US009847575B2

(12) **United States Patent**
Wu

(10) **Patent No.: US 9,847,575 B2**
(45) **Date of Patent: Dec. 19, 2017**

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

(71) Applicant: **Wistron Corp.**, New Taipei (TW)

(72) Inventor: **Jian Rong Wu**, New Taipei (TW)

(73) Assignee: **Wistron Corp.**, New Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 3 days.

(21) Appl. No.: **15/177,278**

(22) Filed: **Jun. 8, 2016**

(65) **Prior Publication Data**

US 2017/0237166 A1 Aug. 17, 2017

(30) **Foreign Application Priority Data**

Feb. 16, 2016 (TW) ..... 105104433 A

(51) **Int. Cl.**

H01Q 1/38	(2006.01)
H01Q 5/307	(2015.01)
H01Q 1/24	(2006.01)
H01Q 9/04	(2006.01)

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

CPC ***H01Q 5/307*** (2015.01); ***H01Q 1/241*** (2013.01); ***H01Q 9/0414*** (2013.01)

(58) **Field of Classification Search**

CPC A61G 17/08; H01Q 1/243; H01Q 1/38; H01Q 5/374; H01Q 9/04; H01Q 9/0421; H01Q 1/22

See application file for complete search history.

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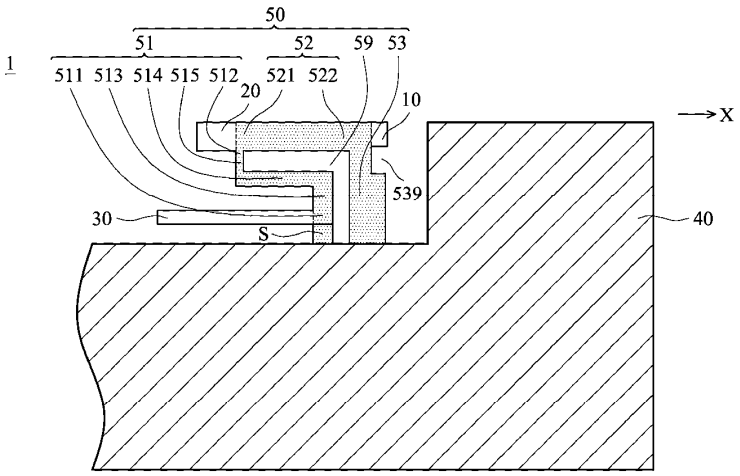
Primary Examiner — Tho G Phan

(57) **ABSTRACT**

An antenna is provided. The antenna includes a first radiator, a second radiator, a third radiator, a ground portion and a short structure. The first radiator extends in a first direction. The second radiator extends in a second direction. The first direction is opposite to the second direction. The short structure is coupled to the ground portion. The first radiator, the second radiator and the third radiator are connected to the short structure. The short structure defines an L-shaped groove.

15 Claims, 7 Drawing Sheets



US009847580B2

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

(10) **Patent No.: US 9,847,580 B2**
(45) **Date of Patent: Dec. 19, 2017**

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

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

(72) Inventors: **Wen Wang**, Shenzhen (CN); **Qing Liu**, Shenzhen (CN); **Yao Lan**, Shenzhen (CN); **Zhenghao Li**, Shenzhen (CN); **Lintao Jiang**, Shenzhen (CN)

(73) Assignee: **HUAWEI DEVICE CO., LTD.**, Shenzhen (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 361 days.

(21) Appl. No.: **14/579,897**

(22) Filed: **Dec. 22, 2014**

(65) **Prior Publication Data**

US 2015/0102978 A1 Apr. 16, 2015

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2014/082014, filed on Jul. 11, 2014.

(30) **Foreign Application Priority Data**

Jul. 31, 2013 (CN) 2013 1 0329288

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

(52) **U.S. Cl.**
CPC ***H01Q 9/0407*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 5/321*** (2015.01); ***H01Q 5/371*** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 9/0407; H01Q 5/371; H01Q 5/321; H01Q 1/38
See application file for complete search history.

(56) **References Cited**

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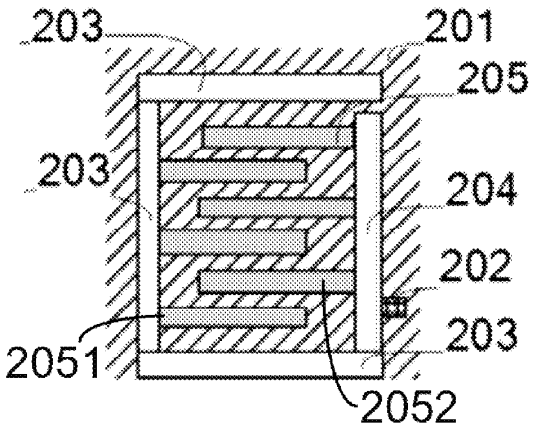
Primary Examiner — Dameon E Levi
Assistant Examiner — Hasan Islam
(74) *Attorney, Agent, or Firm* — Slater Matsil, LLP

(57) **ABSTRACT**

The present invention disclose a printed antenna, so as to increase power and a frequency band width of an antenna. The printed antenna includes a printed circuit board, an antenna pattern, and a signal feed-in point, where the antenna pattern is printed on a front surface of the printed circuit board, and the antenna pattern includes a first antenna pattern, a second antenna pattern, and a third antenna pattern; the signal feed-in point is connected to the second antenna pattern; one end of a side, of the first antenna pattern is connected to the second antenna pattern; the second antenna pattern is vertically laid out in parallel to an edge of the printed circuit board; and the third antenna pattern includes a first part and a second part, and the first part and the second part are arranged in parallel in the non-closed rectangle.

20 Claims, 4 Drawing Sheets



US009847585B2

(12) **United States Patent**
Yosui

(10) **Patent No.: US 9,847,585 B2**
(45) **Date of Patent: Dec. 19, 2017**

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

(71) Applicant: **Murata Manufacturing Co., Ltd.**, Nagaokakyo-shi, Kyoto-fu (JP)

(72) Inventor: **Kuniaki Yosui**, Nagaokakyo (JP)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 163 days.

(21) Appl. No.: **14/592,984**

(22) Filed: **Jan. 9, 2015**

(65) **Prior Publication Data**

US 2015/0180136 A1 Jun. 25, 2015

Related U.S. Application Data

(63) Continuation of application No. 14/591,038, filed on Jan. 7, 2015, now Pat. No. 9,705,206, which is a (Continued)

(30) **Foreign Application Priority Data**

Dec. 21, 2012 (JP) 2012-280243

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 21/28 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 21/28*** (2013.01); ***H01Q 1/2208*** (2013.01); ***H01Q 1/2216*** (2013.01); ***H01Q 1/243*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 21/28; H01Q 1/2216; H01Q 9/42; H01Q 5/335; H01Q 5/371; H01Q 5/328; H01Q 1/2208; H01Q 1/243; H01Q 7/00
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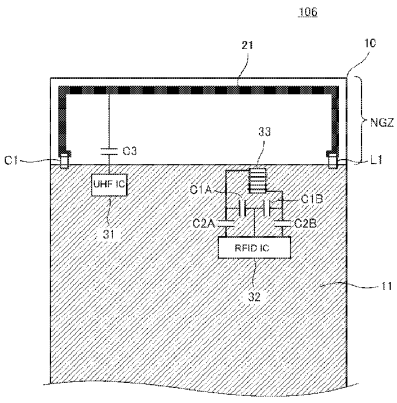
Primary Examiner — Hoang Nguyen
Assistant Examiner — Jae Kim
(74) *Attorney, Agent, or Firm* — Keating & Bennett, LLP

(57) **ABSTRACT**

A square bracket-shaped radiation element is in a non-ground region of a board. A first reactance element that equivalently enters a short-circuited state in a second frequency band is connected between a second end of the radiation element and a ground conductor. A second reactance element that equivalently enters a short-circuited state in a first frequency band s connected between a first end of the radiation element and the ground conductor. In the UHF band, the radiation element and the ground conductor function as an inverted F antenna that contributes to field emission. In the HF band, a loop including the radiation element and the ground conductor functions as a loop antenna that contributes to magnetic field emission.

