

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

(10) **Patent No.:** **US 10,756,415 B2**  
(45) **Date of Patent:** **Aug. 25, 2020**

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

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

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

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

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 240 days.

(21) Appl. No.: **15/833,884**

(22) Filed: **Dec. 6, 2017**

(65) **Prior Publication Data**  
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(30) **Foreign Application Priority Data**  
Mar. 24, 2017 (TW) ..... 106109884 A

(51) **Int. Cl.**  
**H01Q 1/22** (2006.01)  
**H01Q 9/04** (2006.01)  
(Continued)

(52) **U.S. Cl.**  
CPC ..... **H01Q 1/2266** (2013.01); **H01Q 1/2291** (2013.01); **H01Q 5/307** (2015.01);  
(Continued)

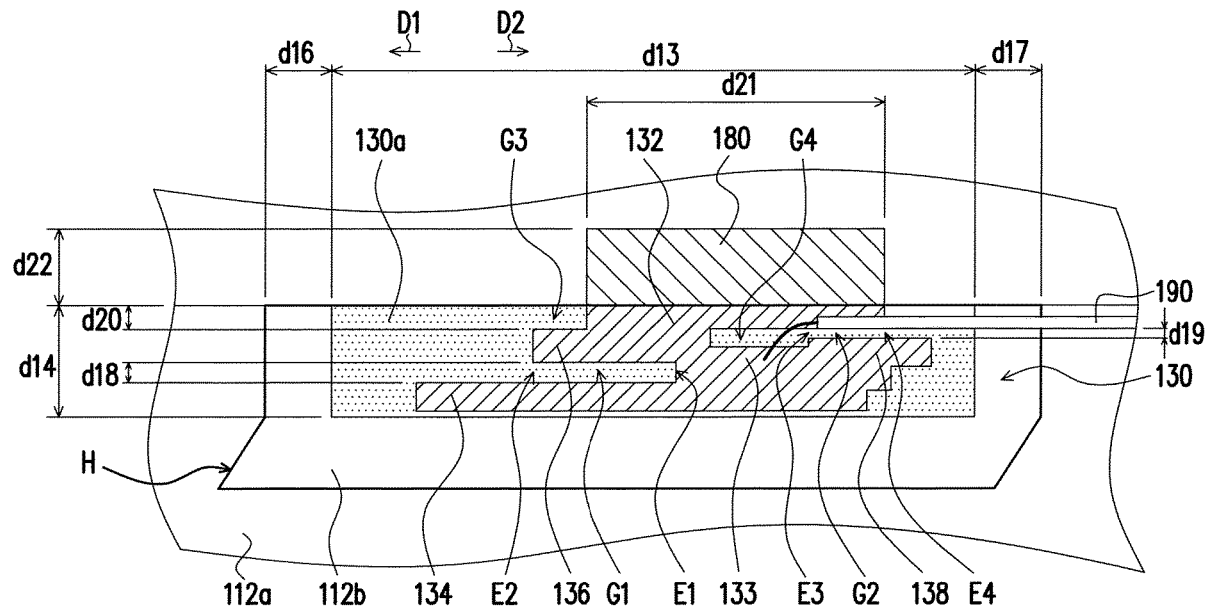
(58) **Field of Classification Search**  
CPC ..... H01Q 1/2258; H01Q 1/2266; H01Q 1/24; H01Q 1/241; H01Q 1/242; H01Q 1/243;  
(Continued)

(56) **References Cited**  
**U.S. PATENT DOCUMENTS**  
5,677,698 A 10/1997 Snowdon  
7,053,844 B2\* 5/2006 Gaucher ..... H01Q 9/0421 343/700 MS  
(Continued)

**FOREIGN PATENT DOCUMENTS**  
TW M365554 9/2009  
TW 1518981 1/2016  
*Primary Examiner* — Daniel Munoz  
*Assistant Examiner* — Patrick R Holecek  
(74) *Attorney, Agent, or Firm* — J.C. Patents

(57) **ABSTRACT**  
An antenna structure including a grounding portion, a feeding portion, a first radiating portion, a second radiating portion, and a third radiating portion is provided. The first radiating portion is connected to the feeding portion, wherein the first radiating portion is adapted to generate a low-frequency resonant mode. The second radiating portion is connected to the feeding portion, wherein a first gap is formed between the first radiating portion and the second radiating portion, and the second radiating portion is adapted to generate a first high-frequency resonant mode. The third radiating portion is connected to the feeding portion, wherein a second gap is formed between the third radiating portion and the grounding portion, and the third radiating portion is adapted to generate a second high-frequency resonant mode. In addition, an electronic device including the antenna structure is also provided.

**18 Claims, 6 Drawing Sheets**





US010756435B2

(12) **United States Patent**  
**Desclos**

(10) **Patent No.:** **US 10,756,435 B2**  
(45) **Date of Patent:** **Aug. 25, 2020**

(54) **LOW PROFILE ANTENNA MODULE**

(71) Applicant: **ETHERTRONICS, INC.**, San Diego, CA (US)  
(72) Inventor: **Laurent Desclos**, San Diego, CA (US)  
(73) Assignee: **Ethertronics, Inc.**, San Diego, CA (US)  
(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 433 days.  
(21) Appl. No.: **15/490,875**

(22) Filed: **Apr. 18, 2017**

(65) **Prior Publication Data**  
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**Related U.S. Application Data**  
(60) Provisional application No. 62/324,221, filed on Apr. 18, 2016.

(51) **Int. Cl.**  
**H01Q 9/04** (2006.01)  
**H01Q 1/48** (2006.01)  
**H01Q 1/22** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **H01Q 9/0407** (2013.01); **H01Q 1/2233** (2013.01); **H01Q 1/48** (2013.01)

(58) **Field of Classification Search**  
CPC ..... H01Q 1/38; H01Q 9/0421; H01Q 1/243; H01Q 1/26; H01Q 23/00  
USPC ..... 343/700 MS, 702, 703  
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,285,324 B1 *	9/2001	Korisch .....	H01Q 1/243 333/26
6,717,551 B1	4/2004	Desclos et al.	
6,744,410 B2	6/2004	Shamblin et al.	
6,906,667 B1	6/2005	Poilasne et al.	
7,123,209 B1	10/2006	Desclos et al.	
9,413,062 B2	8/2016	Ortiz	
9,923,260 B2	3/2018	Desclos et al.	
10,084,240 B2	9/2018	Shamblin et al.	
2003/0201942 A1	10/2003	Poilasne et al.	
2013/0285877 A1	10/2013	Desclos et al.	
2016/0020648 A1 *	1/2016	Contopanagos .....	H01Q 19/185 307/104
2016/0294046 A1 *	10/2016	Hsieh .....	H01Q 1/243
2016/0365647 A1 *	12/2016	Du .....	H01Q 1/246

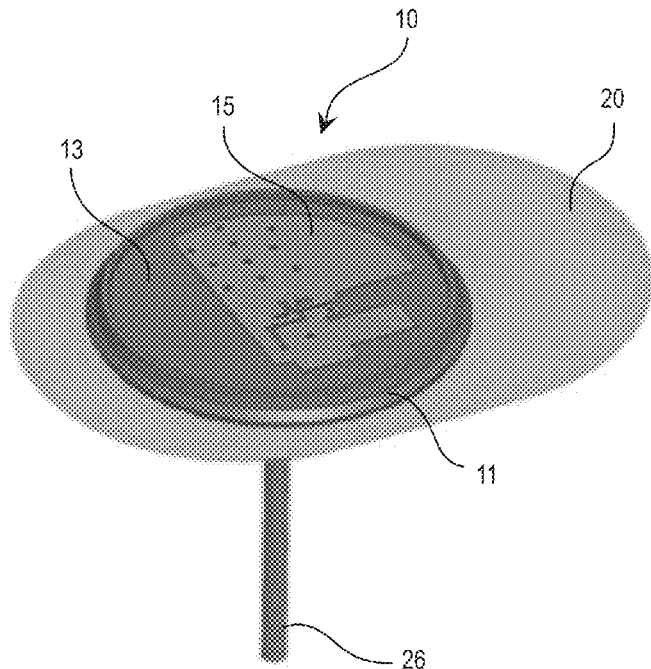
\* cited by examiner

*Primary Examiner* — Daniel Munoz  
(74) *Attorney, Agent, or Firm* — Dority & Manning, PA

(57) **ABSTRACT**

An antenna module is described where uniform radiation pattern coverage is provided in the plane of a low profile antenna radiating element. A polarization that is orthogonal to the plane of the low profile antenna radiating element can be achieved for the radiated field. A ground plate aperture is implemented into the antenna ground plate to minimize frequency shift as the antenna is installed on metallic (conductive) and non-metallic (non-conductive) ground planes of varying sizes. This antenna system technique is applicable for use in communication systems such as a local Area network (LAN), cellular communication network, and Machine to Machine (M2M).

