



US009293806B2

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

(10) **Patent No.:** **US 9,293,806 B2**
(45) **Date of Patent:** **Mar. 22, 2016**

(54) **ELECTRONIC DEVICE WITH DISPLAY
FRAME ANTENNA**

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

(72) Inventors: **Kelvin Kwong**, Cupertino, CA (US);
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(73) Assignee: **Apple Inc.**, Cupertino, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 134 days.

(21) Appl. No.: **14/201,501**

(22) Filed: **Mar. 7, 2014**

(65) **Prior Publication Data**

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H01Q 1/24 (2006.01)
H01Q 1/22 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/24** (2013.01); **H01Q 1/2258**
(2013.01); **H01Q 1/243** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/22; H01Q 1/2258; H01Q 1/2283;
H01Q 1/2291; H01Q 1/241-1/243
USPC 343/702
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,804,881 B1 * 10/2004 Shipley C25D 5/022
174/262
7,545,628 B2 * 6/2009 Takuma G06F 1/1616
349/58
7,852,273 B2 12/2010 Saitou

7,982,675 B2 * 7/2011 Tsujimura H01Q 1/22
343/702
8,072,388 B2 * 12/2011 Nysen H01Q 1/2258
343/702
8,269,675 B2 * 9/2012 Kough H01Q 1/2266
343/702
8,326,347 B2 12/2012 Wagner et al.
8,669,909 B2 3/2014 Yamaguchi et al.
8,922,527 B2 * 12/2014 Ryshtun G06F 3/0416
345/174
2009/0135073 A1 5/2009 Yokote et al.
2010/0026590 A1 2/2010 Chiang et al.
2011/0025922 A1 * 2/2011 Toya G02F 1/133308
348/731
2012/0050114 A1 * 3/2012 Li H01Q 1/2266
343/702
2013/0076574 A1 * 3/2013 Rappoport H01Q 1/243
343/702
2013/0335275 A1 12/2013 Sanford et al.

* cited by examiner

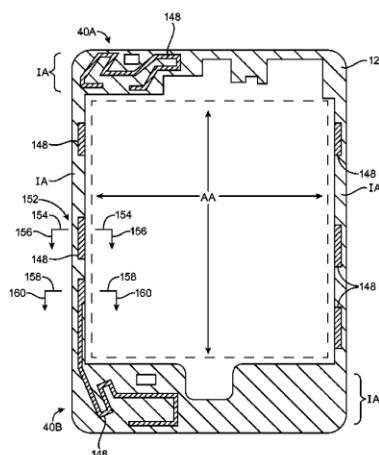
Primary Examiner — Howard Williams

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

(57) **ABSTRACT**

An electronic device has a display mounted in a housing using a plastic display frame. The display has an active area and an inactive area. A display cover layer may have polymer coating layers in the inactive area. The display frame may lie under the inactive area. A patterned metal coating layer may be formed on the display frame. The patterned metal coating layer may have portions that form adhesion promotion structures for promoting adhesion between the frame and the adhesive. The patterned metal coating layer may also have portions that form antenna structures. The antenna structures may be used to transmit and receive radio-frequency signals and may be used as adhesion promotion structures. Adhesive may be interposed between the polymer coating layers and the metal coating layer on the display frame to attach the display cover layer and the display to the display frame.

20 Claims, 13 Drawing Sheets





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

(10) **Patent No.:** **US 9,293,807 B2**
(45) **Date of Patent:** **Mar. 22, 2016**

(54) **MOBILE WIRELESS COMMUNICATIONS
DEVICE WITH ELECTRICALLY
CONDUCTIVE CONTINUOUS RING AND
RELATED METHODS**

(71) Applicant: **BLACKBERRY LIMITED**, Waterloo
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(72) Inventors: **Joshua Kwan Ho Wong**, Waterloo
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(73) Assignee: **BLACKBERRY LIMITED**, Waterloo,
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patent is extended or adjusted under 35
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(21) Appl. No.: **14/260,363**

(22) Filed: **Apr. 24, 2014**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. 13/099,025, filed on
May 2, 2011, now Pat. No. 8,774,880, which is a
continuation-in-part of application No. 13/005,311,
filed on Jan. 12, 2011, now Pat. No. 8,615,279.

(60) Provisional application No. 61/367,113, filed on Jul.
23, 2010.

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

(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 9/0442**
(2013.01); **H01Q 9/0464** (2013.01);

(Continued)

(58) **Field of Classification Search**

CPC ... H04W 88/02; H04M 1/026; H04M 1/0202;
H04M 1/0277
USPC 455/575.1, 575.7
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,483,727 B2 1/2009 Zhu et al.
7,705,795 B2 4/2010 Chiang et al.
(Continued)

FOREIGN PATENT DOCUMENTS

EP 1693925 8/2006
EP 1693925 A1 8/2006
(Continued)

OTHER PUBLICATIONS

Bennett et al., "The design of broad-band aircraft-antenna systems",
Proceedings of the IRE, vol. 33, No. 10, Oct. 1945, pp. 671-700.

(Continued)

Primary Examiner — Charles Appiah

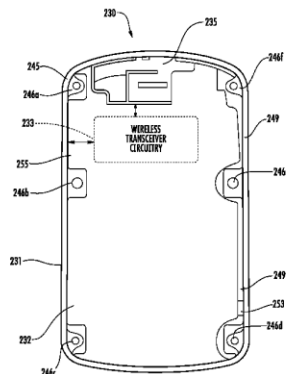
Assistant Examiner — Jaime Holliday

(74) *Attorney, Agent, or Firm* — Guntin & Gust, PLC; Jay H.
Anderson

(57) **ABSTRACT**

A mobile wireless communications device may include a portable housing that may include an electrically conductive continuous ring defining a perimeter of the portable housing. The electrically conductive continuous ring may be configured to function as an antenna. The mobile wireless communications device may further include a printed circuit board (PCB) carried by the portable housing and may include an electrically conductive layer defining a ground plane. The mobile wireless communications device may further include wireless transceiver circuitry carried by the PCB and coupled to the antenna. The mobile wireless communications device may also include an electrically conductive shorting member coupled between the electrically conductive continuous ring and the ground plane.

23 Claims, 14 Drawing Sheets





US009293816B2

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

(10) **Patent No.:** **US 9,293,816 B2**
(45) **Date of Patent:** **Mar. 22, 2016**

(54) **ELECTRONIC DEVICE PLATE ANTENNA**

(75) Inventors: **Miroslav Samardzija**, Mountain View, CA (US); **Rodney A. Gomez Angulo**, Sunnyvale, CA (US); **Qingxiang Li**, Mountain View, CA (US); **Robert W. Schlub**, Cupertino, CA (US); **Ruben Caballero**, San Jose, CA (US)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 372 days.

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(22) Filed: **Jul. 6, 2012**

(65) **Prior Publication Data**

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H01Q 1/24 (2006.01)
H01Q 1/42 (2006.01)
H01Q 1/38 (2006.01)
H01Q 9/04 (2006.01)
H01Q 13/16 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/42** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 9/0407** (2013.01); **H01Q 13/16** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/38; H01Q 13/16
USPC 343/702, 872
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,394,160	A *	2/1995	Iwasaki et al.	343/702
6,191,740	B1	2/2001	Kates et al.	
6,317,084	B1	11/2001	Chen et al.	
6,359,595	B1	3/2002	Abraham et al.	
6,456,242	B1 *	9/2002	Crawford	H01Q 1/22 343/700 MS
6,774,849	B2	8/2004	Umehara et al.	
6,894,647	B2 *	5/2005	Jenwatanavet	343/700 MS
6,914,563	B2	7/2005	Chen et al.	
2008/0316120	A1 *	12/2008	Hirota et al.	343/702
2009/0085812	A1 *	4/2009	Qi et al.	343/702
2010/0103612	A1 *	4/2010	Weber et al.	361/679.56
2010/0321253	A1 *	12/2010	Ayala Vazquez et al.	343/702
2011/0050508	A1	3/2011	Guterman et al.	

* cited by examiner

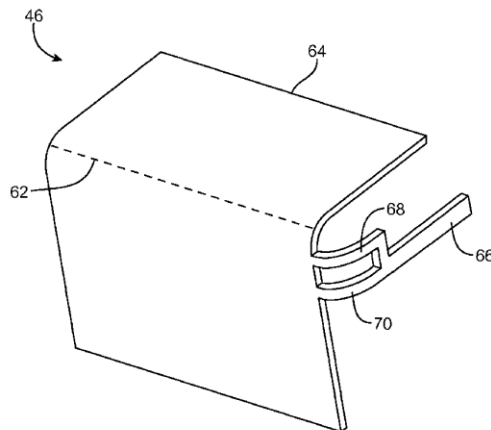
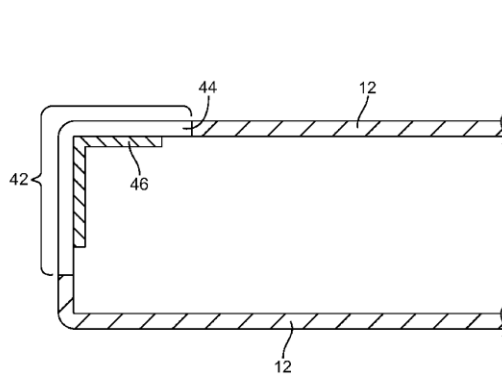
Primary Examiner — Dieu H Duong

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

(57) **ABSTRACT**

An electronic device may be provided with antenna structures. The antenna structures may include a plate antenna. The electronic device may have a conductive housing such as a metal housing with an opening. A dielectric antenna window may be formed within the opening. A dielectric support structure such as a flexible printed circuit may overlap the opening. A conductive trace on the dielectric support structure may form an antenna resonating element plate for the plate antenna. The plate may have a periphery that is separated from adjacent portions of the metal housing by a gap. The antenna resonating element plate may have a rectangular shape with a bend that lies along an edge of the conductive housing. The dielectric antenna window may have a bend that also lies along the edge of the conductive housing.

17 Claims, 9 Drawing Sheets





US009293819B2

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

(10) **Patent No.:** **US 9,293,819 B2**
(45) **Date of Patent:** **Mar. 22, 2016**

(54) **ANTENNA APPARATUS AND MOBILE
TERMINAL HAVING THE SAME**

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

(72) Inventors: **Jaegon Lee**, Seoul (KR); **Chisang You**,
Seoul (KR); **Changil Kim**, Seoul (KR)

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

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
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(21) Appl. No.: **13/889,836**

(22) Filed: **May 8, 2013**

(65) **Prior Publication Data**
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(30) **Foreign Application Priority Data**
May 9, 2012 (KR) 10-2012-0049340

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/50 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/42 (2006.01)
H01Q 5/378 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 1/50** (2013.01); **H01Q 1/243**
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(2013.01)

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,136,020	B2 *	11/2006	Yamaki	.....	343/702
8,988,292	B2 *	3/2015	Hotta et al.	.....	343/702
2004/0113845	A1 *	6/2004	Mikkola et al.	.....	343/700 MS
2007/0229358	A1 *	10/2007	Chi et al.	.....	343/700 MS
2014/0361948	A1 *	12/2014	TANAKA et al.	.....	343/861

* cited by examiner

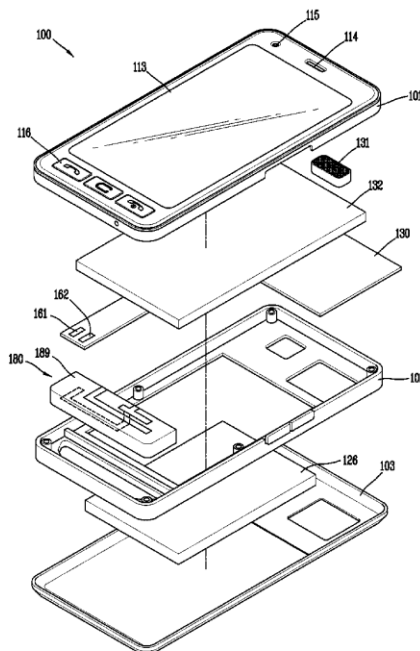
Primary Examiner — Tan Ho

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

(57) **ABSTRACT**

An antenna apparatus includes: a first member ground-connected to a ground of a printed circuit board (PCB); a second member spaced from the first member in parallel, and configured to capacitively coupling-feed the first member so as to transmit and receive signals of a first frequency band; and a third member extending from the second member by a prescribed length, so as to have a bandwidth extending up to a second frequency band adjacent to the first frequency band.

20 Claims, 12 Drawing Sheets





US009293826B2

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

(10) **Patent No.:** **US 9,293,826 B2**
(45) **Date of Patent:** **Mar. 22, 2016**

(54) **PLANAR INVERTED F ANTENNA WITH
IMPROVED FEEDING LINE CONNECTION**

USPC 343/700 MS, 845, 848, 718, 702
See application file for complete search history.

(75) Inventors: **Yoshiyuki Yonei**, Chiba (JP); **Masahiro Sobu**, Chiba (JP); **Akinori Matsui**, Fukaya (JP); **Misao Haneishi**, Saitama (JP)

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,229,487 B1 * 5/2001 Sadler et al. 343/700 MS
6,423,915 B1 * 7/2002 Winter 200/292

(Continued)

FOREIGN PATENT DOCUMENTS

EP 1026774 8/2000
JP 05299929 11/1993

(Continued)

OTHER PUBLICATIONS

International Search Report mailed Sep. 25, 2012 issued in International Appln. No. PCT/JP2012/070455.

(Continued)

Primary Examiner — Lam T Mai

(74) Attorney, Agent, or Firm — Adams & Wilks

(57) **ABSTRACT**

A planar inverted F antenna has a ground conductive plate and a main conductive plate that are short-circuited by a short circuit member. The main conductive plate connects to a feeding line for feeding power to the antenna and includes opposite side ends, a base extending from one side end to a prescribed position in the direction toward the other side end, and at least one slit extending from the other side end up to the prescribed position to form a microstrip line to which the feeding line is connected and at least one excitation conductive plate spaced apart from the microstrip line. Power is supplied to a feeding point at the prescribed position from the feeding line via the microstrip line which has a width selected so that both an input impedance of the antenna at the feeding point and a characteristic impedance of the transmission line become Z.

20 Claims, 25 Drawing Sheets

(73) Assignees: **SEIKO SOLUTIONS INC.** (JP);
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H01Q 9/04 (2006.01)

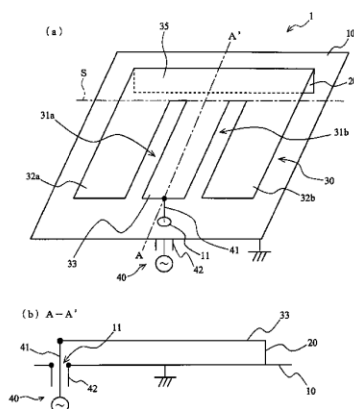
H01Q 5/371 (2015.01)

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

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(58) **Field of Classification Search**

CPC ... H01Q 9/0421; H01Q 9/0407; H01Q 9/045; H01Q 9/0471; H01Q 9/42; H01Q 1/243; H01Q 1/273; H01Q 1/38; H01Q 1/40; H01Q 5/364; H01Q 5/371





US009293827B2

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

(10) **Patent No.:** **US 9,293,827 B2**
(45) **Date of Patent:** **Mar. 22, 2016**

(54) **COMMUNICATION TERMINAL AND
ANTENNA APPARATUS THEREOF**

(75) Inventors: **Hoon Park**, Seoul (KR); **Jin Kyu Bang**,
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(KR)

(73) Assignee: **Samsung Electronics Co., Ltd.**,
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(21) Appl. No.: **13/099,747**

(22) Filed: **May 3, 2011**

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H01Q 1/38 (2006.01)
H01Q 1/40 (2006.01)
H01Q 1/42 (2006.01)
H01Q 19/00 (2006.01)
H01Q 9/04 (2006.01)

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

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/245; H01Q 9/0421;
H04B 1/3833
USPC 343/700 MS, 702, 833, 844, 872, 873
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,781,556 B2	8/2004	Kojima et al.	
2006/0092084 A1 *	5/2006	Sakurai	343/702
2006/0170599 A1 *	8/2006	Gilmore et al.	343/702
2007/0182658 A1 *	8/2007	Ozden	343/866
2008/0007468 A1	1/2008	Sato et al.	
2008/0055160 A1	3/2008	Kim et al.	
2008/0129611 A1 *	6/2008	Jiang	H01Q 1/2266 343/702
2008/0252536 A1 *	10/2008	Anguera et al.	343/702
2009/0040120 A1 *	2/2009	Tsubaki et al.	343/702
2009/0167615 A1 *	7/2009	Teng et al.	343/702
2009/0174604 A1 *	7/2009	Keskitalo et al.	343/700 MS
2010/0103068 A1	4/2010	Chen et al.	
2010/0109954 A1	5/2010	Shim et al.	
2011/0248895 A1 *	10/2011	Bungo et al.	343/702

FOREIGN PATENT DOCUMENTS

DE	195 45 224 A1	6/1997
DE	102 48 756 A1	3/2004
EP	1 414 107 A1	4/2004

(Continued)

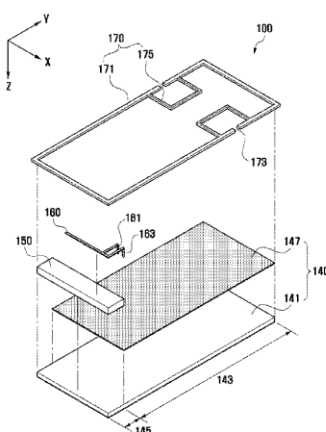
Primary Examiner — Laura Gudorf

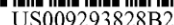
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

A communication terminal and an antenna apparatus of the communication terminal are provided. The communication terminal includes a body having a circuit board, an antenna element which is mounted inside the body and connected electrically to the circuit board and, when electric current is supplied via a main plate, resonant in a resonant frequency band for transmitting and receiving signals, and a metal case having an antenna pattern which is coupled to an edge of the body to be resonant and, when the antenna element is resonant, in the resonant frequency band for supporting operation of the antenna element.

