



US010056679B2

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

(10) **Patent No.:** **US 10,056,679 B2**  
(45) **Date of Patent:** **Aug. 21, 2018**

- (54) **ANTENNA AND METHOD FOR STEERING ANTENNA BEAM DIRECTION FOR WIFI APPLICATIONS**
- (71) Applicant: **Ethertronics, Inc.**, San Diego, CA (US)
- (72) Inventors: **Sebastian Rowson**, San Diego, CA (US); **Laurent Desclos**, San Diego, CA (US); **Jeffrey Shamblin**, San Marcos, CA (US)

- H01Q 1/24* (2006.01)
- H01Q 9/04* (2006.01)
- (52) **U.S. Cl.**  
CPC ..... *H01Q 1/243* (2013.01); *H01Q 3/00* (2013.01); *H01Q 9/0421* (2013.01)
- (58) **Field of Classification Search**  
CPC ..... H01Q 1/243; H01Q 3/00; H01Q 9/0421; H01Q 1/38  
See application file for complete search history.

- (73) Assignee: **Ethertronics, Inc.**, San Diego, CA (US)
- (\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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- (21) Appl. No.: **15/660,907**
- (22) Filed: **Jul. 26, 2017**
- (65) **Prior Publication Data**  
US 2017/0331174 A1 Nov. 16, 2017

**Related U.S. Application Data**

- (63) Continuation of application No. 14/965,881, filed on Dec. 10, 2015, now Pat. No. 9,748,637, which is a continuation-in-part of application No. 14/144,461, filed on Dec. 30, 2013, now Pat. No. 9,240,634, which is a continuation of application No. 13/726,477, filed on Dec. 24, 2012, now Pat. No. 8,648,755, which is a continuation of application No. 13/029,564, filed on Feb. 17, 2011, now Pat. No. 8,362,962, which is a continuation of application No. 12/043,090, filed on Mar. 5, 2008, now Pat. No. 7,911,402.

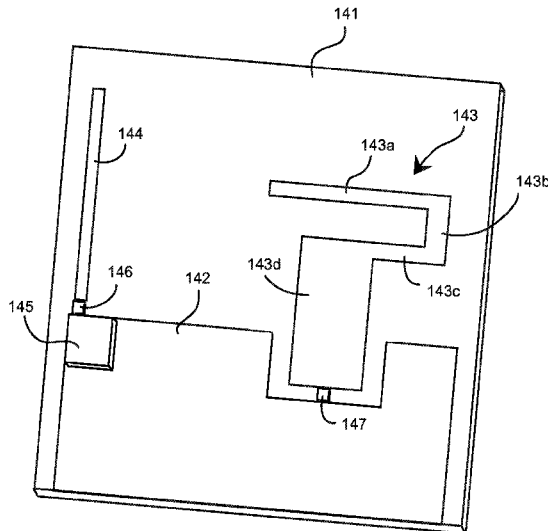
*Primary Examiner* — Tho G Phan  
(74) *Attorney, Agent, or Firm* — Dority & Manning, P.A.

(57) **ABSTRACT**

An antenna comprising an IMD element and one or more parasitic and active tuning elements is disclosed. The IMD element, when used in combination with the active tuning and parasitic elements, allows antenna operation at multiple resonant frequencies. In addition, the direction of antenna radiation pattern may be arbitrarily rotated in accordance with the parasitic and active tuning elements. Unique antenna architectures for beam steering in Wi-Fi band applications is further described.

- (51) **Int. Cl.**  
*H01Q 1/38* (2006.01)  
*H01Q 3/00* (2006.01)

**16 Claims, 16 Drawing Sheets**





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

(10) **Patent No.:** **US 10,056,680 B2**  
(45) **Date of Patent:** **Aug. 21, 2018**

(54) **MOBILE TERMINAL**  
(71) Applicant: **LG ELECTRONICS INC.**, Seoul (KR)  
(72) Inventors: **Yunmo Kang**, Seoul (KR); **Kangjae Jung**, Seoul (KR); **Sungjoon Hong**, Seoul (KR); **Byungwoon Jung**, Seoul (KR); **Sungjung Rho**, Seoul (KR)  
(73) Assignee: **LG ELECTRONICS INC.**, Seoul (KR)  
(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(52) **U.S. Cl.**  
CPC ..... **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 1/48** (2013.01); **H01Q 1/50** (2013.01); **H01Q 5/35** (2015.01); **H01Q 5/50** (2015.01); **H01Q 7/00** (2013.01); **H01Q 9/26** (2013.01); **H01Q 13/10** (2013.01); **H01Q 21/30** (2013.01)

(58) **Field of Classification Search**  
CPC ..... H01Q 1/242-1/245  
See application file for complete search history.

(21) Appl. No.: **15/860,427**  
(22) Filed: **Jan. 2, 2018**

(56) **References Cited**  
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(65) **Prior Publication Data**  
US 2018/0131077 A1 May 10, 2018

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**Related U.S. Application Data**  
(63) Continuation of application No. 14/010,900, filed on Aug. 27, 2013, now Pat. No. 9,871,286.

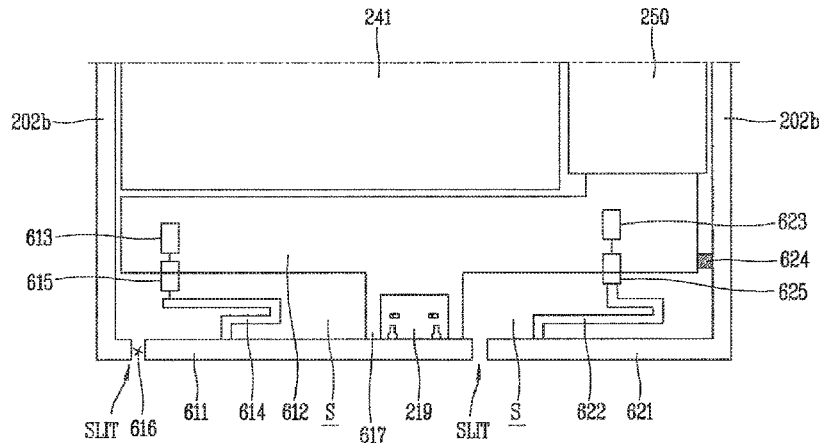
(30) **Foreign Application Priority Data**  
Sep. 19, 2012 (KR) ..... 10-2012-0104152

