



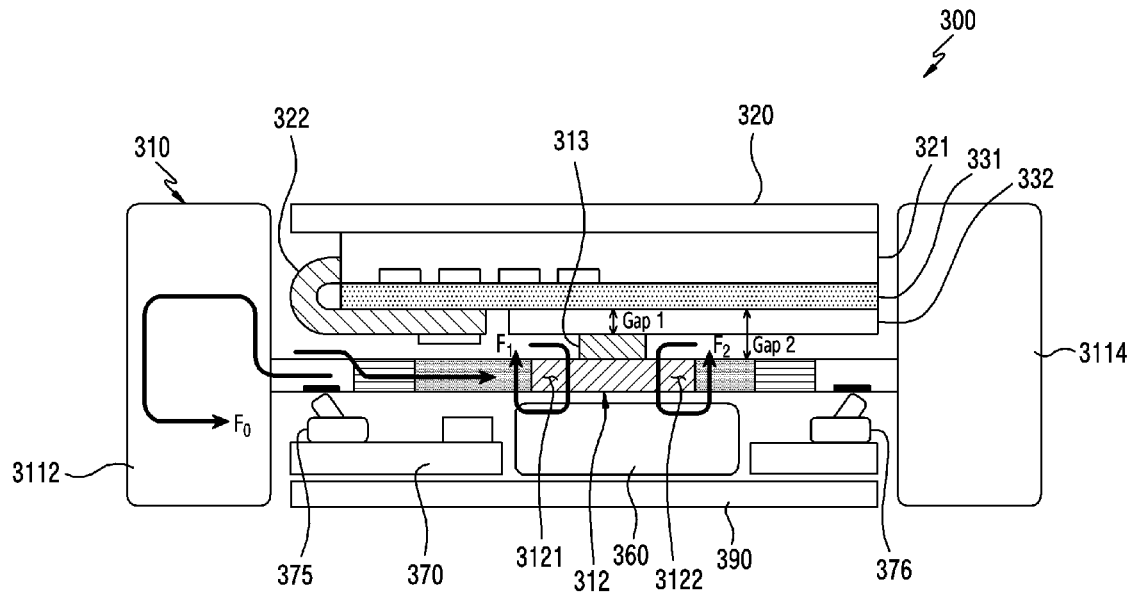
US 20190058244A1

(19) **United States**(12) **Patent Application Publication** (10) **Pub. No.: US 2019/0058244 A1**  
(43) **Pub. Date: Feb. 21, 2019**(54) **ANTENNA DEVICE AND ELECTRONIC  
DEVICE INCLUDING THE SAME**(52) **U.S. Cl.**  
CPC ..... **H01Q 1/243** (2013.01); **H01Q 13/10**  
(2013.01)(71) Applicant: **Samsung Electronics Co., Ltd.**,  
Gyeonggi-do (KR)(72) Inventors: **Jeong-Sik KIM**, Gyeongsangbuk-do  
(KR); **Ho-Yeon KIM**,  
Gyeongsangbuk-do (KR); **Hyeontae  
CHO**, Gyeongsangbuk-do (KR);  
**Ji-Woo LEE**, Gyeongsangbuk-do (KR)(57) **ABSTRACT**

According to various embodiments, an electronic device comprises a housing comprising: a front surface plate; a rear surface plate spaced apart from the front surface plate opposite thereto; and a side surface member surrounding a space between the front surface plate and the rear surface plate, wherein at least a portion of the side surface member comprises at least one conductive portion disposed between a first nonconductive portion and a second nonconductive portion; at least one wireless communication circuit electrically connected to the conductive portion; a conductive plate disposed in the space, and comprising a slot having a longitudinal direction perpendicular to the conductive portion; a conductor disposed on the conductive plate; and at least one conductive member dividing the slot into a plurality of portions.

(21) Appl. No.: **16/003,342**(22) Filed: **Jun. 8, 2018**(30) **Foreign Application Priority Data**

Aug. 21, 2017 (KR) ..... 10-2017-0105164

**Publication Classification**(51) **Int. Cl.**  
**H01Q 1/24** (2006.01)  
**H01Q 13/10** (2006.01)



US 20190058246A1

(19) **United States**(12) **Patent Application Publication****Lee et al.**(10) **Pub. No.: US 2019/0058246 A1**(43) **Pub. Date: Feb. 21, 2019**(54) **ANTENNA DEVICE AND ELECTRONIC APPARATUS**(71) Applicant: **E Ink Holdings Inc.**, Hsinchu (TW)(72) Inventors: **Yu-Ming Lee**, Hsinchu (TW);  
**Chuen-Jen Liu**, Hsinchu (TW)(73) Assignee: **E Ink Holdings Inc.**, Hsinchu (TW)(21) Appl. No.: **15/904,448**(22) Filed: **Feb. 26, 2018**(30) **Foreign Application Priority Data**

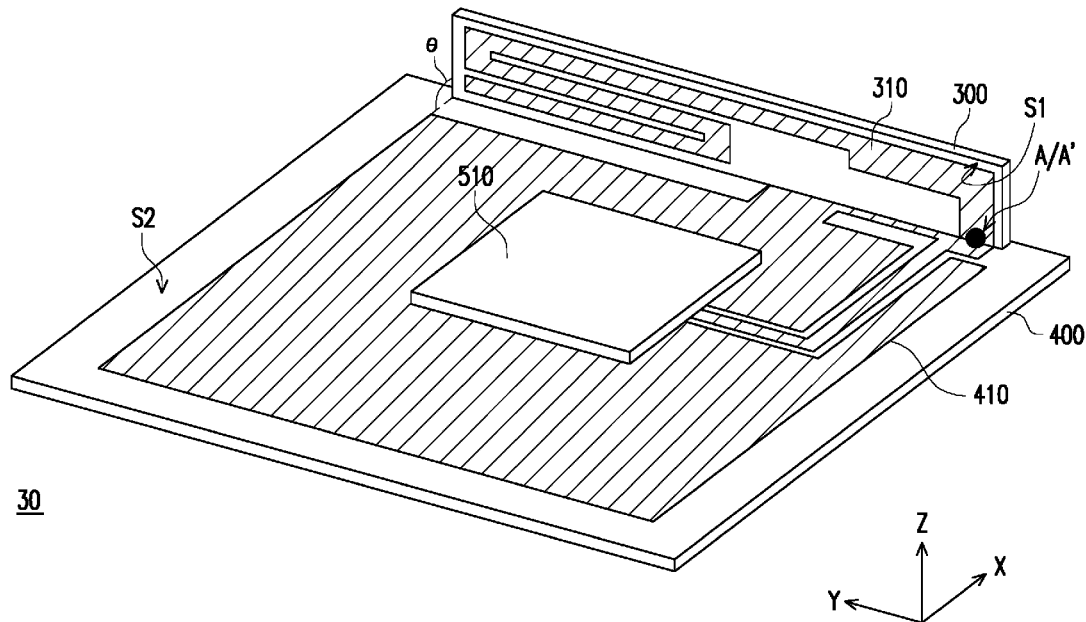
Aug. 17, 2017 (CN) ..... 201710705390.6

**Publication Classification**(51) **Int. Cl.**  
**H01Q 1/24** (2006.01)  
**H01Q 9/04** (2006.01)**H01Q 13/10** (2006.01)**H01Q 5/30** (2006.01)(52) **U.S. Cl.**CPC ..... **H01Q 1/248** (2013.01); **H01Q 5/30**  
(2015.01); **H01Q 13/10** (2013.01); **H01Q**  
**9/0457** (2013.01)

(57)

**ABSTRACT**

An antenna device including an antenna radiator and a feed line layer is provided. The antenna radiator is disposed on a first surface of a detachable substrate. The antenna radiator receives a microwave signal of at least one frequency band. The feed line layer is disposed on a second surface of a control circuit board. The feed line layer includes a signal feed line. The signal feed line is coupled to the antenna radiator through a connection point. The connection point is located on one side of the control circuit board. The detachable substrate and the control circuit board are arranged to have an angle between the first surface and the second surface. In addition, an electronic apparatus is also provided.





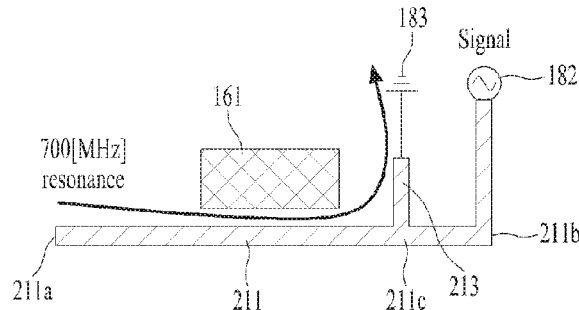
US 20190058781A1

(19) **United States**(12) **Patent Application Publication**  
**HONG et al.**(10) **Pub. No.: US 2019/0058781 A1**(43) **Pub. Date: Feb. 21, 2019**(54) **MOBILE TERMINAL**(52) **U.S. Cl.**(71) Applicant: **LG ELECTRONICS INC.**, Seoul  
(KR)CPC ..... **H04M 1/0277** (2013.01); **H01Q 1/38**  
(2013.01); **H04B 1/3833** (2013.01); **H01Q**  
**1/243** (2013.01)(72) Inventors: **Changho HONG**, Seoul (KR); **Geunsu KIM**, Seoul (KR); **Doochan JUNG**, Seoul (KR); **Hyunyun HWANG**, Seoul (KR)(57) **ABSTRACT**(73) Assignee: **LG ELECTRONICS INC.**, Seoul  
(KR)

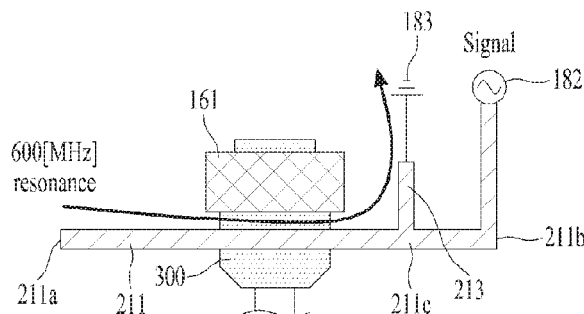
There is disclosed a mobile terminal comprising a body; a ground of a printed circuit board loaded in the body; a data port located in the body to have an external input terminal inserted therein and connected with the ground; a metallic member defining an exterior of the body and comprising a slit; a feeding portion connected with a first point of the metallic member and configured to supply power; a first ground line connected with the ground at a second point located between the first point of the metallic member and the slit; and a second ground line connected with the data port connected with the ground when the external input terminal is inserted in the data port, so that the mobile terminal has to include no additional switch to reduce the number of the components and the antenna of the mobile terminal may be selectively and structurally connected without the algorithm configured to manipulate the switch by sensing that the external input terminal is inserted in the data port to operate the switch to minimize the expense increase cost to improve the antenna performance.

