



US008361062B2

(12) **United States Patent
Bonn**

(10) **Patent No.: US 8,361,062 B2**
(45) **Date of Patent: *Jan. 29, 2013**

- (54) **SLIDABLE CHOKE MICROWAVE ANTENNA**
- (75) Inventor: **Kenlyn S. Bonn**, Arvada, CO (US)
- (73) Assignee: **Vivant Medical, Inc.**, Boulder, CO (US)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

4,700,716	A	10/1987	Kasevich et al.
4,743,725	A	5/1988	Risman
4,776,086	A	10/1988	Kasevich et al.
4,798,215	A	1/1989	Turner
4,800,899	A	1/1989	Elliott
4,807,620	A	2/1989	Strul et al.
4,817,635	A	4/1989	Joines et al.
4,825,880	A	5/1989	Stauffer et al.
4,841,988	A	6/1989	Fetter et al.
4,934,365	A	6/1990	Morgenthaler
4,945,912	A	8/1990	Langberg
5,026,959	A	6/1991	Ito et al.

(Continued)

- (21) Appl. No.: **13/268,143**
- (22) Filed: **Oct. 7, 2011**

FOREIGN PATENT DOCUMENTS

DE	390937	3/1924
(Continued)		

- (65) **Prior Publication Data**
US 2012/0029503 A1 Feb. 2, 2012

OTHER PUBLICATIONS

U.S. Appl. No. 08/483,742 Jun. 7, 1995.
(Continued)

Related U.S. Application Data

- (62) Division of application No. 12/129,482, filed on May 29, 2008, now Pat. No. 8,059,059.
- (51) **Int. Cl.**
A61B 18/04 (2006.01)
H01Q 1/10 (2006.01)
- (52) **U.S. Cl.** **606/33**; 343/902; 343/906
- (58) **Field of Classification Search** None
See application file for complete search history.

Primary Examiner — Trinh Dinh

(57) **ABSTRACT**

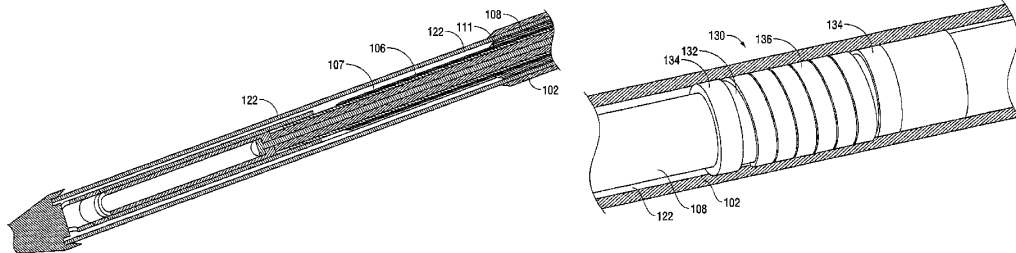
A microwave antenna assembly is disclosed. The antenna assembly includes a feedline having an inner conductor, an outer conductor and an inner insulator disposed therebetween and a radiating portion including a dipole antenna coupled to the feedline and a trocar coupled to the dipole antenna at a distal end thereof. The antenna assembly also includes a slidable outer jacket disposed about the radiating portion and the feedline. The slidable outer jacket being configured to slide about at least one of the radiating portion and the feedline from a closed configuration, in which the slidable outer jacket is mated with the trocar and a retracted configuration, in which the slidable outer jacket is retracted in a proximally exposing at least a portion the radiating portion.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,230,957	A	1/1966	Seifert
3,631,363	A	12/1971	Miller
4,557,272	A	12/1985	Carr
4,612,940	A	9/1986	Kasevich et al.
4,643,186	A	2/1987	Rosen et al.
4,658,836	A	4/1987	Turner
4,674,481	A	6/1987	Boddie, Jr. et al.

10 Claims, 15 Drawing Sheets





US008362783B2

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

(10) **Patent No.:** **US 8,362,783 B2**
(45) **Date of Patent:** **Jan. 29, 2013**

- (54) **METHOD FOR VERIFYING A COMPLETENESS OF AN ANTENNA**
- (75) Inventors: **Tracy M. Baker**, Belle Center, OH (US); **Kevin J. Salm**, Minster, OH (US); **Terry A. Richardson**, Urbana, OH (US)
- (73) Assignee: **AGC Automotive Americas Co.**, Hebron, KY (US)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 696 days.

