

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

(10) **Patent No.:** **US 10,236,556 B2**
(45) **Date of Patent:** **Mar. 19, 2019**

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

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

(72) Inventors: **Jung-Sheng Chih**, New Taipei (TW);
Te-Chang Lin, New Taipei (TW);
Wen-Chang 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 1 day.

(21) Appl. No.: **15/655,912**

(22) Filed: **Jul. 21, 2017**

(65) **Prior Publication Data**
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Related U.S. Application Data
(60) Provisional application No. 62/365,391, filed on Jul. 22, 2016, provisional application No. 62/365,342, filed on Jul. 21, 2016.

(30) **Foreign Application Priority Data**
Jul. 20, 2017 (CN) 2017 1 0596080

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

(52) **U.S. Cl.**
CPC **H01Q 1/242** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/335** (2015.01);
(Continued)

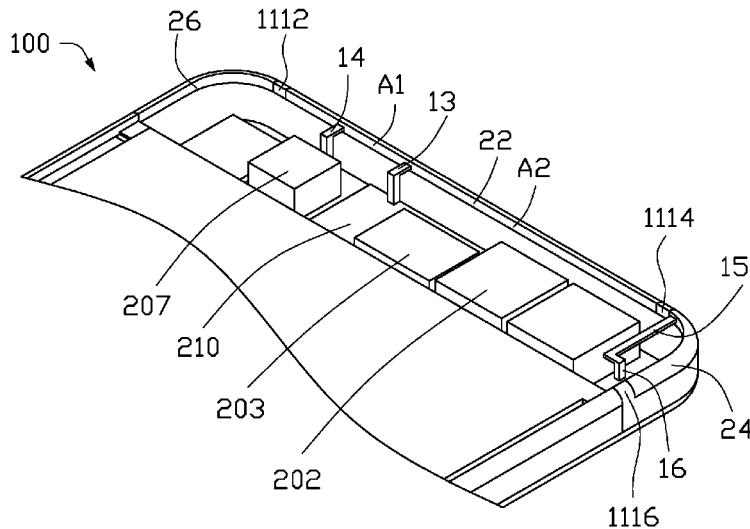
(58) **Field of Classification Search**
CPC H01Q 13/18; H01Q 1/24; H01Q 1/242; H01Q 1/48; H01Q 5/50; H01Q 1/243;
(Continued)

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

(57) **ABSTRACT**
An antenna structure includes a metallic member. The metallic member includes a front frame, a backboard, and a side frame. The side frame defines a slot. The front frame defines a first gap and a second gap. The front frame between the first gap and the second gap forms a first radiating section, the front frame between the first gap and an end of the slot forms a third radiating section. Current enters the first radiating section from the first feed portion, the current flows through the first radiating section and towards the first gap and the second gap, respectively, thus activating radiating signals in a first frequency band and a second frequency band, the third radiating section obtains current from the first radiating section by coupling, thus activating radiation signals in a fourth different frequency band. A wireless communication device using the antenna structure is provided.

19 Claims, 22 Drawing Sheets





US010236558B2

(12) **United States Patent
Mai**

(10) **Patent No.: US 10,236,558 B2**

(45) **Date of Patent: Mar. 19, 2019**

(54) **LTE FULL-BAND CELLPHONE ANTENNA
STRUCTURE**

(71) Applicant: **Jianchun Mai**, Shenzhen (CN)

(72) Inventor: **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 25 days.

(21) Appl. No.: **15/416,913**

(22) Filed: **Jan. 26, 2017**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

May 3, 2016 (CN) 2016 1 0284245

(51) **Int. Cl.**

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H01Q 5/50 (2015.01)
H01Q 1/48 (2006.01)
H01Q 3/24 (2006.01)
H01Q 5/328 (2015.01)
H01Q 5/335 (2015.01)

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

CPC **H01Q 1/243** (2013.01); **H01Q 1/48**
(2013.01); **H01Q 3/24** (2013.01); **H01Q 5/328**
(2015.01); **H01Q 5/335** (2015.01); **H01Q 5/50**
(2015.01)

(58) **Field of Classification Search**

CPC . H01Q 1/241–1/243; H01Q 1/48–1/50; H01Q
3/24; H01Q 5/50

See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Dameon E Levi

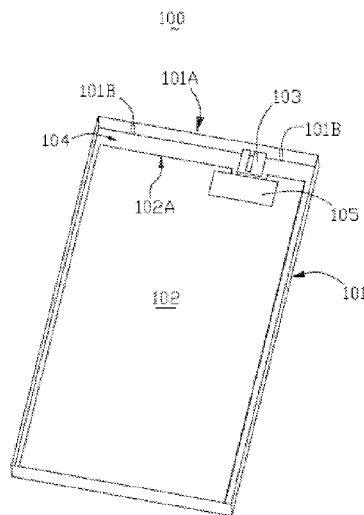
Assistant Examiner — Hasan Z Islam

(74) *Attorney, Agent, or Firm* — Na Xu; IPro, PLLC

(57) **ABSTRACT**

Provided is an LTE full-band cellphone antenna structure, including a ground plate, a circuit board having a feeding point, a feeding terminal matching circuit provided on the circuit board and a metal unit surrounding the circuit board and the ground plate. The metal unit includes a grounding portion electrically connected with the ground plate and a non-grounding portion electrically disconnected with the grounding portion. The feeding point is electrically connected with the non-grounding portion so that the non-grounding portion serves as a middle-high frequency radiator. A gap is provided between the non-grounding portion and the ground plate, and the ground plate is excited in a coupling manner so as to generate a current, such that the ground plate serves as a low frequency radiator. The antenna of the present disclosure covers all LTE frequency bands, which has advantages of less tuning difficulty and less influence by processing accuracy.

4 Claims, 5 Drawing Sheets



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

(10) **Patent No.:** **US 10,236,559 B2**
(45) **Date of Patent:** **Mar. 19, 2019**

(54) **THREE-SLOTTED ANTENNA APPARATUS AND METHOD**

(71) Applicant: **Futurewei Technologies, Inc.**, Plano, TX (US)

(72) Inventors: **Chulmin Han**, San Diego, CA (US);
Wee Kian Toh, San Diego, CA (US);
Wei Huang, San Diego, CA (US);
Hongwei Liu, San Diego, CA (US)

(73) Assignee: **Futurewei Technologies, Inc.**, Plano, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1 day.