14 Claims, 12 Drawing Sheets



US009853348B2

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

(10) **Patent No.: US 9,853,348 B2**
(45) **Date of Patent: Dec. 26, 2017**

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

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

(72) Inventors: **Woosup Lee**, Gyeonggi-do (KR); **Yeonwoo Kim**, Gyeonggi-do (KR); **Jungsik Park**, Gyeonggi-do (KR); **Seunggil Jeon**, Gyeonggi-do (KR); **Juseok Noh**, Gyeonggi-do (KR); **Jaebong Chun**, Gyeonggi-do (KR); **Hyunju Hong**, Gyeonggi-do (KR)

(73) Assignee: **Samsung Electronics Co., Ltd.**, Suwon-si, Gyeonggi-do (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 32 days.

(21) Appl. No.: **14/873,595**

(22) Filed: **Oct. 2, 2015**

(65) **Prior Publication Data**

US 2016/0104930 A1 Apr. 14, 2016

(30) **Foreign Application Priority Data**

Oct. 8, 2014 (KR) 10-2014-0135898

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/40 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/40*** (2013.01); ***H01Q 1/42*** (2013.01); ***H01Q 9/26*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/42; H01Q 9/42; H01Q 9/26; H01Q 1/40; H01Q 21/29; H01Q 21/28
(Continued)

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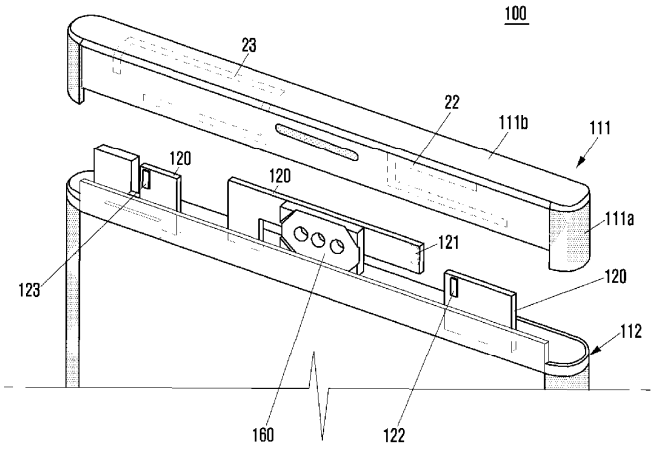
Primary Examiner — Hoang Nguyen
(74) *Attorney, Agent, or Firm* — Cha & Reiter, LLC

(57) **ABSTRACT**

An electronic device having a housing formed of a conductive material, and an antenna device thereof. The electronic device includes a housing provided with a plurality of housing modules, and a printed circuit board positioned inside the housing, and having an antenna power feeding unit electrically connected to the printed circuited board. The plurality of housing modules may be at least partially formed of a conductive material. At least one of the conductive materials of the plurality of housing modules may be electrically connected to the antenna power feeding unit of the printed circuit board so as to function as an antenna of the electronic device. Various embodiments may be made based on the technical idea of the present disclosure.

21 Claims, 12 Drawing Sheets



US009853350B2

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

(10) **Patent No.: US 9,853,350 B2**
(45) **Date of Patent: Dec. 26, 2017**

(54) **ANTENNA MODULE AND WIRELESS COMMUNICATION DEVICE USING SAME**

(71) Applicant: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

(72) Inventors: **Jin-Bo Chen**, New Taipei (TW); **Cheng-An Chen**, New Taipei (TW); **Chih-Wei Liao**, New Taipei (TW)

(73) Assignee: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

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

(21) Appl. No.: **15/083,434**

(22) Filed: **Mar. 29, 2016**

(65) **Prior Publication Data**

US 2017/0133745 A1 May 11, 2017

(30) **Foreign Application Priority Data**

Nov. 11, 2015 (CN) 2015 1 0761916

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 9/04	(2006.01)
H01Q 21/28	(2006.01)
H01Q 5/371	(2015.01)

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

CPC ***H01Q 1/243*** (2013.01); ***H01Q 5/371*** (2015.01); ***H01Q 9/0414*** (2013.01); ***H01Q 21/28*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243
USPC 343/702
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

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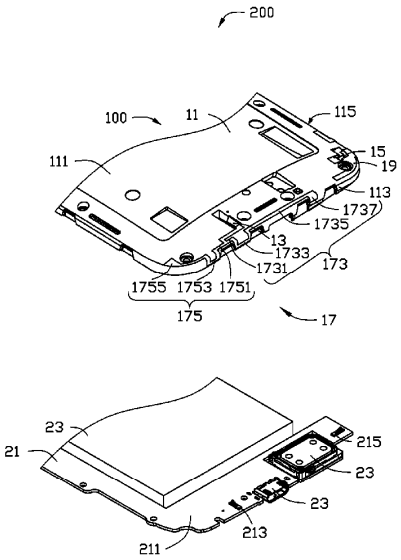
Primary Examiner — Graham Smith
(74) *Attorney, Agent, or Firm* — ScienBiziP, P.C.

(57) **ABSTRACT**

An antenna module includes a holder, a first feed portion, a second feed portion, a first antenna unit, and a second antenna unit. The holder includes a top surface, an end surface, and a side surface. The first feed portion is positioned on the top surface. The second feed portion is positioned on the top surface and is spaced from the first feed portion. The first antenna unit is positioned on the top surface and the end surface, and is electrically connected to the first feed portion. The second antenna unit is spaced from the second antenna unit and is positioned on the top surface and the side surface. The second antenna unit is electrically connected to the second feed portion. The first feed portion and the second feed portion respectively feed current to the first antenna unit and the second antenna unit.

15 Claims, 4 Drawing Sheets



US009853351B2

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

(10) **Patent No.: US 9,853,351 B2**
(45) **Date of Patent: Dec. 26, 2017**

(54) **COMMUNICATION DEVICE WITH METAL-FRAME HALF-LOOP ANTENNA ELEMENT**

(71) Applicant: **Acer Incorporated**, New Taipei (TW)

(72) Inventors: **Kin-Lu Wong**, New Taipei (TW); **Hsuan-Jui Chang**, New Taipei (TW)

(73) Assignee: **Acer Incorporated**, New Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **15/216,424**

(22) Filed: **Jul. 21, 2016**

(65) **Prior Publication Data**

US 2017/0338546 A1 Nov. 23, 2017

(30) **Foreign Application Priority Data**

May 23, 2016 (TW) ..... 105115954 A

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/48 (2006.01)
H01Q 7/00 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 7/00*** (2013.01)

