US010516208B2

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

(10) **Patent No.: US 10,516,208 B2**
(45) **Date of Patent: Dec. 24, 2019**

(54) **ELECTRONIC DEVICE INCLUDING SHIELDING STRUCTURE**

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

(72) Inventors: **Woo-Sup Lee**, Suwon-si (KR); **Youn-Ju Kim**, Suwon-si (KR); **Kyeong-Jo Keum**, Suwon-si (KR); **Jung-Sik Park**, Suwon-si (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 83 days.

(21) Appl. No.: **15/648,794**

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

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Aug. 4, 2016 (KR) 10-2016-0099482

(51) **Int. Cl.**
H01Q 1/52 (2006.01)
H04B 5/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 1/526*** (2013.01); ***G06K 19/07779*** (2013.01); ***H04B 5/0031*** (2013.01); ***H04B 5/0087*** (2013.01); ***H04B 5/02*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/526; H01Q 1/40; H01Q 1/38; H01Q 7/00; H01Q 7/06; H01Q 1/243;
(Continued)

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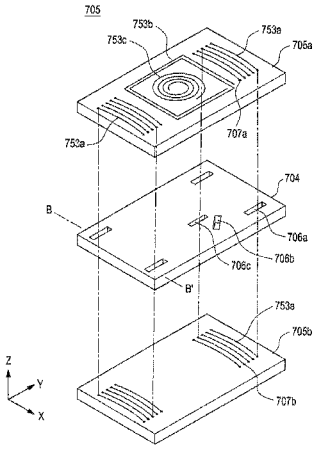
Primary Examiner — Jianxun Yang
(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye P.C.

(57) **ABSTRACT**

An electronic device, of the present disclosure, may include: a housing; an antenna unit disposed inside the housing and including a conductive pattern configured to generate a magnetic field; a plate comprising at least a part of the housing and including a material through which at least a part of the magnetic field generated by the conductive pattern can pass; and a control circuit configured to transmit at least one piece of payment information to an external device using the conductive pattern, wherein the antenna unit including the conductive pattern includes: a first coil having a first plurality of turns that is substantially perpendicular to one surface of the plate; and a second coil having a second plurality of turns that is substantially parallel to the surface of the plate, and a shielding structure comprising a shielding material is disposed inside the first coil or below the second coil. The electronic device, according to various example embodiments of the present disclosure, can implement various read-out methods (for example, a Near Field Communication (NFC) method and a Magnetic Secure
(Continued)



US010516202B2

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

(10) **Patent No.: US 10,516,202 B2**
(45) **Date of Patent: *Dec. 24, 2019**

(54) **MOBILE DEVICE AND ANTENNA STRUCTURE**

(71) Applicant: **HTC Corporation**, Taoyuan (TW)

(72) Inventors: **Tiao-Hsing Tsai**, Taoyuan (TW); **Chien-Pin Chiu**, Taoyuan (TW); **Hsiao-Wei Wu**, Taoyuan (TW); **Chao-Chiang Kuo**, Taoyuan (TW)

(73) Assignee: **HTC CORPORATION**, Taoyuan (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 102 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **15/599,255**

(22) Filed: **May 18, 2017**

(65) **Prior Publication Data**

US 2017/0256846 A1 Sep. 7, 2017

Related U.S. Application Data

(63) Continuation of application No. 13/672,464, filed on Nov. 8, 2012, now Pat. No. 9,716,307.

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

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 13/106*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 13/106; H01Q 13/10; H01Q 1/24; H01Q 1/243; H01Q 1/38
See application file for complete search history.

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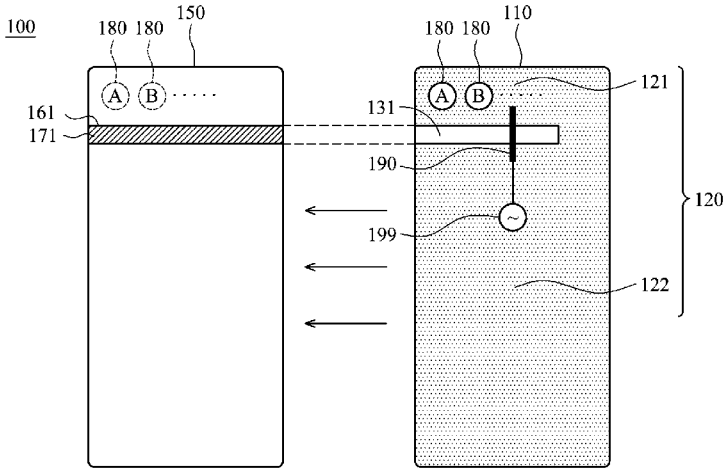
(Continued)

Primary Examiner — Tho G Phan
(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

A mobile device includes a dielectric substrate, a metal layer, a metal housing, a nonconductive partition, at least one connection element, and a feeding element. The metal layer is disposed on the dielectric substrate, and includes an upper element and a main element, wherein a slot is formed between the upper element and the main element. The metal housing is substantially a hollow structure, and has a slit, wherein the slit is substantially aligned with the slot of the metal layer. The connection element couples the upper element of the metal layer to the metal housing. The feeding element is coupled to the upper element of the metal layer or coupled to the metal housing. An antenna structure is formed by the feeding element, the upper element of the metal layer, the connection element, and the metal housing.

72 Claims, 59 Drawing Sheets



US010516203B2

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

(10) **Patent No.: US 10,516,203 B2**
(45) **Date of Patent: Dec. 24, 2019**

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

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

(72) Inventors: **Jianchuan Liu**, Shenzhen (CN); **Yuehua Yue**, Shenzhen (CN); **Wei Yan**, Shenzhen (CN); **Li Han**, Shenzhen (CN); **Chi Xie**, 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 73 days.

(21) Appl. No.: **15/893,813**

(22) Filed: **Feb. 12, 2018**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Jun. 21, 2017 (CN) 2017 1 0476833

(51) **Int. Cl.**

H01Q 1/06	(2006.01)
H01Q 1/24	(2006.01)
H04M 1/02	(2006.01)
H01Q 13/10	(2006.01)

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

CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/06*** (2013.01); ***H01Q 13/10*** (2013.01); ***H04M 1/026*** (2013.01); ***H04M 1/0266*** (2013.01); *H04M 1/0283* (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 1/06; H01Q 13/10; H01Q 1/38

USPC 343/721

See application file for complete search history.