(21) Appl. No.: **15/488,308**

(22) Filed: **Apr. 14, 2017**

(65) **Prior Publication Data**

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(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/50 (2015.01)
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(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/48**
(2013.01); **H01Q 5/50** (2015.01); **H01Q 13/18**
(2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 5/50; H01Q 13/18;
H01Q 1/48; H01Q 1/24; H04B 7/0413;
H04B 7/0404; H04B 7/04
(Continued)

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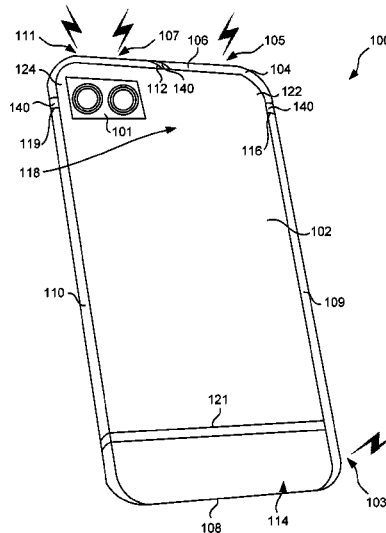
Primary Examiner — Jean B Jeanglaude

(74) *Attorney, Agent, or Firm* — Daniel Burns

(57) **ABSTRACT**

An apparatus and associated method are provided involving a housing having a periphery configured to operate as a second antenna, a third antenna, and a fourth antenna. The periphery includes a top wall having a first slot formed therein, a first side wall having a second slot formed therein, and a second side wall having a third slot formed therein. The top wall is arranged between the first side wall and the second side wall, and a top portion of the periphery is defined between the second slot and the third slot. The top portion is divided into a first top side portion and a second top side portion via the first slot. Further, the first top side portion operates as the second antenna, and the second top side portion operates as both the third antenna and the fourth antenna.

25 Claims, 14 Drawing Sheets



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

(10) **Patent No.:** **US 10,236,560 B2**
(45) **Date of Patent:** **Mar. 19, 2019**

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

(58) **Field of Classification Search**
CPC H01Q 5/314; H01Q 1/44
See application file for complete search history.

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

(56) **References Cited**

(72) Inventors: **Yongjoo Shin**, Suwon-si (KR); **Ji-Hyun Park**, Seongnam-si (KR); **Kyung-Hee Lee**, Seoul (KR); **Juyeong Lee**, Seoul (KR)

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(Continued)

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

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

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Search Report and Written Opinion dated Jan. 19, 2018 in counterpart International Patent Application No. PCT/KR2017/010850.

(21) Appl. No.: **15/712,675**

Primary Examiner — Tuan H Nguyen

(22) Filed: **Sep. 22, 2017**

(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye P.C.

(65) **Prior Publication Data**

US 2018/0102586 A1 Apr. 12, 2018

(57) **ABSTRACT**

(30) **Foreign Application Priority Data**

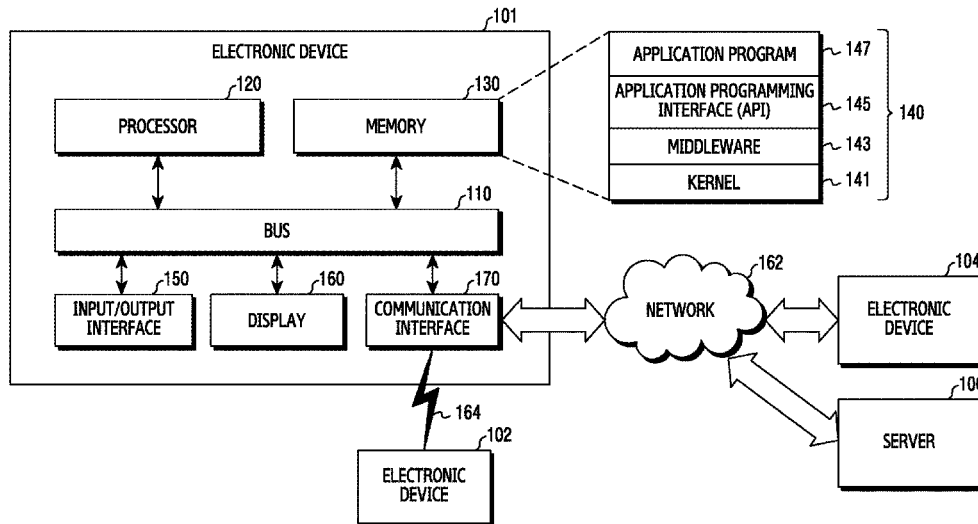
Oct. 10, 2016 (KR) 10-2016-0130702

According to various example embodiments, an electronic device including: a housing; a conductive member formed as a part of the housing or disposed in the housing as at least a part of the housing; a communication circuit electrically connected to a first region of the conductive member; a ground electrically connected to a second region of the conductive member spaced from the first region of the conductive member; a tunable circuit interposed in an electric connection path electrically connected with the ground in a third region of the conductive member, the third region being located between the first region and the second region of the conductive member; and at least one processor configured to generate a control signal based on a current mode of the electronic device and to provide the control signal to the tunable circuit.

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/314 (2015.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/44** (2013.01); **H01Q 5/314** (2015.01); **H01Q 5/328** (2015.01); **H01Q 5/364** (2015.01); **H01Q 7/00** (2013.01); **H04B 1/48** (2013.01); **H04M 1/0202** (2013.01); **H04B 2001/485** (2013.01); **H04M 1/026** (2013.01)

20 Claims, 16 Drawing Sheets





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

(10) **Patent No.:** **US 10,236,562 B2**
(45) **Date of Patent:** **Mar. 19, 2019**

(54) **SEPARATED AND OPTIMIZATION SENSOR PAD DESIGN FOR DUAL MODE LTE APPLICATION**

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

(72) Inventors: **Kun-Sheng Chang**, New Taipei (TW);
Ching-Chi Lin, 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 55 days.

