



US 20190384358A1

(19) **United States**(12) **Patent Application Publication**
CHOE et al.(10) **Pub. No.: US 2019/0384358 A1**(43) **Pub. Date: Dec. 19, 2019**(54) **ELECTRONIC DEVICE INCLUDING
FLEXIBLE PRINTED CIRCUIT BOARD
ADJACENT TO ANTENNA****Publication Classification**

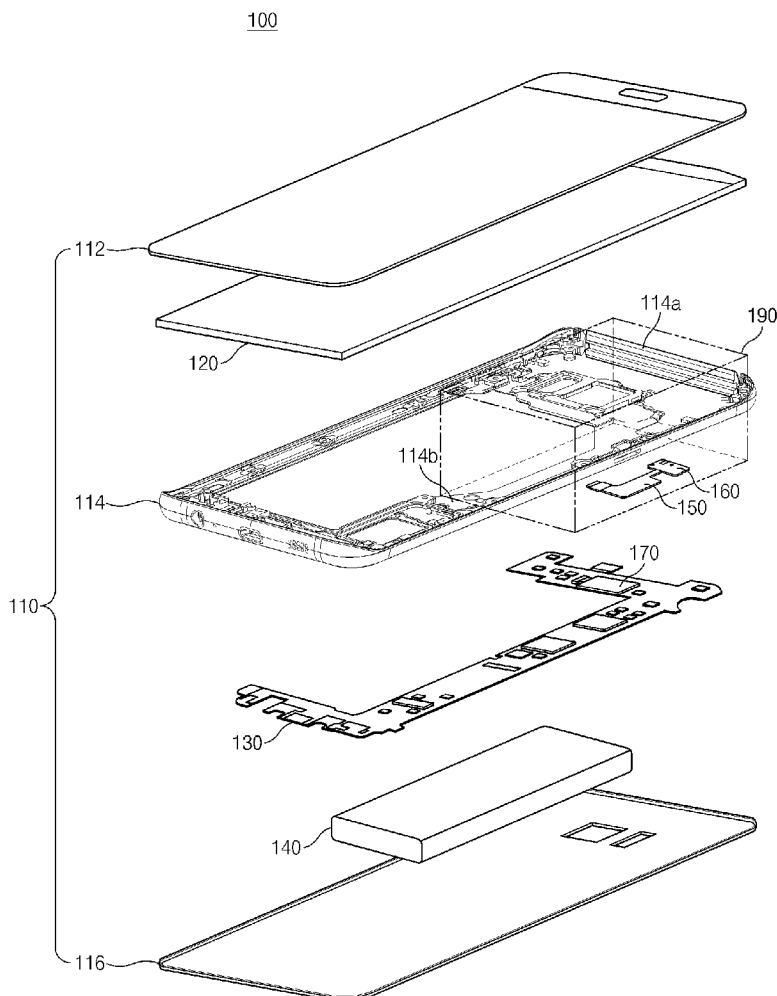
(51) **Int. Cl.**
G06F 1/16 (2006.01)
H05K 1/02 (2006.01)
H01Q 1/24 (2006.01)
(52) **U.S. Cl.**
CPC *G06F 1/1626* (2013.01); *H01Q 1/243*
(2013.01); *H05K 1/0298* (2013.01); *G06F*
1/1698 (2013.01)

(71) Applicant: **Samsung Electronics Co., Ltd.**,
Gyeonggi-do (KR)(72) Inventors: **Jaewon CHOE**, Gyeonggi-do (KR);
Kyungmoon SEOL, Gyeonggi-do
(KR); **Jaemoon LEE**, Gyeonggi-do
(KR); **Jungkyu LEE**, Gyeonggi-do
(KR)(73) Assignee: **Samsung Electronics Co., Ltd.**(21) Appl. No.: **16/441,861**(22) Filed: **Jun. 14, 2019**(30) **Foreign Application Priority Data**

Jun. 15, 2018 (KR) 10-2018-0068563

(57) **ABSTRACT**

An electronic device includes a cover glass, a back cover, a side member that surrounds a space between the cover glass and the back cover, wherein at least a portion of the side member is formed of a conductive member, a support member that is extended from the side member and includes at least one opening, a first printed circuit board that is interposed between the support member and the back cover or between the support member and the cover glass, a second printed circuit board that is interposed between the first printed circuit board and the back cover or between the first printed circuit board and the cover glass, an electrical component that is positioned on the first printed circuit board, and a wireless communication circuit that is positioned on the second printed circuit board.





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(19) **United States**

(12) **Patent Application Publication**

Dong et al.

(10) **Pub. No.: US 2019/0386377 A1**

(43) **Pub. Date: Dec. 19, 2019**

(54) **ANTENNA SYSTEM AND MOBILE
TERMINAL USING SAME**

(71) Applicant: **AAC Technologies Pte. Ltd.**,
Singapore city (SG)

(72) Inventors: **Kai Dong**, Shenzhen (CN); **Dawei Shi**,
Shenzhen (CN)

(21) Appl. No.: **16/438,470**

(22) Filed: **Jun. 12, 2019**

(30) **Foreign Application Priority Data**

Jun. 13, 2018 (CN) 201810604313.6

Publication Classification

(51) **Int. Cl.**

H01Q 1/24 (2006.01)
H01Q 1/48 (2006.01)
H01Q 1/38 (2006.01)

H04M 1/03 (2006.01)

H04M 1/02 (2006.01)

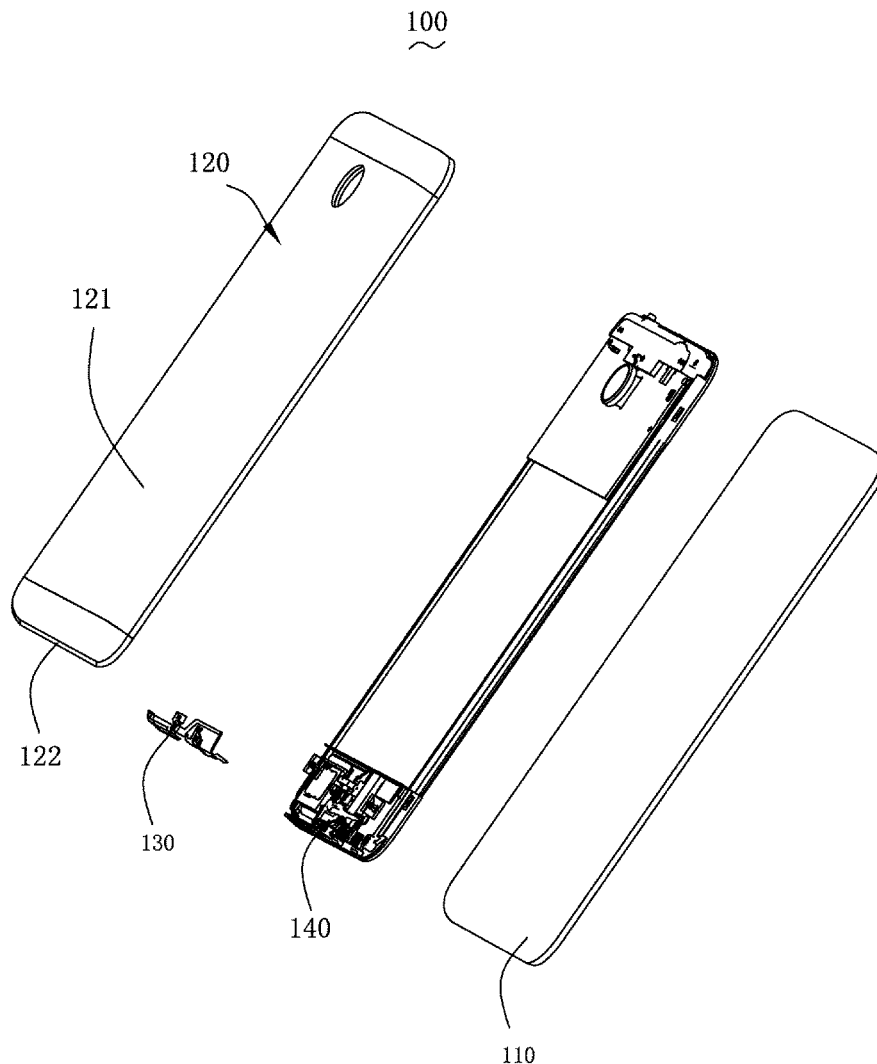
(52) **U.S. Cl.**

CPC **H01Q 1/243** (2013.01); **H01Q 1/48**
(2013.01); **H04M 1/0266** (2013.01); **H04M**
1/03 (2013.01); **H01Q 1/38** (2013.01)

(57)

ABSTRACT

The present disclosure discloses an antenna system. The antenna system includes a circuit board having a feeding point, an RF switch, and a system ground. The antenna further includes a feeding portion electrically connected to the feeding point, a ground portion connected to the system ground by the RF switch, and a connecting portion connecting the feeding portion to the ground portion. The ground portion includes a first metal segment for connecting to the connecting portion, and a second metal segment; the feeding portion includes a third metal segment and a fourth segment. The RF switch electrically connects to the second metal segment, and the feeding point electrically connects to the fourth segment.