(21) Appl. No.: **15/946,644**(22) Filed: **Apr. 5, 2018**(30) **Foreign Application Priority Data**

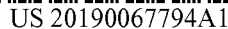
Aug. 17, 2017 (KR) ..... 10-2017-0104026

**Publication Classification**(51) **Int. Cl.****H04M 1/02** (2006.01)  
**H01Q 1/24** (2006.01)  
**H04B 1/3827** (2006.01)

(a)



(b)



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

(43) **Pub. Date:** **Feb. 28, 2019**

*H01Q 1/48* (2006.01)

(52) U.S. Cl.

CPC ..... ***H01Q 1/2266*** (2013.01); ***H01Q 1/48***  
(2013.01); ***H01Q 1/521*** (2013.01); ***H01Q 5/30***  
(2015.01)

(57)

## ABSTRACT

Antenna of a shape that allows for its integration in a laptop or tablet computer, which antenna has dual band or multi band functionality, and comprises: an elongate carrier structure of electrically insulating material, and an electric circuitry provided on the carrier structure, which comprises the following electrically conductive elements: a ground plane, two or more antenna elements spaced apart from each other, one or more filter elements which are positioned between a pair of adjacent antenna elements, wherein the antenna elements and the filter elements are electrically connected to the ground plane, and wherein the carrier structure contains a feed connector system that allows for an electrical connection between an external feed line and the antenna elements, and wherein the parts of the carrier structure on which the antenna elements are provided, has a relative dielectric constant of at least 2.0, and is of a substantially solid design, which preferably has a minimum cross-sectional area of 0.30 to 1.5 cm<sup>2</sup>.

(22) PCT Filed: **Oct. 10, 2016**

(86) PCT No.: **PCT/NL2016/050701**

§ 371 (c)(1),

(2) Date: **Apr. 9, 2018**

(30) **Foreign Application Priority Data**

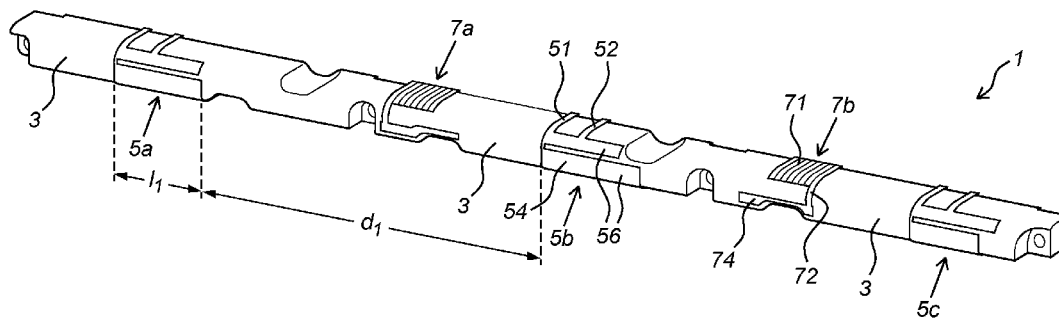
Oct. 9, 2015 (NL) ..... 2015592

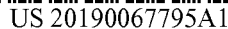
## Publication Classification

(51) **Int. Cl.**

*H01Q 1/22* (2006.01)

*H01Q 5/30* (2006.01)





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

(10) **Pub. No.: US 2019/0067795 A1**  
(43) **Pub. Date: Feb. 28, 2019**

*H05K 1/18* (2006.01)  
*H01Q 1/50* (2006.01)  
*H01Q 9/04* (2006.01)

(52) **U.S. Cl.**  
CPC ..... ***H01Q 1/2283*** (2013.01); ***H05K 1/028***  
(2013.01); ***H05K 1/181*** (2013.01); ***H05K***  
***2201/10128*** (2013.01); ***H01Q 9/0414***  
(2013.01); ***H05K 2201/093*** (2013.01); ***H05K***  
***2201/10098*** (2013.01); ***H01Q 1/50*** (2013.01)

(57) **ABSTRACT**

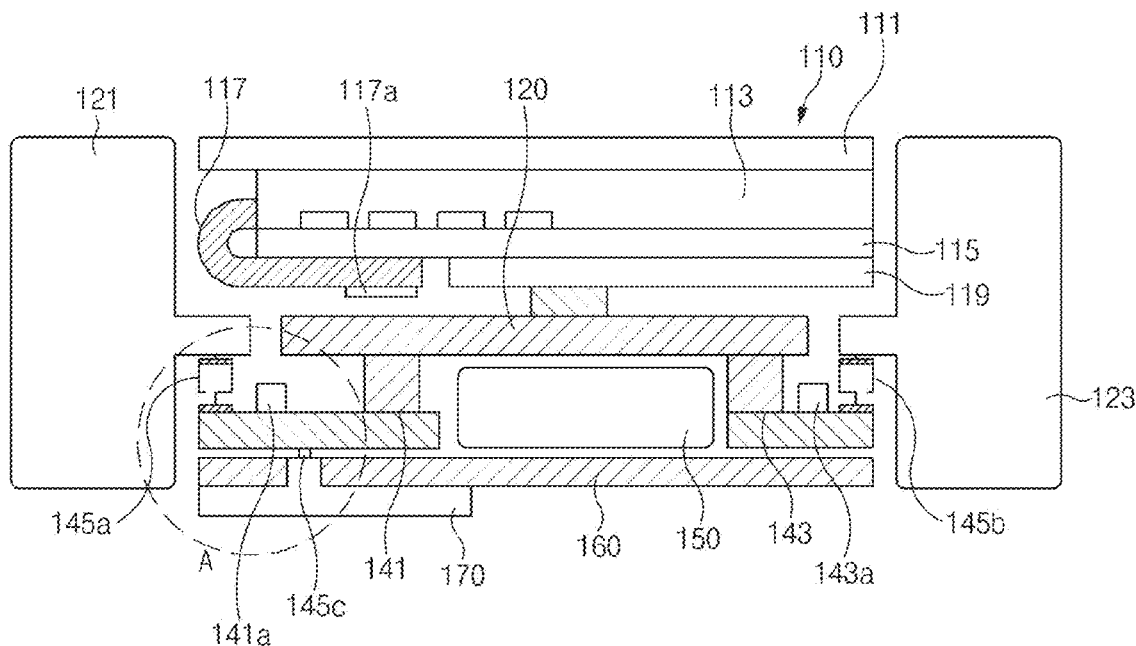
An electronic device which includes a housing is provided. The housing includes a first surface, a second surface facing away from the first surface, and a side member surrounding a space between the first surface and the second surface, a display that is exposed through a substantial portion of the first surface of the housing, a first radiator that forms a portion of the side member, a PCB that is positioned within the housing and includes a ground layer, a communication circuit that is positioned on the PCB, and a conductive pattern having a length corresponding to a length of the first radiator.

(30) **Foreign Application Priority Data**

Aug. 23, 2017 (KR) ..... 10-2017-0106954

## Publication Classification

(51) **Int. Cl.**  
*H01Q 1/22* (2006.01)  
*H05K 1/02* (2006.01)





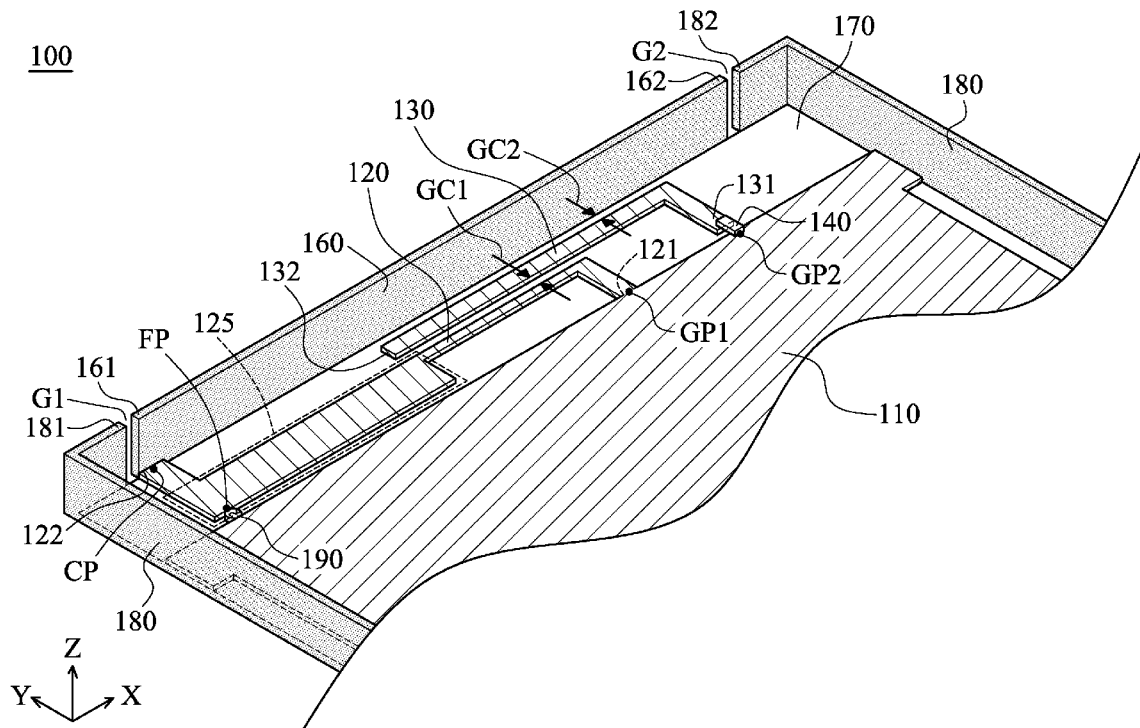
US 20190067796A1

(19) **United States**(12) **Patent Application Publication**  
LU et al.(10) **Pub. No.: US 2019/0067796 A1**(43) **Pub. Date: Feb. 28, 2019**(54) **MOBILE DEVICE**(71) Applicant: **Quanta Computer Inc.**, Taoyuan City (TW)(72) Inventors: **Yu-Chun LU**, Taoyuan City (TW);  
**Chun-Yuan WANG**, Taoyuan City (TW); **Chi-Hsuan LEE**, Taoyuan City (TW)(21) Appl. No.: **15/828,668**(22) Filed: **Dec. 1, 2017**(30) **Foreign Application Priority Data**