*Primary Examiner* — Jessica Han  
*Assistant Examiner* — Amal Patel  
(74) *Attorney, Agent, or Firm* — Lee, Hong, Degerman, Kang & Waimey PC

(51) **Int. Cl.**  
**H01Q 1/24** (2006.01)  
**H01Q 1/38** (2006.01)  
**H01Q 5/50** (2015.01)  
**H01Q 9/26** (2006.01)  
**H01Q 13/10** (2006.01)  
**H01Q 1/50** (2006.01)  
**H01Q 1/48** (2006.01)  
**H01Q 7/00** (2006.01)

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

(Continued) **21 Claims, 13 Drawing Sheets**



(12) **United States Patent**  
**Ayala Vazquez et al.**

(10) **Patent No.:** **US 10,056,695 B2**  
(45) **Date of Patent:** **Aug. 21, 2018**

- (54) **ELECTRONIC DEVICE ANTENNA WITH SWITCHABLE RETURN PATHS**
- (71) Applicant: **Apple Inc.**, Cupertino, CA (US)
- (72) Inventors: **Enrique Ayala Vazquez**, Watsonville, CA (US); **Hongfei Hu**, Santa Clara, CA (US); **Nanbo Jin**, Milpitas, CA (US); **Matthew A. Mow**, Los Altos, CA (US); **Liang Han**, Sunnyvale, CA (US); **Ming-Ju Tsai**, Cupertino, CA (US); **Erica J. Tong**, Pacifica, CA (US); **Erdinc Irci**, Santa Clara, CA (US); **Salih Yarga**, Sunnyvale, CA (US); **Mattia Pascolini**, San Francisco, CA (US); **Benjamin Shane Bustle**, Cupertino, CA (US); **Ruben Caballero**, San Jose, 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 457 days.

(21) Appl. No.: **14/811,714**

(22) Filed: **Jul. 28, 2015**

(65) **Prior Publication Data**  
US 2017/0033460 A1 Feb. 2, 2017

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

(52) **U.S. Cl.**  
CPC ..... **H01Q 13/103** (2013.01); **H01Q 1/245** (2013.01)

(58) **Field of Classification Search**  
CPC ..... H01Q 13/103; H01Q 1/245  
USPC ..... 343/702  
See application file for complete search history.

- (56) **References Cited**  
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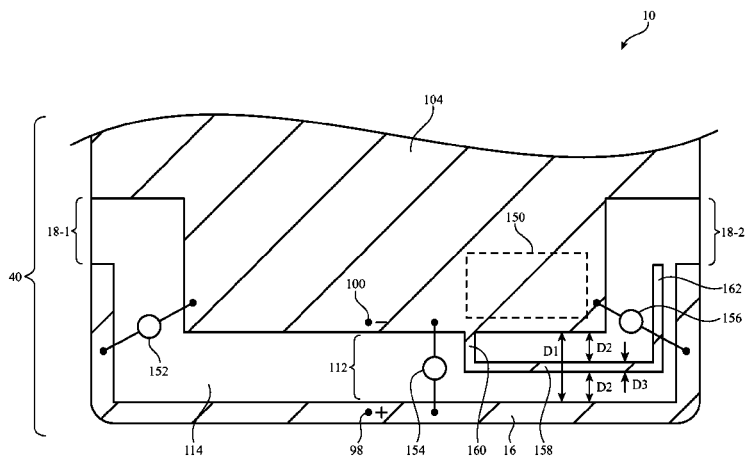
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*Primary Examiner* — Andrea Lindgren Baltzell  
(74) *Attorney, Agent, or Firm* — Treyz Law Group, P.C.;  
G. Victor Treyz; Joseph F. Guihan

(57) **ABSTRACT**

An electronic device may have wireless circuitry with antennas. An antenna resonating element arm for an antenna may be formed from conductive housing structures running along the edges of a device. The antenna may have a pair of switchable return paths that bridge a slot between the antenna resonating element and an antenna ground. An adjustable component and a feed may be coupled in parallel across the slot. The adjustable component may switch a capacitor into use or out of use and the return paths may be selectively opened and closed to compensate for antenna loading due to the presence of external objects near the electronic device.

**20 Claims, 10 Drawing Sheets**



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

(10) **Patent No.:** **US 10,056,696 B2**  
(45) **Date of Patent:** **Aug. 21, 2018**

(54) **ANTENNA STRUCTURE**  
(71) Applicant: **Wistron NeWeb Corp.**, Hsinchu (TW)  
(72) Inventors: **Shih-Hsien Tseng**, Hsinchu (TW);  
**Chia-Hao Chang**, Hsinchu (TW);  
**Yu-Sheng Fan**, 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 71 days.

(58) **Field of Classification Search**  
CPC ..... H01Q 5/357; H01Q 13/10; H01Q 13/106  
See application file for complete search history.

(21) Appl. No.: **15/361,243**  
(22) Filed: **Nov. 25, 2016**  
(65) **Prior Publication Data**  
US 2017/0207542 A1 Jul. 20, 2017

(56) **References Cited**  
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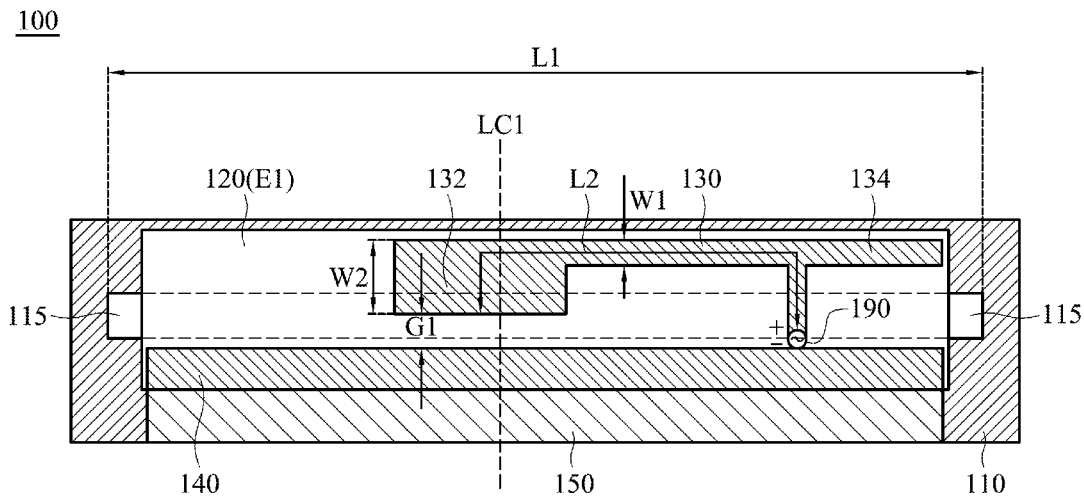
**Related U.S. Application Data**  
(60) Provisional application No. 62/278,668, filed on Jan. 14, 2016.