**3 Claims, 6 Drawing Sheets**





US010756437B2

(12) **United States Patent**  
**Saldivar Morales**

(10) **Patent No.:** **US 10,756,437 B2**

(45) **Date of Patent:** **\*Aug. 25, 2020**

(54) **SYSTEMS, DEVICES AND METHODS FOR FLEXIBLE MEANDER LINE PATCH ANTENNA**

(71) Applicant: **Taoglas Group Holdings Limited**, San Diego, CA (US)

(72) Inventor: **Juan Alberto Saldivar Morales**, Baja California (MX)

(73) Assignee: **TAOGLAS GROUP HOLDINGS LIMITED**, Enniscorthy, County Wexford (IE)

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

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **16/512,117**

(22) Filed: **Jul. 15, 2019**

(65) **Prior Publication Data**

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**Related U.S. Application Data**

(63) Continuation of application No. 15/401,393, filed on Jan. 9, 2017, now Pat. No. 10,355,360.

(60) Provisional application No. 62/344,818, filed on Jun. 2, 2016, provisional application No. 62/281,009, filed on Jan. 20, 2016.

(51) **Int. Cl.**

**H01Q 9/04** (2006.01)  
**H01Q 1/36** (2006.01)  
**H01Q 1/48** (2006.01)  
**H01Q 5/364** (2015.01)

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

CPC ..... **H01Q 9/0407** (2013.01); **H01Q 1/36** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/364** (2015.01); **H01Q 9/0414** (2013.01)

(58) **Field of Classification Search**

CPC .... H01Q 9/0407; H01Q 5/364; H01Q 9/0414; H01Q 1/36; H01Q 1/48; H01Q 1/50  
See application file for complete search history.

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

6,404,391 B1 6/2002 Apostolos  
6,642,893 B1 11/2003 Hebron et al.  
7,190,322 B2 3/2007 Apostolos et al.  
8,063,845 B2\* 11/2011 Rabinovich ..... H01Q 1/3241  
343/713

(Continued)

**FOREIGN PATENT DOCUMENTS**

CN 101399395 4/2009  
CN 204333252 5/2015

(Continued)

*Primary Examiner* — Hai V Tran

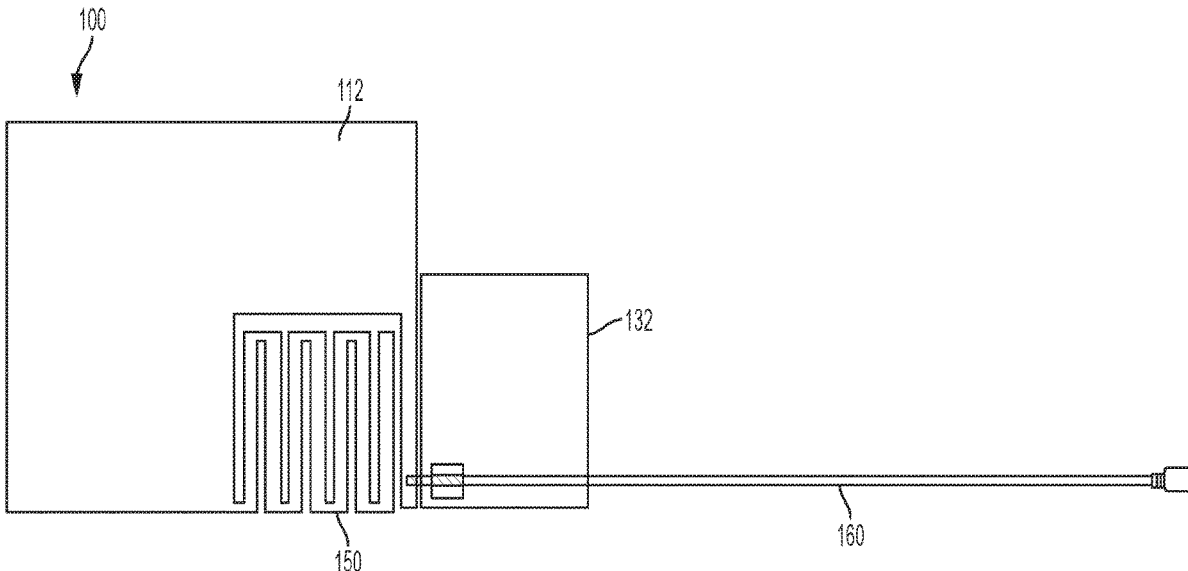
*Assistant Examiner* — Michael M Bouizza

(74) *Attorney, Agent, or Firm* — Knobbe Martens Olson & Bear LLP

(57) **ABSTRACT**

The disclosed antenna is designed to work at GPS L1, GPS L2, GPS L5/GLONASS/BEIDOU frequencies. The antenna is fabricated on a flexible body and includes a meander line between a 50Ω RF feeding cable on the ground plane and a patch element. The resonant mechanism is excited by the meander line structure from 1170 Mhz to 1610 MHz and the Patch gives the wideband performance. Most configurations of the antenna have a low profile of about 0.15 mm.

**14 Claims, 5 Drawing Sheets**



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

(10) **Patent No.:** **US 10,763,571 B2**  
(45) **Date of Patent:** **\*Sep. 1, 2020**

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

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

(72) Inventors: **Jin-Bo Chen**, New Taipei (TW);  
**Cheng-An Chen**, New Taipei (TW);  
**Chih-Wei Liao**, 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 136 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **16/051,018**

(22) Filed: **Jul. 31, 2018**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Sep. 27, 2017 (CN) ..... 2017 1 0890527

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

(52) **U.S. Cl.**  
CPC ..... **H01Q 1/243** (2013.01); **G06F 1/1626** (2013.01); **G06F 1/1698** (2013.01);  
(Continued)

(58) **Field of Classification Search**  
CPC .... H04B 5/0018; H04B 10/00; H04B 7/1555;  
H04B 10/2581; H04W 40/06;  
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,905,909 B2 2/2018 Liou et al.  
10,547,100 B2\* 1/2020 Lin ..... H04M 1/026  
(Continued)

FOREIGN PATENT DOCUMENTS

CN 104852122 A 8/2015  
CN 205543232 U 8/2016  
(Continued)

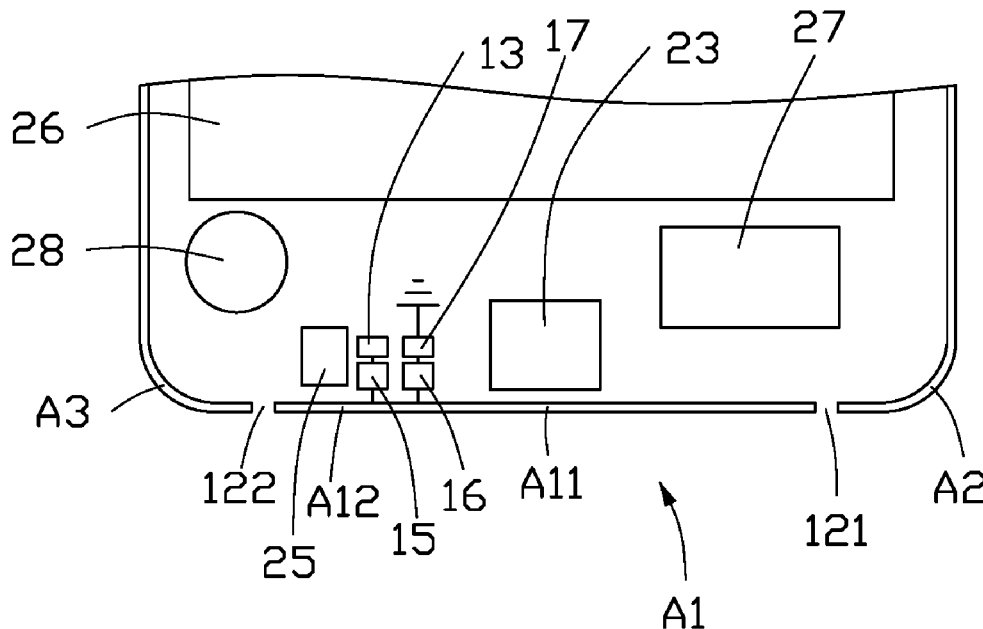
*Primary Examiner* — Khai M Nguyen

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

(57) **ABSTRACT**

An antenna structure includes a housing and a feeding source. The housing forms a radiating portion, a first coupling portion, and a second coupling portion. The first coupling portion and the second coupling portion are grounded. The feeding source is electrically connected to the radiating portion for feeding current to the radiating portion and divides the radiating portion into a first radiating section and a second radiating section. When the feeding source supplies current, the current flows through the first radiating section and is coupled to the first coupling portion to activate a first operation mode and a second operation mode. When the feeding source supplies current, the current flows through the second radiating section and is coupled to the second coupling portion to activate a third operation mode and a fourth operation mode.

