein λ is an operating wavelength of the system.





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

(43) **Pub. Date:** **Oct. 24, 2019**

CPC **H01Q 21/0006** (2013.01); **H01Q 5/307**
(2015.01); **H01Q 9/0421** (2013.01)

(57) **ABSTRACT**

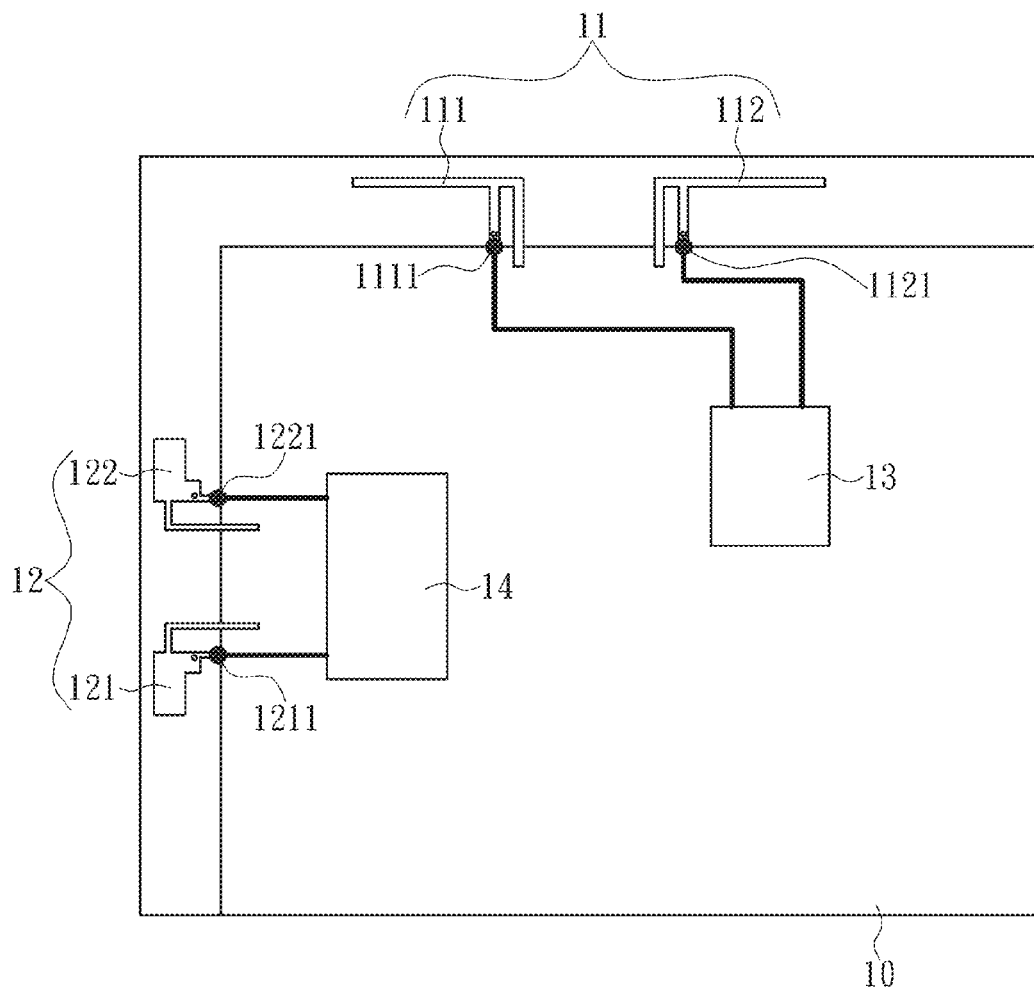
(22) Filed: **Jan. 3, 2019**

Apr. 20, 2018 (TW) 107205217

Publication Classification

H010 5/307 (2006.01)

An antenna assembly with compact layout traces includes a circuit board and at least one wireless antenna unit, wherein the circuit board is provided with an antenna module, the at least one wireless antenna unit can be located at the same edge or at different edges of the circuit board, each of the at least one wireless antenna unit includes two antennas of the planar inverted-F antenna (PIFA) structure and a neutralization line, and the two antennas are spaced apart from each other and the two ends of the neutralization line are electrically connected to and overlap the two antennas respectively. By arranging antennas of the same working band along the same edge of the circuit board, the corresponding layout traces can be effectively shortened.





US 20190334232A1

(19) **United States**

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

(10) **Pub. No.: US 2019/0334232 A1**

(43) **Pub. Date: Oct. 31, 2019**

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

(30) **Foreign Application Priority Data**

Nov. 23, 2016 (KR) 10-2016-0156609

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

Publication Classification

(72) Inventors: **Dohyuk HA**, Gyeonggi-do (KR);
Junsig KUM, Gyeonggi-do (KR);
Jungyub LEE, Gyeonggi-do (KR);
Youngju LEE, Seoul (KR)

(51) **Int. Cl.**

H01Q 1/42 (2006.01)

H01Q 1/22 (2006.01)

H01Q 1/52 (2006.01)

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

CPC **H01Q 1/42** (2013.01); **H01Q 1/528**
(2013.01); **H01Q 1/2283** (2013.01)

(21) Appl. No.: **16/462,054**

(57)

ABSTRACT

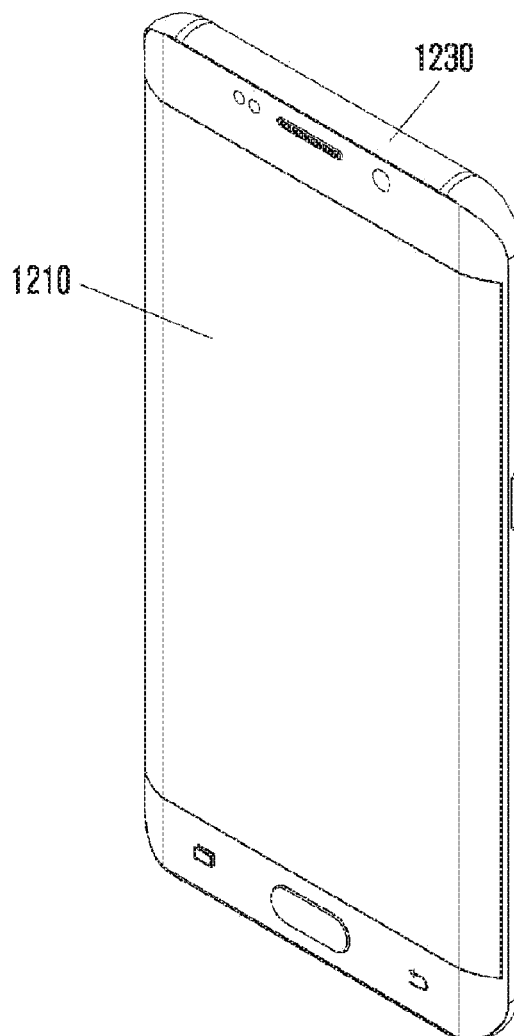
(22) PCT Filed: **Nov. 20, 2017**

An antenna device can include: an antenna substrate, on which an array antenna including at least one radiation element is arranged; and a cover spaced apart from the antenna substrate at at least a predetermined distance and further including at least one relay radiation element arranged to correspond to the at least one radiation element.