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

(51) **Int. Cl.**  
**H01Q 13/10** (2006.01)  
**H01Q 1/24** (2006.01)  
**H01Q 1/36** (2006.01)  
**H01Q 1/48** (2006.01)  
**H01Q 5/357** (2015.01)  
(52) **U.S. Cl.**  
CPC ..... **H01Q 13/106** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/36** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/357** (2015.01); **H01Q 13/10** (2013.01)

(57) **ABSTRACT**  
An antenna structure includes a metal piece, a dielectric substrate, a feeding radiation element, a grounding radiation element, and a grounding metal element. The metal piece has a slot. A lower surface of the dielectric substrate is adjacent to the slot of the metal piece. The feeding radiation element is disposed on an upper surface of the dielectric substrate, and is coupled to a positive electrode of a signal source. The grounding radiation element is disposed on the upper surface of the dielectric substrate, and is coupled to a negative electrode of the signal source. The grounding radiation element is coupled through the grounding metal element to the metal piece. At least one of the feeding radiation element and the grounding radiation element has a vertical projection which at least partially overlaps the slot of the metal piece.

**17 Claims, 8 Drawing Sheets**





US010062950B2

(12) **United States Patent**  
**Wang**

(10) **Patent No.:** **US 10,062,950 B2**

(45) **Date of Patent:** **Aug. 28, 2018**

(54) **HEAT DISSIPATER WITH AN ANTENNA STRUCTURE**

(56) **References Cited**

U.S. PATENT DOCUMENTS

(71) Applicant: **Chih-Yuan Wang**, Taipei (TW)

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165/185

(72) Inventor: **Chih-Yuan Wang**, Taipei (TW)

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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 80 days.

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361/704

5,831,830 A \* 11/1998 Mahler ..... H01Q 1/02  
165/185

(21) Appl. No.: **15/133,232**

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(22) Filed: **Apr. 20, 2016**

*Primary Examiner* — Huedung Mancuso

(65) **Prior Publication Data**

(57) **ABSTRACT**

US 2017/0309986 A1 Oct. 26, 2017

A heat dissipater with an antenna structure comprises a heat conductive portion capable of being contacted with a heat source of an electronic device for heat dissipation; and an antennal portion integrally formed to the heat conductive portion so as to form as an integral body; and the antenna portion comprises at least one sheet body. A conductive layer is coated on a surface of the sheet body; in that the conductive layer can be connected to a conductive wire for being lead to the portable electronic device for signal receiving and transmission. The heat conductive portion **10** has the function of heat dissipation and the antenna portion **20** has the function of wireless transmission which are made integrally with a compact space so that the space in an portable electronic device for receiving the heat conductive device is sufficient to receiving the whole structure.

(51) **Int. Cl.**

**H01Q 1/20** (2006.01)

**H01Q 1/02** (2006.01)

**H01Q 9/04** (2006.01)

**H05K 7/20** (2006.01)

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

CPC ..... **H01Q 1/02** (2013.01); **H01Q 9/04** (2013.01); **H05K 7/2039** (2013.01)

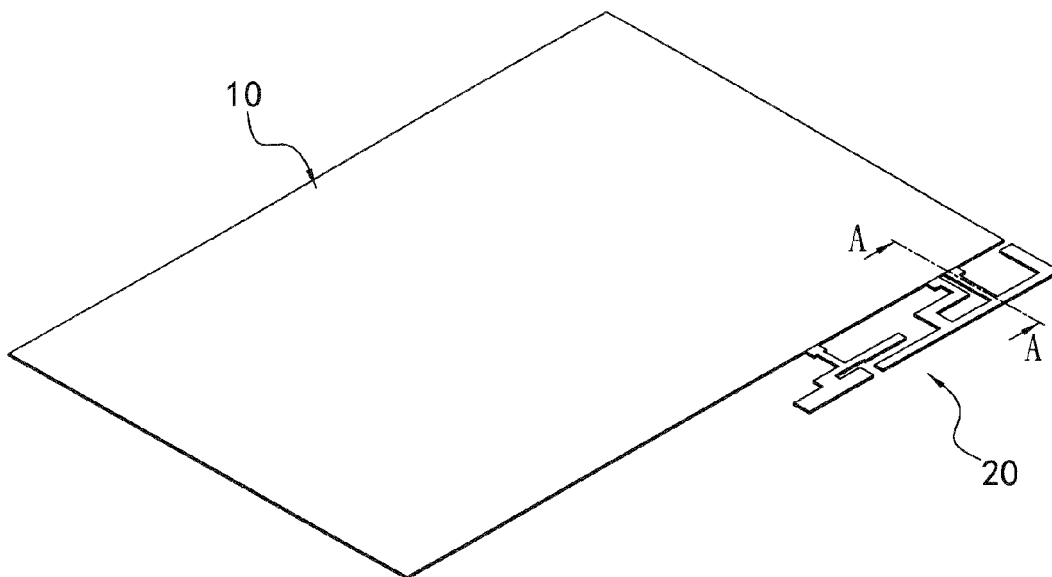
(58) **Field of Classification Search**

CPC ..... H01Q 1/02; H01Q 9/04

USPC ..... 343/720

See application file for complete search history.

**11 Claims, 4 Drawing Sheets**



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

(10) **Patent No.:** **US 10,069,192 B2**  
(45) **Date of Patent:** **Sep. 4, 2018**

(54) **PORTABLE COMMUNICATION DEVICE**

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

(72) Inventors: **Tun-Yuan Tsou**, Taoyuan (TW);  
**Pei-Ling Teng**, Taoyuan (TW);  
**Yi-Chun Chen**, Taoyuan (TW);  
**Hong-Lung Chen**, Taoyuan (TW);  
**Kuo-Cheng Chen**, 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 412 days.