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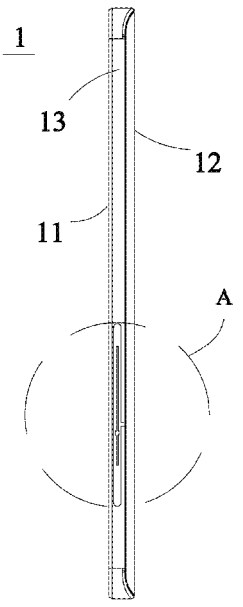
* cited by examiner

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

(57) **ABSTRACT**

A mobile terminal, including a display screen, a rear cover facing the display screen, a metal frame, and a circuit board; the metal frame and the circuit board are between the display screen and the rear cover and extend along outer profile of the rear cover. The antenna system includes at least one antenna unit. Each antenna unit includes a first gap in the metal frame and a second gap communicated with the first gap; the first gap extends along perimeter of the metal frame to form a strip-like hollow; the second gap extends from the middle of the first gap toward the rear cover until through the metal frame so as to divide the metal frame into a first section and a second section; the first section and the second section are electrically connected with the feeding point to form a first radiator and a second radiator, respectively.

9 Claims, 4 Drawing Sheets



US010516204B2

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

(10) **Patent No.: US 10,516,204 B2**
(45) **Date of Patent: Dec. 24, 2019**

(54) **ELECTRONIC DEVICE INCLUDING SUPPORT MEMBER HAVING ANTENNA RADIATOR**

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

(72) Inventors: **Bumjin Cho**, Gyeonggi-do (KR); **Yong-Youn Kim**, Gyeonggi-do (KR); **Soon Park**, Gyeonggi-do (KR); **Kyu-Hyuck Kwak**, Gyeonggi-do (KR); **Han-Jib Kim**, Gyeonggi-do (KR); **Hyo-Seok Na**, Gyeonggi-do (KR); **Chi-Hyun Cho**, Gyeonggi-do (KR)

(73) Assignee: **Samsung Electronics Co., Ltd.**, Yeongtong-gu, 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 0 days.

(21) Appl. No.: **15/902,035**

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

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Feb. 23, 2017 (KR) 10-2017-0023960

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H04M 1/02 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/36*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 21/061*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/24; H01Q 1/241; H01Q 1/243; H01Q 1/36; H01Q 1/38; H01Q 1/2291; H01Q 21/061; H01Q 21/08
See application file for complete search history.

(56) **References Cited**

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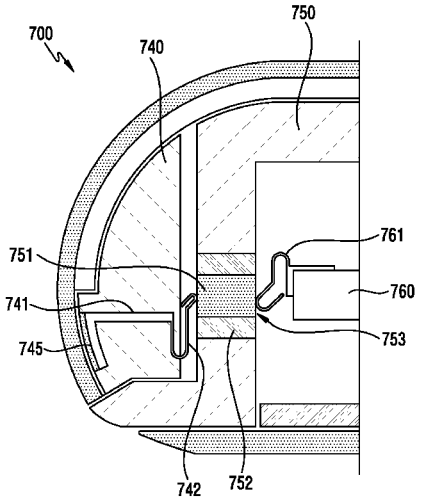
Primary Examiner — Hoang V Nguyen
(74) *Attorney, Agent, or Firm* — Cha & Reiter, LLC

(57) **ABSTRACT**

An embodiment disclosed herein relate to an electronic device including a support member on which an antenna radiator is formed. The electronic device may include: a housing including a first face facing in a first direction, a second face facing in a second direction opposite the first direction, a side face facing in a third direction that is perpendicular to both the first and second directions and surrounding at least a part of a space between the first and second faces; a display including a first region disposed in at least a part of the first face and at least one second region extending from the first region, the at least one second region disposed in at least a part of the side face of the housing; a support member disposed in a partial region of the space along the side face and configured to support the at least one second region; a bracket disposed on another partial region of the space and configured to support the display; and at least one antenna radiator disposed on the support member.

19 Claims, 28 Drawing Sheets



US010516772B2

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

(10) **Patent No.: US 10,516,772 B2**
(45) **Date of Patent: *Dec. 24, 2019**

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

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

(72) Inventors: **Hyung Joo Lee**, Seongnam-si (KR); **Gyu Sub Kim**, Seoul (KR); **Dong Yeon Kim**, Suwon-si (KR); **Chae Up Yoo**, 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.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **15/991,568**

(22) Filed: **May 29, 2018**

(65) **Prior Publication Data**

US 2018/0278731 A1 Sep. 27, 2018

Related U.S. Application Data

(63) Continuation of application No. 15/673,097, filed on Aug. 9, 2017, now Pat. No. 10,015,294, which is a (Continued)

(30) **Foreign Application Priority Data**

Aug. 13, 2015 (KR) 10-2015-0114638

(51) **Int. Cl.**
H04B 1/44 (2006.01)
H04M 1/02 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04M 1/0202*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/48*** (2013.01);
(Continued)

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

(56) **References Cited**

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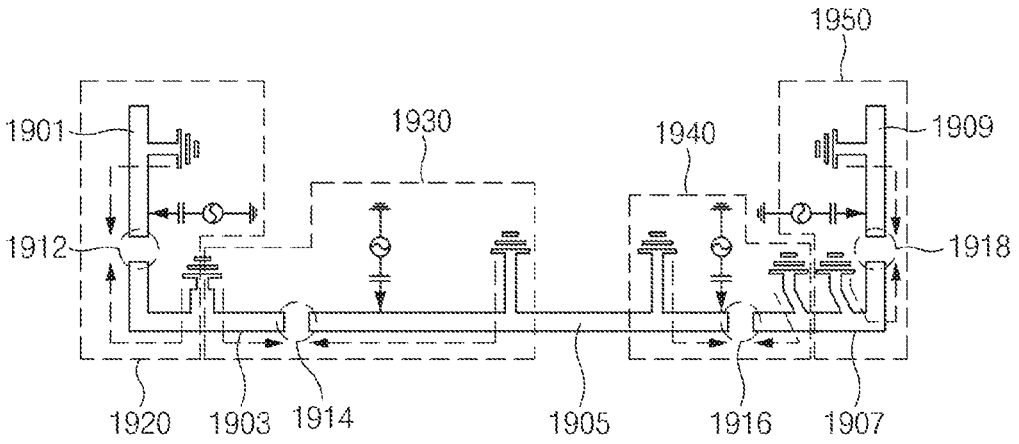
Primary Examiner — Tuan A Tran
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

An electronic device is provided. The electronic device includes a housing including a first surface, a second surface disposed facing an opposite side of the first surface, and a side surface configured to surround at least a portion of a space between the first surface and the second surface, a first elongated metal member configured to form a first portion of the side surface and including a first end and a second end, at least one communication circuit electrically connected to a first point of the first elongated metal member through a capacitive element, at least one ground member disposed in an interior of the housing, and a first conductive member configured to electrically connect a second point of the first elongated metal member to the ground member. The second point of the first elongated metal member is disposed closer to the second end than to the first point.