4,409,541	A	*	10/1983	Richards	.....	324/505
4,905,261	A	*	2/1990	Knight	.....	377/19
5,208,543	A		5/1993	Albiniak		
5,337,004	A	*	8/1994	Murakami et al.	.....	324/505
5,666,065	A		9/1997	Ravas et al.		
5,864,319	A	*	1/1999	Paulus	.....	343/703
6,288,552	B1		9/2001	Palmgren		
6,313,799	B1		11/2001	Thimm et al.		
6,614,922	B1		9/2003	Walton		
7,123,876	B2	*	10/2006	Wang et al.	.....	455/25
7,148,698	B2		12/2006	Becker et al.		
7,456,796	B2		11/2008	Nagayama et al.		
7,471,092	B2		12/2008	Amanuma et al.		
7,472,028	B2		12/2008	Foote		
7,478,298	B2		1/2009	Jaworski et al.		
2008/0169990	A1		7/2008	Taniguchi et al.		
2008/0309565	A1		12/2008	Villarroel et al.		

(21) Appl. No.: **12/548,879**

(22) Filed: **Aug. 27, 2009**

(65) **Prior Publication Data**
US 2010/0052718 A1 Mar. 4, 2010

Related U.S. Application Data
(60) Provisional application No. 61/190,286, filed on Aug. 27, 2008.

- (51) **Int. Cl.** *G01R 31/00* (2006.01)
- (52) **U.S. Cl.** **324/505**; 324/503
- (58) **Field of Classification Search** 324/503-505
See application file for complete search history.

(56) **References Cited**
U.S. PATENT DOCUMENTS
3,911,357 A 10/1975 Adam
4,095,172 A 6/1978 Strand
4,276,509 A 6/1981 Bryant et al.

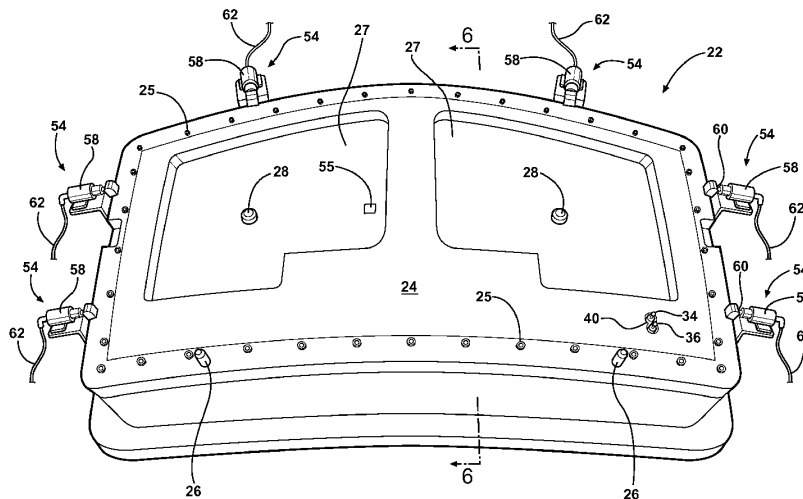
* cited by examiner

Primary Examiner — Joshua Benitez Rosario
(74) *Attorney, Agent, or Firm* — Howard & Howard Attorneys PLLC

(57) **ABSTRACT**

A method verifies a completeness of an antenna disposed on a window. The antenna is electrically conductive and has a first end and a second end spaced from each other. The method comprises the step of placing the window on a fixture for supporting the window. The method also includes the steps of automatically aligning a distributing probe and the first end of the antenna and automatically aligning a receiving probe and the second end of the antenna. The method further includes the step of activating a current source to pass an electrical current from the distributing probe to the receiving probe through the antenna. The method also includes the step of indicating passage of the electrical current from the antenna to the receiving probe with the indicator to verify a completeness of the antenna.

26 Claims, 7 Drawing Sheets





US008362954B2

(12) **United States Patent**
Nogami

(10) **Patent No.:** **US 8,362,954 B2**
(45) **Date of Patent:** **Jan. 29, 2013**

(54) **ARRAY ANTENNA, TAG COMMUNICATION DEVICE, TAG COMMUNICATION SYSTEM, AND BEAM CONTROL METHOD FOR ARRAY ANTENNA**

(75) Inventor: **Hidekatsu Nogami**, Kyoto (JP)

(73) Assignee: **Omron Corporation**, Kyoto (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 165 days.