(21) Appl. No.: **14/823,112**

(22) Filed: **Aug. 11, 2015**

(65) **Prior Publication Data**

US 2015/0349408 A1 Dec. 3, 2015

**Related U.S. Application Data**

(63) Continuation of application No. 13/304,726, filed on Nov. 28, 2011, now Pat. No. 9,160,058.

(51) **Int. Cl.**

**H01Q 9/42** (2006.01)

**H01Q 1/24** (2006.01)

(Continued)

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

CPC ..... **H01Q 1/243** (2013.01); **H01Q 1/2266** (2013.01); **H01Q 1/48** (2013.01); **H01Q 1/52** (2013.01);

(Continued)

(58) **Field of Classification Search**

CPC ..... H01C 23/00

(Continued)

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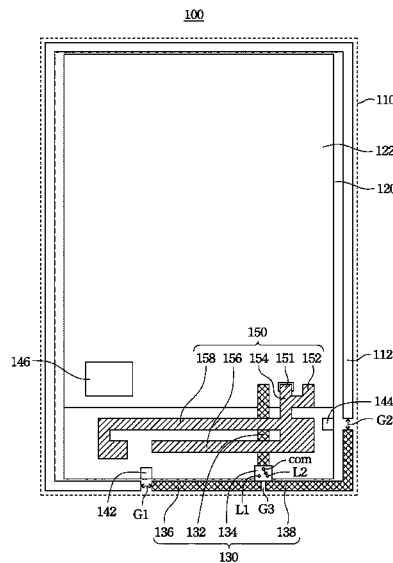
*Primary Examiner* — Andrea Lindgren Baltzell

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

(57) **ABSTRACT**

A portable communication device includes an appearance, a substrate and a switchable resonant antenna. The substrate is disposed in the appearance, and the substrate has a ground plane. The switchable resonant antenna comprises a first connection portion, a switching unit, a first metal element and a second metal element, where the first connection portion is electrically coupled between the ground plane and the switching unit, the switching unit is configured to electrically couple the first connection portion to the first metal element or the second metal element according to a control signal generated corresponding to a detecting result, in order to generate a first resonant mode.

**20 Claims, 6 Drawing Sheets**





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

(10) **Patent No.:** **US 10,069,193 B2**  
(45) **Date of Patent:** **Sep. 4, 2018**

- (54) **ANTENNA AND MOBILE TERMINAL**
- (71) Applicant: **Huawei Device (Dongguan) Co., Ltd.**, Dongguan (CN)
- (72) Inventors: **Jianming Li**, Taipei (TW); **Hanyang Wang**, Reading (GB)
- (73) Assignee: **HUAWEI DEVICE (DONGGUAN) CO., LTD.**, Dongguan (CN)
- (\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 25 days.

- (56) **References Cited**
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- (21) Appl. No.: **15/118,323**
- (22) PCT Filed: **Feb. 6, 2015**
- (86) PCT No.: **PCT/CN2015/072407**  
§ 371 (c)(1),  
(2) Date: **Aug. 11, 2016**

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- (87) PCT Pub. No.: **WO2015/120780**  
PCT Pub. Date: **Aug. 20, 2015**

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

- (65) **Prior Publication Data**  
US 2017/0170546 A1 Jun. 15, 2017

- (30) **Foreign Application Priority Data**  
Feb. 12, 2014 (CN) ..... 2014 1 0049276

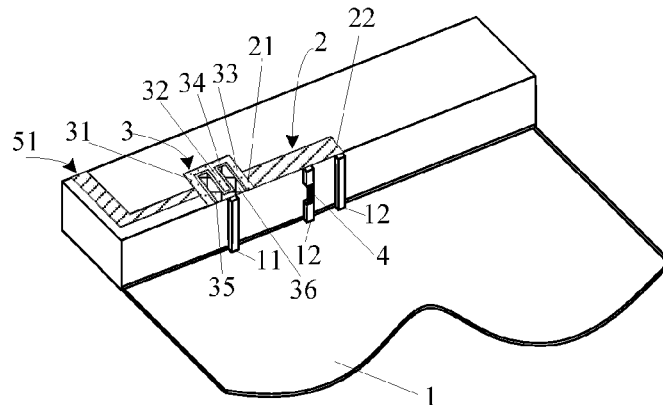
- (51) **Int. Cl.**  
**H01Q 1/24** (2006.01)  
**H01Q 1/48** (2006.01)  
**H01Q 1/38** (2006.01)

- (52) **U.S. Cl.**  
CPC ..... **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 1/48** (2013.01)

- (58) **Field of Classification Search**  
CPC ..... H01Q 1/241-1/243; H01Q 1/38 (Continued)

- (57) **ABSTRACT**
- An antenna and a mobile terminal with the antenna including a first radiator and a first capacitor structure. A first end of the first radiator is electrically connected to a signal feed end of a printed circuit board by means of the first capacitor structure, and a second end of the first radiator is electrically connected to a ground end of the printed circuit board. The first radiator, the first capacitor structure, the signal feed end, and the ground end form a first antenna, configured to generate a first resonance frequency. An electrical length of the first radiator is less than or equal to one eighth of a wavelength corresponding to the first resonance frequency.

**18 Claims, 10 Drawing Sheets**



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

(10) **Patent No.:** **US 10,069,194 B2**  
(45) **Date of Patent:** **Sep. 4, 2018**

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

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

(71) Applicant: **BYD COMPANY LIMITED**,  
Shenzhen, Guangdong (CN)

(56) **References Cited**

(72) Inventors: **Qinyang Cai**, Guangdong (CN); **Yijin Wang**, Guangdong (CN); **Wensong Wang**, Guangdong (CN); **Munyong Choi**, Guangdong (CN)

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(73) Assignee: **BYD Company Limited** (CN)

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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.: **15/313,033**

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(22) PCT Filed: **May 26, 2015**

International Search Report from PCT Application No. PCT/CN2015/079774 dated Sep. 9, 2015.