14 Claims, 42 Drawing Sheets



US010522900B2

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

(10) **Patent No.: US 10,522,900 B2**
(45) **Date of Patent: Dec. 31, 2019**

(54) **WIRELESS COMMUNICATION DEVICE WITH LEAKY-WAVE PHASED ARRAY ANTENNA**

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

(72) Inventors: **Alexander Nikolaevich Khripkov**, Lobnya (RU); **Gennadiy Alexandrovich Evtyushkin**, Moscow (RU); **Anton Sergeevich Lukyanov**, Moscow (RU); **Won-Bin Hong**, 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.: **15/291,488**

(22) Filed: **Oct. 12, 2016**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

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Jul. 6, 2016 (KR) 10-2016-0085454

(51) **Int. Cl.**
H01Q 13/20 (2006.01)
H01Q 1/24 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 1/42*** (2013.01); ***H01Q 1/50*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/38; H01Q 1/42; H01Q 1/50; H01Q 3/443; H01Q 13/00;
(Continued)

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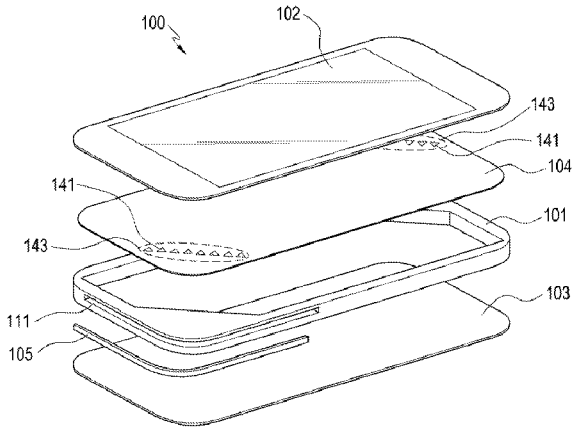
Primary Examiner — Daniel Munoz
Assistant Examiner — Bamidele A Jegede
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

A wireless communication device including an antenna device is provided. The wireless a communication device includes a housing having a conductive structure, a millimeter wave (mmWave) antenna having a plurality of antenna elements, the mmWave antenna being disposed within the housing, and a leaky-wave radiator having at least one opening formed in the conductive structure of the housing. An electromagnetic field generated by the mmWave antenna may be radiated outside of the housing of the wireless communication device through the leaky-wave radiator. The wireless communication device and/or an electronic device may be diversified according to embodiments.

18 Claims, 25 Drawing Sheets



US010522901B2

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

(10) **Patent No.: US 10,522,901 B2**
(45) **Date of Patent: Dec. 31, 2019**

(54) **TERMINAL CASING AND TERMINAL**

(71) Applicant: **XIAOMI INC.**, Haidian District, Beijing (CN)

(72) Inventors: **Xiaofeng Xiong**, Beijing (CN); **Zonglin Xue**, Beijing (CN); **Linchuan Wang**, Beijing (CN)

(73) Assignee: **XIAOMI INC.**, Beijing (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 246 days.

(21) Appl. No.: **15/368,872**

(22) Filed: **Dec. 5, 2016**

(65) **Prior Publication Data**

US 2017/0162933 A1 Jun. 8, 2017

(30) **Foreign Application Priority Data**

Dec. 3, 2015 (CN) 2015 1 0881118

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

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

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

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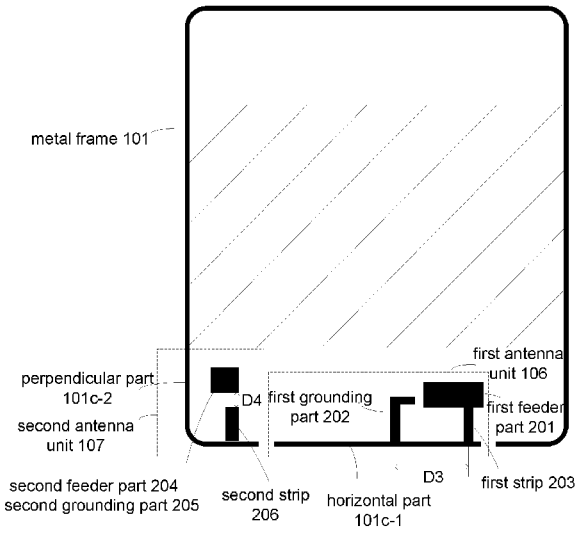
Primary Examiner — Robert Karacsony
(74) *Attorney, Agent, or Firm* — Arch & Lake LLP

(57) **ABSTRACT**

A terminal casing and a terminal are provided. A bottom frame is divided into a horizontal part and two perpendicular parts by two gaps in the bottom frame of a metal frame; and a first feeder unit and a second feeder unit are arranged in a clearance area, the first feeder unit and the horizontal part of the bottom frame form a first antenna unit, and the second feeder unit and any perpendicular part form a second antenna unit orthogonal to the first antenna unit.

17 Claims, 3 Drawing Sheets



US010522902B1

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

(10) **Patent No.: US 10,522,902 B1**
(45) **Date of Patent: Dec. 31, 2019**

(54) **ANTENNA STRUCTURE**

(71) Applicant: **Quanta Computer Inc.**, Taoyuan (TW)

(72) Inventors: **Yi-Ling Tseng**, Taoyuan (TW); **Chung-Hung Lo**, Taoyuan (TW); **Chin-Lung Tsai**, Taoyuan (TW); **Ching-Hai Chiang**, Taoyuan (TW); **Kuan-Hsien Lee**, Taoyuan (TW); **Ying-Cong Deng**, Taoyuan (TW); **Chung-Ting Hung**, Taoyuan (TW)

(73) Assignee: **QUANTA COMPUTER INC.**, Guishan Dist., Taoyuan (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.: **16/137,580**

(22) Filed: **Sep. 21, 2018**

(30) **Foreign Application Priority Data**

Jul. 26, 2018 (TW) ..... 107125869 A

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 1/48	(2006.01)
H01Q 5/30	(2015.01)
H01Q 9/04	(2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 5/30*** (2015.01); ***H01Q 9/0442*** (2013.01)

(58) **Field of Classification Search**
CPC .. H01Q 1/243; H01Q 1/48; H01Q 5/30–5/35; H01Q 9/0407–9/0442
USPC 343/702, 846
See application file for complete search history.