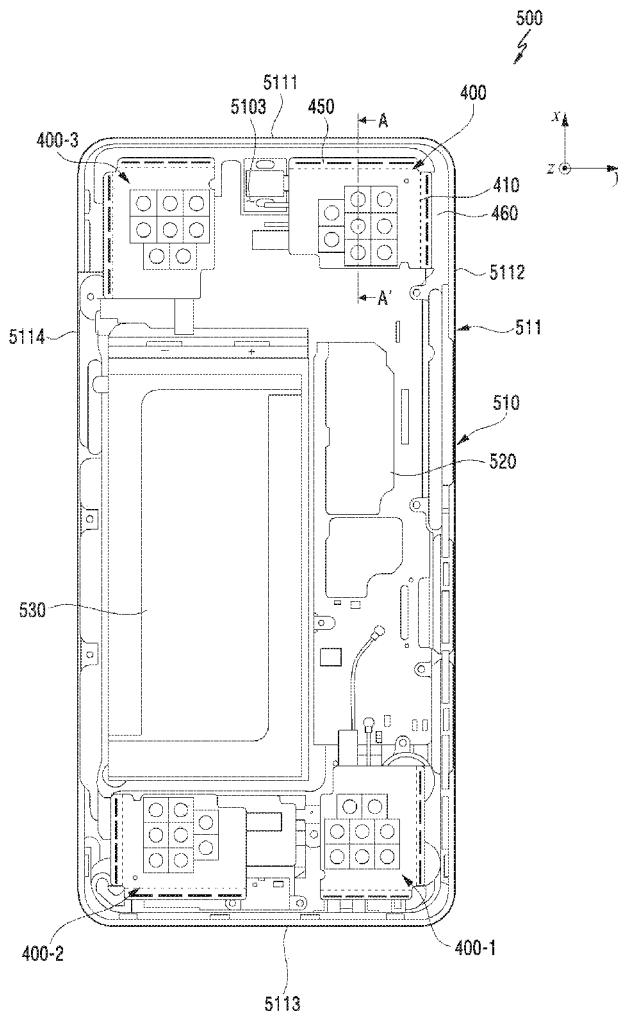
US 20190386380A1

(19) **United States**(12) **Patent Application Publication** (10) **Pub. No.: US 2019/0386380 A1**
(43) **Pub. Date: Dec. 19, 2019**(54) **ANTENNA INCLUDING CONDUCTIVE
PATTERN AND ELECTRONIC DEVICE
INCLUDING THE SAME**(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H05K 1/16**
(2013.01); **H01Q 9/065** (2013.01)(71) Applicant: **Samsung Electronics Co., Ltd.**,
Suwon-si (KR)(57) **ABSTRACT**(72) Inventors: **Chungkyun HAM**, Suwon-si (KR);
Seunggil JEON, Suwon-si (KR);
Jaehun JUNG, Suwon-si (KR);
Youngsik KIM, Suwon-si (KR)(21) Appl. No.: **16/441,376**(22) Filed: **Jun. 14, 2019**(30) **Foreign Application Priority Data**

Jun. 14, 2018 (KR) 10-2018-0068292

Publication Classification(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 9/06 (2006.01)

An electronic device is provided. The electronic device includes a housing including a first plate, a second plate facing away from the first plate, and a side member surrounding a space between the first plate and the second plate, a first PCB disposed in parallel with the first plate in the space between the first plate and the second plate, and including a first face facing the first plate and a second face facing the second plate, at least one conductive plate formed on the second face, a first conductive pattern embedded in the first PCB and disposed to be closer to a portion of the side member than the conductive plate when viewed from above the first plate, a first wireless communication circuit mounted on a first face of the first PCB, electrically coupled to the conductive plate and the first conductive pattern.





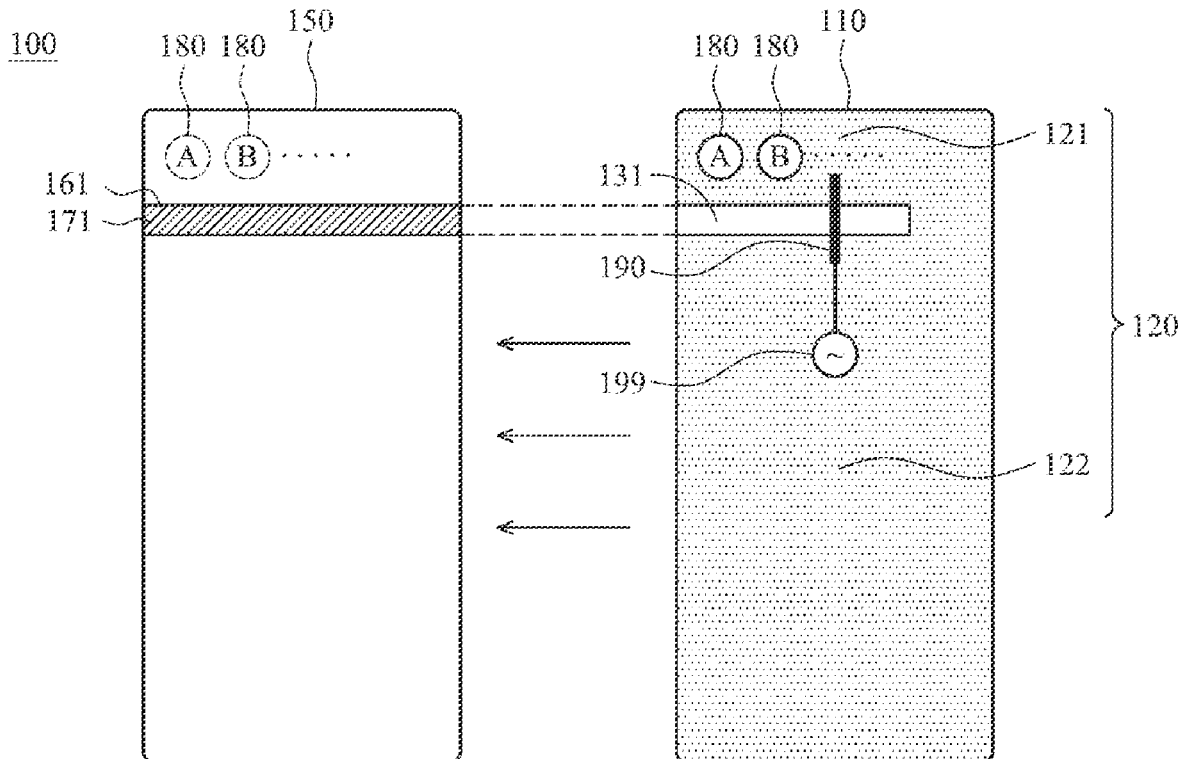
US 20190386381A1

(19) **United States**(12) **Patent Application Publication**
TSAI et al.(10) **Pub. No.: US 2019/0386381 A1**(43) **Pub. Date: Dec. 19, 2019**(54) **MOBILE DEVICE AND ANTENNA
STRUCTURE**(71) Applicant: **HTC Corporation**, Taoyuan City (TW)(72) Inventors: **Tiao-Hsing TSAI**, Taoyuan City (TW);
Chien-Pin CHIU, Taoyuan City (TW);
Hsiao-Wei WU, Taoyuan City (TW);
Chao-Chiang KUO, Taoyuan City
(TW)(73) Assignee: **HTC Corporation**, Taoyuan City (TW)(21) Appl. No.: **16/557,320**(22) Filed: **Aug. 30, 2019****Related U.S. Application Data**(60) Division of application No. 15/599,247, filed on May
18, 2017, which is a continuation of application No.
13/672,464, filed on Nov. 8, 2012, now Pat. No.
9,716,307.**Publication Classification**(51) **Int. Cl.****H01Q 1/24** (2006.01)**H01Q 13/10** (2006.01)(52) **U.S. Cl.**CPC **H01Q 1/243** (2013.01); **H01Q 13/106**
(2013.01)

(57)

ABSTRACT

A mobile device, at least including a metal housing, being substantially a hollow structure, wherein the metal housing has a back region and at least one side region, a first slit, formed on the metal housing, a dielectric substrate, comprising at least a first protruded portion, a first connection element, positioned between the metal housing and the dielectric substrate, and electrically coupled to the metal housing and a first signal source, positioned inside and electrically coupled to the metal housing, wherein at least one portion of the metal housing is configured to receive and transmit at least one wireless signal.