(86) PCT No.: **PCT/CN2015/079774**

§ 371 (c)(1),  
(2) Date: **Nov. 21, 2016**

*Primary Examiner* — Robert Karacsony  
(74) *Attorney, Agent, or Firm* — Calfee, Halter & Griswold LLP

(87) PCT Pub. No.: **WO2015/180619**

PCT Pub. Date: **Dec. 3, 2015**

(57) **ABSTRACT**

(65) **Prior Publication Data**

US 2017/0093022 A1 Mar. 30, 2017

An electric device includes a metal shell having a back metal shell part and a first side metal shell part, and a first antenna which includes: a first radiating surface formed by the back metal shell part and the first side metal shell part and having a variant T-shaped group of slots and a first L-shaped slot, a part of the variant T-shaped group of slots being formed in the back metal shell part, and the other part thereof being formed in the first side metal shell part, the first L-shaped slot being formed in the first side metal shell part; a first dielectric sheet disposed on a front surface of the back metal shell part; and a first L-shaped feeder disposed on a front surface of the first dielectric sheet.

(30) **Foreign Application Priority Data**

May 26, 2014 (CN) ..... 2014 1 0225498

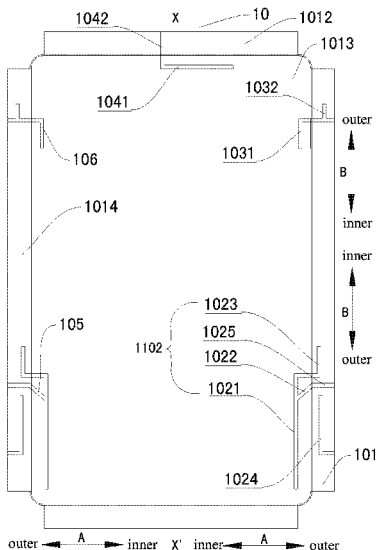
(51) **Int. Cl.**

**H01Q 1/24** (2006.01)  
**H01Q 13/10** (2006.01)

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

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

**14 Claims, 11 Drawing Sheets**





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

(10) **Patent No.:** **US 10,069,196 B1**  
(45) **Date of Patent:** **Sep. 4, 2018**

(54) **MOBILE DEVICE**

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

(72) Inventors: **Ming-Ching Yen**, New Taipei (TW);  
**Kun-Sheng Chang**, New Taipei (TW);  
**Shih-Ting Huang**, New Taipei (TW);  
**Cheng-Yu Hsieh**, 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 0 days.

(21) Appl. No.: **15/792,978**

(22) Filed: **Oct. 25, 2017**

(30) **Foreign Application Priority Data**

Aug. 21, 2017 (TW) ..... 106128246 A

(51) **Int. Cl.**  
**H04M 1/02** (2006.01)  
**H01Q 1/24** (2006.01)  
**H01Q 21/00** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **H01Q 1/244** (2013.01); **H01Q 21/0031** (2013.01); **H04M 1/026** (2013.01)

(58) **Field of Classification Search**  
CPC ..... H04B 1/3838; H01Q 5/50; H01Q 1/244;  
H01Q 1/245; H01Q 1/362; H01Q 2/0031;  
H04M 1/026

See application file for complete search history.

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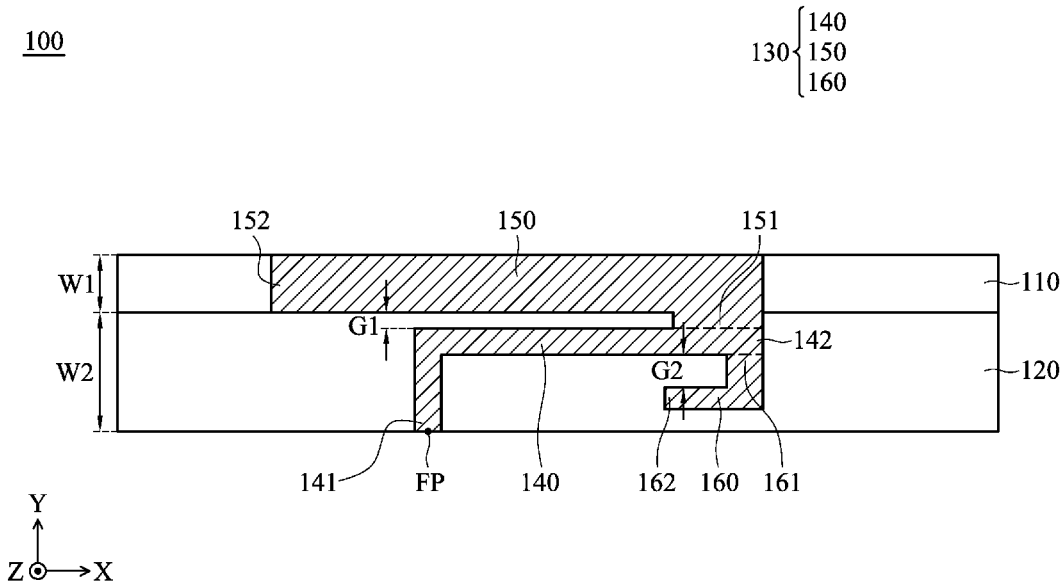
*Primary Examiner* — Thanh Le

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

(57) **ABSTRACT**

A mobile device includes a first nonconductive supporting element, a second nonconductive supporting element, and an antenna structure. The first nonconductive supporting element and the second nonconductive supporting element are adjacent to each other. The first nonconductive supporting element and the second nonconductive supporting element have different heights. The antenna structure is formed on the first nonconductive supporting element and the second nonconductive supporting element. The antenna element includes a feeding connection element, a first radiation element, and a second radiation element. The feeding connection element is coupled to a feeding point. The first radiation element and the second radiation element are coupled to the feeding connection element. The feeding connection element is disposed between the first radiation element and the second radiation element.

**17 Claims, 8 Drawing Sheets**



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

(10) **Patent No.:** **US 10,069,199 B2**  
(45) **Date of Patent:** **Sep. 4, 2018**

(54) **ANTENNA AND RADIO FREQUENCY SIGNAL TRANSCIEIVING DEVICE**

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

(72) Inventors: **Jun-Fu Chen**, 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 248 days.