(21) Appl. No.: **15/426,400**

(22) Filed: **Feb. 7, 2017**

(65) **Prior Publication Data**
US 2018/0138581 A1 May 17, 2018

(30) **Foreign Application Priority Data**
Nov. 11, 2016 (TW) 105136811 A

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H04B 1/3827 (2015.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/245** (2013.01); **H01Q 1/2266** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/44** (2013.01); **H01Q 5/30** (2015.01); **H01Q 5/371** (2015.01); **H01Q 5/378** (2015.01); **H01Q 9/42** (2013.01); **H04B 1/3838** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/245; H01Q 1/243; H01Q 5/30; H04B 1/3838
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Dameon E Levi

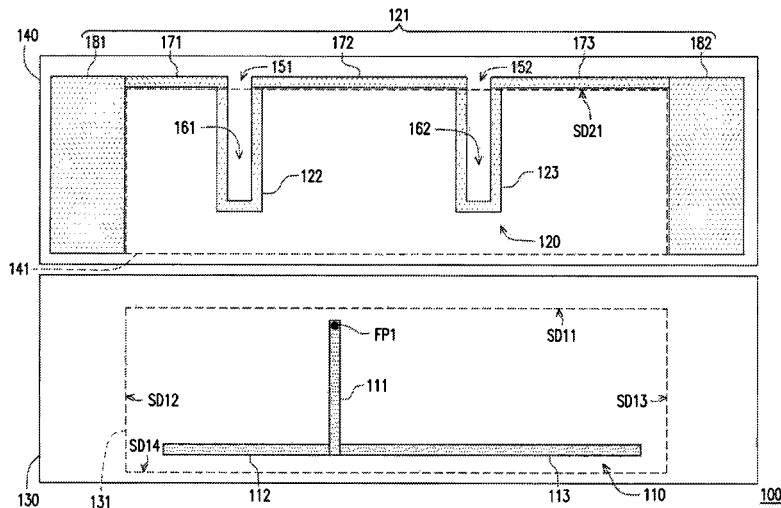
Assistant Examiner — Ab Salam Alkassim, Jr.

(74) *Attorney, Agent, or Firm* — Edell, Shapiro & Finnan, LLC

(57) **ABSTRACT**

A mobile device includes a dual band T-shaped antenna and a sensing element. The sensing element includes a first sensing part extending in first direction, a second sensing part, and a third sensing part, wherein the second sensing part and the third sensing part each includes portions that extend in a second direction that is perpendicular to the first direction. The sensing element is used to both detect proximity to an object, to meet specific absorption rate (SAR) criteria, and to affect resonance of the dual band T-shaped antenna.

19 Claims, 6 Drawing Sheets





US010243257B2

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

(10) **Patent No.:** **US 10,243,257 B2**

(45) **Date of Patent:** **Mar. 26, 2019**

(54) **PORTABLE ELECTRONIC DEVICE COVER**

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

(72) Inventors: **Wonseok Jeong**, Gyeonggi-do (KR);
Donghwan Kim, Gyeonggi-do (KR);
Bumjin Cho, Gyeonggi-do (KR);
Donguk Choi, Gyeonggi-do (KR);
Sangmin Han, 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 88 days.

(21) Appl. No.: **15/038,848**

(22) PCT Filed: **Nov. 27, 2014**

(86) PCT No.: **PCT/KR2014/011457**

§ 371 (c)(1),
(2) Date: **May 24, 2016**

(87) PCT Pub. No.: **WO2015/080479**

PCT Pub. Date: **Jun. 4, 2015**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

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

(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/245**
(2013.01); **H01Q 1/50** (2013.01); **H01Q**
9/0414 (2013.01);

(Continued)

(58) **Field of Classification Search**

CPC H01Q 1/24; H01Q 1/241; H01Q 1/242;
H01Q 1/243; H01Q 1/245; H01Q 1/40;
(Continued)

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Primary Examiner — Tho G Phan

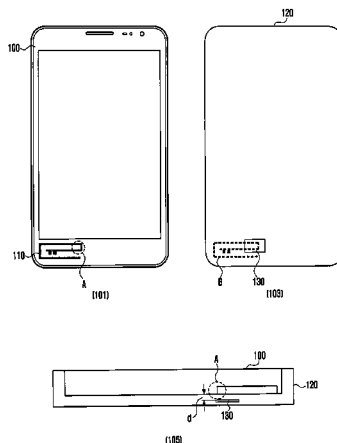
Assistant Examiner — Patrick Holecsek

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

(57) **ABSTRACT**

A portable electronic device cover, according to the present
invention, comprises a conductive plate which is spaced at
a predetermined distance from an antenna mounted in a
portable electronic device and is arranged at a position
overlapped with at least a part of the antenna when the
portable electronic device is mounted in the portable elec-
tronic device cover.

9 Claims, 6 Drawing Sheets



(12) **United States Patent**
Woo

(10) **Patent No.:** **US 10,243,258 B2**
(45) **Date of Patent:** **Mar. 26, 2019**

(54) **MOBILE TERMINAL**

(56) **References Cited**

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

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(72) Inventor: **Seungmin Woo**, Seoul (KR)

(Continued)

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

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

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(21) Appl. No.: **15/461,412**

PCT International Application No. PCT/KR2017/002453, Notification of Transmittal of the International Search Report and the Written Opinion of the International Searching Authority, or Declaration dated Jun. 16, 2017, 11 pages.

(22) Filed: **Mar. 16, 2017**

Primary Examiner — Hai V Tran

(65) **Prior Publication Data**

US 2018/0069298 A1 Mar. 8, 2018

(74) *Attorney, Agent, or Firm* — Lee Hong Degerman Kang & Waimey

(30) **Foreign Application Priority Data**

Sep. 7, 2016 (KR) 10-2016-0115094

(57) **ABSTRACT**

(51) **Int. Cl.**

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H01Q 5/335 (2015.01)

(Continued)

A mobile terminal comprises a case; a main board packaged in the case; a signal supply unit packaged on the main board, supplying a radio signal; an antenna radiator packaged in the case, including a conductive material and transmitting and receiving a signal of a first frequency; an antenna tuner packaged in the case, including a conductive material; a feeding line located on the main board, having one end connected with the signal supply unit and the other end connected with the antenna radiator; and a tuning line located on the main board, having one end connected to the feeding line and the other end connected with the antenna tuner, wherein the tuning line and the antenna tuner compensate for impedance of the feeding line and the antenna radiator. The mobile terminal can prevent wireless communication performance from being deteriorated by impedance distorted by an external environment like that a body of a user approaches the antenna radiator.