(86) PCT No.: **PCT/KR2017/013179**

§ 371 (c)(1),

(2) Date: **May 17, 2019**





US 20190334236A1

(19) **United States**

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

(10) **Pub. No.: US 2019/0334236 A1**

(43) **Pub. Date: Oct. 31, 2019**

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

Publication Classification

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

(72) Inventors: **Hyunjin KIM**, Seoul (KR);
Kwanghyun BAEK, Hwaseong-si
(KR); **Byungchul KIM**, Yongin-si
(KR); **Jungmin PARK**, Seoul (KR);
Youngju LEE, Seoul (KR); **Sungchul
PARK**, Seoul (KR)

(51) **Int. Cl.**

H01Q 1/52 (2006.01)

H01Q 21/24 (2006.01)

H01Q 13/08 (2006.01)

H01Q 1/24 (2006.01)

H01Q 13/02 (2006.01)

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

CPC **H01Q 1/525** (2013.01); **H01Q 21/24**
(2013.01); **H01P 5/107** (2013.01); **H01Q**
1/243 (2013.01); **H01Q 13/02** (2013.01);
H01Q 13/085 (2013.01)

(21) Appl. No.: **16/504,920**

(22) Filed: **Jul. 8, 2019**

Related U.S. Application Data

(63) Continuation of application No. 15/685,363, filed on
Aug. 24, 2017, now Pat. No. 10,347,985.

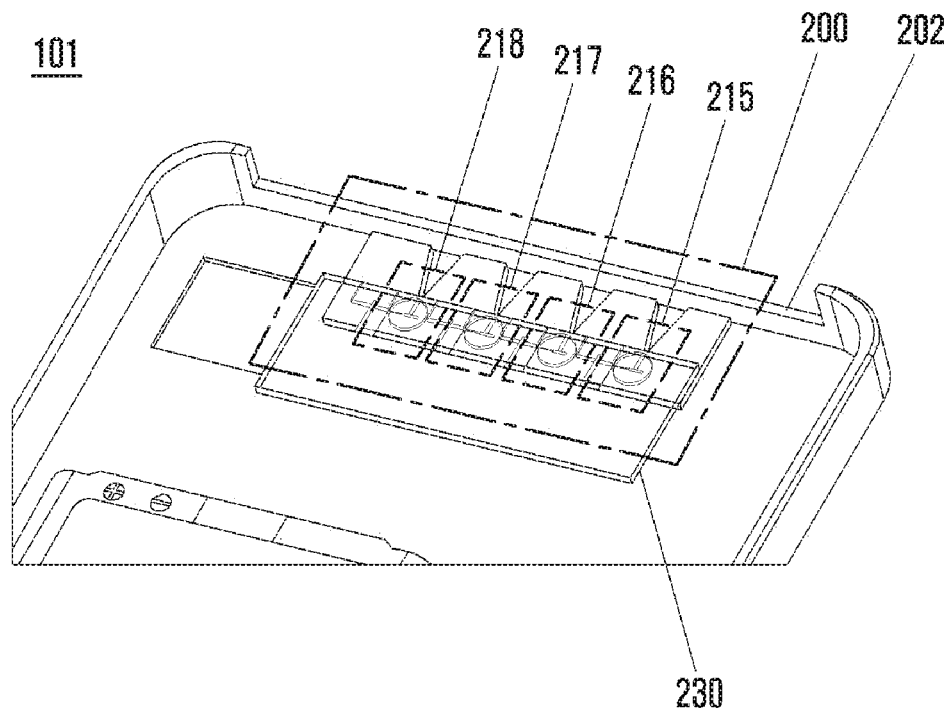
(30) **Foreign Application Priority Data**

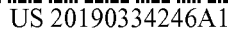
Aug. 25, 2016 (KR) 10-2016-0108334

(57)

ABSTRACT

An electronic device is provided that includes a circuit board received in the electronic device and in which at least one board is layered, a communication module disposed at one surface of the circuit board and electrically connected to the circuit board, an antenna electrically connected to the communication module, and a metal structure whose one surface is separated from the other surface of the circuit board to form a space within the electronic device by enclosing the circuit board and in which at least one aperture is formed at one side thereof.





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

(43) **Pub. Date:** **Oct. 31, 2019**

Publication Classification

(51) **Int. Cl.**
H01Q 13/08 (2006.01)
H01Q 1/52 (2006.01)
H01Q 19/02 (2006.01)
H01Q 1/38 (2006.01)
H01Q 9/06 (2006.01)
H01Q 19/00 (2006.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 13/08*** (2013.01); ***H01Q 1/52***
(2013.01); ***H01Q 19/02*** (2013.01); ***H01Q***
9/045 (2013.01); ***H01Q 9/065*** (2013.01);
H01Q 19/005 (2013.01); ***H01Q 1/38*** (2013.01)