Aug. 22, 2017 (TW) ..... 106128391

**Publication Classification**(51) **Int. Cl.**  
**H01Q 1/24** (2006.01)  
**H01Q 5/328** (2006.01)  
**H01Q 1/44** (2006.01)  
**H01Q 5/335** (2006.01)**H01Q 21/30** (2006.01)**H01Q 5/321** (2006.01)(52) **U.S. Cl.**CPC ..... **H01Q 1/243** (2013.01); **H01Q 5/328**  
(2015.01); **H01Q 5/321** (2015.01); **H01Q**  
**5/335** (2015.01); **H01Q 21/30** (2013.01);  
**H01Q 1/44** (2013.01)(57) **ABSTRACT**

A mobile device includes a ground element, a first radiation element, a second radiation element, a matching circuit, and a first metal frame. The first radiation element is coupled to a first grounding point on the ground element. The second radiation element is coupled through the matching circuit to a second grounding point on the ground element. A first coupling gap is formed between the second radiation element and the first radiation element. The first metal frame is coupled to a connection point on the first radiation element. A second coupling gap is formed between the second radiation element and the first metal frame. An antenna structure is formed by the first radiation element, the second radiation element, the matching circuit, and the first metal frame. A signal source is coupled to a feeding point on the first radiation element, so as to excite the antenna structure.





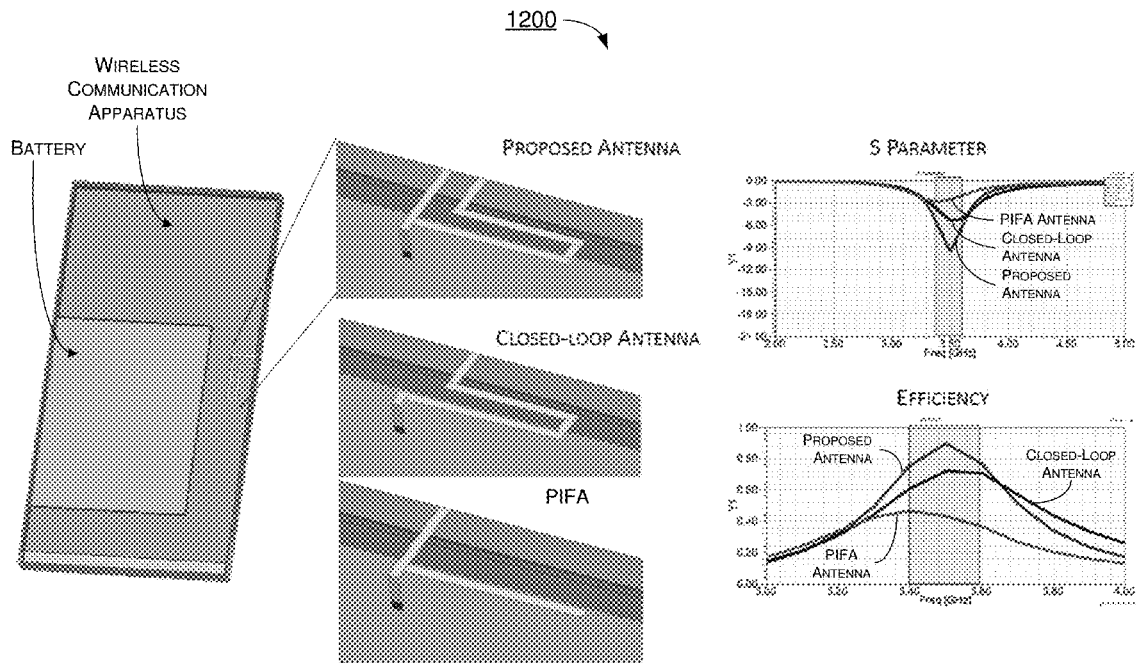
US 20190067815A1

(19) **United States**(12) **Patent Application Publication**  
Wu et al.(10) **Pub. No.: US 2019/0067815 A1**(43) **Pub. Date: Feb. 28, 2019**(54) **CLOSED-LOOP ANTENNA WITH MULTIPLE  
GROUNDING POINTS**(71) Applicant: **MediaTek Inc.**, Hsinchu City (TW)(72) Inventors: **Tsung-Ju Wu**, Hsinchu City (TW);  
**Ting-Wei Kang**, Hsinchu City (TW);  
**Chung-Yu Hung**, Hsinchu City (TW)(21) Appl. No.: **16/110,506**(22) Filed: **Aug. 23, 2018****Related U.S. Application Data**

(60) Provisional application No. 62/549,480, filed on Aug. 24, 2017.

**Publication Classification**(51) **Int. Cl.**  
**H01Q 5/35** (2006.01)  
**H01Q 7/00** (2006.01)  
**H01Q 1/48** (2006.01)(52) **H01Q 1/50** (2006.01)  
**H01Q 5/50** (2006.01)  
**U.S. Cl.**  
CPC ..... **H01Q 5/35** (2015.01); **H01Q 7/00**  
(2013.01); **H01Q 5/50** (2015.01); **H01Q 1/50**  
(2013.01); **H01Q 1/48** (2013.01)(57) **ABSTRACT**

Various examples and schemes pertaining to a closed-loop antenna with multiple grounding points are described. An apparatus includes an electromagnetic (EM) wave interface device capable of radiating and sensing EM waves. The EM wave interface device includes a feeding port, a first grounding port coupled to an electric ground, and a second grounding port coupled to the electric ground. A first electrically-conductive path connected between the feeding port and the first grounding port forms a closed-loop antenna. A second electrically-conductive path connected between the feeding port and the second grounding port forms a non-radiative closed-loop path. A length of the first electrically-conductive path is greater than a length of the second electrically-conductive path.





US 20190067817A1

(19) **United States**(12) **Patent Application Publication**  
**Oh et al.**(10) **Pub. No.: US 2019/0067817 A1**(43) **Pub. Date: Feb. 28, 2019**(54) **ANTENNA PORTIONS****Publication Classification**(71) Applicant: **Hewlett-Packard Development Company, L.P.**, Houston, TX (US)(72) Inventors: **Sung Oh**, Palo Alto, CA (US); **Philip Wright**, San Diego, CA (US)(73) Assignee: **Hewlett-Packard Development Company, L.P.**, Houston, TX (US)(21) Appl. No.: **15/772,180**(22) PCT Filed: **Feb. 19, 2016**(86) PCT No.: **PCT/US2016/018736**

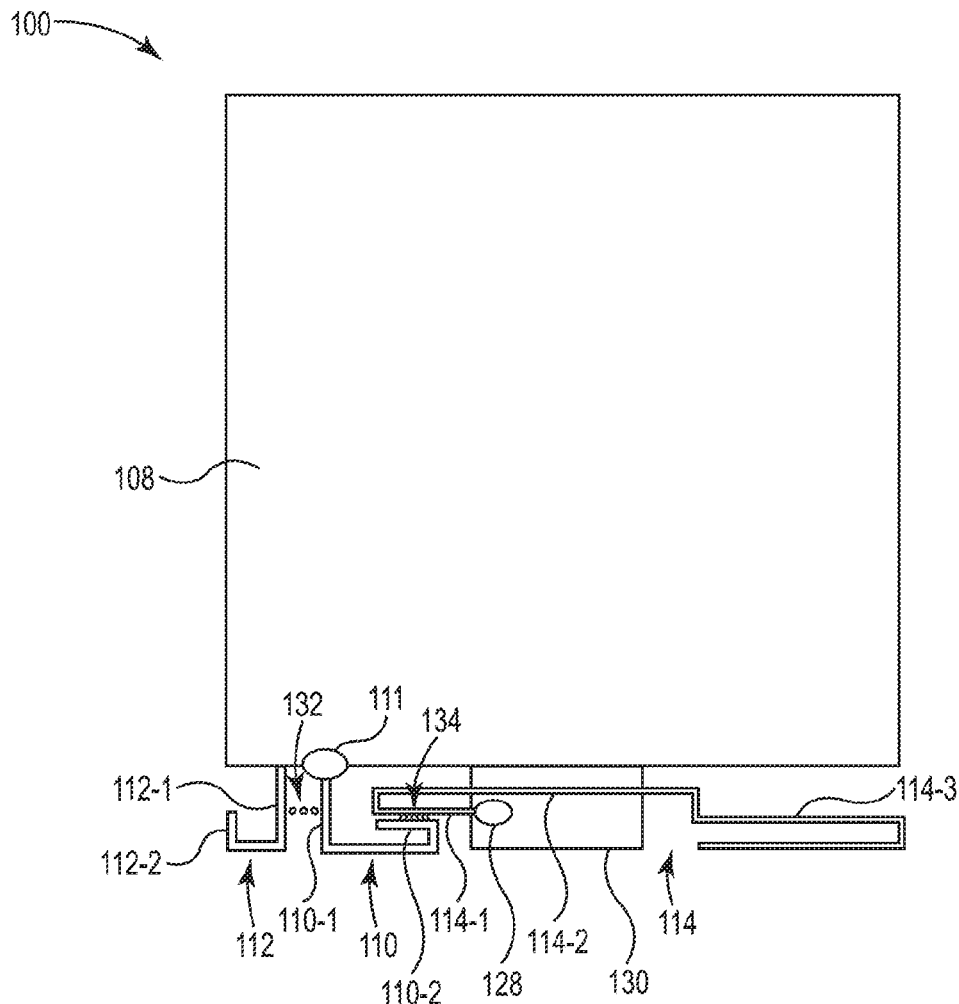
§ 371 (c)(1),

(2) Date: **Apr. 30, 2018**(51) **Int. Cl.****H01Q 5/392** (2006.01)**H01Q 1/22** (2006.01)**H01Q 9/42** (2006.01)(52) **U.S. Cl.**CPC ..... **H01Q 5/392** (2015.01); **H01Q 9/42** (2013.01); **H01Q 1/2266** (2013.01)