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

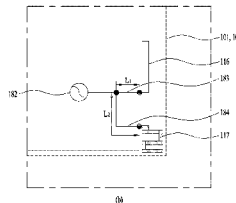
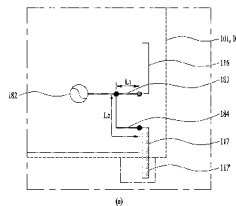
CPC **H01Q 1/243** (2013.01); **H01Q 5/335** (2015.01); **H01Q 5/35** (2015.01); **H03H 1/00** (2013.01); **H03H 7/38** (2013.01); **H01Q 1/52** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 1/38; H01Q 1/52; H01Q 5/335; H01Q 1/24

(Continued)

14 Claims, 14 Drawing Sheets





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

(10) **Patent No.:** **US 10,243,269 B2**
(45) **Date of Patent:** **Mar. 26, 2019**

(54) **ANTENNA**

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(71) Applicant: **NXP B.V.**, Eindhoven (NL)

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(72) Inventors: **Liesbeth Gommé**, Anderlecht (BE);
Anthony Kerselaers, Herselt (BE)

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(73) Assignee: **NXP B.V.**, Eindhoven (NL)

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

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(21) Appl. No.: **15/873,714**

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(65) **Prior Publication Data**

US 2018/0233811 A1 Aug. 16, 2018

Primary Examiner — Robert Karacsony

(30) **Foreign Application Priority Data**

(74) *Attorney, Agent, or Firm* — Rajeev Madnawat

Feb. 15, 2017 (EP) 17156294.5

(57) **ABSTRACT**

(51) **Int. Cl.**

H01Q 1/32 (2006.01)
H01Q 5/40 (2015.01)
H01Q 9/32 (2006.01)

The disclosure relates to an antenna including a substrate and a conductor pattern on the substrate. The conductor pattern comprises first and second conductor areas and the first conductor area is generally at a first end of the substrate and the second conductor area is generally at an opposing second end of the substrate. A first direction extends between the first and second ends of the substrate. The first conductor area has two arms, the two first conductor area arms extend parallel to the first direction and define a first slot between them; wherein the second conductor area has two arms with a second slot defined between them, and the two second conductor area arms extend parallel to the first direction. The two second conductor area arms sit within the first slot with a portion of the first slot at the outer sides of the two second conductor area arms.

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

CPC **H01Q 5/40** (2015.01); **H01Q 1/3275** (2013.01); **H01Q 9/32** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/3216; H01Q 1/3275; H01Q 1/38; H01Q 5/35; H01Q 5/40; H01Q 5/42; H01Q 9/32; H01Q 13/106

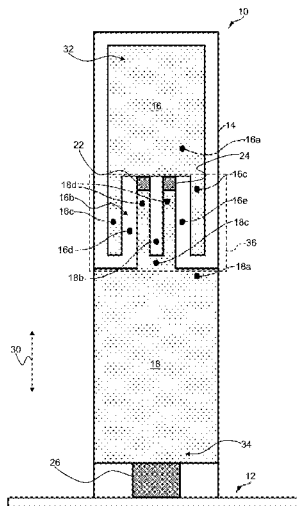
See application file for complete search history.

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15 Claims, 10 Drawing Sheets





US010243274B2

(12) **United States Patent**
Lee

(10) **Patent No.:** **US 10,243,274 B2**
(45) **Date of Patent:** **Mar. 26, 2019**

- (54) **SLOT ANTENNA DEVICE**
- (71) Applicant: **E Ink Holdings Inc.**, Hsinchu (TW)
- (72) Inventor: **Yu-Ming Lee**, Taoyuan (TW)
- (73) Assignee: **E Ink Holdings Inc.**, Hsinchu (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.: **15/406,801**
- (22) Filed: **Jan. 16, 2017**
- (65) **Prior Publication Data**
US 2017/0244171 A1 Aug. 24, 2017

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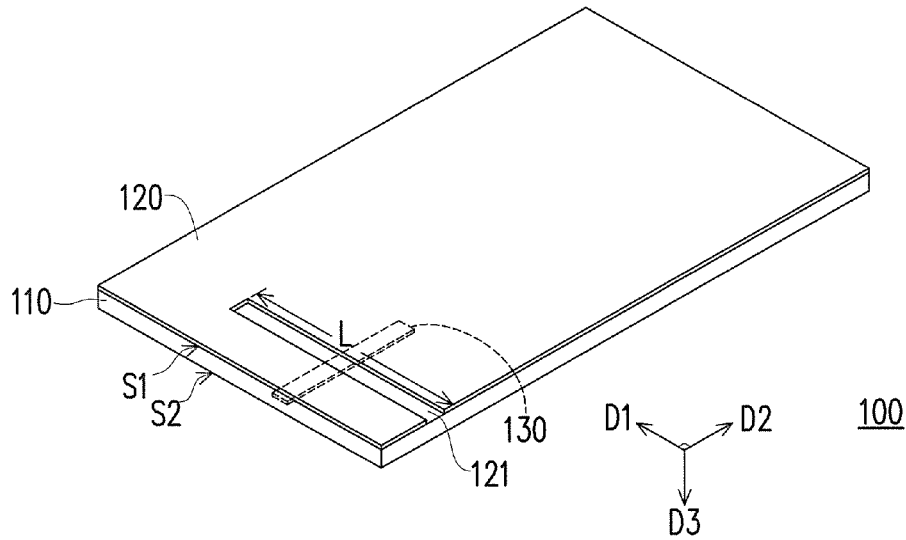
- Related U.S. Application Data**
- (60) Provisional application No. 62/296,601, filed on Feb. 18, 2016.
- (30) **Foreign Application Priority Data**
Sep. 26, 2016 (CN) 2016 1 0849318
- (51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 1/36 (2006.01)
(Continued)
- (52) **U.S. Cl.**
CPC **H01Q 13/106** (2013.01); **H01Q 1/2291**
(2013.01); **H01Q 1/243** (2013.01);
(Continued)
- (58) **Field of Classification Search**
None
See application file for complete search history.