5 Claims, 15 Drawing Sheets





(10) **Patent No.:** US 9,293,828 B2
(45) **Date of Patent:** *Mar. 22, 2016

[illegible]



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

(10) **Patent No.:** **US 9,293,833 B2**

(45) **Date of Patent:** **Mar. 22, 2016**

(54) **LOW IMPEDANCE SLOT FED ANTENNA**

(75) Inventors: **Shaikh Farooq Jawed**, Aalborg (DK);
Simon Svendsen, Aalborg (DK); **Ole**
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Bahramzy, Taastrup (DK)

(73) Assignee: **Molex, LLC**, Lisle, IL (US)

(*) Notice: Subject to any disclaimer, the term of this
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(86) PCT No.: **PCT/US2011/055869**

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(2), (4) Date: **Apr. 10, 2013**

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H01Q 9/42 (2006.01)

(52) **U.S. Cl.**
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(2013.01); **H01Q 9/42** (2013.01); **H01Q 13/10**
(2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/38; H01Q 1/50

USPC 343/757, 700 MS, 702, 860

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,133,878	A *	10/2000	Lee	343/700 MS
6,873,291	B2	3/2005	Aoyama et al.	
7,629,929	B2 *	12/2009	Son et al.	343/700 MS
8,654,012	B2 *	2/2014	Kim et al.	343/700 MS
8,870,077	B2 *	10/2014	Kato	235/492
2003/0098812	A1	5/2003	Ying et al.	
2007/0080867	A1	4/2007	Son et al.	
2008/0001837	A1	1/2008	Liu	
2008/0309578	A1	12/2008	Son et al.	
2009/0140928	A1 *	6/2009	Choi et al.	343/700 MS
2009/0174604	A1	7/2009	Keskitalo et al.	

FOREIGN PATENT DOCUMENTS

KR	2010-0095910	A	9/2010
WO	WO 2011/031668	A1	3/2011

OTHER PUBLICATIONS

International Search Report for PCT/US2011/055869.

* cited by examiner

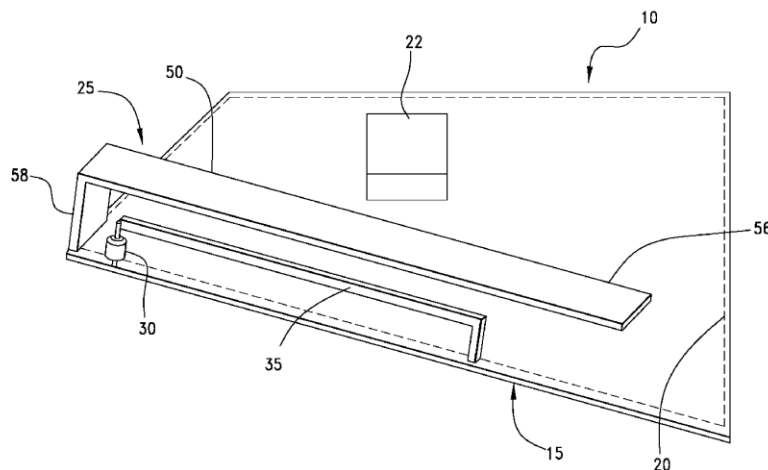
Primary Examiner — Huedung Mancuso

(74) *Attorney, Agent, or Firm* — Stephen L. Sheldon

(57) **ABSTRACT**

A low impedance slot fed antenna with a slot and an element configured to resonate is depicted. The orientation of the slot is configured so that a slot current is not opposed to a return current associated with the element. This helps decrease coupling between the slot and the element, which can benefit high Q antennas.

6 Claims, 14 Drawing Sheets





US009300033B2

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

(10) **Patent No.:** **US 9,300,033 B2**

(45) **Date of Patent:** **Mar. 29, 2016**

(54) **WIRELESS COMMUNICATION DEVICE
WITH AN ANTENNA ADJACENT TO AN
EDGE OF THE DEVICE**

(75) Inventors: **Chul Min Han**, San Diego, CA (US);
Jorge Fabrega Sanchez, San Diego, CA
(US)

(73) Assignee: **Futurewei Technologies, Inc.**, Plano,
TX (US)

(*) Notice: Subject to any disclaimer, the term of this
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H01Q 13/10 (2006.01)
H01Q 21/29 (2006.01)

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(2013.01); **H01Q 21/293** (2013.01)

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,762,723 B2 *	7/2004	Nallo	.....	H01Q 1/243	343/700 MS
7,551,142 B1 *	6/2009	Zhang	.....	H01Q 1/243	343/700 MS
2005/0280579 A1 *	12/2005	Liang	.....	H01Q 1/38	343/700 MS
2007/0241971 A1 *	10/2007	Tsujimura	.....	G06F 1/1616	343/702
2009/0153412 A1 *	6/2009	Chiang	.....	H01Q 1/52	343/702
2009/0256757 A1 *	10/2009	Chiang	.....	H01Q 13/10	343/702

OTHER PUBLICATIONS

"iPhone 4 Technical Specifications," <http://www.apple.com/iphone/specs.html>, downloaded Sep. 29, 2011, 3 pages.

* cited by examiner

Primary Examiner — Hoang V Nguyen

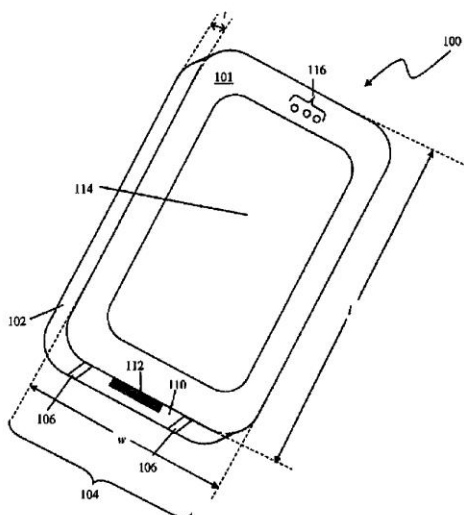
Assistant Examiner — Hai Tran

(74) *Attorney, Agent, or Firm* — Futurewei Technologies, Inc.

(57) **ABSTRACT**

A wireless communication device comprising a housing comprising a plurality of edges and configured to serve as an external surface for the wireless communication device, and an antenna adjacent to at least a first edge of the housing, wherein the antenna comprises at least a conductive strip and at least one slot and wherein the antenna is configured to receive and transmit wireless signals, wherein the first edge of the housing is one of an edge of the housing nearest an ear piece and an edge of the housing that is opposite the edge of the housing nearest the ear piece, and wherein the conductive strip and the slot are adjacent to at least the first edge of the housing.

21 Claims, 10 Drawing Sheets





US009300034B2

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

(10) **Patent No.:** **US 9,300,034 B2**

(45) **Date of Patent:** **Mar. 29, 2016**

(54) **MULTI-ANTENNA STRUCTURE**

(71) Applicant: **Auden Techno.Corp.**, Taoyuan Hsien (TW)

(72) Inventors: **Chun-Hua Chen**, Taoyuan Hsien (TW);
Hsien-Wen Liu, Taoyuan Hsien (TW)

(73) Assignee: **AUDEN TECHNO. CORP.**, Pa-Te, Taoyuan Hsien (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 327 days.

(21) Appl. No.: **13/936,035**

(22) Filed: **Jul. 5, 2013**

(65) **Prior Publication Data**

US 2015/0009092 A1 Jan. 8, 2015

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 1/52 (2006.01)

H01Q 9/42 (2006.01)

H01Q 5/371 (2015.01)

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

CPC **H01Q 1/243** (2013.01); **H01Q 1/521** (2013.01); **H01Q 5/371** (2015.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

2015/0009092 A1 * 1/2015 Chen H01Q 1/243
343/893

* cited by examiner

Primary Examiner — Hoang V Nguyen

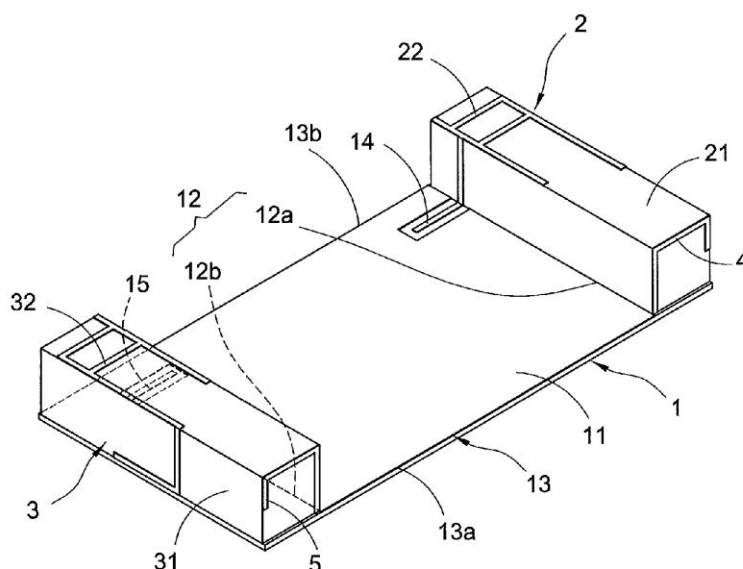
Assistant Examiner — Hai Tran

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

(57) **ABSTRACT**

A multi-antenna structure includes a base plate, a first antenna, a second antenna, a first metal line, and a second metal line. The base plate includes a grounded metal surface. The grounded metal surface includes two short sides and two long sides. The first antenna and the second antenna are arranged on the base plate. The first metal line and the second metal line are electrically connected to the two short sides of the grounded metal surface. A current path of the two short sides is prolonged because of the first metal line and the second metal line. A longitudinal current is equal to a transverse current at a low frequency. A current of the first antenna and a current of the second antenna does not interfere each other. Isolation between the first antenna and the second antenna is improved.

5 Claims, 5 Drawing Sheets





US009300035B2

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

(10) **Patent No.:** **US 9,300,035 B2**

(45) **Date of Patent:** ***Mar. 29, 2016**

(54) **MOBILE WIRELESS COMMUNICATIONS
DEVICE ANTENNA ASSEMBLY WITH
ANTENNA ELEMENT AND FLOATING
DIRECTOR ELEMENT ON FLEXIBLE
SUBSTRATE AND RELATED METHODS**

(2013.01); **H01Q 1/245** (2013.01); **H01Q
9/0421** (2013.01); **H01Q 19/005** (2013.01);
Y10T 29/49002 (2015.01); **Y10T 29/49016**
(2015.01); **Y10T 29/49018** (2015.01)

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

(72) Inventors: **Yihong Qi**, Waterloo (CA); **Ying Tong
Man**, Waterloo (CA); **Adrian Matthew
Cooke**, Kitchener (CA)

(58) **Field of Classification Search**

CPC **H01Q 1/38**; **H01Q 1/243**; **H01Q 1/145**;
H01Q 9/0421; **H01Q 19/005**

USPC **343/702**, **700 M**, **701**
See application file for complete search history.

(73) Assignee: **BLACKBERRY LIMITED**, Waterloo,
Ontario

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,031,505 A 2/2000 Qi et al.
6,249,255 B1 * 6/2001 Eggleston **343/702**

(Continued)

FOREIGN PATENT DOCUMENTS

EP 1487051 12/2004
EP 1895617 3/2008

(Continued)

Primary Examiner — Dylan White

(74) *Attorney, Agent, or Firm* — Guntin & Gust, PLC;
Andrew Gust

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 333 days.

This patent is subject to a terminal dis-
claimer.

(21) Appl. No.: **13/927,691**

(22) Filed: **Jun. 26, 2013**

(65) **Prior Publication Data**

US 2013/0285868 A1 Oct. 31, 2013

Related U.S. Application Data

(63) Continuation of application No. 12/901,641, filed on
Oct. 11, 2010, now Pat. No. 8,487,815, which is a
continuation of application No. 11/863,324, filed on
Sep. 28, 2007, now Pat. No. 7,812,773.

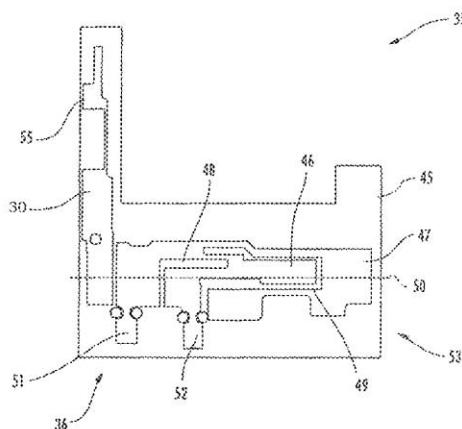
(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/04 (2006.01)
H01Q 19/00 (2006.01)

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

(57) **ABSTRACT**

A mobile wireless communications device may include a portable housing, a circuit board carried by the portable housing and having a ground plane thereon, wireless communications circuitry carried by the circuit board, and an antenna assembly carried by the housing. More particularly, the antenna assembly may include a flexible substrate, an electrically conductive antenna element on the flexible substrate and connected to the wireless communications circuitry and the ground plane, and a floating, electrically conductive director element on the flexible substrate for directing a beam pattern of the antenna element.

20 Claims, 7 Drawing Sheets





US009300040B2

(12) **United States Patent**
Mayo

(10) **Patent No.:** **US 9,300,040 B2**

(45) **Date of Patent:** **Mar. 29, 2016**

(54) **PHASED ARRAY ANTENNA AND A METHOD OF OPERATING A PHASED ARRAY ANTENNA**

(75) Inventor: **Richard Mayo**, Ledbury Hereford and Worcester (GB)

(73) Assignee: **Phasor Solutions Ltd.**, Ledbury Hereford and Worcester (GB)

(*) 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.: **12/988,923**

(22) PCT Filed: **Jul. 17, 2009**

(86) PCT No.: **PCT/GB2009/050880**

§ 371 (c)(1),
(2), (4) Date: **Jan. 5, 2011**

(87) PCT Pub. No.: **WO2010/007442**

PCT Pub. Date: **Jan. 21, 2010**

(65) **Prior Publication Data**

US 2011/0291889 A1 Dec. 1, 2011

(30) **Foreign Application Priority Data**

Jul. 18, 2008 (GB) 0813237.5

(51) **Int. Cl.**
H01Q 3/00 (2006.01)
H01Q 3/34 (2006.01)
H01Q 1/32 (2006.01)
H01Q 3/26 (2006.01)
H04B 7/08 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 3/34** (2013.01); **H01Q 1/3216** (2013.01); **H01Q 1/3275** (2013.01); **H01Q 3/2605** (2013.01); **H01Q 3/267** (2013.01); **H04B 7/0848** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 3/34; H01Q 3/2605; H01Q 3/267; H01Q 1/3216; H01Q 1/3275; H01Q 7/0848

USPC 342/372
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,384,895 A 5/1968 Webb
3,725,938 A * 4/1973 Black G01S 1/02 342/434

(Continued)

FOREIGN PATENT DOCUMENTS

EP 0987560 A1 3/2000
EP 1538698 6/2005

(Continued)

OTHER PUBLICATIONS

United Kingdom Examination Report, Application No. GB0813237.5, dated Jul. 8, 2010, pp. 1-2.

