US010424844B2

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

(10) **Patent No.: US 10,424,844 B2**
(45) **Date of Patent: Sep. 24, 2019**

(54) **ELECTRONIC DEVICE**

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

(72) Inventors: **Kwang-Pi Lee**, New Taipei (TW); **Wei-Ting Cheng**, New Taipei (TW); **Yen-Hui Lin**, New Taipei (TW); **Szu-Tso Lin**, 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 14 days.

(21) Appl. No.: **15/838,369**

(22) Filed: **Dec. 12, 2017**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Jan. 5, 2017 (CN) 2017 1 0007308

(51) **Int. Cl.**

H01Q 13/10	(2006.01)
H01Q 1/52	(2006.01)
H01Q 1/24	(2006.01)
H01Q 1/48	(2006.01)

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

CPC ***H01Q 13/10*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/521*** (2013.01); *H01Q 1/48* (2013.01)

(58) **Field of Classification Search**

CPC H01Q 13/10; H01Q 1/243; H01Q 1/521; H01Q 1/48

USPC 343/721

See application file for complete search history.

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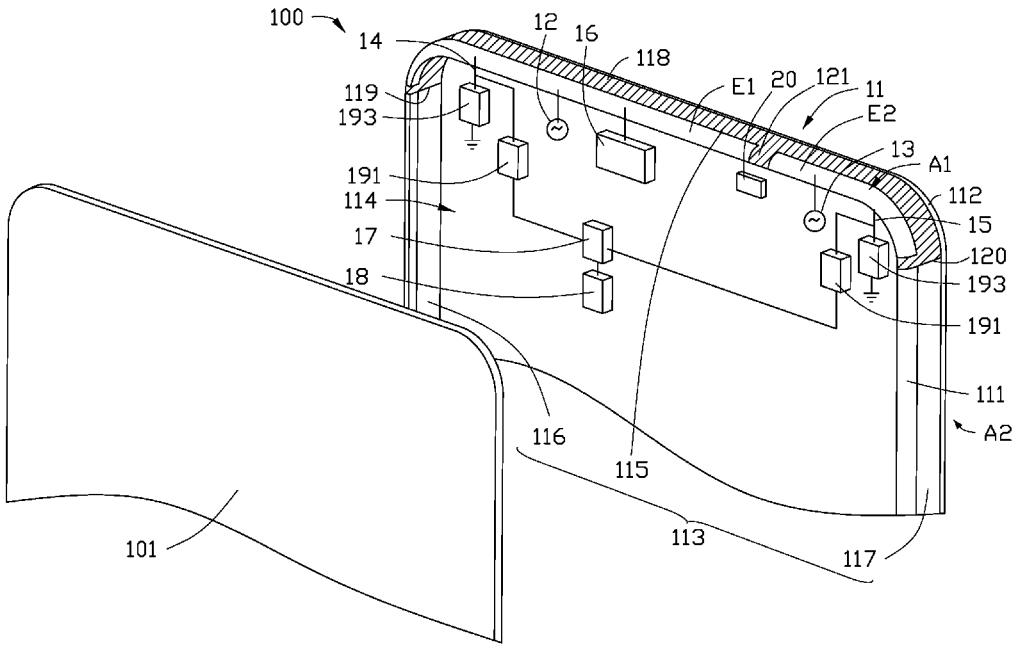
Primary Examiner — Brian K Young

(74) *Attorney, Agent, or Firm* — ScienBiziP, P.C.

(57) **ABSTRACT**

An electronic device includes a housing. The housing defines a slot and a groove communicating with the slot. The housing is divided into at least a first radiating portion and a second radiating portion by the slot and the groove. The first radiating portion is spaced apart from the second radiating portion. The first radiating portion and the second radiating portion cooperatively serve as an antenna structure of the electronic device to receive and/or transmit wireless signals. The electronic device further performs a predetermined function through the groove.

20 Claims, 5 Drawing Sheets



US010425137B2

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

(10) **Patent No.: US 10,425,137 B2**
(45) **Date of Patent: *Sep. 24, 2019**

(54) **FACILITATING SWITCHING BETWEEN TRANSMITTING ANTENNAS IN PORTABLE ELECTRONIC DEVICES**

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

(72) Inventors: **Ming Hu**, Cupertino, CA (US); **Haining Zhang**, Cupertino, CA (US); **Xueting Liu**, Cupertino, 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 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **15/482,236**

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

(65) **Prior Publication Data**

US 2017/0279510 A1 Sep. 28, 2017

Related U.S. Application Data

(63) Continuation of application No. 14/577,834, filed on Dec. 19, 2014, now Pat. No. 9,621,245, which is a continuation of application No. 13/597,771, filed on Aug. 29, 2012, now Pat. No. 8,918,066.

(60) Provisional application No. 61/657,528, filed on Jun. 8, 2012.

(51) **Int. Cl.**

H04B 7/06	(2006.01)
H04B 1/3827	(2015.01)
H01Q 1/24	(2006.01)
H01Q 21/28	(2006.01)
H04B 17/11	(2015.01)
H01Q 3/24	(2006.01)
H03C 7/02	(2006.01)

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

CPC ***H04B 7/0602*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 3/24*** (2013.01); ***H01Q 21/28*** (2013.01); ***H04B 1/3838*** (2013.01); ***H04B 7/0608*** (2013.01); ***H04B 17/11*** (2015.01)

(58) **Field of Classification Search**

CPC H04W 52/42; H04B 7/0608
USPC 455/101; 375/299
See application file for complete search history.

(56) **References Cited**

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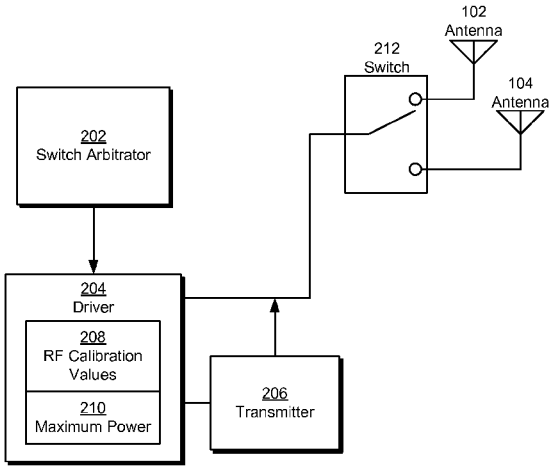
Primary Examiner — Lee Nguyen
(74) *Attorney, Agent, or Firm* — Sterne, Kessler, Goldstein & Fox P.L.L.C.

(57) **ABSTRACT**

The disclosed embodiments provide a system that uses a first antenna and a second antenna in a portable electronic device. During operation, the system receives a request to switch from the first antenna to the second antenna to transmit a signal to a cellular receiver. Next, the system loads a set of radio-frequency (RF) calibration values for the second antenna. Finally, the system performs the switch from the first antenna to the second antenna to transmit the signal, wherein the second antenna is operated using the RF calibration values after the switch.