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

(56) **References Cited**

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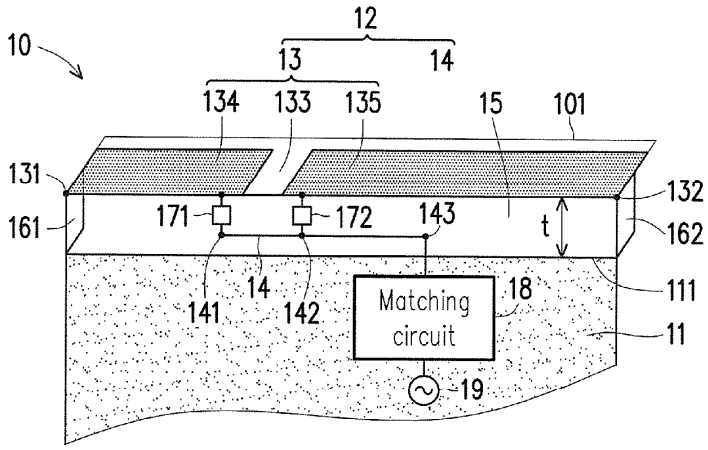
Primary Examiner — Trinh Dinh
(74) *Attorney, Agent, or Firm* — J.C. Patents

(57) **ABSTRACT**

A communication device includes a ground plane and an antenna element. The antenna element includes a radiation metal strip and a feed metal line. The feed metal line is disposed between the radiation metal strip and the ground plane. A first metal strip of the radiation metal strip has a first end electrically connected to the ground plane by a first metal section. A second metal strip of the radiation metal strip has a second end electrically connected to the ground plane by a second metal section. The first metal strip is coupled to a first connection point on the feed metal line through a first capacitive element. The second metal strip is coupled to a second connection point on the feed metal line through a second capacitive element. The feed metal line has a third connection point as a feeding point of the antenna element.

12 Claims, 3 Drawing Sheets



US009853352B1

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

(10) **Patent No.: US 9,853,352 B1**
(45) **Date of Patent: Dec. 26, 2017**

(54) **ANTENNA MODULE, SIGNAL ENHANCEMENT DEVICE AND COMMUNICATION DEVICE**

(71) Applicant: **Cheng Uei Precision Industry Co., Ltd.**, New Taipei (TW)

(72) Inventors: **Guan Yi Chen**, New Taipei (TW); **Wen Bing Hsu**, New Taipei (TW); **Kuo Wei Chang**, New Taipei (TW)

(73) Assignee: **Cheng Uei Precision Industry Co., Ltd.**, New Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 30 days.

(21) Appl. No.: **15/232,643**

(22) Filed: **Aug. 9, 2016**

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

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/241*** (2013.01); ***H01Q 1/242*** (2013.01); ***H01Q 1/245*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/24; H01Q 1/241; H01Q 1/242; H01Q 1/243; H01Q 9/42
See application file for complete search history.

(56) **References Cited**

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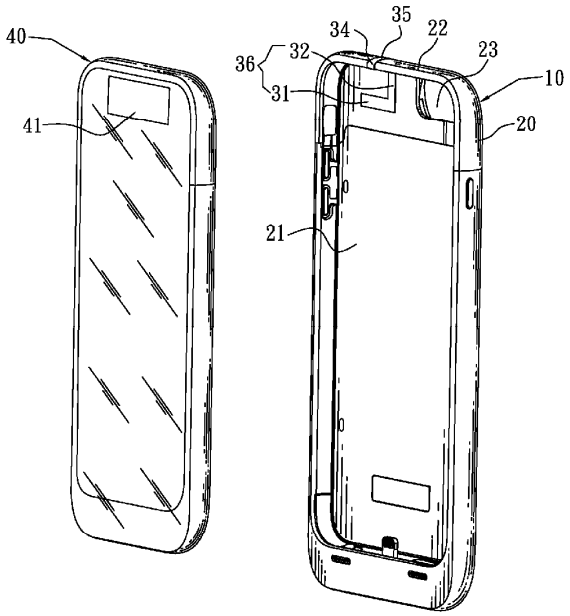
Primary Examiner — Hoang Nguyen
(74) *Attorney, Agent, or Firm* — WPAT, P.C., Intellectual Property Attorneys; Anthony King

(57) **ABSTRACT**

A signal enhancement device includes a back cover and an antenna module. The back cover includes a backboard for covering a rear surface of a main body and a top board for covering a top of the main body. The antenna module includes a base portion of board shape for being fixed on a portion of an inside surface of the backboard adjacent to the top board, a first bending portion for being fixed on an inside surface of the top board, a second bending portion for being fixed on a front end surface of the top board, and a third bending portion for being fixed on an outside surface of the top board and a portion of an outside surface of the backboard adjacent to the top board. When the signal enhancement device is mounted on the main body, the antenna module is capable of coupling with a communication antenna of the main body so as to enhance signal quality of the communication antenna.

17 Claims, 2 Drawing Sheets



US009853355B2

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

(10) **Patent No.: US 9,853,355 B2**
(45) **Date of Patent: Dec. 26, 2017**

(54) **ELECTRONIC DEVICE CASE WITH ANTENNA AND ELECTRONIC DEVICE FOR USE THEREWITH**

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

(72) Inventors: **Chi Jeong Choi**, Gyeonggi-do (KR); **Yun Bum Lee**, Busan (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 126 days.

(21) Appl. No.: **14/678,191**

(22) Filed: **Apr. 3, 2015**

(65) **Prior Publication Data**

US 2015/0288056 A1 Oct. 8, 2015

(30) **Foreign Application Priority Data**

Apr. 3, 2014 (KR) 10-2014-0039845

(51) **Int. Cl.**

H01Q 1/44	(2006.01)
H01Q 1/50	(2006.01)
H04B 1/3888	(2015.01)
H01Q 21/28	(2006.01)
H01Q 9/04	(2006.01)
H01Q 9/42	(2006.01)
H04M 1/725	(2006.01)

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

CPC ***H01Q 1/44*** (2013.01); ***H01Q 1/50*** (2013.01); ***H04B 1/3888*** (2013.01); *H01Q 9/0421* (2013.01); *H01Q 9/42* (2013.01); *H01Q 21/28* (2013.01); *H04M 1/72527* (2013.01)

(58) **Field of Classification Search**

CPC H04B 1/3888; H04M 1/0283; H01Q 1/44; H01Q 1/40

USPC 455/575.8

See application file for complete search history.

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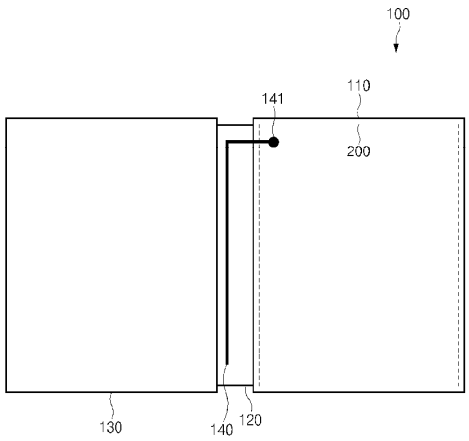
Primary Examiner — Robert Karacsony

(74) *Attorney, Agent, or Firm* — The Farrell Law Firm, P.C.

(57) **ABSTRACT**

A case for an electronic device is provided. The case includes a rear cover configured to attach to at least a portion of a rear side of the electronic device, and a front cover configured to removably cover at least a portion of a front side of the electronic device. The case also includes a connection portion that connects the front cover and the rear cover, and includes an antenna structure for transmitting and receiving signals in at least one frequency band.

19 Claims, 8 Drawing Sheets



US009854076B2

(12) **United States Patent**
Yun

(10) **Patent No.: US 9,854,076 B2**
(45) **Date of Patent: Dec. 26, 2017**

(54) **MOBILE TERMINAL**

(71) Applicant: **LG ELECTRONICS INC.**, Seoul (KR)

(72) Inventor: **Hyuk Yun**, Seoul (KR)

(73) Assignee: **LG ELECTRONICS INC.**, Seoul (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 232 days.