(56) **References Cited**

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2018/0053990	A1 *	2/2018	Caballero	H01Q 1/243
2018/0183137	A1 *	6/2018	Tsai	H01Q 9/42

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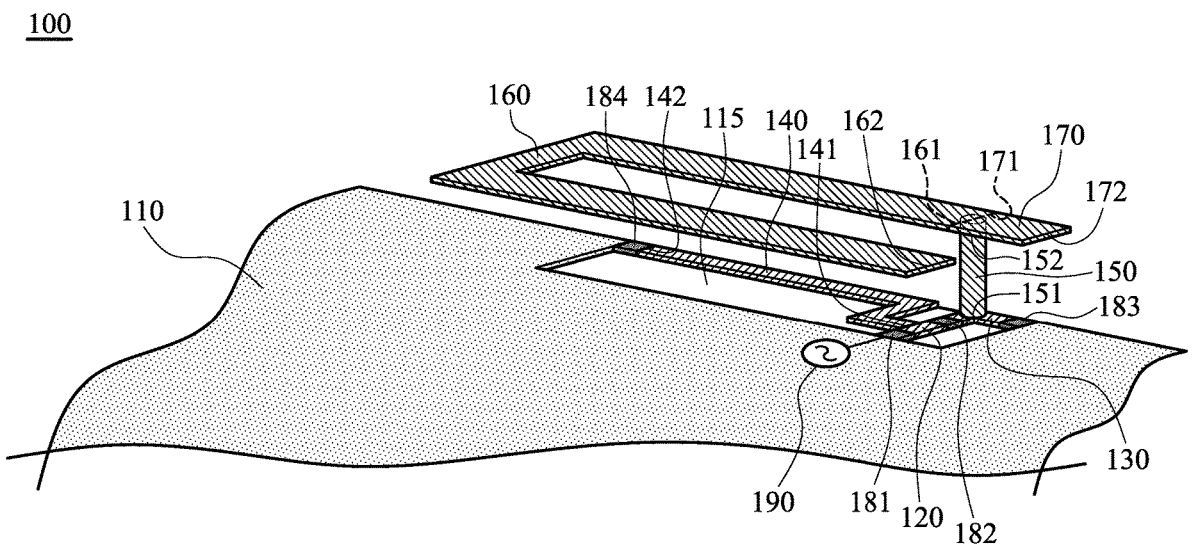
Primary Examiner — Dameon E Levi
Assistant Examiner — Hasan Z Islam
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

An antenna structure includes a ground plane, a first feeding element, a second feeding element, a connection element, a first radiation element, a second radiation element, a third radiation element, a first tuning circuit, a second tuning circuit, a third tuning circuit, and a fourth tuning circuit. The ground plane has a notch region. The first tuning circuit is coupled between a signal source and the first feeding element. The second tuning circuit is coupled between the first feeding element and the second feeding element. The third tuning circuit is coupled between the second feeding element and the ground plane. The first radiation element is coupled to the first feeding element. The fourth tuning circuit is coupled between the first radiation element and the ground plane. Both the second radiation element and the third radiation element are coupled through the connection element to the second feeding element.

10 Claims, 3 Drawing Sheets



US010522909B2

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

(10) **Patent No.: US 10,522,909 B2**
(45) **Date of Patent: Dec. 31, 2019**

(54) **MULTI-INPUT MULTI-OUTPUT ANTENNA**

(71) Applicant: **GALTRONICS USA, INC.**, Tempe, AZ (US)

(72) Inventors: **Matti Martiskainen**, Upper Tiberias (IL); **Vitali Spector**, Tiberias (IL)

(73) Assignee: **GALTRONICS USA, INC.**, Tempe, AZ (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 373 days.

(21) Appl. No.: **15/013,572**

(22) Filed: **Feb. 2, 2016**

(65) **Prior Publication Data**

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Related U.S. Application Data

(60) Provisional application No. 62/111,089, filed on Feb. 2, 2015.

(51) **Int. Cl.**
H01Q 5/392 (2015.01)

(52) **U.S. Cl.**
CPC ***H01Q 5/392*** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 5/30; H01Q 5/392; H01Q 1/243; H01Q 1/521; H01Q 9/42; H01Q 21/28
See application file for complete search history.

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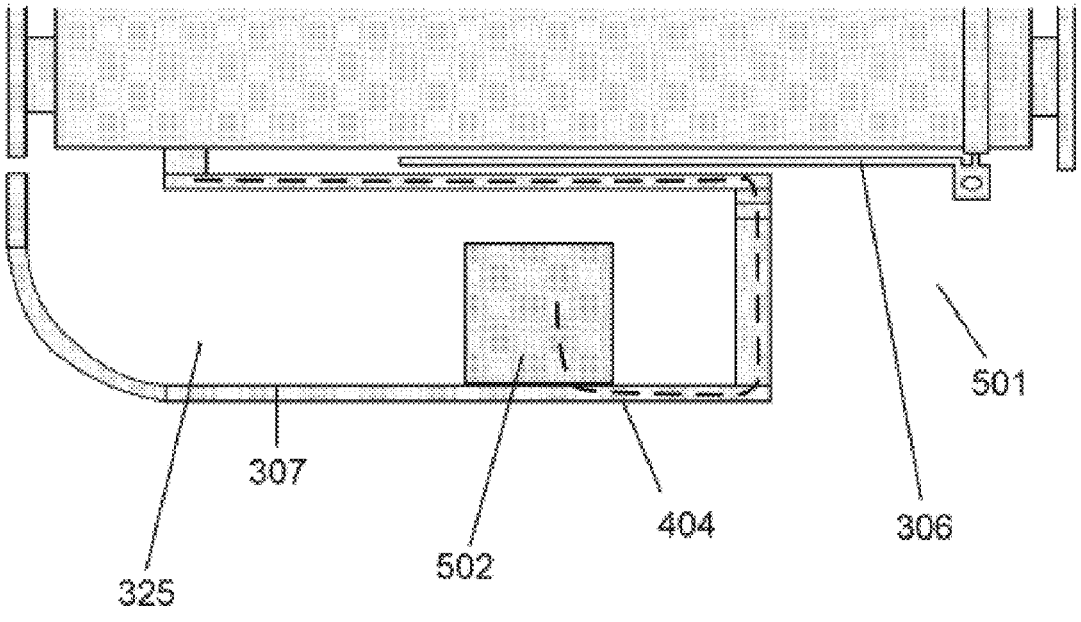
Primary Examiner — Graham P Smith
(74) *Attorney, Agent, or Firm* — Brion Raffoul

(57) **ABSTRACT**

A wireless device includes an antenna structure having at least one parallel resonance element and a plurality of serial resonance components. The at least one parallel resonance element may be configured to radiate in at least one frequency. The plurality of serial resonance components may be configured to radiate in a plurality of frequencies. The antenna structure may further include a distributed feed element configured to couple to the parallel resonance element and the serial resonance components and serve as a radiofrequency signal feed. The wireless device may include two or more similar antenna structures.