US 20190386382A1

(19) **United States**

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

(10) **Pub. No.: US 2019/0386382 A1**

(43) **Pub. Date: Dec. 19, 2019**

(54) **ANTENNA SYSTEM WITH DECREASED SAR VALUE**

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

CPC **H01Q 1/245** (2013.01); **H01Q 1/50** (2013.01)

(71) Applicant: **AAC Technologies Pte. Ltd.**,
Singapore City (SG)

(72) Inventors: **Kai Dong**, Shenzhen (CN); **Dawei Shi**,
Shenzhen (CN)

(21) Appl. No.: **16/439,723**

(22) Filed: **Jun. 13, 2019**

(30) **Foreign Application Priority Data**

Jun. 13, 2018 (CN) 201810604287.7

Publication Classification

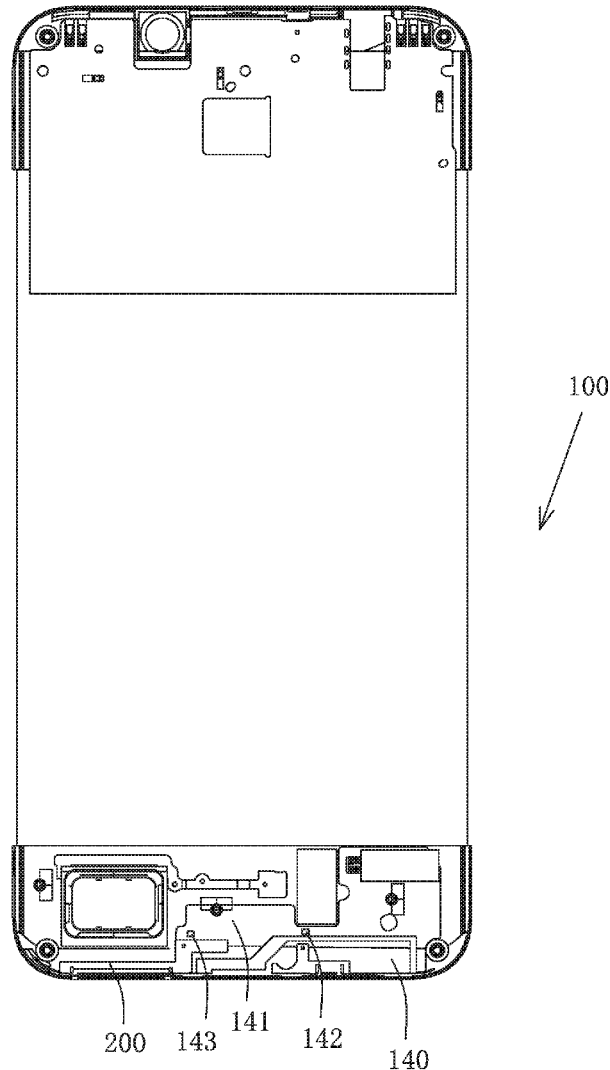
(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 1/50 (2006.01)

(57) **ABSTRACT**

The present disclosure discloses an antenna system with decreased SAR. The antenna system includes a circuit board having a feeding point, an RF switch for making the antenna system work under a number of working modes with different frequency bands, and a system ground. The antenna further includes a radiation body including a feeding portion electrically connected to the feeding point, a ground portion connected to the system ground by the RF switch, and a connecting portion connecting the feeding portion to the ground portion. The ground portion includes a first metal segment for connecting to the connecting portion, and a second metal segment; the feeding portion includes a third metal segment and a fourth segment. The RF switch electrically connects to the second metal segment, and the feeding point electrically connects to the fourth segment. A method for decreasing the SAR value is also provide.





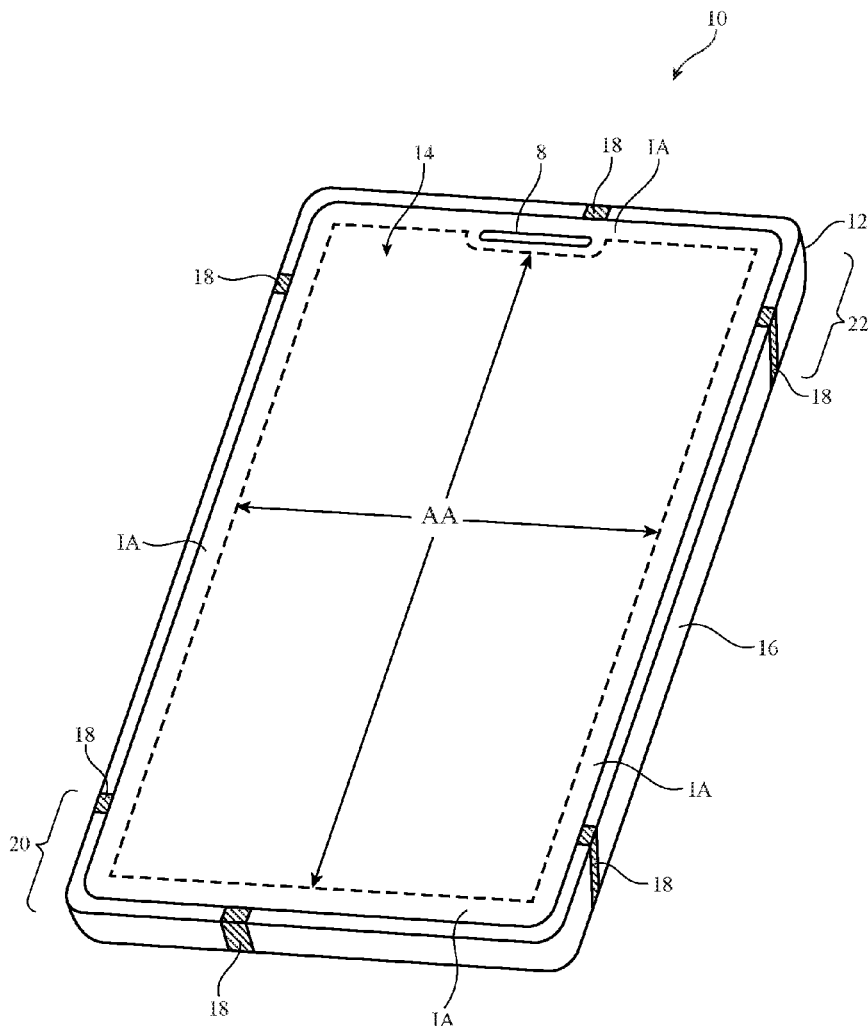
US 20190393586A1

(19) **United States**(12) **Patent Application Publication****Ayala Vazquez et al.**(10) **Pub. No.: US 2019/0393586 A1**(43) **Pub. Date: Dec. 26, 2019**(54) **ELECTRONIC DEVICE ANTENNAS HAVING SWITCHABLE FEED TERMINALS**(52) **U.S. Cl.**CPC *H01Q 1/242* (2013.01); *H01Q 5/328* (2015.01); *H01Q 13/103* (2013.01); *H01Q 1/48* (2013.01)(71) Applicant: **Apple Inc.**, Cupertino, CA (US)(72) Inventors: **Enrique Ayala Vazquez**, Watsonville, CA (US); **Hongfei Hu**, Cupertino, CA (US); **Mattia Pascolini**, San Francisco, CA (US); **Nanbo Jin**, San Jose, CA (US); **Kevin M. Froese**, San Francisco, CA (US); **Erica J. Tong**, Pacifica, CA (US); **Xu Han**, San Jose, CA (US)

(57)

ABSTRACT

An electronic device may include a conductive housing and an antenna. The antenna may include an arm formed from a first segment of the housing. A gap may separate the first segment from a second segment. The antenna may include a feed coupled to a transmission line having a signal conductor. The feed may include first and second positive terminals on the first segment and a third positive terminal on the second segment. An adjustable component may be coupled between the first and third terminals. The signal conductor may be coupled to the first terminal. A wide conductive trace may be coupled between the signal conductor and the second terminal. A switch may be interposed on the signal conductor. The second terminal may cover a cellular low band when the switch is open. The first terminal may cover the cellular low band and higher bands when the switch is closed.

