



US009608310B2

(12) **United States Patent**
Huang

(10) **Patent No.:** **US 9,608,310 B2**
(45) **Date of Patent:** **Mar. 28, 2017**

(54) **APPARATUS HAVING A CONDUCTIVE HOUSING AND AN ANTENNA WITH TUNABLE RESONANCE**

(71) Applicant: **Nokia Technologies Oy**, Espoo (FI)

(72) Inventor: **Wei Huang**, San Diego, CA (US)

(73) Assignee: **Nokia Technologies Oy**, Espoo (FI)

(*) 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.: **14/286,365**

(22) Filed: **May 23, 2014**

(65) **Prior Publication Data**

US 2015/0340756 A1 Nov. 26, 2015

(51) **Int. Cl.**
H04M 1/00 (2006.01)
H01Q 1/24 (2006.01)
H01Q 13/10 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 13/10** (2013.01)

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,424,300 B1 7/2002 Sanford et al.
7,551,142 B1 6/2009 Zhang et al.
7,724,532 B2 5/2010 Zadesky et al.
2010/0123632 A1* 5/2010 Hill H01Q 1/243
343/702

2010/0123635 A1 5/2010 Lopez et al.
2011/0085316 A1* 4/2011 Myers H05K 3/284
361/818
2011/0255252 A1* 10/2011 Sloey H04B 1/3816
361/752
2012/0009884 A1 1/2012 Rao et al.
2013/0023816 A1* 1/2013 Bachinski A61N 1/36014
604/20

(Continued)

FOREIGN PATENT DOCUMENTS

EP 1 858 112 A1 11/2007
EP 2405534 A1 1/2012

(Continued)

OTHER PUBLICATIONS

International Search Report and Written Opinion for International Application No. PCT/FI2015/050296, dated Jun. 25, 2015.

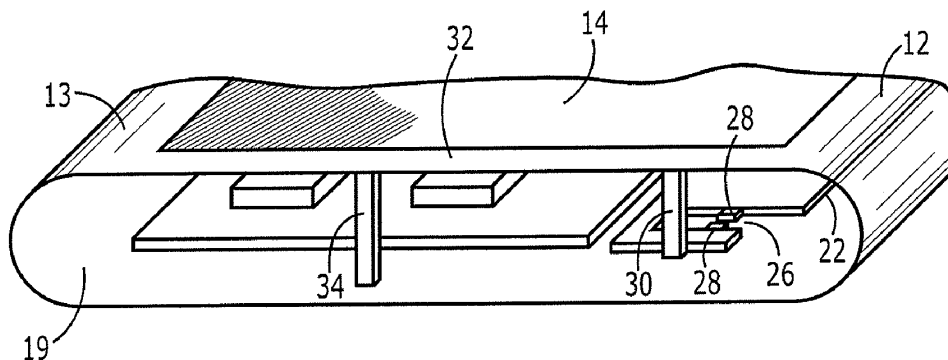
Primary Examiner — Adolf Dsouza

(74) Attorney, Agent, or Firm — Alston & Bird LLP

(57) **ABSTRACT**

An apparatus and a portable electronic device are provided to facilitate tuning of the resonance of an antenna at least partially disposed within a conductive housing. As such, an apparatus is provided that includes a conductive housing having a first conductive portion. The first conductive portion defines a non-conductive aperture. The apparatus also includes a second conductive portion disposed at least partially within the conductive housing. The second conductive portion defines an open-ended non-conductive slot. The slot is configured to couple to radio frequency circuitry. The apparatus further includes a conductive element extending between and conductively coupling the first and second conductive portions. A personal electronic device that embodies the apparatus is also provided.

20 Claims, 4 Drawing Sheets





US009608329B2

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

(10) **Patent No.:** **US 9,608,329 B2**

(45) **Date of Patent:** **Mar. 28, 2017**

(54) **SPACE SAVING MULTIBAND ANTENNA**

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

(72) Inventors: **Luyi Liu**, Sammamish, WA (US); **Devis
Iellici**, Cambridge (GB)

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

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 13 days.

(21) Appl. No.: **14/440,561**

(22) PCT Filed: **Nov. 8, 2013**

(86) PCT No.: **PCT/US2013/069342**

§ 371 (c)(1),

(2) Date: **May 4, 2015**

(87) PCT Pub. No.: **WO2014/074948**

PCT Pub. Date: **May 15, 2014**

(65) **Prior Publication Data**

US 2015/0280323 A1 Oct. 1, 2015

(30) **Foreign Application Priority Data**

Nov. 8, 2012 (GB) 1220131.5

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

(Continued)

(52) **U.S. Cl.**
CPC **H01Q 9/0414** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 5/307** (2015.01); **H01Q**
5/328 (2015.01);

(Continued)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 5/307; H01Q 5/328;
H01Q 5/335; H01Q 5/357; H01Q 9/0414;
H01Q 9/0421

(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,049,314 A * 4/2000 Munson H01Q 1/38
343/700 MS
7,319,432 B2 * 1/2008 Andersson H01Q 1/243
343/702

(Continued)

FOREIGN PATENT DOCUMENTS

CN 2509741 Y 9/2002
CN 101442153 A 5/2009

(Continued)

OTHER PUBLICATIONS

United Kingdom Intellectual Property Office Search Report, Appli-
cation No. GB1220131.5, dated Mar. 5, 2013. 4 pages.

(Continued)

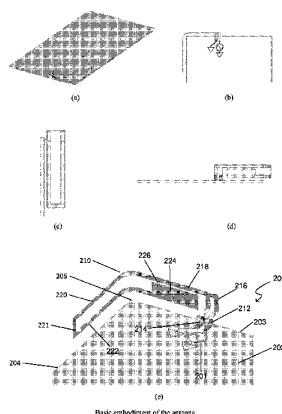
Primary Examiner — Tho G Phan

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

(57) **ABSTRACT**

There is disclosed a multiband antenna device comprising a
conductive elongated antenna element configured for elec-
trical connection to a conductive groundplane at a grounding
point, and for electrical connection to a radio transmitter/
receiver at a feeding point. The antenna element comprises
a first portion and a second portion. The first portion is
configured to extend in a first direction along a first outside
edge of the groundplane, and then in a second direction
along a second outside edge of the groundplane. The second
portion of the antenna element is configured to double back
next to the first portion in a third, substantially counter-
parallel direction back along the second outside edge of the
groundplane, and then in a fourth direction along the first

(Continued)



Basic embodiment of the antenna



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

- (54) SAR REDUCTION ARCHITECTURE AND TECHNIQUE FOR WIRELESS DEVICES

- (75) Inventors: **Sebastian Rowson**, San Diego, CA (US); **Laurent Desclos**, San Diego, CA (US); **Jeffrey Shamblyn**, San Marcos, CA (US); **Abhishek Singh**, 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 775 days.

- (21) Appl. No.: 13/608,988

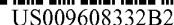
- (22) Filed: **Sep. 10, 2012**

Related U.S. Application Data

- (60) Provisional application No. 61/532,456, filed on Sep. 8, 2011.

- (51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 9/42 (2006.01)
H01Q 9/16 (2006.01)

- (52) U.S. Cl. CPC **H01Q 9/16** (2013.01); **H01Q 9/0442** (2013.01); **H01Q 9/42** (2013.01)



(10) **Patent No.:** US 9,608,332 B2
(45) **Date of Patent:** Mar. 28, 2017

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,123,994 B2	9/2015	Lee et al.	
2007/0008221 AI*	1/2007	Tseng	H01Q 1/2216 343/700 MS
2009/0256763 AI*	10/2009	Chi	H01Q 9/26 343/741

2011/0109509 A1 5/2011 Chou et al.

FOREIGN PATENT DOCUMENTS

CN	102800928	11/2012
CN	202633498	12/2012
JP	10270920 A *	10/1998

* cited by examiner

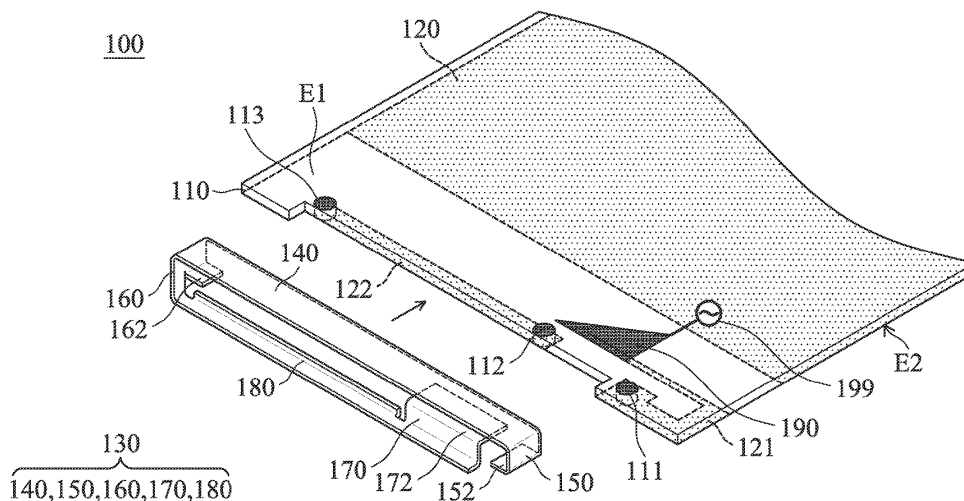
Primary Examiner — Dieu H Duong

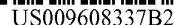
(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

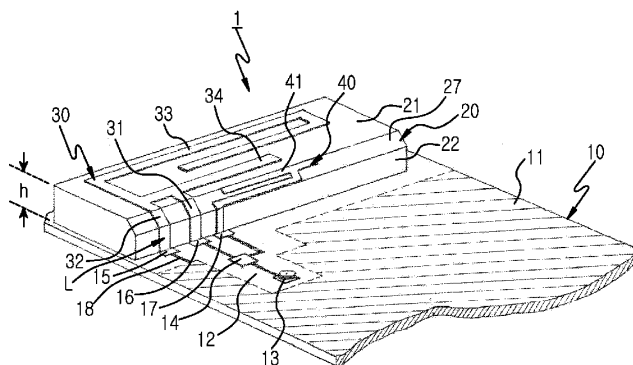
A hybrid antenna includes a dielectric substrate and a stamping element. The stamping element includes a main radiator, a first holder, a second holder, a feeding element, and an extension branch. The main radiator is substantially disposed above the dielectric substrate. The first holder is coupled to a first end of the main radiator. The second holder is coupled to a second end of the main radiator. The feeding element is coupled to a signal source. The extension branch is substantially disposed below the dielectric substrate, and is coupled between the second holder and the feeding element.