(Continued)

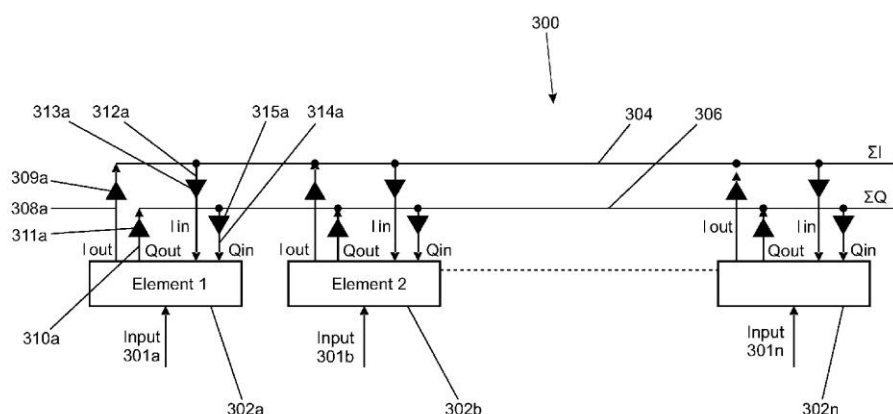
Primary Examiner — Frank J McGue

(74) *Attorney, Agent, or Firm* — Reza Mollaaghababa; Thomas Engellenner; Pepper Hamilton LLP

(57) **ABSTRACT**

An element of a phased array antenna is provided. The element comprises a phase tracking circuit configured to multiply the in-phase component (In) of a local output signal by the quadrature phase component (Qout) of an external output signal to generate a phase control signal (535) and/or to multiply the quadrature component (Qn) of a local output signal by the in-phase component (Iout) of an external output signal to generate a phase control signal (535).

40 Claims, 13 Drawing Sheets





US009300041B2

(12) **United States Patent**
Xu

(10) **Patent No.:** **US 9,300,041 B2**

(45) **Date of Patent:** **Mar. 29, 2016**

(54) **MULTIMODE BROADBAND ANTENNA
MODULE AND WIRELESS TERMINAL**

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

(72) Inventor: **Huiliang Xu**, Shenzhen (CN)

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

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 200 days.

(21) Appl. No.: **14/145,441**

(22) Filed: **Dec. 31, 2013**

(65) **Prior Publication Data**

US 2014/0111386 A1 Apr. 24, 2014

Related U.S. Application Data

(63) Continuation of application No.
PCT/CN2012/083096, filed on Oct. 17, 2012.

(51) **Int. Cl.**
H01Q 9/42 (2006.01)
H01Q 5/01 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 5/01** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 5/371** (2015.01); **H01Q 5/392**
(2015.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 9/42; H01Q 5/392;
H01Q 5/371
USPC 343/702, 825–829, 833, 834, 846;
455/575.7

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,621,455 B2 9/2003 Wang et al.
6,650,294 B2 * 11/2003 Ying H01Q 1/243
343/700 MS

(Continued)

FOREIGN PATENT DOCUMENTS

CN 101174730 A 5/2008
CN 101557030 A 10/2009

(Continued)

OTHER PUBLICATIONS

Foreign Communication From a Counterpart Application, European
Application No. 12879150.6, Extended European Search Report
dated Sep. 12, 2014, 7 pages.

(Continued)

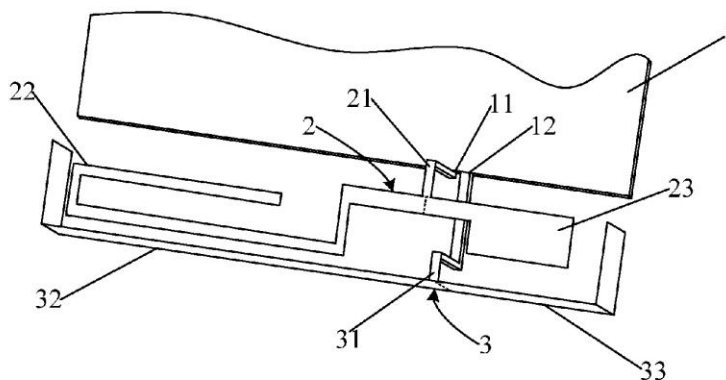
Primary Examiner — Michael C Wimer

(74) *Attorney, Agent, or Firm* — Conley Rose, P.C.; Grant
Rodolph; Nicholas K. Beaulieu

(57) **ABSTRACT**

A multimode broadband antenna module and a wireless terminal are provided. The multimode broadband antenna module includes a printed circuit board and an antenna body, where the antenna body includes a first radiator and a second radiator that are electrically connected to the printed circuit board, where the first radiator includes a connection portion, a low frequency portion, and a high frequency portion, the second radiator includes a grounding portion, a low frequency portion, and a high frequency portion, and a first predetermined distance exists between the low frequency portion of the first radiator and the low frequency portion of the second radiator, and a second predetermined distance exists between the high frequency portion of the first radiator and the high frequency portion of the second radiator, so as to form a coupling capacitance effect between the first radiator and the second radiator.

4 Claims, 12 Drawing Sheets





US009300045B2

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

(10) **Patent No.:** **US 9,300,045 B2**

(45) **Date of Patent:** **Mar. 29, 2016**

(54) **COMMUNICATION DEVICE WITH
ANTENNA ELEMENT**

(56) **References Cited**

U.S. PATENT DOCUMENTS

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

7,528,785 B2 * 5/2009 Forster G06K 19/041

(72) Inventors: **Kin-Lu Wong**, New Taipei (TW);
Zih-Guang Liao, New Taipei (TW)

8,798,554 B2 * 8/2014 Darnell H01Q 5/35

8,884,831 B2 * 11/2014 Amari 333/132

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

9,070,975 B2 * 6/2015 Collins 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 15 days.

FOREIGN PATENT DOCUMENTS

TW 201340467 10/2013

TW M473615 3/2014

OTHER PUBLICATIONS

(21) Appl. No.: **14/338,691**

Taiwanese language office action dated Feb. 11, 2015, issued in
application No. 103117263.

(22) Filed: **Jul. 23, 2014**

* cited by examiner

(65) **Prior Publication Data**

US 2015/0333403 A1 Nov. 19, 2015

Primary Examiner — Brian Young

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

(30) **Foreign Application Priority Data**

May 16, 2014 (TW) 103117263 A

(57) **ABSTRACT**

(51) **Int. Cl.**

H01Q 1/50 (2006.01)

H01Q 5/50 (2015.01)

H01Q 5/20 (2015.01)

H01Q 5/335 (2015.01)

H01Q 5/30 (2015.01)

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

CPC . **H01Q 5/50** (2015.01); **H01Q 5/20** (2015.01);

H01Q 5/30 (2015.01); **H01Q 5/335** (2015.01)

(58) **Field of Classification Search**

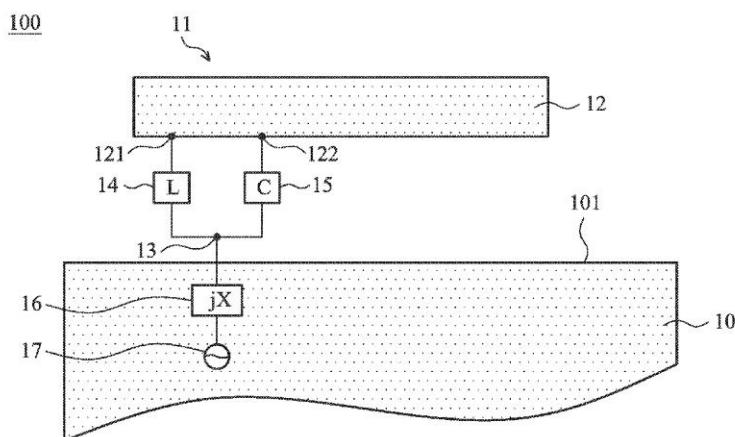
CPC H01Q 5/50; H01Q 5/20; H01Q 5/30;
H01Q 5/335

USPC 343/857, 858, 860

See application file for complete search history.

A communication device including a ground element and an antenna element is provided. The antenna element includes a metal element. The metal element is disposed adjacent to an edge of the ground element. The metal element has a first connection point and a second connection point. A feeding point of the antenna element is coupled through an inductive element to the first connection point. A first feeding path is formed from the feeding point through the inductive element to the first connection point. The feeding point of the antenna element is further coupled through a capacitive element to the second connection point. A second feeding path is formed from the feeding point through the capacitive element to the second connection point. The feeding point of the antenna element is further coupled through a matching circuit to a signal source.

14 Claims, 5 Drawing Sheets





US009300049B2

(12) **United States Patent**
Jo

(10) **Patent No.:** **US 9,300,049 B2**
(45) **Date of Patent:** **Mar. 29, 2016**

(54) **ANTENNA AND PORTABLE DEVICE HAVING THE SAME**

(71) Applicant: **Samsung Electronics Co., Ltd.**,
Gyeonggi-do (KR)
(72) Inventor: **Myungjae Jo**, Gyeongsangbuk-do (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 231 days.

(21) Appl. No.: **14/012,197**

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

(65) **Prior Publication Data**
US 2014/0062816 A1 Mar. 6, 2014

(30) **Foreign Application Priority Data**
Aug. 29, 2012 (KR) 10-2012-0094974

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 9/04 (2006.01)
(52) **U.S. Cl.**
CPC . **H01Q 9/04** (2013.01); **H01Q 1/243** (2013.01)
(58) **Field of Classification Search**
CPC H01Q 1/38; H01Q 1/22; H01Q 1/24;
H01Q 1/241; H01Q 1/242; H01Q 1/243;
H01Q 1/42; H01Q 1/422; H01Q 1/52; H01Q
3/44; H01Q 9/0485; H01Q 15/08
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,320,561	A *	6/1994	Cook et al.	439/500
7,852,258	B2 *	12/2010	Kato et al.	342/82
8,421,689	B2 *	4/2013	Schlub et al.	343/702
2007/0296638	A1	12/2007	Kim et al.	
2009/0069061	A1	3/2009	Laurent et al.	
2010/0137042	A1 *	6/2010	Na et al.	455/575.5
2010/0234081	A1	9/2010	Wong et al.	
2010/0302123	A1	12/2010	Knudsen et al.	
2011/0260932	A1	10/2011	Hong et al.	
2012/0050114	A1	3/2012	Li et al.	

FOREIGN PATENT DOCUMENTS

EP	1 870 956	A1	12/2007
EP	2 192 652	A1	6/2010
EP	2 381 530	A2	10/2011
JP	2005-102286	A	4/2005
JP	2007-180704	A	7/2007
KR	10-2012-0027985	A	3/2012
KR	10-2012-0056699	A	6/2012

* cited by examiner

Primary Examiner — Robert Karacsony

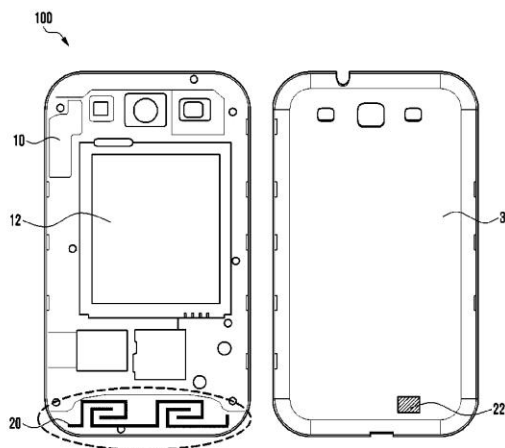
Assistant Examiner — Patrick Holecsek

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

(57) **ABSTRACT**

An antenna and a portable device having the same are provided. The antenna provided in a portable device includes: a radiator unit housed at one surface of the portable device; and a resonant frequency compensation unit housed at another surface of the portable device facing the one surface and adjusting a resonant frequency of the radiator unit changed by an environment change to a preset resonant frequency. Examples of the environment change include a device color change, and a battery size change.

21 Claims, 9 Drawing Sheets





US009300050B2

(12) **United States Patent**
Laurent

(10) **Patent No.:** **US 9,300,050 B2**

(45) **Date of Patent:** **Mar. 29, 2016**

(54) **MULTIBAND RF ANTENNA**

(56) **References Cited**

(71) Applicant: **BANG & OLUFSEN A/S**, Struer (DK)

U.S. PATENT DOCUMENTS

(72) Inventor: **Claude Laurent**, Aalborg (DK)

(73) Assignee: **BANG & OLUFSEN A/S**, Struer (DK)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 108 days.

6,191,740	B1 *	2/2001	Kates et al.	343/700	MS
6,937,196	B2 *	8/2005	Korva	343/702	
6,963,309	B2 *	11/2005	Andersson et al.	343/702	
7,053,837	B2 *	5/2006	Il et al.	343/700	MS
8,531,337	B2 *	9/2013	Soler Castany et al.	343/702	
8,638,271	B2 *	1/2014	Wang et al.	343/846	
9,088,072	B2 *	7/2015	Takaki et al.	343/700	MS
2002/0003499	A1	1/2002	Kouam et al.		
2003/0011521	A1	1/2003	Edimo et al.		
2004/0021605	A1	2/2004	Kouam et al.		
2005/0116873	A1	6/2005	Castany et al.		
2005/0200545	A1	9/2005	Bancroft		
2011/0037657	A1	2/2011	Yang		

(21) Appl. No.: **14/187,948**

(22) Filed: **Feb. 24, 2014**

FOREIGN PATENT DOCUMENTS

(65) **Prior Publication Data**

US 2014/0240185 A1 Aug. 28, 2014

EP	1276170	8/2006
GB	2453160	9/2009
WO	WO 03075401 A1	9/2003

OTHER PUBLICATIONS

(30) **Foreign Application Priority Data**

Feb. 22, 2013 (DK) 2013 00105

Search Report prepared by the Danish Patent and Trademark Office on Oct. 8, 2013, for Danish Patent Application No. PA 2013 00105.

* cited by examiner

Primary Examiner — Khai M Nguyen

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

(51) **Int. Cl.**

H01Q 13/10 (2006.01)

H01Q 9/04 (2006.01)

H01Q 1/38 (2006.01)

H01Q 1/48 (2006.01)

H01Q 5/357 (2015.01)

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

CPC **H01Q 9/0407** (2013.01); **H01Q 1/38** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/357** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 5/357; H01Q 1/48; H01Q 1/38; H01Q 9/0407

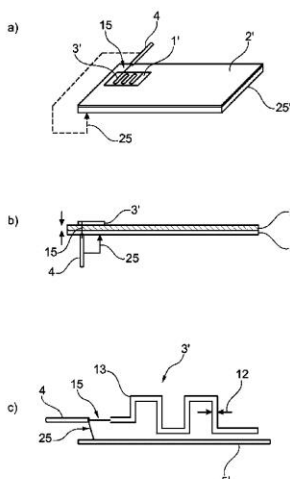
USPC 343/767, 700 MS, 905

See application file for complete search history.

(57) **ABSTRACT**

This invention relates to a miniature multiband antenna, in which a substrate being the carrier of a conductive element, and the conductive element configured as a layer onto the substrate and being the radiator in form of a slot, and a conductive layer configured onto the substrate and being the antenna feed line in form of a polygon patch area. Alternative embodiments illustrate use of slot type—and meander type antennas. The invention may be applied in any kind of electronic equipment, where a high capacity wireless system is required and within a very small physical embodiment.