**15 Claims, 10 Drawing Sheets**





US010763573B2

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

(10) **Patent No.:** **US 10,763,573 B2**  
(45) **Date of Patent:** **Sep. 1, 2020**

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

5/35; H01Q 1/48; H01Q 1/38; H01Q 5/378; H01Q 21/28; H01Q 5/371; H01Q 5/328; H01Q 5/335; H01Q 1/242; H01Q 5/364; H01Q 5/307; H01Q 1/50

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

USPC ..... 434/848  
See application file for complete search history.

(72) Inventors: **Chih-Wei Liao**, New Taipei (TW);  
**Cheng-An Chen**, New Taipei (TW);  
**Jin-Bo Chen**, New Taipei (TW)

(56) **References Cited**

U.S. PATENT DOCUMENTS

(73) Assignee: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

9,413,058 B1 \* 8/2016 Kuo ..... H01Q 1/243  
10,020,579 B1 \* 7/2018 Zheng ..... H01Q 1/24  
10,063,100 B2 \* 8/2018 Singh ..... H01F 27/38  
2017/0294952 A1 \* 10/2017 Uchida ..... H01Q 9/42

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 6 days.

(Continued)

FOREIGN PATENT DOCUMENTS

(21) Appl. No.: **16/261,976**

CN 105514604 A 4/2016  
CN 105514624 A 4/2016  
CN 205960191 U 2/2017

(22) Filed: **Jan. 30, 2019**

Primary Examiner — Don P Le

(65) **Prior Publication Data**

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

(30) **Foreign Application Priority Data**

Feb. 9, 2018 (CN) ..... 2018 1 0136694

(57) **ABSTRACT**

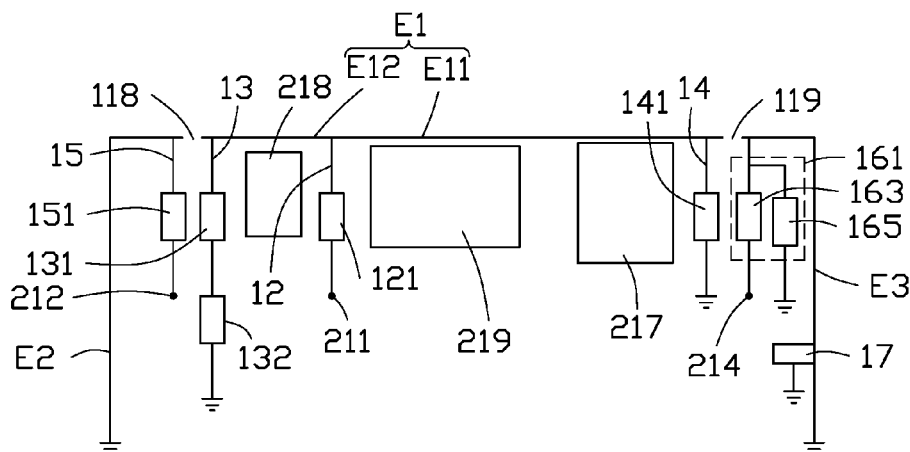
(51) **Int. Cl.**  
**H01Q 1/24** (2006.01)  
**H01Q 1/38** (2006.01)  
**H01Q 1/48** (2006.01)  
**H01Q 5/35** (2015.01)

An antenna structure includes a side frame, a first feed portion, a second feed portion, and a first ground portion. The side frame defines a first gap and a second gap. The side frame is divided into a first radiating portion by the first gap and the second gap. When the first feed portion supplies current, the current flows through a first resonance section and is grounded through the first ground portion to activate a first operating mode and a second operating mode. When the first feed portion supplies current, the current flows through a second resonance section and is grounded through the second feed portion to activate a third operating mode. When the second feed portion supplies current, the current flows through the second resonance section and the first resonance section, and is grounded through the first ground portion to activate a fourth operating mode.

(52) **U.S. Cl.**  
CPC ..... **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/35** (2015.01)

**20 Claims, 9 Drawing Sheets**

(58) **Field of Classification Search**  
CPC . H01C 1/243; H01C 9/42; H01C 1/22; H01C 5/28; H01C 1/44; H01Q 1/36; H01Q





US010763577B2

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

(10) **Patent No.:** **US 10,763,577 B2**  
(45) **Date of Patent:** **Sep. 1, 2020**

(54) **ANTENNA SYSTEM FOR OPTIMIZING ISOLATION AND MOBILE TERMINAL**

(71) Applicant: **JRD COMMUNICATION (SHENZHEN) LTD**, Shenzhen, Guangdong (CN)

(72) Inventors: **Liye Gao**, Guangdong (CN); **Mingchao He**, Guangdong (CN)

(73) Assignee: **JRD COMMUNICATION (SHENZHEN) 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 0 days.

(21) Appl. No.: **16/333,231**

(22) PCT Filed: **Sep. 27, 2017**

(86) PCT No.: **PCT/CN2017/103632**  
§ 371 (c)(1),  
(2) Date: **Mar. 14, 2019**

(87) PCT Pub. No.: **WO2018/086424**  
PCT Pub. Date: **May 17, 2018**

(65) **Prior Publication Data**  
US 2019/0229416 A1 Jul. 25, 2019

(30) **Foreign Application Priority Data**  
Nov. 10, 2016 (CN) ..... 2016 1 0991317

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

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

(58) **Field of Classification Search**  
CPC ..... H01Q 1/521; H01Q 1/243  
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2007/0229364 A1\* 10/2007 Shor ..... H01Q 1/2291 343/700 MS  
2008/0204347 A1\* 8/2008 Alvey ..... H01Q 1/52 343/841  
2010/0238072 A1\* 9/2010 Ayatollahi ..... H01Q 1/48 343/700 MS  
2011/0309992 A1 12/2011 Ali  
2013/0293425 A1\* 11/2013 Zhu ..... H01Q 1/243 343/702  
2017/0012341 A1\* 1/2017 Mai ..... H01Q 1/243

FOREIGN PATENT DOCUMENTS

CN 201345425 Y 11/2009  
CN 104218327 A 12/2014

(Continued)

OTHER PUBLICATIONS

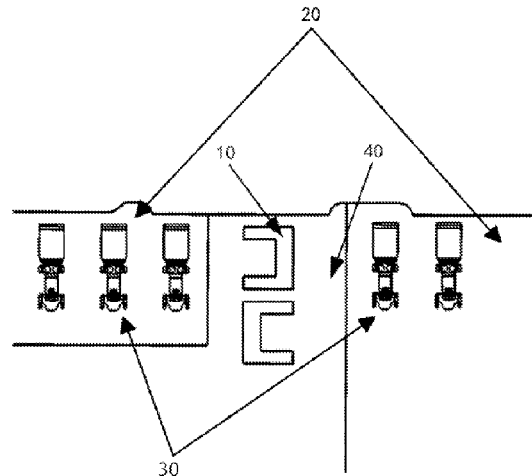
2nd Office Action of counterpart Chinese Patent Application No. 201610991317.5 dated Apr. 20, 2020.

*Primary Examiner* — Ernest G Tacsik

(57) **ABSTRACT**

The present disclosure provides an antenna system for optimizing isolation and a mobile terminal. The system defines clearance slots in an electromagnetic conductor and between antenna feed points for optimizing isolation between antenna units, and comprises clearance areas disposed on both sides of the electromagnetic conductor having the clearance slots of the circuit board for arranging the antenna feed points. Through the present disclosure, it is possible to increase isolation between the diversity antenna and other antenna in a limited space, avoid the coupling effect between the antennas, and alleviate the problem present in traditional multiple-input multiple-output antennas limited by the size of the terminal device.

**14 Claims, 2 Drawing Sheets**





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

(10) **Patent No.:** **US 10,763,578 B2**  
(45) **Date of Patent:** **Sep. 1, 2020**

- (54) **DUAL BAND MULTIPLE-INPUT MULTIPLE-OUTPUT ANTENNAS**
- (71) Applicant: **Laird Technologies, Inc.**, Chesterfield, MO (US)
- (72) Inventors: **Jonathan Cleston Harris White**, Stow, OH (US); **William Steinike**, Cedarburg, WI (US); **Brian E. Petted**, Cedarburg, WI (US); **Kean Meng Lim**, Kedah (MY); **Chit Yong Hang**, Penang (MY)
- (73) Assignee: **LAIRD CONNECTIVITY, INC.**, Akron, OH (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.