(21) Appl. No.: **14/307,919**

(22) Filed: **Jun. 18, 2014**

(65) **Prior Publication Data**

US 2015/0181005 A1 Jun. 25, 2015

(30) **Foreign Application Priority Data**

Dec. 24, 2013 (KR) 10-2013-0162167

(51) **Int. Cl.**

H04W 4/20	(2009.01)
H04M 1/02	(2006.01)
H01Q 1/24	(2006.01)
H01Q 9/42	(2006.01)
H01Q 21/28	(2006.01)

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

CPC ***H04M 1/026*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 9/42*** (2013.01); ***H01Q 21/28*** (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

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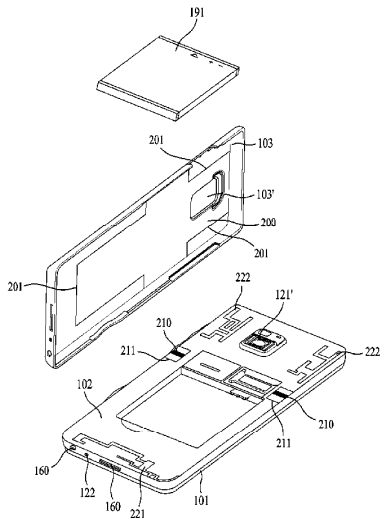
(Continued)

Primary Examiner — Daniel Lai
Assistant Examiner — Frank Donado
(74) *Attorney, Agent, or Firm* — Ked & Associates, LLP

(57) **ABSTRACT**

There is disclosed a mobile terminal including a case, a first antenna mounted in the case to perform wireless communication in a specific frequency band, a grounding surface mounted in the case, a receiver mounted in the case, toward a front surface of the case, a battery cover coupled to a rear surface of the case, the battery cover comprising a conductive portion, and a contact pin configured to connect the conductive portion and the grounding surface with each other, wherein the contact pin is formed in a predetermined portion where a phase of an electromagnetic field formed by the first antenna changes. The mobile terminal may adjust the HAC grade to a base grade or higher of the HAC by adjusting the position of the electromagnetic field peak, regardless of the size of the mobile terminal.

16 Claims, 8 Drawing Sheets



US009859606B2

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

(10) **Patent No.: US 9,859,606 B2**
(45) **Date of Patent: Jan. 2, 2018**

(54) **WIRELESS COMMUNICATION DEVICE**

(71) Applicant: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

(72) Inventors: **Cheng-Han Lee**, New Taipei (TW); **Wei-Xuan Ye**, New Taipei (TW)

(73) Assignee: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 109 days.

(21) Appl. No.: **14/591,553**

(22) Filed: **Jan. 7, 2015**

(65) **Prior Publication Data**

US 2016/0164166 A1 Jun. 9, 2016

(30) **Foreign Application Priority Data**

Dec. 3, 2014 (CN) 2014 1 0721710

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 5/00	(2015.01)
H01Q 1/38	(2006.01)
H01Q 1/48	(2006.01)
H01Q 5/307	(2015.01)
H01Q 5/328	(2015.01)
H01Q 5/371	(2015.01)

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

CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 5/307*** (2015.01); ***H01Q 5/328*** (2015.01); ***H01Q 5/371*** (2015.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 5/30; H01Q 5/307; H01Q 5/314; H01Q 5/335; H01Q 5/357; H01Q 5/364; H01Q 1/241; H01Q 1/242

USPC 343/702

See application file for complete search history.

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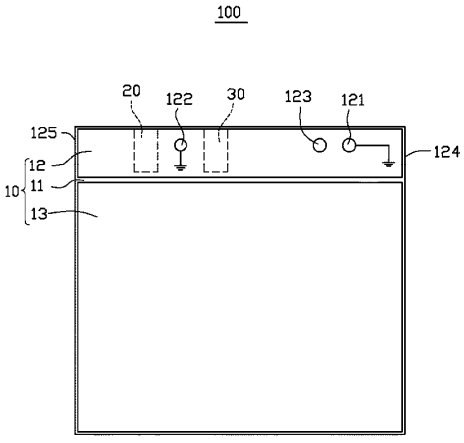
(Continued)

Primary Examiner — Dameon E Levi
Assistant Examiner — Jennifer F Hu
(74) *Attorney, Agent, or Firm* — ScienBiziP, P.C.

(57) **ABSTRACT**

A wireless communication device includes a metal housing and a printed circuit board. The metal housing serves as an antenna and includes a slit separating the metal housing into a radiating body and a grounding body. The slit completely separates the radiating body from the grounding body. The printed circuit board includes a system grounding point and a radio frequency circuit. The system grounding point is electronically coupled to the grounding body. The radiating body has a first grounding point, a second grounding point and a feeding point located between the first and second points. The feeding point is electronically coupled to the radio frequency circuit. The first and second grounding points are electronically coupled to the system grounding point.

14 Claims, 4 Drawing Sheets



US009859607B2

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

(10) **Patent No.: US 9,859,607 B2**
(45) **Date of Patent: Jan. 2, 2018**

(54) **ANTENNA OF ELECTRONIC DEVICE**

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

(72) Inventors: **Soon Ho Hwang**, Seoul (KR); **Ui Chul Jeong**, Gyeonggi-do (KR); **Sung Koo Park**, Gyeonggi-do (KR); **Chan Kyu An**, Incheon (KR); **Joon Ho Byun**, Gyeonggi-do (KR); **Sang Keun Yoo**, Gyeonggi-do (KR); **Yoon Jae Lee**, Gyeonggi-do (KR); **Jin Woo Jung**, Seoul (KR); **Jae Bong Chun**, Gyeonggi-do (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 103 days.

(21) Appl. No.: **14/829,305**

(22) Filed: **Aug. 18, 2015**

(65) **Prior Publication Data**

US 2016/0049720 A1 Feb. 18, 2016

(30) **Foreign Application Priority Data**

Aug. 18, 2014 (KR) 10-2014-0106730

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 1/48	(2006.01)
H01Q 9/14	(2006.01)
H01Q 9/42	(2006.01)

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

CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 9/145*** (2013.01); ***H01Q 9/42*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 1/48; H01Q 1/46; H01Q 9/0407; H01Q 9/145; H01Q 9/42; H01Q 1/38

USPC ..... 343/700 MS, 702, 829, 846; 455/575.5, 455/575.7, 575.8

See application file for complete search history.

(56) **References Cited**

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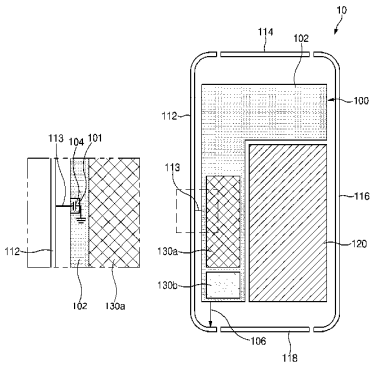
Primary Examiner — Tho G Phan
(74) *Attorney, Agent, or Firm* — The Farrell Law Firm, P.C.

(57) **ABSTRACT**

An antenna of an electronic device is provided, which includes a radiator including at least part of a metal housing of the electronic device; a capacitor connected to the radiator; a feeding part connected to the radiator; and a ground part connected to the capacitor.

