



US009425496B2

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

(10) **Patent No.:** **US 9,425,496 B2**
(45) **Date of Patent:** **Aug. 23, 2016**

(54) **DISTRIBUTED LOOP SPEAKER ENCLOSURE ANTENNA**
(71) Applicant: **Apple, Inc.**, Cupertino, CA (US)

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343/700 MS
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(72) Inventors: **Jiang Zhu**, Sunnyvale, CA (US);
Qingxiang Li, Mountain View, CA (US);
Robert W. Schlub, Cupertino, CA (US);
Ruben Caballero, San Jose, CA (US)

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(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 564 days.

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(21) Appl. No.: **13/629,061**

(22) Filed: **Sep. 27, 2012**

Primary Examiner — Md S Elahee

(74) Attorney, Agent, or Firm — Treyz Law Group, P.C.; G. Victor Treyz; Michael H. Lyons

(65) **Prior Publication Data**

US 2014/0086441 A1 Mar. 27, 2014

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/44 (2006.01)
H01Q 7/00 (2006.01)

(57) **ABSTRACT**

An electronic device may be provided with antenna structures. The antenna structures may be formed using a dielectric carrier structure such as a speaker enclosure, so that interior space within the electronic device that is occupied by a speaker can be used in forming an antenna. A speaker driver may be mounted in the speaker enclosure. Openings in the speaker enclosure may allow sound from the speaker driver to be emitted from the speaker enclosure. The antenna structures may have first and second loop antenna resonating elements. The first loop antenna resonating element may indirectly feed the second loop antenna resonating element. The second loop antenna resonating element may be a distributed loop element formed from a strip of metal with a width that loops around the speaker enclosure. Openings in the second loop antenna resonating element may be aligned with the speaker enclosure openings.

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/44** (2013.01); **H01Q 7/00** (2013.01)

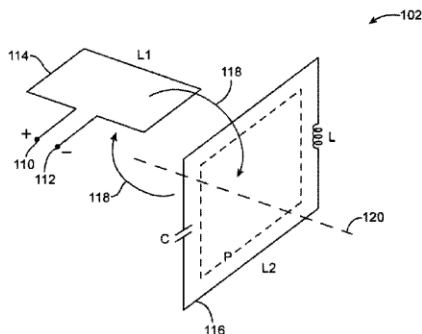
(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/44; H01Q 7/00
USPC 345/173; 455/41.1, 41.2, 77, 566; 343/700 MS, 702, 846, 848, 866, 893; 381/315, 332; 379/431
See application file for complete search history.

(56) **References Cited**

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23 Claims, 15 Drawing Sheets





US009425498B2

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

(10) **Patent No.:** **US 9,425,498 B2**
(45) **Date of Patent:** **Aug. 23, 2016**

(54) **WIDEBAND ANTENNA MODULE**

(71) Applicant: **QUANTA COMPUTER INC.**, Tao Yuan Hsien (TW)

(72) Inventors: **Chi-Hsuan Lee**, Tao Yuan Hsien (TW);
Pei-Ling Teng, Tao Yuan Hsien (TW);
Kuo-Cheng Chen, Tao Yuan Hsien (TW)

(73) Assignee: **QUANTA COMPUTER INC.**, Tao Yuan Hsien (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 36 days.

(21) Appl. No.: **14/570,326**

(22) Filed: **Dec. 15, 2014**

(65) **Prior Publication Data**

US 2015/0295312 A1 Oct. 15, 2015

(30) **Foreign Application Priority Data**

Apr. 11, 2014 (TW) 103113461 A

(51) **Int. Cl.**

H01Q 1/24 (2006.01)
H01Q 1/52 (2006.01)
H01Q 9/42 (2006.01)
H01Q 21/28 (2006.01)

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

CPC **H01Q 1/243** (2013.01); **H01Q 1/521** (2013.01); **H01Q 9/42** (2013.01); **H01Q 21/28** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 21/28; H01Q 9/42; H01Q 1/521
USPC 343/841, 845, 702
See application file for complete search history.

(56) **References Cited**

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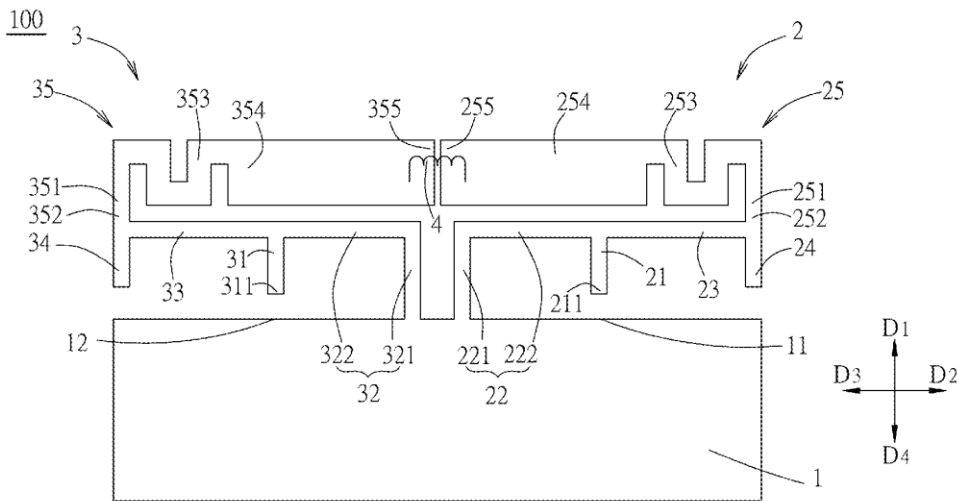
Primary Examiner — Dieu H Duong

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

(57) **ABSTRACT**

A wideband antenna module includes a ground conductor, two radiating conductors and a decoupling inductor. Each of the radiating conductors includes a feed-in portion, a ground portion and three radiating portions. The feed-in portion is spaced apart from the ground conductor and has a feed-in end part. The ground portion is connected to the feed-in portion and the ground conductor. For each of the radiating conductors, the radiating portions are arranged in sequence from the feed-in portion to a free end part. The decoupling inductor is connected between the free end parts of the two radiating conductors.

16 Claims, 6 Drawing Sheets





US009425500B2

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

(10) **Patent No.:** **US 9,425,500 B2**
(45) **Date of Patent:** **Aug. 23, 2016**

(54) **ANTENNA OR A STRAP FOR ACCOMMODATING AN INTEGRATED CIRCUIT, AN ANTENNA ON A SUBSTRATE, A STRAP FOR AN INTEGRATED CIRCUIT AND A TRANSPONDER**

19/07786 (2013.01); *H01Q 1/22* (2013.01); *H01Q 9/285* (2013.01); *H01L 2224/16225* (2013.01); *H01L 2224/16227* (2013.01); *Y10T 29/49018* (2015.01)

(75) Inventors: **Christian Zenz**, Graz (AT); **Dietmar Nessmann**, Graz (AT)

(58) **Field of Classification Search**
CPC H01Q 13/10; H01Q 13/106; H01Q 1/38
USPC 343/906, 767, 700 MS; 29/601, 600, 29/829, 832, 842, 854
See application file for complete search history.

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 815 days.

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(21) Appl. No.: **12/744,356**

(22) PCT Filed: **Nov. 21, 2008**

(86) PCT No.: **PCT/IB2008/054899**

§ 371 (c)(1),
(2), (4) Date: **May 24, 2010**

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EP 1724712 A1 11/2006
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(87) PCT Pub. No.: **WO2009/069053**
PCT Pub. Date: **Jun. 4, 2009**

Primary Examiner — Dameon E Levi
Assistant Examiner — Collin Dawkins

(65) **Prior Publication Data**
US 2010/0253589 A1 Oct. 7, 2010

(30) **Foreign Application Priority Data**

Nov. 26, 2007 (EP) 07121512

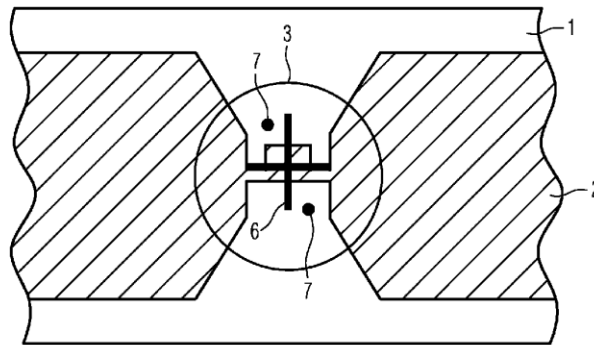
(57) **ABSTRACT**

In a method of manufacturing an antenna (11) formed on a substrate (1) an antenna structure (2) is formed on the substrate (1). The antenna structure (2) comprises an area (3) which initially is electrically short-circuited and is designed to be turned into an antenna contact (4a,4b) to be contacted with contacts (12,13) of an integrated circuit (IC). The antenna contact (4a,4b) is formed by mechanically separating the electrically short-circuited 5 area (3) particularly utilizing cutting or stamping means (5).

(51) **Int. Cl.**
H01Q 1/50 (2006.01)
H01Q 1/38 (2006.01)
G06K 19/077 (2006.01)
H01Q 1/22 (2006.01)
H01Q 9/28 (2006.01)

(52) **U.S. Cl.**
CPC *H01Q 1/38* (2013.01); *G06K 19/0775* (2013.01); *G06K 19/07749* (2013.01); *G06K*

12 Claims, 6 Drawing Sheets





US009425502B2

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

(10) **Patent No.:** **US 9,425,502 B2**
(45) **Date of Patent:** **Aug. 23, 2016**

(54) **WIRELESS MODULE WITH INTEGRATED ANTENNA BY USING RIGID-FLEX BOARD**

(71) Applicants: **Universal Scientific Industrial (Shanghai) Co., Ltd.**, Shanghai (CN); **Universal Global Scientific Industrial Co., Ltd.**, Caotun Township, Nantou County (TW)

(72) Inventors: **Hsin-Hong Chen**, Taichung (TW); **Ruei-Kun Shih**, Caotun Township, Nantou County (TW); **Echan Liu**, Caotun Township, Nantou County (TW)

(73) Assignees: **UNIVERSAL SCIENTIFIC INDUSTRIAL (SHANGHAI) CO., LTD.**, Shanghai (CN); **UNIVERSAL GLOBAL SCIENTIFIC INDUSTRIAL CO., LTD.**, Caotun Township, Nantou County (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 87 days.

(21) Appl. No.: **14/191,992**

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

(65) **Prior Publication Data**
US 2015/0116156 A1 Apr. 30, 2015

(30) **Foreign Application Priority Data**
Oct. 31, 2013 (TW) 102139614 A

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/22 (2006.01)
H01Q 23/00 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/38** (2013.01); **H01Q 1/2208** (2013.01); **H01Q 23/00** (2013.01)

(58) **Field of Classification Search**
USPC 343/700 MS, 702
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Hoang V Nguyen

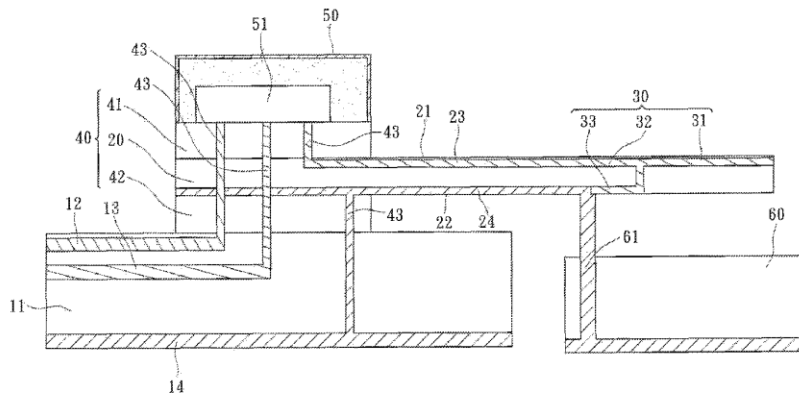
Assistant Examiner — Hai Tran

(74) *Attorney, Agent, or Firm* — Muncy, Geissler, Olds & Lowe, P.C.

(57) **ABSTRACT**

A wireless module includes a flex substrate, an antenna integrated in the flex substrate and electrically connected to a signal layer and a ground layer of the flex substrate, a first rigid substrate stacked on one side of the flex substrate remote from the antenna, and a communication unit mounted on the first rigid substrate and electrically connected to the signal layer. Thus, the flex substrate and the first rigid substrate are laminated into a Rigid-Flex board. Further, the signal layer and the ground layer are continuously arranged in the same flex substrate. It will be helpful in decreasing the uncertainty and loss of RF signal transmission path, reducing component costs, facilitating optimization of the antenna and reducing the module size.

9 Claims, 2 Drawing Sheets





US009425508B2

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

(10) **Patent No.:** **US 9,425,508 B2**
(45) **Date of Patent:** **Aug. 23, 2016**

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

USPC 343/853, 893, 702, 700 MS
See application file for complete search history.

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

(56) **References Cited**

(72) Inventors: **Chih-Hung Lai**, New Taipei (TW);
Yen-Hui Lin, New Taipei (TW)

U.S. PATENT DOCUMENTS

(73) Assignee: **Chiun Mai Communication Systems, Inc.**, New 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 324 days.