(21) Appl. No.: **16/019,322**(22) Filed: **Jun. 26, 2018****Publication Classification**(51) **Int. Cl.***H01Q 1/24* (2006.01)*H01Q 1/48* (2006.01)*H01Q 13/10* (2006.01)*H01Q 5/328* (2006.01)



US 20190393603A1

(19) **United States**

(12) **Patent Application Publication**
Rutfors

(10) **Pub. No.: US 2019/0393603 A1**

(43) **Pub. Date: Dec. 26, 2019**

(54) **ANTENNA ARRANGEMENT AND A DEVICE
COMPRISING SUCH AN ANTENNA
ARRANGEMENT**

H01Q 1/38 (2006.01)

H01Q 9/04 (2006.01)

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

CPC **H01Q 5/335** (2015.01); **H01Q 9/045**
(2013.01); **H01Q 1/38** (2013.01); **H01Q 1/48**
(2013.01)

(71) Applicant: **PROANT AB**, Umea (SE)

(72) Inventor: **Tomas Rutfors**, Holmsund (SE)

(21) Appl. No.: **16/487,465**

(22) PCT Filed: **Feb. 27, 2018**

(86) PCT No.: **PCT/EP2018/054758**

§ 371 (c)(1),

(2) Date: **Aug. 21, 2019**

(30) **Foreign Application Priority Data**

Feb. 27, 2017 (EP) 17158217.4

Publication Classification

(51) **Int. Cl.**

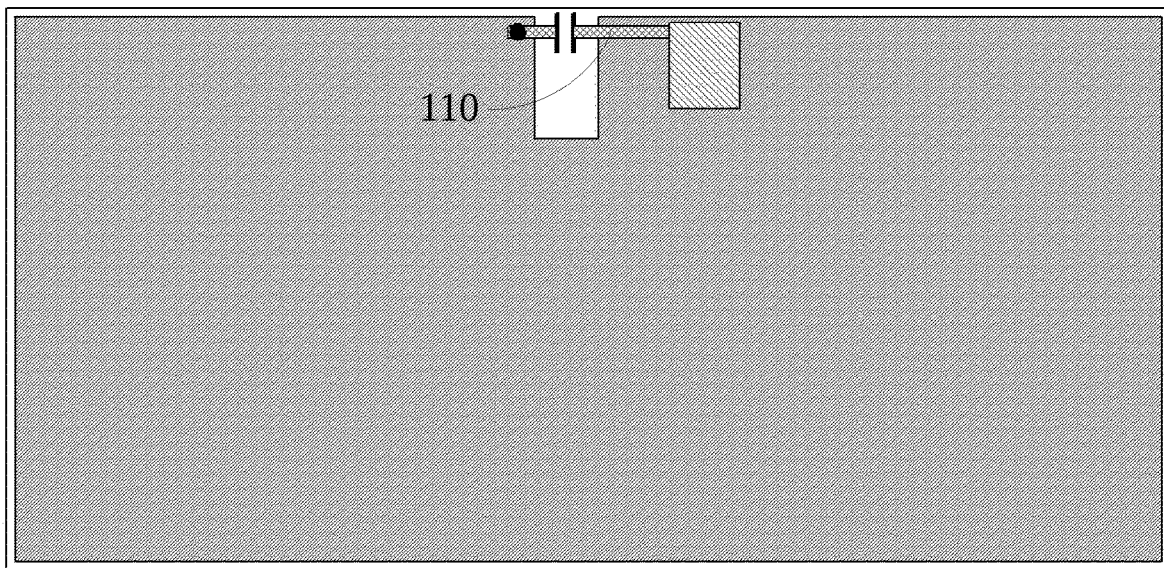
H01Q 5/335 (2006.01)

H01Q 1/48 (2006.01)

(57)

ABSTRACT

The invention concerns an antenna arrangement (1) comprising: —a printed circuit board (2) having a metallised area (3) acting as a ground plane (3) in use, —a recess portion (4) in an edge portion of the ground plane (3), —a first electrically reactive network (9) bridging the recess portion (4) —a second electrically reactive network (16) bridging the recess portion (4), separately from the first electrically reactive network (9), wherein an electrical length of the recess portion (4) is $\frac{1}{10}$ th of a wavelength of the resonance frequency of the antenna arrangement (1) or less, and wherein a physical distance between the first (9) and second (16) electrically reactive networks (9, 16) is less than $\frac{1}{12}$ of a wavelength of the resonance frequency of the antenna arrangement (1). The invention also concerns a device comprising an antenna arrangement (1).





US 20190393911A1

(19) **United States**(12) **Patent Application Publication**
Hawaka(10) **Pub. No.: US 2019/0393911 A1**(43) **Pub. Date: Dec. 26, 2019**(54) **ELECTRONIC APPARATUS**(52) **U.S. Cl.**(71) Applicant: **LENOVO (SINGAPORE) PTE. LTD.,**
SINGAPORE (SG)CPC **H04B 1/1009** (2013.01); **H01Q 1/2266**
(2013.01); **H04B 15/00** (2013.01)(72) Inventor: **Shigekazu Hawaka, YOKOHAMA (JP)**

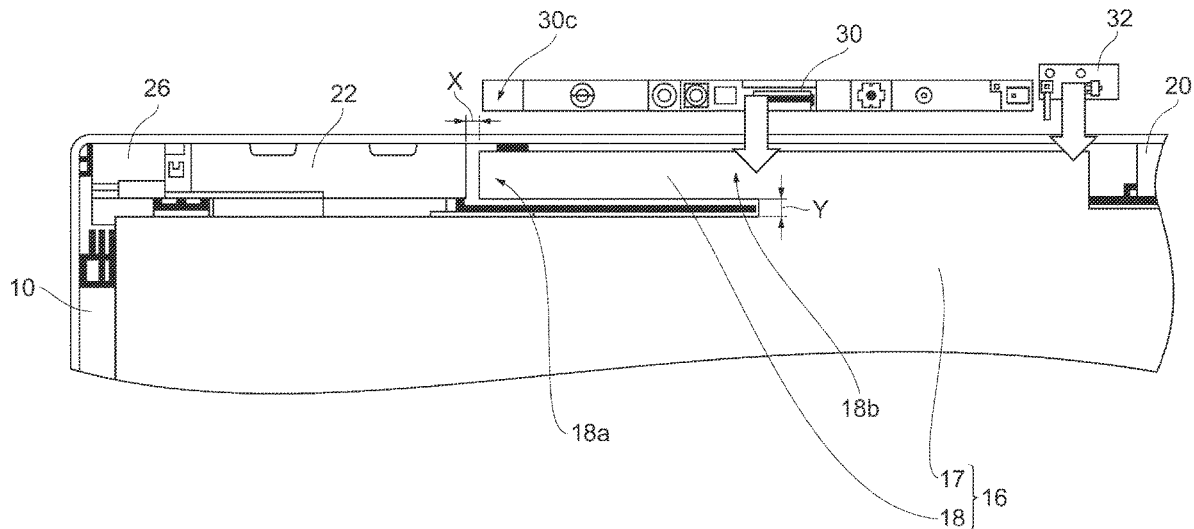
(57)

ABSTRACT(73) Assignee: **LENOVO (SINGAPORE) PTE. LTD.,**
SINGAPORE (SG)(21) Appl. No.: **16/107,279**(22) Filed: **Aug. 21, 2018**(30) **Foreign Application Priority Data**

Jun. 22, 2018 (JP) 2018119191

Publication Classification(51) **Int. Cl.****H04B 1/10** (2006.01)**H04B 15/00** (2006.01)**H01Q 1/22** (2006.01)

An electronic apparatus includes: a chassis in which a display device is housed; a noise eliminating layer that is positioned between the chassis and the display device, and eliminates noise emitted from the display device; and an antenna for wireless communication that is housed in the chassis, in which the noise eliminating layer has a main body area and an auxiliary antenna area that extends from the main body area to the antenna and assists wireless communication of the antenna, and a portion of the auxiliary antenna area between one end on the side of the antenna and the other end on the side opposite to the one end is spaced apart from the main body area.