21 Claims, 4 Drawing Sheets



US010431872B1

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

(10) **Patent No.: US 10,431,872 B1**
(45) **Date of Patent: Oct. 1, 2019**

(54) **MOBILE TERMINAL**

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

(72) Inventors: **Dongjin Kim**, Seoul (KR); **Yunmo Kang**, Seoul (KR); **Youngbae Kwon**, Seoul (KR); **Yeomin Youn**, Seoul (KR); **Jihun Ha**, 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 0 days.

(21) Appl. No.: **16/020,925**

(22) Filed: **Jun. 27, 2018**

Related U.S. Application Data

(60) Provisional application No. 62/653,548, filed on Apr. 5, 2018.

(30) **Foreign Application Priority Data**

May 3, 2018 (KR) 10-2018-0051313

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 21/30 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 1/242*** (2013.01); ***H01Q 13/10*** (2013.01); ***H01Q 21/30*** (2013.01); ***H04B 1/401*** (2013.01); ***H04M 1/0266*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/242; H01Q 21/30; H01Q 13/10; H04B 1/40
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(56) **References Cited**

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KR 10-2018-0024674 3/2018

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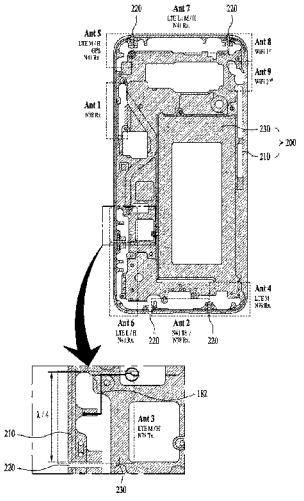
Primary Examiner — Ayodeji O Ayotunde
(74) *Attorney, Agent, or Firm* — Lee, Hong, Degerman, Kang & Waimey

(57) **ABSTRACT**

A mobile terminal is provided including a display unit; a middle frame including a supporting unit that supports a rear surface of the display unit with a side portion around the supporting portion; a main board at a rear surface of the middle frame including a ground; a first wireless communication unit in the main board to transceive a first signal; a second wireless communication unit in the main board to transceive a second signal; and a rear case covering a rear surface of the main board, where the side portion includes a plurality of conductive members with ends divided into slits and the plurality of the conductive members includes a common antenna electrically connectable with the first and second wireless communication units to receive the first and second signals such that the mobile terminal receives different signals with antennas for LTE and 5G communication arranged in a limited space.

18 Claims, 12 Drawing Sheets



US010431874B2

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

(10) **Patent No.: US 10,431,874 B2**
(45) **Date of Patent: Oct. 1, 2019**

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

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

(72) Inventors: **Kuo-Cheng Chen**, Taoyuan (TW); **You-Chieh Chen**, Taipei (TW); **Ahmed Hussain**, Suwon-si (KR); **Hosaeng Kim**, Anyang-si (KR); **Yoon Jae Lee**, Seoul (KR); **Hyung Joo Lee**, Seongnam-si (KR); **Jinwoo 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 237 days.

(21) Appl. No.: **15/366,441**

(22) Filed: **Dec. 1, 2016**

(65) **Prior Publication Data**

US 2017/0244153 A1 Aug. 24, 2017

Related U.S. Application Data

(60) Provisional application No. 62/297,517, filed on Feb. 19, 2016.

(30) **Foreign Application Priority Data**

Jul. 18, 2016 (KR) 10-2016-0090734

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 1/38	(2006.01)
H01Q 1/48	(2006.01)
H01Q 9/42	(2006.01)
H01Q 13/10	(2006.01)
H01Q 21/28	(2006.01)

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

CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 9/42*** (2013.01); ***H01Q 13/10*** (2013.01); ***H01Q 21/28*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 1/48; H01Q 9/42; H01Q 13/10; H01Q 13/28

USPC 174/50.51

See application file for complete search history.

(56) **References Cited**

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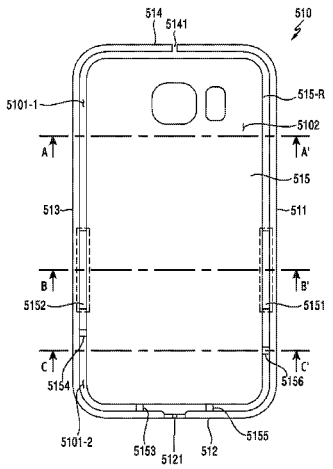
Primary Examiner — Dhiru R Patel
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

An electronic device is provided. The electronic device includes a housing including a front face having a substantially rectangular shape and facing in a first direction, a rear face having a substantially rectangular shape and facing in a second direction that is opposite to the first direction, and first to fourth side face members that enclose a space between the front face and the rear face, wherein at least a portion of the first to fourth side face members is formed of a conductive material, a touch screen display exposed through the front face, and at least one wireless communication circuit arranged within the housing. The rear face includes a substantially flat conductive plate that constitutes a substantial portion of the rear face, and an elongated non-conductive strip that encloses the conductive plate when viewed from above the rear face, and extends along the first to fourth side face members.

20 Claims, 55 Drawing Sheets



US010431876B2

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

(10) **Patent No.: US 10,431,876 B2**
(45) **Date of Patent: Oct. 1, 2019**

(54) **BROADBAND ANTENNA MODULE FOR LTE**

(71) Applicant: **AMOTECH CO., LTD.**, Incheon (KR)

(72) Inventors: **Chul Hwang**, Incheon (KR); **In-Jo Jeong**, Incheon (KR); **Sang-O Kim**, Incheon (KR); **Dong-Hwan Koh**, Seoul (KR)

(73) Assignee: **Amotech Co., Ltd.**, Incheon (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.: **15/746,195**

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

(86) PCT No.: **PCT/KR2016/008045**
§ 371 (c)(1),
(2) Date: **Jan. 19, 2018**

(87) PCT Pub. No.: **WO2017/014598**
PCT Pub. Date: **Jan. 26, 2017**

(65) **Prior Publication Data**

US 2018/0212311 A1 Jul. 26, 2018

(30) **Foreign Application Priority Data**

Jul. 22, 2015 (KR) 10-2015-0103917

(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 5/335*** (2015.01); ***H01Q 9/045*** (2013.01); ***H01Q 9/0421*** (2013.01); ***H01Q 9/42*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/378; H01Q 9/0421
See application file for complete search history.