(57)

**ABSTRACT**

An antenna system, in one example implementation, can include antenna portions including a first portion of the antenna to receive a radio frequency (RF) signal. The antenna can include a second portion capacitively coupled to the first portion, wherein the capacitive coupling of the second portion to the first portion increases the high-band resonances. The antenna can include a third portion of the antenna connected to a connector. The third portion can be capacitively coupled to the first portion to excite wide low-band resonances and high-band resonances. The connector can be a ground for the third portion.







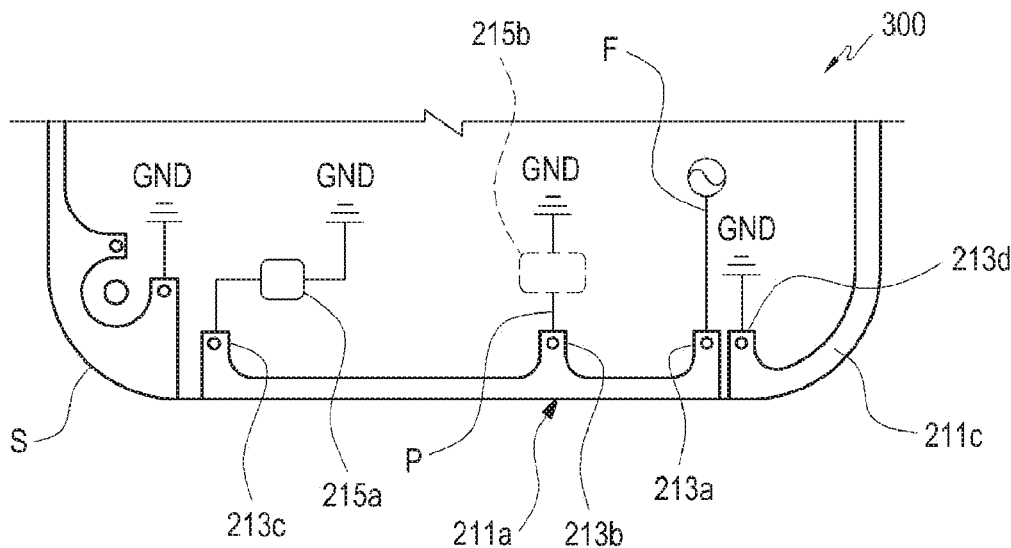
US 20190067821A1

(19) **United States**(12) **Patent Application Publication**  
**KIM et al.**(10) **Pub. No.: US 2019/0067821 A1**(43) **Pub. Date: Feb. 28, 2019**(54) **ANTENNA DEVICE AND ELECTRONIC  
DEVICE INCLUDING THE SAME****Publication Classification**(71) Applicants: **Samsung Electronics Co., Ltd.**,  
Gyeonggi-do (KR); **Industry-Academic  
Cooperation Foundation, Yonsei  
University**, Seoul (KR)(51) **Int. Cl.**  
**H01Q 9/04** (2006.01)  
**H01Q 1/24** (2006.01)  
**H01Q 5/371** (2006.01)  
**H01Q 7/00** (2006.01)  
(52) **U.S. Cl.**  
CPC ..... **H01Q 9/0421** (2013.01); **H01Q 7/00**  
(2013.01); **H01Q 5/371** (2015.01); **H01Q**  
**1/243** (2013.01)(72) Inventors: **Sung-Soo KIM**, Gyeonggi-do (KR);  
**Young-Joong Yoon**, Seoul (KR);  
**Seon-Ho Lim**, Seoul (KR)(73) Assignees: **Samsung Electronics Co., Ltd.**;  
**Industry-Academic Cooperation  
Foundation, Yonsei University**(57) **ABSTRACT**

An antenna device is provided. The antenna device includes a first radiating conductor including a feeding portion and a radiating portion extending from the feeding portion, the feeding portion including a feeding terminal and a shorting pin, a ground electrically connected with the first radiating conductor via the shorting pin and configured to provide a reference potential for the first radiating conductor, and a first switch circuit provided on a side of the radiating portion and configured to selectively connect the radiating portion with the ground. The first radiating conductor is configured to form at least part of an inverted-F antenna structure when the first switch circuit is open and to form at least part of a loop antenna structure when the first switch circuit is closed.

(21) Appl. No.: **16/020,387**(22) Filed: **Jun. 27, 2018**(30) **Foreign Application Priority Data**

Aug. 25, 2017 (KR) ..... 10-2017-0107845





US 20190074575A1

(19) **United States**(12) **Patent Application Publication**  
**WANG et al.**(10) **Pub. No.: US 2019/0074575 A1**(43) **Pub. Date: Mar. 7, 2019**(54) **MOBILE DEVICE****H01Q 21/30** (2006.01)**H01Q 5/321** (2006.01)(71) Applicant: **Quanta Computer Inc.**, Taoyuan City  
(TW)(52) **U.S. Cl.**CPC ..... **H01Q 1/243** (2013.01); **H01Q 13/103**  
(2013.01); **H01Q 5/328** (2015.01); **H01Q**  
**5/321** (2015.01); **H01Q 1/44** (2013.01); **H01Q**  
**5/335** (2015.01); **H01Q 21/30** (2013.01);  
**H01Q 9/0442** (2013.01)(72) Inventors: **Chun-Yuan WANG**, Taoyuan City  
(TW); **Yu-Chun LU**, Taoyuan City  
(TW); **Chi-Hsuan LEE**, Taoyuan City  
(TW)(21) Appl. No.: **15/828,686**(22) Filed: **Dec. 1, 2017**(30) **Foreign Application Priority Data**

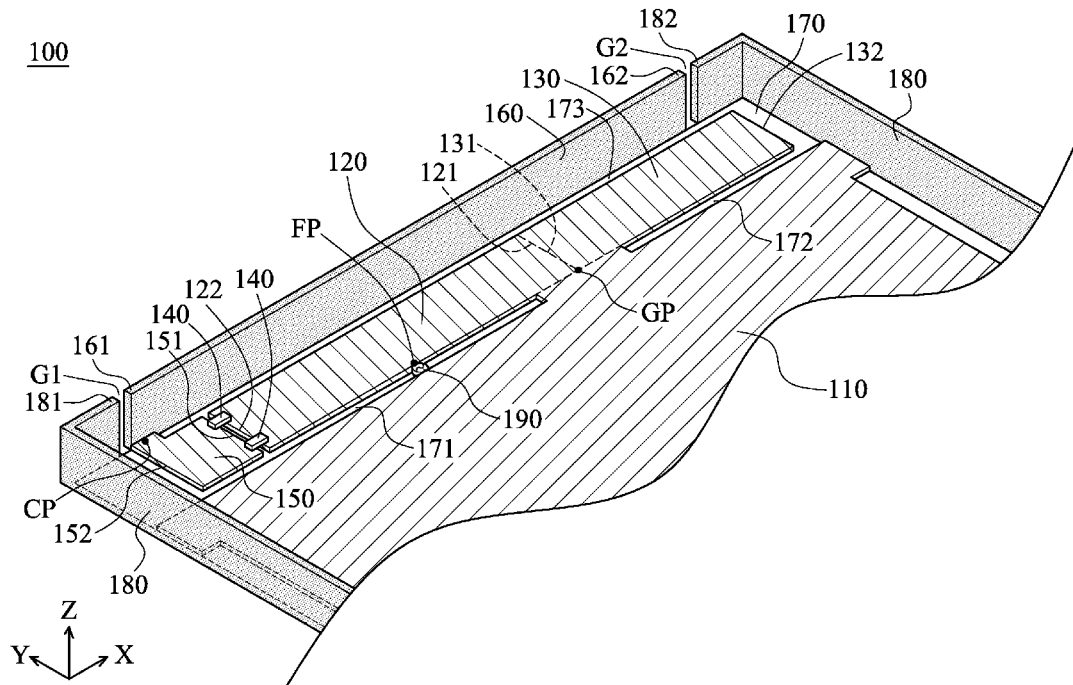
Sep. 4, 2017 (TW) ..... 106130126

**Publication Classification**(51) **Int. Cl.****H01Q 1/24** (2006.01)**H01Q 13/10** (2006.01)**H01Q 5/328** (2006.01)**H01Q 9/04** (2006.01)**H01Q 1/44** (2006.01)**H01Q 5/335** (2006.01)

(57)

**ABSTRACT**

A mobile device includes a ground element, a first radiation element, a second radiation element, a third radiation element, a matching circuit, and a first metal frame. The first radiation element and the second radiation element are both coupled to a grounding point on the ground element. The second radiation element and the first radiation element extend in opposite directions. The third radiation element is coupled through the matching circuit to the first radiation element. The first metal frame is coupled to a connection point on the third radiation element. An antenna structure is formed by the first radiation element, the second radiation element, the matching circuit, the third radiation element, and the first metal frame. A signal source is coupled to a feeding point on the first radiation element, so as to excite the antenna structure.