18 Claims, 12 Drawing Sheets



US009859608B2

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

(10) **Patent No.: US 9,859,608 B2**
(45) **Date of Patent: Jan. 2, 2018**

(54) **ANTENNA MODULE**

(71) Applicants: **Chao Wang**, Shenzhen (CN); **Jianchun Mai**, Shenzhen (CN)

(72) Inventors: **Chao Wang**, Shenzhen (CN); **Jianchun Mai**, Shenzhen (CN)

(73) Assignee: **AAC TECHNOLOGIES PTE. LTD.**, Singapore (SG)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 164 days.

(21) Appl. No.: **15/008,641**

(22) Filed: **Jan. 28, 2016**

(65) **Prior Publication Data**

US 2017/0012354 A1 Jan. 12, 2017

(30) **Foreign Application Priority Data**

Jul. 8, 2015 (CN) ..... 2015 2 0490777 U

(51) **Int. Cl.**

H01Q 1/38	(2006.01)
H01Q 1/24	(2006.01)
H01Q 9/04	(2006.01)
H01Q 5/371	(2015.01)

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

CPC ***H01Q 1/243*** (2013.01); ***H01Q 5/371*** (2015.01); ***H01Q 9/0421*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/24; H01Q 1/38; H01Q 9/0421; H01Q 5/371

USPC ..... 343/700 MS

See application file for complete search history.

(56) **References Cited**

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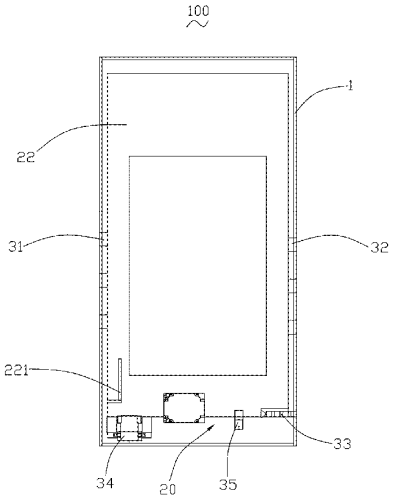
Primary Examiner — Huedung Mancuso
(74) *Attorney, Agent, or Firm* — Na Xu; IPro, PLLC

(57) **ABSTRACT**

An antenna module applicable to a mobile device is provided in the present disclosure. The antenna module includes a metal frame, a circuit board surrounded by the metal frame, and an antenna portion on the circuit board. The circuit board includes a main board and a ground board placed on the main board. The antenna portion includes at least one low frequency (LF) ground point and at least one high frequency (HF) ground point arranged on the ground board, and a feed point arranged on the main board. The at least one LF ground point and the at least one HF ground point contact the metal frame; a first current path length between the feed point and the at least one LF ground point is greater than a second current path length between the feed point and the at least one HF ground point.

10 Claims, 2 Drawing Sheets



US009859609B2

(12) **United States Patent**
Chiang

(10) **Patent No.: US 9,859,609 B2**
(45) **Date of Patent: Jan. 2, 2018**

(54) **MOBILE COMMUNICATION DEVICE AND REAR COVER THEREOF**

(71) Applicant: **AUDEN TECHNO CORP.**, Taoyuan County (TW)

(72) Inventor: **Chi-Ming Chiang**, Taoyuan County (TW)

(73) Assignee: **AUDEN TECHNO CORP.**, Taoyuan County (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **15/145,096**

(22) Filed: **May 3, 2016**

(65) **Prior Publication Data**

US 2017/0324149 A1 Nov. 9, 2017

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

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

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

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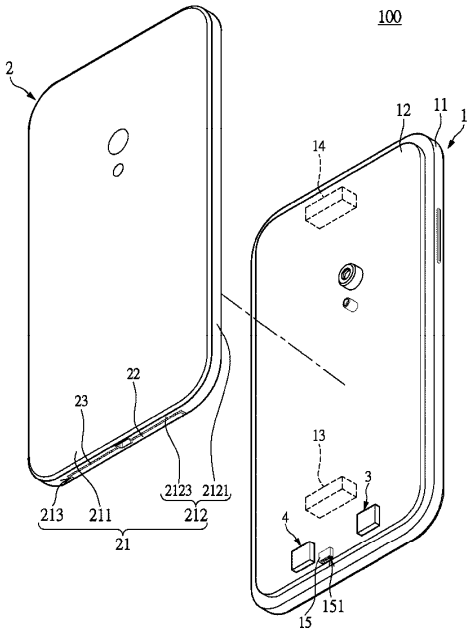
Primary Examiner — Robert Karacsony
(74) *Attorney, Agent, or Firm* — Li & Cai Intellectual Property (USA) Office

(57) **ABSTRACT**

A rear cover of a mobile communication device includes a metal case, a communication antenna, and an insulating body connecting the metal case and the communication antenna. The metal case has a rear plate and a surrounding plate connected to the edge of the rear plate, and the surrounding plate has two side plates, a top plate, and a bottom plate. A notch is recessed on the edge of the bottom plate. The communication antenna is arranged in the notch, and part of the edge of the communication antenna faces toward the edge of the notch. A slot is recessed on the part of the edge of the communication antenna. The insulating body connects the part of the edge of the communication antenna and the edge of the notch, such that the communication antenna is electrically isolated from the metal case by the insulating body.

9 Claims, 7 Drawing Sheets



US009859617B1

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

(10) **Patent No.: US 9,859,617 B1**
(45) **Date of Patent: Jan. 2, 2018**

(54) **ACTIVE ANTENNA STRUCTURE MAXIMIZING APERTURE AND ANCHORING RF BEHAVIOR**

(75) Inventors: **Laurent Desclos**, San Diego, CA (US); **Sung-Soo Nam**, Seoul (KR); **Ji-Chul Lee**, Gyeomggi-do (KR); **Sung Hawan**, Gyeomggi-do (KR); **Chun-Su Yoon**, Gyeomggi-do (KR)

(73) Assignee: **ETHERTRONICS, INC.**, San Diego, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1045 days.

(21) Appl. No.: **13/609,138**

(22) Filed: **Sep. 10, 2012**

Related U.S. Application Data

(60) Provisional application No. 61/532,822, filed on Sep. 9, 2011.

(51) **Int. Cl.**

H01Q 7/00	(2006.01)
H01Q 9/04	(2006.01)
H01Q 9/28	(2006.01)
H01Q 9/42	(2006.01)
H01Q 5/48	(2015.01)
H01Q 5/321	(2015.01)

(52) **U.S. Cl.**
CPC ***H01Q 9/285*** (2013.01); ***H01Q 5/321*** (2015.01); ***H01Q 5/48*** (2015.01); ***H01Q 7/00*** (2013.01); ***H01Q 9/0414*** (2013.01); ***H01Q 9/42*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 9/0414; H01Q 9/42; H01Q 5/321; H01Q 5/48; H01Q 7/00
See application file for complete search history.

(56) **References Cited**

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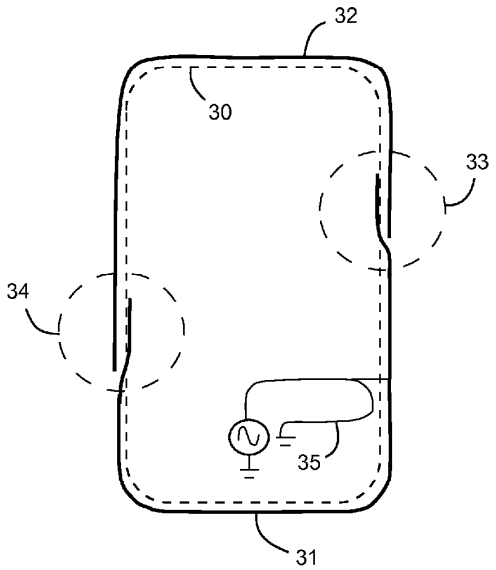
Primary Examiner — Dieu H Duong
Assistant Examiner — Michael Bouizza
(74) *Attorney, Agent, or Firm* — Coastal Patent Law Group, P.C.