10 Claims, 6 Drawing Sheets





US009300051B2

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

(10) **Patent No.:** **US 9,300,051 B2**

(45) **Date of Patent:** **Mar. 29, 2016**

(54) **COMMUNICATION DEVICE WITH
COUPLED-FED MULTIBAND ANTENNA
ELEMENT**

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

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

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

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

(21) Appl. No.: **14/165,509**

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

(65) **Prior Publication Data**

US 2015/0145738 A1 May 28, 2015

(30) **Foreign Application Priority Data**

Nov. 22, 2013 (TW) 102142678 A

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 5/335 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 9/0457** (2013.01); **H01Q 5/335**
(2015.01)

(58) **Field of Classification Search**
CPC ... H01Q 5/0041; H01Q 9/0457; H01Q 5/328;
H01Q 5/50; H01Q 13/08
USPC 343/702, 893, 768, 770, 767, 700 MS,
343/745, 749

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,489,913	A *	2/1996	Raguenet et al.	343/767
2004/0140935	A1 *	7/2004	Korva	343/700 MS
2007/0080867	A1 *	4/2007	Son et al.	343/700 MS
2009/0174604	A1 *	7/2009	Kesitalo et al.	343/700 MS
2010/0045552	A1 *	2/2010	Ueki	343/745
2011/0095949	A1 *	4/2011	Wong et al.	343/702
2011/0273360	A1 *	11/2011	Campero et al.	343/893
2013/0314283	A1 *	11/2013	Hong et al.	343/700 MS

* cited by examiner

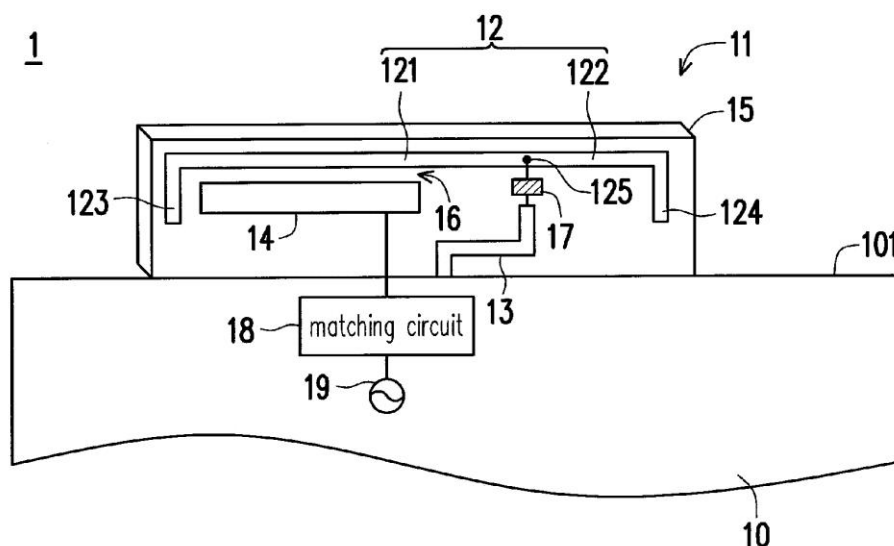
Primary Examiner — Jean B Jeanglaude

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

(57) **ABSTRACT**

A communication device includes a ground element and an antenna element. The antenna element is disposed on a dielectric substrate which is adjacent to an edge of the ground element. The antenna element includes a radiating element, a shorting element and a feeding element. The radiating element has a first open end, a second open end and a shorting point. The radiating element is divided into a first element and a second element by the shorting point. The first element includes the first open end, and the second element includes the second open end. One end of the shorting element is coupled to the shorting point through a first inductive element, and another end is electrically connected to the ground element. The feeding element and the first element are spaced by a coupling gap, and the feeding element is coupled to a signal source through a matching circuit.

11 Claims, 4 Drawing Sheets





US009300055B2

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

(10) **Patent No.:** **US 9,300,055 B2**
(45) **Date of Patent:** **Mar. 29, 2016**

(54) **MOBILE DEVICE WITH TWO ANTENNAS
AND ANTENNA SWITCH MODULES**

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

(72) Inventors: **Kuo-Hua Tseng**, New Taipei (TW);
Chih-Hua Chang, New Taipei (TW);
Shao-Yu Huang, New Taipei (TW)

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

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 358 days.

(21) Appl. No.: **13/951,380**

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

(65) **Prior Publication Data**
US 2014/0198012 A1 Jul. 17, 2014

(30) **Foreign Application Priority Data**
Jan. 14, 2013 (TW) 102101301 A

(51) **Int. Cl.**
H01Q 3/24 (2006.01)
H01Q 21/28 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/42 (2006.01)
H01Q 21/30 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 21/28** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 9/42** (2013.01); **H01Q 21/30**
(2013.01)

(58) **Field of Classification Search**
CPC H01Q 21/28; H01Q 21/30; H01Q 29/42;
H01Q 1/243
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,138,977 B2	3/2012	Zhang et al.	
8,154,460 B2 *	4/2012	Sakata	H01Q 1/243 343/702
8,237,519 B2	8/2012	Achour	
2007/0176836 A1 *	8/2007	Abramov	H01Q 1/2291 343/702
2012/0306718 A1	12/2012	Koyanagi et al.	

FOREIGN PATENT DOCUMENTS

TW	200737597	10/2001
TW	200913370	3/2009
TW	200950363	12/2009
WO	WO 2012/125176	9/2012

OTHER PUBLICATIONS

Chinese language office action dated Sep. 2, 2015, issued in appli-
cation No. TW 102101301.

* cited by examiner

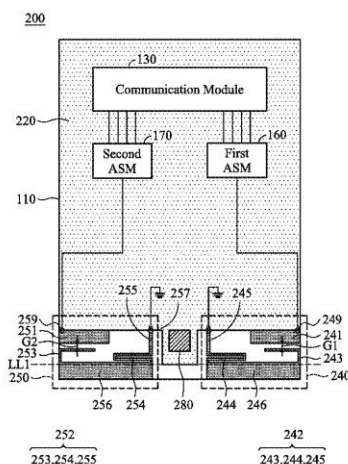
Primary Examiner — Trinh Dinh

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

(57) **ABSTRACT**

A mobile device includes a system circuit board, a ground element, a communication module, a first antenna, a second antenna, a first ASM (Antenna Switch Module), and a second ASM. The first antenna is configured to receive or transmit a first signal in a first frequency band. The second antenna is configured to receive or transmit a second signal in a second frequency band. The second frequency band is different from the first frequency band. The first ASM is coupled between the first antenna and the communication module, and is configured to separate frequencies of the first signal. The second ASM is coupled between the second antenna and the communication module, and is configured to separate frequencies of the second signal.

14 Claims, 8 Drawing Sheets





US009306266B2

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

(10) **Patent No.:** **US 9,306,266 B2**
(45) **Date of Patent:** **Apr. 5, 2016**

(54) **MULTI-BAND ANTENNA FOR WIRELESS COMMUNICATION**

USPC 343/860, 700 MS, 702
See application file for complete search history.

(71) Applicant: **Aalto University Foundation**, Aalto (FI)

(56) **References Cited**

(72) Inventors: **Risto Valkonen**, Espoo (FI); **Janne Ilvonen**, Lohja (FI)

U.S. PATENT DOCUMENTS

(73) Assignee: **AALTO UNIVERSITY FOUNDATION**, Aalto (FI)

6,483,464 B2 * 11/2002 Rawnick et al. 343/700 MS
6,639,558 B2 * 10/2003 Kellerman et al. 343/700 MS
7,528,780 B2 * 5/2009 Thiam et al. 343/700 MS
8,325,093 B2 * 12/2012 Holland et al. 343/700 MS
2007/0279289 A1 * 12/2007 Baliarda et al. 343/700 MS
2008/0174508 A1 * 7/2008 Iwai et al. 343/850
2010/0099367 A1 * 4/2010 Shamim et al. 455/95

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 488 days.

* cited by examiner

(21) Appl. No.: **13/624,202**

Primary Examiner — Huedung Mancuso

(22) Filed: **Sep. 21, 2012**

(74) *Attorney, Agent, or Firm* — Young & Thompson

(65) **Prior Publication Data**

US 2014/0085160 A1 Mar. 27, 2014

(51) **Int. Cl.**

H01Q 1/50 (2006.01)

H01Q 1/24 (2006.01)

H01Q 9/42 (2006.01)

H01Q 5/335 (2015.01)

H01Q 5/35 (2015.01)

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

CPC **H01Q 1/243** (2013.01); **H01Q 5/335** (2015.01); **H01Q 5/35** (2015.01); **H01Q 9/42** (2013.01)

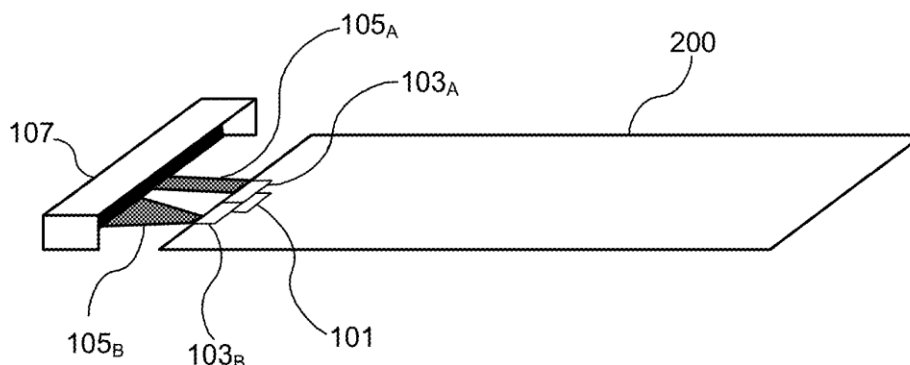
(58) **Field of Classification Search**

CPC H01Q 1/38; H01Q 9/42; H01Q 5/0003; H01Q 1/243; H03H 7/38

(57) **ABSTRACT**

A multi-band antenna includes a ground plane, a single antenna element, a frequency multiplexing circuit and at least two feeding strips coupled between the frequency multiplexing circuit and the single antenna element. Furthermore, the feeding of the antenna is arranged by one or more feeding points arranged between the ground plane and the frequency multiplexing circuit. According to first implementation one feeding point is arranged for at least two antenna branches. The signal fed into the feeding point is multiplexed by the multiplexing circuit to the antenna branches. According to at least one other implementation a dedicated feeding point is arranged for each of the antenna branches. At the same time the isolation of the frequencies between the different branches is arranged. This can be achieved e.g. by a multiplexing circuit. Moreover, impedance of the antenna branches can be matched with matching circuitry.

22 Claims, 5 Drawing Sheets





US009306267B2

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

(10) **Patent No.:** **US 9,306,267 B2**
(45) **Date of Patent:** **Apr. 5, 2016**

(54) **ANTENNA ASSEMBLY INTEGRAL WITH METAL HOUSING AND ELECTRONIC DEVICE USING THE ANTENNA ASSEMBLY**

- (71) Applicant: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)
(72) Inventors: **Chia-Ming Liang**, New Taipei (TW); **Cho-Kang Hsu**, New Taipei (TW)
(73) Assignee: **Chiun Mai Communications 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 380 days.

(21) Appl. No.: **14/014,641**

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

(65) **Prior Publication Data**

US 2014/0354487 A1 Dec. 4, 2014

(30) **Foreign Application Priority Data**

May 31, 2013 (TW) 102119263 A

- (51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 9/42 (2006.01)
H01Q 5/385 (2015.01)
(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 5/385** (2015.01); **H01Q 9/42** (2013.01)
(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 5/385; H01Q 9/42
USPC 343/700 MS, 702, 829, 846
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,365,246 A * 11/1994 Rasinger H01Q 1/243
343/702
5,711,014 A * 1/1998 Crowley H01Q 1/241
343/841
6,239,753 B1 * 5/2001 Kado G08C 17/04
343/702
6,642,892 B2 * 11/2003 Masaki H01Q 1/2266
343/700 MS
7,161,548 B2 * 1/2007 Tsukamoto H01Q 13/10
343/702
7,315,284 B2 * 1/2008 Hsu H01Q 1/243
343/700 MS
2007/0252764 A1 * 11/2007 Keski-Opas H01Q 1/243
343/702

* cited by examiner

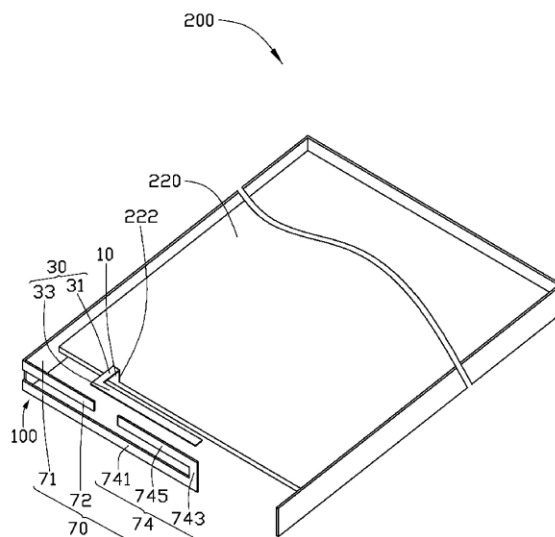
Primary Examiner — Tho G Phan

(74) Attorney, Agent, or Firm — Novak Druce Connolly Bove + Quigg LLP

(57) **ABSTRACT**

The metal housing of a miniaturized electronic device is shaped to function as a multiband antenna assembly. The antenna assembly includes a feeding terminal, a radiator connecting to the feeding terminal, and a metal element. The metal element is part of a housing of the electronic device. The metal element includes two antenna units, both of which are adjacent to and spaced from the radiator. An electronic device using the antenna assembly is also described.

16 Claims, 2 Drawing Sheets





US009306274B2

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

(10) **Patent No.:** **US 9,306,274 B2**
(45) **Date of Patent:** **Apr. 5, 2016**

(54) **ANTENNA DEVICE AND ANTENNA MOUNTING METHOD**

(71) Applicant: **FUJIKURA LTD.**, Tokyo (JP)

(72) Inventors: **Hiroiku Tayama**, Sakura (JP); **Ning Guan**, Sakura (JP)

(73) Assignee: **FUJIKURA LTD.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 182 days.

(21) Appl. No.: **14/158,312**

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

(65) **Prior Publication Data**

US 2014/0132471 A1 May 15, 2014

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2012/071366, filed on Aug. 23, 2012.

(30) **Foreign Application Priority Data**

Sep. 26, 2011 (JP) 2011-209640

(51) **Int. Cl.**

H01Q 1/48 (2006.01)

H01Q 1/38 (2006.01)

H01Q 9/42 (2006.01)

H01Q 1/22 (2006.01)

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

CPC . **H01Q 1/48** (2013.01); **H01Q 1/22** (2013.01);

H01Q 1/38 (2013.01); **H01Q 9/42** (2013.01);

Y10T 29/49018 (2015.01)

(58) **Field of Classification Search**

CPC **H01Q 1/48**; **H01Q 1/22**; **H01Q 1/38**;
H01Q 1/42; **Y10T 29/49018**

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,602,343 B2 *	10/2009	Takada	.....	H01Q 1/243	343/700 MS
8,373,600 B2 *	2/2013	Chang	.....	H01Q 1/243	343/700 MS
2005/0024268 A1 *	2/2005	McKinzie	.....	H01Q 9/0421	343/700 MS
2006/0119517 A1	6/2006	Futamata	.....		
2009/0115664 A1 *	5/2009	Chung	.....	H01Q 1/243	343/700 MS
2010/0149065 A1 *	6/2010	Wong	.....	H01Q 5/00	343/848

(Continued)

FOREIGN PATENT DOCUMENTS

CN	1720640 A	1/2006
CN	2838056 Y	11/2006

(Continued)

OTHER PUBLICATIONS

Decision to Grant a Patent dated Feb. 3, 2015, issued in corresponding Japanese Patent Application No. 2013-536088 (3 pages).
Chinese Office Action dated Oct. 17, 2014, issued in corresponding CN application No. 201280036512.2 with English translation (32 pages).