US 20190074576A1

(19) **United States**

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

(10) **Pub. No.: US 2019/0074576 A1**

(43) **Pub. Date: Mar. 7, 2019**

(54) **ELECTRONIC DEVICE COMPRISING ANTENNA**

**Publication Classification**

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

(72) Inventors: **Hong Pyo BAE**, Gyeonggi-do (KR);  
**Dong Yeon KIM**, Gyeonggi-do (KR);  
**Ho Jung NAM**, Gyeonggi-do (KR);  
**Sung Koo PARK**, Gyeonggi-do (KR);  
**Jae Woon PARK**, Seoul (KR); **Min**  
**Cheol SEO**, Seoul (KR); **Him Chan**  
**YUN**, Gyeonggi-do (KR); **Han Dug**  
**LEE**, Gyeonggi-do (KR); **Hyun Woo**  
**LEE**, Gyeonggi-do (KR); **Hyung Joo**  
**LEE**, Gyeonggi-do (KR); **Byung Man**  
**LIM**, Seoul (KR); **Nak Chung CHOI**,  
Seoul (KR)

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

(21) Appl. No.: **16/125,163**

(22) Filed: **Sep. 7, 2018**

(30) **Foreign Application Priority Data**

Sep. 7, 2017 (KR) ..... 10-2017-0114626

(51) **Int. Cl.**

**H01Q 1/24** (2006.01)

**H01Q 1/38** (2006.01)

**H01Q 13/10** (2006.01)

**H04M 1/02** (2006.01)

**H05K 1/02** (2006.01)

**H01Q 1/52** (2006.01)

**H01Q 9/04** (2006.01)

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

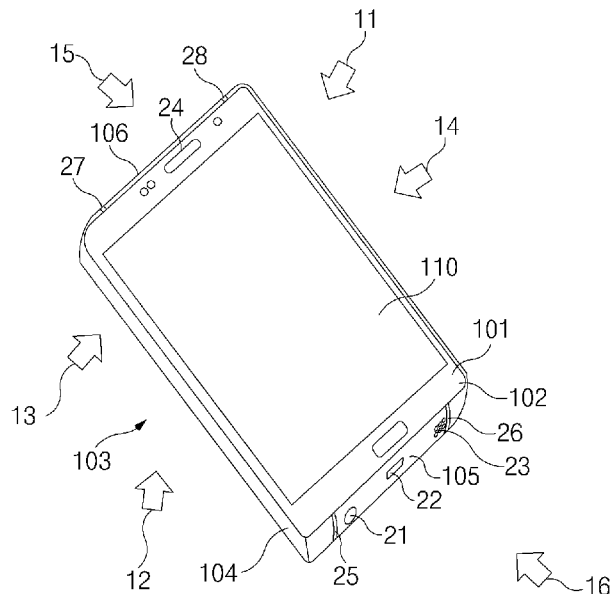
CPC ..... **H01Q 1/243** (2013.01); **H01Q 1/38**  
(2013.01); **H01Q 13/10** (2013.01); **H05K**  
**1/0216** (2013.01); **H05K 1/0237** (2013.01);  
**H01Q 1/526** (2013.01); **H01Q 9/0407**  
(2013.01); **H04M 1/0266** (2013.01)

(57)

**ABSTRACT**

An electronic device is provided. The electronic device includes a housing including a front plate, a rear plate facing away from the front plate, and a side member surrounding a space between the front plate and the rear plate, the housing including at least one antenna element extended along one portion of the side member, a display exposed through the front plate and including a display panel and a shield layer, a wireless communication circuit electrically connected to the antenna element, a support member, at least a portion of which is positioned in the space in parallel with the shield layer, and a conductive patch layer interposed between the shield layer and the support member.

100





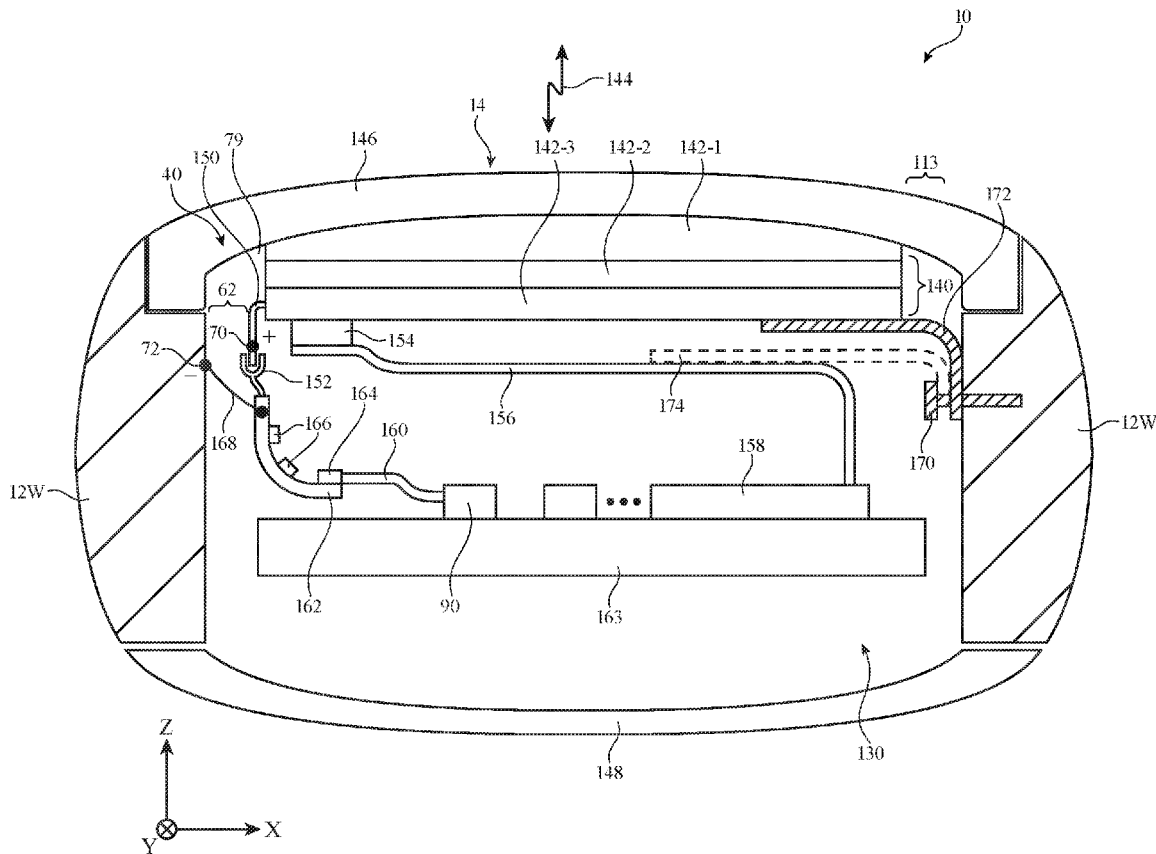
US 20190074586A1

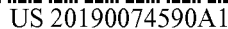
(19) **United States**(12) **Patent Application Publication****Ruaro et al.**(10) **Pub. No.: US 2019/0074586 A1**(43) **Pub. Date: Mar. 7, 2019**(54) **ELECTRONIC DEVICE SLOT ANTENNAS****H01Q 1/22** (2006.01)**H01Q 9/04** (2006.01)(71) Applicant: **Apple Inc.**, Cupertino, CA (US)(52) **U.S. Cl.**CPC ..... **H01Q 1/528** (2013.01); **H01Q 9/04**  
(2013.01); **H01Q 1/2266** (2013.01); **H01Q**  
**1/273** (2013.01)(72) Inventors: **Andrea Ruaro**, Campbell, CA (US);  
**Carlo Di Nallo**, Belmont, CA (US);  
**Eduardo Jorge Da Costa Bras Lima**,  
Sunnyvale, CA (US); **Jayesh Nath**,  
Milpitas, CA (US); **Mario Martinis**,  
Cupertino, CA (US); **Mattia Pascolini**,  
San Francisco, CA (US); **Zheyu Wang**,  
Sunnyvale, CA (US); **Sameer Pandya**,  
Sunnyvale, CA (US)

(57)

**ABSTRACT**

An electronic device such as a wristwatch may have a housing with metal sidewalls and a display having conductive display structures. Printed circuits having corresponding ground traces may be coupled to the display for conveying data to and/or from the display. The conductive display structures may be separated from the metal sidewalls by a gap. A conductive interconnect may be coupled to the metal sidewalls and may extend across the gap to the conductive display structures. The conductive interconnect may be coupled to the ground traces on the printed circuits and/or may be shorted or capacitively coupled to the conductive display structures. When configured in this way, the metal sidewalls, the conductive display structures, and the conductive interconnect may define the edges of a slot antenna resonating element for a slot antenna.