(58) **Field of Classification Search**  
 CPC .... H01Q 1/523; H01Q 21/065; H01Q 9/0421; H01Q 21/30; H01Q 1/38; H01Q 5/307; H01Q 1/48; H01Q 21/28  
 See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

D683,720 S	6/2013	Quinlan et al.	
8,779,988 B2	7/2014	Yang et al.	
8,810,457 B2	8/2014	Flores-Cuadras et al.	
9,472,852 B2	10/2016	O'Shea et al.	
2008/0198082 A1*	8/2008	Soler Castany	..... H01Q 1/38 343/770
2009/0009400 A1*	1/2009	Kim	..... H01Q 1/521 343/700 MS

(Continued)

- (21) Appl. No.: **16/112,021**
- (22) Filed: **Aug. 24, 2018**
- (65) **Prior Publication Data**  
US 2020/0021020 A1 Jan. 16, 2020
- Related U.S. Application Data**
- (60) Provisional application No. 62/698,575, filed on Jul. 16, 2018.
- (51) **Int. Cl.**  
**H01Q 1/52** (2006.01)  
**H01Q 1/38** (2006.01)  
**H01Q 21/06** (2006.01)  
**H01Q 21/30** (2006.01)  
**H01Q 9/04** (2006.01)
- (52) **U.S. Cl.**  
CPC ..... **H01Q 1/523** (2013.01); **H01Q 1/38** (2013.01); **H01Q 9/0421** (2013.01); **H01Q 21/065** (2013.01); **H01Q 21/30** (2013.01)

OTHER PUBLICATIONS

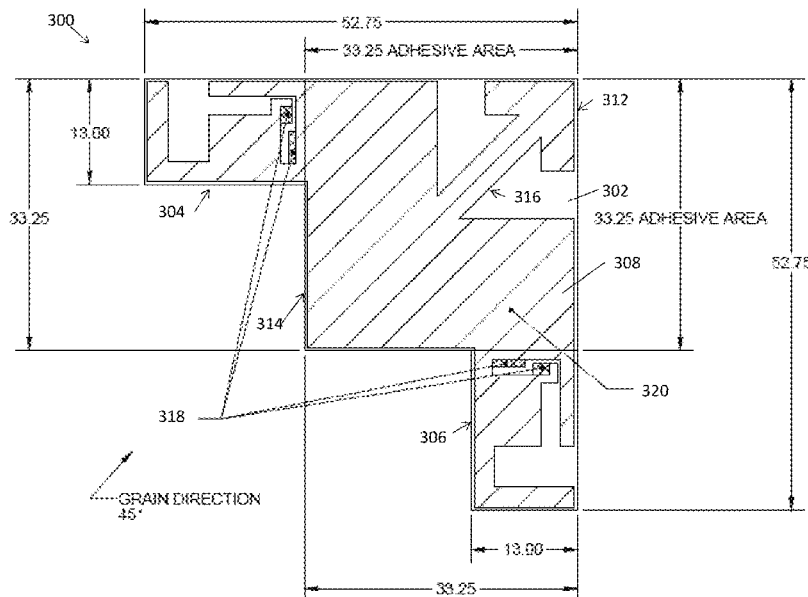
FXUB71 Wide Band Flex 2xMIMO 150mm Ø1.37, <http://www.taoglas.com>, Copyright 2017, 4 pages.

*Primary Examiner* — Dimary S Lopez Cruz  
*Assistant Examiner* — Michael M Bouizza  
 (74) *Attorney, Agent, or Firm* — Harness, Dickey & Pierce, P.L.C.; Anthony G. Fussner

(57) **ABSTRACT**

Exemplary embodiments are disclosed of dual-band multiple-input multiple-output (MIMO) antennas. In an exemplary embodiment, an antenna generally includes a circuit board, a first antenna radiating element positioned on the circuit board, a second antenna radiating element positioned on the circuit board, and at least two antenna feeding elements extending from the circuit board. Each of the at least two antenna feeding elements is electrically connected with a different one of the first and second antenna elements.

**18 Claims, 20 Drawing Sheets**



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

(10) **Patent No.:** **US 10,763,584 B2**  
(45) **Date of Patent:** **Sep. 1, 2020**

(54) **CONDUCTIVE PLANE ANTENNA**

(56) **References Cited**

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

U.S. PATENT DOCUMENTS

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

5,175,561 A 12/1992 Goto  
5,216,430 A \* 6/1993 Rahm ..... H01Q 9/0435  
343/700 MS

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

6,646,618 B2 11/2003 Sievenpiper  
8,223,081 B2 7/2012 Tu  
8,319,688 B2 11/2012 Parche  
8,912,966 B2 12/2014 Kerselaers

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 316 days.

(Continued)

FOREIGN PATENT DOCUMENTS

(21) Appl. No.: **15/873,050**

EP 1906487 A1 4/2008

(22) Filed: **Jan. 17, 2018**

OTHER PUBLICATIONS

(65) **Prior Publication Data**

“Vivaldi Antennas”; retrieved from the Internet <http://www.antenna-theory.com/antennas/aperture/vivaldi.php>; 10 pages; (Jan. 15, 2018).

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(Continued)

*Primary Examiner* — Robert Karacsony

(51) **Int. Cl.**

(57) **ABSTRACT**

**H01Q 5/35** (2015.01)  
**H01Q 1/38** (2006.01)  
**H01Q 1/22** (2006.01)  
**H01Q 1/27** (2006.01)  
**H01Q 13/10** (2006.01)

Example discloses a conductive plane antenna, including, a non-conductive substrate; a conductive plane coupled to the non-conductive substrate; wherein the conductive plane includes an open cavity over the non-conductive substrate; wherein the cavity includes a closed end and an open end; a first feed point coupled to the conductive plane and configured to pass a first polarity of a set of electromagnetic signals; and a second feed point coupled to the conductive plane and configured to pass a second polarity of the set of electromagnetic signals wherein the conductive plane is configured to generate a first antenna gain pattern in response to the first and second polarity signals; wherein the cavity is configured to generate a second antenna gain pattern in response to the first and second polarity signals; and wherein a magnitude of the first antenna gain pattern is greater than a magnitude of the second antenna gain pattern.

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

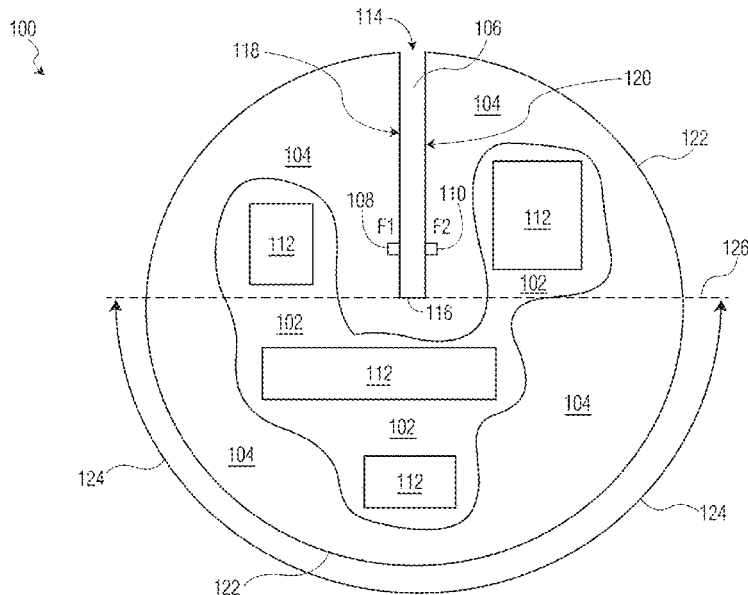
CPC ..... **H01Q 5/35** (2015.01); **H01Q 1/2291** (2013.01); **H01Q 1/273** (2013.01); **H01Q 1/38** (2013.01); **H01Q 13/10** (2013.01)

(58) **Field of Classification Search**

CPC ..... H01Q 1/2291; H01Q 1/273; H01Q 1/276; H01Q 1/38; H01Q 5/35; H01Q 5/45; H01Q 13/10; H01Q 13/106; H01Q 13/18; H01Q 21/24

See application file for complete search history.