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- “Office Action of Taiwan Counterpart Application,” dated Sep. 19, 2017, p. 1-p. 5.
(Continued)
- Primary Examiner* — Trinh Dinh
- (74) *Attorney, Agent, or Firm* — JCIPRNET

(57) **ABSTRACT**

A slot antenna device including a substrate, a metal layer and a feeding element is provided. The substrate has a first surface and a second surface opposite to the first surface. The metal layer is disposed on the first surface, and includes a slot extending along a first direction. The feeding element is disposed on the second surface, and extended along a second direction, where the first direction is perpendicular to the second direction. A length of the slot is a sum of each quarter wavelength of at least three frequency bands, so that the slot antenna device is operated at the at least three frequency bands. A projection of the feeding element on the first surface crosses the slot, so that the slot is divided into a first section and a second section, where a length of the first section is equal to a length of the second section.

15 Claims, 7 Drawing Sheets





US010243279B2

(12) **United States Patent**
Liu

(10) **Patent No.:** **US 10,243,279 B2**
(45) **Date of Patent:** **Mar. 26, 2019**

(54) **SLOT ANTENNA WITH RADIATOR ELEMENT**

(56) **References Cited**

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(71) Applicant: **Microsoft Technology Licensing, LLC**,
Redmond, WA (US)

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343/700 MS

(72) Inventor: **Luyi Liu**, Sammamish, WA (US)

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(73) Assignee: **Microsoft Technology Licensing, LLC**,
Redmond, WA (US)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 133 days.

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(21) Appl. No.: **15/056,814**

“International Search Report and Written Opinion Issued in PCT Application No. PCT/US2017/019224”, dated Jun. 8, 2017, 13 Pages.

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

(Continued)

(65) **Prior Publication Data**

Primary Examiner — Trinh V Dinh

US 2017/0250475 A1 Aug. 31, 2017

(74) *Attorney, Agent, or Firm* — Holzer Patel Drennan

(51) **Int. Cl.**

(57) **ABSTRACT**

H01Q 1/24 (2006.01)
H01Q 21/30 (2006.01)
H01Q 13/10 (2006.01)
H01Q 1/22 (2006.01)
H01Q 5/371 (2015.01)

An antenna assembly includes a conductive plate having a slot formed within the conductive plate. A conductive coupling element is positioned within the slot of the conductive plate to form a slot antenna structure with the conductive plate. At least one conductive radiator element is positioned outside of the slot. An antenna feed structure is electrically coupled to the conductive coupling element and the at least one conductive radiator element. The antenna feed structure is configured to simultaneously resonate the slot antenna structure and the at least one conductive radiator element. The slot antenna structure and the conductive radiator element work in combination to resonate at substantially similar (e.g., overlapping) RF communication bands or at different RF communication bands.

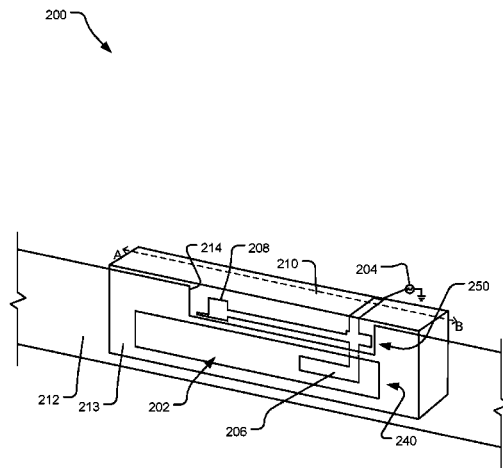
(52) **U.S. Cl.**

CPC **H01Q 21/30** (2013.01); **H01Q 1/2266** (2013.01); **H01Q 1/24** (2013.01); **H01Q 1/243** (2013.01); **H01Q 5/371** (2015.01); **H01Q 13/10** (2013.01); **H01Q 13/106** (2013.01)

(58) **Field of Classification Search**

None
See application file for complete search history.

19 Claims, 5 Drawing Sheets





US010243624B2

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

(10) **Patent No.:** **US 10,243,624 B2**
(45) **Date of Patent:** ***Mar. 26, 2019**

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

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

(72) Inventors: **Jaehyung Kim**, Gyeonggi-do (KR);
Jae-Ho Lim, Gyeonggi-do (KR);
Hosaeng Kim, Gyeonggi-do (KR);
Jesun Moon, Gyeonggi-do (KR);
Sungyeul Hong, Gyeonggi-do (KR);
Kyung-Jong Lee, Gyeonggi-do (KR);
Jinkyu Bang, Gyeonggi-do (KR);
Hanbin Lee, Gyeonggi-do (KR);
Kyung-Bae Ko, Gyeonggi-do (KR);
Donghwan Kim, Gyeonggi-do (KR);
Taegy Kim, Gyeonggi-do (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 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **15/792,017**

(22) Filed: **Oct. 24, 2017**

(65) **Prior Publication Data**
US 2018/0048359 A1 Feb. 15, 2018

Related U.S. Application Data

(63) Continuation of application No. 15/351,142, filed on Nov. 14, 2016, now Pat. No. 9,831,928.

(30) **Foreign Application Priority Data**

Nov. 13, 2015 (KR) 10-2015-0159674
Apr. 8, 2016 (KR) 10-2016-0043135

(51) **Int. Cl.**
H04B 1/38 (2015.01)
H04B 7/0404 (2017.01)
(Continued)

(52) **U.S. Cl.**
CPC **H04B 7/0404** (2013.01); **H01Q 1/2266** (2013.01); **H01Q 1/24** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H04B 7/0404; H04B 1/40; H04M 1/0216; H04M 1/0266
See application file for complete search history.

(56) **References Cited**
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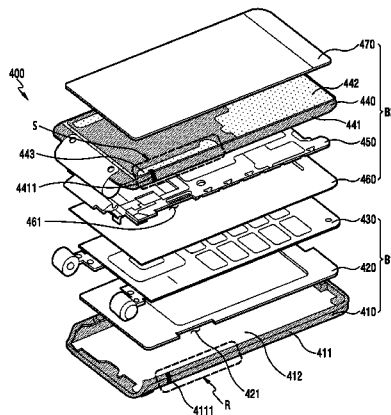
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Primary Examiner — Tuan Pham
(74) *Attorney, Agent, or Firm* — The Farrell Law Firm, P.C.