(21) Appl. No.: **14/077,448**

(22) Filed: **Nov. 12, 2013**

(65) **Prior Publication Data**

US 2014/0354506 A1 Dec. 4, 2014

(30) **Foreign Application Priority Data**

Jun. 4, 2013 (TW) 102119841 A

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

(52) **U.S. Cl.**
CPC **H01Q 5/0058** (2013.01); **H01Q 5/0062** (2013.01); **H01Q 5/0093** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/0058; H01Q 5/0093

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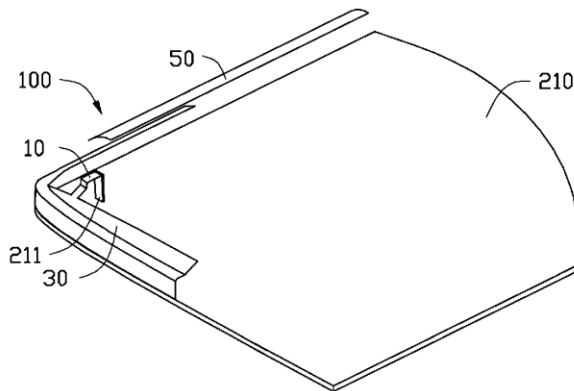
Primary Examiner — Hoanganh Le
(74) *Attorney, Agent, or Firm* — ScienBiziP, P.C.

(57) **ABSTRACT**

An antenna structure includes a feed terminal, a first antenna, and a second antenna. The first antenna includes a first antenna portion connected to the feed terminal, and a second antenna portion connected to the first antenna portion. The second antenna is substantially parallel to the second antenna portion and cooperatively defines a space with the second antenna portion.

20 Claims, 4 Drawing Sheets

200





US009425509B2

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

(10) **Patent No.:** **US 9,425,509 B2**
(45) **Date of Patent:** **Aug. 23, 2016**

- (54) **ANTENNA STRUCTURE AND WIRELESS COMMUNICATION DEVICE USING THE SAME**
- (71) Applicant: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)
- (72) Inventors: **Geng-Hong Liou**, New Taipei (TW); **Yen-Hui 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 157 days.
- (21) Appl. No.: **14/224,848**
- (22) Filed: **Mar. 25, 2014**

(65) **Prior Publication Data**
US 2015/0002340 A1 Jan. 1, 2015

(30) **Foreign Application Priority Data**
Jun. 27, 2013 (TW) 102122950

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/00 (2015.01)
H01Q 7/00 (2006.01)
H01Q 9/42 (2006.01)
H01Q 19/00 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 5/0062** (2013.01); **H01Q 7/00** (2013.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 9/42; H01Q 11/14; H01Q 11/16; H01Q 11/18; H01Q 19/00; H01Q 1/24; H01Q 5/371; H01Q 5/50; H01Q 5/392; H01Q 1/392
USPC 343/702
See application file for complete search history.

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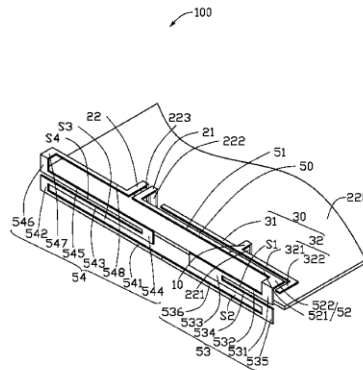
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Primary Examiner — Dameon E Levi
Assistant Examiner — Awat Salih
(74) *Attorney, Agent, or Firm* — ScienBiziP, P.C.

(57) **ABSTRACT**
An antenna structure includes a feed portion, a first ground portion, a second ground portion, a first antenna, and a second antenna. The first antenna includes a first radiator and a second radiator. The second antenna includes a first radiation portion, a second radiation portion, a third radiation portion, and a fourth radiation portion, the first radiation portion, the second radiation portion, the third radiation portion, and the fourth radiation portion are connected in turn to substantially form a loop structure. Both of the first radiator and the second radiator are connected to the feed portion, the first radiator is parallel to the first radiation portion, the second radiator is parallel to the second radiation portion, the first radiation portion is connected to the first ground portion, and the fourth radiation portion is connected to the second ground portion.

17 Claims, 2 Drawing Sheets





US009425510B2

(12) **United States Patent**
Flores-Cuadras

(10) **Patent No.:** **US 9,425,510 B2**
(45) **Date of Patent:** **Aug. 23, 2016**

(54) **COUPLED DUAL-BAND DIPOLE ANTENNA WITH INTERFERENCE CANCELLATION GAP, METHOD OF MANUFACTURE AND KITS THEREFOR**

(58) **Field of Classification Search**
USPC 343/700 MS, 702, 726, 793, 795
See application file for complete search history.

(75) Inventor: **Javier Ruben Flores-Cuadras**, Tijuana (MX)

(56) **References Cited**

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(73) Assignee: **TAOGLAS GROUP HOLDINGS**, San Diego, CA (US)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 559 days.

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WO 2012071266 A2 5/2012

(22) PCT Filed: **Nov. 21, 2011**

(Continued)

(86) PCT No.: **PCT/US2011/061625**

§ 371 (c)(1),
(2), (4) Date: **Aug. 16, 2013**

Primary Examiner — Hoang V Nguyen

Assistant Examiner — Hai Tran

(87) PCT Pub. No.: **WO2012/071315**

(74) *Attorney, Agent, or Firm* — Shartis Friese LLP; Cecily Anne O'Regan

PCT Pub. Date: **May 31, 2012**

(65) **Prior Publication Data**

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Related U.S. Application Data

(60) Provisional application No. 61/416,365, filed on Nov. 23, 2010.

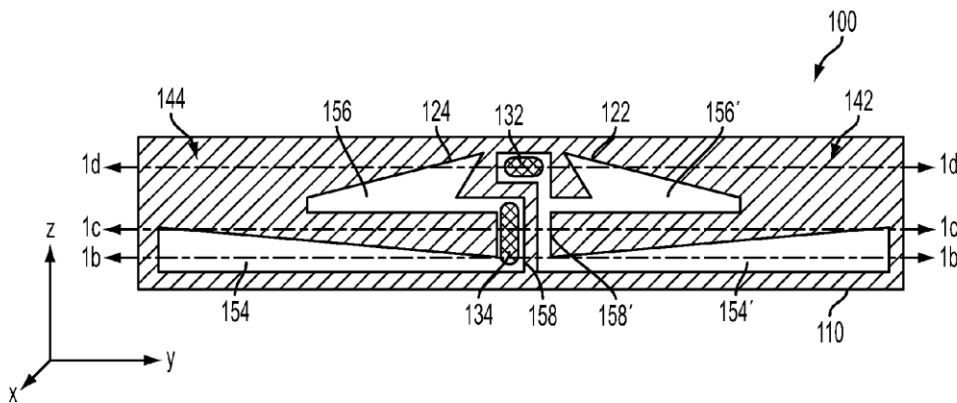
(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 9/16 (2006.01)
H01Q 9/28 (2006.01)
H01Q 5/371 (2015.01)

(57) **ABSTRACT**

A planar dipole antenna for dual-band Wi-Fi application is disclosed. The antenna has a ground copper and a radiation copper. The ground copper is adhered to a substrate and has an upper, shorter and generally horizontal segment and a lower, longer and also generally horizontal segment that are connected at one end thereof by a vertical segment. The radiation copper is adhered to the substrate and has a copper shaped substantially as a mirror symmetry of the ground copper and spaced apart from the ground copper by a gap at the end of the ground and radiation coppers where the shorter and longer horizontal segments thereof are connected. The antenna has a gross span of approximately 42 mm and a height of approximately 7 mm. The gap is approximately 0.6 mm.

(52) **U.S. Cl.**
CPC **H01Q 9/16** (2013.01); **H01Q 5/371** (2015.01); **H01Q 9/285** (2013.01)

26 Claims, 4 Drawing Sheets





US009425514B2

(12) **United States Patent**
Chou

(10) **Patent No.:** **US 9,425,514 B2**
(45) **Date of Patent:** **Aug. 23, 2016**

- (54) **WIDEBAND ANTENNA**
- (71) Applicant: **Wistron Corporation**, New Taipei (TW)
- (72) Inventor: **Chen-Yu Chou**, New Taipei (TW)
- (73) Assignee: **Wistron Corporation**, 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 142 days.

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343/700 MS

- (21) Appl. No.: **14/260,288**
- (22) Filed: **Apr. 24, 2014**
- (65) **Prior Publication Data**
US 2015/0188235 A1 Jul. 2, 2015

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- (30) **Foreign Application Priority Data**
Jan. 2, 2014 (TW) 103100056 A

Primary Examiner — Dameon E Levi
Assistant Examiner — Awat Salih
(74) *Attorney, Agent, or Firm* — Jianq Chyun IP Office

- (51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 19/185 (2006.01)
H01Q 11/06 (2006.01)

(57) **ABSTRACT**

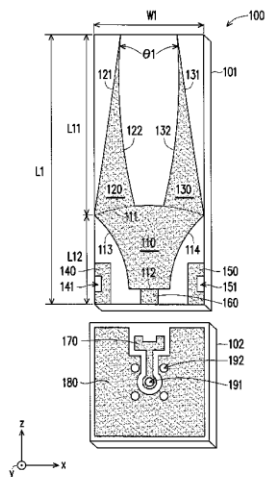
A wideband antenna includes a radiation element, first and second extension elements, first and second reflection elements, and a feeding element. The radiation element is symmetric to a reference direction and has a top edge, a bottom edge, a first side edge, and a second side edge. A width of the radiation element gradually increases along the reference direction. The first and second extension elements are extended toward the reference direction respectively from two ends of the top edge and are mirror-symmetric to each other with respect to the reference direction. Widths of the first and second extension elements gradually decrease along the reference direction. The first and second reflection elements are respectively opposite to the first and second side edges and are mirror-symmetric to each other with respect to the reference direction. The feeding element is electrically connected to the bottom edge and has a feeding point.

- (52) **U.S. Cl.**
CPC **H01Q 19/185** (2013.01); **H01Q 11/06**
(2013.01)

- (58) **Field of Classification Search**
CPC H01Q 1/38; H01Q 5/55; H01Q 5/28;
H01Q 13/085; H01Q 9/285; H01Q 9/28;
H01Q 21/06; H01Q 9/16; H01Q 13/10
USPC 343/700 MS, 795, 807, 825, 828, 829,
343/830, 846, 767, 770
See application file for complete search history.

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343/700 MS

15 Claims, 7 Drawing Sheets





US009425515B2

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

(10) **Patent No.:** **US 9,425,515 B2**
(45) **Date of Patent:** **Aug. 23, 2016**

(54) **MULTI-SLOT COMMON APERTURE DUAL POLARIZED OMNI-DIRECTIONAL ANTENNA**

USPC 343/767, 770, 771
See application file for complete search history.

(71) Applicant: **LHC2 INC**, Liberty Lake, WA (US)

(56) **References Cited**

(72) Inventors: **Royden M. Honda**, Post Falls, ID (US);
Robert J. Conley, Liberty Lake, WA (US);
Jon Thorpe, Liberty Lake, WA (US)

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(73) Assignee: **LHC2 INC**, Liberty Lake, WA (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.: **14/846,117**

(22) Filed: **Sep. 4, 2015**

(65) **Prior Publication Data**

US 2016/0064828 A1 Mar. 3, 2016

Related U.S. Application Data

(62) Division of application No. 13/839,839, filed on Mar. 15, 2013, now Pat. No. 9,184,507.

(60) Provisional application No. 61/615,006, filed on Mar. 23, 2012.

(51) **Int. Cl.**
H01Q 13/12 (2006.01)
H01Q 21/00 (2006.01)
H01Q 21/20 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 21/0062** (2013.01); **H01Q 13/12** (2013.01); **H01Q 21/00** (2013.01); **H01Q 21/20** (2013.01)

(58) **Field of Classification Search**
CPC ... H01Q 13/12; H01Q 21/00; H01Q 21/0062; H01Q 21/20

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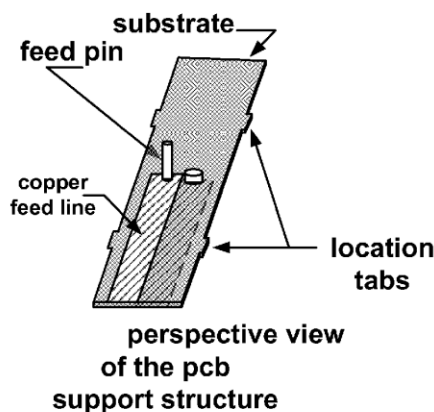
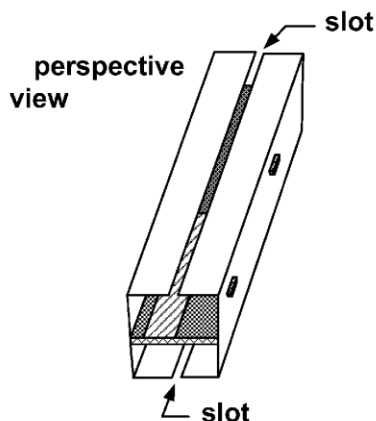
Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — Lee & Hayes, PLLC

(57) **ABSTRACT**

Horizontally polarized and dual polarized antennas are described herein. In some examples, a horizontally polarized and dual polarized antenna may be mounted or operated with the physical vertical axis of the antenna being substantially perpendicular to a plane defined by the surface of the earth, and emanate an electric field that is parallel to the surface of the earth. The antenna may have a multi-slot aperture that reduces a variation in the far field omni-directional pattern. The antenna may have various cross-sectional configurations, and may have a radome at least partially surrounding the antenna and a supporting structure.