**20 Claims, 11 Drawing Sheets**





(12) **United States Patent**  
**Stowell**

(10) **Patent No.:** **US 10,763,586 B2**  
(45) **Date of Patent:** **Sep. 1, 2020**

(54) **ANTENNA WITH FREQUENCY-SELECTIVE ELEMENTS**

(71) Applicant: **LytEn, Inc.**, Sunnyvale, CA (US)

(72) Inventor: **Michael W. Stowell**, Sunnyvale, CA (US)

(73) Assignee: **LytEn, Inc.**, Sunnyvale, 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.: **16/282,895**

(22) Filed: **Feb. 22, 2019**

(65) **Prior Publication Data**

US 2019/0190154 A1 Jun. 20, 2019

**Related U.S. Application Data**

(63) Continuation of application No. 15/944,482, filed on Apr. 3, 2018, now Pat. No. 10,218,073.  
(Continued)

(51) **Int. Cl.**

**H01Q 11/04** (2006.01)  
**H01Q 9/42** (2006.01)  
**H01Q 9/04** (2006.01)  
**H01Q 1/24** (2006.01)  
**H01Q 1/36** (2006.01)  
**H01Q 15/00** (2006.01)  
**H01Q 5/364** (2015.01)  
**H01Q 1/42** (2006.01)

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

CPC ..... **H01Q 9/0407** (2013.01); **H01Q 1/248** (2013.01); **H01Q 1/36** (2013.01); **H01Q 5/364** (2015.01); **H01Q 9/42** (2013.01); **H01Q 11/04** (2013.01); **H01Q 15/0013** (2013.01); **H01Q 1/422** (2013.01)

(58) **Field of Classification Search**

CPC ..... H01Q 9/0407; H01Q 11/04; H01Q 9/42; H01Q 1/36; H01Q 5/364; H01Q 15/0013; H01Q 1/24; H01Q 1/248

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,107,920 A 8/2000 Eberhardt et al.  
6,300,914 B1 10/2001 Yang  
(Continued)

FOREIGN PATENT DOCUMENTS

JP 2002321725 A 11/2002  
JP 6071964 B2 2/2017  
(Continued)

OTHER PUBLICATIONS

International Search Report dated Jul. 26, 2018 for PCT Patent Application No. PCT/US2018/025939.  
(Continued)

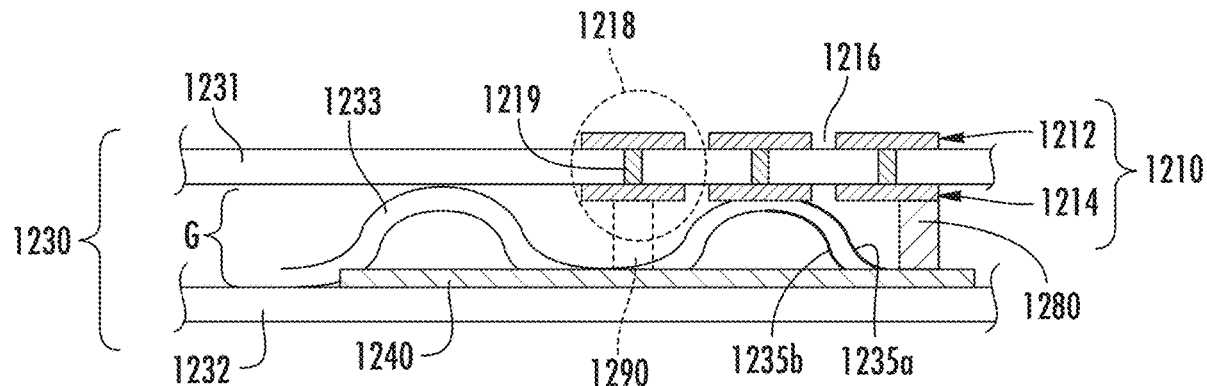
*Primary Examiner* — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Paradice & Li LLP

(57) **ABSTRACT**

Antenna systems have a substrate and antenna on the substrate, where the antenna has a plurality of leg elements. The plurality of leg elements comprises a conductive ink and forms a continuous path. At least one of the plurality of leg elements is individually selectable or de-selectable to change a resonant frequency of the antenna, and leg elements that are selected create an antenna path length corresponding to the resonant frequency. In some embodiments, the antennas are energy harvesters.

**21 Claims, 17 Drawing Sheets**



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

(10) **Patent No.:** **US 10,763,589 B2**  
(45) **Date of Patent:** **Sep. 1, 2020**

(54) **MILLIMETER WAVE PATCH ANTENNAS WITH PARASITIC ELEMENTS**

(56) **References Cited**

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

U.S. PATENT DOCUMENTS  
5,661,494 A \* 8/1997 Bondyopadhyay .... H01Q 1/364  
343/700 MS

(72) Inventors: **Jiangfeng Wu**, San Jose, CA (US); **Yi Jiang**, Cupertino, CA (US); **Siwen Yong**, San Francisco, CA (US); **Lijun Zhang**, San Jose, CA (US); **Mattia Pascolini**, San Francisco, CA (US)

8,354,972 B2 1/2013 Borja et al.  
(Continued)

FOREIGN PATENT DOCUMENTS

JP 2009284088 A \* 12/2009

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

OTHER PUBLICATIONS

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 93 days.

Alexander Bondarik\* and Daniel Sjoberg, "Gridded Parasitic Patch Stacked Microstrip Antenna with Beam Shift Capability for 60 GHz Band", Progress in Electromagnetics Research B, vol. 62, 319-331, 2015 (Year: 2015).\*

(Continued)

(21) Appl. No.: **16/031,964**

*Primary Examiner* — Dieu Hien T Duong

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

(22) Filed: **Jul. 10, 2018**

(57) **ABSTRACT**

(65) **Prior Publication Data**

US 2020/0021037 A1 Jan. 16, 2020

An electronic device may be provided with wireless circuitry. The wireless circuitry may include one or more antenna structures and transceiver circuitry such as millimeter wave transceiver circuitry. Antenna structures in the wireless circuitry may include patch antennas that are organized in a phased antenna array. Each patch antenna may include an antenna resonating element and a parasitic element. The parasitic element for the patch antenna may have dielectric-filled openings formed between coplanar parasitic conductors. The parasitic conductors may include a central parasitic conductor, four rectangular parasitic conductors formed around the central parasitic conductor, and corner parasitic conductors formed at the corners of the parasitic element. The corner parasitic conductors may be non-rectangular. For example, the corner parasitic conductors may have first and second perpendicular edges and a straight or curved third edge that joins the first and second edges.

(51) **Int. Cl.**

**H01Q 1/38** (2006.01)  
**H01Q 19/00** (2006.01)

(Continued)

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

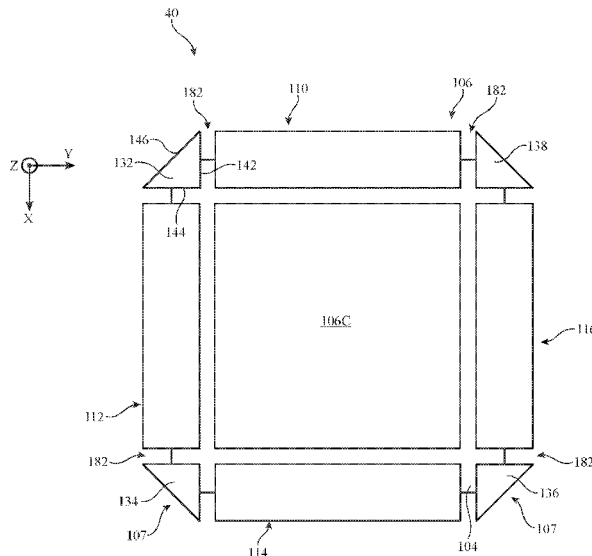
CPC ..... **H01Q 19/005** (2013.01); **H01Q 5/385** (2015.01); **H01Q 5/392** (2015.01); **H01Q 9/0414** (2013.01); **H01Q 21/065** (2013.01)

(58) **Field of Classification Search**

CPC .... H01Q 19/005; H01Q 9/0414; H01Q 5/392; H01Q 21/065; H01Q 5/385

See application file for complete search history.

**18 Claims, 16 Drawing Sheets**



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

(10) **Patent No.:** **US 10,763,900 B2**  
(45) **Date of Patent:** **Sep. 1, 2020**

(54) **ANTENNA MODULE, MOBILE TERMINAL AND METHOD FOR TUNING THE ANTENNA MODULE**

(58) **Field of Classification Search**  
CPC ..... H04B 1/006  
See application file for complete search history.