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(19) **United States**(12) **Patent Application Publication**
YOUN et al.(10) **Pub. No.: US 2019/0393919 A1**(43) **Pub. Date: Dec. 26, 2019**(54) **MOBILE TERMINAL****Publication Classification**(71) Applicant: **LG ELECTRONICS INC.**, Seoul (KR)(72) Inventors: **Yeomin YOUN**, Seoul (KR); **Jaehyun CHOI**, Seoul (KR); **Jungsun AHN**, Seoul (KR); **Changil KIM**, Seoul (KR); **Kangjae JUNG**, Seoul (KR)(73) Assignee: **LG ELECTRONICS INC.**, Seoul (KR)(21) Appl. No.: **16/562,738**(22) Filed: **Sep. 6, 2019****Related U.S. Application Data**

(63) Continuation of application No. 16/122,600, filed on Sep. 5, 2018, now Pat. No. 10,461,794, which is a continuation of application No. 15/961,227, filed on Apr. 24, 2018, now Pat. No. 10,122,401, which is a continuation of application No. 15/783,873, filed on Oct. 13, 2017, now Pat. No. 9,985,679, which is a continuation of application No. 15/498,210, filed on Apr. 26, 2017, now Pat. No. 9,819,383, which is a continuation of application No. 14/480,149, filed on Sep. 8, 2014, now Pat. No. 9,680,206.

Foreign Application Priority Data

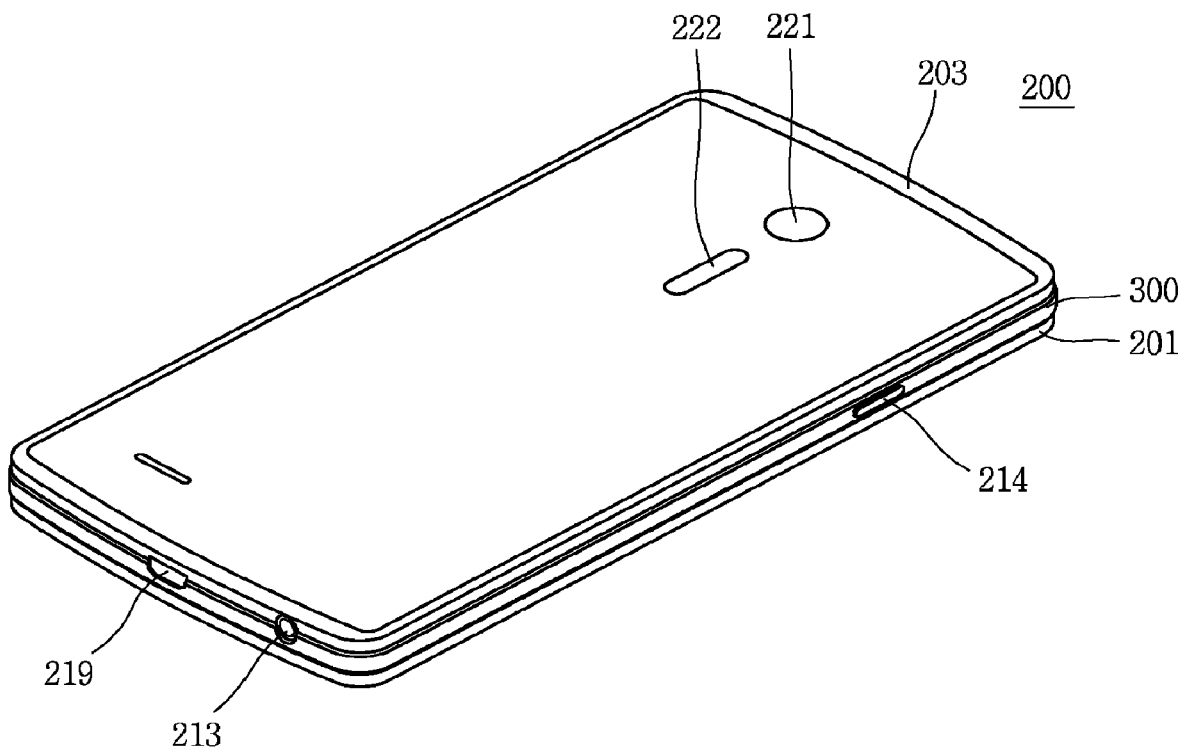
Dec. 3, 2013 (KR) 10-2013-0149413

(51) **Int. Cl.****H04B 1/3888** (2006.01)**H01Q 1/24** (2006.01)**G06F 1/16** (2006.01)**G06F 1/20** (2006.01)**H01Q 1/44** (2006.01)**H04M 1/02** (2006.01)**H04M 1/18** (2006.01)**H01Q 5/30** (2006.01)(52) **U.S. Cl.**CPC **H04B 1/3888** (2013.01); **H01Q 1/243** (2013.01); **G06F 1/1656** (2013.01); **G06F 1/1626** (2013.01); **G06F 1/1698** (2013.01); **H04B 2001/3894** (2013.01); **H01Q 1/44** (2013.01); **H04M 1/0249** (2013.01); **H04M 1/18** (2013.01); **H01Q 5/30** (2015.01); **H04M 1/0202** (2013.01); **G06F 1/203** (2013.01)

(57)

ABSTRACT

A mobile terminal includes a metal frame including a base portion and an edge portion formed along the outer edge of the base portion, first and second cases bonded to the front and back sides of the metal frame so as to expose the edge portion to the outside, first and second waterproof layers formed between the cases and the metal frame, conductive members that operate a radiator for antennas, together with the edge portion, and are formed on one side of the second case, and feeding portions for feeding the conductive members, the feeding portions being disposed in an enclosed space formed by the waterproof layers.





US 20200007184A1

(19) **United States**(12) **Patent Application Publication****Jung et al.**(10) **Pub. No.: US 2020/0007184 A1**(43) **Pub. Date: Jan. 2, 2020**(54) **MOBILE TERMINAL****Publication Classification**(71) Applicant: **LG ELECTRONICS INC.**, Seoul (KR)(72) Inventors: **Kangjae Jung**, Seoul (KR); **Dongjin Kim**, Seoul (KR); **Yunmo Kang**, Seoul (KR); **Sungjoon Hong**, Seoul (KR); **Kyoungsun Hwang**, Seoul (KR); **Sungjung Rho**, Seoul (KR)(73) Assignee: **LG ELECTRONICS INC.**, Seoul (KR)(21) Appl. No.: **16/480,978**(22) PCT Filed: **Jan. 26, 2017**(86) PCT No.: **PCT/KR2017/000952**

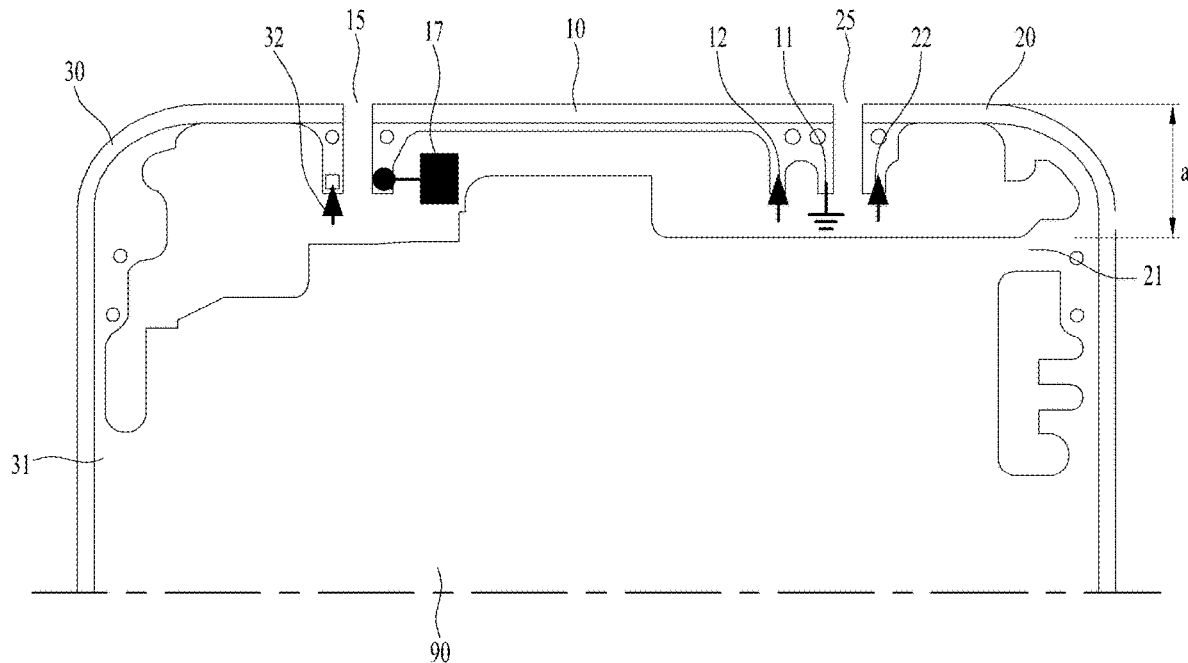
§ 371 (c)(1),

(2) Date: **Jul. 25, 2019**(51) **Int. Cl.****H04B 1/525** (2006.01)**H01Q 1/24** (2006.01)**H04M 1/02** (2006.01)(52) **U.S. Cl.**CPC **H04B 1/525** (2013.01); **H04M 1/0202** (2013.01); **H01Q 1/243** (2013.01)

(57)

ABSTRACT

A mobile terminal comprises: a body having an electronic equipment part therein; a middle frame mounted in the body; a main substrate mounted in the body; a side case which is located around a lateral surface of the body and includes a plurality of antenna radiators and a plurality of slits among the plurality of antenna radiators; a ground line connected to the antenna radiators; and a power feeding line for applying power to the antenna radiators, wherein the slits include first and second slits, which are located at a first lateral surface of the mobile terminal, and third and fourth slits, which are located at second and third lateral surfaces adjacent to the first lateral surface of the mobile terminal, thereby improving antenna performance by minimizing interference among the antenna radiators for transmitting and receiving each frequency signal.