(57) **ABSTRACT**

(22) Filed: **Jul. 8, 2019**

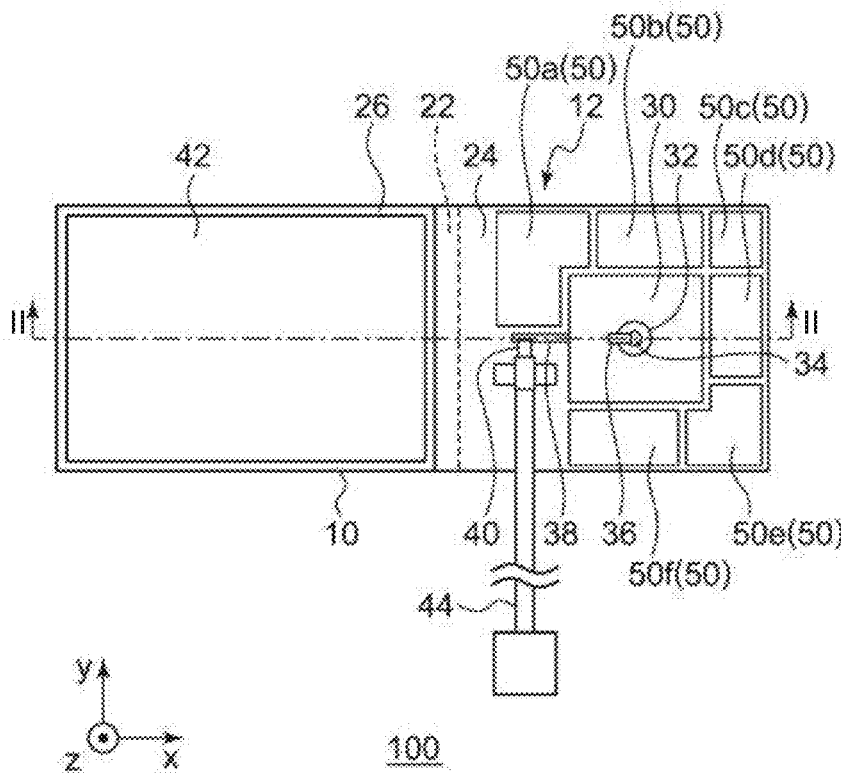
Related U.S. Application Data

(63) Continuation of application No. PCT/JP2018/000604, filed on Jan. 12, 2018.

(30) **Foreign Application Priority Data**

Jan. 18, 2017	(JP)	2017-007038
Jan. 18, 2017	(JP)	2017-007039
Jan. 18, 2017	(JP)	2017-007040

An antenna includes a dielectric substrate, a ground element, a feed element, a microstrip line, and a feed point. The ground element is disposed on a first surface of the dielectric substrate. The ground element includes a slit. The feed element is disposed on a second surface of the dielectric substrate. The microstrip line extends from the feed element toward the slit. The feed point is disposed on the second surface of the dielectric substrate, and connected to the feed element via the microstrip line. The feed point is positioned between the feed element and the slit, and disposed at an end of the microstrip line.





US 20190334254A1

(19) **United States**(12) **Patent Application Publication**
WU(10) **Pub. No.: US 2019/0334254 A1**(43) **Pub. Date: Oct. 31, 2019**(54) **HIGH-ISOLATION DUAL-BAND ANTENNA**(52) **U.S. Cl.**(71) Applicant: **ARCADYAN TECHNOLOGY CORPORATION**, Hsinchu (TW)CPC *H01Q 21/28* (2013.01); *H01Q 1/48* (2013.01); *H01Q 5/50* (2015.01); *H01Q 5/307* (2015.01)(72) Inventor: **Min-Chi WU**, Zhubei City (TW)

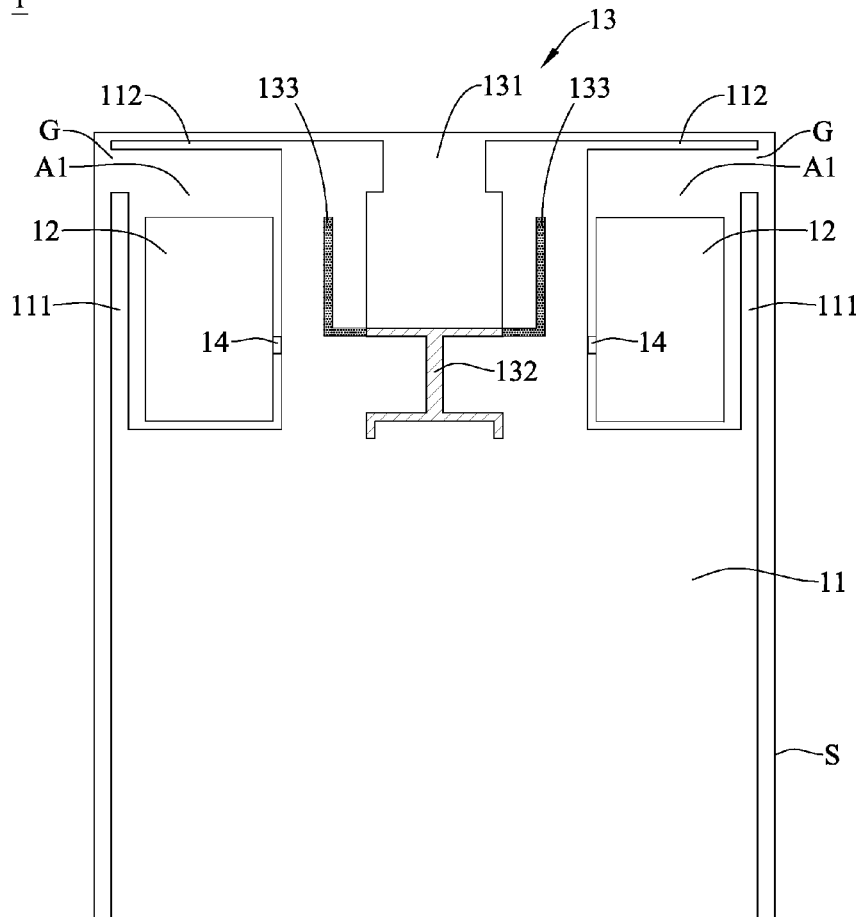
(57)

ABSTRACT(21) Appl. No.: **16/396,922**(22) Filed: **Apr. 29, 2019**(30) **Foreign Application Priority Data**

Apr. 30, 2018 (TW) 107114678

Publication Classification(51) **Int. Cl.***H01Q 21/28* (2006.01)*H01Q 5/307* (2006.01)*H01Q 5/50* (2006.01)*H01Q 1/48* (2006.01)

A high-isolation dual-band antenna is provided, which may be operated in a first frequency band and a second frequency band, and include a ground zone, two radiators and an isolation zone. The radiators may be disposed at the both sides of the ground zone respectively. The isolation zone may include a main body, a first-slot and two second-slots; the first-slot may be disposed at one end of the main body and the second-slots may be disposed at the both sides of the main body respectively. At least a portion of the first-slot and the second-slots may serve as the isolation section of the first frequency band, and at least a portion of each second-slot may serve as the isolation section of the second frequency band, such that the isolation section of the first frequency band may partially overlap the isolation section of the second frequency band.