(21) Appl. No.: **15/698,481**(22) Filed: **Sep. 7, 2017****Publication Classification**(51) **Int. Cl.****H01Q 1/52** (2006.01)**H01Q 1/27** (2006.01)



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

(10) **Pub. No.: US 2019/0074590 A1**  
(43) **Pub. Date: Mar. 7, 2019**

## Publication Classification

(51) **Int. Cl.**  
*H01Q 9/04* (2006.01)  
*H01Q 21/28* (2006.01)

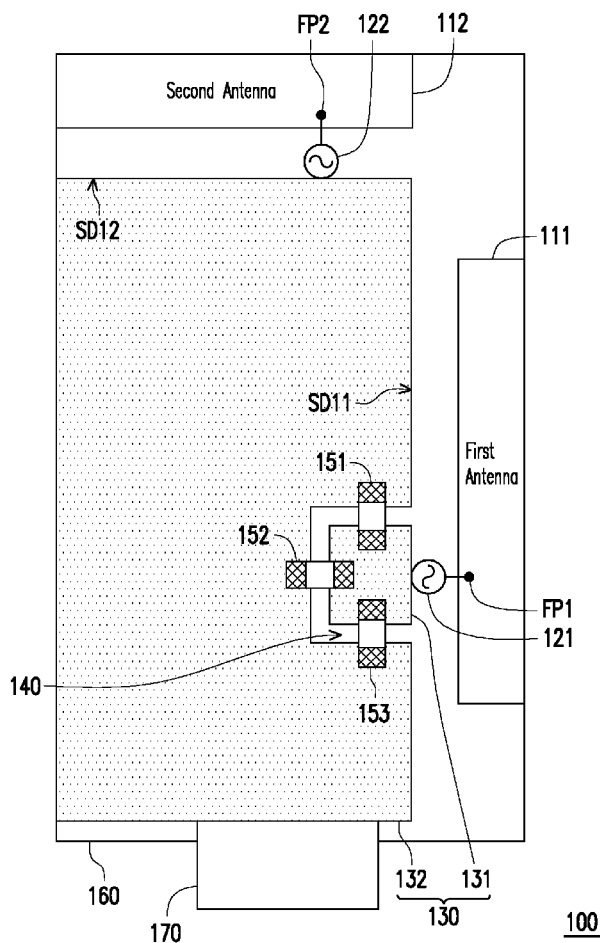
(52) U.S. Cl.  
CPC ..... *H01Q 9/0407* (2013.01); *H01Q 1/243*  
(2013.01); *H01Q 21/28* (2013.01)

(57) **ABSTRACT**

A mobile electronic device includes a ground plane, a first slot, a plurality of first inductive elements, a first antenna, a second antenna, a first signal source, and a second signal source. The first slot is disposed in the ground plane to form a first ground portion and a second ground portion separated from each other. The first inductive elements are respectively connected to the first ground portion and the second ground portion. The first antenna and the second antenna respectively receive a radio-frequency signal in a predetermined band. The first signal source is electrically connected between the first antenna and the first ground portion and receives the radio-frequency signal from the first antenna. The second signal source is electrically connected between the second antenna and the second ground portion and receives the radio-frequency signal from the second antenna.

(30) **Foreign Application Priority Data**

Sep. 4, 2017 (TW) ..... 106130165





US 20190081385A1

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

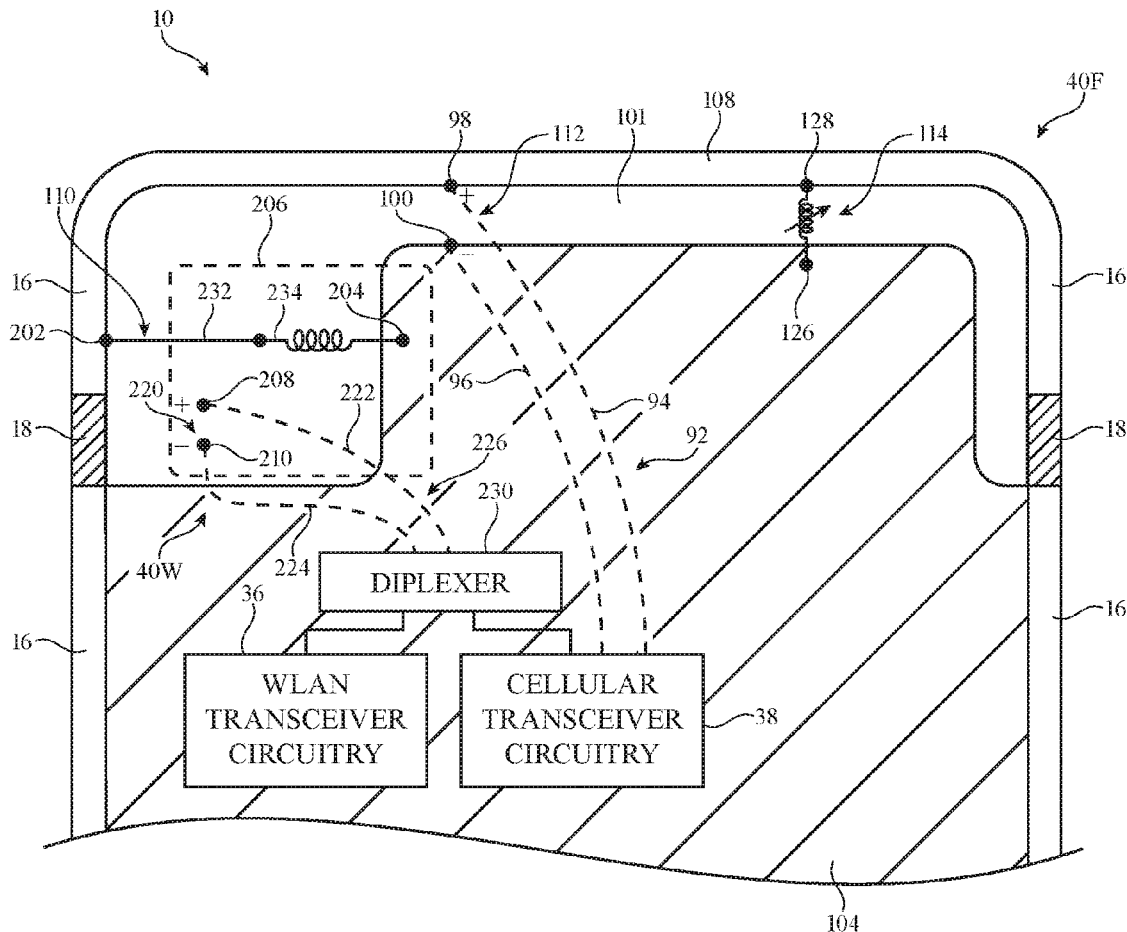
Avser et al.

(10) **Pub. No.: US 2019/0081385 A1**(43) **Pub. Date: Mar. 14, 2019**(54) **ELECTRONIC DEVICE HAVING SHARED ANTENNA STRUCTURES**(52) **U.S. Cl.**CPC ..... *H01Q 1/243* (2013.01); *H01Q 1/38* (2013.01); *H01Q 9/0421* (2013.01); *H01Q 5/50* (2015.01)(71) Applicant: **Apple Inc.**, Cupertino, CA (US)(72) Inventors: **Bilgehan Avser**, Mountain View, CA (US); **Georgios Atmatzakis**, Cupertino, CA (US); **Hao Xu**, Cupertino, CA (US); **Mattia Pascolini**, San Francisco, CA (US); **Salih Yarga**, Sunnyvale, CA (US); **Xu Gao**, Santa Clara, CA (US); **Xu Han**, Santa Clara, CA (US); **Yijun Zhou**, Mountain View, CA (US)

(57)

**ABSTRACT**

An electronic device may be provided with wireless circuitry. The wireless circuitry may include multiple antennas and transceiver circuitry. The antennas may include antenna structures at opposing first and second ends of the electronic device. The antenna structures at a given end of the device may include antenna structures that are shared between multiple antennas. The electronic device may include a first antenna with an inverted-F antenna resonating element formed from portions of a peripheral conductive housing structure and may have an antenna ground that is separated from the antenna resonating element by a gap. A return path may bridge the gap. The electronic device may also include a second antenna that includes the antenna ground and an additional antenna resonating element. The antenna resonating element of the second antenna may be parasitically coupled to the return path of the inverted-F antenna at given frequencies.

(21) Appl. No.: **15/699,879**(22) Filed: **Sep. 8, 2017****Publication Classification**(51) **Int. Cl.***H01Q 1/24* (2006.01)  
*H01Q 5/50* (2006.01)  
*H01Q 9/04* (2006.01)



US 20190081386A1

(19) **United States**(12) **Patent Application Publication**  
**Edwards et al.**(10) **Pub. No.: US 2019/0081386 A1**(43) **Pub. Date: Mar. 14, 2019**(54) **ELECTRONIC DEVICE HAVING ISOLATED  
ANTENNA STRUCTURES**(52) **U.S. Cl.**CPC ..... *H01Q 1/243* (2013.01); *H01Q 1/526*  
(2013.01); *H01Q 1/523* (2013.01); *H01Q 1/38*  
(2013.01); *H01Q 1/48* (2013.01); *H04M*  
*1/0266* (2013.01); *H01Q 5/10* (2015.01)(71) Applicant: **Apple Inc.**, Cupertino, CA (US)(72) Inventors: **Jennifer M. Edwards**, San Francisco,  
CA (US); **Yijun Zhou**, Mountain View,  
CA (US); **Yiren Wang**, Santa Clara,  
CA (US); **Hao Xu**, Cupertino, CA (US);  
**Mattia Pascolini**, San Francisco, CA  
(US)

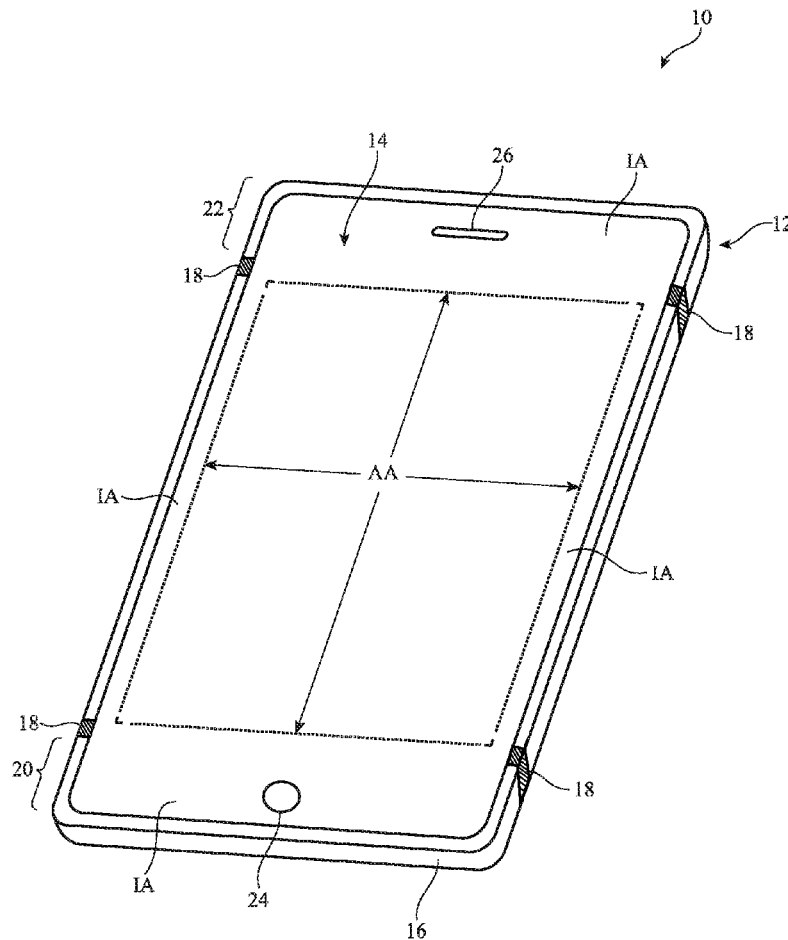
(57)