20 Claims, 31 Drawing Sheets





US00D764446S

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

(10) **Patent No.:** **US D764,446 S**

(45) **Date of Patent:** **** Aug. 23, 2016**

- (54) **ANTENNA**
- (71) Applicant: **Airgain Incorporated**, San Diego, CA (US)
- (72) Inventors: **Wei Chang**, Zhang Jia Gang (CN); **David Wu**, Zhang Jia Gang (CN); **Bei Zheng**, Zhang Jia Gang (CN); **Simon Yang**, Carlsbad, CA (US)
- (73) Assignee: **Airgain Incorporated**, San Diego, CA (US)
- (**) Term: **14 Years**
- (21) Appl. No.: **29/516,664**
- (22) Filed: **Feb. 4, 2015**
- (51) **LOC (10) CL** **14-03**
- (52) **U.S. CL**
USPC **D14/230**
- (58) **Field of Classification Search**
USPC D14/138, 230–238.1, 299, 358; D13/182
CPC H01L 33/48; H01L 33/486; H01L 23/02; H05K 5/00; H01Q 13/10
See application file for complete search history.

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- D635,127 S 3/2011 Tsai et al.
- 7,907,971 B2 3/2011 Salo et al.
- D635,560 S 4/2011 Tsai et al.
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Primary Examiner — Manpreet Matharu

Assistant Examiner — Mojtaba Tehrani

(74) *Attorney, Agent, or Firm* — Claus Eight IPS; Michael Catania

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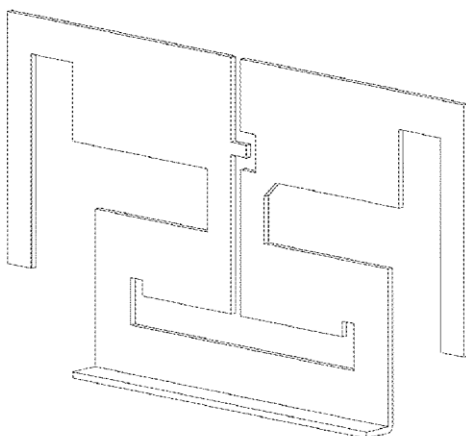
(57) **CLAIM**

The ornamental design for an antenna, as shown.

DESCRIPTION

FIG. 1 is a top perspective view of an antenna, showing our new design;
FIG. 2 is a top plan view thereof;
FIG. 3 is a front elevation view thereof; and,
FIG. 4 is a side view thereof; the opposite side view being a mirror image.

1 Claim, 1 Drawing Sheet





US00D764447S

(12) **United States Design Patent**
Yang et al.

(10) **Patent No.:** **US D764,447 S**

(45) **Date of Patent:** **** Aug. 23, 2016**

- (54) **ANTENNA**
- (71) Applicant: **Airgain, Incorporated**, San Diego, CA (US)
- (72) Inventors: **Simon Yang**, Carlsbad, CA (US); **Bei Zheng**, Zhang Jia Gang (CN); **Mengyi Tao**, Zhang Jia Gang (CN)
- (73) Assignee: **Airgain Incorporated**, San Diego, CA (US)
- (**) Term: **14 Years**
- (21) Appl. No.: **29/524,190**
- (22) Filed: **Apr. 17, 2015**
- (51) **LOC (10) CL** **14-03**
- (52) **U.S. CL** **D14/230**
USPC **D14/230**
- (58) **Field of Classification Search**
USPC D14/138, 230–238.1, 299, 358; D13/182
CPC H01L 33/48; H01L 33/486; H01L 23/02; H05K 5/00; H01Q 13/10
See application file for complete search history.

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- D608,769 S 1/2010 Bufe
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- 7,705,783 B2 4/2010 Rao et al.
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- D621,819 S 8/2010 Tsai et al.
- 7,843,390 B2 11/2010 Liu
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- D635,127 S 3/2011 Tsai et al.
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Primary Examiner — Manpreet Matharu
Assistant Examiner — Mojtaba Tehrani
(74) *Attorney, Agent, or Firm* — Clause Eight IPS; Michael Catania

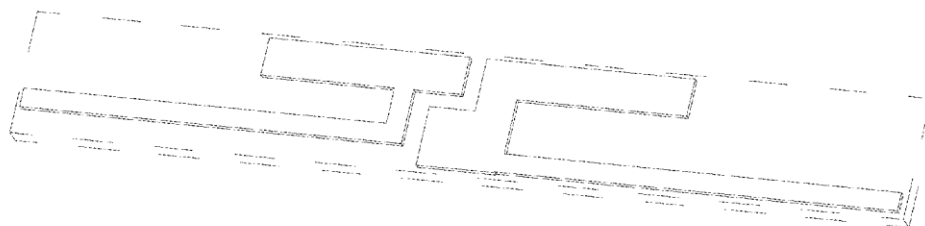
(57) **CLAIM**
The ornamental design for an antenna, as shown and described.

DESCRIPTION

FIG. 1 is a front elevation view of an antenna, showing our new design;
FIG. 2 is a side plan view thereof;
FIG. 3 is a top plan view thereof;
FIG. 4 is a rear elevation view thereof;
FIG. 5 is a top perspective view thereof;
FIG. 6 is a front elevation view thereof, with unclaimed environment not shown; and,
FIG. 7 is a top elevation view thereof, with unclaimed environment not shown.
The broken line in the figure drawings represents unclaimed environment only and forms no part of the claimed design.

1 Claim, 2 Drawing Sheets

- (56) **References Cited**
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- D599,334 S 9/2009 Chiang





US009431693B2

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

(10) **Patent No.:** **US 9,431,693 B2**
(45) **Date of Patent:** **Aug. 30, 2016**

(54) **MOBILE TERMINAL**
(75) Inventors: **Daeyong Kwak**, Gyeonggi-Do (KR);
Sungjung Rho, Seoul (KR); **Kangjae Jung**, 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 269 days.

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(21) Appl. No.: **13/161,418**
(22) Filed: **Jun. 15, 2011**
(65) **Prior Publication Data**
US 2012/0218723 A1 Aug. 30, 2012

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(30) **Foreign Application Priority Data**
Feb. 25, 2011 (KR) 10-2011-0017410

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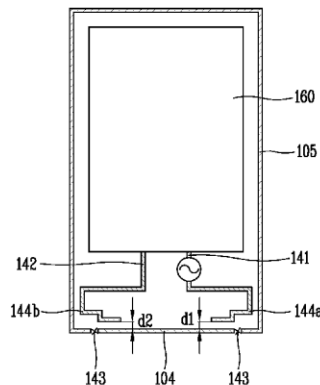
(51) **Int. Cl.**
H05K 7/00 (2006.01)
H01Q 1/24 (2006.01)
H01Q 7/00 (2006.01)
H01Q 5/371 (2015.01)
(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 5/371** (2015.01); **H01Q 7/00** (2013.01)
(58) **Field of Classification Search**
CPC H05K 7/00; H01Q 1/243; H01Q 7/00; H01Q 5/371
USPC 361/814
See application file for complete search history.

Primary Examiner — David M Sinclair
Assistant Examiner — Theron Milliser
(74) *Attorney, Agent, or Firm* — Lee, Hong, Degerman, Kang & Waimey; Jonathan Kang; Harry Lee

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5,086,509 A * 2/1992 Inubushi et al. 455/575.8

(57) **ABSTRACT**
Disclosed herein is a mobile terminal including a terminal body comprising a circuit board formed to process radio signals, a first and a second member configured to form an external appearance of the terminal and disposed to cover a lateral surface of the circuit board, a power feed connecting portion to allow the first member and the circuit board to be power feed connected, and a ground connecting portion to allow the first member and the circuit board to be ground connected. Accordingly, an electrical element and an antenna are disposed adjacent to each other, allowing the effective use of a space within the terminal.

25 Claims, 8 Drawing Sheets





US009431696B2

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

(10) **Patent No.:** **US 9,431,696 B2**

(45) **Date of Patent:** **Aug. 30, 2016**

(54) **COMMUNICATION DEVICE WITH GROUND PLANE ANTENNA**

- (71) Applicant: **Acer Incorporated**, New Taipei (TW)
- (72) Inventors: **Kin-Lu Wong**, New Taipei (TW);
Tseng-Wei Weng, 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.: **13/949,245**
- (22) Filed: **Jul. 24, 2013**

(65) **Prior Publication Data**
US 2014/0327593 A1 Nov. 6, 2014

(30) **Foreign Application Priority Data**
May 2, 2013 (TW) 102115722 A

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/48 (2006.01)
H01Q 9/26 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/04 (2006.01)
H01Q 5/364 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 1/48** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 9/0414** (2013.01); **H01Q 9/26** (2013.01); **H01Q 5/364** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/38; H01Q 9/0414; H01Q 9/0421; H01Q 9/16; H01Q 9/0407; H01Q 1/2283; H01Q 5/364
USPC 343/702, 846, 700 MS, 848, 793, 794
See application file for complete search history.

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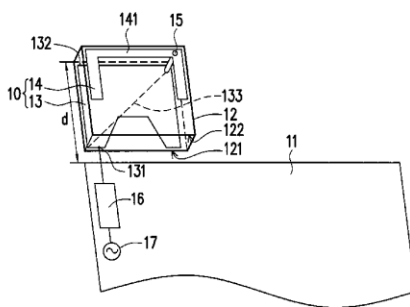
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Primary Examiner — Dameon E Levi
Assistant Examiner — Ricardo Magallanes
(74) *Attorney, Agent, or Firm* — Jianq Chyun IP Office

(57) **ABSTRACT**

A communication device including a ground element, a dielectric substrate, and an antenna element is provided. The dielectric substrate is disposed nearby the ground element and has a first surface and a second surface. The antenna element includes a first metal portion and a second metal portion. The first metal portion is disposed on the first surface and has a feeding point. The second metal portion is disposed on the second surface. The first metal portion is electrically connected to the second metal portion through a conductive via-hole, and the conductive via-hole is located at or nearby a first edge of the first metal portion. The first edge is away from the ground element. The projection of the second metal portion on the first surface is covered by the first metal portion.

8 Claims, 3 Drawing Sheets





US009431706B2

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

(10) **Patent No.:** **US 9,431,706 B2**
(45) **Date of Patent:** **Aug. 30, 2016**

(54) **MULTI-BAND ANTENNA**
(71) Applicant: **Acer Incorporated**, New Taipei (TW)
(72) Inventors: **Kun-Sheng Chang**, New Taipei (TW);
Ching-Chi Lin, New Taipei (TW);
Ming-Yu Chou, 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 161 days.

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Primary Examiner — Tho G Phan
(74) *Attorney, Agent, or Firm* — Jianq Chyun IP Office

(21) Appl. No.: **14/295,357**
(22) Filed: **Jun. 4, 2014**
(65) **Prior Publication Data**
US 2015/0042517 A1 Feb. 12, 2015
(30) **Foreign Application Priority Data**
Aug. 6, 2013 (TW) 102128118 A

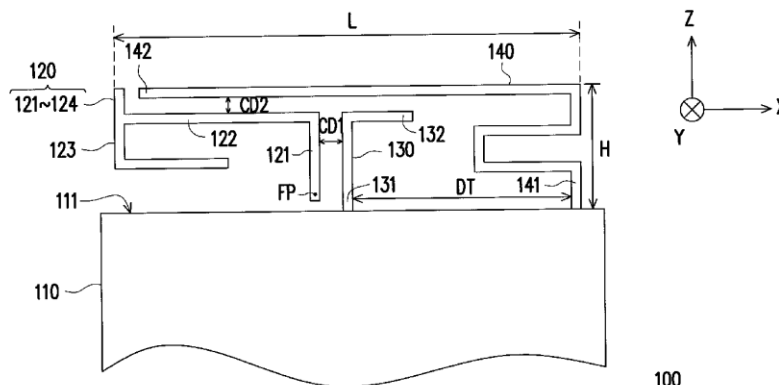
(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/385 (2015.01)
H01Q 5/371 (2015.01)
(52) **U.S. Cl.**
CPC **H01Q 5/385** (2015.01); **H01Q 5/371** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 5/371; H01Q 5/385
USPC 343/700 MS, 702, 829, 846
See application file for complete search history.

(56) **References Cited**
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343/700 MS
8,643,558 B2 * 2/2014 Tseng H01Q 9/145
343/749

(57) **ABSTRACT**
A multi-band antenna including a ground plane, a radiation element, a first extension element and a second extension element is provided. The radiation element includes a first portion and a second portion electrically connected with each other. The first portion has a feeding point. The first and the second extension elements are extended from the ground plane. The first extension element and the first portion are spaced by a first coupling distance. The second extension element and the second portion are spaced by a second coupling distance. The multi-band antenna is operated in a first band through the radiation element. A feeding signal from the radiation element excites the first and the second extension elements through the first and the second coupling distances so that the multi-band antenna is operated further in a second band and a third band.

9 Claims, 5 Drawing Sheets





US009431708B2

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

(10) **Patent No.:** **US 9,431,708 B2**

(45) **Date of Patent:** **Aug. 30, 2016**

(54) **CAPACITIVELY COUPLED COMPOUND LOOP ANTENNA**

- (71) Applicant: **DOCKON AG**, Zurich (CH)
- (72) Inventors: **Ryan James Orsi**, San Diego, CA (US); **Matthew Robert Foster**, San Diego, CA (US); **Gregory Poilasne**, El Cajon, CA (US)
- (73) Assignee: **DOCKON AG**, Zurich (CH)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 464 days.