19 Claims, 17 Drawing Sheets



US010522922B2

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

(10) **Patent No.: US 10,522,922 B2**
(45) **Date of Patent: Dec. 31, 2019**

(54) **ANTENNA SYSTEM**

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

(72) Inventors: **Jianchuan Liu**, Shenzhen (CN); **Mao Liu**, Shenzhen (CN); **Yuehua Yue**, 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 86 days.

(21) Appl. No.: **15/869,187**

(22) Filed: **Jan. 12, 2018**

(65) **Prior Publication Data**

US 2018/0375222 A1 Dec. 27, 2018

(30) **Foreign Application Priority Data**

Jun. 22, 2017 (CN) 2017 1 0482127

(51) **Int. Cl.**

H01Q 21/29	(2006.01)
H01Q 21/06	(2006.01)
H01Q 21/00	(2006.01)
H01Q 1/52	(2006.01)

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

CPC ***H01Q 21/293*** (2013.01); ***H01Q 1/523*** (2013.01); ***H01Q 21/0025*** (2013.01); ***H01Q 21/0075*** (2013.01); ***H01Q 21/061*** (2013.01); *H01Q 21/065* (2013.01)

(58) **Field of Classification Search**

CPC .. H01Q 21/293; H01Q 1/523; H01Q 21/0025; H01Q 21/0075; H01Q 21/061; H01Q 21/065

See application file for complete search history.

(56) **References Cited**

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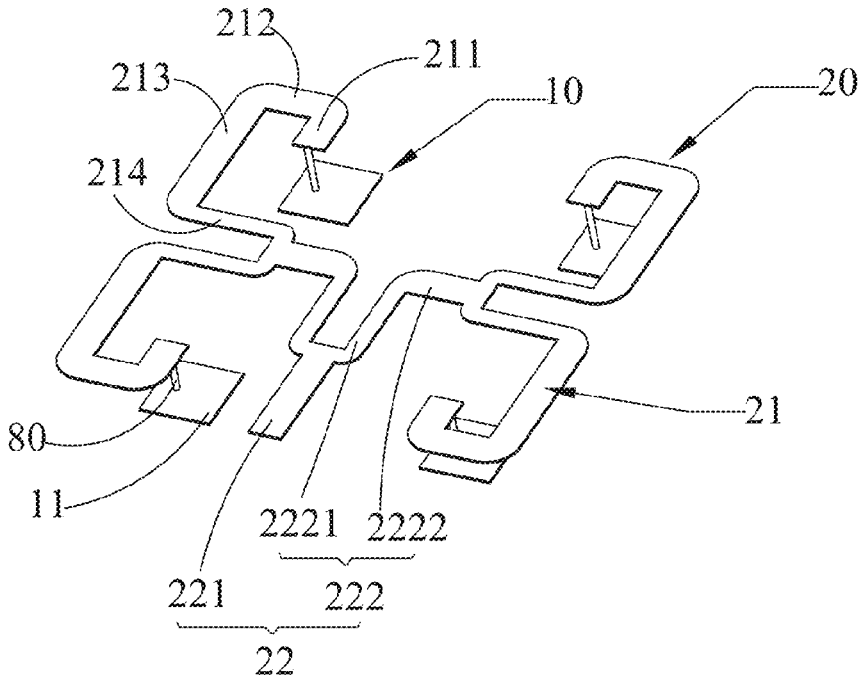
Primary Examiner — Robert J Pascal
Assistant Examiner — Kimberly E Glenn
(74) *Attorney, Agent, or Firm* — IPro, PLLC; Na Xu

(57) **ABSTRACT**

An antenna system includes a feeding point, an antenna array comprising four antenna units and a power division network comprising four power division modules, the antenna array and the power division network are respectively arranged at two opposite planes, one end of each of the four power division modules is respectively connected with one of the four antenna units, and the other ends of the four power division modules are connected with each other and are connected with the feeding point, so as to form a 5G antenna. In the antenna system, the power division network and the antenna array are structured as separate layers to reduce an area of a millimeter wave array formed by the power division network and the antenna array, so that the cellphone can have enough space for the millimeter wave array, thereby reducing difficulties of applying the millimeter wave to a mobile terminal.

10 Claims, 3 Drawing Sheets



US010530041B2

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

(10) **Patent No.: US 10,530,041 B2**
(45) **Date of Patent: Jan. 7, 2020**

(54) **ELECTRONIC DEVICE COMPRISING ANTENNA**

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

(72) Inventors: **Sang Min Jung**, Anyang-si (KR); **Min Ho Soh**, Suwon-si (KR); **Hyun Kim**, Seoul (KR); **Gwang Un Oh**, Suwon-si (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 203 days.

(21) Appl. No.: **15/374,213**

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

(65) **Prior Publication Data**

US 2017/0264003 A1 Sep. 14, 2017

(30) **Foreign Application Priority Data**

Mar. 10, 2016 (KR) 10-2016-0029145

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

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

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 5/328; H01Q 1/42
See application file for complete search history.

(56) **References Cited**

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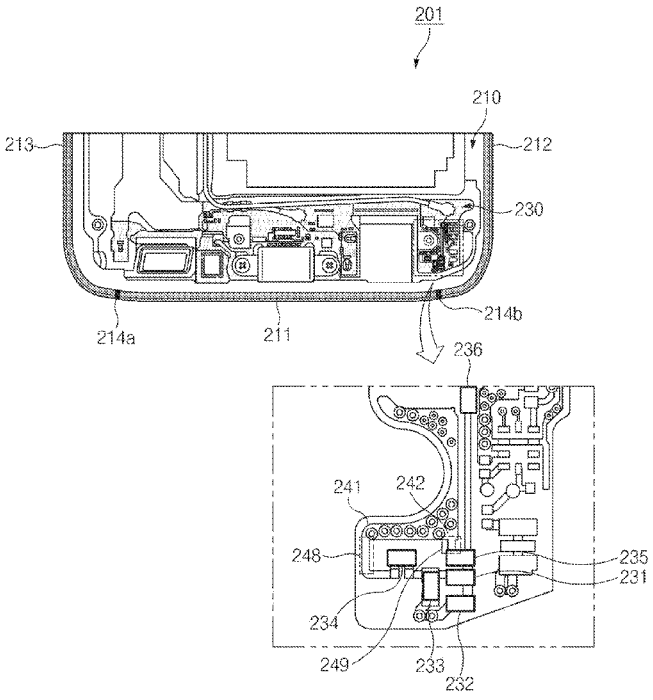
Primary Examiner — Hoang V Nguyen
Assistant Examiner — Awat M Salih
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

An electronic device is provided. The electronic device includes an antenna radiator, a first feeding terminal configured to supply a first frequency band signal to the antenna radiator, a second feeding terminal configured to supply a second frequency band signal to the antenna radiator, and a plurality of grounds electrically connected with the antenna radiator. The first feeding terminal is connected with the antenna radiator and at least one of the plurality of grounds through a passive circuit including a plurality of electrical paths.