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

(56) **References Cited**

(72) Inventors: **Jing Wu**, Shenzhen (CN); **Haibing Chen**, Shenzhen (CN); **Ke Hua**, Shenzhen (CN)

U.S. PATENT DOCUMENTS

(73) Assignee: **AAC Technologies Pte. Ltd.**,  
Singapore (SG)

2013/0257712 A1\* 10/2013 Imamura ..... G06F 1/1658  
345/156  
2017/0005413 A1\* 1/2017 Tai ..... H01Q 1/243  
2019/0081393 A1\* 3/2019 Zhou ..... H01Q 1/20  
2019/0198999 A1\* 6/2019 Ashrafi ..... H04L 5/12

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

\* cited by examiner

*Primary Examiner* — Hsinchun Liao

(21) Appl. No.: **16/699,701**

(74) *Attorney, Agent, or Firm* — W&G Law Group LLP

(22) Filed: **Dec. 1, 2019**

(65) **Prior Publication Data**

US 2020/0204199 A1 Jun. 25, 2020

(30) **Foreign Application Priority Data**

Dec. 24, 2018 (CN) ..... 2018 1 1581064

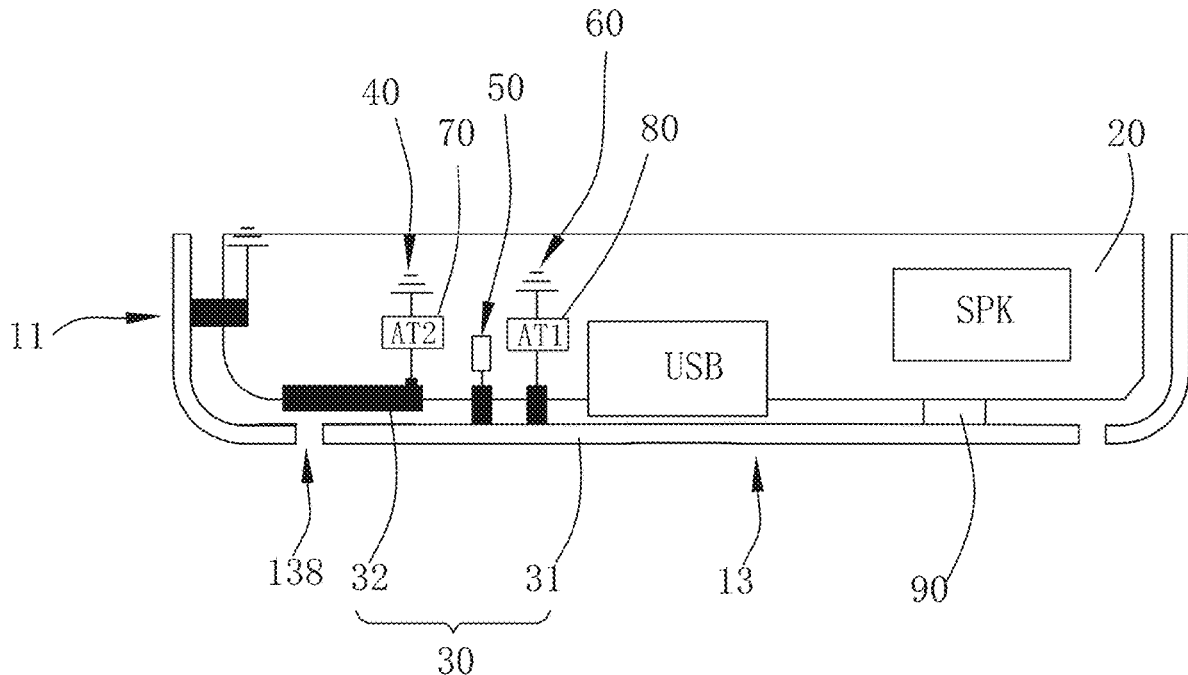
(51) **Int. Cl.**  
**H04B 1/00** (2006.01)  
**H01Q 5/328** (2015.01)  
**H01Q 1/48** (2006.01)  
**H01Q 1/24** (2006.01)

(57) **ABSTRACT**

An antenna module and a mobile terminal are provided. The mobile terminal has a metal frame and a system grounding spaced apart from the metal frame. The antenna module has a radiating body formed in the metal frame and a parasitic element coupled to the radiating body. The radiating body is configured for generating a main harmonic, and the parasitic element is configured for generating a parasitic harmonic. The antenna module further has a first tuning circuit connected in series between the radiating body and the system grounding, and a second tuning circuit connected in series between the parasitic element and the system grounding. The antenna system has at least four operation modes. The antenna system of the present invention may cover the LTE low, medium and high frequencies as a single antenna. A flexible and convenient method for tuning the antenna module is also provided.

(52) **U.S. Cl.**  
CPC ..... **H04B 1/006** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/328** (2015.01)

**11 Claims, 8 Drawing Sheets**





US010770781B1

(12) **United States Patent**  
**Harper**

(10) **Patent No.:** **US 10,770,781 B1**  
(45) **Date of Patent:** **Sep. 8, 2020**

(54) **RESONANT CAVITY AND PLATE HYBRID ANTENNA**

8,125,394 B2 \* 2/2012 Chiang ..... H01Q 9/30  
343/702

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

8,410,986 B2 4/2013 Hill et al.  
8,489,162 B1 7/2013 Dou et al.  
9,577,331 B2 \* 2/2017 Tseng ..... H01Q 1/243  
9,698,466 B2 \* 7/2017 Harper ..... H01Q 5/328  
9,705,571 B2 7/2017 Gerszberg et al.

(72) Inventor: **Marc Harper**, Snohomish, WA (US)

9,837,697 B2 \* 12/2017 Strong ..... H05K 1/025  
10,211,504 B2 \* 2/2019 Strong ..... H01P 5/028  
10,615,480 B2 \* 4/2020 Strong ..... H05K 1/025

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

(Continued)

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 9 days.

**FOREIGN PATENT DOCUMENTS**

(21) Appl. No.: **16/285,644**

CN 102842757 A 12/2012  
CN 103151618 A 6/2013

(22) Filed: **Feb. 26, 2019**

(Continued)

(51) **Int. Cl.**

**H01Q 1/12** (2006.01)  
**H01Q 1/22** (2006.01)  
**H01Q 5/10** (2015.01)  
**H01Q 9/04** (2006.01)  
**H01Q 5/30** (2015.01)  
**H01Q 13/24** (2006.01)

**OTHER PUBLICATIONS**

Costa, et al., "Dual-Band Slotted Waveguide Antenna Array for Adaptive Mm-wave 5G Networks". In Proceedings of 11th European Conference on Antennas and Propagation, Mar. 19, 2017, pp. 1322-1325.

(Continued)

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

CPC ..... **H01Q 1/2266** (2013.01); **H01Q 5/10** (2015.01); **H01Q 5/30** (2015.01); **H01Q 9/0485** (2013.01); **H01Q 1/12** (2013.01); **H01Q 1/2258** (2013.01); **H01Q 13/24** (2013.01)

*Primary Examiner* — Thuy Vinh Tran

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

(58) **Field of Classification Search**

CPC ..... H01Q 1/12; H01Q 1/2258; H01Q 13/24  
USPC ..... 343/878; 455/347, 349  
See application file for complete search history.

(57)

**ABSTRACT**

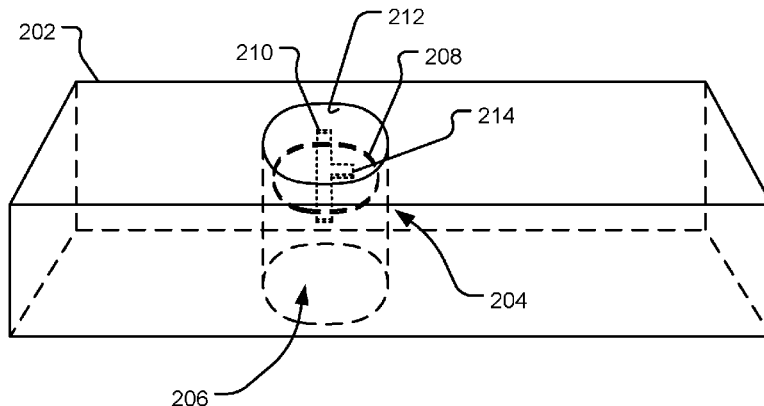
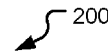
A computing device includes a metal frame forming an exterior surface of the computing device and including an array of resonant cavities. Each resonant cavity has a center axis and defining a volume within the metal frame. Each volume contains a corresponding metal plate positioned within the volume on the center axis of the resonant cavity and a corresponding metal feed line positioned to capacitively drive the corresponding metal plate and the resonant cavity. A least a portion of the corresponding metal feed line is positioned within the volume on the center axis of the resonant cavity.