24 Claims, 8 Drawing Sheets





(45) **Date of Patent:** **Mar. 28, 2017**





US009609094B2

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

(10) **Patent No.:** **US 9,609,094 B2**

(45) **Date of Patent:** **Mar. 28, 2017**

(54) **MOBILE DEVICE**

(71) Applicant: **Sharp Kabushiki Kaisha**, Osaka-shi,
Osaka (JP)

(72) Inventors: **Tetsuya Yamashita**, Osaka (JP);
Kohichi Murota, Osaka (JP); **Keijiroh**
Higashi, Osaka (JP)

(73) Assignee: **SHARP KABUSHIKI KAISHA**, Sakai
(JP)

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

(21) Appl. No.: **14/783,543**

(22) PCT Filed: **Apr. 15, 2014**

(86) PCT No.: **PCT/JP2014/060670**

§ 371 (c)(1),

(2) Date: **Oct. 9, 2015**

(87) PCT Pub. No.: **WO2014/175111**

PCT Pub. Date: **Oct. 30, 2014**

(65) **Prior Publication Data**

US 2016/0036947 A1 Feb. 4, 2016

(30) **Foreign Application Priority Data**

Apr. 25, 2013 (JP) 2013-092503

(51) **Int. Cl.**

H04M 1/02 (2006.01)

H01Q 1/40 (2006.01)

(Continued)

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

CPC **H04M 1/0202** (2013.01); **H01Q 1/40**
(2013.01); **H01Q 9/42** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 1/38** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 1/242; H01Q 1/244;
H01Q 1/084; H04B 1/3833; H04M
1/0214; H04M 1/23; H04M 1/0247;
H04M 1/0237

(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

2004/0023701 A1* 2/2004 Hankui H01Q 1/244
455/575.7

2004/0036656 A1 2/2004 Nevermann

(Continued)

FOREIGN PATENT DOCUMENTS

CN 1471789 A 1/2004
JP 2007-288360 A 11/2007

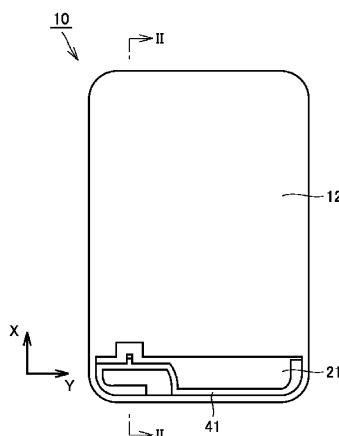
Primary Examiner — Cong Tran

(74) *Attorney, Agent, or Firm* — Keating & Bennett, LLP

(57) **ABSTRACT**

A mobile phone includes an antenna housing made of a resin, an insert metal plate made of a metal, which is buried in the antenna housing and has a connecting portion exposed from an outer surface of the antenna housing, and an antenna element provided on the outer surface of the antenna housing and brought into contact with the connecting portion. A boundary between a region where the antenna element is in contact with the connecting portion and a region where the antenna element is in contact with the antenna housing is nonlinear. With this structure, a mobile device is provided in which deterioration of the antenna performance is reduced even in the event of being subjected to an excessive external shock.

5 Claims, 7 Drawing Sheets





US009614271B2

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

(10) **Patent No.:** **US 9,614,271 B2**
(45) **Date of Patent:** **Apr. 4, 2017**

(54) **COMPOSITE MODULE AND ELECTRONIC APPARATUS INCLUDING THE SAME**

USPC 343/906, 904, 878; 361/760, 904, 878;
174/350-377

See application file for complete search history.

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

(72) Inventors: **Morihiro Nakano**, Nagaokakyo (JP);
Yuichi Ito, Nagaokakyo (JP); **Taro Hirai**, Nagaokakyo (JP); **Hidetaka Kuwahara**, Nagaokakyo (JP)

2003/0193794	A1	10/2003	Reis et al.	
2005/0045358	A1 *	3/2005	Arnold	H05K 9/0024 174/51
2007/0096997	A1 *	5/2007	Nishikawa	G06F 1/1616 343/702
2009/0040117	A1 *	2/2009	Miyaura	H05K 1/0295 343/702
2009/0168386	A1	7/2009	Suzuki et al.	
2010/0315787	A1 *	12/2010	Li	H01L 23/3677 361/709

(Continued)

(73) Assignee: **Murata Manufacturing Co., Ltd.**,
Kyoto (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 343 days.

(21) Appl. No.: **14/010,790**

FOREIGN PATENT DOCUMENTS

(22) Filed: **Aug. 27, 2013**

JP	63-040400	A	2/1988
JP	3-292799	A	12/1991

(Continued)

(65) **Prior Publication Data**

US 2014/0091983 A1 Apr. 3, 2014

OTHER PUBLICATIONS

(30) **Foreign Application Priority Data**

Sep. 28, 2012 (JP) 2012-217180

Official Communication issued in corresponding Japanese Patent Application No. 2012-217180, mailed on Aug. 5, 2014.

Primary Examiner — Graham Smith

Assistant Examiner — Collin Dawkins

(74) *Attorney, Agent, or Firm* — Keating & Bennett, LLP

(51) **Int. Cl.**
H01Q 1/50 (2006.01)
H05K 7/00 (2006.01)
H05K 9/00 (2006.01)
H01Q 1/24 (2006.01)
H01Q 1/52 (2006.01)

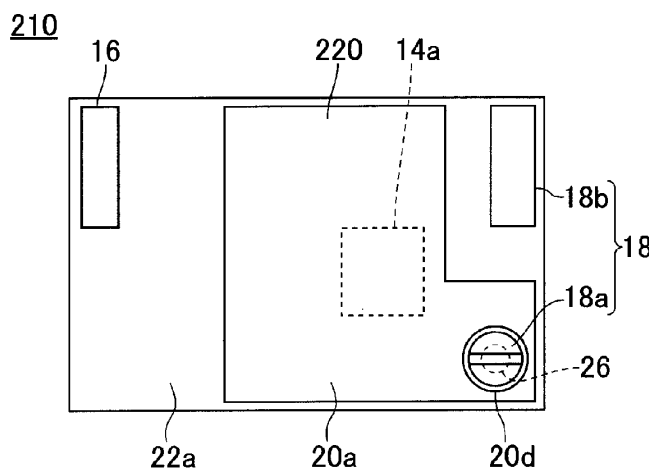
(57) **ABSTRACT**

A wireless communication module includes a circuit board, and an antenna and a connection member mounted on a mounting surface of the circuit board. The antenna is mounted in a region along a first end edge of the circuit board, and the connection member is mounted in a region along a second end edge of the circuit board.

(52) **U.S. Cl.**
CPC **H01Q 1/24** (2013.01); **H01Q 1/52** (2013.01); **H01Q 1/243** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/2291; H01Q 1/2283; H01R 2201/02; H01R 2201/06

15 Claims, 3 Drawing Sheets





US009614274B2

(12) **United States Patent**
Chiu

(10) **Patent No.:** **US 9,614,274 B2**
(45) **Date of Patent:** **Apr. 4, 2017**

(54) **MULTI-ARM TRAP ANTENNA**

(71) Applicant: **Hung-Hsien Chiu**, Hsinchu (TW)

(72) Inventor: **Hung-Hsien Chiu**, Hsinchu (TW)

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

(21) Appl. No.: **14/672,249**

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

(65) **Prior Publication Data**

US 2016/0294057 A1 Oct. 6, 2016

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 9/42 (2006.01)
H01Q 5/321 (2015.01)
H01Q 5/371 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 1/38** (2013.01); **H01Q 5/321**
(2015.01); **H01Q 9/42** (2013.01); **H01Q 5/371**
(2015.01)

(58) **Field of Classification Search**
CPC .. H01Q 5/10; H01Q 1/38; H01Q 5/00; H01Q
9/04; H01Q 5/0034
USPC 343/749
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2001/0045908 A1* 11/2001 Keilen H01Q 1/243
343/700 MS
2005/0280579 A1* 12/2005 Liang H01Q 1/38
343/700 MS
2012/0188135 A1* 7/2012 Wong H01Q 1/38
343/749
2013/0249765 A1* 9/2013 Su H01Q 1/243
343/850
2015/0155627 A1* 6/2015 Wong H01Q 5/0034
343/749

* cited by examiner

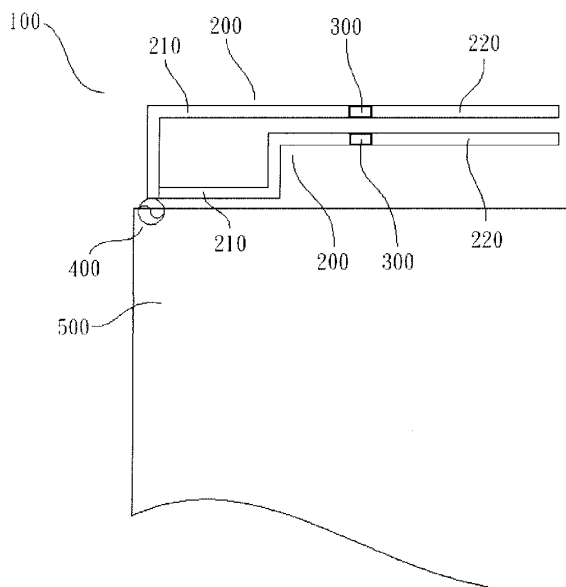
Primary Examiner — Huedung Mancuso

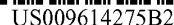
(74) *Attorney, Agent, or Firm* — Leong C. Lei

(57) **ABSTRACT**

A multi-arm trap antenna for use with a wireless communication device includes at least two arms, each of which includes at least one arm segment; at least one wave trapping assembly, which includes an electrical inductor electrically connecting the arm segments of the arms; a signal feeding element, which electrically connects a radio frequency signal positive to at least one of the arms; and a grounding element, which is electrically connected to a radio frequency signal negative for grounding to form a monopole antenna, or electrically connects the radio frequency signal negative to the arms to which the radio frequency signal positive is electrically connected to form an inverted F-shaped antenna, or electrically connects the radio frequency signal negative to at least one of the arms to form an aperture-coupled antenna. The arms are arranged adjacent to the grounding element in a low-profile bent manner to reduce height.