(21) Appl. No.: **14/938,858**

(22) Filed: **Nov. 12, 2015**

(65) **Prior Publication Data**  
US 2016/0352025 A1 Dec. 1, 2016

(30) **Foreign Application Priority Data**  
Jun. 1, 2015 (TW) ..... 104117655 A

(51) **Int. Cl.**  
**H01Q 1/38** (2006.01)  
**H01Q 1/24** (2006.01)  
**H01Q 1/48** (2006.01)  
**H01Q 5/392** (2015.01)

(52) **U.S. Cl.**  
CPC ..... **H01Q 1/38** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/392** (2015.01)

(58) **Field of Classification Search**  
CPC ..... H01Q 1/38; H01Q 5/392  
USPC ..... 343/700  
See application file for complete search history.

(56) **References Cited**

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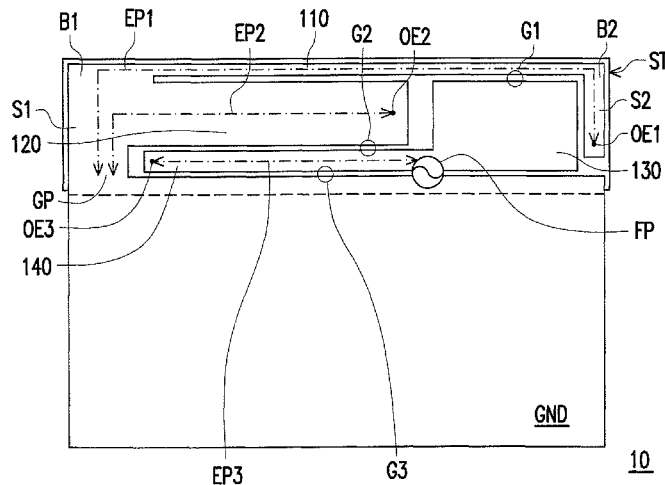
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*Primary Examiner* — Dameon E Levi  
*Assistant Examiner* — Walter Davis  
(74) *Attorney, Agent, or Firm* — JCIPRNET

(57) **ABSTRACT**

An antenna including an antenna structure disposed on a substrate is provided. The antenna structure includes a first radiation part, a second radiation part, a metal coupling part, a third radiation part and a feeding point. The first radiation part has a first bend, a second bend and an opening end. The first radiation part extends from a grounding point of a grounding plane and the opening end thereof is nearing the grounding plane. The second radiation part extends from a section between the first bend of the first radiation part and the grounding point. The metal coupling part is nearing the first radiation part and the second radiation part. The third radiation part is disposed between the second radiation part and the grounding plane, and extends from the metal coupling part. The feeding point is coupled to where the third radiation part and the metal coupling part connected.

**20 Claims, 4 Drawing Sheets**





US010069204B2

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

(10) **Patent No.:** **US 10,069,204 B2**  
(45) **Date of Patent:** **Sep. 4, 2018**

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

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

(72) Inventors: **Gyu Sub Kim**, Seoul (KR); **Yeon Woo Kim**, Seoul (KR); **Se Hyun Park**,  
Suwon-si (KR); **Jaе Bong Chun**,  
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 35 days.

(21) Appl. No.: **14/820,107**

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

(65) **Prior Publication Data**

US 2016/0049734 A1 Feb. 18, 2016

(30) **Foreign Application Priority Data**

Aug. 14, 2014 (KR) ..... 10-2014-0106058

(51) **Int. Cl.**

**H01Q 9/04** (2006.01)  
**H01Q 5/371** (2015.01)  
**H01Q 21/28** (2006.01)  
**H01Q 1/24** (2006.01)  
**H01Q 13/10** (2006.01)  
**H01Q 13/16** (2006.01)

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

CPC ..... **H01Q 9/0421** (2013.01); **H01Q 1/243** (2013.01); **H01Q 5/371** (2015.01); **H01Q 13/10** (2013.01); **H01Q 13/16** (2013.01); **H01Q 21/28** (2013.01)

(58) **Field of Classification Search**

CPC ..... H01Q 9/0421; H01Q 13/10; H01Q 13/16  
See application file for complete search history.

(56) **References Cited**

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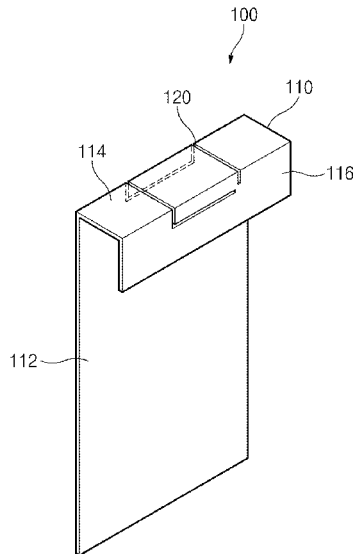
*Primary Examiner* — Robert Karacsony

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

(57) **ABSTRACT**

An antenna device is provided. The antenna device includes a base plate of a conductive material, at least one slit disposed in at least one area of the base plate and having a form in which a portion of a closed curve is open, and a feeding part configured to supply current to an inner area surrounded by the slit.

**13 Claims, 12 Drawing Sheets**



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

(10) **Patent No.:** **US 10,069,209 B2**  
(45) **Date of Patent:** **Sep. 4, 2018**

(54) **CAPACITIVELY COUPLED ANTENNA APPARATUS AND METHODS**

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(71) Applicant: **Pulse Finland OY**, Kempele (FI)

(72) Inventors: **Prasadh Ramachandran**, Oulu (FI);  
**Petteri Annamaa**, Oulunsalo (FI)

(73) Assignee: **Pulse Finland OY**, Oulunsalo (FI)

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1071 days.

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(21) Appl. No.: **13/794,343**

(22) Filed: **Mar. 11, 2013**

(65) **Prior Publication Data**

US 2014/0125535 A1 May 8, 2014

**Related U.S. Application Data**

(60) Provisional application No. 61/723,243, filed on Nov. 6, 2012.