**20 Claims, 6 Drawing Sheets**

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

6,091,373 A 7/2000 Raguinet  
6,680,712 B2 \* 1/2004 Yamamoto ..... H01Q 1/007  
343/700 MS





US010770786B2

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

(10) **Patent No.:** **US 10,770,786 B2**

(45) **Date of Patent:** **\*Sep. 8, 2020**

(54) **REPEATER WITH MULTIMODE ANTENNA**

8,362,962, which is a continuation of application No. 12/043,090, filed on Mar. 5, 2008, now Pat. No. 7,911,402.

(71) Applicant: **Ethertronics, Inc.**, San Diego, CA (US)

(72) Inventors: **Abhishek Singh**, San Diego, CA (US); **Sebastian Rowson**, San Diego, CA (US); **Laurent Desclos**, San Diego, CA (US); **Jeffrey Shamblin**, San Marcos, CA (US)

(51) **Int. Cl.**  
**H01Q 1/52** (2006.01)  
**H01Q 9/04** (2006.01)  
**H04B 7/15** (2006.01)  
**H04W 52/52** (2009.01)  
**H01Q 1/24** (2006.01)  
**H01Q 3/00** (2006.01)

(73) Assignee: **Ethertronics, Inc.**, San Diego, CA (US)

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

(52) **U.S. Cl.**  
CPC ..... **H01Q 1/521** (2013.01); **H01Q 1/243** (2013.01); **H01Q 3/00** (2013.01); **H01Q 9/0421** (2013.01)

This patent is subject to a terminal disclaimer.

(58) **Field of Classification Search**  
CPC H01Q 1/243; H01Q 1/24; H01Q 1/38; H01Q 1/52; H01Q 1/521; H01Q 3/00; H01Q 9/04; H01Q 9/0421

(21) Appl. No.: **16/380,222**

See application file for complete search history.

(22) Filed: **Apr. 10, 2019**

(56) **References Cited**

(65) **Prior Publication Data**

U.S. PATENT DOCUMENTS

US 2019/0237864 A1 Aug. 1, 2019

2,236,102 A 3/1941 Kilster  
2,318,516 A 5/1943 Newbold  
2,433,804 A 12/1947 Wolff  
2,761,134 A 8/1956 Tewsbury et al.

**Related U.S. Application Data**

(Continued)

(63) Continuation of application No. 15/917,101, filed on Mar. 9, 2018, now Pat. No. 10,263,326, which is a continuation of application No. 15/242,514, filed on Aug. 20, 2016, now Pat. No. 9,917,359, which is a continuation-in-part of application No. 14/965,881, filed on Dec. 10, 2015, now Pat. No. 9,748,637, which is a continuation of application No. 14/144,461, filed on Dec. 30, 2013, now Pat. No. 9,240,634, which is a continuation of application No. 13/726,477, filed on Dec. 24, 2012, now Pat. No. 8,648,755, which is a continuation of application No. 13/029,564, filed on Feb. 17, 2011, now Pat. No.

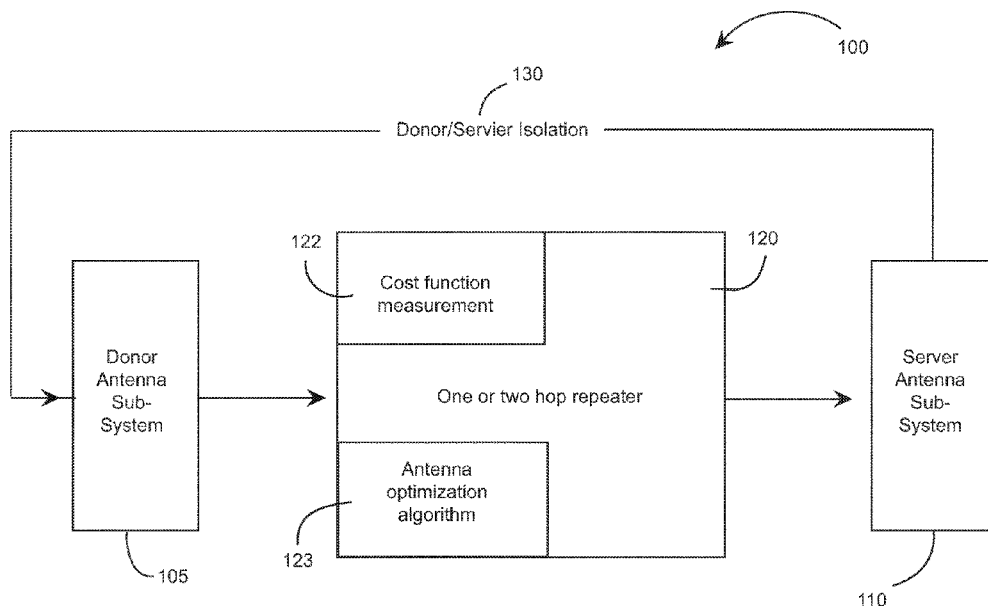
*Primary Examiner* — Tho G Phan

(74) *Attorney, Agent, or Firm* — Dority & Manning, PA

(57) **ABSTRACT**

The disclosure concerns an antenna subsystem that can be used in various repeater systems to optimize gain of the repeater by increasing isolation between donor and server antennas, wherein at least one of the donor and server antennas is an active multi-mode antenna.

**17 Claims, 5 Drawing Sheets**





US010770793B2

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

(10) **Patent No.:** **US 10,770,793 B2**

(45) **Date of Patent:** **Sep. 8, 2020**

- (54) **ANTENNA MODULE AND DUAL-BAND ANTENNA APPARATUS**
- (71) Applicant: **Samsung Electro-Mechanics Co., Ltd.**, Suwon-si (KR)
- (72) Inventors: **Jeong Ki Ryoo**, Suwon-si (KR); **Sang Hyun Kim**, Suwon-si (KR); **Seung Goo Jang**, Suwon-si (KR); **Thomas A. Kim**, Suwon-si (KR); **Hong In Kim**, Suwon-si (KR); **Nam Ki Kim**, Suwon-si (KR)
- (73) Assignee: **Samsung Electro-Mechanics Co., Ltd.**, Suwon-si (KR)

- (56) **References Cited**
- U.S. PATENT DOCUMENTS
- 9,806,422 B2 \* 10/2017 Garcia ..... G06K 19/077
- 10,468,763 B2 11/2019 Yokoyama et al.
- (Continued)

- FOREIGN PATENT DOCUMENTS
- CN 105337023 A 2/2016
- CN 107078406 A 8/2017
- (Continued)

- OTHER PUBLICATIONS
- Japanese Office Action dated Mar. 19, 2019 in counterpart Japanese Patent Application No. 2018-106651 (4 pages in English and 2 pages in Japanese).
- (Continued)

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 211 days.

(21) Appl. No.: **15/993,821**  
(22) Filed: **May 31, 2018**

(65) **Prior Publication Data**  
US 2019/0198995 A1 Jun. 27, 2019

(30) **Foreign Application Priority Data**  
Dec. 26, 2017 (KR) ..... 10-2017-0179224

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

(52) **U.S. Cl.**  
CPC ..... **H01Q 5/35** (2015.01); **H01Q 1/2283** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01);  
(Continued)

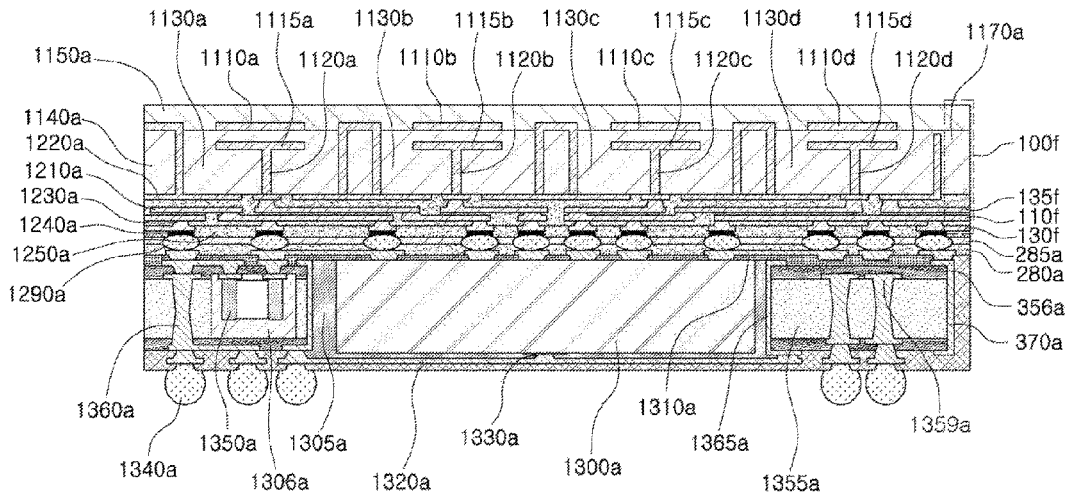
(58) **Field of Classification Search**  
CPC ..... H01Q 5/35; H01Q 9/42; H01Q 1/243; H01Q 1/38; H01Q 1/24; H01Q 1/2283; H01Q 21/062; H01Q 21/065; H01Q 21/20

See application file for complete search history.