(56) **References Cited**

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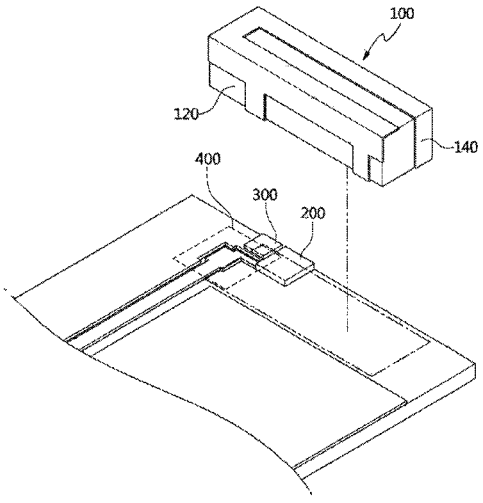
Primary Examiner — Daniel Munoz
(74) *Attorney, Agent, or Firm* — Baker & Hostetler LLP

(57) **ABSTRACT**

The disclosed broadband antenna module for LTE includes: a feeding pin and a direct short pin that are spaced apart from each other on one surface of a printed circuit board; a coupling short pin formed of a conductive material on the other surface of the printed circuit board and connected to a ground plane; and a radiation patch antenna including a dielectric and a radiation pattern formed on an outer circumference of the dielectric and mounted on one surface of the printed circuit board, in which the radiation pattern of the radiation patch antenna is directly connected to the feeding pin and direct short pin and coupled to the coupling short pin in an overlapping manner.

5 Claims, 8 Drawing Sheets



US010431881B2

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

(10) **Patent No.: US 10,431,881 B2**
(45) **Date of Patent: Oct. 1, 2019**

(54) **ELECTRONIC APPARATUS AND DUAL BAND PRINTED ANTENNA OF THE SAME**

(71) Applicant: **PEGATRON CORPORATION**, Taipei (TW)

(72) Inventors: **Chien-Yi Wu**, Taipei (TW); **Shih-Keng Huang**, Taipei (TW); **Chao-Hsu Wu**, Taipei (TW); **Ya-Jyun Li**, Taipei (TW); **Chia-Chi Chang**, Taipei (TW)

(73) Assignee: **PEGATRON CORPORATION**, Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 497 days.

(21) Appl. No.: **15/410,790**

(22) Filed: **Jan. 20, 2017**

(65) **Prior Publication Data**

US 2017/0317412 A1 Nov. 2, 2017

(30) **Foreign Application Priority Data**

Apr. 29, 2016 (TW) ..... 105113498 A

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 9/06 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 1/38*** (2013.01); ***H01Q 1/2291*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 5/30*** (2015.01);
(Continued)

(58) **Field of Classification Search**
CPC .. H01Q 5/48; H01Q 5/30; H01Q 1/38; H01Q 21/30; H01Q 9/285; H01Q 1/243; H01Q 9/065
See application file for complete search history.

(56) **References Cited**

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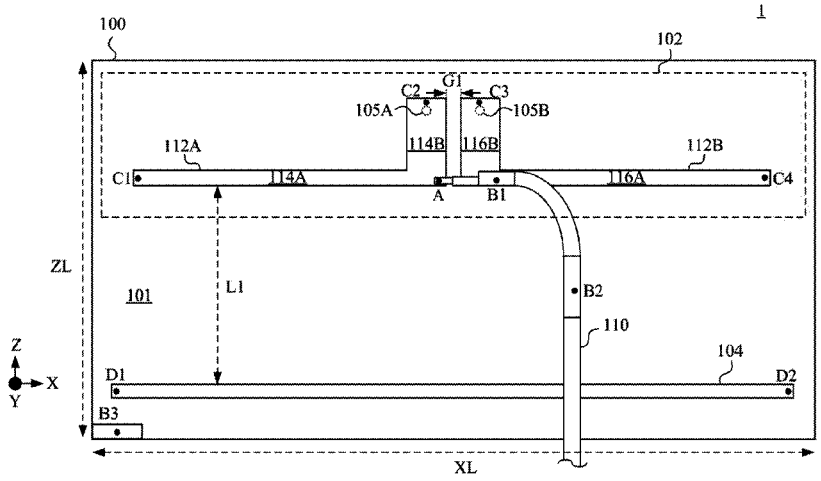
Primary Examiner — Dameon E Levi
Assistant Examiner — Ab Salam Alkassim, Jr.
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

A dual band printed antenna that includes a substrate including a first and a second surfaces opposite to each other and conductive holes, a first and a second drivers, a first and a second reflectors and a transmission line is provided. The first driver is disposed on the first surface to generate a radiation pattern of a first frequency band. The first reflector is disposed on the first surface and apart from the first driver. The second driver is disposed on the second surface to generate a radiation pattern of a second frequency band and electrically coupled to the first driver through the conductive holes. The reflector is disposed on the second surface, corresponding to a position of the first driver and apart from the second driver. The transmission line is disposed on the first surface and coupled to a feeding point and a ground point of the first driver.

18 Claims, 6 Drawing Sheets



US010439268B2

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

(10) **Patent No.: US 10,439,268 B2**
(45) **Date of Patent: Oct. 8, 2019**

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

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

(72) Inventors: **Gunhee Son**, Gyeongsangbuk-do (KR); **Minsuk Kim**, Gyeongsangbuk-do (KR); **Soon-Sang Park**, Daegu (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 352 days.

(21) Appl. No.: **15/185,171**

(22) Filed: **Jun. 17, 2016**

(65) **Prior Publication Data**

US 2017/0033441 A1 Feb. 2, 2017

(30) **Foreign Application Priority Data**

Jul. 28, 2015 (KR) 10-2015-0106677

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 1/48	(2006.01)
H04B 1/3827	(2015.01)
H01Q 7/00	(2006.01)
H01Q 21/28	(2006.01)
H01Q 5/328	(2015.01)
H01Q 5/335	(2015.01)
H01Q 5/364	(2015.01)

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

CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 5/328*** (2015.01); ***H01Q 5/335*** (2015.01); ***H01Q 5/364*** (2015.01); ***H01Q 7/00*** (2013.01); ***H01Q 21/28*** (2013.01); ***H04B 1/385*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 5/328; H01Q 5/335; H01Q 7/00; H01Q 21/28; H01Q 5/364; H01Q 1/48; H04B 1/385

See application file for complete search history.

(56) **References Cited**

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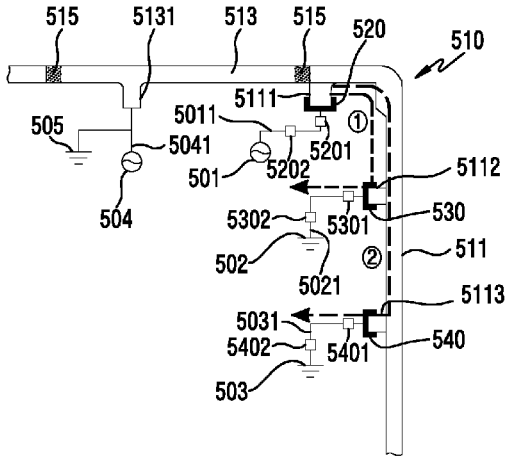
Primary Examiner — Hai V Tran
Assistant Examiner — Michael M Bouizza
(74) *Attorney, Agent, or Firm* — Cha & Reiter, LLC.