**ABSTRACT**

An electronic device may be provided with wireless circuitry. The wireless circuitry may include multiple antennas and transceiver circuitry. The antenna structures at a first end of the electronic device may include an inverted-F antenna resonating element for a first antenna formed from portions of a peripheral conductive electronic device housing structure and an antenna ground that is separated from the antenna resonating element by a gap. The inverted-F antenna resonating element arm may have a first end adjacent a first dielectric-filled gap and an opposing second end adjacent a second dielectric-filled gap. A second antenna may include an additional antenna resonating element arm and the antenna ground. A second end of the additional antenna resonating element arm may be interposed between the first dielectric-filled gap and a first end of the additional antenna resonating element arm. This type of arrangement may ensure the first and second antennas are isolated.

(21) Appl. No.: **15/700,636**(22) Filed: **Sep. 11, 2017****Publication Classification**(51) **Int. Cl.**

|                  |           |
|------------------|-----------|
| <i>H01Q 1/24</i> | (2006.01) |
| <i>H01Q 1/52</i> | (2006.01) |
| <i>H01Q 5/10</i> | (2006.01) |
| <i>H01Q 1/48</i> | (2006.01) |
| <i>H04M 1/02</i> | (2006.01) |
| <i>H01Q 1/38</i> | (2006.01) |





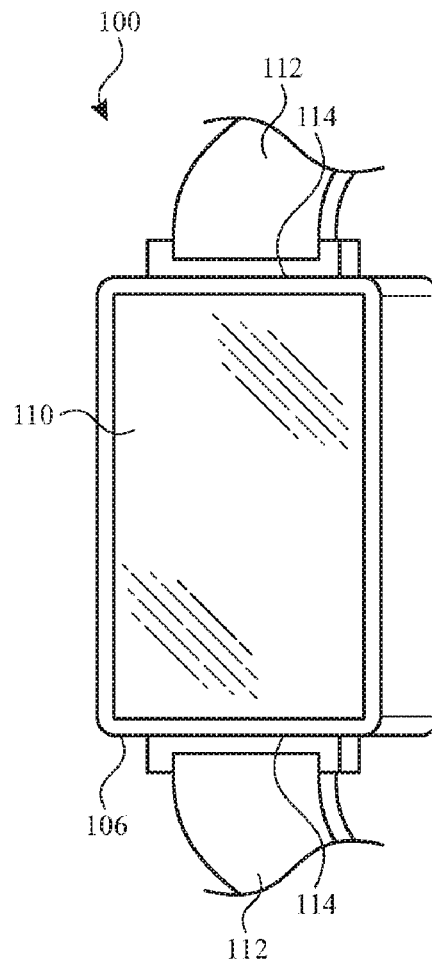
US 20190081387A1

(19) **United States**(12) **Patent Application Publication**  
**PANDYA et al.**(10) **Pub. No.: US 2019/0081387 A1**(43) **Pub. Date: Mar. 14, 2019**(54) **INTEGRATED ANTENNAS FOR PORTABLE  
ELECTRONIC DEVICES****Publication Classification**(71) Applicant: **Apple Inc.**, Cupertino, CA (US)(72) Inventors: **Sameer PANDYA**, Sunnyvale, CA  
(US); **Mario MARTINIS**, Cupertino,  
CA (US); **Baris OZGEN**, Mountain  
View, CA (US); **Tyler S. BUSHNELL**,  
Mountain View, CA (US); **Sherry**  
**TANG**, Cupertino, CA (US); **Henry H.**  
**YANG**, San Jose, CA (US);  
**Christopher M. WERNER**, San Jose,  
CA (US); **Jayesh NATH**, Milpitas, CA  
(US); **Carlo DI NALLO**, Belmont, CA  
(US); **Andrea RUARO**, Campbell, CA  
(US)(51) **Int. Cl.****H01Q 1/24** (2006.01)**H04M 1/02** (2006.01)**H04L 29/06** (2006.01)(52) **U.S. Cl.**CPC ..... **H01Q 1/243** (2013.01); **H01Q 1/38**  
(2013.01); **H04L 69/18** (2013.01); **H04M**  
**1/0266** (2013.01)(21) Appl. No.: **15/874,805**(22) Filed: **Jan. 18, 2018****Related U.S. Application Data**(60) Provisional application No. 62/557,054, filed on Sep.  
11, 2017.

(57)

**ABSTRACT**

Aspects of the subject technology relate to electronic devices with antennas. The antenna may be a display-integrated antenna. An antenna feed for the antenna may be located in a recess in a sidewall of a housing of the device. The antenna feed may be coupled to transceiver circuitry on a logic board of the device by a pair of flex circuits. A first one of the pair of flex circuits may form a portion of an antenna feed assembly. A second one of the pair of flex circuits may be an impedance-matching flex having an end that is soldered to the main logic board. The antenna may be coupled to a conductive portion of the housing of the device.







US 20190081388A1

(19) **United States**

(12) **Patent Application Publication**  
**LO HINE TONG et al.**

(10) **Pub. No.: US 2019/0081388 A1**

(43) **Pub. Date: Mar. 14, 2019**

(54) **LOW-PROFILE MULTI-BAND ANTENNA**

**Publication Classification**

(71) Applicant: **Thomson Licensing**,  
Issy-Ies-Moulineaux (FR)

(72) Inventors: **Dominique LO HINE TONG**,  
Cesson-Sevigne (FR); **Philippe**  
**MINARD**, Cesson-Sevigne (FR); **Lizhi**  
**ZHAO**, Beijing (CN)

(51) **Int. Cl.**

**H01Q 1/24** (2006.01)

**H01Q 1/22** (2006.01)

**H01Q 7/00** (2006.01)

**H01Q 9/42** (2006.01)

**H01Q 5/30** (2006.01)

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

CPC ..... **H01Q 1/243** (2013.01); **H01Q 1/2291**

(2013.01); **H01Q 5/30** (2015.01); **H01Q 9/42**

(2013.01); **H01Q 7/00** (2013.01)

(21) Appl. No.: **16/087,128**

(22) PCT Filed: **Mar. 21, 2017**

(86) PCT No.: **PCT/EP2017/056738**

§ 371 (c)(1),

(2) Date: **Sep. 21, 2018**

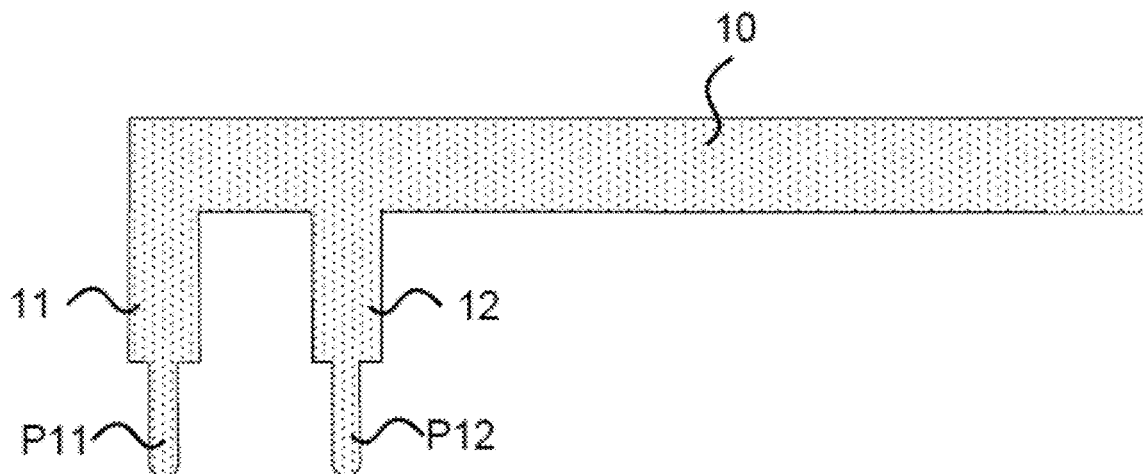
(30) **Foreign Application Priority Data**

Mar. 23, 2016 (EP) ..... 16305326.7

(57)

**ABSTRACT**

The invention relates to an antenna system mounted onto a printed circuit board, said antenna system comprising first and second radiating elements, an antenna feeding element connected to an antenna feeding pad of the printed circuit board, a ground return element connected to a ground pad of the printed circuit board. A third radiating element having first and second ends, the first end of the third radiating element is connected to the second end of the second radiating element. The third radiating element, the second radiating element, the ground return element and the antenna feeding element are arranged to form an inverted-F antenna.