1



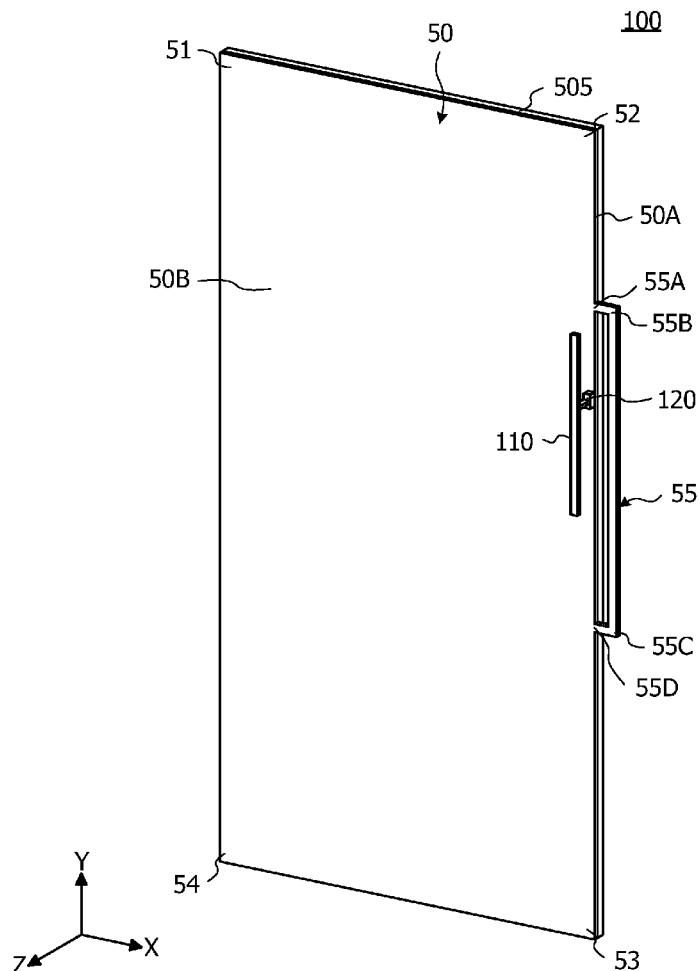
US 20190341675A1

(19) **United States**(12) **Patent Application Publication**
YAMAGAJO et al.(10) **Pub. No.: US 2019/0341675 A1**(43) **Pub. Date: Nov. 7, 2019**(54) **ANTENNA DEVICE**(71) Applicant: **Fujitsu Limited**, Kawasaki-shi (JP)(72) Inventors: **Takashi YAMAGAJO**, Yokosuka (JP);
Yohei Koga, Kawasaki (JP); **Manabu Yoshikawa**, Yokohama (JP); **Tabito Tonooka**, Kawasaki (JP); **Hirotake Sumi**, Kawasaki (JP)(73) Assignee: **Fujitsu Limited**, Kawasaki-shi (JP)(21) Appl. No.: **16/374,255**(22) Filed: **Apr. 3, 2019**(30) **Foreign Application Priority Data**

May 7, 2018 (JP) 2018-089427

Publication Classification(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/38 (2006.01)
H01Q 1/48 (2006.01)**H01Q 13/08** (2006.01)**H01Q 5/10** (2006.01)**H01Q 9/42** (2006.01)**H01Q 7/00** (2006.01)(52) **U.S. Cl.**CPC **H01Q 1/243** (2013.01); **H01Q 1/38**
(2013.01); **H01Q 1/48** (2013.01); **H01Q 7/00**
(2013.01); **H01Q 5/10** (2015.01); **H01Q 9/42**
(2013.01); **H01Q 13/08** (2013.01)(57) **ABSTRACT**

An antenna device includes a ground plane that includes an edge and a surface, a protruding metallic member that includes a first connecting part and a second connecting part coupled to the ground plane, protrudes from the edge, and constructs a first loop including the edge, and a T-shaped antenna element that extends from a feeding point to a first end and a second end along the edge, the feeding point being disposed in the vicinity of the surface between the first connecting part and the second connecting part of the first loop, wherein a length of the first loop corresponds to an electric length of one wavelength in a first frequency, and corresponds to an electric length of two wavelengths in a second frequency that is a second order harmonic of the first frequency.





US 20190341676A1

(19) **United States**(12) **Patent Application Publication**
Yamaguchi et al.(10) **Pub. No.: US 2019/0341676 A1**(43) **Pub. Date: Nov. 7, 2019**(54) **ANTENNA DEVICE AND
COMMUNICATIONS DEVICE**(71) Applicant: **Panasonic Intellectual Property
Management Co., Ltd., Osaka (JP)**(72) Inventors: **Shuichiro Yamaguchi, Fukuoka (JP);
Hiroshi SAKAI, Saga (JP)**(21) Appl. No.: **16/511,735**(22) Filed: **Jul. 15, 2019****H01Q 13/16** (2006.01)**G06K 7/10** (2006.01)**H01F 27/36** (2006.01)**H01Q 7/00** (2006.01)**H01Q 7/06** (2006.01)(52) **U.S. Cl.**CPC **H01Q 1/243** (2013.01); **H04B 5/0081**(2013.01); **H01Q 13/16** (2013.01); **G06K****7/10316** (2013.01); **H01Q 7/06** (2013.01);**H01Q 1/24** (2013.01); **H01F 27/36** (2013.01);**H01Q 7/00** (2013.01); **G06K 7/10336**

(2013.01)

Related U.S. Application Data(63) Continuation of application No. 16/156,825, filed on
Oct. 10, 2018, now Pat. No. 10,396,439, which is a
continuation of application No. 14/426,112, filed on
Mar. 4, 2015, now Pat. No. 10,224,601, filed as
application No. PCT/JP2013/005304 on Sep. 6, 2013.**Foreign Application Priority Data**