*Primary Examiner* — Hoang V Nguyen  
(74) *Attorney, Agent, or Firm* — NSIP Law

- (57) **ABSTRACT**
- An antenna module includes a connection member including at least one wiring layer and at least one insulating layer; an IC disposed on a first surface of the connection member and electrically connected to at least one wiring layer of the connection member; and an antenna package disposed on a second surface of the connection member and including first antenna members and feed vias, wherein the connection member includes a feed line having a first end electrically connected to a corresponding wire of at least one wiring layer of the connection member; a second antenna member electrically connected to a second end of the feed line and configured to transmit or receive a radio frequency (RF) signal; and a ground member spaced apart from the feed line in a direction toward the first surface or the second surface of the connection member.

**18 Claims, 12 Drawing Sheets**



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

(10) **Patent No.:** **US 10,770,797 B2**  
(45) **Date of Patent:** **Sep. 8, 2020**

(54) **ANTENNA ELEMENT**

(71) Applicant: **ASUSTeK COMPUTER INC.**, Taipei (TW)

(72) Inventors: **Cheng-Tse Lee**, Taipei (TW);  
**Saou-Wen Su**, 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 192 days.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,864,848 B2 \* 3/2005 Sievenpiper ..... H01Q 9/14 343/767

7,129,902 B2 \* 10/2006 Bancroft ..... H01Q 13/10 343/767

(Continued)

FOREIGN PATENT DOCUMENTS

CN 103700936 A 4/2014

CN 105098369 A 11/2015

TW M336547 U 7/2008

(21) Appl. No.: **15/950,309**

(22) Filed: **Apr. 11, 2018**

(65) **Prior Publication Data**  
US 2018/0301789 A1 Oct. 18, 2018

OTHER PUBLICATIONS

Office Action issued in corresponding Taiwan patent application dated Apr. 18, 2018.

*Primary Examiner* — Ab Salam Alkassim, Jr.

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

(30) **Foreign Application Priority Data**  
Apr. 18, 2017 (TW) ..... 106112998 A

(57) **ABSTRACT**

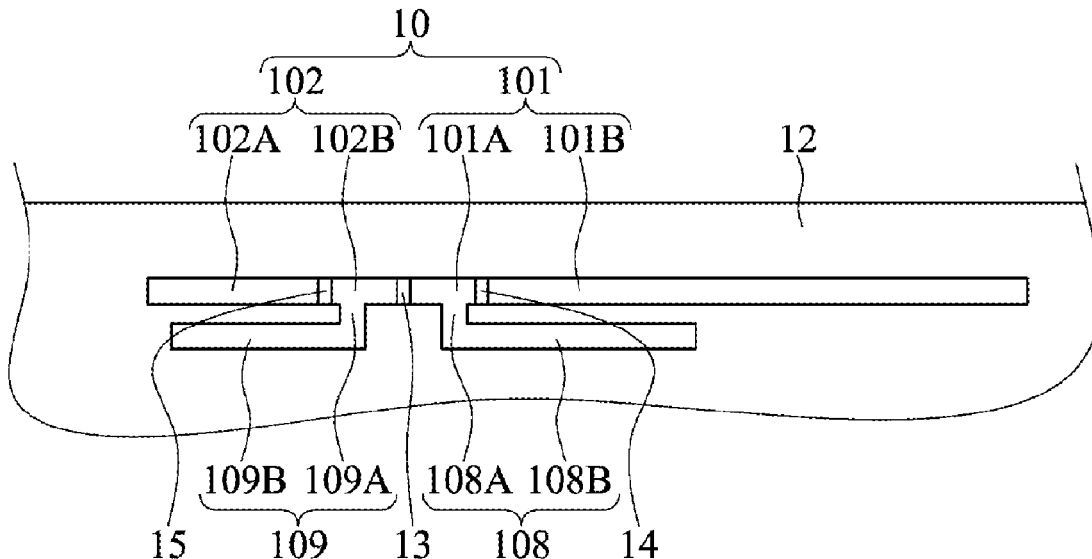
The disclosure provides an antenna element. The antenna element comprises a metal substrate, a first closed slot, a feed part and a first matching part. The first closed slot is formed in the metal substrate, and comprises a first slot section and a second slot section, wherein the length of the first slot section is greater than the length of the second slot section. The feed part spans across the closed slot, the closed slot is divided into the first slot section and the second slot section by the feed part, the feed part is used for exciting the first slot section to generate a resonant mode in a first frequency band and generate a resonant mode in a second frequency band, and exciting the second slot section to generate a resonant mode in a third frequency band. The first matching part is formed on the first slot section, and is connected to parts of the metal substrate, which are positioned on two sides of the first slot section.

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

(52) **U.S. Cl.**  
CPC ..... **H01Q 13/10** (2013.01); **H01Q 1/2266** (2013.01); **H01Q 1/243** (2013.01); **H01Q 5/307** (2015.01);  
(Continued)

(58) **Field of Classification Search**  
CPC ..... H01Q 13/10; H01Q 13/103; H01Q 13/16; H01Q 13/106  
See application file for complete search history.

**4 Claims, 8 Drawing Sheets**



(12) **United States Patent**  
Wu

(10) **Patent No.:** US 10,777,910 B2  
(45) **Date of Patent:** Sep. 15, 2020

(54) **HIGH-ISOLATION DUAL-BAND ANTENNA**

(71) Applicant: **ARCADYAN TECHNOLOGY CORPORATION**, Hsinchu (TW)

(72) Inventor: **Min-Chi Wu**, Zhubei (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 8 days.

(21) Appl. No.: **16/396,922**

(22) Filed: **Apr. 29, 2019**

(65) **Prior Publication Data**

US 2019/0334254 A1 Oct. 31, 2019

(30) **Foreign Application Priority Data**

Apr. 30, 2018 (TW) ..... 107114678 A

(51) **Int. Cl.**  
**H01Q 21/28** (2006.01)  
**H01Q 1/48** (2006.01)  
**H01Q 5/50** (2015.01)  
**H01Q 5/307** (2015.01)

(52) **U.S. Cl.**  
CPC ..... **H01Q 21/28** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/307** (2015.01); **H01Q 5/50** (2015.01)

(58) **Field of Classification Search**  
CPC ..... H01Q 21/28; H01Q 25/00; H01Q 5/40; H01Q 5/50; H01Q 5/35; H01Q 5/321; H01Q 5/328; H01Q 5/307; H01Q 5/371; H01Q 9/0435; H01Q 9/42; H01Q 1/38; H01Q 1/48; H01Q 1/243; H01Q 1/521  
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,172,651 B1 *	1/2001	Du	.....	H01Q 1/125	333/109
8,354,972 B2 *	1/2013	Borja	.....	H01Q 1/38	343/700 MS
8,937,578 B2 *	1/2015	Montgomery	.....	H01Q 1/243	343/841
9,484,631 B1 *	11/2016	Napoles	.....	H01Q 1/243	
10,148,011 B2 *	12/2018	Wu	.....	H01Q 5/35	
2007/0001911 A1	1/2007	Fujio et al.			
2010/0238079 A1	9/2010	Ayatollahi et al.			
2012/0274522 A1	11/2012	Ayatollahi			
2016/0093949 A1	3/2016	Chang et al.			

\* cited by examiner

*Primary Examiner* — Haissa Philogene

(74) *Attorney, Agent, or Firm* — Locke Lord LLP; Tim Tingkang Xia, Esq.

(57) **ABSTRACT**

A high-isolation dual-band antenna is provided, which may be operated in a first frequency band and a second frequency band, and include a ground zone, two radiators and an isolation zone. The radiators may be disposed at the both sides of the ground zone respectively. The isolation zone may include a main body, a first-slot and two second-slots; the first-slot may be disposed at one end of the main body and the second-slots may be disposed at the both sides of the main body respectively. At least a portion of the first-slot and the second-slots may serve as the isolation section of the first frequency band, and at least a portion of each second-slot may serve as the isolation section of the second frequency band, such that the isolation section of the first frequency band may partially overlap the isolation section of the second frequency band.

**11 Claims, 7 Drawing Sheets**