(21) Appl. No.: **13/669,389**

(22) Filed: **Nov. 5, 2012**

(65) **Prior Publication Data**

US 2013/0113666 A1 May 9, 2013

Related U.S. Application Data

(60) Provisional application No. 61/556,145, filed on Nov. 4, 2011.

(51) **Int. Cl.**

- H01Q 7/00** (2006.01)
- H01Q 9/30** (2006.01)
- H01Q 21/29** (2006.01)
- H01Q 5/00** (2015.01)
- H01Q 5/35** (2015.01)

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

CPC **H01Q 7/00** (2013.01); **H01Q 5/35** (2015.01); **H01Q 9/30** (2013.01); **H01Q 21/29** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 7/005; H01Q 7/02; H01Q 7/04; H01Q 7/06; H01Q 7/08
USPC 343/700 MS, 726, 745, 866, 788
See application file for complete search history.

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Primary Examiner — Sue A Purvis

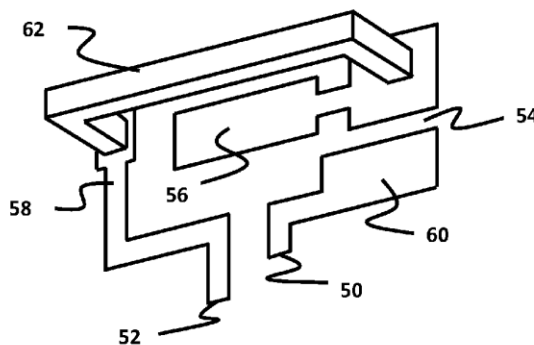
Assistant Examiner — Daniel J Munoz

(74) *Attorney, Agent, or Firm* — Baker & Hostetler LLP

(57) **ABSTRACT**

A compound loop antenna (CPL) is described that includes a capacitively fed magnetic loop and/or a capacitively fed electric field radiator. Embodiments include single-band CPL antennas and multi-band CPL antennas. The CPL antennas have been reduced in physical size by capacitively feeding the loop and/or radiator. The embodiments include at least one e-field radiation element that is capacitively coupled or not capacitively coupled, at least one magnetic loop element that is capacitively coupled. A continuation of the magnetic loop may be continued with either a wire or a connection to a second layer.

23 Claims, 14 Drawing Sheets





US009431710B2

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

(10) **Patent No.:** **US 9,431,710 B2**
(45) **Date of Patent:** **Aug. 30, 2016**

- (54) **PRINTED WIDE BAND MONOPOLE ANTENNA MODULE**
- (71) Applicant: **Arcadyan Technology Corporation**, Hsinchu (TW)
- (72) Inventors: **Chih-Yung Huang**, Taichung (TW); **Kuo-Chang Lo**, Miaoli County (TW); **Jen-Hsiang Fang**, Hsinchu (TW)
- (73) Assignee: **ARCADYAN TECHNOLOGY CORPORATION**, Hsinchu (TW)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 219 days.

- (21) Appl. No.: **13/916,124**
- (22) Filed: **Jun. 12, 2013**
- (65) **Prior Publication Data**
US 2014/0145885 A1 May 29, 2014
- (30) **Foreign Application Priority Data**
Nov. 26, 2012 (TW) 101144190 A

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

- (52) **U.S. Cl.**
CPC **H01Q 9/0407** (2013.01); **H01Q 1/38** (2013.01); **H01Q 5/307** (2015.01); **H01Q 5/50** (2015.01); **H01Q 9/40** (2013.01)

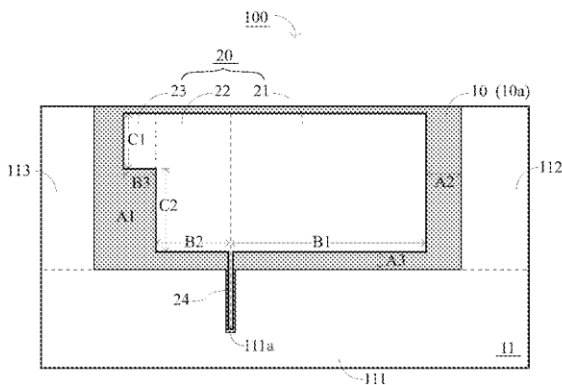
- (58) **Field of Classification Search**
CPC H01Q 1/38; H01Q 9/0407; H01Q 5/307; H01Q 5/50; H01Q 9/40
USPC 343/700, 825, 829, 830, 848, 860, 343/700 MS
See application file for complete search history.

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Primary Examiner — Sue A Purvis
Assistant Examiner — Bamidele A Jegede
 (74) *Attorney, Agent, or Firm* — Rabin & Berdo, P.C.

- (57) **ABSTRACT**
A printed wide band monopole antenna module is provided. The module comprises: a substrate having a first surface, a ground terminal part formed on the first surface, and an antenna body disposed on the first surface opposite to the ground terminal part. The antenna body comprises: a first extending part having a first length, a second extending part having a second length, and a third extending part having a first width. The width of the second extending part is the first width plus a second width. The second extending part forms a connection with the first and the third extending part. The ratio of the first length to the second length is less than a first value. The ratio of the first length to the sum of the first and the second width is less than a second value.

14 Claims, 4 Drawing Sheets





US009431711B2

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

(10) **Patent No.:** **US 9,431,711 B2**
(45) **Date of Patent:** **Aug. 30, 2016**

(54) **BROADBAND MULTI-STRIP PATCH ANTENNA**
(75) Inventors: **Qidong Guo**, Gurnee, IL (US); **Adem Celebi**, Oak Park, IL (US); **Chris Lotesto**, Prospect Heights, IL (US); **Walter Harwood**, Streamwood, IL (US)

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(73) Assignee: **SHURE INCORPORATED**, Niles, IL (US)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 590 days.

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Written Opinion for PCT/US2013/052185, mailed Nov. 4, 2013.

(21) Appl. No.: **13/601,011**

(22) Filed: **Aug. 31, 2012**

(65) **Prior Publication Data**
US 2014/0062794 A1 Mar. 6, 2014

(Continued)
Primary Examiner — Hoang V Nguyen
Assistant Examiner — Hai Tran
(74) *Attorney, Agent, or Firm* — Marshall, Gerstein & Borun LLP

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 9/04 (2006.01)
H01Q 5/378 (2015.01)

(57) **ABSTRACT**

(52) **U.S. Cl.**
CPC **H01Q 9/0414** (2013.01); **H01Q 5/378** (2015.01); **H01Q 1/38** (2013.01)

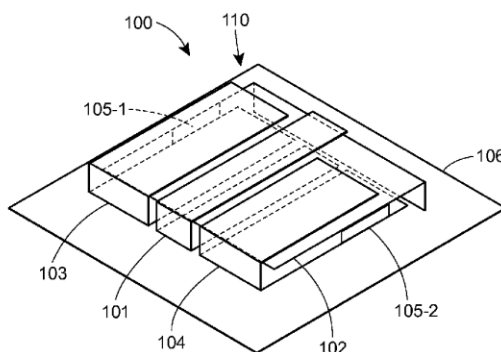
A system and method of providing a broadband patch antenna includes a main patch having a first strip and a second strip positioned about a ground strip extending from a ground plane, wherein at least a portion of the first strip of the main patch is disposed above the ground strip and forms a first radiating edge with the ground strip, and at least a portion of the second strip of the main patch is disposed below the ground strip and forms a second radiating edge with the ground plane. A parasitic patch is coupled to the main patch along at least a portion of a non-radiating edge of the main patch, and the parasitic patch includes a first strip and a second strip, wherein at least a portion of the first strip of the parasitic patch is disposed above the ground strip and at least a portion of the second strip of the parasitic patch is disposed below the ground strip.

(58) **Field of Classification Search**
USPC 343/700 MS, 702
See application file for complete search history.

(56) **References Cited**
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254/104

30 Claims, 16 Drawing Sheets





US009431712B2

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

(10) **Patent No.:** **US 9,431,712 B2**
(45) **Date of Patent:** **Aug. 30, 2016**

(54) **ELECTRICALLY-SMALL, LOW-PROFILE, ULTRA-WIDEBAND ANTENNA**

(71) Applicant: **Wisconsin Alumni Research Foundation, Madison, WI (US)**

(72) Inventors: **Seyed Mohamad Amin Momeni Hasan Abadi, Madison, WI (US); Nader Behdad, Madison, WI (US)**

(73) Assignee: **Wisconsin Alumni Research Foundation, Madison, WI (US)**

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 345 days.

(21) Appl. No.: **13/899,726**

(22) Filed: **May 22, 2013**

(65) **Prior Publication Data**
US 2014/0347243 A1 Nov. 27, 2014

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 1/48 (2006.01)
H01Q 5/25 (2015.01)
H01Q 5/364 (2015.01)
H01Q 9/36 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 9/0421** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/25** (2015.01); **H01Q 5/364** (2015.01); **H01Q 9/045** (2013.01); **H01Q 9/0442** (2013.01); **H01Q 9/36** (2013.01)

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

(56) **References Cited**
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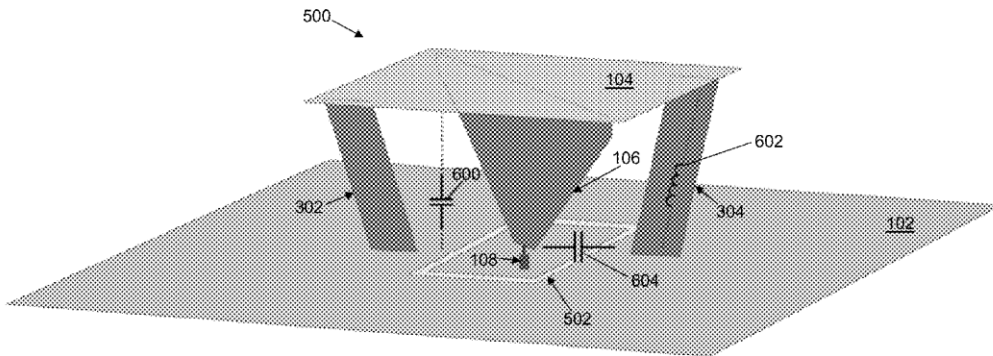
Primary Examiner — Robert Karacsony

(74) *Attorney, Agent, or Firm* — Bell & Manning, LLC

(57) **ABSTRACT**

An ultra-wideband, low profile antenna is provided. The antenna includes a ground plane substrate, a feed conductor, a top hat conductor, a shorting arm, and a ring slot. The feed conductor includes a first end and a second end. The first end is configured for electrical coupling to a feed network through a feed element extending from the ground plane substrate. The top hat conductor includes a generally planar sheet mounted to the second end of the feed conductor in a first plane approximately parallel to a second plane defined by the ground plane substrate. The shorting arm includes a third end and a fourth end. The third end is mounted to the top hat conductor, and the fourth end is mounted to the ground plane substrate. The ring slot is formed in the ground plane substrate around the feed element.

20 Claims, 29 Drawing Sheets





US009431717B1

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

(10) **Patent No.:** **US 9,431,717 B1**
(45) **Date of Patent:** **Aug. 30, 2016**

(54) **WIDEBAND DUAL-ARM ANTENNA WITH PARASITIC ELEMENT**

(71) Applicant: **AMAZON TECHNOLOGIES, INC.**,
Reno, NV (US)

(72) Inventors: **Tzung-I Lee**, San Jose, CA (US); **In Chul Hyun**, San Jose, 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 475 days.

(21) Appl. No.: **13/926,873**

(22) Filed: **Jun. 25, 2013**

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 19/00 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 19/005** (2013.01)

(58) **Field of Classification Search**
USPC 343/700 MS, 702, 829, 846
See application file for complete search history.

(56) **References Cited**

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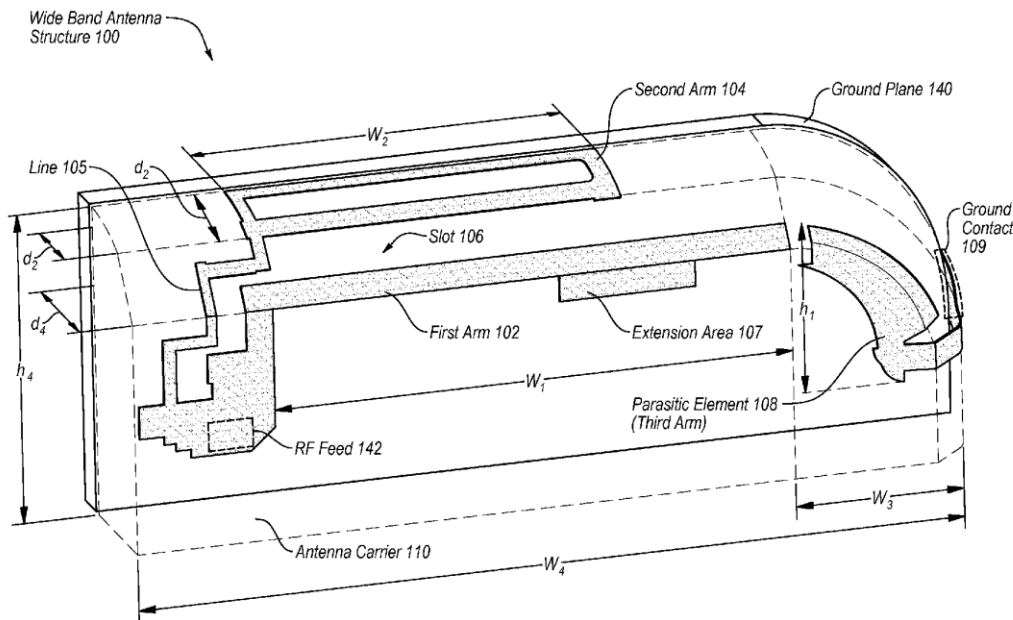
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Primary Examiner — Tho G Phan
(74) *Attorney, Agent, or Firm* — Lowenstein Sandler LLP

(57) **ABSTRACT**

Antenna structures and methods of operating the same of a wideband dual-arm antenna of an electronic device are described. One wideband antenna includes a first feeding arm coupled to a radio frequency (RF) feed and a second feeding arm coupled to the RF feed. At least a portion of the second feeding arm is parallel to the first feeding arm. The wideband dual-arm antenna further includes a third arm coupled to the ground plane. The third arm is a parasitic ground element that forms a coupling to the first feeding arm and the second feeding arm. The parasitic element increases a bandwidth of the wideband antenna.