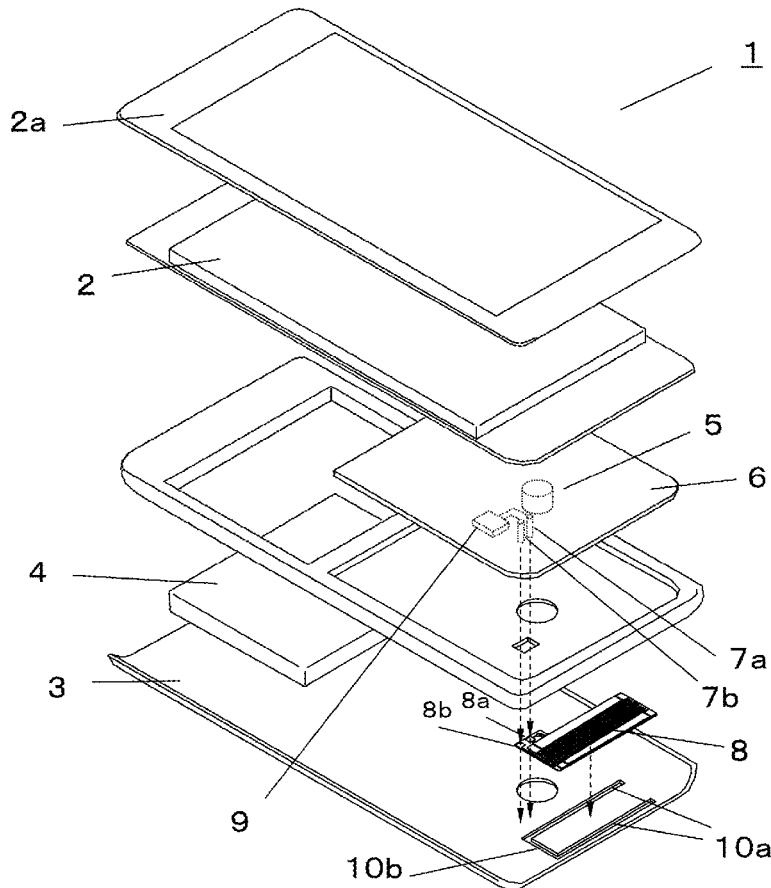
Sep. 6, 2012 (JP) 2012-195870

Publication Classification(51) **Int. Cl.****H01Q 1/24** (2006.01)**H04B 5/00** (2006.01)

(57)

ABSTRACT

A small antenna device having good communications performance and a wide communications area even when a metal plate is present in the antenna communications direction, even when the antenna is arranged, for example, inside a box-shaped metal case, and even when a through hole is used that has a smaller area than the antenna. This device comprises: the antenna; a rear surface cover overlapping with the antenna and being a conductor that faces the winding of the antenna; two first insulating areas provided in the rear surface cover and extending in a direction that intersects the winding axis of the antenna; and a second insulating area that connects between the first insulating areas. At least part of the area sandwiched by the first insulating areas faces the antenna.





US 20190341686A1

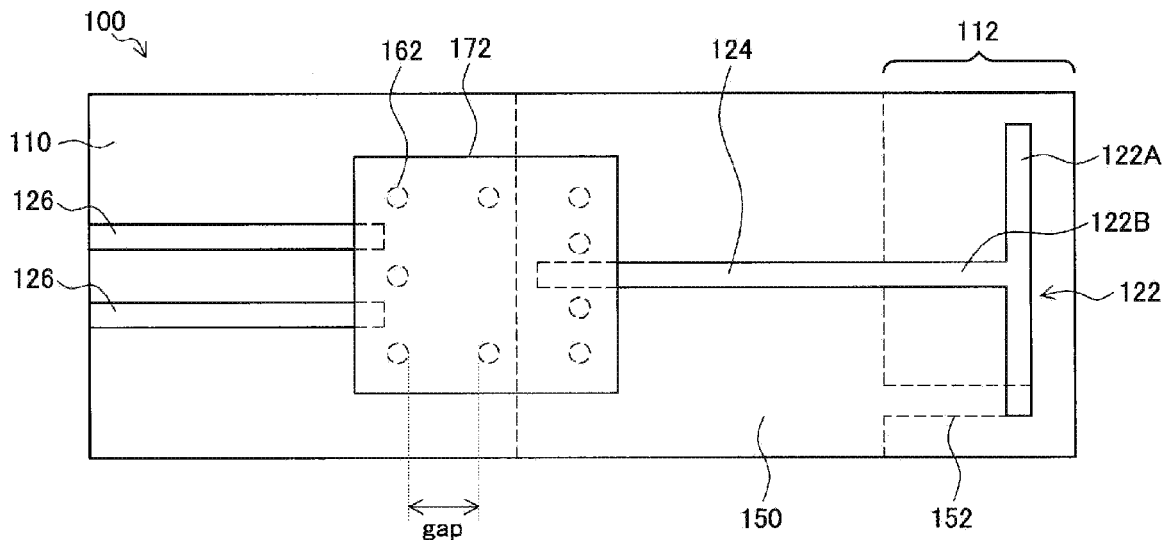
(19) **United States**(12) **Patent Application Publication**
SATO et al.(10) **Pub. No.: US 2019/0341686 A1**(43) **Pub. Date: Nov. 7, 2019**(54) **HIGH-FREQUENCY MODULE AND
COMMUNICATION DEVICE****Publication Classification**(71) Applicant: **SONY SEMICONDUCTOR
SOLUTIONS CORPORATION,**
KANAGAWA (JP)(51) **Int. Cl.****H01Q 1/52** (2006.01)**H01Q 23/00** (2006.01)(52) **U.S. Cl.**CPC **H01Q 1/526** (2013.01); **H01Q 1/246**
(2013.01); **H01Q 23/00** (2013.01); **H01Q**
1/525 (2013.01)(72) Inventors: **MASAHIRO SATO, TOKYO (JP);**
TAKASHI KAWAMURA,
KANAGAWA (JP)(57) **ABSTRACT**(21) Appl. No.: **16/344,015**(22) PCT Filed: **Oct. 19, 2017**(86) PCT No.: **PCT/JP2017/037794**

§ 371 (c)(1),

(2) Date: **Apr. 22, 2019**(30) **Foreign Application Priority Data**

Nov. 29, 2016 (JP) 2016-231177

[Object] To provide a high-frequency module and a communication device, each of which includes a non-directional antenna and is suitable for transmission/reception of a radio wave in a high frequency band. [Solution] A high-frequency module including: an antenna portion provided to project from a board; an antenna element at least a part of which is provided on the antenna portion; a transmission line formed on a same surface as the antenna element and including a same material as the antenna element; and a high-frequency element mounted on a surface of the board on which the transmission line is formed.