(57) **ABSTRACT**

One embodiment disclosed in the present disclosure may provide an antenna device that includes: a metal member that forms at least a part of an external housing for the electronic device; a printed circuit board (PCB) coupled to a feed connector of the metal member, such that the metal member is configured to operate as an antenna radiator for the PCB; and the metal member further including at least two grounding connectors that are coupled to ground through the PCB, wherein the feed connector and the two grounding connectors are located at different positions on the metal member, and may provide an electronic device that includes the same. Accordingly, it is possible to easily design an antenna that operates in a desired frequency band, to reduce the cost, to make the exterior of the device appealing due to the advantage of design, and to maximize the efficient use of space for the design of a multiband antenna.

19 Claims, 21 Drawing Sheets



US010439269B2

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

(10) **Patent No.: US 10,439,269 B2**
(45) **Date of Patent: Oct. 8, 2019**

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

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

(72) Inventors: **Shih-Chiang Wei**, Hsinchu (TW); **Yu-Yu Chiang**, 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 111 days.

(21) Appl. No.: **15/712,064**

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

(65) **Prior Publication Data**

US 2018/0323495 A1 Nov. 8, 2018

(30) **Foreign Application Priority Data**

May 4, 2017 (TW) ..... 106114777 A

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 5/328	(2015.01)
H01Q 5/321	(2015.01)
H01Q 5/392	(2015.01)
H01Q 1/22	(2006.01)
H01Q 21/28	(2006.01)
H01Q 5/385	(2015.01)

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

CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/2266*** (2013.01); ***H01Q 1/2291*** (2013.01); ***H01Q 5/321*** (2015.01); ***H01Q 5/328*** (2015.01); ***H01Q 5/385*** (2015.01); ***H01Q 5/392*** (2015.01); ***H01Q 21/28*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 5/328; H01Q 5/321; H01Q 5/392

See application file for complete search history.

(56) **References Cited**

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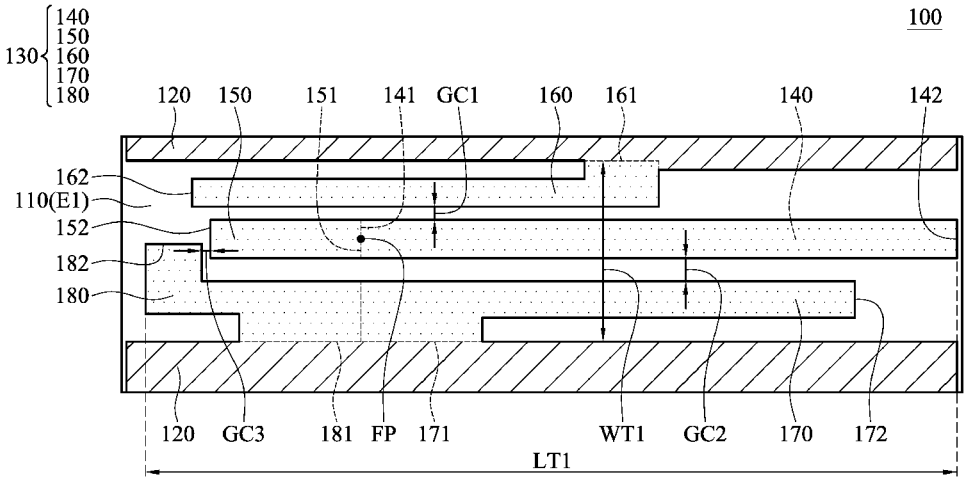
Primary Examiner — Dameon E Levi
Assistant Examiner — Jennifer F Hu

(57) **ABSTRACT**

A mobile device includes a supporting element, a ground element, and an antenna structure. The antenna structure includes a first feeding radiation element, a second feeding radiation element, a first parasitic radiation element, a second parasitic radiation element, and a third parasitic radiation element. The first feeding radiation element and the second feeding radiation element are both coupled to a signal feeding point. Each of the first parasitic radiation element, the second parasitic radiation element, and the third parasitic radiation element is coupled to the ground element. A first coupling gap is formed between the first parasitic radiation element and the first feeding radiation element. A second coupling gap is formed between the second parasitic radiation element and the first feeding radiation element. A third coupling gap is formed between the third parasitic radiation element and the second feeding radiation element.

19 Claims, 8 Drawing Sheets



US010439270B2

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

(10) **Patent No.: US 10,439,270 B2**
(45) **Date of Patent: Oct. 8, 2019**

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

(71) Applicant: **PEGATRON CORPORATION**, Taipei (TW)

(72) Inventors: **Chien-Yi Wu**, Taipei (TW); **Chao-Hsu Wu**, Taipei (TW); **Shih-Keng Huang**, Taipei (TW); **Ya-Jyun Li**, Taipei (TW); **Ching-Hsiang Ko**, Taipei (TW); **Cheng-Hsiung Wu**, Taipei (TW)

(73) Assignee: **PEGATRON CORPORATION**, 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.: **15/972,039**

(22) Filed: **May 4, 2018**

(65) **Prior Publication Data**

US 2018/0342791 A1 Nov. 29, 2018

(30) **Foreign Application Priority Data**

May 25, 2017 (TW) ..... 106117461 A

(51) **Int. Cl.**
H01Q 1/36 (2006.01)
H01Q 1/24 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***G06F 1/1698*** (2013.01); ***H01Q 1/2266*** (2013.01); ***H01Q 1/36*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 5/314; H01Q 1/2266; H01Q 1/36; H01Q 7/00; H01Q 9/0421;
(Continued)

(56) **References Cited**

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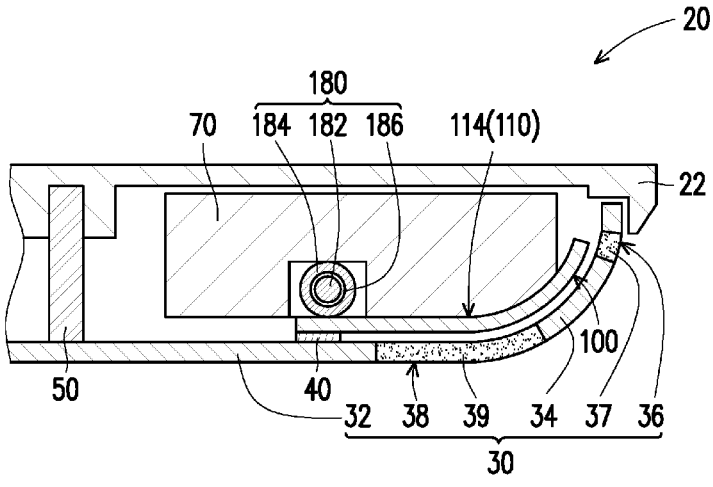
Primary Examiner — Graham P Smith
(74) *Attorney, Agent, or Firm* — J.C. Patents

(57) **ABSTRACT**

An antenna structure including a metal casing and an antenna assembly is provided. The metal casing has a slit and a slot adjacent to each other. A length of the slit is greater than a length of the slot, and a width of the slit is less than a width of the slot. The antenna assembly is located in the metal casing and near the slit and the slot. An antenna assembly includes a substrate and an antenna pattern. The antenna pattern is disposed on the substrate and encloses a closed zone. The antenna pattern includes a feed end and a ground end to form a first loop and a second loop. Orthographic projections of the antenna pattern and the enclosed closed zone on the metal casing overlap with the slot. The antenna pattern resonates with the slit and the slot to generate a first frequency band and a second frequency band. An electronic device having the antenna structure is further provided.