20 Claims, 8 Drawing Sheets





US009437924B2

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

(10) **Patent No.:** US 9,437,924 B2
(45) **Date of Patent:** Sep. 6, 2016

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

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

(72) Inventors: **Kun-Lin Sung**, New Taipei (TW);
Yen-Hui 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 185 days.

(21) Appl. No.: **14/055,972**

(22) Filed: **Oct. 17, 2013**

(65) **Prior Publication Data**
US 2014/0333483 A1 Nov. 13, 2014

(30) **Foreign Application Priority Data**
May 10, 2013 (TW) 102116638 A

(51) **Int. Cl.**
H01Q 5/00 (2015.01)
H01Q 1/24 (2006.01)
H01Q 5/371 (2015.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 5/371** (2015.01); **H01Q 1/243** (2013.01); **H01Q 9/0421** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/371; H01Q 1/243; H01Q 1/36; H01Q 5/378
See application file for complete search history.

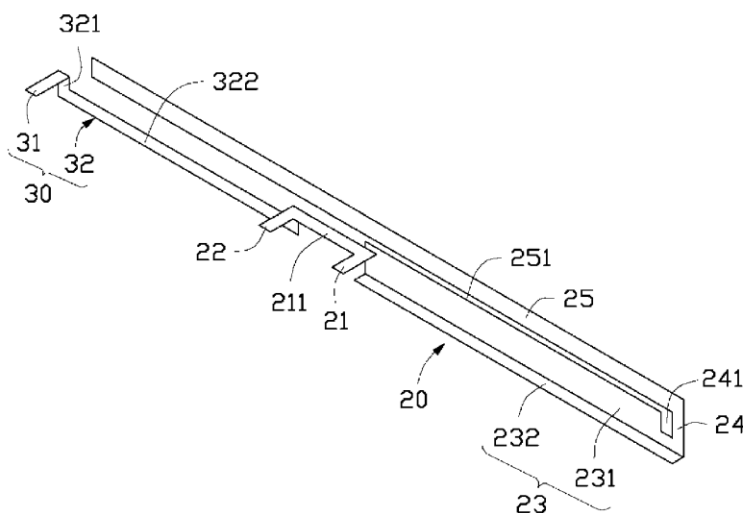
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Primary Examiner — Dameon E Levi
Assistant Examiner — Ricardo Magallanes
(74) *Attorney, Agent, or Firm* — Zhigang Ma

(57) **ABSTRACT**
An antenna structure includes a first radiating body and a second radiating body. The first radiating body includes a feed portion, a first ground portion, a first extending portion, a second extending portion, and a third extending portion. The feed portion is electronically connected to the first ground portion. The first extending portion is electronically connected to the second extending portion. The second extending portion is perpendicularly connected between the first extending portion and the third extending portion. The second radiating body includes a second ground portion and a combining portion electronically connected to the second ground portion. The combining portion is spaced from the third extending portion.

18 Claims, 3 Drawing Sheets

100





US009437925B2

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

(10) **Patent No.:** **US 9,437,925 B2**
(45) **Date of Patent:** **Sep. 6, 2016**

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

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

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

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 239 days.

(21) Appl. No.: **14/205,763**

(22) Filed: **Mar. 12, 2014**

(65) **Prior Publication Data**
US 2015/0162659 A1 Jun. 11, 2015

(30) **Foreign Application Priority Data**
Dec. 11, 2013 (TW) 102145503 A

(51) **Int. Cl.**
H01Q 5/371 (2015.01)
H01Q 7/00 (2006.01)
H01Q 5/378 (2015.01)
H01Q 1/24 (2006.01)
H01Q 5/321 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 5/371** (2015.01); **H01Q 1/243** (2013.01); **H01Q 5/321** (2015.01); **H01Q 5/378** (2015.01); **H01Q 7/00** (2013.01)

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

(56) **References Cited**

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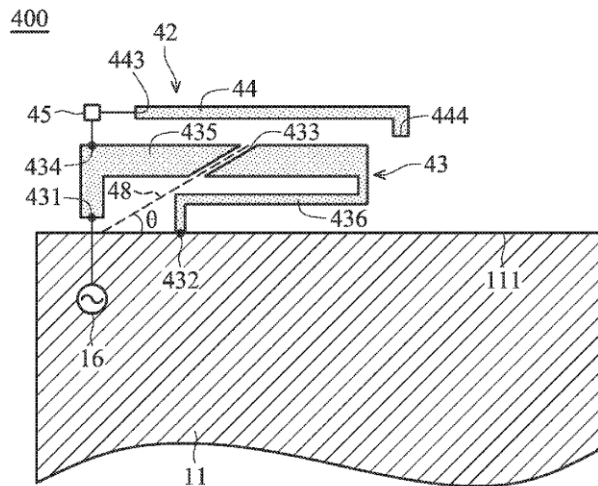
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Primary Examiner — Robert Karacsony
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

A communication device including a ground element and an antenna element is provided. The antenna element is disposed adjacent to an edge of the ground element. The antenna element includes a loop metal element and a branch metal element. The loop metal element has a first end and a second end. The first end is coupled to a signal source. The second end is coupled to the ground element. The loop metal element includes a first segment and a second segment. The first segment is separated from the second segment by a gap. The first segment includes the first end, and the second segment includes the second end. The branch metal element has a third end and a fourth end. The third end is coupled through an inductive element to a connection point on the loop metal element. The fourth end is open.

8 Claims, 5 Drawing Sheets





US009437926B2

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

(10) **Patent No.:** **US 9,437,926 B2**
(45) **Date of Patent:** **Sep. 6, 2016**

(54) **ANTENNA HAVING ASYMMETRIC T SHAPE COUPLED FEED**

(71) Applicant: **Wistron Corporation**, New Taipei (TW)

(72) Inventors: **Mohammed Ziaul Azad**, Rolling Meadows, IL (US); **Firass Badaruzzaman**, Rolling Meadows, IL (US); **Hou-Chun Huang**, New Taipei (TW)

(73) Assignee: **Wistron Corporation**, 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 50 days.

(21) Appl. No.: **14/557,016**

(22) Filed: **Dec. 1, 2014**

(65) **Prior Publication Data**

US 2016/0156102 A1 Jun. 2, 2016

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/378 (2015.01)
H01Q 1/50 (2006.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 5/378** (2015.01); **H01Q 1/50** (2013.01); **H01Q 9/04** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/38; H01Q 1/50; H01Q 9/0457; H01Q 5/378
See application file for complete search history.

(56) **References Cited**

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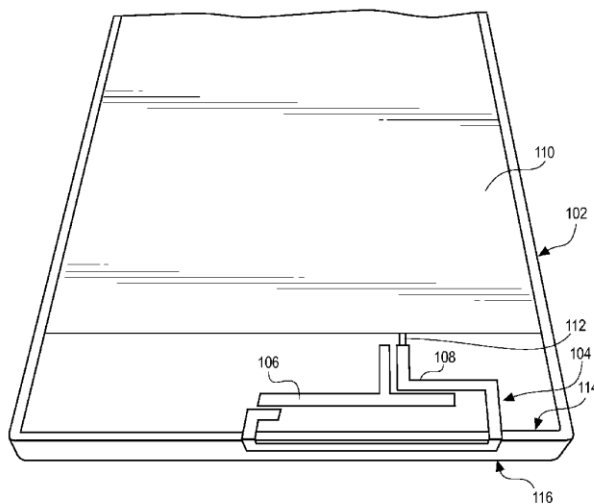
Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Leydig, Voit & Mayer, Ltd.

(57) **ABSTRACT**

A broadband antenna for interfacing an electronic device with a plurality of radio access technologies is provided. The antenna includes an excitation element and a parasitic element. The excitation element includes a feed line with a first distal end and a second distal end with first and second arms extending from the second distal end, wherein one of the first or second arms is shorter than the other such that the excitation element forms an asymmetrical T shape. The length of the first and second arms determines at least two modes of operation of the antenna. The parasitic element wraps around the asymmetrical T shape and includes a length configured to provide another mode of operation of the antenna.

25 Claims, 5 Drawing Sheets





US009437928B2

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

(10) **Patent No.:** **US 9,437,928 B2**
(45) **Date of Patent:** **Sep. 6, 2016**

(54) **FEEDING MATCHING APPARATUS OF MULTIBAND ANTENNA, MULTIBAND ANTENNA, AND RADIO COMMUNICATION DEVICE**

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

(72) Inventors: **Yuanpeng Li**, Beijing (CN); **Hanyang Wang**, Shenzhen (CN); **Yafang Yu**, Beijing (CN); **Meng Hou**, Shanghai (CN)

(73) Assignee: **Huawei Device Co., Ltd.**, Shenzhen (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 311 days.

(21) Appl. No.: **14/143,367**

(22) Filed: **Dec. 30, 2013**

(65) **Prior Publication Data**
US 2014/0197993 A1 Jul. 17, 2014

Related U.S. Application Data
(63) Continuation of application No. PCT/CN2013/070557, filed on Jan. 16, 2013.

(51) **Int. Cl.**
H01Q 1/50 (2006.01)
H01Q 9/04 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 9/04** (2013.01); **H01Q 5/314** (2015.01); **H01Q 5/328** (2015.01); **H01Q 5/335** (2015.01); **H04B 1/0057** (2013.01); **H04B 1/0458** (2013.01); **H04B 1/18**

(2013.01); **H01P 1/2039** (2013.01); **H01P 1/2135** (2013.01); **H01P 5/12** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/24; H01Q 5/378; H01Q 5/371
USPC 343/850, 852, 860, 700 MS, 702
See application file for complete search history.

(56) **References Cited**

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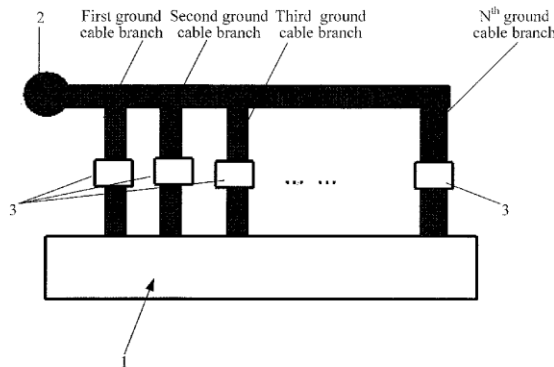
Primary Examiner — Hoanganh Le

(74) Attorney, Agent, or Firm — Leydig, Voit & Mayer, Ltd.

(57) **ABSTRACT**

The present disclosure relates to the field of antenna technologies and discloses a feeding matching apparatus of a multiband antenna, a multiband antenna, and a radio communication device to improve a bandwidth and efficiency of a lower frequency band. The feeding matching apparatus of a multiband antenna includes: a grounding portion; a feeding portion connected to a signal source, where a signal of the signal source is input into the feeding portion; and two or more ground cable branches with different lengths, where one end of each ground cable branch is electrically connected to the feeding portion, the other end is electrically connected to the grounding portion, at least one ground cable branch is connected in series to a signal filtering component, and the signal filtering component is capable of preventing a signal lower than a frequency point corresponding to the signal filtering component from passing through it.

16 Claims, 5 Drawing Sheets





US009444128B2

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

(10) **Patent No.:** **US 9,444,128 B2**
(45) **Date of Patent:** **Sep. 13, 2016**

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

USPC 343/702
See application file for complete search history.

(71) Applicants: **Li-Chun Lee**, Taipei (TW); **Chieh-Tsao Hwang**, Taipei (TW); **Shih-Chia Liu**, Taipei (TW); **Yen-Hao Yu**, Taipei (TW); **Jhin-Ciang Chen**, Taipei (TW)

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248/125.9
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16/367

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(72) Inventors: **Li-Chun Lee**, Taipei (TW); **Chieh-Tsao Hwang**, Taipei (TW); **Shih-Chia Liu**, Taipei (TW); **Yen-Hao Yu**, Taipei (TW); **Jhin-Ciang Chen**, Taipei (TW)

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(73) Assignee: **COMPAL ELECTRONICS, INC.**, 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 0 days.

"Office Action of Taiwan Counterpart Application," issued on Jan. 19, 2016, p. 1-p. 5.

(21) Appl. No.: **14/557,453**

Primary Examiner — Hoang V Nguyen

(22) Filed: **Dec. 2, 2014**

(74) *Attorney, Agent, or Firm* — Jianq Chyun IP Office

(65) **Prior Publication Data**

US 2015/0295303 A1 Oct. 15, 2015

Related U.S. Application Data

(60) Provisional application No. 61/979,505, filed on Apr. 14, 2014.