US 20200014092A1

(19) **United States**(12) **Patent Application Publication**
WEI et al.(10) **Pub. No.: US 2020/0014092 A1**(43) **Pub. Date: Jan. 9, 2020**(54) **MOBILE DEVICE AND ANTENNA
STRUCTURE THEREIN**(71) Applicant: **Wistron Corp.**, New Taipei City (TW)(72) Inventors: **Wan Chu WEI**, New Taipei City
(TW); **Hsieh Chih LIN**, New Taipei
City (TW); **Yu-Chia CHANG**, New
Taipei City (TW); **Jung-Chin HSIEH**,
New Taipei City (TW); **Wen-Chieh
WU**, New Taipei City (TW)(21) Appl. No.: **16/112,443**(22) Filed: **Aug. 24, 2018**(30) **Foreign Application Priority Data**

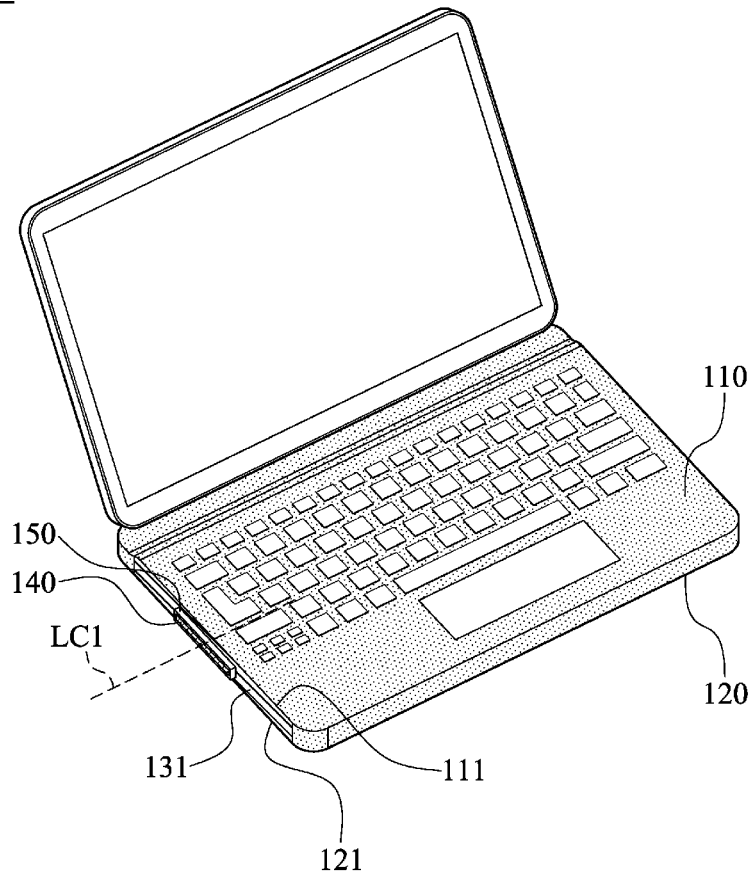
Jul. 5, 2018 (TW) 107123302

Publication Classification(51) **Int. Cl.****H01Q 1/24** (2006.01)
H04M 1/02 (2006.01)
H01Q 1/42 (2006.01)**H01Q 5/30** (2006.01)**H01Q 1/22** (2006.01)**H01Q 9/04** (2006.01)(52) **U.S. Cl.**CPC **H01Q 1/242** (2013.01); **H04M 1/0283**
(2013.01); **H01Q 9/0421** (2013.01); **H01Q**
5/30 (2015.01); **H01Q 1/2266** (2013.01);
H01Q 1/42 (2013.01)

(57)

ABSTRACT

A mobile device includes a host upper cover, a host lower cover, a metal cavity structure, a protruding radiation element, a nonconductive connection element, and a feeding element. The metal cavity structure is coupled between the host upper cover and the host lower cover. The metal cavity structure includes a first metal partition and a second metal partition. The first metal partition has an opening. The nonconductive connection element is connected to the edge of the opening of the first metal partition. The nonconductive connection element is configured to support and surround the protruding radiation element. The feeding element is coupled to a signal source and is disposed adjacent to the protruding radiation element. An antenna structure is formed by the feeding element and the protruding radiation element.

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132



US 20200014093A1

(19) **United States**(12) **Patent Application Publication**
KIM et al.(10) **Pub. No.: US 2020/0014093 A1**(43) **Pub. Date: Jan. 9, 2020**(54) **MOBILE TERMINAL****Publication Classification**(71) Applicant: **LG ELECTRONICS INC.**, Seoul (KR)(72) Inventors: **Dongjin KIM**, Seoul (KR); **Kangjae JUNG**, Seoul (KR); **Duckyun KIM**, Seoul (KR); **Changwon YUN**, Seoul (KR); **Soyeon LEE**, Seoul (KR); **Songyi LEE**, Seoul (KR)(73) Assignee: **LG ELECTRONICS INC.**, Seoul (KR)(21) Appl. No.: **16/479,072**(22) PCT Filed: **Jan. 26, 2017**(86) PCT No.: **PCT/KR2017/000942**

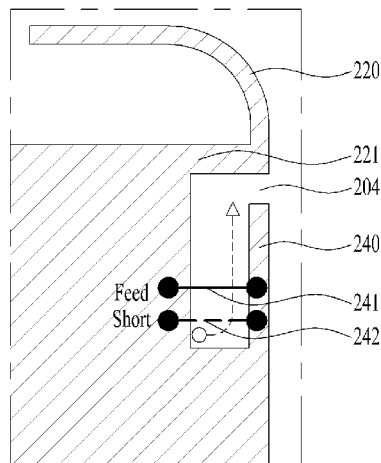
§ 371 (c)(1),

(2) Date: **Jul. 18, 2019**(51) **Int. Cl.****H01Q 1/24** (2006.01)**H01Q 1/52** (2006.01)(52) **U.S. Cl.****CPC** **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01); **H01Q 1/521** (2013.01)

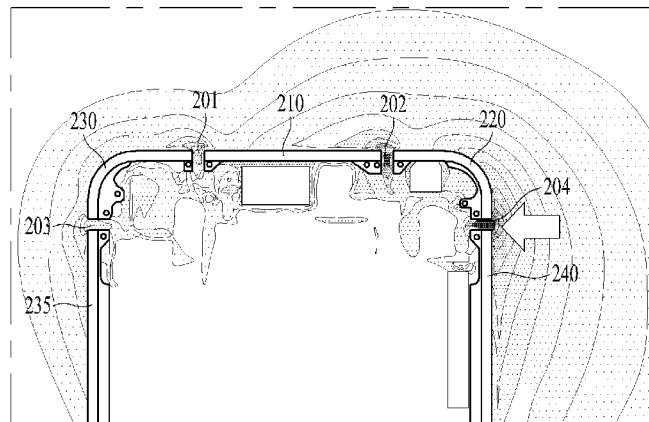
(57)

ABSTRACT

A mobile terminal, which comprises: a case including an electric component mounting part therein; a middle frame mounted on the case; a main board mounted on the case; a first antenna spaced apart from and arranged in parallel to the middle frame, and having a first end that is open and a second end connected to the middle frame; a first feed line connected to a first part of the first antenna so as to transmit a signal; a ground line connected to a second part of the first antenna and performing grounding; a second antenna connected to the ground line; and a second feed line connected to the second antenna, increases the number of Wi-Fi antennas, thereby enabling data transmission speed to become faster.