11 Claims, 5 Drawing Sheets



US010444426B2

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

(10) **Patent No.: US 10,444,426 B2**
(45) **Date of Patent: Oct. 15, 2019**

(54) **INFORMATION PROCESSING APPARATUS**

(71) Applicant: **Fujitsu Client Computing Limited**, Kanagawa (JP)

(72) Inventors: **Goki Yamaguchi**, Kawasaki (JP); **Yoshiyuki Sando**, Kawasaki (JP); **Yasufumi Yamamoto**, Kawasaki (JP)

(73) Assignee: **Fujitsu Client Computing Limited**, Kanagawa (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 132 days.

(21) Appl. No.: **15/238,800**

(22) Filed: **Aug. 17, 2016**

(65) **Prior Publication Data**

US 2017/0068035 A1 Mar. 9, 2017

(30) **Foreign Application Priority Data**

Sep. 9, 2015 (JP) 2015-177277

(51) **Int. Cl.**

F21V 8/00	(2006.01)
G06F 1/16	(2006.01)
H04W 88/02	(2009.01)
H01Q 1/22	(2006.01)

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

CPC ***G02B 6/009*** (2013.01); ***G02B 6/0023*** (2013.01); ***G02B 6/0083*** (2013.01); ***G02B 6/0088*** (2013.01); ***G02B 6/0091*** (2013.01); ***G02B 6/0093*** (2013.01); ***G06F 1/1656*** (2013.01); ***G06F 1/1698*** (2013.01); *H01Q 1/2266* (2013.01); *H01Q 1/2291* (2013.01); *H04W 88/02* (2013.01)

(58) **Field of Classification Search**

CPC G02B 6/009; G02B 6/0023; G02B 6/0088; H04W 88/02; G06F 1/1656

See application file for complete search history.

(56) **References Cited**

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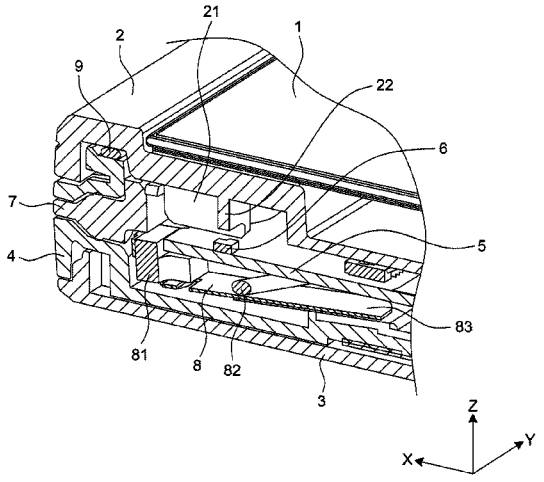
Primary Examiner — Anabel Ton

(74) *Attorney, Agent, or Firm* — Osha Liang LLP

(57) **ABSTRACT**

A front cover and a rear cover are engaged to form an internal space. An LED is mounted on a main board, and it is laid over an antenna within the space in a thickness direction of the front cover and the rear cover that are engaged. A light guiding member is provided on the side surface of the front cover and the rear cover that are engaged, and it receives the light, generated by the LED, and emits light to outside. A side shielding member and a back shielding member protrude from the front cover toward the optical path between the LED and the light guiding member so as to shield the optical path from the LED toward the light guiding member.

4 Claims, 19 Drawing Sheets



US010446318B2

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

(10) **Patent No.: US 10,446,318 B2**
(45) **Date of Patent: Oct. 15, 2019**

(54) **ELECTRONIC DEVICE FOR REDUCING INTERFERENCE BETWEEN A CHARGING COIL AND AN ANTENNA**

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

(72) Inventors: **Woo-Ram Lee**, Gyeonggi-do (KR); **Ki-Hyun Kim**, Gyeonggi-do (KR); **Jin-Hyoung Park**, Gangwon-do (KR); **Kil-Soo Ko**, Gyeonggi-do (KR); **Joon-Il Kim**, Seoul (KR); **Sung-Kweon Park**, Gyeonggi-do (KR); **Se-Ho Park**, 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.

(21) Appl. No.: **15/837,429**

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

(65) **Prior Publication Data**

US 2018/0102212 A1 Apr. 12, 2018

Related U.S. Application Data

(63) Continuation of application No. 14/920,299, filed on Oct. 22, 2015, now Pat. No. 9,859,053, which is a (Continued)

(30) **Foreign Application Priority Data**

Jan. 4, 2012 (KR) 10-2012-0000879

(51) **Int. Cl.**
H02J 50/10 (2016.01)
H01F 38/14 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01F 38/14*** (2013.01); ***H01M 2/1066*** (2013.01); ***H01M 10/4257*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC .. H01F 38/14; H01Q 7/00; H02J 7/025; H02J 50/80; H02J 50/40; H01M 10/4257
(Continued)

(56) **References Cited**

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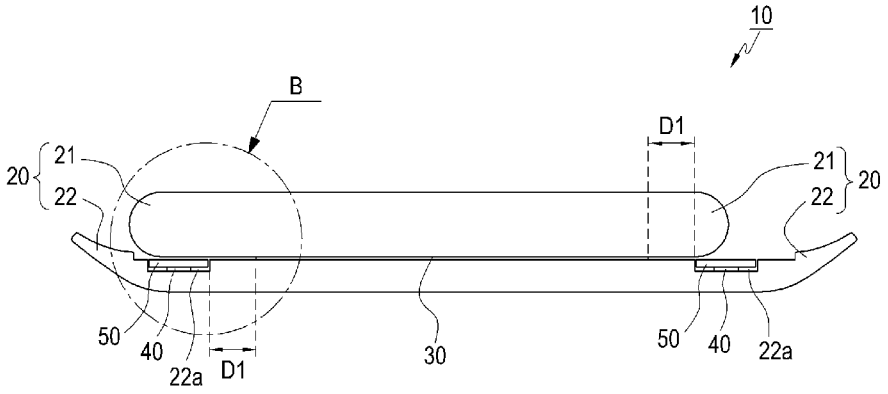
Primary Examiner — Dameon E Levi
Assistant Examiner — Hasan Z Islam
(74) *Attorney, Agent, or Firm* — The Farrell Law Firm, P.C.