(21) Appl. No.: **12/744,299**

(22) PCT Filed: **Feb. 24, 2009**

(86) PCT No.: **PCT/JP2009/053261**

§ 371 (c)(1),
(2), (4) Date: **Aug. 9, 2010**

(87) PCT Pub. No.: **WO2009/107601**

PCT Pub. Date: **Mar. 9, 2009**

(65) **Prior Publication Data**

US 2010/0295729 A1 Nov. 25, 2010

(30) **Foreign Application Priority Data**

Feb. 29, 2008 (JP) 2008-049959

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

(52) **U.S. Cl.** **342/372; 342/373**

(58) **Field of Classification Search** **342/81, 342/372, 373; 343/700 MS, 777**

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,359,337	A *	10/1994	Eguchi	343/765
6,184,828	B1	2/2001	Shoki	
2008/0036662	A1	2/2008	Iwata et al.	
2009/0284434	A1 *	11/2009	Gothard et al.	343/834
2011/0148707	A1 *	6/2011	Thiesen et al.	342/372
2012/0033761	A1 *	2/2012	Guo et al.	375/316

FOREIGN PATENT DOCUMENTS

JP	6-326510	A	11/1994
JP	2006-20083	A	1/2006
JP	2006-60771	A	3/2006
JP	2006-295966	A	10/2006
JP	2007-303935	A	11/2007
JP	2008-48077	A	2/2008
WO	WO 2008/018254	A1	2/2008

* cited by examiner

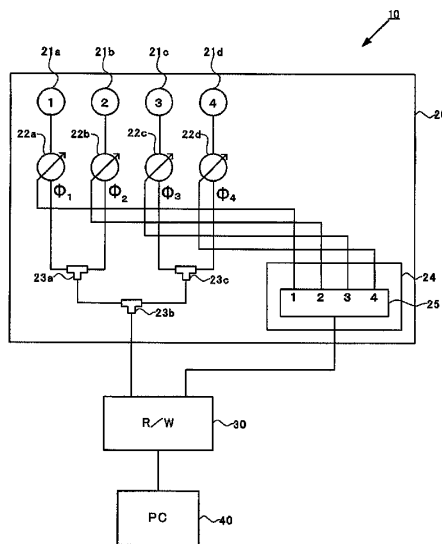
Primary Examiner — Dao Phan

(74) *Attorney, Agent, or Firm* — Dickstein Shapiro LLP

(57) **ABSTRACT**

Provided are an array antenna capable of miniaturizing an array antenna while reducing side lobes, a tag communication device and tag communication system provided with the array antenna, and a beam control method for the array antenna. When XY coordinates and a feeding phase of each antenna element (21a to 21d) are defined as the antenna element (21a) (0, Y1)·φ1, the antenna element (21b) (-X1, 0)·φ2, the antenna element (21c) (X2, 0)·φ3, the antenna element (21d) (0, -Y2)·φ4, wavelengths of λ, and directivity directions of θ, each of the feeding phases is set so that the following conditional equations φ1=φ4, φ2=2π·X1·sin(θ)/λ+φ1, φ3=φ1-2π·X2·sin(θ)/λ are all satisfied.

11 Claims, 7 Drawing Sheets





US008362956B2

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

(10) **Patent No.:** **US 8,362,956 B2**
(45) **Date of Patent:** **Jan. 29, 2013**

(54) **ELECTRICALLY SMALL, SOURCE DIRECTION RESOLVING ANTENNAS**

(76) Inventors: **Nader Behdad**, Madison, WI (US);
Mudar Ala Al-Joumayly, Madison, WI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 238 days.

(21) Appl. No.: **12/949,276**

(22) Filed: **Nov. 18, 2010**

(65) **Prior Publication Data**

US 2012/0127035 A1 May 24, 2012

(51) **Int. Cl.**
G01S 5/04 (2006.01)

(52) **U.S. Cl.** **342/442**

(58) **Field of Classification Search** 342/434,
342/442, 445, 448

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,963,173 A * 10/1999 Lian et al. 343/742
8,134,516 B1 * 3/2012 Yaghjian et al. 343/834
2012/0080957 A1 * 4/2012 Cooper et al. 307/104

OTHER PUBLICATIONS

Yoo et al., Biometric Direction Sensitive Micromachined Diaphragm for Ultrasonic Transducers, 2001 IEEE Ultrasonics Symposium, vol. 2, pp. 887-890, 2001.