10 Claims, 20 Drawing Sheets





(10) **Patent No.:** US 9,614,275 B2
(45) **Date of Patent:** Apr. 4, 2017

- (56)
- References Cited**

- U.S. PATENT DOCUMENTS

- | | | | | |
|-----------|-----|--------|--------------------|-----------------------|
| 2,822,542 | A | 2/1958 | Butterfield et al. | |
| 4,803,495 | A * | 2/1989 | Monser | H01Q 1/523
343/725 |

- | | | | | |
|-----------|------|--------|------------------|------------|
| 5,126,751 | A | 6/1992 | Wada et al. | |
| 6,278,410 | B1 | 8/2001 | Soliman et al. | |
| 7,589,686 | B2 | 9/2009 | Balzovsky et al. | |
| 7,649,501 | B2 | 1/2010 | Wong et al. | |
| 8,736,502 | B1 * | 5/2014 | Langfield | H01Q 19/06 |
- 343/753

- 2014/0266950 A1 9/2014 Cicero

OTHER PUBLICATIONS

- PCT Search Report and Written Opinion of the ISA for PCT/
US2016/026099 dated Nov. 17, 2016; 10 Pages.

- * cited by examiner

- (65) **Prior Publication Data**

Primary Examiner — Hoang V Nguyen

- US 2017/0069961 A1 Mar. 9, 2017

(74) *Attorney, Agent, or Firm* — Daly, Crowley, Mofford & Durkee, LLP

- (51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 1/38 (2006.01)
H01Q 9/04 (2006.01)
H01Q 13/02 (2006.01)
H01Q 1/28 (2006.01)

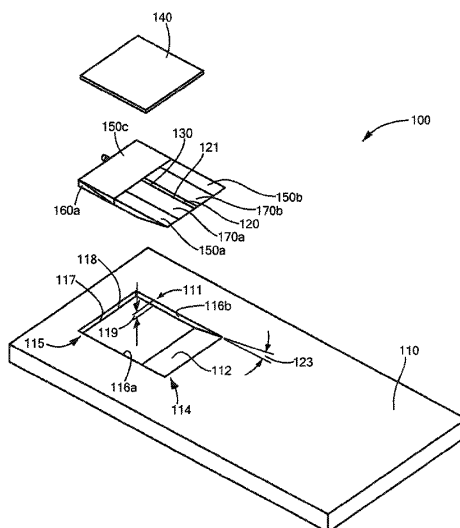
(57) **ABSTRACT**

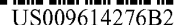
- (52) U.S. Cl.
CPC *H01Q 1/38* (2013.01); *H01Q 1/28*
(2013.01); *H01Q 9/0485* (2013.01); *H01Q*
13/02 (2013.01); *H01Q 13/10* (2013.01)

Methods and apparatus for a directive, instantaneous wide bandwidth antenna including a ground plane having a recess with a tapered region accessible by an electromagnetic field via a radiating aperture at a forward end of the recess. The dielectric feed can have a tapered portion proximate the tapered region to guide the electromagnetic field into the recess through the radiating aperture and influence pattern directivity. The antenna can further include a conductive plating disposed at least partially about the dielectric feed in a wedge configuration to influence pattern beam width. The dielectric feed can include a conductive portion on a bottom of the wedge coupled to the conductive plating and to a grooved trace.

- (58) **Field of Classification Search**
CPC H01Q 13/10; H01Q 13/02; H01Q 1/28
See application file for complete search history.

20 Claims, 11 Drawing Sheets





(10) **Patent No.:** US 9,614,276 B2
(45) **Date of Patent:** Apr. 4, 2017

USPC 343/848, 846
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,008,774	A	12/1999	Wu	343/828
6,333,716	B1	12/2001	Pontoppidan	343/702
6,404,395	B1	6/2002	Masuda	343/702
6,624,789	B1*	9/2003	Kangasvieri et al.	343/702
6,864,845	B2	3/2005	Kuo et al.	343/702

(Continued)

FOREIGN PATENT DOCUMENTS

CN	1261211	A	7/2000
CN	1495966	A	5/2004

(Continued)

OTHER PUBLICATIONS

Liang, Jing, Yang, H.Y. David; "Multi-Band Frequency Reconfigurable Planar Inverted-F Antenna Designs"; URSI XXIX; 4 pgs.

(Continued)

Primary Examiner — Dameon E Levi

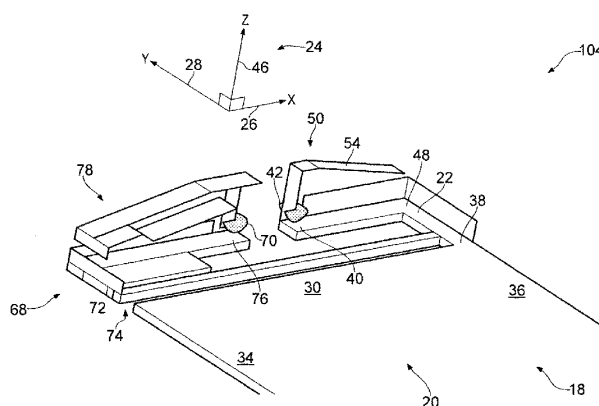
Assistant Examiner — Jennifer F Hu

(74) *Attorney, Agent, or Firm* — Harrington & Smith

(57) **ABSTRACT**

An apparatus including: a first ground member; a second ground member extending from the first ground member and including a feed point, the feed point being configured to receive a signal in a first frequency band and to receive an antenna configured to operate in the first frequency band, the first ground member and the second ground member having an electrical length configured to provide a resonant mode in the first ground member and the second ground member in the first frequency band.

20 Claims, 10 Drawing Sheets





US009614283B2

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

(10) **Patent No.:** **US 9,614,283 B2**

(45) **Date of Patent:** **Apr. 4, 2017**

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

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

(72) Inventors: **Shih-Chieh Lin**, Shindian (TW);
Hao-Ying Chang, Shindian (TW);
Cheng-Hung Ko, Shindian (TW)

(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 424 days.

(21) Appl. No.: **14/193,204**

(22) Filed: **Feb. 28, 2014**

(65) **Prior Publication Data**

US 2015/0022415 A1 Jan. 22, 2015

(30) **Foreign Application Priority Data**

Jul. 17, 2013 (TW) 102125486 A

(51) **Int. Cl.**
H01Q 1/52 (2006.01)
H01Q 5/371 (2015.01)
H01Q 1/24 (2006.01)
H01Q 9/42 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 5/371** (2015.01); **H01Q 1/243** (2013.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 5/371; H01Q 9/42
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,259,407 B1 * 7/2001 Tran H01Q 9/42
343/700 MS
2012/0162017 A1 * 6/2012 Lee H01Q 5/371
343/700 MS

* cited by examiner

Primary Examiner — Hoang V Nguyen

Assistant Examiner — Michael Bouizza

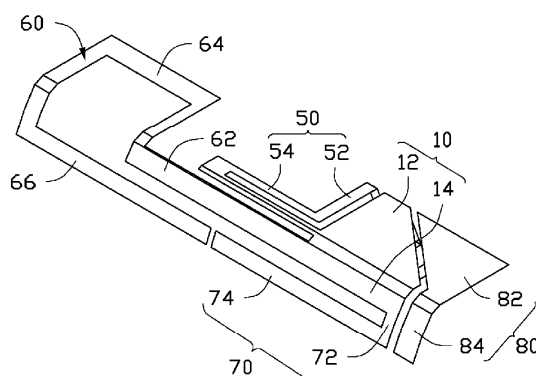
(74) *Attorney, Agent, or Firm* — Steven M. Reiss

(57) **ABSTRACT**

An antenna structure includes a main portion, a first radiating portion connected to the main portion, a second radiating portion connected to the main portion and opposite to the first radiating portion, and a coupling portion spaced from and coplanar with the main portion and opposite to the second radiating portion. The main portion and the first radiating portion excite a low frequency mode, the main portion, the first radiating portion, the second radiating portion, and the coupling portion excite a high frequency mode, and when the antenna structure is interfered by a user's human body when close to the user's human body, the coupling portion transmits the interference to ground. A wireless communication device employing the antenna structure is also disclosed.

18 Claims, 9 Drawing Sheets

100





US009614286B2

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

(10) **Patent No.:** **US 9,614,286 B2**
(45) **Date of Patent:** **Apr. 4, 2017**

(54) **DUAL-BAND DIPOLE ANTENNA**

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

(72) Inventors: **Jian-Jhih Du**, Taipei (TW); **Chih-Yung Huang**, Taichung County (TW); **Kuo-Chang Lo**, Miaoli County (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 49 days.

(21) Appl. No.: **14/694,439**

(22) Filed: **Apr. 23, 2015**

(65) **Prior Publication Data**

US 2016/0233586 A1 Aug. 11, 2016

(30) **Foreign Application Priority Data**

Feb. 6, 2015 (TW) 104104118 A

(51) **Int. Cl.**

H01Q 9/16 (2006.01)

H01Q 1/24 (2006.01)

H01Q 1/38 (2006.01)

H01Q 9/38 (2006.01)

H01Q 9/42 (2006.01)

H01Q 5/371 (2015.01)

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

CPC **H01Q 9/16** (2013.01); **H01Q 1/241** (2013.01); **H01Q 1/38** (2013.01); **H01Q 5/371** (2015.01); **H01Q 9/38** (2013.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,692,599 B2 *	4/2010	Wong		H01Q 9/285
				343/700 MS
2009/0115679 A1 *	5/2009	Chou		H01Q 1/38
				343/795
2009/0184876 A1 *	7/2009	Liu		H01Q 1/38
				343/700 MS
2012/0001818 A1 *	1/2012	Lee		H01Q 1/38
				343/817
2013/0321231 A1 *	12/2013	Flores-Cuadras		H01Q 9/285
				343/793
2015/0162664 A1 *	6/2015	Kawata		H01Q 9/285
				343/749

* cited by examiner

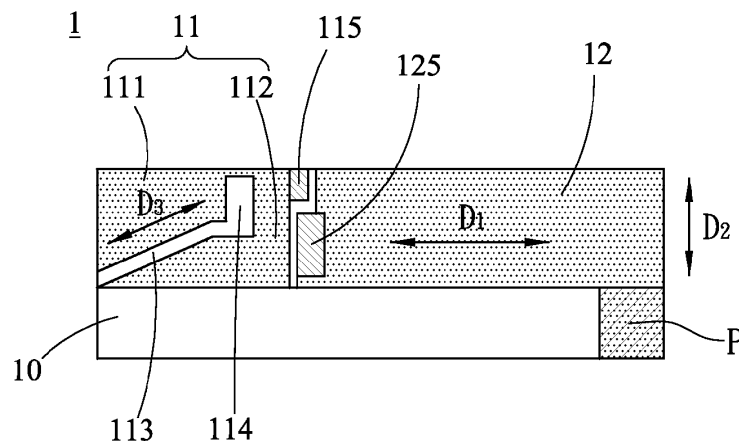
Primary Examiner — Trinh Dinh

(74) *Attorney, Agent, or Firm* — WPAT, PC; Justin King

(57) **ABSTRACT**

A dual-band dipole antenna includes a substrate, grounding area, main radiator, grounding point and a feed-in point. The grounding point may be disposed on the substrate. The main radiator may be disposed on the substrate and in the vicinity of the grounding point; the main radiator may comprises a first radiator and a second radiator, wherein the first radiator may be connected to the second radiator, and there may be a groove between the first radiator and the second radiator; besides the size of the main radiator is disproportional to the size of the grounding area. The grounding point may be disposed on the substrate and connected to the grounding area. The feed-in point may be disposed on the substrate and connected to the main radiator; the grounding point may be in the vicinity of the feed-in point.