(57) **ABSTRACT**

Disclosed is an electronic device including a battery, a case covering the battery, a wireless charging coil positioned between the battery and the case; and a communication antenna positioned between the battery and the wireless charging coil, wherein one of the communication antenna and the wireless charging coil is positioned to surround the other one of the communication antenna and the wireless charging coil, and wherein the communication antenna is spaced from the wireless charging coil by a predetermined distance and prevents interference between the communication antenna and the wireless charging coil.

8 Claims, 7 Drawing Sheets



US010446908B2

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

(10) **Patent No.: US 10,446,908 B2**
(45) **Date of Patent: Oct. 15, 2019**

(54) **ANTENNA INTEGRATION IN HINGE SHROUD**

(71) Applicant: **DEll Products L.P.**, Round Rock, TX (US)

(72) Inventors: **Benny J. Bologna**, Austin, TX (US); **Patrick A. Hampton**, Round Rock, TX (US)

(73) Assignee: **Dell Products L.P.**, Round Rock, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 147 days.

(21) Appl. No.: **15/192,785**

(22) Filed: **Jun. 24, 2016**

(65) **Prior Publication Data**

US 2017/0373375 A1 Dec. 28, 2017

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 1/22	(2006.01)
H01Q 1/50	(2006.01)
H01Q 3/04	(2006.01)

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

CPC ***H01Q 1/2266*** (2013.01); ***H01Q 1/50*** (2013.01); ***H01Q 3/04*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 1/50; H01Q 3/04; H01Q 1/2266

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

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U.S. Appl. No. 15/132,362, filed Apr. 19, 2016, entitled Information Handling System Low Profile Housing and Hinge Assembly, by Patrick A. Hampton et al., 27 pages.

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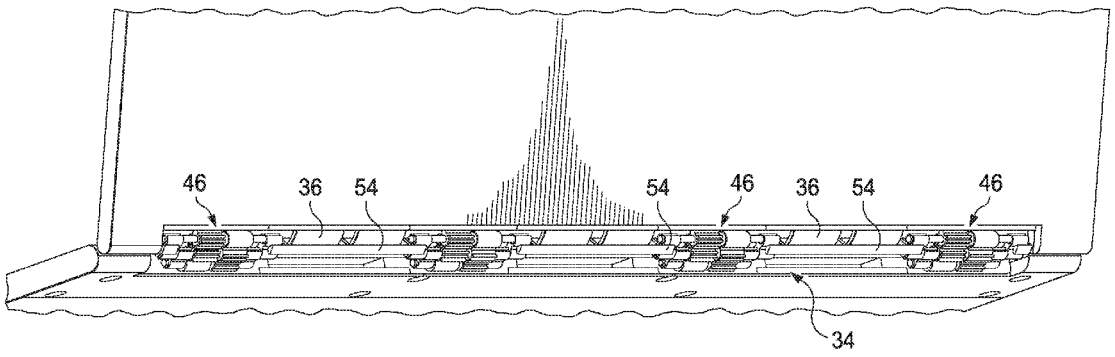
Primary Examiner — Dieu Hien T Duong

(74) *Attorney, Agent, or Firm* — Baker Botts L.L.P.

(57) **ABSTRACT**

Systems and methods are disclosed for positioning an antenna in a portable information handling system. A portable information handling system includes a housing having a first housing portion and a second housing portion. The portable information handling system also includes a hinge assembly coupling the first and second housing portions, the hinge assembly comprising at least one gear to rotate the first and second housing portions relative to each other. In addition, the system includes an antenna frame coupled to the gear. The portable information handling system also includes an antenna coupled to the antenna frame, the antenna operable to communicate wirelessly with a wireless-enabled device.

9 Claims, 11 Drawing Sheets



US010446910B2

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

(10) **Patent No.: US 10,446,910 B2**
(45) **Date of Patent: Oct. 15, 2019**

(54) **ELECTRONIC DEVICE WITH ANTENNA**

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

(72) Inventors: **Sang Min Han**, Seongnam-si (KR); **Young Jung Kim**, 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 166 days.

(21) Appl. No.: **15/437,396**

(22) Filed: **Feb. 20, 2017**

(65) **Prior Publication Data**

US 2017/0244151 A1 Aug. 24, 2017

(30) **Foreign Application Priority Data**

Feb. 20, 2016 (KR) 10-2016-0020121

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 5/30	(2015.01)
H01Q 1/48	(2006.01)
H01Q 21/00	(2006.01)
H01Q 9/42	(2006.01)
H01Q 21/30	(2006.01)
H01Q 5/328	(2015.01)
H01Q 5/335	(2015.01)

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

CPC ***H01Q 1/241*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 5/30*** (2015.01); ***H01Q 5/328*** (2015.01); ***H01Q 5/335*** (2015.01); ***H01Q 9/42*** (2013.01); ***H01Q 21/00*** (2013.01); ***H01Q 21/30*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 21/30; H01Q 5/30; H01Q 1/243

See application file for complete search history.

(56) **References Cited**

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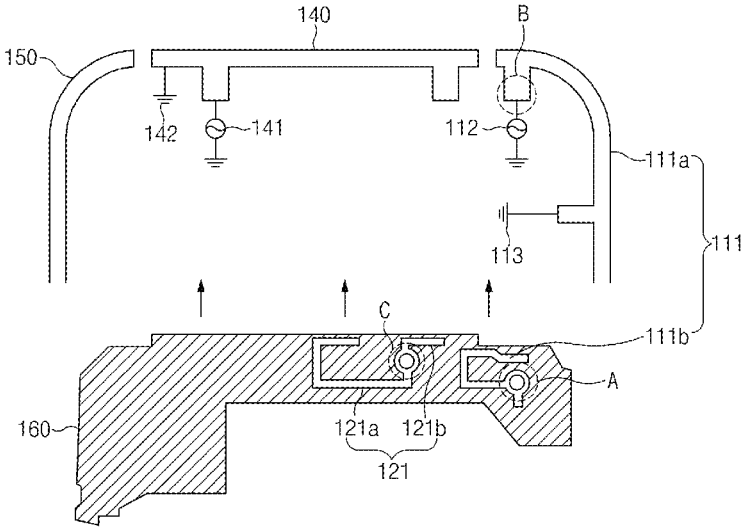
Primary Examiner — Ricardo I Magallanes

(57) **ABSTRACT**

An electronic device includes a first antenna radiator configured to transmit or receive a signal of a first frequency band and a signal of a second frequency band, a second antenna radiator configured to transmit or receive the signal of the second frequency band, a matching circuit mismatched with the second antenna radiator in the first frequency band and matched with the second antenna radiator in the second frequency band, a radio frequency circuit electrically connected to the first antenna radiator and the second antenna radiator, and a processor configured to control the RF circuit such that the signal of the second frequency band is transmitted or received through the first antenna radiator and the second antenna radiator in a multi-input multi-output mode or such that the signal of the first frequency band is transmitted or received through the first antenna radiator in a single input single output mode.