(57) **ABSTRACT**

An antenna methodology where a set of antennas are formed that take the shape of a mobile wireless device and can be integrated into the outer housing of the mobile device. Tuning points are integrated into the design to provide the capability to compensate for hand effects and loading while the mobile device and antenna are touched by the user. The body then becomes a part of the antenna and acts as an anchor for the poles within the matching circuit. These antennas are actively tuned based on detection criteria while dynamically tracking system performance. The structure is based on a loaded loop coupled to an isolated magnetic dipole (IMD) element. The loop is actively tuned according to design rules residing in a processor in the mobile device.

19 Claims, 16 Drawing Sheets



US009865914B2

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

(10) **Patent No.: US 9,865,914 B2**
(45) **Date of Patent: Jan. 9, 2018**

(54) **MULTI-POSITION DISPLAY DECK AND ANTENNA**

(71) Applicant: **Hewlett-Packard Development Company, L.P.**, Houston, TX (US)

(72) Inventors: **Hui Leng Lim**, Houston, TX (US); **Leo J Gerten**, Houston, TX (US); **Shih-Huang Wu**, Houston, TX (US)

(73) Assignee: **Hewlett-Packard Development Company, L.P.**, Houston, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 318 days.

(21) Appl. No.: **14/765,320**

(22) PCT Filed: **Jan. 31, 2013**

(86) PCT No.: **PCT/US2013/023994**
§ 371 (c)(1),
(2) Date: **Jul. 31, 2015**

(87) PCT Pub. No.: **WO2014/120170**
PCT Pub. Date: **Aug. 7, 2014**

(65) **Prior Publication Data**

US 2015/0380804 A1 Dec. 31, 2015

(51) **Int. Cl.**
H01Q 1/22 (2006.01)
G06F 1/16 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/2266*** (2013.01); ***G06F 1/162*** (2013.01); ***G06F 1/1637*** (2013.01); ***G06F 1/1654*** (2013.01); ***G06F 1/1662*** (2013.01); ***G06F 1/1677*** (2013.01); ***G06F 1/1684*** (2013.01); ***G06F 1/1698*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/2266
See application file for complete search history.

(56) **References Cited**

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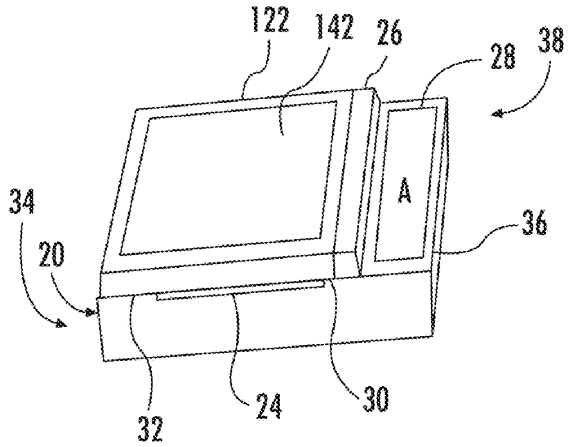
(Continued)

Primary Examiner — Graham Smith
(74) *Attorney, Agent, or Firm* — Rathe Lindenbaum LLP

(57) **ABSTRACT**

A display (**122**, **622**, **722**) comprising a display screen (**142**, **742**) is repositionable with respect to a deck (**20**, **120**, **220**, **520**, **720**) comprising keys (**24**, **724**). The display (**122**, **622**, **722**) is repositionable between a raised position and a lowered horizontal position. An antenna (**28**, **528**, **628**, **728**) is located within the deck (**20**, **120**, **220**, **520**, **720**) at a location outwardly beyond the display (**122**, **622**, **722**) when the display (**122**, **622**, **722**) is in the lowered horizontal position.

13 Claims, 9 Drawing Sheets



US009865916B2

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

(10) **Patent No.: US 9,865,916 B2**
(45) **Date of Patent: Jan. 9, 2018**

(54) **ANTENNA STRUCTURE AND WIRELESS COMMUNICATION DEVICE USING THE ANTENNA STRUCTURE**

(71) Applicant: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

(72) Inventors: **Tze-Hsuan Chang**, New Taipei (TW); **Cho-Kang Hsu**, New Taipei (TW)

(73) Assignee: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 301 days.

(21) Appl. No.: **14/524,469**

(22) Filed: **Oct. 27, 2014**

(65) **Prior Publication Data**

US 2015/0188214 A1 Jul. 2, 2015

(30) **Foreign Application Priority Data**

Dec. 31, 2013 (CN) 2013 1 0747898

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 7/00 (2006.01)
H01Q 5/335 (2015.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 5/335*** (2015.01); ***H01Q 7/00*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 5/335; H01Q 7/00
See application file for complete search history.

(56) **References Cited**

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2013/0201074	A1 *	8/2013	Harper	H01Q 1/38 343/870

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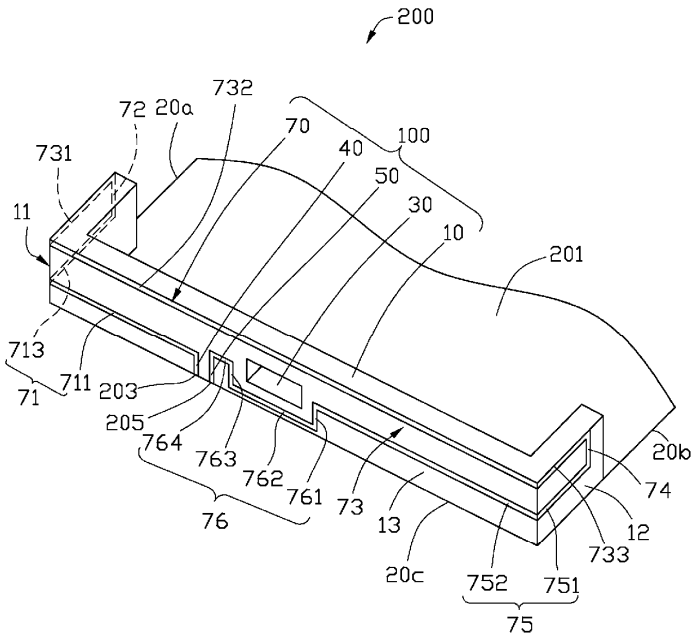
Primary Examiner — Dieu H Duong
Assistant Examiner — Michael Bouizza
(74) *Attorney, Agent, or Firm* — ScienBiziP, P.C.

(57) **ABSTRACT**

An antenna structure includes an antenna holder, a radiating body, a feed portion, and a grounding portion. The antenna holder includes a plurality of surfaces. The feed portion is positioned on one surface of the antenna holder and electronically connected to a first end of the radiating body. The ground portion is positioned on one surface of the antenna holder and electronically connected to a second end of the radiating body so as to form a loop antenna. An electronic element is surrounded by the loop antenna.