14 Claims, 10 Drawing Sheets





US009614294B2

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

(10) **Patent No.:** **US 9,614,294 B2**

(45) **Date of Patent:** **Apr. 4, 2017**

(54) **ANTENNA DEVICE**

(71) Applicant: **FUJITSU LIMITED**, Kawasaki-shi,
Kanagawa (JP)

(72) Inventors: **Yohei Koga**, Kawasaki (JP); **Hiroyuki Egawa**, Fukuoka (JP)

(73) Assignee: **FUJITSU LIMITED**, Kawasaki (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 10 days.

(21) Appl. No.: **14/739,679**

(22) Filed: **Jun. 15, 2015**

(65) **Prior Publication Data**

US 2016/0020527 A1 Jan. 21, 2016

(30) **Foreign Application Priority Data**

Jul. 15, 2014 (JP) 2014-144999

(51) **Int. Cl.**
H01Q 21/00 (2006.01)
H01Q 21/30 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 21/30** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/385** (2015.01); **H01Q 9/16** (2013.01); **H01Q 9/42** (2013.01); **H01Q 1/243** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 9/16; H01Q 21/30; H01Q 5/385; H01Q 1/48; H01Q 9/42; H01Q 1/243
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

2004/0066341 A1 4/2004 Ito et al.
2004/0108957 A1 6/2004 Umehara et al.
(Continued)

FOREIGN PATENT DOCUMENTS

JP 2002-271118 A 9/2002
JP 2003-198410 A 7/2003
(Continued)

OTHER PUBLICATIONS

Lin, "Multiband Folded Planar Monopole Antenna for Mobile Handset", IEEE Transactions on Antennas and Propagation, Jul. 2004, vol. 52, No. 7, pp. 1790-1794.

(Continued)

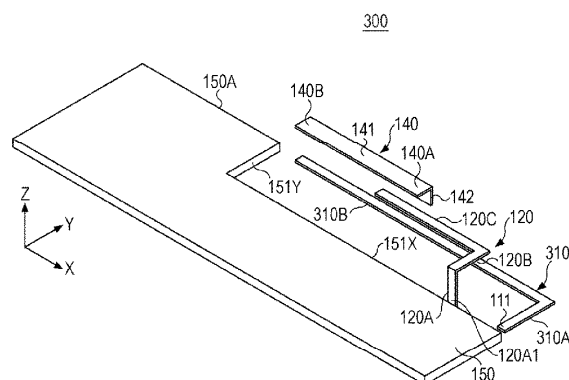
Primary Examiner — Jean B Jeanglaude

(74) *Attorney, Agent, or Firm* — Arent Fox LLP

(57) **ABSTRACT**

An antenna device includes a ground; a monopole antenna including a first section running from a feeding point along the ground, a second section running in a direction away from the ground, and a third section running along the ground, the monopole antenna having a length corresponding to $\frac{1}{4}$ of a wavelength at a first resonance frequency; a parasitic element including a first section whose end is connected to the ground in the vicinity of the end of the first section of the monopole antenna and that runs in a direction away from the ground, and a second section, the parasitic element having a length corresponding to $\frac{1}{4}$ of a wavelength at a second resonance frequency; and a dipole antenna provided along the third section of the monopole antenna and the parasitic element, the dipole antenna having a length corresponding to $\frac{1}{2}$ of a wavelength at a third resonance frequency.

11 Claims, 18 Drawing Sheets





US009614571B2

(12) **United States Patent**
Harper

(10) **Patent No.:** **US 9,614,571 B2**

(45) **Date of Patent:** ***Apr. 4, 2017**

(54) **MULTI-BAND ISOLATOR ASSEMBLY**

(56) **References Cited**

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

U.S. PATENT DOCUMENTS

(72) Inventor: **Marc Harper**, Seattle, 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.

This patent is subject to a terminal disclaimer.

5,485,167 A	1/1996	Wong et al.	
6,624,789 B1 *	9/2003	Kangasvieri	H01Q 1/243 343/702
8,362,960 B2	1/2013	Mumbru et al.	
8,552,913 B2 *	10/2013	Ayatollahi	H01Q 1/243 343/702
8,816,921 B2 *	8/2014	Ayatollahi	H01Q 1/243 343/702
8,922,488 B2 *	12/2014	Fahlander	G06F 3/03546 345/163
8,933,842 B2 *	1/2015	Ayatollahi	H01Q 1/243 343/700 MS

(21) Appl. No.: **15/010,886**

(22) Filed: **Jan. 29, 2016**

(65) **Prior Publication Data**

US 2016/0241297 A1 Aug. 18, 2016

Related U.S. Application Data

(63) Continuation of application No. 14/188,513, filed on Feb. 24, 2014, now Pat. No. 9,287,919.

(51) **Int. Cl.**

H01Q 1/52 (2006.01)

H04B 1/401 (2015.01)

H04B 1/44 (2006.01)

H01Q 1/24 (2006.01)

H01Q 9/14 (2006.01)

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

CPC **H04B 1/401** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/521** (2013.01); **H01Q 9/14** (2013.01); **H04B 1/44** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 9/14; H01Q 1/521;
H04B 1/44; H04B 1/401

USPC 343/841, 722, 702

See application file for complete search history.

2005/0093750 A1	5/2005	Vance
2008/0258991 A1	10/2008	Montgomery et al.
2009/0027286 A1	1/2009	Ohishi et al.
2010/0053022 A1	3/2010	Mak et al.

(Continued)

OTHER PUBLICATIONS

Lin, et al., "A Compact Planar Near Field Resonant Parasitic (NFRP) Antenna for MIMO Application," in IEEE International Symposium on Antenna and Propagation, Jul. 3, 2011, 4 pages.

(Continued)

Primary Examiner — Khai M Nguyen

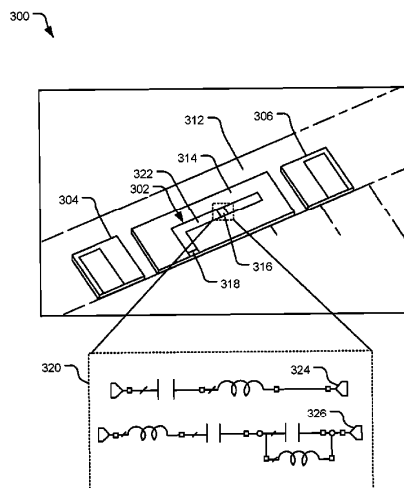
(74) *Attorney, Agent, or Firm* — Holzer Patel Drennan

(57)

ABSTRACT

An isolator assembly is configured to provide isolation in each of multiple non-overlapping frequency bands and includes a selection network to select one of the multiple non-overlapping frequency bands for an isolation operation. During the isolation operation, the isolator assembly prevents signal coupling between antennas that are positioned on opposite sides of the isolator assembly.

20 Claims, 11 Drawing Sheets





US009618606B2

(12) **United States Patent**
Hellsten

(10) **Patent No.:** **US 9,618,606 B2**

(45) **Date of Patent:** **Apr. 11, 2017**

(54) **ANTENNA SYSTEM FOR POLARIZATION DIVERSITY**

(71) Applicant: **SAAB AB**, Linköping (SE)

(72) Inventor: **Hans Hellsten**, Linköping (SE)

(73) Assignee: **SAAB AB**, Linköping (SE)

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

(21) Appl. No.: **15/124,885**

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

(86) PCT No.: **PCT/SE2014/050304**

§ 371 (c)(1),

(2) Date: **Sep. 9, 2016**

(87) PCT Pub. No.: **WO2015/137853**

PCT Pub. Date: **Sep. 17, 2015**

(65) **Prior Publication Data**

US 2017/0016978 A1 Jan. 19, 2017

(51) **Int. Cl.**
G01S 7/02 (2006.01)
H01Q 1/28 (2006.01)

(Continued)

(52) **U.S. Cl.**
CPC **G01S 7/024** (2013.01); **G01S 7/025**
(2013.01); **G01S 7/026** (2013.01); **H01Q 1/28**
(2013.01);

(Continued)

(58) **Field of Classification Search**
CPC **G01S 7/024-7/026**; **G01S 13/885**; **G01S**
13/887; **G01S 13/888**; **H01Q 1/28**; **H01Q**
25/00; **H01Q 25/001**

(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,006,481 A * 2/1977 Young E02F 9/245

324/329

4,728,897 A * 3/1988 Gunton G01S 7/026

324/329

(Continued)

FOREIGN PATENT DOCUMENTS

WO WO 2004/042427 A1 5/2004

WO WO 2014/098660 A1 6/2014

OTHER PUBLICATIONS

International Searching Authority, International Search Report and Written Opinion for International Application No. PCT/SE2014/050304, Nov. 25, 2014, 8 pages, Swedish Patent and Registration Office, Sweden.

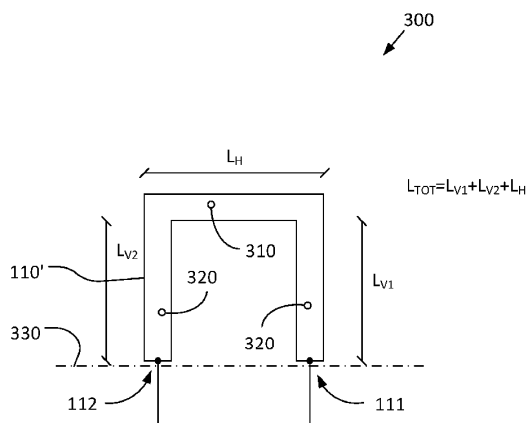
Primary Examiner — Peter Bythrow

(74) *Attorney, Agent, or Firm* — Alston & Bird LLP

(57) **ABSTRACT**

An antenna system (100) comprising a single antenna element having first (111) and second (112) antenna ports arranged to pass a respective first and second antenna signal. The first and second antenna signals being derived from a first common antenna signal (J_1) and arranged to be essentially equal in envelope. An antenna pattern of the system being arranged to be selectable between a first antenna pattern having a first polarization and a second antenna pattern having a second polarization substantially orthogonal to the first polarization. The first antenna pattern being selected by setting the first and second antenna signal to have the same polarity on first (111) and second (112) antenna ports, the second antenna pattern being selected by setting the first and second antenna signal to have substantially opposite polarities on first (111) and second (112) antenna ports.