(57) **ABSTRACT**

An electronic device having antenna structure is provided. The electronic device includes a first body, a pivot assembly, a second body and an antenna structure. The pivot assembly is pivoted to the first body along a first axis. The second body is pivoted to the pivot assembly along a second axis. The antenna structure is disposed in the pivot assembly and has a first radiation portion, a second radiation portion and a third radiation portion. The first radiation portion and the second radiation portion have a slot therebetween to form a slot antenna. The third radiation portion forms a monopole antenna and is aligned to the slot. The third radiation portion and the slot are not coplanar.

(51) **Int. Cl.**

H01Q 1/22 (2006.01)
H01Q 1/24 (2006.01)
H01Q 13/10 (2006.01)
H01Q 9/42 (2006.01)
H01Q 21/28 (2006.01)

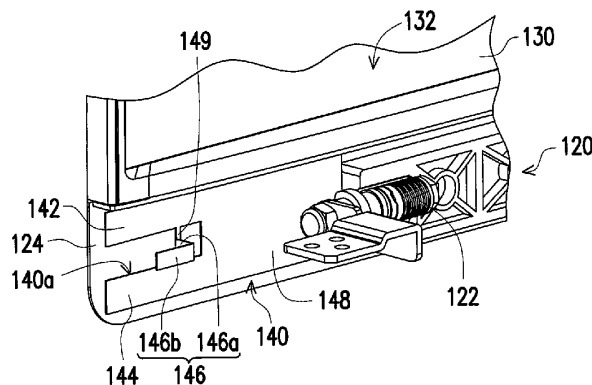
(52) **U.S. Cl.**

CPC **H01Q 1/2266** (2013.01); **H01Q 9/42** (2013.01); **H01Q 13/10** (2013.01); **H01Q 21/28** (2013.01)

(58) **Field of Classification Search**

CPC .. H01Q 1/2266; H01Q 1/2258; H01Q 1/243; H01Q 9/42; H01Q 13/10; H01Q 21/0006; H01Q 21/28

13 Claims, 6 Drawing Sheets





US009444130B2

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

(10) **Patent No.:** **US 9,444,130 B2**
(45) **Date of Patent:** **Sep. 13, 2016**

(54) **ANTENNA SYSTEM WITH RETURN PATH TUNING AND LOOP ELEMENT**

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5,926,139 A * 7/1999 Korisch H01Q 1/243
343/700 MS

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

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(Continued)

(72) Inventors: **Peter Bevelacqua**, San Jose, CA (US);
Hao Xu, Cupertino, CA (US); **Jayesh Nath**, Milpitas, CA (US); **Jennifer M. Edwards**, San Francisco, CA (US);
Mattia Pascolini, Campbell, CA (US)

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

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 483 days.

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Bevelacqua et al., U.S. Appl. No. 13/860,396, filed Apr. 10, 2013.
(Continued)

(21) Appl. No.: **13/860,396**

Primary Examiner — Dieu H Duong

(22) Filed: **Apr. 10, 2013**

(74) *Attorney, Agent, or Firm* — Treyz Law Group, P.C.; G. Victor Treyz; Michael H. Lyons

(65) **Prior Publication Data**

US 2014/0306857 A1 Oct. 16, 2014

(57) **ABSTRACT**

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 7/00 (2006.01)
H01Q 9/04 (2006.01)

Electronic devices may include radio-frequency transceiver circuitry and antenna structures. The antenna structures may include a dual arm inverted-F antenna resonating element and an antenna ground. An antenna feed may be coupled between the inverted-F antenna resonating element and the antenna ground. An adjustable component such as an adjustable inductor may be coupled between the inverted-F antenna resonating element and the antenna ground in parallel with the antenna feed. The adjustable component may be operable in multiple states such as an open circuit state, a short circuit state, and a state in which the adjustable component exhibits a non-zero inductance. Antenna bandwidth can be broadened by coupling a loop antenna resonating element across the antenna feed. A portion of the antenna ground may overlap the loop antenna resonating element to further enhance antenna bandwidth.

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 7/00** (2013.01); **H01Q 9/0442** (2013.01)

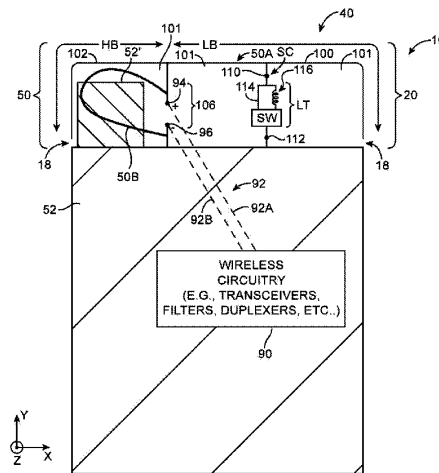
(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 7/00; H01Q 9/0442
USPC 343/702, 700 MS, 866, 750
See application file for complete search history.

(56) **References Cited**

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16 Claims, 8 Drawing Sheets





US009444137B2

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

(10) **Patent No.:** **US 9,444,137 B2**
(45) **Date of Patent:** **Sep. 13, 2016**

- (54) **HANDHELD DEVICE**
- (71) Applicant: **Acer Incorporated**, New Taipei (TW)
- (72) Inventors: **Chih-Hua Chang**, New Taipei (TW);
Wan-Chu Wei, 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 136 days.
- (21) Appl. No.: **14/334,682**
- (22) Filed: **Jul. 18, 2014**

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2015/0042520 A1 *	2/2015	Zhao	H01Q 1/523 343/702

(65) **Prior Publication Data**
US 2015/0270606 A1 Sep. 24, 2015

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(30) **Foreign Application Priority Data**
Mar. 19, 2014 (TW) 103110323 A

TW 1254492 5/2006

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(51) **Int. Cl.**
H01Q 1/48 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/42 (2006.01)
H01Q 21/28 (2006.01)

Primary Examiner — Trinh Dinh
(74) *Attorney, Agent, or Firm* — Jianq Chyun IP Office

(52) **U.S. Cl.**
CPC **H01Q 1/48** (2013.01); **H01Q 1/243** (2013.01); **H01Q 9/42** (2013.01); **H01Q 21/28** (2013.01)

(57) **ABSTRACT**

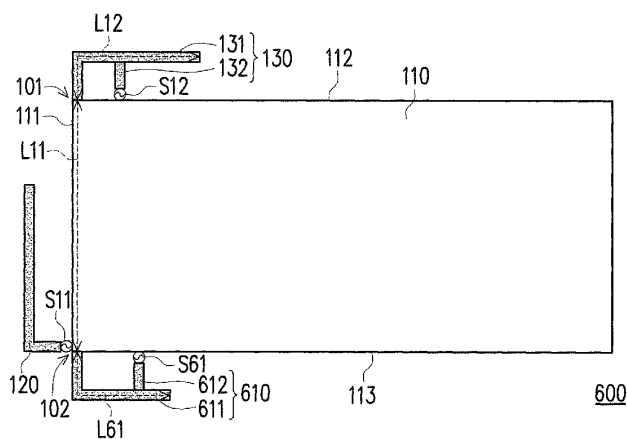
A handheld device including a ground plane, a first antenna element and a second antenna element is provided. The ground plane includes a short edge and a first long edge adjacent to each other to form a first corner. The first antenna element is opposite to the short edge of the ground plane. The second antenna element is opposite to the first long edge of the ground plane and includes a first radiation portion. An end of the first radiation portion is electrically connected to the first long edge and adjacent to the first corner. The handheld device uses the second antenna element to adjust an equivalent ground plane length of the first antenna element.

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

(56) **References Cited**
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7 Claims, 3 Drawing Sheets

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343/700 MS
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US009444142B2

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

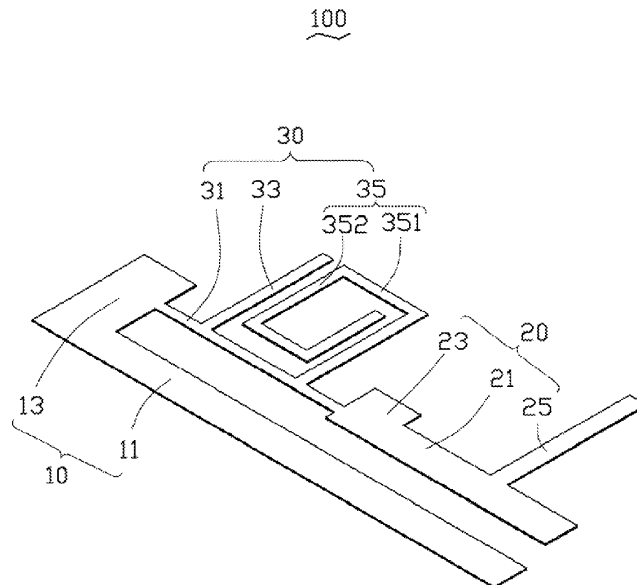
(10) **Patent No.:** **US 9,444,142 B2**
(45) **Date of Patent:** **Sep. 13, 2016**

- (54) **DUAL BAND ANTENNA AND WIRELESS COMMUNICATION DEVICE EMPLOYING SAME**
- (71) Applicant: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)
- (72) Inventors: **Yi-Chieh Lee**, New Taipei (TW); **Yen-Hui 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 184 days.
- (21) Appl. No.: **14/014,574**
- (22) Filed: **Aug. 30, 2013**
- (65) **Prior Publication Data**
US 2014/0111382 A1 Apr. 24, 2014
- (30) **Foreign Application Priority Data**
Oct. 19, 2012 (TW) 101138831 A
- (51) **Int. Cl.**
H01Q 5/357 (2015.01)
- (52) **U.S. Cl.**
CPC **H01Q 5/357** (2015.01)
- (58) **Field of Classification Search**
CPC H01Q 5/357; H01Q 5/0093
See application file for complete search history.

- (56) **References Cited**
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* cited by examiner
Primary Examiner — Michael C Wimer
Assistant Examiner — Noel Maldonado
(74) *Attorney, Agent, or Firm* — Zhigang Ma

- (57) **ABSTRACT**
A dual band antenna includes a first radiating portion, a second radiating portion, and a resonating portion. The first radiating portion includes a first feeding arm that feeds first signals at a first frequency band. The second radiating portion is positioned spaced apart from the first radiating portion. The second radiating portion includes a second feeding arm that feeds second signals at a second frequency band. The resonating portion is connected between the first radiating portion and the second radiating portion. The resonating portion resonates with the first and second radiating portions to generate two different frequency bands, so that the dual band antenna receives and sends wireless signals at the first and second frequency bands.

8 Claims, 4 Drawing Sheets





US009444144B2

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

(10) **Patent No.:** **US 9,444,144 B2**
(45) **Date of Patent:** **Sep. 13, 2016**

- (54) **ELECTRONIC DEVICE**
- (71) Applicants: **Tsung-Han Cheng**, Taipei (TW);
Liang-Jen Lin, Taipei (TW);
Hung-Chieh Wu, Taipei (TW)
- (72) Inventors: **Tsung-Han Cheng**, Taipei (TW);
Liang-Jen Lin, Taipei (TW);
Hung-Chieh Wu, Taipei (TW)
- (73) Assignee: **ASUSTeK COMPUTER INC.**, Taipei (TW)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 272 days.

- (21) Appl. No.: **14/153,101**
- (22) Filed: **Jan. 13, 2014**
- (65) **Prior Publication Data**
US 2014/0198010 A1 Jul. 17, 2014

- Related U.S. Application Data**
- (60) Provisional application No. 61/753,439, filed on Jan. 17, 2013.

- (30) **Foreign Application Priority Data**
Dec. 9, 2013 (TW) 102145212 A
- (51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 7/00 (2006.01)
H01Q 1/22 (2006.01)
H01Q 1/52 (2006.01)
H01Q 21/28 (2006.01)

- (52) **U.S. Cl.**
CPC **H01Q 7/00** (2013.01); **H01Q 1/2208** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/521** (2013.01); **H01Q 21/28** (2013.01)

- (58) **Field of Classification Search**
CPC H01Q 7/00; H01Q 1/2208; H01Q 21/28; H01Q 1/521; H01Q 1/243
USPC 343/702, 833, 872, 873; 455/41.1, 41.2
See application file for complete search history.

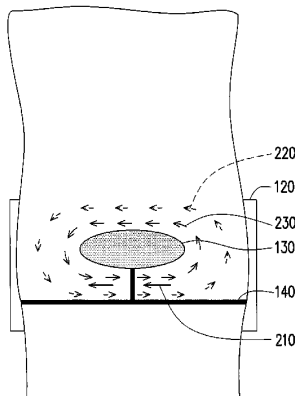
- (56) **References Cited**
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Primary Examiner — Michael C Wimer
(74) *Attorney, Agent, or Firm* — Jianq Chyun IP Office

- (57) **ABSTRACT**
An electronic device is provided. The electronic device includes a conductive housing, a first antenna element, a second antenna element and an insulation structure. The first antenna element is disposed in the conductive housing. The second antenna element is disposed on an external surface of the conductive housing and is opposite to the first antenna element. The conductive housing generates a first current in response to the operation of the second antenna element. The insulation structure penetrates through the conductive housing and extends from at least one side of the conductive housing to the second antenna element. The conductive housing generates an induction current in response to the operation of the first antenna element. The insulation structure blocks the induction current so that the conductive housing generates a second current, and a direction of the first current is the same as a direction of the second current.