US 20190341688A1

(19) **United States**(12) **Patent Application Publication**
KIM et al.(10) **Pub. No.: US 2019/0341688 A1**(43) **Pub. Date: Nov. 7, 2019**(54) **ANTENNA AND ELECTRONIC DEVICE**
INCLUDING SAME**H01Q 5/35** (2006.01)**H04M 1/02** (2006.01)**H01Q 1/24** (2006.01)(71) Applicant: **Samsung Electronics Co., Ltd.**,
Suwon-si (KR)(52) **U.S. Cl.**CPC **H01Q 1/526** (2013.01); **H05K 1/0224**
(2013.01); **H05K 1/0215** (2013.01); **G06F**
1/1698 (2013.01); **H01Q 1/243** (2013.01);
H01Q 1/38 (2013.01); **H01Q 1/48** (2013.01);
H01Q 5/35 (2015.01); **H04M 1/0283**
(2013.01); **H01Q 1/523** (2013.01)(72) Inventors: **Jaehyung KIM**, Suwon-si (KR);
Hanbin LEE, Suwon-si (KR);
Sangmin HAN, Suwon-si (KR);
Jongsuk KIM, Suwon-si (KR); **Taegyu**
KIM, Suwon-si (KR); **Minseok PARK**,
Suwon-si (KR); **Jinkyu BANG**,
Suwon-si (KR)

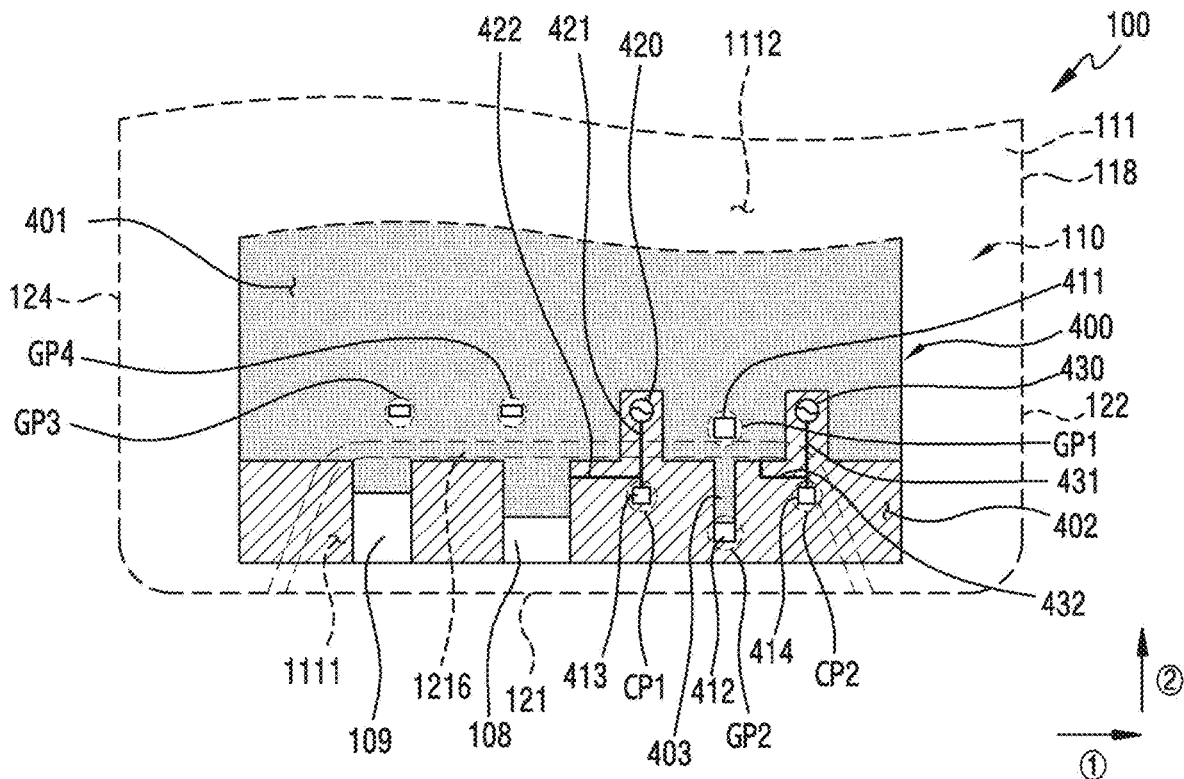
(57)

ABSTRACT

An electronic device is provided. The electronic device includes a housing, a touch screen display arranged inside the housing, a printed circuit board (PCB) which is arranged in parallel with a rear plate, and which includes a ground plane and a conductive path, and a wireless communication circuit arranged on the PCB. The housing includes a first side surface, a second side surface, a third side surface, and a fourth side surface. The first side surface includes a first conductive part, a first nonconductive part, a second conductive part, a second nonconductive part, and a third conductive part successively arranged between the second side surface and the fourth side surface. The rear plate includes, when seen from above the rear plate, a nonconductive slit extending from the first nonconductive part to the second nonconductive part, a first conductive area, and a second conductive area positioned outside the first conductive area across the nonconductive slit.

(21) Appl. No.: **16/402,688**(22) Filed: **May 3, 2019**(30) **Foreign Application Priority Data**

May 4, 2018 (KR) 10-2018-0052101

Publication Classification(51) **Int. Cl.****H01Q 1/52** (2006.01)**H05K 1/02** (2006.01)**G06F 1/16** (2006.01)**H01Q 1/38** (2006.01)**H01Q 1/48** (2006.01)



US 20190341692A1

(19) **United States**(12) **Patent Application Publication**
KUBO(10) **Pub. No.: US 2019/0341692 A1**(43) **Pub. Date: Nov. 7, 2019**(54) **ANTENNA DEVICE AND ELECTRONIC
APPLIANCE**(71) Applicant: **Murata Manufacturing Co., Ltd.**,
Nagaokakyo-shi (JP)(72) Inventor: **Hiroyuki KUBO**, Nagaokakyo-shi (JP)(21) Appl. No.: **16/513,890**(22) Filed: **Jul. 17, 2019****H01Q 1/22** (2006.01)**H02J 7/02** (2006.01)**H02J 50/20** (2006.01)**H02J 50/10** (2006.01)(52) **U.S. Cl.**CPC **H01Q 7/06** (2013.01); **H01Q 1/36**
(2013.01); **H02J 50/10** (2016.02); **H02J 7/025**
(2013.01); **H02J 50/20** (2016.02); **H01Q**
1/2283 (2013.01)**Related U.S. Application Data**(63) Continuation of application No. PCT/JP2018/
037830, filed on Oct. 11, 2018.**Foreign Application Priority Data**