(a)



(b)



US 20200014094A1

(19) **United States**(12) **Patent Application Publication**
HSU(10) **Pub. No.: US 2020/0014094 A1**(43) **Pub. Date: Jan. 9, 2020**(54) **ANTENNA ASSEMBLY AND WIRELESS
COMMUNICATION DEVICE EMPLOYING
SAME**(52) **U.S. Cl.**CPC *H01Q 1/243* (2013.01); *H01Q 1/48*
(2013.01); *H01Q 21/30* (2013.01); *H01Q*
1/521 (2013.01); *H01Q 7/00* (2013.01)(71) Applicant: **Chiun Mai Communication Systems,
Inc.**, New Taipei (TW)(72) Inventor: **YI-WEN HSU**, New Taipei (TW)(21) Appl. No.: **16/502,128**(22) Filed: **Jul. 3, 2019**(30) **Foreign Application Priority Data**

Jul. 4, 2018 (CN) 201810725796.5

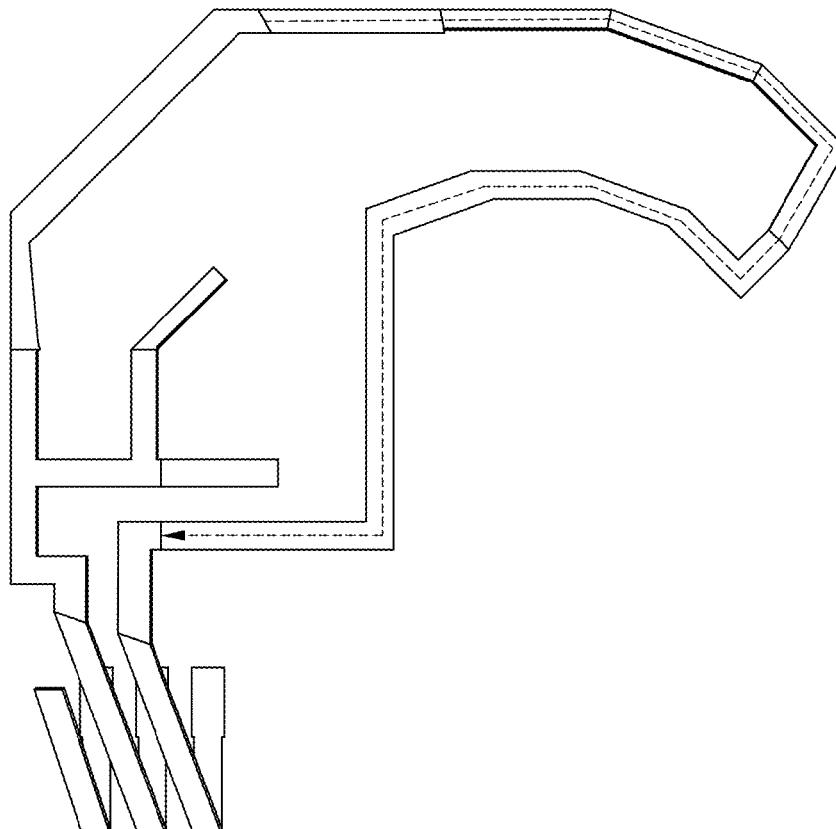
Publication Classification(51) **Int. Cl.***H01Q 1/24* (2006.01)
H01Q 1/48 (2006.01)
H01Q 7/00 (2006.01)
H01Q 1/52 (2006.01)
H01Q 21/30 (2006.01)

(57)

ABSTRACT

An antenna assembly of reduced size but with optimized radiation and reception capabilities through slanted connections between the parts includes a feed portion, a first ground portion, a second ground portion, a first radiating portion, and a second radiating portion. The first radiating portion is a loop antenna on at least three surfaces of a carrier, and is connected between the feed portion and the first ground portion on opposite ends. The first radiating portion feeds in electric current through the feed portion. The second radiating portion is spaced from the first radiating portion, the second radiating portion is arranged on at least two surfaces of the carrier. The second radiating portion is connected between the second ground portion, the second radiating portion couples electric current from the first radiating portion. A wireless communication device employing the antenna assembly is also provided.

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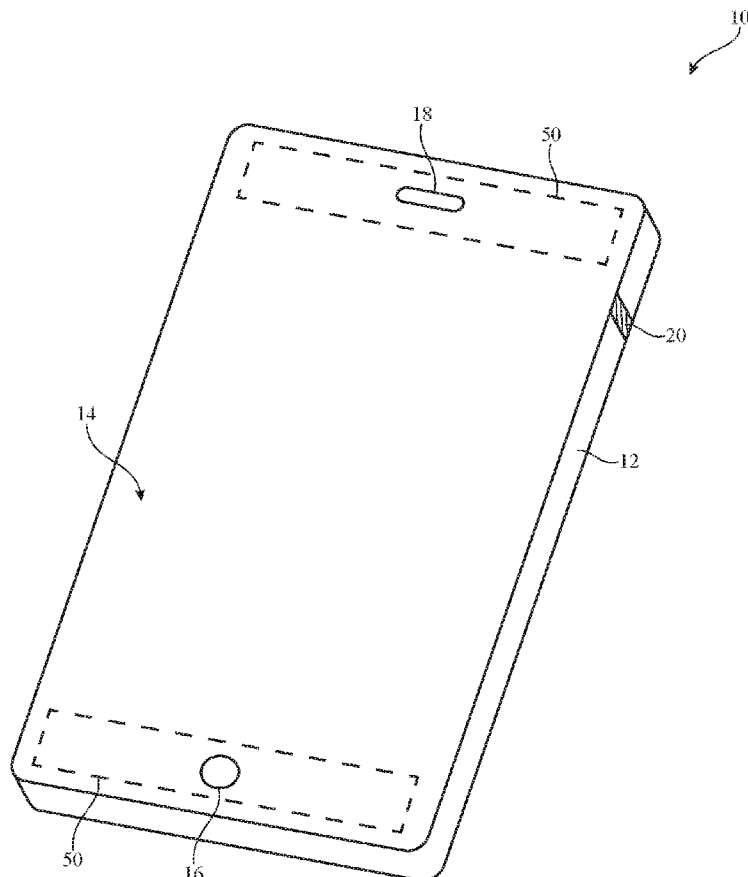
US 20200014095A1

(19) **United States**(12) **Patent Application Publication****Mow et al.**(10) **Pub. No.: US 2020/0014095 A1**(43) **Pub. Date: Jan. 9, 2020**(54) **ELECTRONIC DEVICE WITH MILLIMETER WAVE ANTENNAS ON PRINTED CIRCUITS****H01Q 21/28** (2006.01)**H01Q 21/06** (2006.01)**H01Q 19/30** (2006.01)(71) Applicant: **Apple Inc.**, Cupertino, CA (US)(52) **U.S. Cl.**(72) Inventors: **Matthew A. Mow**, Los Altos, CA (US);
Basim H. Noori, Scotts Valley, CA (US); **Ming-Ju Tsai**, Sunnyvale, CA (US); **Xu Han**, Santa Clara, CA (US); **Victor C. Lee**, Sunnyvale, CA (US); **Mattia Pascolini**, San Francisco, CA (US)CPC **H01Q 1/243** (2013.01); **H04B 10/90** (2013.01); **H01Q 9/065** (2013.01); **H01Q 3/24** (2013.01); **H01Q 1/526** (2013.01); **H01Q 21/28** (2013.01); **H01Q 21/065** (2013.01); **H01Q 19/30** (2013.01); **H01Q 1/2291** (2013.01)(21) Appl. No.: **16/572,370**(22) Filed: **Sep. 16, 2019****Related U.S. Application Data**

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Publication Classification(51) **Int. Cl.****H01Q 1/24** (2006.01)**H04B 10/90** (2006.01)**H01Q 9/06** (2006.01)**H01Q 3/24** (2006.01)**H01Q 1/22** (2006.01)(57) **ABSTRACT**

An electronic device may be provided with wireless circuitry. The wireless circuitry may include one or more antennas and transceiver circuitry such as millimeter wave transceiver circuitry. The antennas may be formed from metal traces on printed circuits. A flexible printed circuit may have an area on which the transceiver circuitry is mounted. Protruding portions may extend from the area on which the transceiver circuitry is mounted and may be separated from the area on which the transceiver circuitry is mounted by bends. Antenna resonating elements such as patch antenna resonating elements and dipole resonating elements may be formed on the protruding portions and may be used to transmit and receive millimeter wave antenna signals through dielectric-filled openings in a metal electronic device housing or a dielectric layer such as a display cover layer formed from glass or other dielectric.