18 Claims, 14 Drawing Sheets



US010446912B2

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

(10) **Patent No.: US 10,446,912 B2**
(45) **Date of Patent: Oct. 15, 2019**

(54) **ELECTRONIC DEVICE AND METHOD OF IMPROVING ANTENNA PERFORMANCE THEREOF**

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

(72) Inventors: **Hoon Choi**, Gyeonggi-do (KR); **Myungjin Kang**, Gyeonggi-do (KR); **Kyoungho Kim**, Gyeonggi-do (KR); **Kihun Lee**, Gyeonggi-do (KR); **Hanjun Yi**, Gyeonggi-do (KR); **Jongwook Choi**, Gyeonggi-do (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 278 days.

(21) Appl. No.: **15/236,367**

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

(65) **Prior Publication Data**

US 2017/0047640 A1 Feb. 16, 2017

(30) **Foreign Application Priority Data**

Aug. 12, 2015 (KR) 10-2015-0113941

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

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

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

(56) **References Cited**

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JP 2013-528999 7/2013
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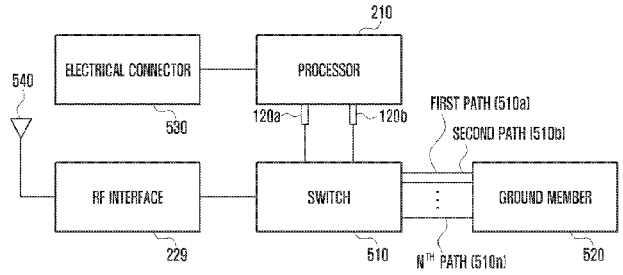
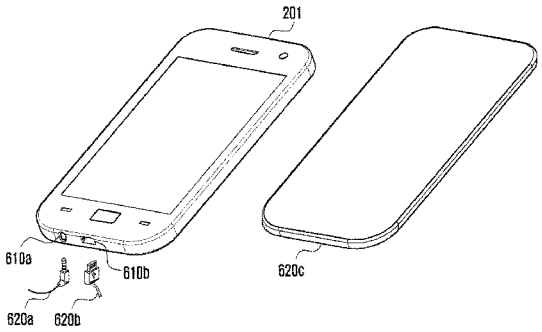
Primary Examiner — Trinh V Dinh

(57) **ABSTRACT**

A method of improving antenna performance and an electronic device configured to improve the antenna performance are provided. The electronic device include: a housing; an antenna located inside the housing or formed as part of the housing; a radio frequency (RF) interface configured to transmit/receive wireless signals via the antenna; a groove formed inside an opening in part of the housing; an electrical connector placed inside the groove; a ground member placed inside the housing; a processor electrically connected to the RF interface and the electrical connector; and a memory electrically connected to the processor. The memory stores instructions which enable the processor to detect an external electrical connector inserted into the electrical connector, and select at least one of a plurality of electrical paths between the RF interface and the ground member, in response to at least part of the inserted external electrical connector. Various embodiments are provided.

10 Claims, 9 Drawing Sheets





US010446913B2

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

(10) **Patent No.: US 10,446,913 B2**
(45) **Date of Patent: Oct. 15, 2019**

(54) **MOBILE TERMINAL**

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

(72) Inventors: **Junghyun Jo**, Seoul (KR); **Younghun Song**, Seoul (KR); **Jungwon Kim**, Seoul (KR); **Minsoo 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 31 days.

(21) Appl. No.: **15/351,020**

(22) Filed: **Nov. 14, 2016**

(65) **Prior Publication Data**

US 2017/0373376 A1 Dec. 28, 2017

(30) **Foreign Application Priority Data**

Jun. 24, 2016 (KR) 10-2016-0079564

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
H01Q 1/38	(2006.01)
H01Q 1/50	(2006.01)
H04M 1/02	(2006.01)
H01Q 1/08	(2006.01)

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

CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/088*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 1/50*** (2013.01); ***H04M 1/0202*** (2013.01); ***H04M 1/026*** (2013.01); ***H04M 1/0277*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 1/50; H01Q 1/38; H01Q 1/088; H04M 1/0277; H04M 1/026; H04M 1/0202

See application file for complete search history.

(56) **References Cited**

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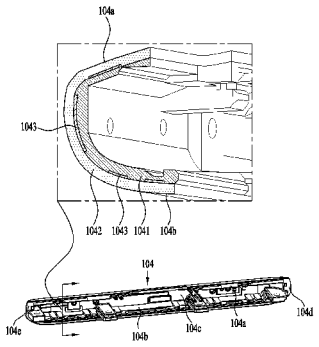
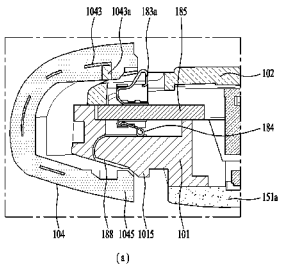
Primary Examiner — Hai V Tran
Assistant Examiner — Michael M Bouizza
(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

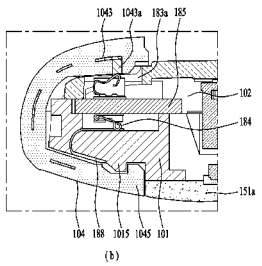
(57) **ABSTRACT**

There is disclosed a mobile terminal including a display unit, a front case of which a front surface the display is mounted, a rear case coupled to a rear surface of the front case, a main board loaded between the front case and the rear case, and a side case coupled to one or more side surfaces of the front and rear cases, wherein the side case comprises an inner injection mold projected toward the front case and the rear case, an outer injection mold exposed externally and an antenna pattern disposed between the inner injection mold and the outer injection mold.

16 Claims, 9 Drawing Sheets







US010446915B2

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

(10) **Patent No.: US 10,446,915 B2**
(45) **Date of Patent: Oct. 15, 2019**

(54) **MOBILE DEVICE**

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

(72) Inventors: **Chun-I Chen**, Taoyuan (TW); **Chi-Hsuan Lee**, Taoyuan (TW)

(73) Assignee: **QUANTA COMPUTER INC.**, 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.: **15/970,130**

(22) Filed: **May 3, 2018**

(65) **Prior Publication Data**

US 2019/0198975 A1 Jun. 27, 2019

(30) **Foreign Application Priority Data**

Dec. 25, 2017 (TW) ..... 106145510 A

(51) **Int. Cl.**

H01Q 1/38	(2006.01)
H01Q 1/24	(2006.01)
H01Q 21/28	(2006.01)
H04M 1/737	(2006.01)

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

CPC ***H01Q 1/243*** (2013.01); ***H01Q 21/28*** (2013.01); *H01Q 1/38* (2013.01); *H04M 1/737* (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 21/28; H01Q 1/38; H04M 1/737

See application file for complete search history.