(Continued)

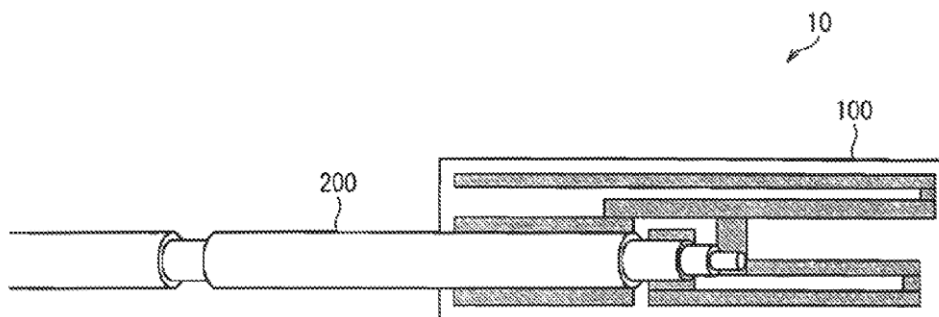
Primary Examiner — Trinh Dinh

(74) *Attorney, Agent, or Firm* — Westerman, Hattori, Daniels & Adrian, LLP

(57) **ABSTRACT**

An antenna device (10) includes: an antenna (100) including a radiating element (101) and an internal ground (103); a coaxial cable (200) whose internal conductor (204) is connected with the radiating element (101) and whose external conductor (203) is connected with the internal ground (103); and an external ground (500) connected with the external conductor (203) of the coaxial cable (200).

7 Claims, 8 Drawing Sheets





US009306275B2

(12) **United States Patent**
Mikata

(10) **Patent No.:** **US 9,306,275 B2**
(45) **Date of Patent:** **Apr. 5, 2016**

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

(71) Applicant: **TAIYO YUDEN CO., LTD.**, Tokyo (JP)

(72) Inventor: **Jin Mikata**, Tokyo (JP)

(73) Assignee: **TAIYO YUDEN CO., LTD.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 210 days.

(21) Appl. No.: **13/849,241**

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

(65) **Prior Publication Data**

US 2013/0271339 A1 Oct. 17, 2013

(30) **Foreign Application Priority Data**

Apr. 17, 2012 (JP) 2012-093974

(51) **Int. Cl.**

H01Q 1/38 (2006.01)

H01Q 21/00 (2006.01)

H01Q 1/50 (2006.01)

H01Q 1/24 (2006.01)

H01Q 9/42 (2006.01)

H01Q 21/28 (2006.01)

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

CPC **H01Q 1/50** (2013.01); **H01Q 1/243** (2013.01); **H01Q 9/42** (2013.01); **H01Q 21/28** (2013.01)

(58) **Field of Classification Search**

USPC 343/700 MS, 702, 833, 834, 835
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,589,680 B2 * 9/2009 Tsai et al. 343/702
2007/0290927 A1 12/2007 Rowell et al.

2011/0122040 A1 * 5/2011 Wakabayashi 343/833
2012/0212389 A1 * 8/2012 Aizawa et al. 343/853
2012/0287012 A1 * 11/2012 Aizawa 343/853
2013/0257674 A1 10/2013 Li et al.
2014/0085164 A1 * 3/2014 Kashiwagi et al. 343/893

FOREIGN PATENT DOCUMENTS

JP 2011-77608 A 4/2011
JP 2011-109547 A 6/2011
JP 2013-214953 A 10/2013
WO 2010/006484 A1 1/2010

OTHER PUBLICATIONS

Japanese Office Action dated Apr. 30, 2014, in a counterpart Japanese patent application No. 2012-093974.

* cited by examiner

Primary Examiner — Tan Ho

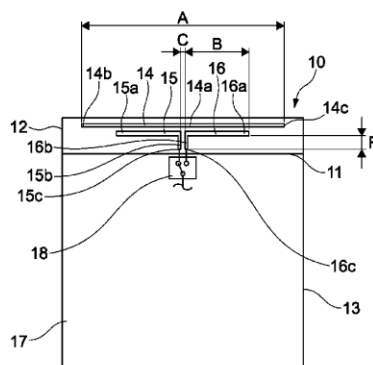
(74) Attorney, Agent, or Firm — Chen Yoshimura LLP

(57)

ABSTRACT

A passive element has an electrical length such that a resonance mode thereof is in a target frequency band, and first and second feed elements, each of which has an electrical length such that a resonance mode thereof is not in the target frequency band. The first feed element has a first coupling conductive part, and a first connecting conductive part, which has a continuous shape with the first coupling conductive part. The second feed element has a second coupling conductive part, and a second connecting conductive part, which has a continuous shape with the second coupling conductive part. The first coupling conductive part is disposed parallel and adjacent to the passive element. The second coupling conductive part is disposed parallel and adjacent to the passive element. The first connecting conductive part and the second connecting conductive part are disposed adjacent and parallel to each other.

8 Claims, 37 Drawing Sheets





US009306277B2

(12) **United States Patent**
Miyake

(10) **Patent No.:** **US 9,306,277 B2**
(45) **Date of Patent:** **Apr. 5, 2016**

(54) **MULTI-ANTENNA DEVICE AND
COMMUNICATION DEVICE**

- (71) Applicant: **Funai Electric Co., Ltd.**, Daito, Osaka
(JP)
(72) Inventor: **Yasunari Miyake**, Osaka (JP)
(73) Assignee: **FUNAI ELECTRIC CO., LTD.**, Osaka
(JP)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 141 days.

(21) Appl. No.: **14/077,755**

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

(65) **Prior Publication Data**
US 2014/0139399 A1 May 22, 2014

(30) **Foreign Application Priority Data**
Nov. 20, 2012 (JP) 2012-254225

- (51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 21/00 (2006.01)
H01Q 1/52 (2006.01)
(52) **U.S. Cl.**
CPC **H01Q 1/521** (2013.01); **H01Q 1/243**
(2013.01)
(58) **Field of Classification Search**
CPC H01Q 1/521; H01Q 1/243
USPC 343/702, 893, 846
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,142,886 B2 *	11/2006	Murayama et al.	455/556.1
7,148,849 B2 *	12/2006	Lin	343/700 MS
8,391,927 B2 *	3/2013	Castaneda et al.	455/562.1
2002/0021250 A1 *	2/2002	Asano et al.	343/702
2002/0190905 A1	12/2002	Flint et al.	
2004/0150579 A1	8/2004	Dotto et al.	
2010/0220015 A1	9/2010	Pintos et al.	

FOREIGN PATENT DOCUMENTS

EP	1617513 A1	1/2006
JP	2010-525680 A	7/2010
WO	2008-131157 A	10/2008

OTHER PUBLICATIONS

Extended European Search Report of the corresponding European
Application No. 13192960.6, dated Mar. 4, 2014.

* cited by examiner

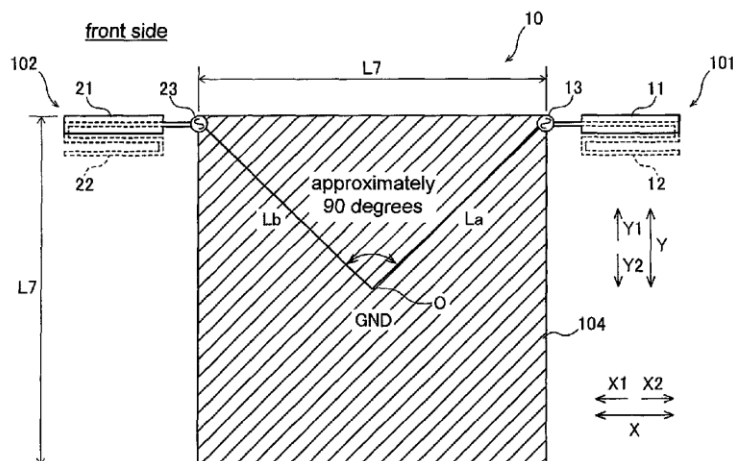
Primary Examiner — Hoanganh Le

(74) *Attorney, Agent, or Firm* — Global IP Counselors, LLP

(57) **ABSTRACT**

A multi-antenna device includes a grounding plate, a first antenna and a second antenna. The first antenna includes a first feed element that is grounded to the grounding plate via a first feed point. The second antenna includes a second feed element that is grounded to the grounding plate via a second feed point. The first feed point and the second feed point are disposed such that a straight line connecting the first feed point and a center of the grounding plate and a straight line connecting the second feed point and the center of the grounding plate are substantially perpendicular to each other in a plan view.

14 Claims, 9 Drawing Sheets





US009306280B2

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

(10) **Patent No.:** **US 9,306,280 B2**
(45) **Date of Patent:** **Apr. 5, 2016**

(54) **MOBILE TERMINAL**

USPC 343/702, 876
See application file for complete search history.

(71) Applicant: **SONY MOBILE COMMUNICATIONS, INC.**, Tokyo (JP)

(56) **References Cited**

(72) Inventors: **Kenichiro Kodama**, Tokyo (JP); **Aiko Yoshida**, Tokyo (JP); **Akihiro Bungo**, Tokyo (JP)

U.S. PATENT DOCUMENTS

6,295,462 B1 9/2001 Kudoh
7,046,201 B2 * 5/2006 Okada 343/700 MS
(Continued)

(73) Assignees: **Sony Corporation**, Tokyo (JP); **Sony Mobile Communications Inc.**, Tokyo (JP)

FOREIGN PATENT DOCUMENTS

EP 2 157 660 A1 2/2010
JP 2008-017047 1/2008

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

(Continued)

OTHER PUBLICATIONS

(21) Appl. No.: **14/594,594**

U.S. Appl. No. 14/594,574, filed Jan. 12, 2015, Kodama, et al.

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

(Continued)

(65) **Prior Publication Data**

US 2015/0207225 A1 Jul. 23, 2015

Primary Examiner — Dieu H Duong

(74) *Attorney, Agent, or Firm* — Oblon, McClelland, Maier & Neustadt, L.L.P.

Related U.S. Application Data

(62) Division of application No. 13/544,418, filed on Jul. 9, 2012.

(60) Provisional application No. 61/524,916, filed on Aug. 18, 2011.

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 3/24 (2006.01)
(Continued)

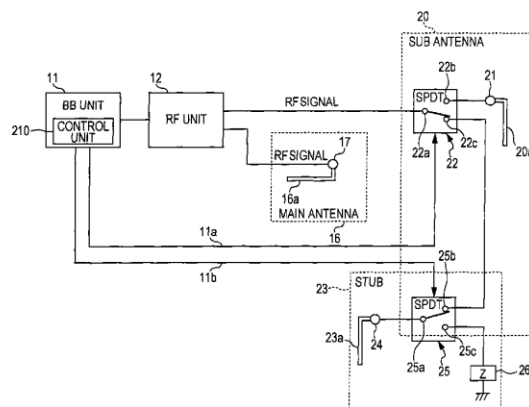
(57) **ABSTRACT**

A mobile terminal that includes a first antenna element disposed in proximity to a first side of the mobile terminal, a second antenna element disposed in proximity to a second side of the mobile terminal, and a third antenna element disposed in proximity to a third side of the mobile terminal. The mobile terminal further including a switching mechanism that switches between a first connection mode in which the first and second antenna elements are feed elements and the third antenna element is a parasitic element, and a second connection mode in which the first and third antenna elements are feed elements, and a control unit that controls the switching mechanism to switch between the first connection mode and the second connection mode in accordance with a predetermined condition.

(52) **U.S. Cl.**
CPC **H01Q 3/24** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/52** (2013.01); **H01Q 1/521** (2013.01); **H01Q 21/0006** (2013.01); **H01Q 21/28** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 3/24

5 Claims, 12 Drawing Sheets





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

(54) **WIRELESS COMMUNICATION DEVICE**

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

(72) Inventors: **Kun-Sheng Chang**, New Taipei (TW);
Ming-Yu Chou, New Taipei (TW);
Ching-Chi Lin, New Taipei (TW)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 89 days.

* cited by examiner

(21) Appl. No.: 14/195,861

(22) Filed: **Mar. 4, 2014**

(65) **Prior Publication Data**

US 2015/0188223 A1 Jul. 2, 2015

(30) **Foreign Application Priority Data**

Dec. 31, 2013 (TW) 102149314 A

(51) **Int. Cl.**
H01Q 5/314 (2015.01)
H01Q 5/00 (2015.01)

(52) **U.S. Cl.**
CPC *H01Q 5/0034* (2013.01); *H01Q 5/314*
(2015.01)

(58) **Field of Classification Search**
USPC 343/702, 722
See application file for complete search history.



US009306282B2

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

(10) **Patent No.:** **US 9,306,282 B2**

(45) **Date of Patent:** **Apr. 5, 2016**

(54) **ANTENNA ARRANGEMENT**

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

(72) Inventors: **Mikko S. Komulainen**, Oulu (FI); **Sami Hienonen**, Oulu (FI); **Tommi Lepisto**, Kempele (FI)

(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.: **14/714,528**

(22) Filed: **May 18, 2015**

(65) **Prior Publication Data**

US 2015/0380819 A1 Dec. 31, 2015

Related U.S. Application Data

(63) Continuation of application No. 13/630,018, filed on Sep. 28, 2012, now Pat. No. 9,035,830.

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/20 (2015.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC ... **H01Q 5/20** (2015.01); **H01Q 9/04** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/521; H01Q 21/28; H01Q 5/371; H01Q 9/42
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,584,585 A 4/1986 Marko et al. 343/702
5,173,715 A 12/1992 Rodal et al. 343/795
6,339,402 B1 * 1/2002 McKivern H01Q 1/243
343/700 MS

6,850,196 B2 * 2/2005 Wong H01Q 1/243
343/702

6,914,565 B2 * 7/2005 Shikata H01Q 9/0421
343/700 MS

6,977,616 B2 * 12/2005 Yuanzhu H01Q 5/378
343/700 MS

7,307,591 B2 12/2007 Zheng 343/702

7,696,928 B2 4/2010 Rowell 343/700 MS

(Continued)

FOREIGN PATENT DOCUMENTS

EP 1 760 833 A1 3/2007

GB 2 396 484 A 6/2004

(Continued)

OTHER PUBLICATIONS

Chebihi et al., "A Novel Isolation Technique for Closely Spaced PIFAs for UMTS Mobile Phones", IEEE Antennas and Wireless Propagation Letters, vol. 7, 2008, pp. 665-669.

(Continued)

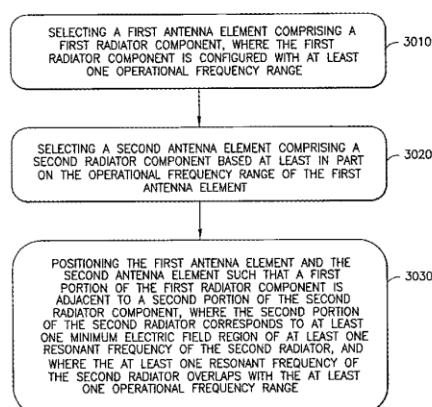
Primary Examiner — Tho G Phan

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

(57) **ABSTRACT**

An apparatus for antenna arrangement isolation is described. The apparatus includes a first antenna element (for example, a CMMB TV antenna) having a first radiator component and a second antenna element (for example, a cellular antenna) having a second radiator component. A first portion of the first radiator component is adjacent to a second portion of the second radiator component. The second radiator component is configured with at least one operational frequency range. The first portion of the first radiator corresponds to at least one minimum electric field region of at least one resonant frequency of the first radiator. The at least one resonant frequency of the first radiator overlaps with the at least one operational frequency range. Methods, Apparatus and Computer readable media for providing the antenna arrangement are also described.

16 Claims, 29 Drawing Sheets





US009306285B2

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

(10) **Patent No.:** **US 9,306,285 B2**
(45) **Date of Patent:** **Apr. 5, 2016**

(54) **ANTENNA HAVING THREE OPERATING FREQUENCY BANDS AND METHOD FOR MANUFACTURING THE SAME**

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

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

(72) Inventors: **Chih-Yung Huang,** Taichung (TW);
Kuo-Chang Lo, Miaoli County (TW);
Jen-Hsiang Fang, Hsinchu (TW)

7,242,352 B2 7/2007 Tavassoli Hozouri
7,256,743 B2 8/2007 Korva
8,441,399 B2 * 5/2013 Wu H01Q 1/2258
343/700 MS

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

2003/0058168 A1 3/2003 Sadler et al.
2004/0104853 A1 * 6/2004 Chen G06F 1/1616
343/702
2008/0180333 A1 * 7/2008 Martiskainen H01Q 1/243
343/722

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 255 days.

(Continued)

FOREIGN PATENT DOCUMENTS

(21) Appl. No.: **14/017,361**

JP 2000-068736 A 3/2000
TW I333715 B 12/2008

(22) Filed: **Sep. 4, 2013**

(Continued)

(65) **Prior Publication Data**

US 2014/0062795 A1 Mar. 6, 2014

OTHER PUBLICATIONS

(30) **Foreign Application Priority Data**

Sep. 4, 2012 (TW) 101132221 A

Search report issued on Feb. 5, 2014 from European Patent Office in a counterpart European patent.