10 Claims, 10 Drawing Sheets



US010530042B2

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

(10) **Patent No.: US 10,530,042 B2**
(45) **Date of Patent: Jan. 7, 2020**

(54) **ELECTRONIC DEVICE HAVING SHARED ANTENNA STRUCTURES**

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

(72) Inventors: **Bilgehan Avser**, Mountain View, CA (US); **Georgios Atmatzakis**, Cupertino, CA (US); **Hao Xu**, Cupertino, CA (US); **Mattia Pascolini**, San Francisco, CA (US); **Salih Yarga**, Sunnyvale, CA (US); **Xu Gao**, Santa Clara, CA (US); **Xu Han**, Santa Clara, CA (US); **Yijun Zhou**, Mountain View, CA (US)

(73) Assignee: **Apple Inc.**, Cupertino, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 224 days.

(21) Appl. No.: **15/699,879**

(22) Filed: **Sep. 8, 2017**

(65) **Prior Publication Data**

US 2019/0081385 A1 Mar. 14, 2019

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 9/04	(2006.01)
H01Q 5/50	(2015.01)
H01Q 5/328	(2015.01)
H01Q 9/42	(2006.01)
H01Q 1/38	(2006.01)

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

CPC ***H01Q 1/243*** (2013.01); ***H01Q 5/328*** (2015.01); ***H01Q 5/50*** (2015.01); ***H01Q 9/0421*** (2013.01); ***H01Q 9/42*** (2013.01); *H01Q 1/38* (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 5/328; H01Q 5/50; H01Q 9/0421; H01Q 9/42

USPC 343/702

See application file for complete search history.

(56) **References Cited**

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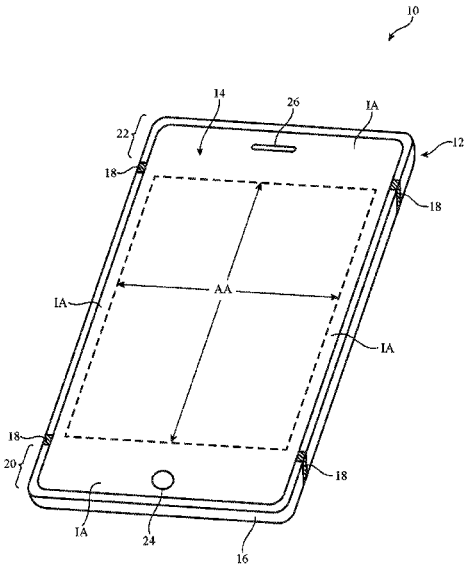
Primary Examiner — Huedung X Mancuso

(74) *Attorney, Agent, or Firm* — Treyz Law Group, P.C.; Joseph F. Guihan

(57) **ABSTRACT**

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

20 Claims, 11 Drawing Sheets



US010530043B2

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

(10) **Patent No.: US 10,530,043 B2**
(45) **Date of Patent: Jan. 7, 2020**

(54) **ANTENNA AND MOBILE TERMINAL INCLUDING THE SAME**

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

(72) Inventors: **Feng Liu**, Shenzhen (CN); **Jingqiang Luo**, Shenzhen (CN); **Yongsheng Peng**, 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 172 days.

(21) Appl. No.: **15/828,828**

(22) Filed: **Dec. 1, 2017**

(65) **Prior Publication Data**

US 2018/0375195 A1 Dec. 27, 2018

(30) **Foreign Application Priority Data**

Jun. 22, 2017 (CN) 2017 1 0482344

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 5/30	(2015.01)
H01Q 9/40	(2006.01)
H01Q 13/10	(2006.01)
H01Q 1/38	(2006.01)
H01Q 1/48	(2006.01)
H04M 1/02	(2006.01)
H04B 1/38	(2015.01)

(Continued)

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

CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 5/328*** (2015.01); ***H01Q 5/364*** (2015.01); ***H01Q 9/40*** (2013.01); ***H01Q 9/42*** (2013.01); ***H01Q 13/10*** (2013.01); ***H04B 1/38*** (2013.01); ***H04M 1/026*** (2013.01); *H01Q 21/28* (2013.01); *H04M 1/0264* (2013.01); *H04M 1/725* (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/24; H01Q 1/241; H01Q 1/242; H01Q 1/243; H01Q 5/307; H01Q 5/328; H01Q 5/364

See application file for complete search history.

(56) **References Cited**

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10,290,925	B2 *	5/2019	Huang	H01Q 5/10

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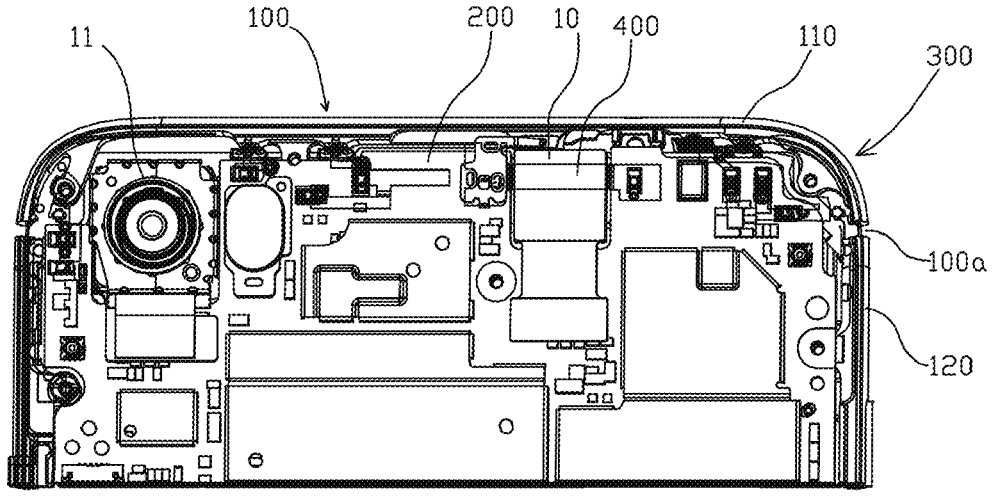
Primary Examiner — Daniel Munoz
Assistant Examiner — Patrick R Holecek
(74) *Attorney, Agent, or Firm* — IPro, PLLC; Na Xu