19 Claims, 10 Drawing Sheets





US009620849B2

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

(10) **Patent No.:** **US 9,620,849 B2**
(45) **Date of Patent:** **Apr. 11, 2017**

(54) **COUPLED-FEED WIDEBAND ANTENNA**

(71) Applicant: **BlackBerry Limited**, Waterloo (CA)

(72) Inventors: **Mohammed Ziaul Azad**, Irving, TX (US); **Steven Eugene Downs**, Irving, TX (US); **Zhong Ji**, Coppell, TX (US); **David Fisk**, Bedford, TX (US); **Seong Heon Jeong**, Irving, TX (US)

(73) Assignee: **BlackBerry Limited**, Waterloo, Ontario (CA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 264 days.

(21) Appl. No.: **13/908,823**

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

(65) **Prior Publication Data**

US 2014/0354483 A1 Dec. 4, 2014

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 9/30 (2006.01)

H01Q 5/385 (2015.01)

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

CPC **H01Q 1/243** (2013.01); **H01Q 5/385** (2015.01); **H01Q 9/30** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 9/0407; H01Q 5/385; H01Q 1/243; H01Q 9/30

USPC 343/702

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,650,294 B2 * 11/2003 Ying H01Q 1/243
343/700 MS

6,985,114 B2 * 1/2006 Egashira 343/702

2004/0246188 A1 12/2004 Egashira
2006/0077104 A1 4/2006 Usui et al.
2012/0001818 A1 1/2012 Lee et al.
2012/0299779 A1 11/2012 Yen et al.

FOREIGN PATENT DOCUMENTS

DE 10346800 5/2005

OTHER PUBLICATIONS

European Patent Office, "Extended European Search Report," issued in connection with European Application No. 13170266.4, dated Nov. 13, 2013, 9 pages.

Mimaki et al., "An Inverted FL Antenna for Dual-Frequency Operation," IEEE Transactions on Antennas and Propagation, vol. 53, No. 8, XP11137399, Aug. 2005, 5 pages.

* cited by examiner

Primary Examiner — Graham Smith

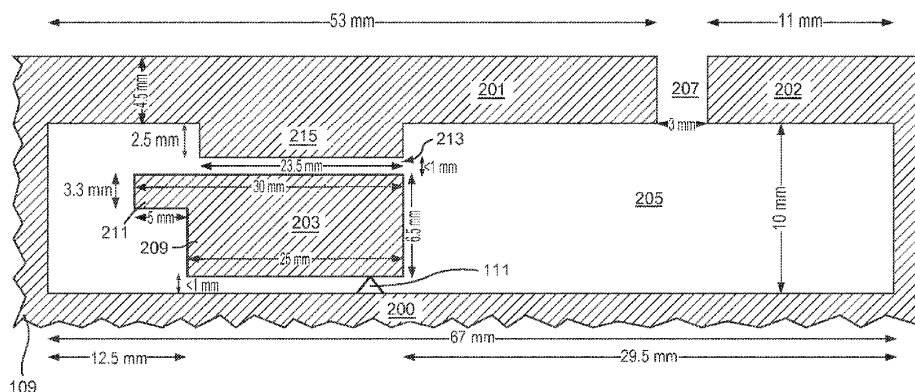
Assistant Examiner — Noel Maldonado

(74) Attorney, Agent, or Firm — Fish & Richardson P.C.

(57) **ABSTRACT**

A device having a coupled-feed wideband antenna is provided. The device comprises: a chassis comprising as a ground plane; an antenna feed, a ground side of the antenna feed connected to the ground plane; and, an antenna comprising: a first radiating arm configured for generating a first resonance at a first frequency, the first radiating arm connected to the chassis and hence the ground plane; a second radiating arm configured for generating a second resonance at a second frequency higher than the first frequency, the second radiating arm connected to the ground plane; and a third radiating arm configured for generating a third resonance at a third frequency higher than the second frequency, the first radiating arm capacitively coupled to the third radiating arm, and the third radiating arm connected to a positive side of the antenna feed.

16 Claims, 11 Drawing Sheets





US009620850B2

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

(10) **Patent No.:** **US 9,620,850 B2**

(45) **Date of Patent:** **Apr. 11, 2017**

(54) **WIRELESS COMMUNICATION DEVICE**

USPC 455/280, 333, 552.1; 343/702
See application file for complete search history.

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

(56) **References Cited**

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

U.S. PATENT DOCUMENTS

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

2008/0182540 A1* 7/2008 Rofougaran H01Q 1/241
455/280
2012/0169547 A1* 7/2012 Oh H01Q 1/44
343/702
2014/0184449 A1* 7/2014 Dong H01Q 21/30
343/702

(*) 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

(21) Appl. No.: **14/573,938**

Primary Examiner — Hsin-Chun Liao

(22) Filed: **Dec. 17, 2014**

(74) *Attorney, Agent, or Firm* — Steven M. Reiss

(65) **Prior Publication Data**

US 2016/0094695 A1 Mar. 31, 2016

(30) **Foreign Application Priority Data**

Sep. 30, 2014 (CN) 2014 1 0517885

(57) **ABSTRACT**

A wireless communication device includes a circuit board, a metal frame, and a slot antenna. The circuit board includes a multiple bandpass filter, a plurality of matching circuits, and a plurality of Radio Frequency (RF) modules. The metal frame surrounds the circuit board. The slot antenna includes a feeding portion, at least one grounding portion, and a radiating portion. The feeding portion and the at least one grounding portion are connected between the circuit board and the metal frame, the radiating portion and the circuit board enclose a slot. The radiating portion is formed on a portion of the metal frame. The slot antenna, the multiple bandpass filter, the plurality of matching circuits, and the plurality of RF modules are electrically connected in that order.

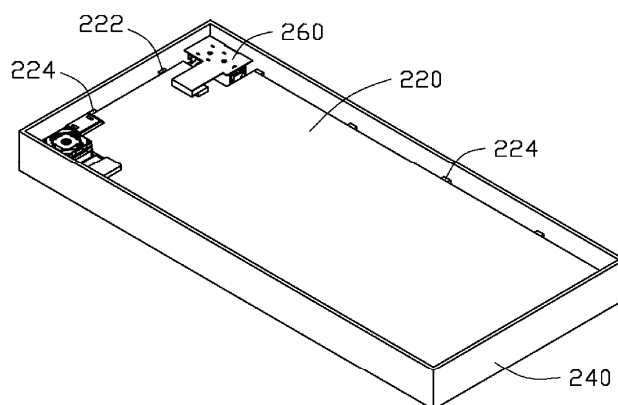
(51) **Int. Cl.**
H04M 1/00 (2006.01)
H01Q 1/24 (2006.01)
H01Q 13/10 (2006.01)
H01Q 5/335 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 5/335**
(2015.01); **H01Q 13/10** (2013.01)

(58) **Field of Classification Search**
CPC H01O 13/10

20 Claims, 7 Drawing Sheets

200





US009620852B2

(12) **United States Patent**
Tai

(10) **Patent No.:** **US 9,620,852 B2**
(45) **Date of Patent:** **Apr. 11, 2017**

(54) **MULTI-BAND ANTENNA**

(56) **References Cited**

(71) Applicant: **HON HAI PRECISION INDUSTRY CO., LTD.**, New Taipei (TW)

U.S. PATENT DOCUMENTS

(72) Inventor: **Lung-Sheng Tai**, New Taipei (TW)

7,170,450 B2 * 1/2007 Chang H01Q 1/243
343/700 MS

(73) Assignee: **HON HAI PRECISION INDUSTRY CO., LTD.**, New Taipei (TW)

7,375,686 B2 5/2008 Ko
7,825,863 B2 * 11/2010 Martiskainen H01Q 1/243
343/700 MS

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 528 days.

8,963,780 B2 * 2/2015 Hsu H01Q 5/378
343/700 MS
8,994,604 B2 * 3/2015 Puente Baliarda H01Q 1/36
343/803

(Continued)

(21) Appl. No.: **13/971,815**

FOREIGN PATENT DOCUMENTS

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

CN 1761106 A 4/2006
CN 201185228 1/2009

(65) **Prior Publication Data**

US 2014/0049431 A1 Feb. 20, 2014

(Continued)

Primary Examiner — Dameon E Levi

Assistant Examiner — Jennifer F Hu

(74) *Attorney, Agent, or Firm* — Wei Te Chung; Ming Chieh Chang

(51) **Int. Cl.**
H01Q 5/371 (2015.01)
H01Q 1/36 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/42 (2006.01)
H01Q 13/16 (2006.01)

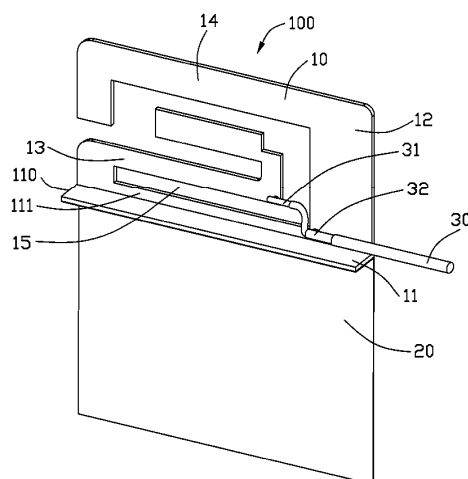
(57) **ABSTRACT**

An antenna includes a grounding portion with a grounding feed point, a radiating plane and a coaxial cable. The grounding portion extends in a lengthwise direction defining two ends opposite to each other in the lengthwise direction. The radiating plane extends upwardly from a lengthwise edge of the grounding portion. The radiating plane includes a first arm extending from one end of the lengthwise edge and a second arm extending from the opposite end. The first arm defines a signal feed point and a first radiating portion while the second arm is defined as a second radiating portion. The coaxial cable includes a core linking to the signal feed point and a shielding layer linking to the grounding feed point. The second arm surrounds the first arm in the radiating plane.