13 Claims, 3 Drawing Sheets



US009865927B2

(12) **United States Patent**
Tsai

(10) **Patent No.: US 9,865,927 B2**
(45) **Date of Patent: Jan. 9, 2018**

(54) **SENSOR PAD TO CAPACITIVELY COUPLE TO AN ANTENNA MODULE**

(71) Applicant: **HEWLETT-PACKARD DEVELOPMENT COMPANY, L.P.**, Houston, TX (US)

(72) Inventor: **Ming-Shien Tsai**, Taipei (TW)

(73) Assignee: **Hewlett-Packard Development Company, L.P.**, Houston, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **15/118,586**

(22) PCT Filed: **Apr. 3, 2014**

(86) PCT No.: **PCT/US2014/032831**

§ 371 (c)(1),
(2) Date: **Aug. 12, 2016**

(87) PCT Pub. No.: **WO2015/152925**

PCT Pub. Date: **Oct. 8, 2015**

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H01Q 1/24 (2006.01)
H01Q 9/04 (2006.01)
H01Q 5/378 (2015.01)

(52) **U.S. Cl.**
CPC ***H01Q 9/0421*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/245*** (2013.01); ***H01Q 5/378*** (2015.01); *H04M 2250/12* (2013.01)

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

(56) **References Cited**

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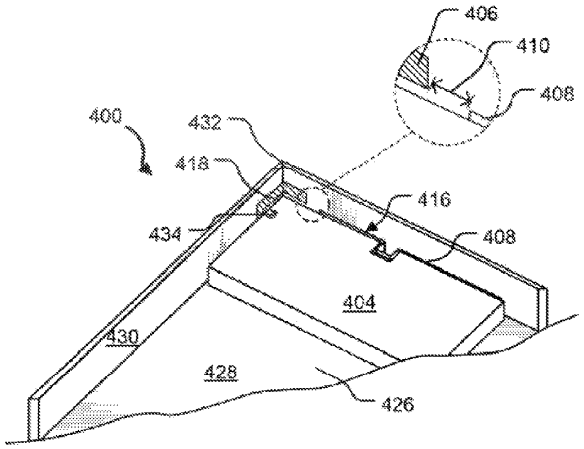
Primary Examiner — Trinh Dinh
(74) *Attorney, Agent, or Firm* — HP Inc Patent Department

(57) **ABSTRACT**

An example computing system may include a proximity sensor including a sensor pad with a tail and an antenna to capacitively couple to the tail to increase a bandwidth of the antenna.

15 Claims, 5 Drawing Sheets



US009865929B2

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

(10) **Patent No.: US 9,865,929 B2**
(45) **Date of Patent: Jan. 9, 2018**

(54) **COMMUNICATION DEVICE AND ANTENNA ELEMENT THEREIN**

(71) Applicant: **Acer Incorporated**, New Taipei (TW)

(72) Inventors: **Kin-Lu Wong**, New Taipei (TW); **Hung-Jen Hsu**, New Taipei (TW)

(73) Assignee: **ACER INCORPORATED**, New Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 229 days.

(21) Appl. No.: **14/012,314**

(22) Filed: **Aug. 28, 2013**

(65) **Prior Publication Data**

US 2015/0002363 A1 Jan. 1, 2015

(30) **Foreign Application Priority Data**

Jun. 26, 2013 (TW) ..... 102122644 A

(51) **Int. Cl.**
H01Q 5/50 (2015.01)
H01Q 9/42 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 9/42*** (2013.01); ***H01Q 5/50*** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 21/28; H01Q 1/243; H01Q 5/385; H01Q 9/30; H01Q 9/0407
USPC 343/866, 893
See application file for complete search history.

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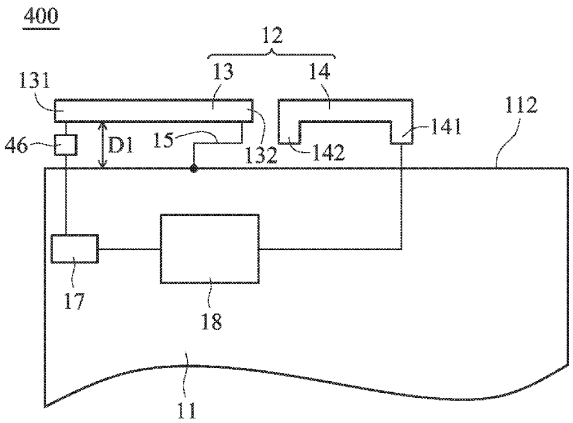
Primary Examiner — Graham Smith
Assistant Examiner — Noel Maldonado
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

A communication device includes a ground element and an antenna element. The antenna element is disposed adjacent to an edge of the ground element. The antenna element includes a first metal element and a second metal element. The first metal element has a first end and a second end. The first end is coupled through a capacitive element to a communication module. The second end is coupled through a shorting element to the ground element. The second metal element has a third end and a fourth end. The third end is coupled to the communication module. The fourth end is open. The first metal element and the second metal element are adjacent to each other, but not connected to each other. The first metal element and the second metal element have projections on the edge of the ground element, wherein the projections do not overlap with each other.

9 Claims, 5 Drawing Sheets



US009866195B2

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

(10) **Patent No.: US 9,866,195 B2**
(45) **Date of Patent: Jan. 9, 2018**

(54) **ANTENNA DEVICE**

(71) Applicant: **MURATA MANUFACTURING CO., LTD.**, Kyoto (JP)

(72) Inventors: **Shoji Nagumo**, Kyoto (JP); **Masashi Nakazato**, Kyoto (JP); **Motoyasu Nakao**, Kyoto (JP); **Yuji Shintomi**, Kyoto (JP)

(73) Assignee: **Murata Manufacturing Co., Ltd.**, Kyoto-Fu (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **15/646,774**

(22) Filed: **Jul. 11, 2017**

(65) **Prior Publication Data**

US 2017/0310298 A1 Oct. 26, 2017

Related U.S. Application Data

(63) Continuation of application No. 14/331,625, filed on Jul. 15, 2014, now Pat. No. 9,748,917, which is a (Continued)

(30) **Foreign Application Priority Data**

Mar. 5, 2012 (JP) 2012-047550

(51) **Int. Cl.**
H01Q 9/42 (2006.01)
H03H 7/40 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H03H 7/40*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/50*** (2013.01); ***H01Q 5/335*** (2015.01); ***H01Q 9/42*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/335; H01Q 1/243; H01Q 1/50; H01Q 9/42; H03H 7/40
See application file for complete search history.

(56) **References Cited**

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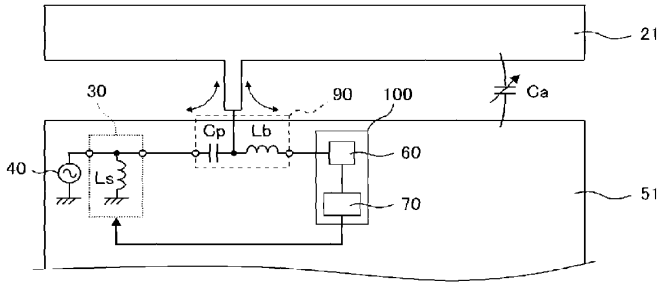
Primary Examiner — Graham Smith
Assistant Examiner — Noel Maldonado
(74) *Attorney, Agent, or Firm* — Studebaker & Brackett PC

(57) **ABSTRACT**

A stray capacitance is generated between an antenna element and a ground electrode. A capacitance detection circuit detects the stray capacitance. An antenna matching circuit, is provided along a wireless communication signal path, which is a transmission path between the antenna element and a feeder circuit. A feedback control circuit transmits a control signal to the variable matching circuit on the basis of a detection result of the capacitance detection circuit in accordance with the stray capacitance. The capacitance detection circuit includes a constant current source and a timing circuit to measure the time taken to charge the antenna from the constant current source and for the voltage to reach a predetermined voltage.