(57) **ABSTRACT**

An antenna includes a metal frame including a radiation frame with a first grounding point, and a grounding frame separated from the radiation frame; a mainboard including a system ground and a feeding end, the system ground including a first and second ground point; a diversity antenna unit including a feeding point and a second grounding point; and a conductive bracket; a front-facing camera is mounted on the mainboard; a gap is between the radiation frame and the grounding frame, the first ground point and the second ground point are at two opposite sides of the camera, respectively; the feeding point is connected with the feeding end, the second grounding point is connected with the system ground; one end of the conductive bracket is connected with the first ground point, and the other end is connected with the second ground point, so that the conductive bracket crosses the camera.

9 Claims, 5 Drawing Sheets



US010530044B2

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

(10) **Patent No.: US 10,530,044 B2**
(45) **Date of Patent: Jan. 7, 2020**

(54) **MOBILE DEVICE AND ANTENNA STRUCTURE THEREOF**

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

(72) Inventors: **Shih-Ting Huang**, New Taipei (TW); **Ching-Chi Lin**, New Taipei (TW); **Chuan-Chun Wang**, New Taipei (TW); **Ming-Ching Yen**, 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 25 days.

(21) Appl. No.: **16/041,845**

(22) Filed: **Jul. 23, 2018**

(65) **Prior Publication Data**

US 2019/0363425 A1 Nov. 28, 2019

(30) **Foreign Application Priority Data**

May 22, 2018 (TW) ..... 107117421 A

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 1/36	(2006.01)
H01Q 5/10	(2015.01)
H01Q 1/52	(2006.01)
G06F 1/16	(2006.01)
H01Q 5/357	(2015.01)
H01Q 5/378	(2015.01)
H01Q 9/42	(2006.01)
H01Q 5/328	(2015.01)

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

CPC ***H01Q 1/243*** (2013.01); ***G06F 1/1616*** (2013.01); ***H01Q 1/36*** (2013.01); ***H01Q 1/52*** (2013.01); ***H01Q 5/10*** (2015.01); ***H01Q 5/328*** (2015.01); ***H01Q 5/357*** (2015.01); ***H01Q 5/378*** (2015.01); ***H01Q 9/42*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 1/24; H01Q 1/52; H01Q 5/357; H01Q 5/328; H01Q 1/36; H01Q 9/42; H01Q 5/378; H01Q 5/10; G06F 1/1616

See application file for complete search history.

(56) **References Cited**

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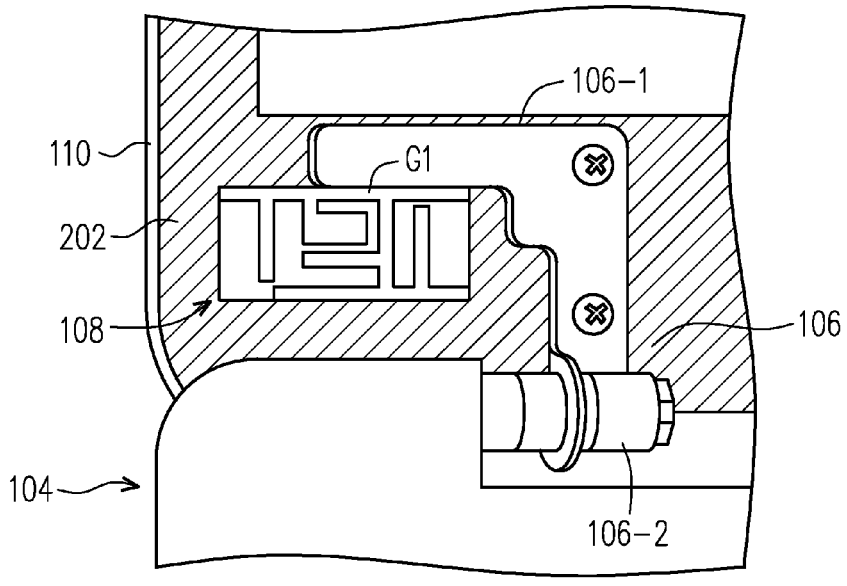
Primary Examiner — Hai V Tran

(74) *Attorney, Agent, or Firm* — JCIPRNET

(57) **ABSTRACT**

A mobile device and antenna structure thereof are provided. An antenna structure is placed next to a pivot structure of the mobile device and a parasitic element is placed next to a high-frequency radiation element extending from a feeding element, so as to resonate with the high-frequency radiation element to generate a resonant mode for compensating the lack of a high-frequency bandwidth.

12 Claims, 4 Drawing Sheets



US010530056B2

(12) **United States Patent**
Chen

(10) **Patent No.: US 10,530,056 B2**
(45) **Date of Patent: Jan. 7, 2020**

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

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

(72) Inventor: **Chang-Je Chen**, 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.: **15/974,768**

(22) Filed: **May 9, 2018**

(65) **Prior Publication Data**

US 2019/0214729 A1 Jul. 11, 2019

(30) **Foreign Application Priority Data**

Jan. 5, 2018 (CN) 2018 1 0010809

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 3/42	(2006.01)
H01Q 5/371	(2015.01)
H01Q 5/25	(2015.01)
H01Q 9/04	(2006.01)

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

CPC ***H01Q 5/371*** (2015.01); ***H01Q 1/243*** (2013.01); ***H01Q 3/42*** (2013.01); ***H01Q 5/25*** (2015.01); ***H01Q 9/0464*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 3/24; H01Q 3/42; H01Q 5/25; H01Q 5/371; H01Q 9/0464; H01Q 21/30

See application file for complete search history.

(56) **References Cited**

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2017/0365914	A1 *	12/2017	Hong	H01Q 3/24

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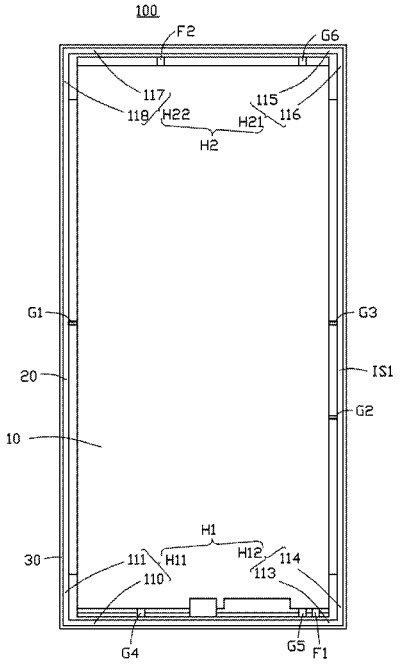
Primary Examiner — Hoang V Nguyen
(74) *Attorney, Agent, or Firm* — ScienBiziP, P.C.