(57) **ABSTRACT**

An electronic device is provided. The electronic device includes a first housing a second housing, a first display disposed on the first housing and a second display disposed on the second housing, a connecting member configured to couple the first housing to the second housing such that the first housing and the second housing are foldable relative to each other, and the second surface and the fourth surface face each other when the first housing and the second housing are folded toward each other, a first conductive
(Continued)





US010249933B2

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

(10) **Patent No.:** **US 10,249,933 B2**
(45) **Date of Patent:** **Apr. 2, 2019**

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

(58) **Field of Classification Search**
CPC H01Q 1/22; H01Q 1/2258; H01Q 1/2266;
H01Q 1/24; H01Q 21/28; H01Q 1/243
See application file for complete search history.

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

(56) **References Cited**

(72) Inventors: **Ji-Hye Moon**, Seoul (KR); **Jang-Sun Yoo**, Seoul (KR); **Myeong-Gil Lee**, Seoul (KR); **Chee-Hwan Yang**, Gyeonggi-do (KR); **Kwang-Yong Lee**, Gyeonggi-do (KR)

U.S. PATENT DOCUMENTS

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

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

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(21) Appl. No.: **15/620,941**

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(22) Filed: **Jun. 13, 2017**

International Search Reported dated Sep. 19, 2017.

(65) **Prior Publication Data**

US 2017/0373374 A1 Dec. 28, 2017

* cited by examiner

Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Cha & Reiter, LLC.

(30) **Foreign Application Priority Data**

Jun. 27, 2016 (KR) 10-2016-0080051

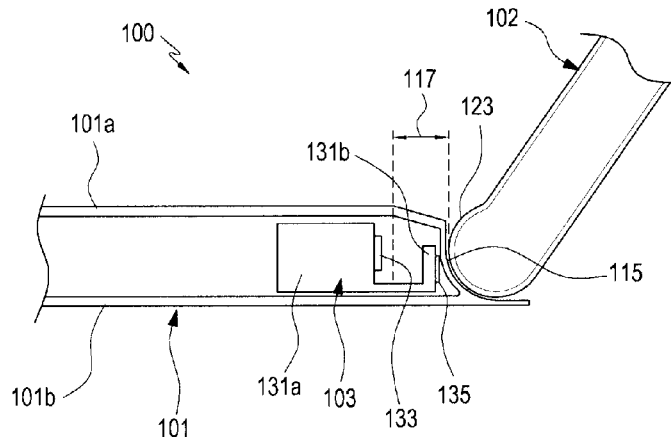
(57) **ABSTRACT**

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/22 (2006.01)
G06F 1/16 (2006.01)
H01Q 21/28 (2006.01)

Disclosed is an antenna device for an electronic device including a first housing and a second housing rotatably coupled to the first housing about a hinge axis. The antenna device may include: a radiation conductor disposed in the first housing; and a reflection member disposed adjacent to the radiation conductor in the first housing. Radio waves transceived by the radiation conductor are radiated via the reflection member. Also disclosed is an electronic device including the antenna device. The antenna device and the electronic device including the same may be variously implemented according to embodiments.

(52) **U.S. Cl.**
CPC **H01Q 1/2258** (2013.01); **G06F 1/1698** (2013.01); **H01Q 1/2266** (2013.01); **H01Q 1/24** (2013.01); **H01Q 1/243** (2013.01); **H01Q 21/28** (2013.01)

17 Claims, 10 Drawing Sheets





US010249936B2

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

(10) **Patent No.:** **US 10,249,936 B2**

(45) **Date of Patent:** **Apr. 2, 2019**

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

(71) Applicant: **AGC Inc.**, Chiyoda-ku (JP)

(72) Inventors: **Toshiki Sayama**, Chiyoda-ku (JP); **Ryuta Sonoda**, Chiyoda-ku (JP); **Koji Ikawa**, Chiyoda-ku (JP)

(73) Assignee: **AGC Inc.**, Chiyoda-ku (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.: **15/468,148**

(22) Filed: **Mar. 24, 2017**

(65) **Prior Publication Data**

US 2017/0194692 A1 Jul. 6, 2017

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2015/078058, filed on Oct. 2, 2015.

(30) **Foreign Application Priority Data**

Oct. 2, 2014 (JP) 2014-204100

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/385 (2015.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/241** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/378** (2015.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/38; H01Q 9/0421; H01Q 1/42; H01Q 1/12
(Continued)

(56) **References Cited**

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Primary Examiner — Dameon E Levi

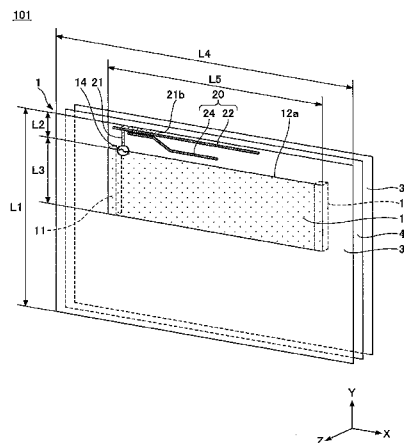
Assistant Examiner — Collin Dawkins

(74) *Attorney, Agent, or Firm* — Oblon, McClelland, Maier & Neustadt, L.L.P.

(57) **ABSTRACT**

An antenna device includes a ground plane; a first resonator extending in a direction at a distance from the ground plane and connected to a feeding point; and a second resonator arranged at a distance from the first resonator. The ground plane includes an edge portion formed along the second resonator, with a resonance current being formed on the first resonator and the ground plane. The second resonator is configured to function as a radiation conductor by resonance of the first resonator. A tip portion of the first resonator is located near a metallic part. The second resonator has a plurality of electrical lengths of differing resonance frequencies.

20 Claims, 11 Drawing Sheets



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

(10) **Patent No.:** **US 10,249,945 B2**
(45) **Date of Patent:** **Apr. 2, 2019**

(54) **ELECTRONIC DEVICE HAVING ANTENNA STRUCTURE**

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

(72) Inventors: **Huang-Tse Peng**, Hsinchu (TW);
Kuo-Jen Lai, Hsinchu (TW);
Cheng-Feng Li, Hsinchu (TW)

(73) Assignee: **Wistron NeWeb Corp.**, Hsinchu (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 420 days.