Oct. 12, 2017 (JP) 2017-198125

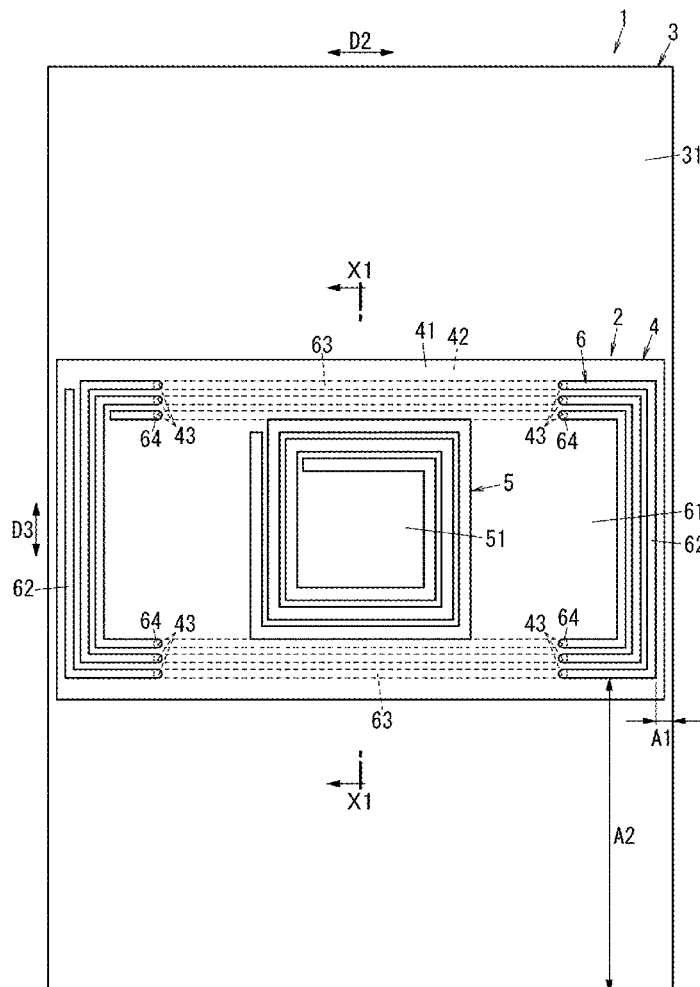
Jul. 25, 2018 (JP) 2018-139751

Publication Classification(51) **Int. Cl.****H01Q 7/06** (2006.01)**H01Q 1/36** (2006.01)

(57)

ABSTRACT

An antenna device includes a magnetic body and first and second antennas. The first coil antenna includes a first opening and is provided on a first main surface side of the magnetic body. The second coil antenna includes a second opening partially superposed with the first opening. The second coil antenna includes first and second coil conductor portions. The first coil conductor portions are provided on the first main surface side of the magnetic body. The second coil conductor portions are provided on a second main surface side of the magnetic body. The second coil conductor portions are closer to the first coil antenna than the first coil conductor portions.





US 20190348750A1

(19) **United States**(12) **Patent Application Publication**
LIN(10) **Pub. No.: US 2019/0348750 A1**(43) **Pub. Date: Nov. 14, 2019**(54) **ANTENNA STRUCTURE AND WIRELESS COMMUNICATION DEVICE USING THE SAME**(52) **U.S. Cl.**CPC *H01Q 1/243* (2013.01); *H01Q 1/48* (2013.01); *H01Q 5/30* (2015.01); *H01Q 1/521* (2013.01)(71) Applicant: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

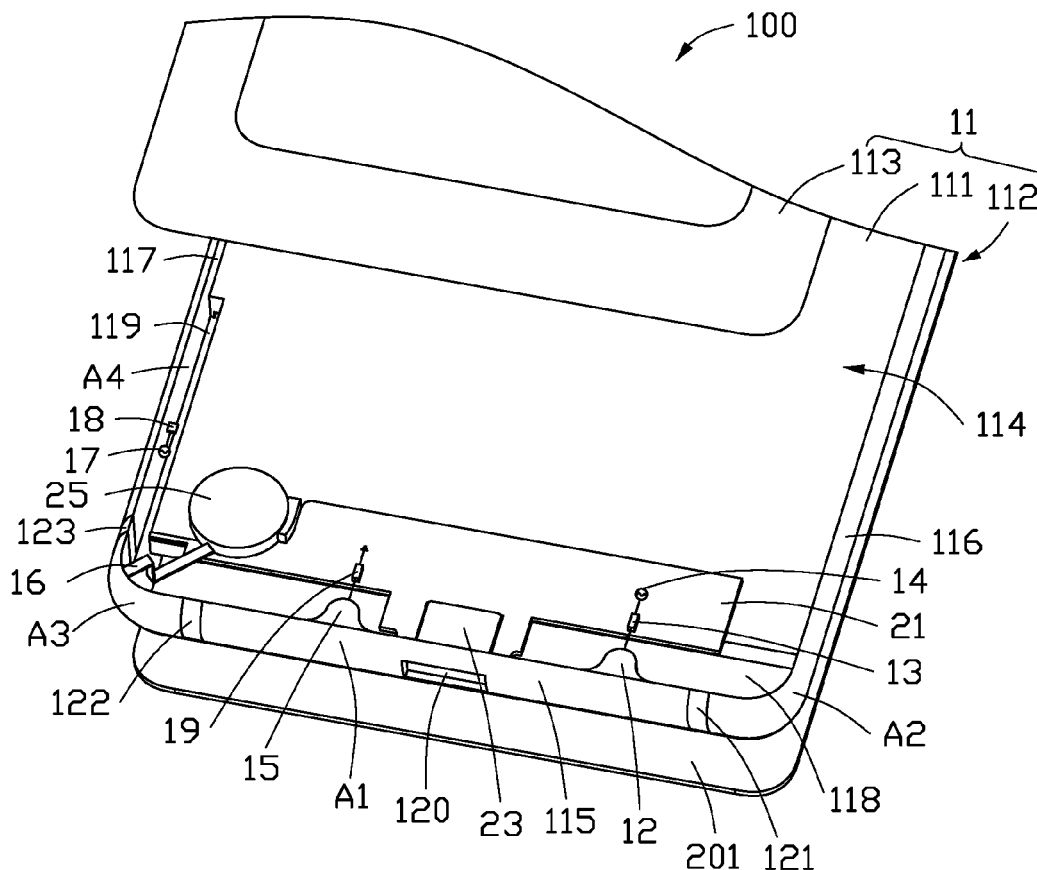
(57)

ABSTRACT(72) Inventor: **YEN-HUI LIN**, New Taipei (TW)(21) Appl. No.: **16/385,615**(22) Filed: **Apr. 16, 2019**(30) **Foreign Application Priority Data**

May 8, 2018 (CN) 201810431335.7

Publication Classification(51) **Int. Cl.***H01Q 1/24* (2006.01)
H01Q 1/52 (2006.01)
H01Q 5/30 (2006.01)
H01Q 1/48 (2006.01)

An antenna structure includes a housing, a first feed source, and a second feed source. The housing includes a side frame. The side frame defines a first gap, a second gap, and a groove. The first gap, the second gap, and the groove divide the side frame into a first radiating portion, an isolation portion, and a second radiating portion. The first feed source is electrically connected to the first radiating portion for supplying current to the first radiating portion. The second feed source is electrically connected to or being coupled to the second radiating portion for supplying current to the second radiating portion. The isolation portion is positioned between the first radiating portion and the second radiating portion. The isolation portion is grounded. The current from the first radiating portion and the current from the second radiating portion are respectively coupled to the isolation portion.