9 Claims, 4 Drawing Sheets





US009444425B2

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

(10) **Patent No.:** **US 9,444,425 B2**
(45) **Date of Patent:** **Sep. 13, 2016**

(54) **ELECTRONIC DEVICE WITH ADJUSTABLE WIRELESS CIRCUITRY**

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

(72) Inventors: **Matthew A. Mow**, Los Altos, CA (US); **Thomas E. Biedka**, San Jose, CA (US); **Liang Han**, Sunnyvale, CA (US); **Ming-Ju Tsai**, Cupertino, CA (US); **James G. Judkins**, Campbell, CA (US); **Enrique Ayala Vazquez**, Watsonville, CA (US); **Jayesh Nath**, Milpitas, CA (US); **Hongfei Hu**, Santa Clara, CA (US); **Nanbo Jin**, Sunnyvale, CA (US); **Hao Xu**, Cupertino, CA (US); **Yijun Zhou**, Sunnyvale, CA (US); **Yuehui Ouyang**, Sunnyvale, CA (US); **Victor Lee**, Sunnyvale, CA (US); **Mattia Pascolini**, San Francisco, 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 8 days.

(21) Appl. No.: **14/310,240**

(22) Filed: **Jun. 20, 2014**

(65) **Prior Publication Data**
US 2015/0372656 A1 Dec. 24, 2015

(51) **Int. Cl.**
H04B 1/04 (2006.01)
H03H 7/38 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H03H 7/38** (2013.01); **H04B 1/0458** (2013.01); **H04B 1/18** (2013.01); **H04B 1/48** (2013.01); **H04B 17/29** (2015.01)

(58) **Field of Classification Search**
CPC . H03H 7/38; H03H 2007/386; H04B 1/1458
USPC 455/120-121; 343/852, 860-861
See application file for complete search history.

(56) **References Cited**

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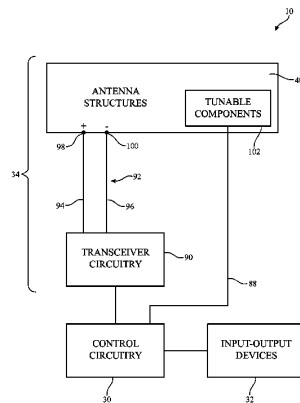
Primary Examiner — Lee Nguyen

(74) *Attorney, Agent, or Firm* — Treyz Law Group, P.C.; G. Victor Treyz; Michael H. Lyons

(57) **ABSTRACT**

An electronic device may be provided with wireless circuitry. Control circuitry may be used to adjust the wireless circuitry. The wireless circuitry may include antennas that are tuned, adjustable impedance matching circuitry, antenna port selection circuitry, and adjustable transceiver circuitry. Wireless circuit adjustments may be made by ascertaining a current usage scenario for the electronic device based on sensor data, information from cellular base station equipment or other external equipment, signal-to-noise ratio information or other signal information, antenna impedance measurements, and other information about the operation of the electronic device.

15 Claims, 9 Drawing Sheets





US009450287B2

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

(10) **Patent No.:** **US 9,450,287 B2**
(45) **Date of Patent:** **Sep. 20, 2016**

- (54) **BROADBAND ANTENNA AND WIRELESS COMMUNICATION DEVICE EMPLOYING SAME**
- (71) Applicant: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)
- (72) Inventors: **Yun-Jian Chang**, New Taipei (TW); **Yen-Hui 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 196 days.

- (58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/245; H01Q 5/357; H01Q 7/00
USPC 343/702, 866, 741
See application file for complete search history.

- (56) **References Cited**
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343/700 MS
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343/870

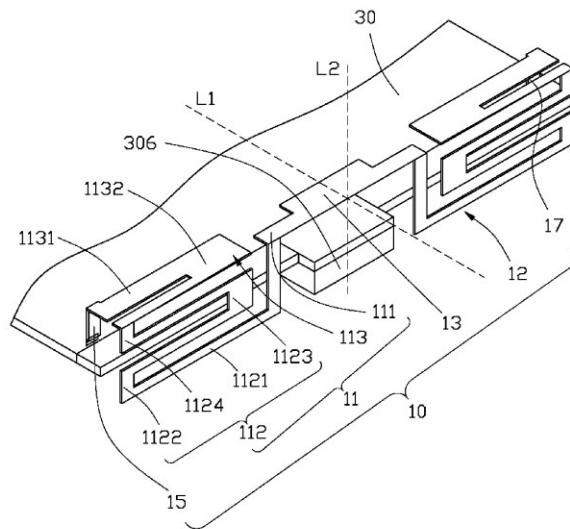
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Primary Examiner — Hoang V Nguyen
(74) *Attorney, Agent, or Firm* — Zhigang Ma

- (21) Appl. No.: **14/278,093**
- (22) Filed: **May 15, 2014**
- (65) **Prior Publication Data**
US 2014/0340281 A1 Nov. 20, 2014
- (30) **Foreign Application Priority Data**
May 17, 2013 (TW) 102117634 A

- (57) **ABSTRACT**
Broadband antenna for wireless communication device is disclosed. The broadband antenna includes a grounding portion, a feeding portion, a connecting portion, a first radiation body connected to an end of the connecting portion, and second radiation body connected to another end of the connecting portion opposite to the first radiating body. The first radiating body and the second radiating body are symmetrical to each other with respect to the connecting body. The feeding portion is connected to an end of the first radiating body away from the second radiating body, the grounding portion is connected to an end of the second radiating body away from the first radiating body.

- (51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/22 (2006.01)
H01Q 7/00 (2006.01)
H01Q 5/357 (2015.01)
- (52) **U.S. Cl.**
CPC **H01Q 1/22** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/245** (2013.01); **H01Q 5/357** (2015.01); **H01Q 7/00** (2013.01)

20 Claims, 4 Drawing Sheets





US009450288B2

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

(10) **Patent No.:** **US 9,450,288 B2**
(45) **Date of Patent:** **Sep. 20, 2016**

(54) **BROADBAND ANTENNA AND WIRELESS COMMUNICATION DEVICE INCLUDING THE SAME**

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

(72) Inventors: **Wei-Hung Ruan**, Hsinchu County (TW); **Wen-Chuan Fan**, Hsinchu County (TW)

(73) Assignee: **WISTRON NEWEB CORP.**, Hsinchu County (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 196 days.

(21) Appl. No.: **13/904,594**

(22) Filed: **May 29, 2013**

(65) **Prior Publication Data**
US 2014/0139377 A1 May 22, 2014

(30) **Foreign Application Priority Data**
Nov. 20, 2012 (TW) 101143248 A

(51) **Int. Cl.**
H01Q 5/10 (2015.01)
H01Q 9/04 (2006.01)
H01Q 1/22 (2006.01)
H01Q 1/36 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/2266** (2013.01); **H01Q 1/36** (2013.01); **H01Q 5/371** (2015.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 9/04; H01Q 9/42; H01Q 1/2266; H01Q 5/371; H01Q 1/36
USPC 343/700, 702
See application file for complete search history.

(56) **References Cited**

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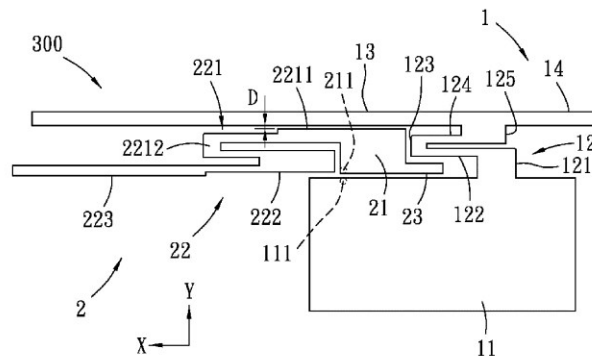
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Primary Examiner — Sue A Purvis
Assistant Examiner — Bamidele A Jegede
(74) *Attorney, Agent, or Firm* — Merchant & Gould P.C.

(57) **ABSTRACT**

A broadband antenna includes first and second radiating conductors. The first radiating conductor includes a short-circuit portion in a serpentine shape, a first radiating arm resonating in a first frequency band, and a second radiating arm. The second radiating conductor includes a feed-in portion coupling with the first radiating arm, a third radiating arm resonating in a second frequency band, and a fourth radiating arm. At least a part of the third radiating arm is in a serpentine shape, couples with the first radiating arm, and resonates in a third frequency band with the short-circuit portion and the second radiating arm. The fourth radiating arm resonates in a fourth frequency band.

17 Claims, 3 Drawing Sheets





US009450291B2

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

(10) **Patent No.:** **US 9,450,291 B2**
(45) **Date of Patent:** **Sep. 20, 2016**

(54) **MULTIBAND SLOT LOOP ANTENNA APPARATUS AND METHODS**

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(75) Inventors: **Heikki Korva**, Tupos (FI); **Petteri Annamaa**, Oulunsalo (FI)

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(73) Assignee: **PULSE FINLAND OY**, Kempele (FI)

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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 1007 days.

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(21) Appl. No.: **13/190,363**

(22) Filed: **Jul. 25, 2011**

"An Adaptive Microstrip Patch Antenna for Use in Portable Transceivers", Rostbakken et al., Vehicular Technology Conference, 1996, Mobile Technology for The Human Race, pp. 339-343.

(Continued)

(65) **Prior Publication Data**

US 2013/0027254 A1 Jan. 31, 2013

(51) **Int. Cl.**

H01Q 1/24 (2006.01)
H01Q 1/00 (2006.01)
H01Q 7/00 (2006.01)
H01Q 5/00 (2015.01)
H01Q 9/30 (2006.01)
H01Q 5/371 (2015.01)

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

CPC **H01Q 1/243** (2013.01); **H01Q 5/371** (2015.01); **H01Q 7/00** (2013.01); **H01Q 9/30** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/24
USPC 343/702
See application file for complete search history.

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Primary Examiner — Dameon E Levi

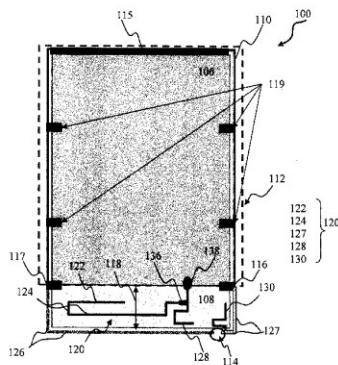
Assistant Examiner — Andrea Lindgren Baltzell

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

(57) **ABSTRACT**

A multiband slot loop antenna apparatus, and methods of tuning and utilizing the same. In one embodiment, the antenna configuration is used within a handheld mobile device (e.g., cellular telephone or smartphone). The antenna comprises two radiating structures: a ring or loop structure substantially enveloping an outside perimeter of the device enclosure, and a tuning structure disposed inside the enclosure. The ring structure is grounded to the ground plane of the device so as to create a virtual portion and an operating portion. The tuning structure is spaced from the ground plane, and includes a plurality of radiator branches effecting antenna operation in various frequency bands; e.g., at least one lower frequency band and three upper frequency bands. On one implementation, a second lower frequency band radiator is effected using a reactive matched circuit coupled between a device feed and a radiator branch.

29 Claims, 7 Drawing Sheets





US009450293B2

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

(10) **Patent No.:** **US 9,450,293 B2**
(45) **Date of Patent:** **Sep. 20, 2016**

(54) **WIRELESS COMMUNICATION DEVICE**

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

(72) Inventors: **Wei-Cheng Su**, New Taipei (TW);
Yen-Hui 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 324 days.

(21) Appl. No.: **14/011,921**

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

(65) **Prior Publication Data**

US 2014/0062803 A1 Mar. 6, 2014

(30) **Foreign Application Priority Data**

Aug. 31, 2012 (TW) 101131943 A

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 1/42 (2006.01)

H01Q 9/42 (2006.01)

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

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

(58) **Field of Classification Search**

CPC H01Q 1/38; H01Q 1/243; H01Q 9/0421

USPC 343/702, 767, 872, 878

See application file for complete search history.

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343/702

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Primary Examiner — Dameon E Levi

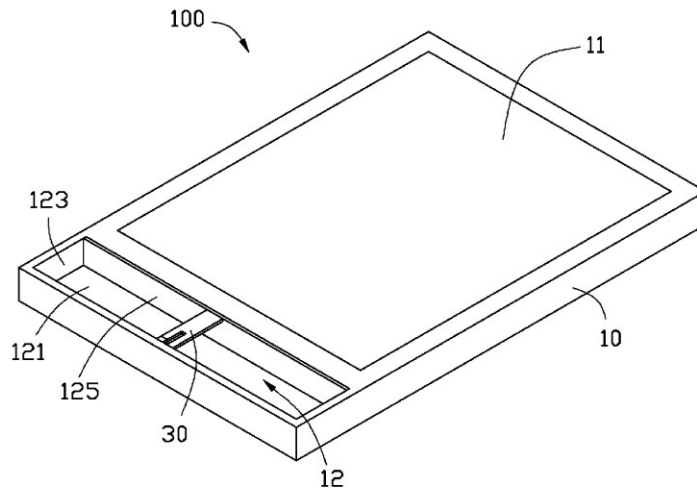
Assistant Examiner — Collin Dawkins

(74) *Attorney, Agent, or Firm* — Zhigang Ma

(57) **ABSTRACT**

A wireless communication device includes a housing and an antenna. The housing is made of metal and defines a conductive chamber. The chamber includes a bottom wall, two opposite first side walls, and two opposite second side walls connecting to the first side walls, the first side walls and the second side walls surrounding around the bottom wall. The antenna comprises a radiating body, a feed end, and a ground end. The radiating body is suspended above the chamber and distanced from the conductive chamber in such a way that the antenna functions in a resonance mode with the conductive chamber, in operating at the required frequencies. The feed end and ground end extend from the radiating body and are connected to one of the second side walls.