(21) Appl. No.: **14/864,905**

(22) Filed: **Sep. 25, 2015**

(65) **Prior Publication Data**
US 2016/0211571 A1 Jul. 21, 2016

(30) **Foreign Application Priority Data**
Jan. 20, 2015 (TW) 104101775 A

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/48 (2006.01)
H01Q 13/10 (2006.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/48** (2013.01); **H01Q 1/243** (2013.01); **H01Q 9/0421** (2013.01); **H01Q 13/10** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/48; H01Q 13/10
See application file for complete search history.

(56) **References Cited**

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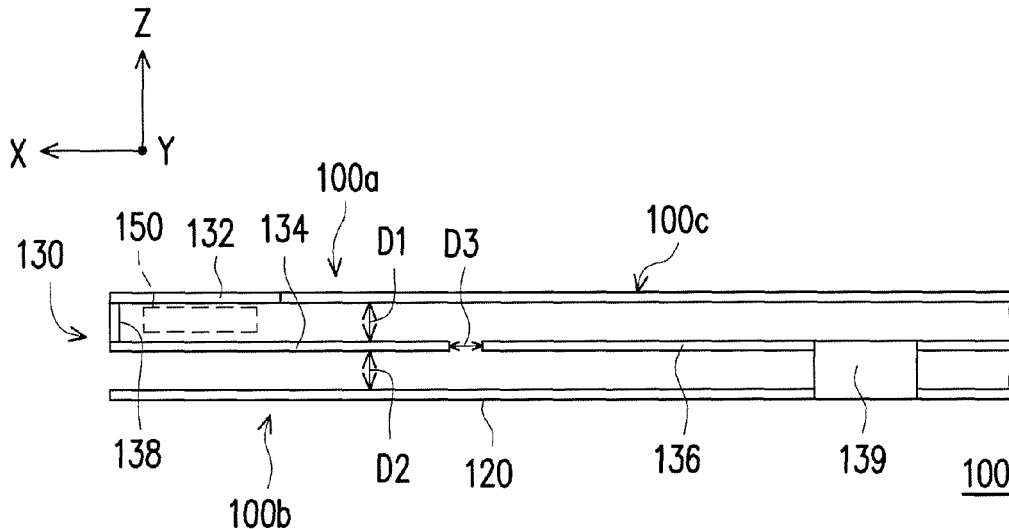
“Office Action of Taiwan Counterpart Application,” dated Apr. 11, 2017, p. 1-p. 6.

Primary Examiner — Dameon E Levi
Assistant Examiner — Ab Salam Alkassim, Jr.
(74) *Attorney, Agent, or Firm* — JCIPRNET

(57) **ABSTRACT**

An electronic device has a front side and a rear side opposite to each other and includes a back cover and an antenna structure. The back cover is disposed at the rear side. The antenna structure includes a first radiation portion, a second radiation portion and a ground portion. The first radiation portion is disposed at the front side. The second radiation portion is disposed between the first radiation portion and the back cover and is connected to the first radiation portion. The ground portion is disposed between the first radiation portion and the back cover, wherein the second radiation portion is grounded to the back cover through the ground portion.

14 Claims, 3 Drawing Sheets





US010249957B2

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

(10) **Patent No.:** **US 10,249,957 B2**

(45) **Date of Patent:** **Apr. 2, 2019**

(54) **WIRELESS COMMUNICATION DEVICE**

(56) **References Cited**

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

U.S. PATENT DOCUMENTS

(72) Inventors: **Wei-Shan Chang**, Hsinchu (TW);
Guan-Nan Lin, Hsinchu (TW);
Chia-Tien Li, Hsinchu (TW)

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					343/702

(73) Assignee: **Wistron NeWeb Corporation**, Hsinchu (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 245 days.

* cited by examiner

(21) Appl. No.: **14/680,052**

Primary Examiner — Hai V Tran

(22) Filed: **Apr. 6, 2015**

Assistant Examiner — Michael M Bouizza

(65) **Prior Publication Data**

US 2016/0294067 A1 Oct. 6, 2016

(74) *Attorney, Agent, or Firm* — Winston Hsu

(51) **Int. Cl.**
H01Q 13/18 (2006.01)
H01Q 5/364 (2015.01)
H01Q 1/22 (2006.01)
H01Q 1/24 (2006.01)

(57) **ABSTRACT**

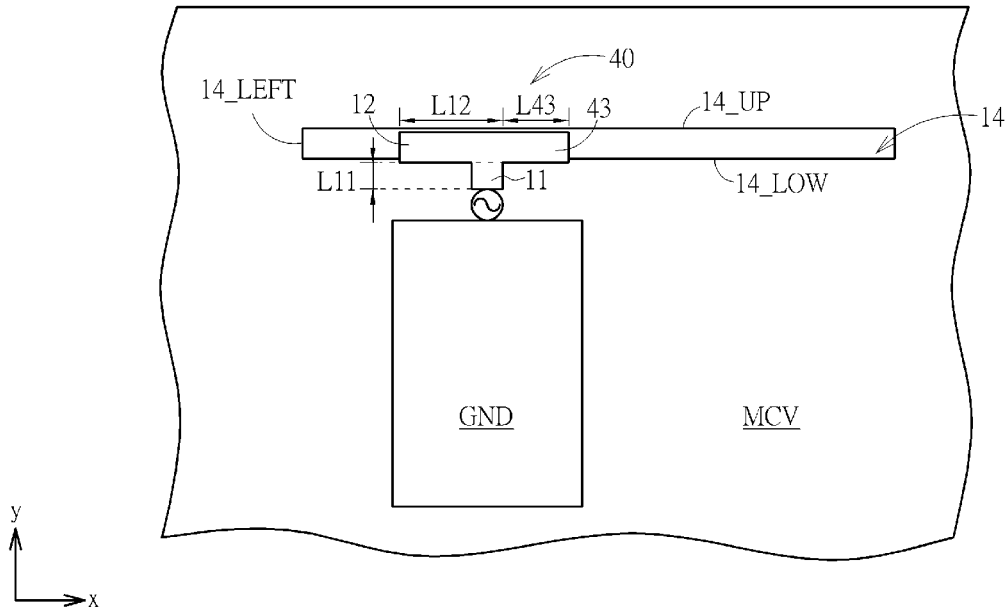
A wireless communication device includes a metal cover and an antenna. The metal cover is formed with a slot. The antenna is disposed in the metal cover for resonating a radio-frequency signal via the slot, and includes a feed terminal, a radiator and a ground. The feed terminal is used for feeding the radio-frequency signal. The radiator includes a first arm electrically connected to the feed terminal and extended from the feed terminal along a first direction, and a second arm electrically connected to the first arm and extended from the first arm along a second direction, wherein the second arm is partially overlapped with a first edge of the slot.