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KIM et al.

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(43) **Pub. Date: Jan. 9, 2020**

(54) **ANTENNA STRUCTURE HAVING PLURAL SLITS ARRANGED AT PREDETERMINED INTERVAL ON CONDUCTIVE SUBSTRATE AND ANOTHER SLIT EXTENDING TO SPACE BETWEEN SLITS, AND ELECTRONIC DEVICE INCLUDING ANTENNA STRUCTURE**

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(30) **Foreign Application Priority Data**

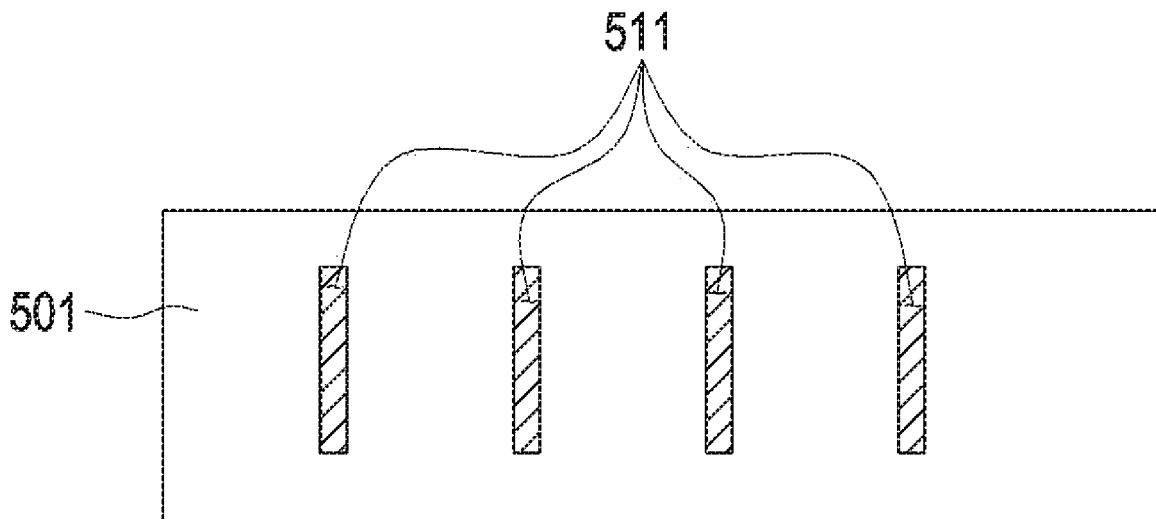
Jul. 6, 2018 (KR) 10-2018-0079015

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CPC **H01Q 21/064** (2013.01); **H01Q 21/0025** (2013.01); **H01Q 1/22** (2013.01); **H01Q 1/523** (2013.01)

(57) **ABSTRACT**

Various embodiments disclosed herein relate to an antenna device that provides a wireless communication function and an electronic device including the antenna device is provided. The electronic device includes a communication module and an antenna structure electrically connected to the communication module. The antenna structure may include a conductive substrate including a first area and a second area adjacent to the first area a plurality of first slits formed in the first area of the conductive substrate parallel to each other with a first predetermined interval therebetween in a predetermined direction and a plurality of second slits formed in the second area of the conductive substrate at a position corresponding to an inter-slit area between at least some slits among the plurality of first slits.





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(19) **United States**(12) **Patent Application Publication**

Lin et al.

(10) **Pub. No.: US 2020/0021021 A1**(43) **Pub. Date: Jan. 16, 2020**(54) **LOW-PROFILE DUAL-BAND
HIGH-ISOLATION ANTENNA MODULE**(71) Applicant: **Alpha Networks Inc.**, Hsinchu (TW)(72) Inventors: **Kuang-Wei Lin**, Hsinchu (TW);
De-Chang Su, Hsinchu (TW)(21) Appl. No.: **16/238,609**(22) Filed: **Jan. 3, 2019**(30) **Foreign Application Priority Data**

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Publication Classification(51) **Int. Cl.**

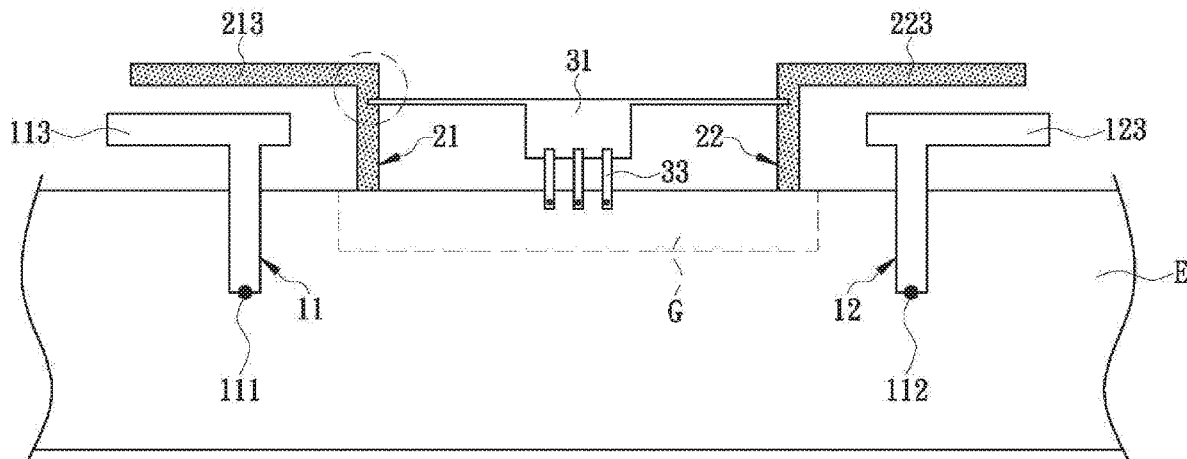
<i>H01Q 1/52</i>	(2006.01)
<i>H01Q 1/38</i>	(2006.01)
<i>H01Q 5/20</i>	(2006.01)
<i>H01Q 5/307</i>	(2006.01)

(52) **U.S. Cl.**CPC *H01Q 1/523* (2013.01); *H01Q 5/307*
(2015.01); *H01Q 5/20* (2015.01); *H01Q 1/38*
(2013.01)

(57)

ABSTRACT

A low-profile dual-band high-isolation antenna module is fixed on a substrate and includes two high-frequency antennas and two low-frequency antennas located on two opposite sides of the substrate respectively. The bottom ends of the low-frequency antennas are connected to a grounding of the substrate. A decoupling element is disposed between the high-frequency antennas and the low-frequency antennas. The top end of each high-frequency antenna forms a bent portion, and so does the top end of each low-frequency antenna. The decoupling element has two ends extending to positions corresponding respectively to the low-frequency antennas but is not in contact with the low-frequency antennas or the high-frequency antennas. The bottom end of the decoupling element is connected to the grounding through at least one metal strip. The bent portions effectively reduce the space occupied by the antennas while the decoupling element provides isolation between the antennas.





US 20200021029A1

(19) **United States**(12) **Patent Application Publication**
CHOU et al.(10) **Pub. No.: US 2020/0021029 A1**(43) **Pub. Date: Jan. 16, 2020**(54) **COMMUNICATION DEVICE**(52) **U.S. Cl.**(71) Applicant: **Jieng Tai International Electronic Corp.**, New Taipei City (TW)CPC **H01Q 9/0421** (2013.01); **H01Q 1/38** (2013.01)(72) Inventors: **Yupang CHOU**, New Taipei City (TW); **Chuohsun SUN**, Taipei City (TW)(57) **ABSTRACT**(21) Appl. No.: **16/110,261**(22) Filed: **Aug. 23, 2018**(30) **Foreign Application Priority Data**

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H01Q 9/04 (2006.01)
H01Q 1/38 (2006.01)

A communication device comprises a plurality of antennas, a sensing unit, a plurality of radio frequency circuits, and a sensing module. The sensing unit is electrically connected to the ground through at least one grounding capacitor, and the sensing unit is further configured to isolate and be coupled to each antenna. Each the radio frequency circuit is electrically connected to the corresponding each antenna. The sensing module is electrically connected to the sensing unit through an inductor, wherein the sensing module is used to sense the distance between the sensing unit and an external object by the sensing unit, and the sensing module generates a distance signal according to the distance.