(52) **U.S. Cl.**
CPC **H01Q 1/36** (2013.01); **H01Q 1/243** (2013.01); **H01Q 5/371** (2015.01); **H01Q 9/42** (2013.01); **H01Q 13/16** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/00; H01Q 5/30; H01Q 5/307; H01Q 5/321; H01Q 5/328; H01Q 5/364; H01Q 5/378; H01Q 5/385; H01Q 5/392; H01Q 13/103; H01Q 13/106; H01Q 1/243; H01Q 1/36; H01Q 5/371; H01Q 9/42; H01Q 13/16
USPC 343/700 MS
See application file for complete search history.

4 Claims, 3 Drawing Sheets





US009620857B2

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

(10) **Patent No.:** **US 9,620,857 B2**

(45) **Date of Patent:** **Apr. 11, 2017**

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

USPC 343/745, 702
See application file for complete search history.

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

(72) Inventors: **Jin-Bo Chen**, New Taipei (TW);
Cho-Kang Hsu, New Taipei (TW)

2007/0030203 A1 * 2/2007 Tsai H01Q 5/371
343/702
2008/0150812 A1 * 6/2008 Kanazawa H01Q 9/0407
343/702
2009/0115671 A1 * 5/2009 Ishihara H01Q 1/243
343/702
2012/0127055 A1 * 5/2012 Yamagajo H01Q 1/243
343/850
2014/0361948 A1 * 12/2014 Tanaka H01Q 1/38
343/861

(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 81 days.

* cited by examiner

(21) Appl. No.: **14/569,999**

Primary Examiner — Dieu H Duong

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

(74) *Attorney, Agent, or Firm* — Steven M. Reiss

(65) **Prior Publication Data**

US 2015/0180124 A1 Jun. 25, 2015

(30) **Foreign Application Priority Data**

Dec. 20, 2013 (CN) 2013 1 0707368

(57) **ABSTRACT**

An antenna structure includes a main antenna, a parasitic antenna, a matching circuit and a switching circuit. The main antenna includes a feeding strip and a first radiating strip coupled to the feeding strip. The parasitic antenna includes a grounding strip and a second radiating strip coupled to the grounding strip. The second radiating strip is positioned adjacent to and apart from the first radiating strip, and further configured to electromagnetically couple to and be parasitically fed by the first radiating strip. The parasitic antenna and main antenna cooperatively generate at least one high-frequency resonate mode and a low-frequency resonate mode. The matching circuit is electronically coupled to the feeding strip. The switching circuit is electronically coupled to the matching circuit, and configured to regulate an inductance value of the matching circuit output to the feeding strip, thereby regulating a central frequency of the low-frequency resonate mode.

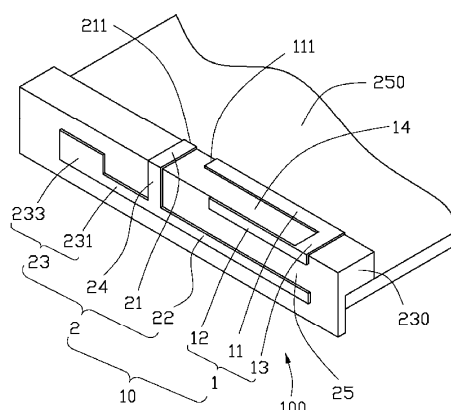
(51) **Int. Cl.**
H01Q 9/00 (2006.01)
H01Q 5/335 (2015.01)
H01Q 5/378 (2015.01)
H01Q 9/04 (2006.01)
H01Q 1/24 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 5/335** (2015.01); **H01Q 1/243** (2013.01); **H01Q 5/378** (2015.01); **H01Q 9/0442** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 9/0442; H01Q 5/335; H01Q 5/378

12 Claims, 3 Drawing Sheets

200





US009620859B2

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

(10) **Patent No.:** **US 9,620,859 B2**

(45) **Date of Patent:** **Apr. 11, 2017**

(54) **CONFORMABLE ANTENNA**

(56) **References Cited**

(71) Applicant: **GALTRONICS CORPORATION LTD.**, Tiberias (IL)

U.S. PATENT DOCUMENTS

(72) Inventors: **Randell Cozzolino**, Phoenix, AZ (US);
Gary Wannagot, Gilbert, AZ (US);
Snir Azulay, Tiberias (IL)

6,313,809 B1 * 11/2001 Gabriel H01Q 1/246
343/797

6,445,297 B1 9/2002 Nicholson
(Continued)

(73) Assignee: **GALTRONICS CORPORATION, LTD.**, Tiberias (IL)

FOREIGN PATENT DOCUMENTS

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 359 days.

CN 1595718 A 3/2005
CN 1706075 A 12/2005
(Continued)

OTHER PUBLICATIONS

(21) Appl. No.: **13/974,469**

U.S. Appl. No. 61/128,284, "Conformable Compact Balanced or unbalanced Antenna with or without Incorporated Balun", filed on May 19, 2008.

(22) Filed: **Aug. 23, 2013**

(Continued)

(65) **Prior Publication Data**

US 2013/0342415 A1 Dec. 26, 2013

Related U.S. Application Data

Primary Examiner — Huedung Mancuso

(74) *Attorney, Agent, or Firm* — Lorenz & Kopf, LLP

(63) Continuation of application No. 13/526,737, filed on Jun. 19, 2012, now Pat. No. 8,519,903, which is a
(Continued)

(57) **ABSTRACT**

(51) **Int. Cl.**
H01Q 9/26 (2006.01)
H01Q 1/36 (2006.01)
(Continued)

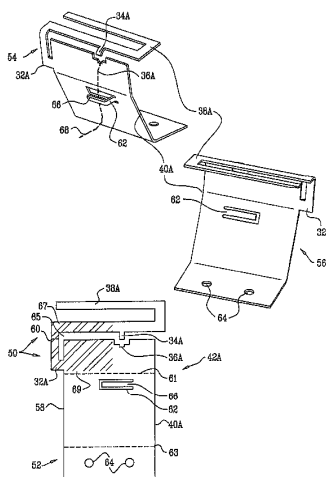
A polymorphic antenna, including a metallic template configurable in at least first and second possible different three-dimensional shapes, the antenna, when configured in the at least first and second different three-dimensional shapes, having a common antenna feed point, a common balun coupled to the common antenna feed point; and a common dipole coupled to the common antenna feed point and to the common balun. The antenna operates in a common frequency band when configured in either of the at least first and second different three-dimensional shapes when fed via the common antenna feed point.

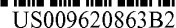
(52) **U.S. Cl.**
CPC **H01Q 9/26** (2013.01); **H01Q 1/36** (2013.01); **H01Q 5/371** (2015.01); **H01Q 9/42** (2013.01);
(Continued)

(58) **Field of Classification Search**

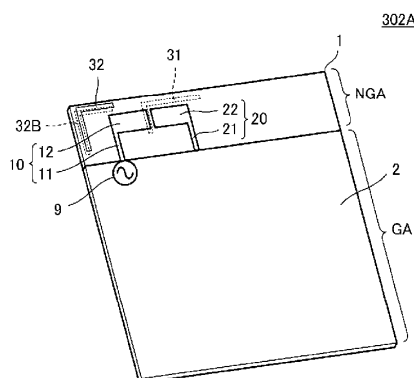
CPC H01Q 9/26
See application file for complete search history.

17 Claims, 16 Drawing Sheets





(10) **Patent No.:** US 9,620,863 B2
(45) **Date of Patent:** Apr. 11, 2017





(10) **Patent No.:** US 9,620,867 B2
(45) **Date of Patent:** Apr. 11, 2017

- (58) **Field of Classification Search**
CPC H01Q 21/28; H01Q 1/243; H01Q 1/521;
H01Q 9/42

(Continued)

- (56)
- References Cited**

U.S. PATENT DOCUMENTS

- | | | | |
|--------------|----|---------|--------------|
| 6,686,886 | B2 | 2/2004 | Flint et al. |
| 2004/0257283 | A1 | 12/2004 | Asano et al. |

(Continued)

- FOREIGN PATENT DOCUMENTS

- | | | |
|----|-------------|--------|
| JP | 2003-101334 | 4/2003 |
| JP | 3618621 | 2/2005 |

(Continued)

- ## OTHER PUBLICATIONS

- International Search Report issued Apr. 23, 2013 in International (PCT) Application No. PCT/JP2013/000401.

(Continued)

- Primary Examiner* — Graham Smith

(74) *Attorney, Agent, or Firm* — Wenderoth, Lind & Ponack, L.L.P.

Related U.S. Application Data

- (57) **ABSTRACT**

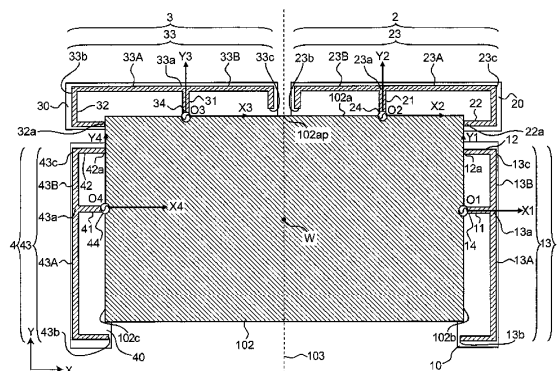
- (30) **Foreign Application Priority Data**

Jan. 31, 2012	(JP)	2012-017703
Jan. 31, 2012	(JP)	2012-017704
Feb. 10, 2012	(JP)	2012-027266

- (Continued)

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

19 Claims, 22 Drawing Sheets





US009621222B2

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

(10) **Patent No.:** **US 9,621,222 B2**

(45) **Date of Patent:** **Apr. 11, 2017**

(54) **ELECTRONIC DEVICE HAVING
SENSOR-COMBINED ANTENNA DEVICE**

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

(72) Inventors: **In-Ho Shin**, Daegu (KR); **Ji-Woong
Oh**, Seoul (KR)

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

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

(21) Appl. No.: **14/691,701**

(22) Filed: **Apr. 21, 2015**

(65) **Prior Publication Data**
US 2015/0303979 A1 Oct. 22, 2015

(30) **Foreign Application Priority Data**
Apr. 22, 2014 (KR) 10-2014-0047885

(51) **Int. Cl.**
H04B 1/74 (2006.01)
H04B 1/3827 (2015.01)
H04B 7/06 (2006.01)
H04B 7/08 (2006.01)

(52) **U.S. Cl.**
CPC **H04B 1/74** (2013.01); **H04B 1/3838**
(2013.01); **H04B 7/06** (2013.01); **H04B 7/08**
(2013.01)

(58) **Field of Classification Search**

CPC H04B 1/18; H04B 1/0053; H04B 1/0458;
H04B 1/3833; H04B 1/44; H04B 1/74;
H04B 7/06; H04B 7/08
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2012/0206556 A1 *	8/2012	Yu	H04M 1/00 348/14.02
2013/0029625 A1 *	1/2013	Park	H01Q 1/243 455/272
2013/0037924 A1 *	2/2013	Lee	H01L 23/66 257/664
2014/0171159 A1 *	6/2014	Endo	H01Q 1/243 455/575.7

FOREIGN PATENT DOCUMENTS

KR 10-2013-0013089 A 2/2013

* cited by examiner

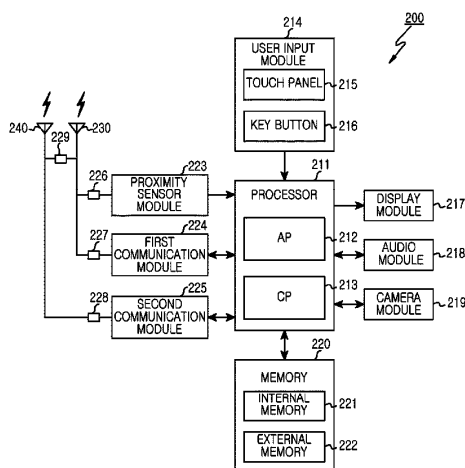
Primary Examiner — Tuan Pham

(74) *Attorney, Agent, or Firm* — Cha & Reiter, LLC.