18 Claims, 7 Drawing Sheets





US009450294B2

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

(10) **Patent No.:** **US 9,450,294 B2**
(45) **Date of Patent:** **Sep. 20, 2016**

(54) **ANTENNA APPARATUS FOR PORTABLE TERMINAL**

(71) Applicant: **Samsung Electronics Co., Ltd.**,
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(72) Inventors: **Young-Jun Cho**, Seoul (KR); **Austin Kim**, Seongnam-si (KR); **Se-Hyun Park**, Suwon-si (KR); **Joon-Ho Byun**, Yongin-si (KR); **Kyung-Jong Lee**, Hwaseong-si (KR); **Byung-Man Lim**, 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 339 days.

(21) Appl. No.: **14/055,332**

(22) Filed: **Oct. 16, 2013**

(65) **Prior Publication Data**
US 2014/0132460 A1 May 15, 2014

(30) **Foreign Application Priority Data**
Nov. 13, 2012 (KR) 10-2012-0128249

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 9/42 (2006.01)
H01Q 21/28 (2006.01)

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

(58) **Field of Classification Search**
CPC H01Q 1/24; H01Q 9/42; H01Q 21/28
See application file for complete search history.

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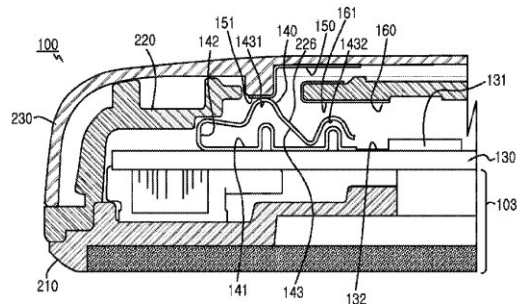
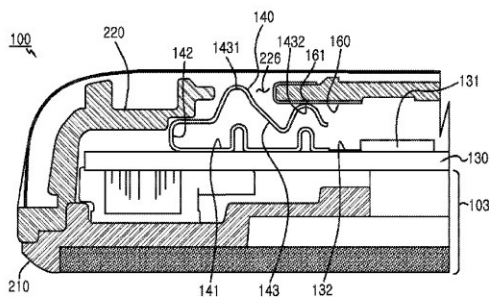
Primary Examiner — Trinh Dinh

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

(57) **ABSTRACT**

A portable terminal is provided. The portable terminal includes a main housing, a sub housing, a mainboard, and an electric connector. The main housing has a first antenna radiator. The sub housing is separable from the main housing and has a second antenna radiator. The mainboard is disposed in the main housing and processes a radio signal. The electric connector is disposed in the main housing. When the sub housing and the main housing are separated from each other, the electric connector electrically connects the mainboard with the first antenna radiator of the main housing. When the sub housing and the main housing are coupled, the electric connector electrically connects the mainboard with the second antenna radiator of the sub housing.

16 Claims, 10 Drawing Sheets





US009450295B2

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

(10) **Patent No.:** **US 9,450,295 B2**
(45) **Date of Patent:** **Sep. 20, 2016**

(54) **WIRELESS COMMUNICATION DEVICE**

(2015.01); **H01Q 21/30** (2013.01); **H01Q 7/00** (2013.01); **H01Q 9/30** (2013.01)

(71) Applicant: **FIH (Hong Kong) Limited**, Kowloon (HK)

(58) **Field of Classification Search**

CPC **H01Q 1/243**; **H01Q 5/371**; **H01Q 21/30**; **H01Q 7/00**; **H01Q 5/378**; **H01Q 9/0407**
USPC **343/702**
See application file for complete search history.

(72) Inventors: **Chih-Yang Tsai**, Shindian (TW);
Hao-Ying Chang, Shindian (TW);
Chuan-Chou Chi, New Taipei (TW)

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343/702
2012/0256800 A1 * 10/2012 Kuonanoja 343/749

(73) Assignee: **FIH (Hong Kong) Limited**, Kowloon (HK)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 201 days.

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Primary Examiner — Dameon E Levi

Assistant Examiner — Ricardo Magallanes

(74) *Attorney, Agent, or Firm* — Zhigang Ma

(21) Appl. No.: **14/057,124**

(22) Filed: **Oct. 18, 2013**

(65) **Prior Publication Data**

US 2014/0333487 A1 Nov. 13, 2014

(57) **ABSTRACT**

An exemplary wireless communication device includes a circuit board, a first antenna, a second antenna, and an end portion. The circuit board includes a feed terminal. The first antenna is located on the circuit board adjacent to the feed terminal. The second antenna is electronically connected to the feed terminal. The end portion serves as a portion of a metal housing of the wireless communication device and includes a positioning portion. The positioning portion secures the first antenna and the end portion to the circuit board.

(30) **Foreign Application Priority Data**

May 9, 2013 (TW) 102116592 A

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 21/30 (2006.01)

H01Q 5/371 (2015.01)

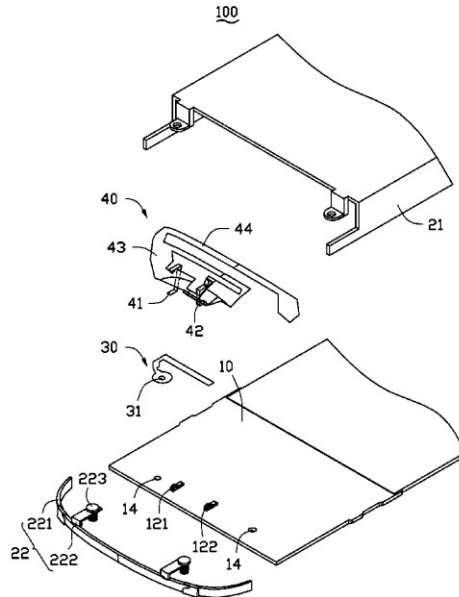
H01Q 7/00 (2006.01)

H01Q 9/30 (2006.01)

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

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

17 Claims, 4 Drawing Sheets





US009450296B2

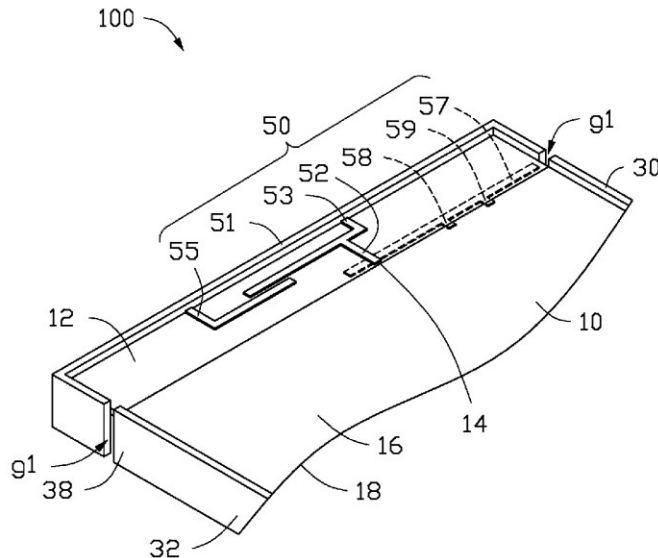
(12) **United States Patent**
Lin

(10) **Patent No.:** **US 9,450,296 B2**
(45) **Date of Patent:** **Sep. 20, 2016**

- (54) **ANTENNA STRUCTURE AND WIRELESS COMMUNICATION DEVICE USING THE SAME**
- (71) Applicant: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)
- (72) Inventor: **Yen-Hui 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 145 days.
- (21) Appl. No.: **14/524,444**
- (22) Filed: **Oct. 27, 2014**
- (65) **Prior Publication Data**
US 2015/0188213 A1 Jul. 2, 2015
- (30) **Foreign Application Priority Data**
Dec. 30, 2013 (CN) 2013 1 0742071
- (51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/38 (2006.01)
H01Q 5/371 (2015.01)
- (52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 5/371** (2015.01)
- (58) **Field of Classification Search**
CPC H01Q 5/371; H01Q 1/38
See application file for complete search history.

- (56) **References Cited**
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- Primary Examiner* — Hoang V Nguyen
Assistant Examiner — Michael Bouizza
(74) *Attorney, Agent, or Firm* — Zhigang Ma

- (57) **ABSTRACT**
An antenna structure includes a feed end, a first radiator plate, a second radiator plate, a third radiator plate, a first ground end, and a second ground end. The first radiator plate and the third radiator plate are coupled to the feed end. The second radiator plate is coupled to the first radiator plate. The first ground end and the second ground end are disposed on the third radiator plate and are spaced from the first ground end. The first ring portion is coupled to the first radiator plate, the second radiator plate, and the third radiator plate.
- 20 Claims, 5 Drawing Sheets**





US009450299B2

(12) **United States Patent
Ridgeway**

(10) **Patent No.: US 9,450,299 B2**
(45) **Date of Patent: Sep. 20, 2016**

(54) **RESONANT EMBEDDED ANTENNA**

(71) Applicant: **Digi International Inc.**, Minnetonka, MN (US)

(72) Inventor: **Robert Wayne Ridgeway**, Doonan (AU)

(73) Assignee: **Digi International Inc.**, Minnetonka, MN (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 796 days.

(21) Appl. No.: **13/733,469**

(22) Filed: **Jan. 3, 2013**

(65) **Prior Publication Data**

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(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 1/38 (2006.01)

H01Q 9/28 (2006.01)

H01Q 5/371 (2015.01)

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

CPC **H01Q 1/38** (2013.01); **H01Q 5/371** (2015.01); **H01Q 9/285** (2013.01); **Y10T 29/49016** (2015.01)

(58) **Field of Classification Search**

CPC H01Q 1/38; H01Q 9/0407; H01Q 13/206
USPC 343/700 MS, 702, 878
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Dameon E Levi

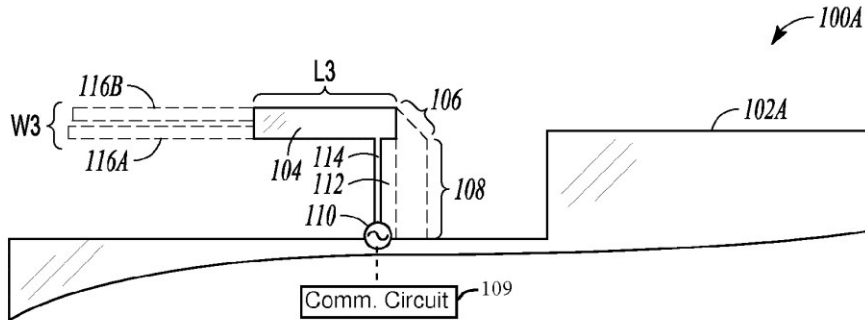
Assistant Examiner — Collin Dawkins

(74) *Attorney, Agent, or Firm* — Fogg & Powers LLC

(57) **ABSTRACT**

A planar antenna, such as included as a portion of a printed circuit board assembly, can include a first conductive layer comprising a feed conductor and a patch. The planar antenna can include a second conductive layer comprising a reference conductor, a first arm defined by a first arm length and a first arm width, and a second arm located parallel to the first arm and defined by a second arm length and a second arm width. The first and second arms can be respectively coupled to the reference conductor, and at least a portion of the first arm and at least a portion of the second arm can overlap with a footprint of the patch projected vertically from a plane of the first conductive layer onto a plane of the second conductive layer.

18 Claims, 5 Drawing Sheets





US009450302B2

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

(10) **Patent No.:** **US 9,450,302 B2**
(45) **Date of Patent:** **Sep. 20, 2016**

(54) **ANTENNA MODULE**

(71) Applicant: **QUANTA COMPUTER INC.**, Tao Yuan Hsien (TW)
(72) Inventors: **Chi-Hsuan Lee**, Tao Yuan Hsien (TW); **Pei-Ling Teng**, Tao Yuan Hsien (TW); **Kuo-Cheng Chen**, Tao Yuan Hsien (TW)
(73) Assignee: **Quanta Computer Inc.**, Tao Yuan Hsien (TW)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 204 days.

(21) Appl. No.: **14/303,028**

(22) Filed: **Jun. 12, 2014**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Sep. 5, 2013 (TW) 102131999 A

(51) **Int. Cl.**
H01Q 1/52 (2006.01)
H01Q 9/42 (2006.01)
H01Q 21/28 (2006.01)
H01Q 1/24 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/521** (2013.01); **H01Q 1/243** (2013.01); **H01Q 9/42** (2013.01); **H01Q 21/28** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 9/42; H01Q 21/28; H01Q 5/35; H01Q 1/48; H01Q 1/243; H01Q 9/521
See application file for complete search history.

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Primary Examiner — Trinh Dinh

(74) Attorney, Agent, or Firm — McNeas Wallace & Nurick LLC

(57) **ABSTRACT**

An antenna module includes a grounding element, first and second radiating conductors, and a decoupling unit. The grounding element has first and second grounding ends. The first radiating conductor includes a first feed-in end that is adjacent spacedly to the first grounding end and that is configured to be fed with a first RF signal. The second radiating conductor includes a second feed-in end that is adjacent spacedly to the second grounding end and that is configured to be fed with a second RF signal. The decoupling unit is connected electrically between a portion of the first radiating conductor and a portion of the second radiating conductor that are proximate to each other, and is one of a decoupling capacitor and a decoupling inductor.

2 Claims, 7 Drawing Sheets