(51) **Int. Cl.**

**H01Q 9/30** (2006.01)  
**H01Q 1/24** (2006.01)

(Continued)

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

CPC ..... **H01Q 9/30** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/52** (2013.01); **H01Q 1/521** (2013.01); **H01Q 21/28** (2013.01)

(58) **Field of Classification Search**

CPC ..... H01Q 9/30; H01Q 1/28  
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*Primary Examiner* — Dameon E Levi

*Assistant Examiner* — Walter Davis

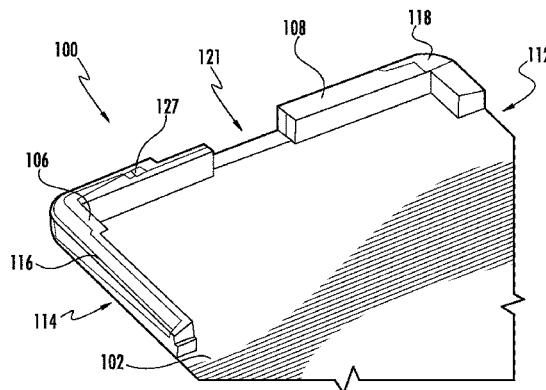
(74) *Attorney, Agent, or Firm* — Gazdzinski & Associates, PC

(57)

**ABSTRACT**

Capacitively coupled antenna apparatus and methods of operating and adaptively tuning the same. In one embodiment, the insertion loss component in “beside the hand/head” use scenarios is significantly reduced or eliminated such that the antenna experiences only absorptive losses (which generally cannot be avoided), and a very small insertion loss by the host device radio frequency tuner. The exemplary antenna apparatus may be configured for multi-band operation, and also has a very small form factor (e.g., 3 mm ground clearance only at the bottom of the PCB, 4 mm height in one implementation), thereby allowing for use in spatially compact host devices such as slim-line smartphones, tablets, and the like. The adaptive antenna arrangement (using capacitive feed) can be tuned such that the tuner is used in free space, and the user’s hand/head tunes the antenna to the band of interest while in use.

**20 Claims, 6 Drawing Sheets**



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

(10) **Patent No.:** **US 10,074,892 B2**  
(45) **Date of Patent:** **\*Sep. 11, 2018**

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

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

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

(56) **References Cited**

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

U.S. PATENT DOCUMENTS

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

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

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(21) Appl. No.: **15/807,591**

*Primary Examiner* — Trinh Dinh

(22) Filed: **Nov. 9, 2017**

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

(65) **Prior Publication Data**

US 2018/0090822 A1 Mar. 29, 2018

**Related U.S. Application Data**

(63) Continuation of application No. 15/216,424, filed on Jul. 21, 2016, now Pat. No. 9,853,351.

(57) **ABSTRACT**

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

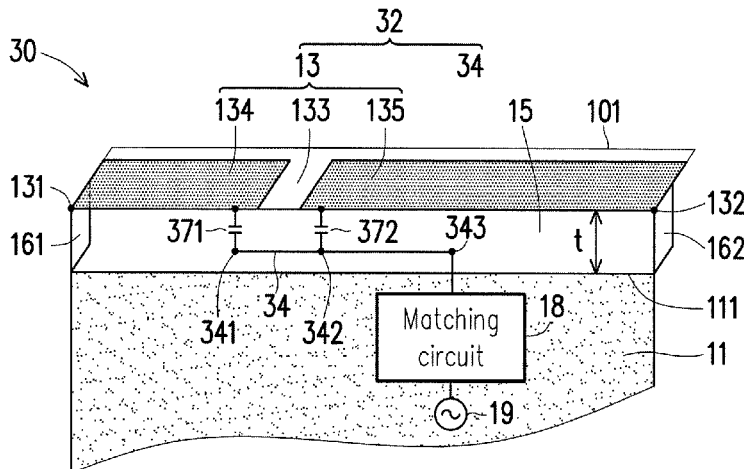
(30) **Foreign Application Priority Data**

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

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

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

**16 Claims, 3 Drawing Sheets**





US010074898B1

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

(10) **Patent No.:** **US 10,074,898 B1**  
(45) **Date of Patent:** **Sep. 11, 2018**

(54) **ANTENNA FOR GPS AND HIGH BAND**

(71) Applicant: **Amazon Technologies, Inc.**, Reno, NV (US)

(72) Inventors: **Jerry Weiming Kuo**, San Jose, CA (US); **Ulf Jan Ove Mattsson**, Saratoga, CA (US); **Adrian Napoles**, Cupertino, CA (US)

(73) Assignee: **Amazon Technologies, Inc.**, Reno, NV (US)

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 555 days.

(21) Appl. No.: **14/033,188**

(22) Filed: **Sep. 20, 2013**

(51) **Int. Cl.**  
**H01Q 1/50** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **H01Q 1/50** (2013.01)

(58) **Field of Classification Search**  
CPC ..... H01Q 5/364; H01Q 5/40; H01Q 1/44  
See application file for complete search history.

(56) **References Cited**

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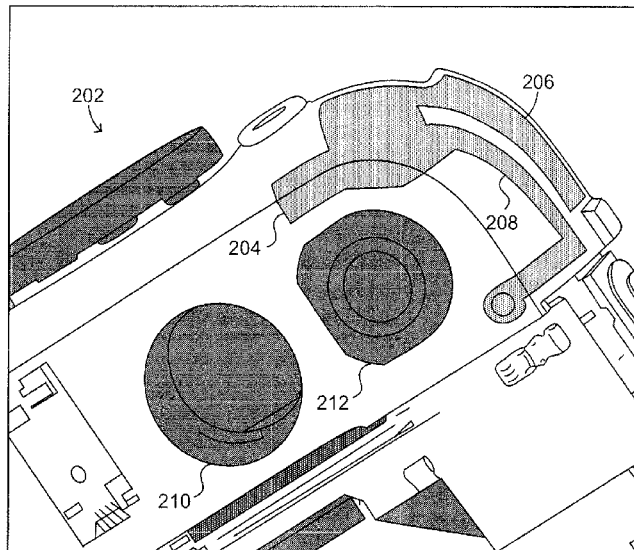
*Primary Examiner* — Graham Smith  
*Assistant Examiner* — Noel Maldonado  
(74) *Attorney, Agent, or Firm* — Polsinelli LLP

(57) **ABSTRACT**

The present disclosure can provide a wideband antenna with a folded monopole structure that operates at GPS frequencies and high band (HB) frequencies. Accordingly, the wideband antenna can function as an integrated GPS and HB Diversity antenna for a computing device. In some embodiments, due to various constraints, the antenna can be designed to have a curved structure to fit within a corner of the computing device. The folded monopole antenna can comprise two substantially parallel conducting arms, which improves antenna performance. In some embodiments, the present disclosure can provide GPS and high band impedance matching for a signal received from the antenna in order to improve/ensure signal quality. The signal can be decoupled into a GPS signal portion and a high band signal portion for additional processing and/or information retrieval.