7 Claims, 9 Drawing Sheets



US009866252B2

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

(10) **Patent No.: US 9,866,252 B2**
(45) **Date of Patent: *Jan. 9, 2018**

(54) **MOBILE TERMINAL**

(71) Applicant: **LG Electronics Inc.**, Seoul (KR)

(72) Inventors: **Sungjoon Hong**, Seoul (KR); **Kangjae Jung**, Seoul (KR); **Sungjung Rho**, Seoul (KR); **Youngbae Kwon**, Seoul (KR); **Jaewoo Lee**, Seoul (KR); **Deuksu Choi**, Seoul (KR)

(73) Assignee: **LG ELECTRONICS INC.**, Seoul (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 128 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **14/937,621**

(22) Filed: **Nov. 10, 2015**

(65) **Prior Publication Data**

US 2016/0315651 A1 Oct. 27, 2016

(30) **Foreign Application Priority Data**

Apr. 22, 2015 (KR) 10-2015-0056845
Jul. 1, 2015 (KR) 10-2015-0093901

(51) **Int. Cl.**
H01Q 21/28 (2006.01)
H01Q 9/42 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04B 1/3888*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 9/42*** (2013.01); ***H01Q 13/10*** (2013.01); ***H01Q 21/28*** (2013.01)

(58) **Field of Classification Search**
CPC H04B 7/00; H04B 1/1607; H04B 1/18; H04B 1/3888; H04M 1/02; H04M 1/0277; H04M 1/0202; H04M 1/026; H04M 1/0266; H04M 1/67; H04M 1/72519; H01Q 1/24; H01Q 1/243; H01Q 13/10; H01Q 21/28; H01Q 13/106; H01Q 1/521; H01Q 21/064; H01Q 9/42; H01Q 1/38; H01Q 1/245; H01Q 1/242; H04W 88/02
See application file for complete search history.

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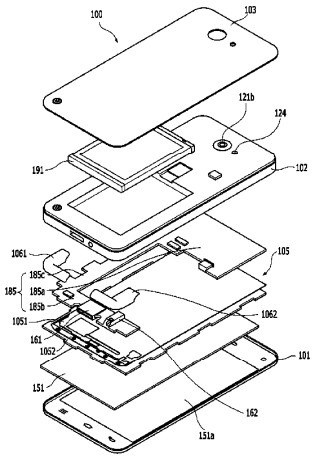
Primary Examiner — Olumide T. Ajibade Akonai
(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

There is disclosed a mobile terminal including a case having a display unit coupled to a front side, a first antenna mounted in the case and comprising a first slot extended in a first direction and having a closed end and an open end, a second antenna mounted in the case and comprising a second slot extended in a second direction opposite to the extended direction of the first slot and comprising a closed end and an open end, a power supply unit mounted in the case, a first feeder supplying the power of the power supply unit to the first antenna, and a second feeder supplying the power of the power supply unit to the second antenna.

9 Claims, 24 Drawing Sheets



US009871286B2

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

(10) **Patent No.: US 9,871,286 B2**
(45) **Date of Patent: Jan. 16, 2018**

(54) **MOBILE TERMINAL**

(71) Applicant: **LG ELECTRONICS INC.**, Seoul (KR)

(72) Inventors: **Yunmo Kang**, Seoul (KR); **Kangjae Jung**, Seoul (KR); **Sungjoon Hong**, Seoul (KR); **Byungwoon Jung**, Seoul (KR); **Sungjung Rho**, Seoul (KR)

(73) Assignee: **LG ELECTRONICS INC.**, Seoul (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 305 days.

(21) Appl. No.: **14/010,900**

(22) Filed: **Aug. 27, 2013**

(65) **Prior Publication Data**

US 2014/0078008 A1 Mar. 20, 2014

(30) **Foreign Application Priority Data**

Sep. 19, 2012 (KR) 10-2012-0104152

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 21/30	(2006.01)
H01Q 9/26	(2006.01)
H01Q 13/10	(2006.01)
H01Q 5/35	(2015.01)
H01Q 5/50	(2015.01)
H01Q 1/38	(2006.01)
H01Q 1/48	(2006.01)
H01Q 1/50	(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 1/50*** (2013.01); ***H01Q 5/35*** (2015.01); ***H01Q 5/50*** (2015.01); ***H01Q 7/00*** (2013.01); ***H01Q 9/26*** (2013.01); ***H01Q 13/10*** (2013.01); ***H01Q 21/30*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/38; H01Q 1/243; H01Q 21/30; H01Q 23/00; H01Q 13/106

USPC 343/702, 767, 872, 878

See application file for complete search history.

(56) **References Cited**

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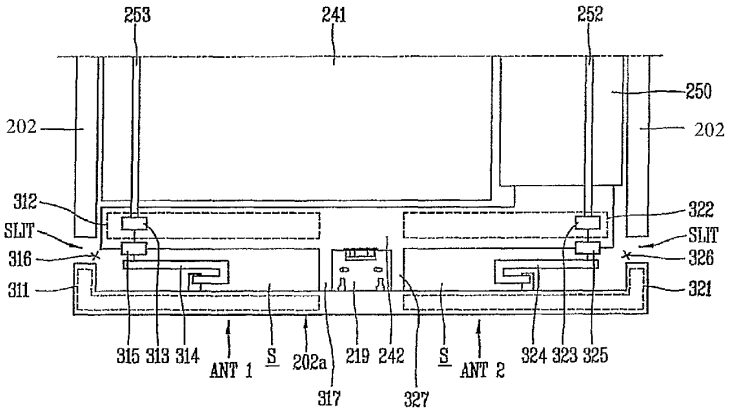
Primary Examiner — Dameon E Levi
Assistant Examiner — Collin Dawkins
(74) *Attorney, Agent, or Firm* — Lee, Hong, Degerman, Kang & Waimey PC

(57) **ABSTRACT**

A mobile terminal comprises: a terminal body; and a first antenna device and a second antenna device disposed at one side of the terminal body in an adjacent manner, and formed to operate at different frequency bands, wherein the first antenna device and the second antenna device are provided with conductive members each having a slit at one side thereof, and wherein the conductive members form part of an appearance of the terminal body.

25 Claims, 13 Drawing Sheets



US009871304B2

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

(10) **Patent No.: US 9,871,304 B2**
(45) **Date of Patent: Jan. 16, 2018**

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

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

(72) Inventors: **Dong-Ryul Shin**, Daegu (KR); **Min Sakong**, Gumi-si (KR); **Joon-Bo Park**, Busan (KR); **Byung-Chan Jang**, Gumi-si (KR); **Soo-Young Jang**, Daegu (KR); **Jin-Woo Jung**, Seoul (KR)

(73) Assignee: **Samsung Electronics Co., Ltd.**, Suwon-si (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/878,468**

(22) Filed: **Oct. 8, 2015**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Oct. 17, 2014 (KR) 10-2014-0140649

(51) **Int. Cl.**

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H01Q 21/30	(2006.01)
H01Q 1/38	(2006.01)
H01Q 13/10	(2006.01)
H01Q 5/364	(2015.01)

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

CPC ***H01Q 21/30*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 5/364*** (2015.01); ***H01Q 13/10*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 21/30; H01Q 13/00; H01Q 5/364

USPC ..... 343/700 MS, 702

See application file for complete search history.

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Primary Examiner — Dieu H Duong

(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

An antenna device and an electronic device including the same are provided. The antenna device includes a first radiator in which a slot is formed, a second radiator, at least a portion of which is disposed in the slot, and a feeder configured to feed the same electricity to the first radiator and the second radiator. The antenna device may have many resonance frequencies in the same installation space, allowing efficient use of the internal space of the electronic device. Moreover, the antenna device and the electronic device including the same may be implemented variously according to various embodiments.

11 Claims, 8 Drawing Sheets