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US 20190348762A1

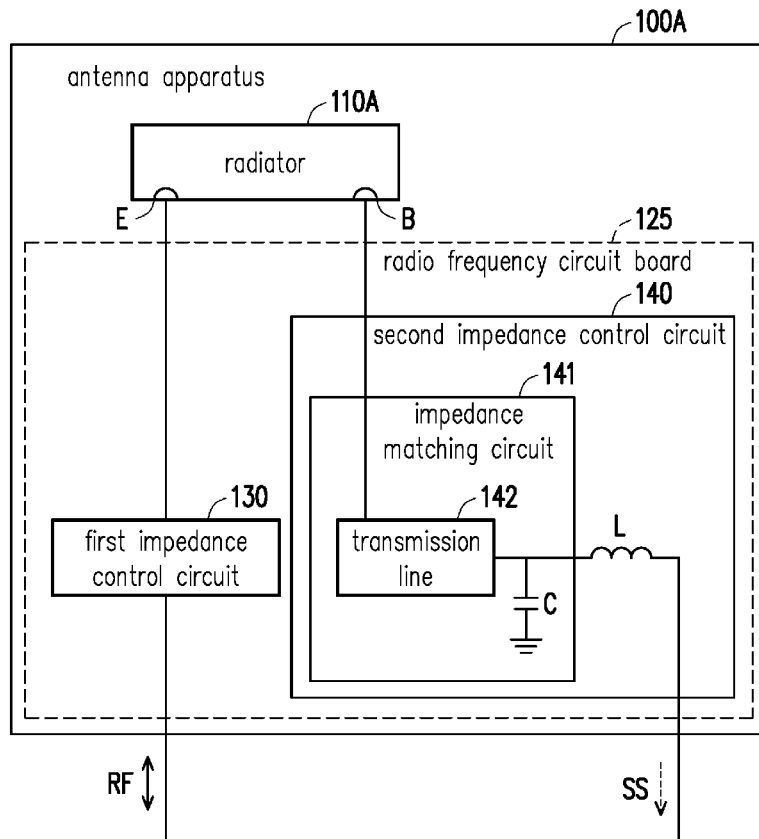
(19) **United States**(12) **Patent Application Publication**
Chou et al.(10) **Pub. No.: US 2019/0348762 A1**(43) **Pub. Date: Nov. 14, 2019**(54) **ANTENNA APPARATUS AND ELECTRONIC APPARATUS****Publication Classification**(51) **Int. Cl.****H01Q 5/335** (2006.01)**H01Q 5/385** (2006.01)**H01Q 5/328** (2006.01)**H01Q 15/16** (2006.01)(52) **U.S. Cl.**CPC **H01Q 5/335** (2015.01); **H01Q 15/167** (2013.01); **H01Q 5/328** (2015.01); **H01Q 5/385** (2015.01)(71) Applicants: **An-Yao Chou**, Taipei City (TW);
Shih-Chia Liu, Taipei City (TW);
Yen-Hao Yu, Taipei City (TW);
Li-Chun Lee, Taipei City (TW);
Jhin-Ciang Chen, Taipei City (TW);
Chao-Lin Wu, Taipei City (TW);
Jui-Hung Lai, Taipei City (TW)(72) Inventors: **An-Yao Chou**, Taipei City (TW);
Shih-Chia Liu, Taipei City (TW);
Yen-Hao Yu, Taipei City (TW);
Li-Chun Lee, Taipei City (TW);
Jhin-Ciang Chen, Taipei City (TW);
Chao-Lin Wu, Taipei City (TW);
Jui-Hung Lai, Taipei City (TW)(73) Assignee: **COMPAL ELECTRONICS, INC.**,
Taipei City (TW)(21) Appl. No.: **16/409,879**(22) Filed: **May 13, 2019****Related U.S. Application Data**

(60) Provisional application No. 62/670,851, filed on May 13, 2018, provisional application No. 62/748,533, filed on Oct. 22, 2018.

(57)

ABSTRACT

An antenna apparatus and an electronic apparatus are provided. The electronic apparatus includes the antenna apparatus. The antenna apparatus includes a radiator, a first and a second impedance control circuit. The radiator receives and transmits a radio frequency (RF) signal. The first impedance control circuit is electrically connected to the radiator and transmits the RF signal. The second impedance control circuit includes an impedance matching circuit and an inductor. The first end of the impedance matching circuit is electrically connected to the radiator. The impedance matching circuit adjusts the impedance matching of the radiator and transmits a sensing signal. The inductor is electrically connected to the second end of the impedance matching circuit. The inductor transmits a sensing signal, and blocks the RF signal. Accordingly, the structures of the antenna and the circuit can be simplified, and the influence between the RF signal and the sensing signal can be reduced.





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(54) **5G MIMO ANTENNA STRUCTURE**

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(71) Applicant: **SHENZHEN SUNWAY
COMMUNICATION CO., LTD.**,
Shenzhen City, Guangdong (CN)

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(72) Inventors: **Anping ZHAO**, Shenzhen (CN);
Zhouyou REN, Shenzhen (CN)

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(73) Assignee: **SHENZHEN SUNWAY
COMMUNICATION CO., LTD.**,
Shenzhen City, Guangdong (CN)

(57) **ABSTRACT**

A 5G MIMO antenna structure includes a PCB and more than one first antenna assembly arranged on the PCB at intervals. Each first antenna assembly includes a feed branch, a first radiator and two second radiators, wherein the first radiator and the two second radiators are coupled to the feed branch, the first radiator is of an inverted U-structure and has two tail ends connected to grounding points of the PCB, the feed branch is located in the first radiator and corresponds to a feed point of the PCB in position, and the two second radiators are arranged in the first radiator, connected to the first radiator, and respectively located on two sides of the feed branch. The 5G MIMO antenna structure has a good radiation effect, a good isolation effect and a smaller size, and can meet the usage requirements of a 5G system below 6 GHz.

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