Office Action was issued on Sep. 2, 2015 from the TW patent Office.

Primary Examiner — Dameon E Levi

Assistant Examiner — Ab Salam Alkassim, Jr.

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

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/40 (2006.01)
H01Q 9/42 (2006.01)
H01Q 5/371 (2015.01)

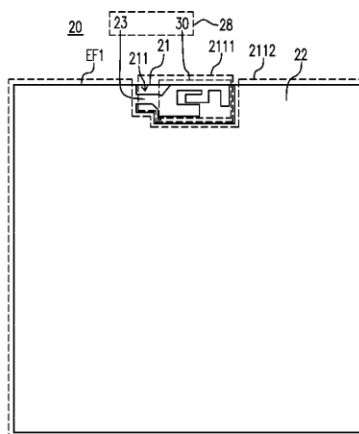
(57) **ABSTRACT**

An antenna including a radiation portion is provided. The radiation portion includes a feed terminal and three conductor branch paths directly extending from the feed terminal. The three conductor branch paths are located on the same side of the feed terminal, and each has an initial direction, and any two of the three initial directions have an acute angle therebetween. A method for manufacturing an antenna having three operating frequency bands is also provided.

(52) **U.S. Cl.**
CPC **H01Q 9/04** (2013.01); **H01Q 1/243** (2013.01); **H01Q 5/371** (2015.01); **H01Q 9/0421** (2013.01); **H01Q 9/40** (2013.01); **H01Q 9/42** (2013.01); **Y10T 29/49016** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 5/371; H01Q 5/30; H01Q 5/20; H01Q 1/243; H01Q 9/0421

20 Claims, 4 Drawing Sheets





US009306287B2

(12) **United States Patent**
Chiang

(10) **Patent No.:** **US 9,306,287 B2**
(45) **Date of Patent:** **Apr. 5, 2016**

(54) **ANTENNA STRUCTURE WITH AN
EFFECTIVE SERIAL CONNECTING
CAPACITANCE**

- (71) Applicant: **Auden Techno Corp.**, Pa-Te, Tao-Yuan
Hsien (TW)
- (72) Inventor: **Chi-Ming Chiang**, Pa-Te (TW)
- (73) Assignee: **AUDEN TECHNO CORP.**, Pa-Te (TW)
- (*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 314 days.

(21) Appl. No.: **14/074,818**

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

(65) **Prior Publication Data**

US 2014/0091975 A1 Apr. 3, 2014

Related U.S. Application Data

- (60) Division of application No. 12/510,380, filed on Jul.
28, 2009, now abandoned, which is a
continuation-in-part of application No. 12/364,681,
filed on Feb. 3, 2009, now abandoned.

- (51) **Int. Cl.**
H01Q 9/16 (2006.01)
H01Q 9/06 (2006.01)
H01Q 1/22 (2006.01)
H01Q 9/04 (2006.01)

- (52) **U.S. Cl.**
CPC **H01Q 9/06** (2013.01); **H01Q 1/2266**
(2013.01); **H01Q 9/0421** (2013.01)

- (58) **Field of Classification Search**
CPC H01Q 9/042; H01Q 9/06; H01Q 1/2266
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,297,776	B1 *	10/2001	Pankinaho	.....	H01Q 1/243 343/700 MS
6,999,037	B2 *	2/2006	Apostolos	.....	H01Q 1/243 343/702
7,012,570	B2 *	3/2006	Chen	.....	H01Q 1/243 343/700 MS
7,616,158	B2 *	11/2009	Mak	.....	H01Q 1/243 343/700 MS
7,808,433	B2 *	10/2010	Rutfors	.....	H01Q 1/243 343/700 MS
7,830,320	B2 *	11/2010	Shamblin	.....	H01Q 1/243 343/702
8,077,116	B2 *	12/2011	Shamblin	.....	H01Q 1/243 343/700 MS
2003/0098812	A1 *	5/2003	Ying	.....	H01Q 1/243 343/702
2008/0129639	A1 *	6/2008	Mitsugi	.....	H01Q 1/243 343/876
2010/0019973	A1 *	1/2010	Yang	.....	H01Q 7/00 343/700 MS
2011/0032170	A1 *	2/2011	Chiang	.....	H01Q 1/2266 343/860

* cited by examiner

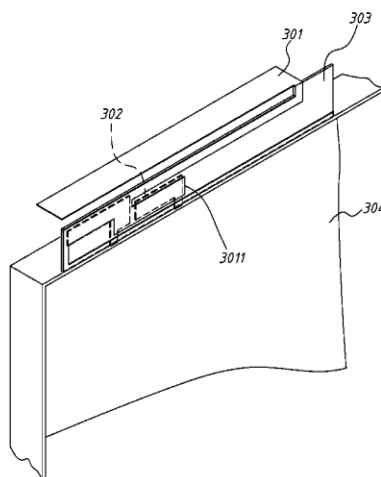
Primary Examiner — Trinh Dinh

(74) *Attorney, Agent, or Firm* — Guice Patents PLLC

(57) **ABSTRACT**

In an antenna structure having a serial connected capacitance effect, mainly a metallic planar antenna is provided thereon at least with a first metallic plane board, and a second metallic plane board being close to but not connected to the first metallic plane board to form the effect of capacitance in serial connecting. And more, the antenna structure further has an extension arm made from a microstrip extended from the antenna or the second metallic plane board, and can be optionally grounded or not grounded, for the purpose of adjusting the impedance value of the antenna structure.

5 Claims, 11 Drawing Sheets





US009306288B2

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

(10) **Patent No.:** **US 9,306,288 B2**
(45) **Date of Patent:** **Apr. 5, 2016**

(54) **SMALL ANTENNA APPARATUS AND METHOD FOR CONTROLLING THE SAME**

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

(72) Inventors: **Jungsik Park**, Bucheon-si (KR);
Sooung Chun, Suwon-si (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 371 days.

(21) Appl. No.: **13/727,205**

(22) Filed: **Dec. 26, 2012**

(65) **Prior Publication Data**

US 2013/0184038 A1 Jul. 18, 2013

(30) **Foreign Application Priority Data**

Jan. 13, 2012 (KR) 10-2012-0004448

(51) **Int. Cl.**

H01Q 11/12 (2006.01)

H04B 1/04 (2006.01)

H04B 1/18 (2006.01)

H01Q 9/16 (2006.01)

H01Q 1/24 (2006.01)

H01Q 9/14 (2006.01)

H01Q 9/42 (2006.01)

H04W 88/02 (2009.01)

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

CPC **H01Q 9/16** (2013.01); **H01Q 1/243** (2013.01); **H01Q 9/145** (2013.01); **H01Q 9/42** (2013.01); **H04W 88/02** (2013.01); **H04B 1/0458** (2013.01); **H04B 1/18** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 9/145; H01Q 1/243; H01Q 9/42

USPC 455/129, 193.1, 193.2, 193.3, 121, 269

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,861,854 A	1/1999	Kawahata et al.
6,040,806 A	3/2000	Kushihi et al.
2003/0060227 A1	3/2003	Sekine et al.
2004/0222925 A1	11/2004	Fabrega-Sanchez et al.
2006/0094458 A1	5/2006	Kitaji
2006/0139218 A1	6/2006	Jang
2007/0146221 A1	6/2007	Oshiyama et al.
2007/0285326 A1 *	12/2007	McKinzie 343/746
2007/0285335 A1	12/2007	Bungo et al.
2009/0231220 A1	9/2009	Zhang et al.
2010/0105425 A1	4/2010	Asokan
2011/0210897 A1	9/2011	Byun et al.
2011/0256841 A1	10/2011	Kakuya et al.
2011/0281532 A1	11/2011	Shin et al.
2012/0280890 A1	11/2012	Kusumoto

FOREIGN PATENT DOCUMENTS

CN	1171640 A	1/1998
CN	1197309 A	10/1998
CN	1770642 A	5/2006
CN	1926720 A	3/2007
CN	102197601 A	9/2011
EP	2 328 233 A2	6/2011
JP	56-27507 A	3/1981
JP	2006-093990 A	4/2006
KR	10-2009-0085321 A	8/2009
KR	10-2009-0111519 A	10/2009
WO	2011-086723 A1	7/2011

* cited by examiner

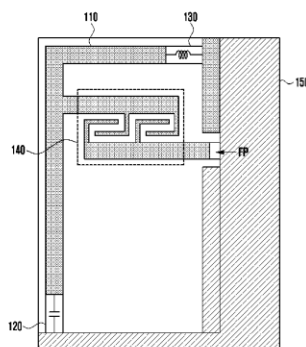
Primary Examiner — Nguyen Vo

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

(57) **ABSTRACT**

An antenna apparatus for a mobile terminal is provided. The antenna apparatus includes an antenna pattern, a first electric circuit and a second electric circuit respectively connected between both ends of the antenna pattern and a system ground, and a third electric circuit disposed between the antenna pattern and a feeding line, wherein the first electric circuit and the second electric circuit extend electrical wave-lengths of the antenna pattern and the third electric circuit increases input impedance matching.

15 Claims, 13 Drawing Sheets





US009306292B2

(12) **United States Patent**
Ryu

(10) **Patent No.:** **US 9,306,292 B2**
(45) **Date of Patent:** **Apr. 5, 2016**

(54) **PORTABLE TERMINAL**

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

(72) Inventor: **Seungwoo Ryu**, Uijeongbu (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 289 days.

2008/0278384	A1 *	11/2008	Shimasaki	.....	H01Q 1/2266	343/702
2008/0316115	A1 *	12/2008	Hill et al.	.....		343/702
2009/0189817	A1 *	7/2009	Yang et al.	.....		343/702
2010/0302110	A1 *	12/2010	Leem	.....		343/702
2011/0215971	A1 *	9/2011	Rao	.....		343/702
2011/0273342	A1 *	11/2011	Park et al.	.....		343/702
2011/0291895	A1 *	12/2011	Zaila et al.	.....		343/702
2012/0056789	A1 *	3/2012	Sohn	.....		343/702
2013/0057438	A1	3/2013	Satou et al.	.....		
2013/0057446	A1	3/2013	Hirobe et al.	.....		

FOREIGN PATENT DOCUMENTS

(21) Appl. No.: **13/757,292**

(22) Filed: **Feb. 1, 2013**

(65) **Prior Publication Data**

US 2013/0207854 A1 Aug. 15, 2013

CA	2377921	A1	1/2001
DE	19929689	A1	1/2001
WO	2011/105650	A1	9/2011
WO	2011/142135	A1	11/2011
WO	2011/145324	A1	11/2011

* cited by examiner

(30) **Foreign Application Priority Data**

Feb. 15, 2012 (KR) 10-2012-0015448

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 21/28 (2006.01)

H01Q 1/52 (2006.01)

H01Q 5/35 (2015.01)

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

CPC **H01Q 21/28** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/521** (2013.01); **H01Q 5/35** (2015.01)

(58) **Field of Classification Search**

CPC H01Q 5/0048; H01Q 1/521; H01Q 1/243

USPC 343/702, 841, 893, 853

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,764,236 B2 * 7/2010 Hill et al. 343/702
2007/0268190 A1 * 11/2007 Huynh 343/702

Primary Examiner — Dameon E Levi

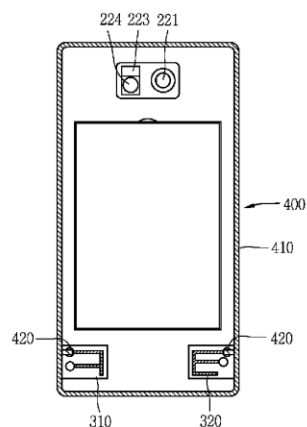
Assistant Examiner — Hasan Islam

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

(57) **ABSTRACT**

The present disclosure relates to a portable terminal having antennas for transmitting or receiving wireless signals. The portable terminal includes a terminal body, a first antenna mounted in the terminal body to transmit or receive a wireless signal, a second antenna disposed with being spaced apart from the first antenna and set to transmit or receive a wireless signal at a frequency band different from the first antenna, and a connection unit configured to electrically connect the first and second antennas to reduce a frequency interference between the first and second antennas, at least part of the connection unit being formed along an edge of the terminal body.

11 Claims, 15 Drawing Sheets





US009312608B2

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

(10) **Patent No.:** **US 9,312,608 B2**
(45) **Date of Patent:** **Apr. 12, 2016**

(54) **MULTIPLE-INPUT MULTIPLE-OUTPUT
ANTENNA DEVICE**

USPC 343/702, 893, 841; 29/600
See application file for complete search history.

(71) Applicant: **TAI-SAW TECHNOLOGY CO., LTD.**,
Taoyuan County (TW)

(56) **References Cited**

(72) Inventors: **Tzu-Chun Tang**, Taoyuan County (TW);
Ken-Huang Lin, Taoyuan County (TW)

U.S. PATENT DOCUMENTS

2010/0053022 A1 * 3/2010 Mak et al. 343/893

(73) Assignee: **TAI-SAW TECHNOLOGY CO, LTD.**,
Taoyuan (TW)

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 324 days.

TW	I255588	5/2006
TW	M341314	9/2008
TW	200943627 A	10/2009

OTHER PUBLICATIONS

(21) Appl. No.: **13/863,900**

Office Action from TW application No. 101113674 dated Mar. 27,
2014.

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

Office Action from TW application No. 101113674 dated Oct. 14,
2014.

(65) **Prior Publication Data**

US 2013/0271345 A1 Oct. 17, 2013

* cited by examiner

(30) **Foreign Application Priority Data**

Apr. 17, 2012 (TW) 101113674 A

Primary Examiner — Dieu H Duong

(74) *Attorney, Agent, or Firm* — Haverstock & Owens LLP

(51) **Int. Cl.**
H01Q 21/00 (2006.01)
H01Q 1/52 (2006.01)
H01Q 5/48 (2015.01)

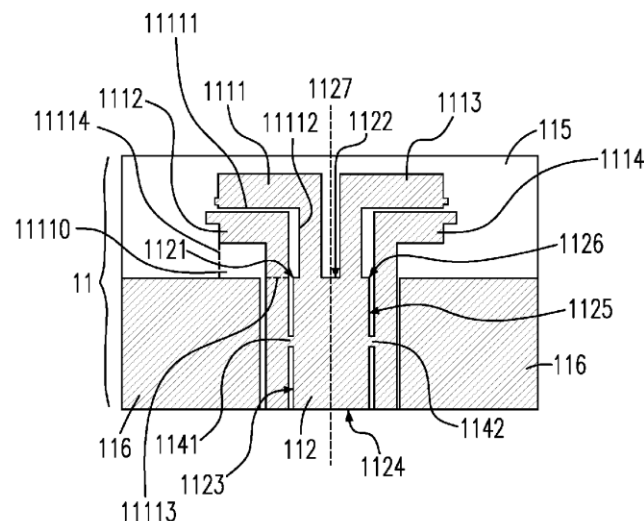
(57) **ABSTRACT**

(52) **U.S. Cl.**
CPC **H01Q 21/0075** (2013.01); **H01Q 1/521**
(2013.01); **H01Q 5/48** (2015.01); **H01Q**
21/0093 (2013.01); **Y10T 29/49016** (2015.01)

A coplanar waveguide fed multiple-input multiple-output (MIMO) antenna device is provided in the present invention. The coplanar waveguide fed multiple-input multiple-output (MIMO) antenna device includes a grounding metal piece; a grounding plane; a first radiation element connected to the grounding plane; and a second radiation element connected to the grounding plane through the grounding metal piece.

(58) **Field of Classification Search**
CPC ... H01Q 1/521; H01Q 1/526; H01Q 21/0075;
H01Q 21/0093; Y10T 29/49016

20 Claims, 15 Drawing Sheets





US009317074B2

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

(10) **Patent No.:** **US 9,317,074 B2**
(45) **Date of Patent:** **Apr. 19, 2016**

(54) **ANTENNA MOUNTING FOR ELECTRONIC DEVICES**

(75) Inventors: **Gang Ji**, Kawakaki (JP); **Tetsuya Ohtani**, Yokohama (JP); **Takayuki Morino**, Yamato (JP); **Akinori Uchino**, Yamato (JP)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1380 days.