(52) **U.S. Cl.**
CPC **H01Q 13/18** (2013.01); **H01Q 5/364** (2015.01); **H01Q 1/2266** (2013.01); **H01Q 1/243** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 13/18; H01Q 5/364; H01Q 1/243; H01Q 1/2266

See application file for complete search history.

8 Claims, 9 Drawing Sheets



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

(10) **Patent No.:** **US 10,256,525 B2**
(45) **Date of Patent:** **Apr. 9, 2019**

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

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

(72) Inventors: **Yi-Ting Chen**, New Taipei (TW);
Yen-Jung Tseng, New Taipei (TW);
Tze-Hsuan Chang, 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 0 days.

(21) Appl. No.: **15/655,899**

(22) Filed: **Jul. 21, 2017**

(65) **Prior Publication Data**
US 2018/0026336 A1 Jan. 25, 2018

Related U.S. Application Data

(60) Provisional application No. 62/365,341, filed on Jul. 21, 2016.

(30) **Foreign Application Priority Data**
Jul. 11, 2017 (CN) 2017 1 0562263

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 13/18 (2006.01)
H01Q 5/50 (2015.01)
H04Q 1/48 (2006.01)
H01Q 21/28 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/242** (2013.01); **H01Q 1/243** (2013.01); **H01Q 5/50** (2015.01); **H01Q 13/18** (2013.01); **H01Q 21/28** (2013.01); **H04Q 1/48** (2013.01)

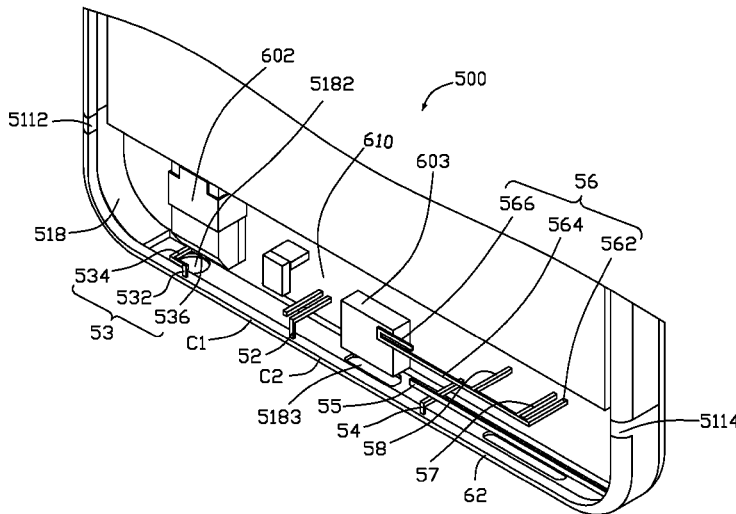
(58) **Field of Classification Search**
CPC H01Q 13/18; H01Q 1/24; H01Q 1/242; H01Q 1/48; H01Q 5/50; H01Q 1/243; H01Q 21/28; H01Q 5/314; H01Q 5/371
See application file for complete search history.

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

(57) **ABSTRACT**
An antenna structure includes a metallic member and an extending section. The metallic member includes a front frame, a backboard, and a side frame. The side frame defines a slot. The front frame defines a first gap and a second gap communicating with the slot and extending across the front frame. A portion of the front frame between the first gap and the second gap forms a radiating section. Current enters the first radiating section from the first feed portion and flows through the first radiating section and towards the first gap and the second gap to generate radiation signals in a first frequency band and a second frequency band; the current flows through the extending section to generate radiation signals in a third frequency band. A wireless communication device using the antenna structure is provided.

20 Claims, 26 Drawing Sheets





US010256527B2

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

(10) **Patent No.:** **US 10,256,527 B2**

(45) **Date of Patent:** **Apr. 9, 2019**

(54) **MOBILE TERMINAL**

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

(72) Inventors: **Minseok Kim**, Seoul (KR); **Hansu Kim**, Seoul (KR); **Kangjae Jung**, Seoul (KR); **Youngbae Kwon**, Seoul (KR); **Sungjung Rho**, Seoul (KR); **Changwon Yun**, Seoul (KR); **Kyoungwon Jeon**, Seoul (KR); **Duckyun Kim**, Seoul (KR); **Hyoungwook Lim**, Seoul (KR); **Yunmo Kang**, Seoul (KR); **Hayong Kim**, 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 50 days.

(21) Appl. No.: **15/244,963**

(22) Filed: **Aug. 23, 2016**

(65) **Prior Publication Data**
US 2017/0201010 A1 Jul. 13, 2017

(30) **Foreign Application Priority Data**
Jan. 11, 2016 (KR) 10-2016-0003385
Jan. 12, 2016 (KR) 10-2016-0003901

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

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 7/00** (2013.01); **H01Q 9/42** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 7/00; H01Q 9/045; H01Q 9/42; H01Q 21/28
See application file for complete search history.

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(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**
A mobile terminal includes a window including a transparent region and an opaque region surrounding the transparent region, a metal case provided below the window to accommodate the window, having a rear surface portion facing the window and a side surface portion formed to extend from the rear surface portion toward a front surface, and exposed outwardly, a non-metal member formed in a region formed by cut away a portion of the case and having a slot formation portion spaced apart from the side surface portion at a predetermined interval and a pair of sectioning portions extending from the slot formation portion and traversing the side surface portion to section the side surface portion into first to third members, and first to third antenna patterns formed in the opaque region and electrically connected to the first to third members to form first and third antennas, respectively.

15 Claims, 12 Drawing Sheets