(57) **ABSTRACT**

An antenna structure includes a first feeding source, a second feeding source, and a ring-shaped frame. The ring-shaped frame defines a first radiating portion and a second radiating portion. A current signal flows from the first feeding source to the first radiating portion, the first radiating portion activates a first resonance mode and a second resonance mode simultaneously to generate radiation signals in a first frequency band and a second frequency band. A current signal flows from the second feeding source to the second radiating portion, the second radiating portion activates a third resonance mode and a fourth resonance mode simultaneously to generate radiation signals in a third frequency band and a fourth frequency band. A wireless communication device is also provided.

20 Claims, 14 Drawing Sheets



US010530057B2

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

(10) **Patent No.: US 10,530,057 B2**
(45) **Date of Patent: Jan. 7, 2020**

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

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

(72) Inventors: **Masayoshi Yamamoto**, Nagaokakyo (JP); **Nobuyuki Tenno**, 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 0 days.

(21) Appl. No.: **16/057,843**

(22) Filed: **Aug. 8, 2018**

(65) **Prior Publication Data**

US 2018/0351256 A1 Dec. 6, 2018

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2017/034402, filed on Sep. 25, 2017.

(30) **Foreign Application Priority Data**

Sep. 26, 2016 (JP) 2016-186559
Oct. 21, 2016 (JP) 2016-207267
Jan. 13, 2017 (WO) PCT/JP2017/000961

(51) **Int. Cl.**
H01Q 7/00 (2006.01)
H01Q 1/38 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 7/00*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 1/42*** (2013.01); ***H01Q 1/44*** (2013.01); ***H01Q 1/48*** (2013.01)

(58) **Field of Classification Search**
CPC .. H01Q 7/00; H01Q 1/38; H01Q 1/42; H01Q 1/44; H01Q 1/48
(Continued)

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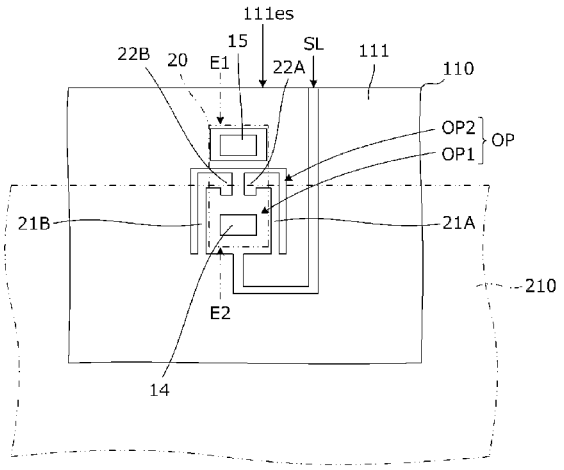
Primary Examiner — Huedung X Mancuso
(74) *Attorney, Agent, or Firm* — Keating & Bennett, LLP

(57) **ABSTRACT**

An antenna device includes a first planar conductor, a second planar conductor that opposes the first planar conductor in a parallel or substantially parallel arrangement, and a coil element with a winding axis that extends in a direction parallel or substantially parallel to the first planar conductor and the second planar conductor, and includes a first coil opening end and a second coil opening end that opposes the first coil opening end. The first planar conductor includes a conductor outer edge, and a conductor opening including a portion that is continuous with the conductor outer edge. At least a portion of the conductor opening is positioned inside a conductor overlapping region. The first coil opening end of the coil element does not overlap the second planar conductor, and the second coil opening end of the coil element
(Continued)



US010530066B2

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

(10) **Patent No.: US 10,530,066 B2**
(45) **Date of Patent: Jan. 7, 2020**

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

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

(72) Inventors: **Young-Ju Lee**, Seoul (KR); **Hyun-Jin Kim**, Seoul (KR); **Jung-Min Park**, Seoul (KR)

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

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(58) **Field of Classification Search**

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See application file for complete search history.

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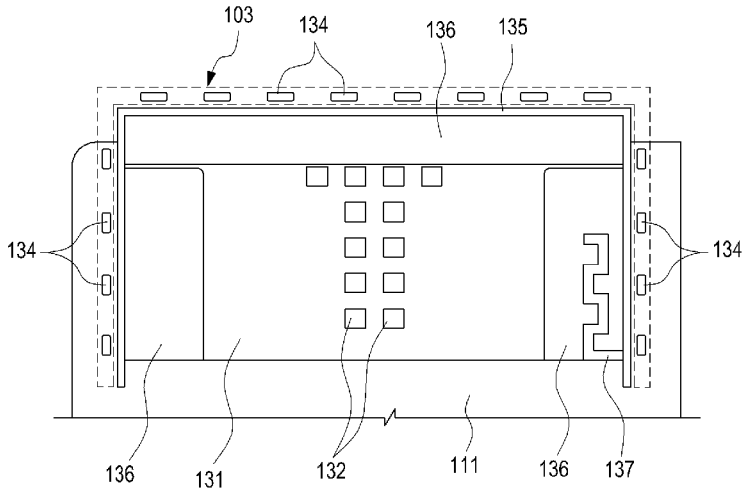
(57) **ABSTRACT**

An electronic device may include a circuit board, radiators disposed on the circuit board, and provided with a first feeding signal to transmit or receive a wireless signal in a first frequency band; and a ground disposed on the circuit board to provide a reference potential for the radiators. The radiators and a whole or a portion of the ground may be provided with an additional feeding signal to transmit or receive a wireless signal in various frequency bands that are lower than the first frequency band.

17 Claims, 9 Drawing Sheets



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Hu

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(54) **RECONFIGURABLE MULTI-BAND ANTENNA WITH FOUR TO TEN PORTS**

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(57) **ABSTRACT**

There is disclosed a reconfigurable antenna device having a substrate incorporating a first groundplane, a two-arm antenna having first and second arms each having a proximal portion and a distal portion, a first unbalanced antenna located generally between the distal portions and adjacent to the proximal portions of the first and second arms, a second unbalanced antenna located generally adjacent to the first arm and a third unbalanced antenna located generally adjacent to the second arm. The antenna device may be configured with four or five feed points, and may drive from four up to ten signal ports.

36 Claims, 26 Drawing Sheets