US 20190081393A1

(19) **United States**(12) **Patent Application Publication** (10) **Pub. No.: US 2019/0081393 A1**  
(43) **Pub. Date: Mar. 14, 2019**(54) **ELECTRONIC DEVICE ANTENNAS HAVING  
DISTRIBUTED CAPACITANCES**(52) **U.S. Cl.**CPC ..... *H01Q 1/48* (2013.01); *H05K 5/0017*  
(2013.01); *H01Q 1/20* (2013.01); *H01Q 3/00*  
(2013.01)(71) Applicant: **Apple Inc.**, Cupertino, CA (US)(72) Inventors: **Yijun Zhou**, Mountain View, CA (US);  
**Jennifer M. Edwards**, San Francisco,  
CA (US); **Yiren Wang**, Santa Clara,  
CA (US); **Hao Xu**, Cupertino, CA (US);  
**Ming-Ju Tsai**, Sunnyvale, CA (US);  
**Mattia Pascolini**, San Francisco, CA  
(US)

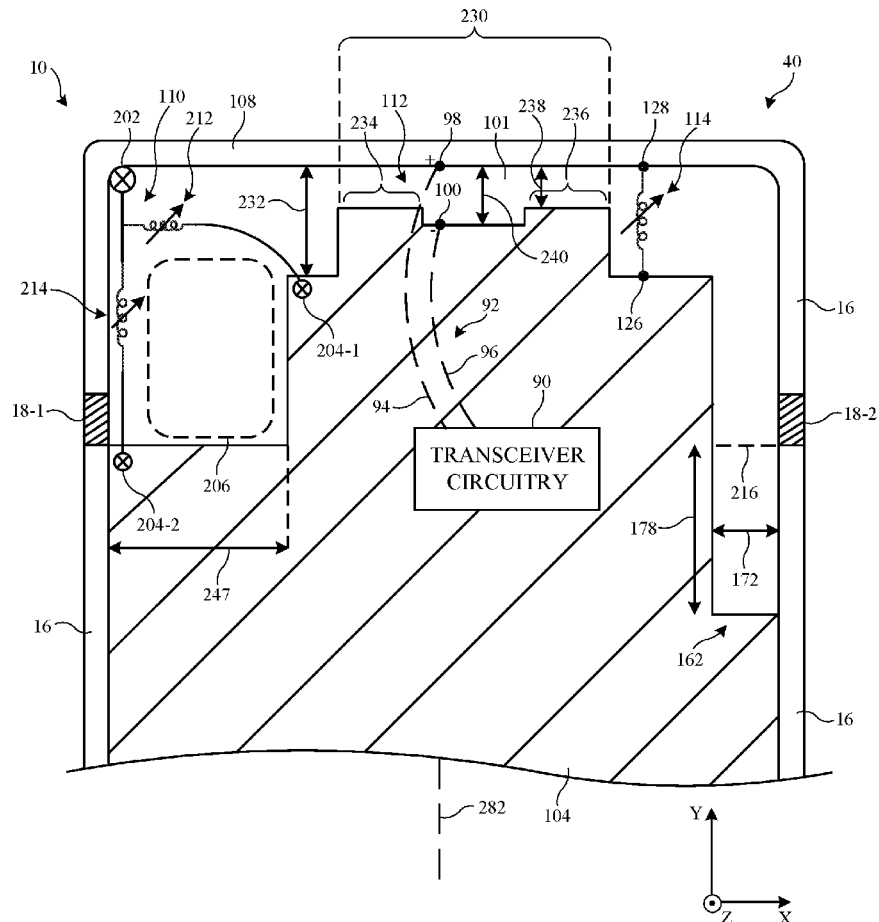
(57)

**ABSTRACT**

An electronic device may be provided with wireless circuitry. The wireless circuitry may include multiple antennas and transceiver circuitry. An antenna may have an antenna resonating element formed from portions of a peripheral conductive electronic device housing structure and may have an antenna ground that is separated from the antenna resonating element by a gap. The antenna ground for the antenna may include a first conductive structure that is separated from the antenna resonating element by a first distance and a second conductive structure that is electrically connected to the first conductive structure and separated from the antenna resonating element by a second distance that is less than the first distance. A distributed impedance matching capacitor for the antenna may be formed from the second conductive structure and the antenna resonating element arm. The second conductive structure may be a conductive frame for an electronic component such as a sensor.

(21) Appl. No.: **15/701,246**(22) Filed: **Sep. 11, 2017****Publication Classification**(51) **Int. Cl.**

|                  |           |
|------------------|-----------|
| <i>H01Q 1/48</i> | (2006.01) |
| <i>H01Q 3/00</i> | (2006.01) |
| <i>H01Q 1/20</i> | (2006.01) |
| <i>H05K 5/00</i> | (2006.01) |





US 20190081398A1

(19) **United States**(12) **Patent Application Publication****Zhou et al.**(10) **Pub. No.: US 2019/0081398 A1**(43) **Pub. Date: Mar. 14, 2019**

(54) **ELECTRONIC DEVICE ANTENNAS HAVING SHARED STRUCTURES FOR NEAR-FIELD COMMUNICATIONS AND NON-NEAR FIELD COMMUNICATIONS**

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

CPC ..... **H01Q 5/328** (2015.01); **H01Q 1/241** (2013.01); **H01Q 9/0421** (2013.01)

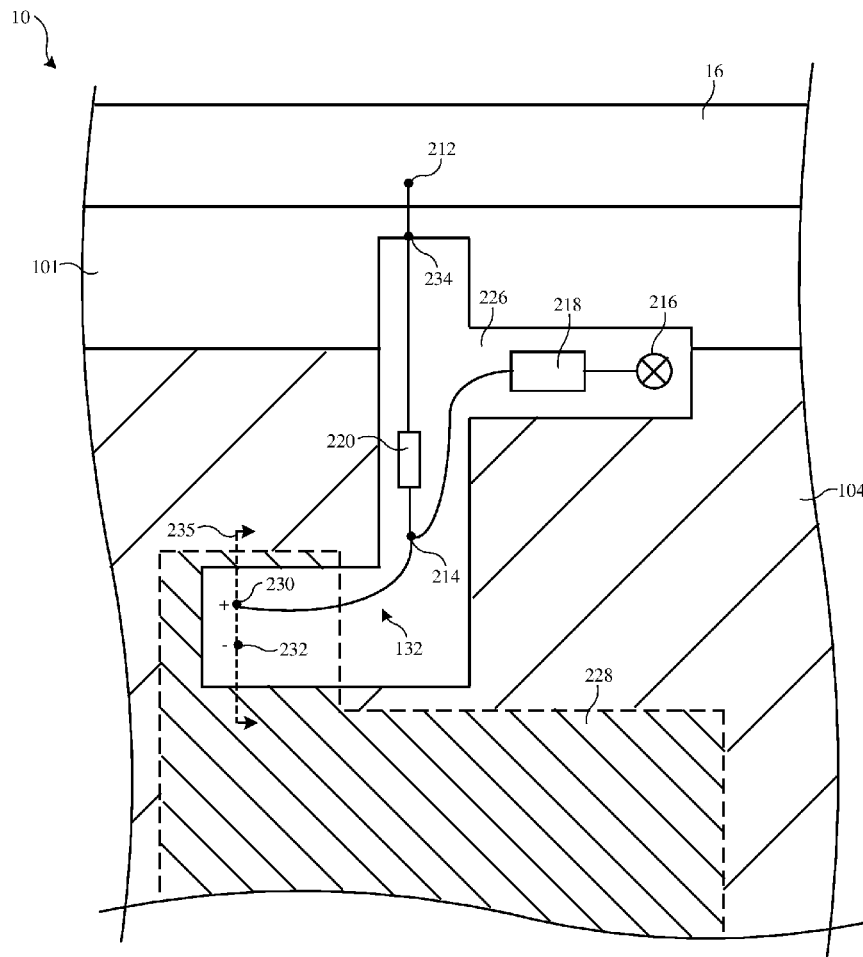
(57)

**ABSTRACT**

An electronic device may be provided with wireless circuitry. The wireless circuitry may include antenna structures such as an antenna resonating element arm and an antenna ground. A split return path may be coupled between the antenna resonating element arm and the antenna ground. The antenna structures may form one or more inverted-F antennas when operated at non-near-field communications frequencies. The antenna structures may be coupled to near-field communications transceiver circuitry using a conductive path. When operated at near-field communications frequencies, near-field communications signals may be conveyed using the conductive path, the antenna resonating element arm, the return path, and the antenna ground. A capacitor may be coupled between the conductive path and an antenna ground. The capacitor may short non-near-field communications signals to the antenna ground and block near-field communications signals from passing from the conductive path to the antenna ground.

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

(72) Inventors: **Yijun Zhou**, Mountain View, CA (US); **Yiren Wang**, Santa Clara, CA (US); **Jennifer M. Edwards**, San Francisco, CA (US); **Hao Xu**, Cupertino, CA (US); **Mattia Pascolini**, San Francisco, CA (US)

(21) Appl. No.: **15/700,565**(22) Filed: **Sep. 11, 2017****Publication Classification**(51) **Int. Cl.****H01Q 5/328** (2006.01)**H01Q 9/04** (2006.01)



US 20190081654A1

(19) **United States**(12) **Patent Application Publication**  
**SONG et al.**(10) **Pub. No.: US 2019/0081654 A1**(43) **Pub. Date: Mar. 14, 2019**(54) **MOBILE TERMINAL****Publication Classification**(71) Applicant: **LG ELECTRONICS INC.**, Seoul (KR)(51) **Int. Cl.**  
**H04B 1/3888** (2006.01)(72) Inventors: **Insu SONG**, Seoul (KR); **Jaewook LEE**, Seoul (KR); **Yunhoon CHO**, Seoul (KR)(52) **U.S. Cl.**  
CPC ..... **H04B 1/3888** (2013.01)(73) Assignee: **LG ELECTRONICS INC.**, Seoul (KR)(57) **ABSTRACT**

A mobile terminal includes: a terminal body; an antenna portion having a feeding portion disposed in the terminal body; a metal case which forms appearance of the terminal body, and configured to support inside of the terminal body; and a molding portion formed at a region of the metal case, wherein the metal case includes a side region which forms a side surface of the terminal body and including a radiation region implemented as a radiator of the antenna portion; and a connection protrusion extended from the radiation region and connected to the feeding portion, and wherein the side region is provided with a plurality of slits, and the molding portion is formed at the plurality of slits so as to divide the radiation region.

(21) Appl. No.: **15/968,179**(22) Filed: **May 1, 2018**(30) **Foreign Application Priority Data**

Sep. 8, 2017 (KR) ..... 10-2017-0115313