**20 Claims, 12 Drawing Sheets**

200  
↓





US010074899B2

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

(10) **Patent No.:** **US 10,074,899 B2**  
(45) **Date of Patent:** **Sep. 11, 2018**

(54) **ANTENNA SYSTEM**

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

(72) Inventors: **Chien-Yi Wu**, Taipei (TW); **Chao-Hsu Wu**, Taipei (TW); **Shih-Keng Huang**, Taipei (TW); **Yu-Yi Chu**, Taipei (TW); **Ya-Jyun Li**, 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.: **15/641,335**

(22) Filed: **Jul. 5, 2017**

(65) **Prior Publication Data**

US 2018/0102589 A1 Apr. 12, 2018

(30) **Foreign Application Priority Data**

Oct. 6, 2016 (TW) ..... 105132400 A

(51) **Int. Cl.**

**H01Q 1/38** (2006.01)  
**H01Q 1/52** (2006.01)  
**H01Q 5/335** (2015.01)  
**H01Q 5/357** (2015.01)  
**H01Q 1/24** (2006.01)  
**H01Q 21/08** (2006.01)

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

CPC ..... **H01Q 1/523** (2013.01); **H01Q 1/24** (2013.01); **H01Q 1/38** (2013.01); **H01Q 5/335** (2015.01); **H01Q 5/357** (2015.01); **H01Q 21/08** (2013.01)

(58) **Field of Classification Search**

None  
See application file for complete search history.

(56) **References Cited**

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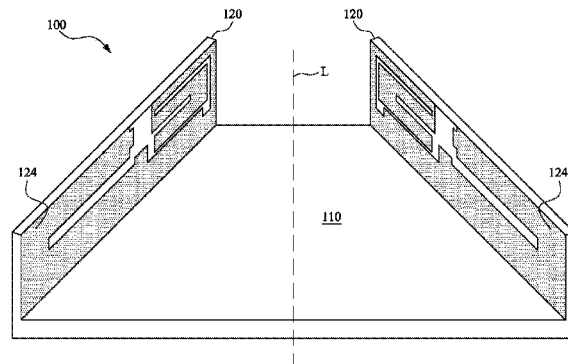
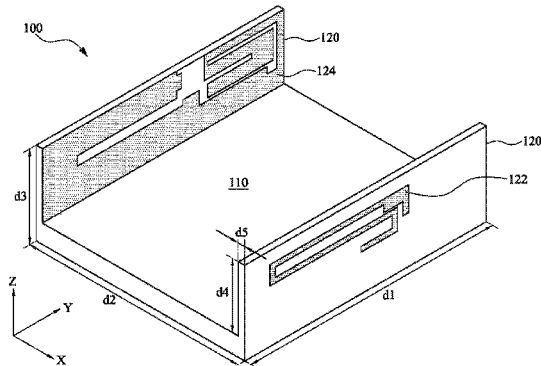
Primary Examiner — Trinh Dinh

(74) Attorney, Agent, or Firm — CKC & Partners Co., Ltd.

(57) **ABSTRACT**

An antenna system includes a system ground and two antenna units. The two antenna units are individually disposed on two opposite sides of the system ground and symmetrically mirrored with each other. Each antenna unit includes a circuit board, a first antenna pattern and a second antenna pattern. The first antenna pattern is disposed at one side of the circuit board. The first antenna pattern resonates to generate a first high resonant frequency. The second antenna pattern is disposed at the other side of the circuit board. The first antenna pattern resonates with part of the second antenna pattern to generate a low resonant frequency.

**14 Claims, 13 Drawing Sheets**





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

(10) **Patent No.:** **US 10,075,203 B2**  
(45) **Date of Patent:** **Sep. 11, 2018**

(54) **ELECTRONIC DEVICE**

(2013.01); **H01Q 9/42** (2013.01); **H01Q 13/10**  
(2013.01); **H01Q 5/30** (2015.01); **H01Q 13/16**  
(2013.01)

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

(58) **Field of Classification Search**

(72) Inventors: **Gyu-Sub Kim**, Suwon-si (KR);  
**Se-Hyun Park**, Suwon-si (KR);  
**Ui-Chul Jeong**, Anyang-si (KR);  
**Austin Kim**, Seongnam-si (KR);  
**Yeon-Woo Kim**, Seoul (KR); **Joon-Ho**  
**Byun**, Yongin-si (KR)

CPC ..... H01Q 5/00; H01Q 5/30; H01Q 5/314;  
H01Q 5/385; H01Q 5/392; H01Q 5/50;  
H01Q 7/00; H01Q 7/005; H01Q 13/103;  
H01Q 13/16  
USPC ..... 455/121-125, 553.1, 575.7  
See application file for complete search history.

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

(56) **References Cited**

(\*) 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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H01Q 5/335

(22) Filed: **Oct. 30, 2015**

(65) **Prior Publication Data**

US 2016/0142083 A1 May 19, 2016

(Continued)

(30) **Foreign Application Priority Data**

Nov. 13, 2014 (KR) ..... 10-2014-0157986

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*Primary Examiner* — Duc M Nguyen

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

(51) **Int. Cl.**

**H01Q 7/00** (2006.01)  
**H04B 1/10** (2006.01)  
**H01Q 1/24** (2006.01)  
**H01Q 9/42** (2006.01)  
**H01Q 13/10** (2006.01)  
**H01Q 5/364** (2015.01)  
**H01Q 5/30** (2015.01)  
**H01Q 13/16** (2006.01)

(57) **ABSTRACT**

An electronic device for communicating in a network is provided. The electronic device includes a circuit board, a frame, a feeding structure formed on the circuit board, and an antenna unit disposed in a plane at a predetermined angle with respect to a surface of the circuit board. In addition, the antenna unit is disposed apart from the frame in electrical connection with the feeding structure.

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

CPC ..... **H04B 1/1009** (2013.01); **H01Q 1/243**  
(2013.01); **H01Q 5/364** (2015.01); **H01Q 7/00**

**22 Claims, 14 Drawing Sheets**