(21) Appl. No.: **12/351,533**

(22) Filed: **Jan. 9, 2009**

(65) **Prior Publication Data**
US 2009/0179806 A1 Jul. 16, 2009

(30) **Foreign Application Priority Data**
Jan. 11, 2008 (JP) 2008-004103

(51) **Int. Cl.**
G06F 1/16 (2006.01)
H01Q 1/24 (2006.01)

(52) **U.S. Cl.**
CPC **G06F 1/1698** (2013.01); **G06F 1/1616** (2013.01); **G06F 1/1637** (2013.01); **G06F 1/1656** (2013.01)

(58) **Field of Classification Search**
USPC 361/679.21, 679.26–679.27, 697.55
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,867,370 A * 2/1999 Masuda 361/800
6,642,892 B2 * 11/2003 Masaki et al. 343/702
6,853,336 B2 * 2/2005 Asano et al. 343/702

7,142,886 B2 * 11/2006 Murayama et al. 455/556.1
7,298,335 B2 * 11/2007 Usui et al. 343/702
7,301,783 B2 * 11/2007 Homer et al. 361/816
8,045,090 B2 * 10/2011 Iijima G06F 1/162
348/58
8,165,624 B2 * 4/2012 Tseng B29C 43/203
343/702
8,379,164 B2 * 2/2013 Ji B29C 45/0001
348/794
8,576,372 B2 * 11/2013 Ji B29C 45/0001
348/794

(Continued)

FOREIGN PATENT DOCUMENTS

JP 03-20492 U1 * 2/1991 H05K 9/00
JP H10-215080 8/1998

(Continued)

OTHER PUBLICATIONS

English translation of Koike, JP 3-20492 U, dated Feb. 28, 1991, translated in Jun. 2012.*

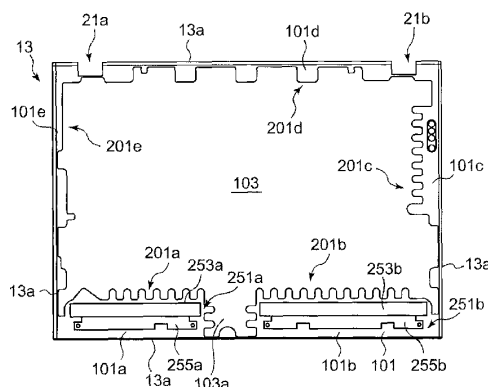
Primary Examiner — Robert J Hoffberg

(74) *Attorney, Agent, or Firm* — Ference & Associates LLC

(57) **ABSTRACT**

The invention broadly contemplates an electronic apparatus that provides improved antenna characteristics, while maintaining a thin size and light weight. The electronic apparatus of the present invention includes a display casing having a nonconductive resin region and a conductive resin region in a bottom surface thereof; a display module accommodated in the display casing; an antenna disposed in the nonconductive resin region; and a system casing accommodating a wireless module connected to the antenna. By disposing the antenna in the nonconductive resin region formed in the bottom surface of the display casing, it is possible to secure high radio wave sensitivity while preventing an antenna mounting portion from being exposed to the outside of the display casing. The casing structure of the electronic apparatus does not become thick because of butt joining even when the joint portions are in a projection area of an LCD module.

19 Claims, 6 Drawing Sheets





US009318791B2

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

(10) **Patent No.:** **US 9,318,791 B2**

(45) **Date of Patent:** **Apr. 19, 2016**

(54) **CARBON FIBER-BASED CHASSIS
COMPONENTS FOR PORTABLE
INFORMATION HANDLING SYSTEMS**

(71) Applicants: **Brian H. Leonard**, Austin, TX (US);
David J. Hernandez, Round Rock, TX
(US); **Chuan Beng Sim**, Shanghai (CN)

(72) Inventors: **Brian H. Leonard**, Austin, TX (US);
David J. Hernandez, Round Rock, TX
(US); **Chuan Beng Sim**, Shanghai (CN)

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

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 121 days.

(21) Appl. No.: **14/169,376**

(22) Filed: **Jan. 31, 2014**

(65) **Prior Publication Data**
US 2015/0222007 A1 Aug. 6, 2015

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/22 (2006.01)
H01Q 9/30 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/2266** (2013.01); **H01Q 9/30**
(2013.01); **Y10T 29/49016** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 9/14; H01Q 1/50; H01Q 9/30
USPC 343/700, 702; 361/679.01
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,552,686	B2 *	4/2003	Ollikainen et al.	....	343/700	MS
8,269,675	B2	9/2012	Kough et al.			
8,325,094	B2	12/2012	Vazquez et al.			
8,410,984	B2 *	4/2013	Sato et al.	.....	343/702	
8,441,783	B2 *	5/2013	Tanaka et al.	.....	361/679.09	
8,773,310	B2 *	7/2014	Shiu et al.	.....	343/700	MS
2011/0006953	A1	1/2011	Chiang et al.			
2011/0050509	A1	3/2011	Vazquez et al.			
2013/0076573	A1	3/2013	Rappoport et al.			
2013/0300618	A1	11/2013	Yarga et al.			

* cited by examiner

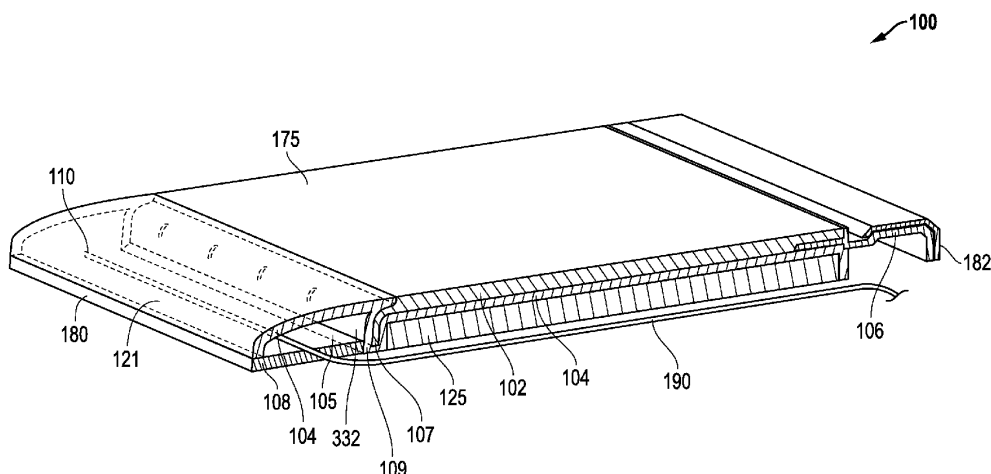
Primary Examiner — Peguy Jean Pierre

(74) *Attorney, Agent, or Firm* — Egan, Peterman, Enders &
Huston LLP

(57) **ABSTRACT**

A chassis component of an information handling system may include a chassis main lid component constructed of carbon fiber composite material that supports a lid chassis antenna housing that includes an internal antenna cavity defined therein to create an antenna window for the system. The carbon fiber composite material may be attached to the chassis antenna housing by an interlocking rib that provides sufficient joint strength to allow for a substantially larger and extended chassis antenna housing with larger antenna window that may be spaced further away from the carbon fiber composite material of the chassis main lid component than would otherwise be possible for the same form factor size so as to minimize or substantially eliminate shielding or blocking of wireless signals by the carbon fiber composite material lid component that would result in reduced system wireless performance.

27 Claims, 8 Drawing Sheets





US009318792B2

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

(10) **Patent No.:** **US 9,318,792 B2**

(45) **Date of Patent:** **Apr. 19, 2016**

(54) **METHOD FOR CONTROLLING ANTENNAS
OF MOBILE TERMINAL DEVICE AND SUCH
A MOBILE TERMINAL DEVICE**

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(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 584 days.

(21) Appl. No.: **12/509,125**

(22) Filed: **Jul. 24, 2009**

(65) **Prior Publication Data**

US 2009/0284438 A1 Nov. 19, 2009

Related U.S. Application Data

(62) Division of application No. 11/445,942, filed on Jun. 3,
2006, now abandoned.

(30) **Foreign Application Priority Data**

Jun. 3, 2005 (JP) 2005-164280

(51) **Int. Cl.**

H04M 1/00 (2006.01)
H04B 1/38 (2015.01)
H01Q 1/22 (2006.01)
H01Q 1/24 (2006.01)
H01Q 3/24 (2006.01)
H04B 1/3827 (2015.01)

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

CPC **H01Q 1/2291** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 3/24** (2013.01); **H04B 1/3838**
(2013.01)

(58) **Field of Classification Search**

CPC H04B 1/3838; H01Q 1/243

USPC 455/550.1, 575.7, 103, 272, 277.1, 566

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,541,609 A * 7/1996 Stutzman H01Q 1/245
343/702
6,456,856 B1 9/2002 Werling
7,724,705 B2 * 5/2010 Erola H04W 92/18
370/331
2002/0106995 A1 8/2002 Callaway, Jr.
2003/0045246 A1 * 3/2003 Lee et al. 455/90
2003/0124982 A1 * 7/2003 Saari H04B 7/0689
455/67.14
2003/0148784 A1 * 8/2003 Sawamura et al. 455/550

(Continued)

FOREIGN PATENT DOCUMENTS

EP 1727290 2/2004
GB 2423191 8/2006

(Continued)

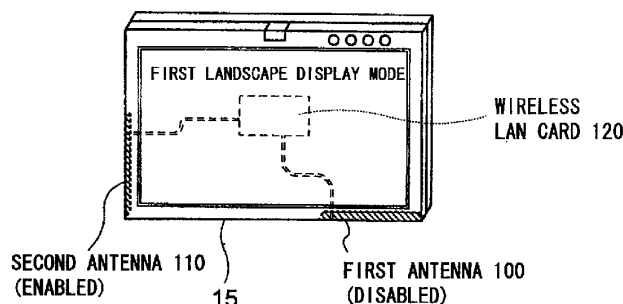
Primary Examiner — Nguyen Vo

(74) *Attorney, Agent, or Firm* — Ference & Associates LLC

(57) **ABSTRACT**

A method for controlling antennas of a mobile terminal device such as a laptop PC and a handheld PC without degrading communication speed or quality and a mobile terminal device having such control are provided. The method comprises determining the usage of the mobile terminal device, determining an antenna to be disabled among the plurality of antennas according to the usage that is determined by the determining of usage, and disabling the antenna which is determined by determining of an antenna to be disabled, wherein the determining of usage determines usage based on the display orientation of the display unit of the mobile terminal device.

20 Claims, 10 Drawing Sheets





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

(10) **Patent No.:** **US 9,318,793 B2**
(45) **Date of Patent:** **Apr. 19, 2016**

(54) **CORNER BRACKET SLOT ANTENNAS**

(56) **References Cited**

(75) Inventors: **Jiang Zhu**, Sunnyvale, CA (US);
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U.S. PATENT DOCUMENTS

3,573,834	A	4/1971	McCabe et al.
4,733,245	A	3/1988	Mussler
5,461,393	A	10/1995	Gordon
5,703,600	A	12/1997	Burrell et al.
5,768,217	A	6/1998	Sonoda et al.
5,872,557	A	2/1999	Wiemer et al.
5,877,728	A	3/1999	Wu et al.
5,914,693	A	6/1999	Takei et al.

(Continued)

FOREIGN PATENT DOCUMENTS

CN	1256802	A	6/2000
CN	1133237		12/2003

(Continued)

OTHER PUBLICATIONS

Guterman et al., U.S. Appl. No. 13/490,356, filed Jun. 6, 2012.

Primary Examiner — Trinh Dinh

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

(57) **ABSTRACT**

A display cover layer may be mounted in an electronic device housing using housing structures such as corner brackets. A slot antenna may be formed from a corner bracket opening, metal traces on a hollow plastic support structure, or other conductive structures. The slot antenna may have a main portion with opposing ends. An antenna feed may be located at one of the ends. The slot antenna may have a slot with one or more bends. The bends may provide the slot antenna with a C-shaped outline. A side branch slot may extend from the main portion of the slot at a location between the two bends. The presence of the side branch slot may enhance antenna bandwidth. A hollow enclosure may serve as an antenna support structure and as a speaker box enclosing a speaker driver. The antenna feed may be positioned so as to overlap the speaker driver.

8 Claims, 11 Drawing Sheets

(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 413 days.

(21) Appl. No.: **13/462,268**

(22) Filed: **May 2, 2012**

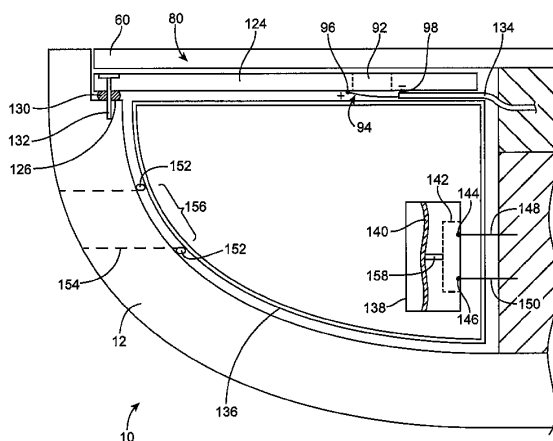
(65) **Prior Publication Data**

US 2013/0293424 A1 Nov. 7, 2013

(51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 1/24 (2006.01)
H01Q 1/44 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/44**
(2013.01); **H01Q 13/10** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/44; H01Q 13/10
See application file for complete search history.





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(12) **United States Patent**
Su

(10) **Patent No.:** **US 9,318,795 B2**

(45) **Date of Patent:** **Apr. 19, 2016**

(54) **WIDEBAND ANTENNA AND RELATED RADIO-FREQUENCY DEVICE**

(75) Inventor: **Chi-Kang Su**, Hsinchu (TW)

(73) Assignee: **Wistron NeWeb Corporation**, Hsinchu Science Park, Hsinchu (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 269 days.

(21) Appl. No.: **13/585,841**

(22) Filed: **Aug. 15, 2012**

(65) **Prior Publication Data**

US 2013/0249765 A1 Sep. 26, 2013

(30) **Foreign Application Priority Data**

Mar. 22, 2012 (TW) 101109847 A

(51) **Int. Cl.**

H01Q 1/38 (2006.01)

H01Q 1/50 (2006.01)

H01Q 1/24 (2006.01)

H01Q 15/02 (2006.01)

H01Q 1/00 (2006.01)

H01Q 9/42 (2006.01)

H01Q 5/371 (2015.01)

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

CPC **H01Q 1/243** (2013.01); **H01Q 5/371** (2015.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**

CPC ... H01Q 21/24; H01Q 13/206; H01Q 5/0072; H01Q 1/38; H01Q 9/40; H01Q 1/48; H01Q 1/50

USPC 343/700 MS, 850, 702, 909, 722

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,513,383	A *	4/1996	Tsao	455/575.7
6,753,815	B2 *	6/2004	Okubora et al.	343/700 MS
7,055,754	B2 *	6/2006	Forster	235/492
7,764,232	B2	7/2010	Achour	
2004/0160380	A1 *	8/2004	Simpson	343/850
2007/0229366	A1 *	10/2007	Kim et al.	343/700 MS
2011/0012789	A1 *	1/2011	Yang et al.	343/700 MS
2012/0027056	A1 *	2/2012	Shinkai et al.	375/219

FOREIGN PATENT DOCUMENTS

CN 102044738 A 5/2011

* cited by examiner

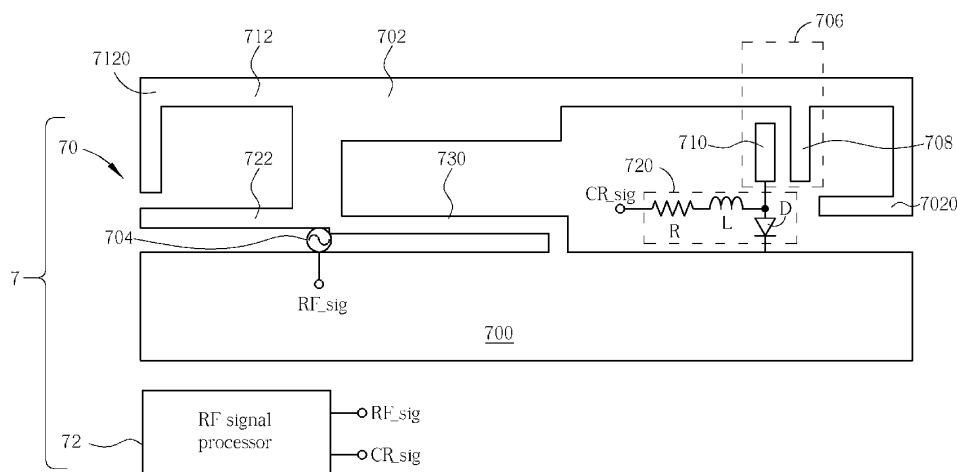
Primary Examiner — Graham Smith

(74) *Attorney, Agent, or Firm* — Winston Hsu; Scott Margo

(57) **ABSTRACT**

A wideband antenna is disclosed. The wideband antenna includes a ground element electrically connected to a ground, a feed element for feeding in a Radio-Frequency signal, a radiation element electrically connected to the feed element for radiating the Radio-Frequency signal, and at least one meta-material structure electrically connected between the radiation element and the ground element.