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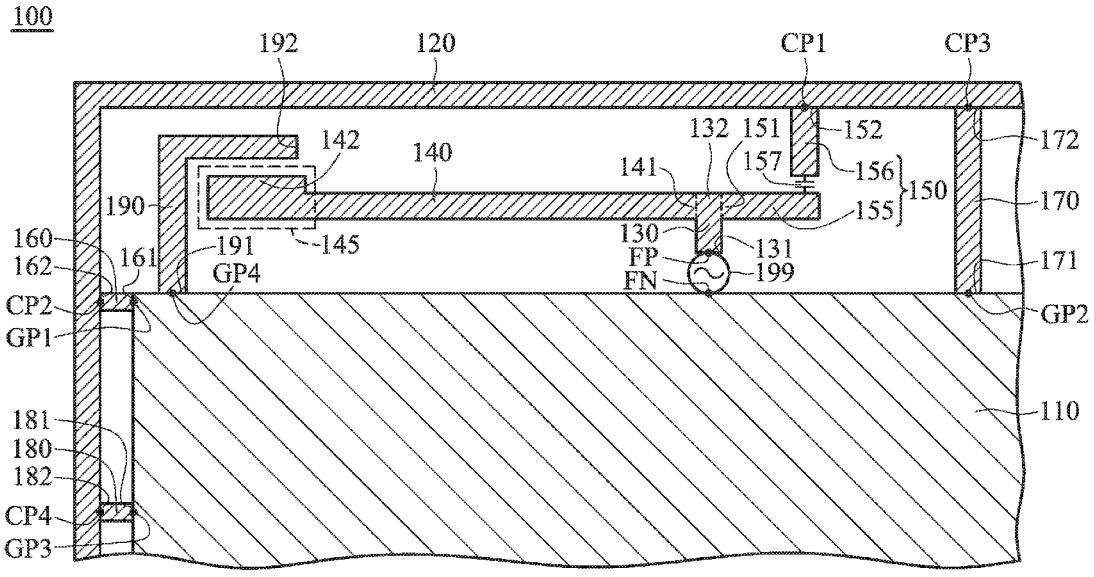
Primary Examiner — Graham P Smith

(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

A mobile device includes a ground element, a metal frame, a feeding connection element, a first radiation element, a second radiation element, a capacitive element, a first shorting element, a second shorting element, and a third shorting element. The first radiation element is coupled to the feeding connection element. The second radiation element includes a first portion and a second portion. The feeding connection element is coupled through the second radiation element to the metal frame. The capacitive element is coupled between the first portion and the second portion. The first shorting element, the second shorting element, and the third shorting element are coupled between the metal frame and the ground element. An antenna structure is formed by the ground element, the metal frame, the feeding connection element, the first radiation element, the second radiation element, the capacitive element, the first shorting element, and the second shorting element.

10 Claims, 7 Drawing Sheets



US010446916B2

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

(10) **Patent No.: US 10,446,916 B2**
(45) **Date of Patent: Oct. 15, 2019**

(54) **MOBILE TERMINAL**

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

(72) Inventors: **Dongjin Kim**, Seoul (KR); **Changil Kim**, Seoul (KR); **Moonsoo Song**, Seoul (KR); **Namyong 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 0 days.

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PCT Pub. Date: **Mar. 1, 2018**

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(30) **Foreign Application Priority Data**

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H01Q 1/24 (2006.01)
(Continued)

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

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/38; H01Q 5/328; H01Q 1/42; H04M 1/0266; H04M 1/026;
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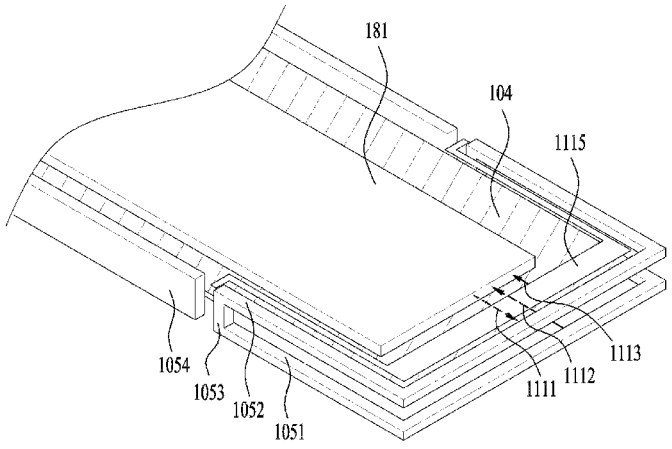
Primary Examiner — Khalid W Shaheed
(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

Disclosed is a mobile terminal comprising: a housing including a rear case positioned on a rear surface thereof and a side case positioned on a side surface thereof; a display unit disposed on a front surface of the housing; and a wireless communication unit, mounted on the main board, for processing a radio signal, wherein the side case includes a first metal part and a second metal part formed in a layered structure and spaced apart in the thickness direction of the first metal part and the housing, wherein the first metal part and the second metal part extend to a first side surface of the housing and to at least a portion of a second side surface and a third side surface located on the right and left sides of the first side surface, wherein at least one of the first metal part and the second metal part is connected to the wireless communication unit to transmit and receive an RF signal. The performance of the mobile terminal can be secured even when the performance of a mobile communication antenna is expanded and thus the mobile terminal is adjacent.

18 Claims, 19 Drawing Sheets



US010447326B2

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

(10) **Patent No.: US 10,447,326 B2**
(45) **Date of Patent: Oct. 15, 2019**

(54) **MOBILE TERMINAL WITH AN ANTENNA HAVING A FEEDING PORTION DISPOSED IN TERMINAL BODY**

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

(72) Inventors: **Insu Song**, Seoul (KR); **Jaewook Lee**, Seoul (KR); **Yunhoon Cho**, Seoul (KR)

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

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(65) **Prior Publication Data**

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H04B 1/3888 (2015.01)
(Continued)

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(58) **Field of Classification Search**
CPC .. H04Q 1/243; H04M 1/0249; H04M 4/1395; H04M 2/0275; H04B 1/3888
(Continued)

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Primary Examiner — William D Cumming
(74) *Attorney, Agent, or Firm* — Lee, Hong, Degerman, Kang & Waimey PC

(57) **ABSTRACT**

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

11 Claims, 5 Drawing Sheets