(57) **ABSTRACT**

An electronic device including an antenna device with an integrated sensor is provided. In an embodiment, first and second antenna radiators are operably connected. A communication module transmits or receive communication signals through the first and/or second antenna radiator. A separation circuit such as a series connected inductor is connected in a path between the first and second antenna radiators. The separation circuit prevents passage of the communication signals through the path while enabling passage of a sensing signal acquired through the first and second antenna radiators. A sensor module such as a proximity sensor receives the sensing signal acquired through the first and second antenna radiators. A processor controls a function of the electronic device based on the sensing signal.

15 Claims, 5 Drawing Sheets





US009621230B2

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

(10) **Patent No.:** **US 9,621,230 B2**
(45) **Date of Patent:** **Apr. 11, 2017**

(54) **ELECTRONIC DEVICE WITH NEAR-FIELD ANTENNAS**

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

(72) Inventors: **Yuehui Ouyang**, Sunnyvale, CA (US);
Joseph Hakim, Cupertino, CA (US);
Dean F. Darnell, Durham, NC (US);
Mattia Pascolini, San Francisco, CA (US)

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

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

(21) Appl. No.: **14/195,247**

(22) Filed: **Mar. 3, 2014**

(65) **Prior Publication Data**

US 2015/0249485 A1 Sep. 3, 2015

(51) **Int. Cl.**
H04B 5/00 (2006.01)
H04B 5/02 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H04B 5/0081** (2013.01); **H01Q 5/35**
(2015.01); **H01Q 7/00** (2013.01); **H01Q 9/42**
(2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 5/35; H01Q 7/00; H01Q
9/0421; H01Q 9/42; H04B 5/0081; H04B
5/02; H04W 88/06

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,936,583 A 8/1999 Sekine et al.
6,308,051 B1 10/2001 Atokawa
(Continued)

FOREIGN PATENT DOCUMENTS

EP 2498336 9/2012
EP 2528165 11/2012
(Continued)

OTHER PUBLICATIONS

Irci et al., U.S. Appl. No. 14/262,486, filed Apr. 25, 2014.
(Continued)

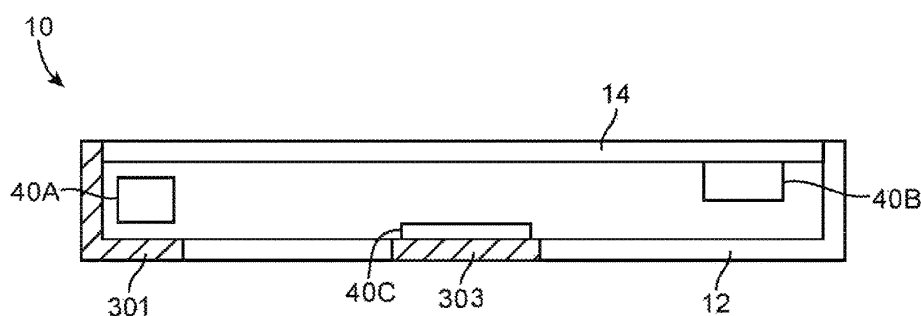
Primary Examiner — Lewis West

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

(57) **ABSTRACT**

An electronic device may have multiple near-field communications antennas. Multiplexer circuitry may have a transceiver port that is coupled to a near-field communications transceiver, and multiple antenna ports coupled to respective near-field communications antennas. Non-near-field communications antennas may be used by non-near-field communications circuitry. The electronic device may have a housing with opposing first and second ends and a display. One of the near-field communications antennas and one of the non-near-field communications antenna may be formed from shared antenna structures at the first end. Another of the near-field communications antennas and another of the non-near-field communications antennas may be formed from shared antenna structures at the second end. An additional near field communications antenna may be overlapped by the display.

20 Claims, 8 Drawing Sheets





US009627750B2

(12) **United States Patent**
Suzuki

(10) **Patent No.:** **US 9,627,750 B2**

(45) **Date of Patent:** **Apr. 18, 2017**

(54) **RADIO DEVICE**

- (71) Applicant: **FUJITSU LIMITED**, Kawasaki-shi,
Kanagawa (JP)
- (72) Inventor: **Yusuke Suzuki**, Fujisawa (JP)
- (73) Assignee: **FUJITSU LIMITED**, Kawasaki (JP)
- (*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 49 days.

(21) Appl. No.: **14/572,826**

(22) Filed: **Dec. 17, 2014**

(65) **Prior Publication Data**

US 2015/0263418 A1 Sep. 17, 2015

(30) **Foreign Application Priority Data**

Mar. 13, 2014 (JP) 2014-050388

- (51) **Int. Cl.**
H01Q 1/52 (2006.01)
H01Q 1/48 (2006.01)
H01Q 21/28 (2006.01)
H01Q 1/38 (2006.01)

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

- (58) **Field of Classification Search**
CPC H01Q 1/52; H01Q 1/38; H01Q
1/241–1/243; H01Q 1/245; H01Q 1/24;
H01Q 1/48; H01Q 9/40
USPC 343/702, 846, 848, 893
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,133,880 A	10/2000	Grangeat et al.	
8,619,001 B2 *	12/2013	Wakabayashi	H01Q 7/005 343/860
9,276,319 B2 *	3/2016	Vazquez	H01Q 9/06
2004/0100406 A1 *	5/2004	Okado	H01Q 9/40 343/700 MS
2007/0001911 A1 *	1/2007	Fujio	H01Q 9/0407 343/700 MS
2009/0079657 A1 *	3/2009	Chung	H01Q 1/2291 343/876
2012/0229357 A1 *	9/2012	Hung	H01Q 1/243 343/848

(Continued)

FOREIGN PATENT DOCUMENTS

JP	11-284430	10/1999
JP	2007-235451	9/2007

(Continued)

Primary Examiner — Dameon E Levi

Assistant Examiner — Awat Salih

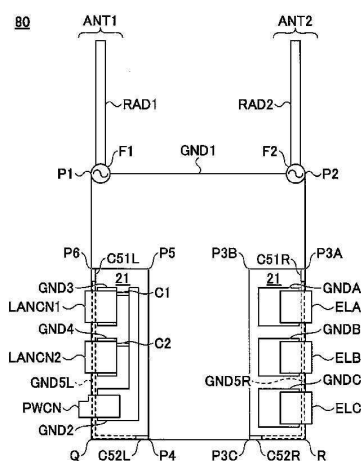
(74) *Attorney, Agent, or Firm* — Fujitsu Patent Center

(57)

ABSTRACT

A radio device includes a rectangular substrate including first and second opposite sides and third and fourth opposite sides; a ground plane formed in the substrate, cut out along the third side from a corner at one end of the second side; a first monopole antenna extending away from the ground plane along the third side from a first feeding unit provided on the third side; a second monopole antenna extending away from the ground plane along the fourth side from a second feeding unit provided on the fourth side; and a ground element formed in the ground plane, extending toward the second side along the third side, from one end of the ground element connected to the ground plane. A length from the first feeding unit through the one end to another end of the ground element corresponds to one fourth of a wavelength of radio waves.

9 Claims, 16 Drawing Sheets





US009627754B2

(12) **United States Patent**
Na

(10) **Patent No.:** **US 9,627,754 B2**
(45) **Date of Patent:** **Apr. 18, 2017**

(54) **MOBILE TERMINAL HAVING ANTENNA WITH TWO CONDUCTIVE MEMBERS**

USPC 343/702, 904
See application file for complete search history.

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

(56) **References Cited**

(72) Inventor: **Youngsoo Na**, Seoul (KR)

U.S. PATENT DOCUMENTS

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

6,498,586 B2 * 12/2002 Pankinaho H01Q 1/243
343/700 MS
7,301,502 B2 * 11/2007 Sinasi H01Q 1/243
343/702
7,642,984 B2 * 1/2010 Tsai H01Q 1/2266
343/702
2004/0104853 A1 * 6/2004 Chen G06F 1/1616
343/702
2004/0130493 A1 * 7/2004 Horita H01Q 1/08
343/702
2004/0252064 A1 * 12/2004 Yuanzhu H01Q 1/243
343/702
2005/0270240 A1 * 12/2005 Qi H01Q 1/243
343/702

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 291 days.

(21) Appl. No.: **14/023,132**

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

(65) **Prior Publication Data**

US 2014/0071022 A1 Mar. 13, 2014

(30) **Foreign Application Priority Data**

Sep. 11, 2012 (KR) 10-2012-0100608

(51) **Int. Cl.**
H01Q 5/00 (2015.01)
H01Q 9/42 (2006.01)
H01Q 5/371 (2015.01)
H01Q 1/24 (2006.01)
H01Q 1/38 (2006.01)
H01Q 21/28 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 5/001** (2013.01); **H01Q 5/371** (2015.01); **H01Q 9/42** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 21/28** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/38; H01Q 21/28; H01Q 1/243; G01Q 9/42

(Continued)

Primary Examiner — Dameon E Levi

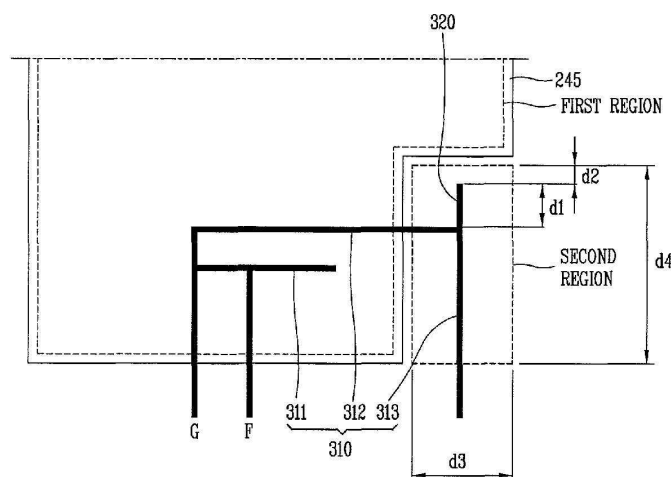
Assistant Examiner — Ab Salam Alkassim, Jr.