16 Claims, 22 Drawing Sheets





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

(10) **Patent No.:** **US 9,318,796 B2**
(45) **Date of Patent:** **Apr. 19, 2016**

(54) **MULTIBAND ANTENNA**

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

(72) Inventors: **Cho-Kang Hsu**, New Taipei (TW);
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(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 208 days.

(21) Appl. No.: **14/014,623**

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

(65) **Prior Publication Data**

US 2014/0313083 A1 Oct. 23, 2014

(30) **Foreign Application Priority Data**

Apr. 19, 2013 (TW) 102113874 A

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 9/04 (2006.01)
H01Q 21/28 (2006.01)
H01Q 5/371 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 5/371** (2015.01); **H01Q 9/0421** (2013.01); **H01Q 21/28** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 5/371; H01Q 1/243; H01Q 21/28;
H01Q 9/0421; H01Q 5/0062; H01Q 5/378;
H01Q 5/385; H01Q 5/392; H01Q 5/00
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,072,389 B2 * 12/2011 Chang et al. 343/846
2008/0129630 A1 * 6/2008 Baliarda et al. 343/793

* cited by examiner

Primary Examiner — Michael C Wimer

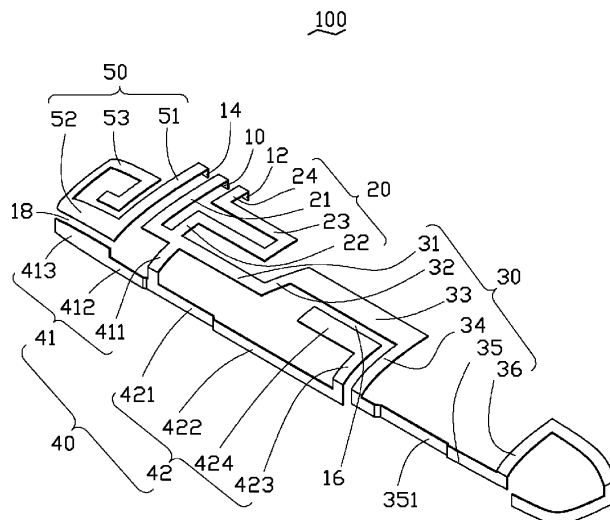
Assistant Examiner — Noel Maldonado

(74) *Attorney, Agent, or Firm* — Novak Druce Connolly Bove + Quigg LLP

(57) **ABSTRACT**

A multiband antenna includes a feed end, a first ground end, a second ground end, a ground path, parasitic member, a first resonating member, and a second resonating member. The ground path is connected between the feed end and the first ground end. The first resonating member operates at a low frequency resonating mode. The second resonating member operates at a high frequency resonating mode. The second resonating member includes a first bent portion and a second bent portion. The first bent portion is coupled with the parasitic member to widen a bandwidth of the second resonating member at the high frequency resonating mode. The second bent portion is coupled with the first resonating member to reduce an electrical length of the first resonating member.

15 Claims, 2 Drawing Sheets





US009318797B2

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

(10) **Patent No.:** **US 9,318,797 B2**
(45) **Date of Patent:** **Apr. 19, 2016**

(54) **ELECTRONIC DEVICE**

(71) Applicants: **Bin-Chyi Tseng**, Taipei (TW);
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Chih-Chung Lin, Taipei (TW)

(72) Inventors: **Bin-Chyi Tseng**, Taipei (TW);
Tsung-Chieh Yen, Taipei (TW);
Chih-Chung Lin, 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 191 days.

(21) Appl. No.: **14/277,065**

(22) Filed: **May 14, 2014**

(65) **Prior Publication Data**

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Related U.S. Application Data

(60) Provisional application No. 61/826,988, filed on May 23, 2013.

(30) **Foreign Application Priority Data**

Feb. 12, 2014 (CN) 2014 1 0048864

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

(52) **U.S. Cl.**
CPC **H01Q 1/245** (2013.01); **H01Q 1/24** (2013.01); **H01Q 1/241** (2013.01); **H01Q 1/242** (2013.01); **H01Q 1/44** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/24; H01Q 1/241; H01Q 1/242;
H01Q 1/245; H01Q 1/44
USPC 343/702, 787
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,193,992 B2 * 6/2012 Ikonen H01Q 1/243
343/702
8,725,222 B2 * 5/2014 Phillips G06K 19/005
455/556.1
9,083,073 B2 * 7/2015 Yang H01Q 1/22
2012/0075148 A1 3/2012 Cho
2014/0080411 A1 * 3/2014 Konanur H04B 5/0031
455/41.1
2014/0111387 A1 * 4/2014 Konanur H01Q 1/243
343/702

FOREIGN PATENT DOCUMENTS

CN 201957086 8/2011

* cited by examiner

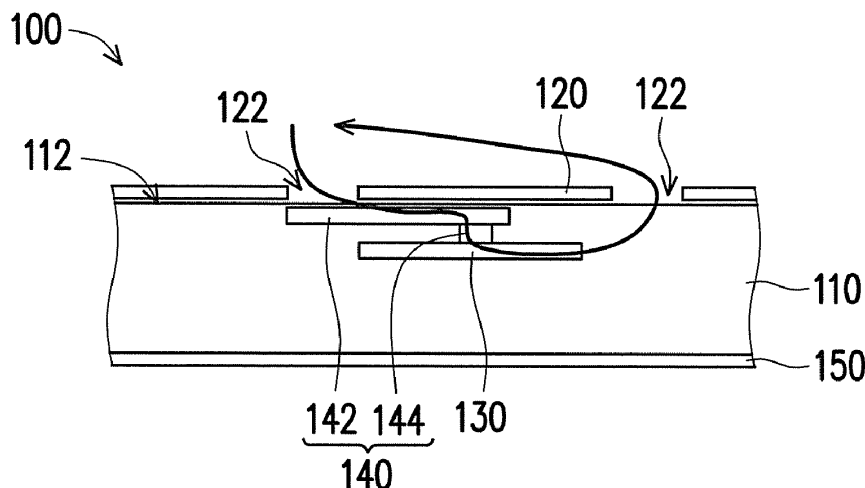
Primary Examiner — Hoang V Nguyen

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

(57) **ABSTRACT**

An electronic device includes a main body, a metal cover, an antenna and a magnetic flux inducer unit. The metal cover is disposed at the main body and the main body includes a nonmetal covered portion. The antenna is disposed in the main body. The magnetic flux inducer unit is disposed in the main body and located between the nonmetal covered portion and the antenna. The permeability of the magnetic flux inducer unit is greater than 1.

9 Claims, 3 Drawing Sheets





US009318803B2

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

(10) **Patent No.:** **US 9,318,803 B2**

(45) **Date of Patent:** **Apr. 19, 2016**

(54) **MULTIMODE ANTENNA STRUCTURE**

(71) Applicant: **Skycross, Inc.**, San Jose, CA (US)

(72) Inventors: **Mark T. Montgomery**, Melbourne Beach, FL (US); **Frank M. Caimi**, Vero Beach, FL (US); **Mark W. Kishler**, Rockledge, FL (US)

(73) Assignee: **Skycross, Inc.**, San Jose, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 103 days.

(21) Appl. No.: **14/319,882**

(22) Filed: **Jun. 30, 2014**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. 13/974,479, filed on Aug. 23, 2013, now Pat. No. 8,803,756, which is a continuation of application No. 13/454,738, filed on Apr. 24, 2012, now Pat. No. 8,547,289, which is a

(Continued)

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H01Q 21/00 (2006.01)
H01Q 1/52 (2006.01)

(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/523** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/36** (2013.01); **H01Q 1/521** (2013.01);

(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/521; H01Q 1/523; H01Q 21/20; H01Q 21/28; H01Q 21/30; H01Q 3/2617; H01Q 5/371; H01Q 9/145
USPC 343/700 MS, 742, 810, 820, 844, 853, 343/867

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,947,987 A 8/1960 Dodington
3,344,425 A * 9/1967 Webb G01S 13/4409 342/153

(Continued)

FOREIGN PATENT DOCUMENTS

CN 1645671 7/2005
EP 0847101 6/1998

(Continued)

OTHER PUBLICATIONS

"European Search Report for EP08746192, dated Nov. 4, 2011".

(Continued)

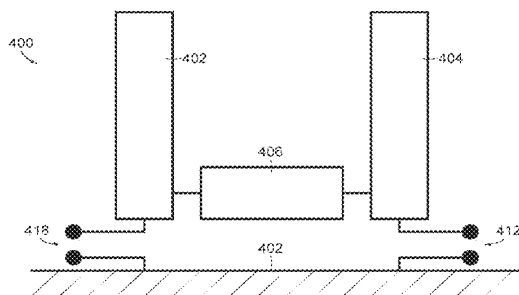
Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — Andrew Gust; Guntin & Gust, PLC

(57) **ABSTRACT**

One or more embodiments are directed to a multimode antenna structure for transmitting and receiving electromagnetic signals in a communications device. The communications device includes circuitry for processing signals communicated to and from the antenna structure. The antenna structure is configured for optimal operation in a given frequency range. The antenna structure includes a plurality of antenna ports operatively coupled to the circuitry, and a plurality of antenna elements, each operatively coupled to a different one of the antenna ports. Each of the plurality of antenna elements is configured to have an electrical length selected to provide optimal operation within the given frequency range. The antenna structure also includes one or more connecting elements electrically connecting the antenna elements such that electrical currents on one antenna element flow to a connected neighboring antenna element and generally bypass the antenna port coupled to the neighboring antenna element. The electrical currents flowing through the one antenna element and the neighboring antenna element are generally equal in magnitude, such that an antenna mode excited by one antenna port is generally electrically isolated from a mode excited by another antenna port at a given desired signal frequency range without the use of a decoupling network connected to the antenna ports, and the antenna structure generates diverse antenna patterns.

20 Claims, 67 Drawing Sheets





US009318806B2

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

(10) **Patent No.:** **US 9,318,806 B2**
(45) **Date of Patent:** **Apr. 19, 2016**

(54) **ELECTRONIC DEVICE WITH
BALANCED-FED SATELLITE
COMMUNICATIONS ANTENNAS**

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(72) Inventors: **Salih Yarga**, Sunnyvale, CA (US);
Miroslav Samardzija, Mountain View,
CA (US); **Enrique Ayala Vazquez**,
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Robert W. Schlub, Cupertino, CA (US)

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

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 183 days.

(21) Appl. No.: **14/058,024**

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

(65) **Prior Publication Data**

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(51) **Int. Cl.**
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H01Q 9/16 (2006.01)
H01Q 5/328 (2015.01)
H01Q 1/24 (2006.01)
H01Q 5/371 (2015.01)

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

(58) **Field of Classification Search**
USPC 343/700 MS, 793, 795, 821
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,532,708	A *	7/1996	Krenz et al.	343/795
6,018,324	A	1/2000	Kitchener	
7,239,290	B2	7/2007	Poilasne et al.	
7,733,285	B2	6/2010	Gainey et al.	
2004/0252070	A1 *	12/2004	Chuang	343/795
2005/0237260	A1 *	10/2005	Bancroft	343/859
2008/0238800	A1	10/2008	Collins	
2009/0207092	A1 *	8/2009	Nysen et al.	343/876
2014/0132469	A1 *	5/2014	Wang et al.	343/821

FOREIGN PATENT DOCUMENTS

EP 2 230 723 9/2010

* cited by examiner

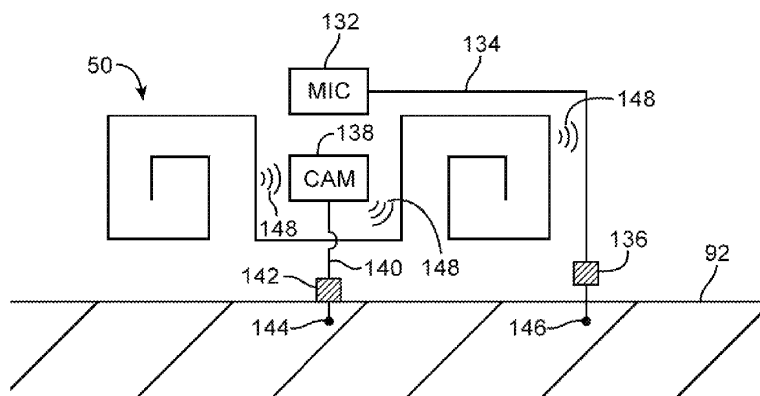
Primary Examiner — Tan Ho

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

(57) **ABSTRACT**

An electronic device may include balance-fed antenna structures that do not have direct paths to ground. The antenna structures may serve as a Global Positioning System (GPS) antenna and may have a dipole structure having a first and second antenna resonating element arms. The antenna structures may include a conductive path that conveys antenna signals between a first feed terminal on the first antenna resonating element arm and a transmission line. The conductive path may overlap with the second antenna resonating element arm such that current flow through the conductive path induces corresponding current flow in the second antenna resonating element arm. The antenna structures may include an impedance matching short-circuit stub path that couples the first antenna resonating element arm to the second antenna resonating element arm. Choke inductors may be used to help block indirect paths from the antenna structures to ground through adjacent circuitry.

19 Claims, 12 Drawing Sheets





US009319987B2

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

(10) **Patent No.:** **US 9,319,987 B2**
(45) **Date of Patent:** **Apr. 19, 2016**

(54) **MOBILE COMMUNICATION**

(56) **References Cited**

(71) Applicant: **BROADCOM CORPORATION**,
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U.S. PATENT DOCUMENTS

(72) Inventors: **Seppo Rousu**, Oulu (FI); **Samuel Vehkalahti**, Haukipudas (FI)

2005/0266904 A1 12/2005 Kitaji et al.
2007/0173208 A1 * 7/2007 Nishio et al. 455/78

(Continued)

(73) Assignee: **BROADCOM CORPORATION**,
Irvine, CA (US)

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 36 days.

EP 0 987 834 A2 3/2000
EP 1 248 386 A1 10/2002
EP 1 715 600 A1 10/2006

(Continued)

OTHER PUBLICATIONS

(21) Appl. No.: **14/101,773**

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(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Dec. 10, 2012 (GB) 1222189.1

Primary Examiner — Ping Hsieh

(74) Attorney, Agent, or Firm — Foley & Lardner LLP;
Christopher J. McKenna; Paul M. H. Pua

(51) **Int. Cl.**

H04B 1/44 (2006.01)

H04W 52/04 (2009.01)

H04W 52/42 (2009.01)

H04B 7/06 (2006.01)

H04B 7/08 (2006.01)

H04B 7/04 (2006.01)

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

CPC **H04W 52/04** (2013.01); **H04B 7/0608**
(2013.01); **H04B 7/0817** (2013.01); **H04W**
52/42 (2013.01); **H04B 7/0413** (2013.01)

(58) **Field of Classification Search**

CPC .. H04B 7/0413; H04B 7/0817; H04B 7/0608;
H04W 52/04; H04W 52/42; H04W 52/16
USPC 455/78, 101, 277.1, 277.2, 67.11;
375/267, 299

See application file for complete search history.

(57) **ABSTRACT**

An apparatus for use in a mobile device includes a switch unit configured to switch a common connection of a transmitter and a first receiver from a first antenna to a second antenna and a connection of a respective second receiver from the second antenna to the first antenna; and a processing system configured to detect a switch condition that the transmitter needs to transmit via the second antenna, obtain power-related reception parameters of said first and said second receivers, cause the switch unit to switch the common connection of the transmitter and the first receiver so that the transmitter transmits via the second antenna, and adjust the power of the transmitter in dependence on the power-related reception parameters.

20 Claims, 5 Drawing Sheets