(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

A mobile terminal including a terminal body; a display configured to display information; and an antenna device mounted in the terminal body. Further, the antenna device includes a first conductive member including a shape such that the antenna device resonates at a first frequency band; a second conductive member diverging from the first conductive member, and extending by a prescribed length; and a ground member spaced apart from the second conductive member, and capacitive-coupled to the second conductive member, such that a frequency resonance added by the second conductive member is generated near a center frequency of the first frequency band.

18 Claims, 7 Drawing Sheets





US009627755B2

(12) **United States Patent**
Lin

(10) **Patent No.:** **US 9,627,755 B2**

(45) **Date of Patent:** **Apr. 18, 2017**

(54) **MULTIBAND ANTENNA AND WIRELESS COMMUNICATION DEVICE**

(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 50 days.

(21) Appl. No.: **14/575,685**

(22) Filed: **Dec. 18, 2014**

(65) **Prior Publication Data**

US 2016/0134017 A1 May 12, 2016

(30) **Foreign Application Priority Data**

Nov. 6, 2014 (CN) 2014 1 0626080

(51) **Int. Cl.**
H01Q 5/378 (2015.01)
H01Q 5/371 (2015.01)
H01Q 5/335 (2015.01)
H01Q 1/24 (2006.01)
H01Q 5/328 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 5/335** (2015.01); **H01Q 1/243** (2013.01); **H01Q 5/328** (2015.01); **H01Q 5/371** (2015.01); **H01Q 5/378** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 5/328; H01Q 5/335; H01Q 5/364; H01Q 5/371; H01Q 5/378; H01Q 5/385;

H01Q 5/42; H01Q 5/392; H01Q 5/357; H01Q 5/321; H01Q 5/314; H01Q 5/30; H01Q 1/245; H01Q 1/243; H01Q 1/24

USPC 343/745, 702
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,493,702 A *	2/1996	Crowley	H01Q 1/241
			343/702
8,890,753 B1 *	11/2014	Lee	H01Q 1/243
			343/702
8,957,827 B1 *	2/2015	Lee	H01Q 5/321
			343/700 MS
9,240,627 B2 *	1/2016	Tseng	H01Q 1/243
2002/0021248 A1 *	2/2002	Ying	H01Q 1/243
			343/700 MS
2003/0052824 A1 *	3/2003	Ollikainen	H01Q 1/243
			343/700 MS
2004/0075613 A1 *	4/2004	Jarmuszewski	H01Q 1/243
			343/702

(Continued)

Primary Examiner — Dameon E Levi

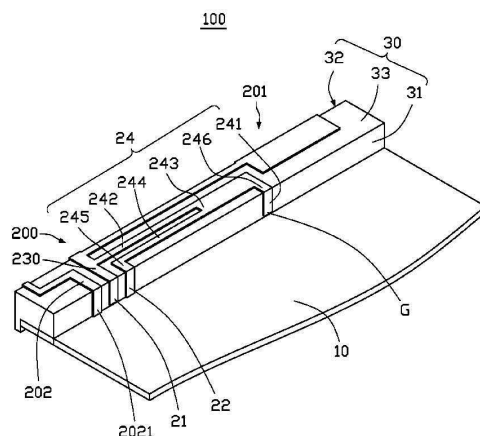
Assistant Examiner — Awat Salih

(74) Attorney, Agent, or Firm — Steven M. Reiss

(57) **ABSTRACT**

A multiband antenna includes main antenna, a switch circuit, and a parasitic antenna. The main antenna includes a radiating portion, a feeding portion, a grounding portion, and an extending portion coupled to the feeding portion and the grounding portion. The radiating portion is configured to generate a low frequency resonate mode. The switch circuit is configured to regulate an impedance matching characteristic of the multiband antenna, thereby regulating an operating frequency of the low frequency resonate mode. The parasitic antenna is positioned apart from and electromagnetically coupled to the main antenna, and configured to generate a high frequency resonate mode.

16 Claims, 5 Drawing Sheets





US009627757B2

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

(10) **Patent No.:** **US 9,627,757 B2**

(45) **Date of Patent:** **Apr. 18, 2017**

(54) **DUAL-BAND PRINTED MONOPOLE ANTENNA**

FOREIGN PATENT DOCUMENTS

(71) Applicant: **Arcadyan Technology Corporation**,
Hsinchu (TW)

TW I239679 B 9/2005
TW 201401649 A 1/2014

(72) Inventors: **Chih-Yung Huang**, Hsinchu (TW);
Kuo-Chang Lo, Hsinchu (TW)

OTHER PUBLICATIONS

(73) Assignee: **ARCADYAN TECHNOLOGY CORPORATION**, Hsinchu (TW)

Office Action was issued on Sep. 4, 2015 from the TW Patent Office.(all the cited references are listed in this IDS.).

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 317 days.

* cited by examiner

(21) Appl. No.: **14/333,023**

Primary Examiner — Graham Smith

Assistant Examiner — Noel Maldonado

(22) Filed: **Jul. 16, 2014**

(74) *Attorney, Agent, or Firm* — The PL Law Group, PLLC

(65) **Prior Publication Data**

US 2015/0194729 A1 Jul. 9, 2015

(57) **ABSTRACT**

(30) **Foreign Application Priority Data**

Jan. 8, 2014 (TW) 103100729 A

A monopole antenna is disclosed. The monopole antenna includes a grounding terminal and a transmission line extending along a first direction and including a first terminal and a feeding terminal adjacent to the grounding terminal. The monopole antenna further includes a first radiator connected to the first terminal, extending along a second direction perpendicular to the first direction and operating within a first frequency range. The first radiator has a portion with a width increasing gradually along the second direction. The monopole antenna further includes a second radiator connected to the first terminal, extending along a third direction far away from the grounding terminal, having a first included angle with the transmission line, including a plurality of turns, and operating within a second frequency range.

(51) **Int. Cl.**
H01Q 5/371 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 5/371** (2015.01)

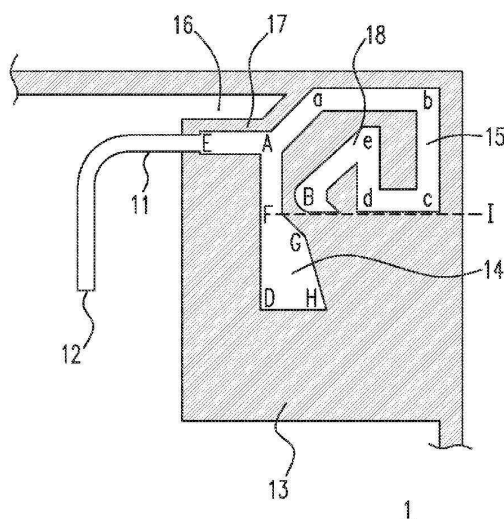
(58) **Field of Classification Search**
CPC H01Q 5/371; H01Q 9/0407; H01Q 5/0027
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

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

18 Claims, 4 Drawing Sheets





US009627769B2

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

(10) **Patent No.:** **US 9,627,769 B2**

(45) **Date of Patent:** **Apr. 18, 2017**

(54) **SLOT ANTENNA AND INFORMATION
TERMINAL APPARATUS USING THE SAME**

(71) Applicants: **LG Display Co., Ltd.**, Seoul (KR);
**Korea Advanced Institute of Science
and Technology**, Daejeon (KR)

(72) Inventors: **Hyungjoon Koo**, Seoul (KR); **Heejung
Hong**, Seoul (KR); **Sooji Lee**, Daegu
(KR); **Kyoungsub Oh**, Gyeonggi-do,
OH (US); **Jongwon Yu**, Daejeon (KR)

(73) Assignees: **LG Display Co., Ltd.**, Seoul (KR);
**Korea Advanced Institute of Science
and Technology**, Daejeon (KR)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 406 days.

(21) Appl. No.: **14/136,571**

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

(65) **Prior Publication Data**

US 2014/0184450 A1 Jul. 3, 2014

(30) **Foreign Application Priority Data**

Dec. 28, 2012 (KR) 10-2012-0157534

(51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 1/22 (2006.01)
H01Q 1/24 (2006.01)
H01Q 5/335 (2015.01)
H01Q 5/385 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 13/10** (2013.01); **H01Q 1/2266**
(2013.01); **H01Q 1/243** (2013.01); **H01Q**
5/335 (2015.01); **H01Q 5/385** (2015.01);
H01Q 13/103 (2013.01); **H01Q 13/106**
(2013.01)

(58) **Field of Classification Search**

CPC H01C 13/103; H01C 13/106; H01C 13/10;
H01C 1/2266

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,339,400	B1	1/2002	Flint et al.
6,686,886	B2	2/2004	Flint et al.
2004/0257283	A1	12/2004	Asano et al.
2005/0146475	A1	7/2005	Bettner et al.
2005/0206573	A1	9/2005	Iigusa et al.
2006/0290569	A1	12/2006	Boyle
2009/0231215	A1	9/2009	Taura
2010/0225553	A1	9/2010	Minard et al.

(Continued)

FOREIGN PATENT DOCUMENTS

CN	1482704	A	3/2004
CN	1836350	A	9/2006

(Continued)

OTHER PUBLICATIONS

Office Action issued in corresponding Chinese Patent Application
No. 201310706048.X dated Aug. 5, 2015.

(Continued)

Primary Examiner — Hoang V Nguyen

Assistant Examiner — Michael Bouizza

(74) *Attorney, Agent, or Firm* — Morgan, Lewis &
Bockius LLP

(57) **ABSTRACT**

A slot antenna and an information terminal apparatus using
the same are provided. The slot antenna comprises: a con-
ductive housing; and at least one slot formed on the corner
and edge of the conductive housing.

10 Claims, 36 Drawing Sheets