Cui et al., Optical Sensing in a Directional MEMS Microphone Inspired by the Ears of the Parasitoid fly Ormia Ochracea, In Proc. of the 19th International Conference on Micro Electro Mechanical Systems, pp. 614-617, Istanbul, Turkey, 2006.

Miles et al., The Development of a Biologically-Inspired Directional Microphone for Hearing Aids, Audiology and Neurotology, vol. 11, pp. 86-94, 2006.

Miles et al., A Low Noise Differential Microphone Inspired by the Ears of the Parasitoid Fly Ormia Ochracea, J. Acoustic. Soc. An., vol. 125, pp. 2013-2026, 2009.

Xin et al., An Improved Two-Antenna Direction of Arrival (DOA) Technique Inspired by Human Ears, Proc. IEEE AP-S Intl Symp., vol. 1, pp. 1-4, San Diego, CA, Jul. 5-11, 2008.

Michelsen, Hearing and Sound Communication in Small Animals: Evolutionary Adaptations to the Laws of Physics, The Evolutionary Biology of Hearing, 1992, pp. 61-77, Springer, New York.

Behdad et al., Super-Resolving Biomimetic Electrically Small Antennas and Their Applications, Accepted to the 2010 Antenna Applications Symposium, Robert Allerton Park, Monticello, IL, Sep. 21-23, 2010.

Behdad et al., Biomimetic Electrically Small Antennas, 2010 IEEE International Conference on Wireless Information Technology and Systems, Honolulu, Hawaii, USA, Aug. 28-Sep. 3, 2010.

Miles et al., Mechanically Coupled Ears for Directional Hearing in the Parasitoid Fly Ormia Ochracea, J. Acoust. Soc. Am., vol. 98, pp. 3059-3070, Dec. 1995.

(Continued)

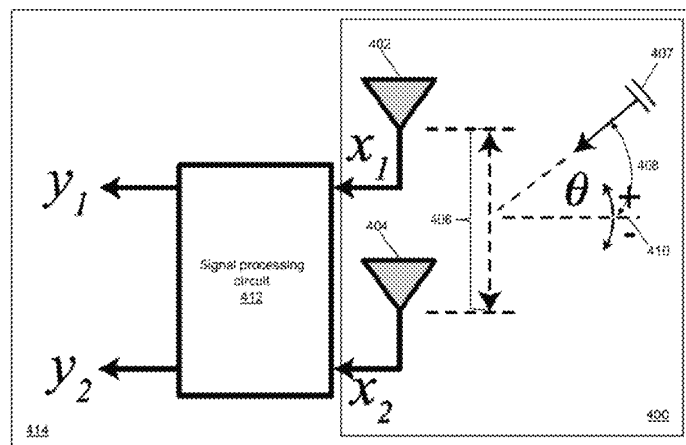
Primary Examiner — Dao Phan

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

(57) **ABSTRACT**

An electrically small receiver system is provided. The receiver system includes a plurality of antennas and a signal processing circuit. The plurality of antennas includes a first antenna configured to receive a first signal and a second antenna configured to receive a second signal. The signal processing circuit includes a first resonant loop and a second resonant loop. The first resonant loop is mounted to receive the first signal from the first antenna. The second resonant loop is mounted to receive the second signal from the second antenna. The first resonant loop and the second resonant loop are coupled such that the first output signal and the second output signal are generated as a function of the first signal and the second signal. A phase difference between the first output signal and the second output signal is greater than a phase difference between the first signal and the second signal.

20 Claims, 13 Drawing Sheets





US008362958B2

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

(10) **Patent No.:** **US 8,362,958 B2**
(45) **Date of Patent:** **Jan. 29, 2013**

(54) **APERTURE ANTENNA**

(75) Inventors: **Shih-Kai Lin**, Taipei (TW); **Bing-Syun Li**, Taipei (TW); **Yi-Cheng Lin**, Taipei (TW)

(73) Assignee: **National Taiwan University**, Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 758 days.

(56) **References Cited**

U.S. PATENT DOCUMENTS
6,762,729 B2 * 7/2004 Egashira 343/767
7,271,768 B2 * 9/2007 Chang et al. 343/700 MS
2007/0097009 A1 * 5/2007 Torres 343/795

* cited by examiner

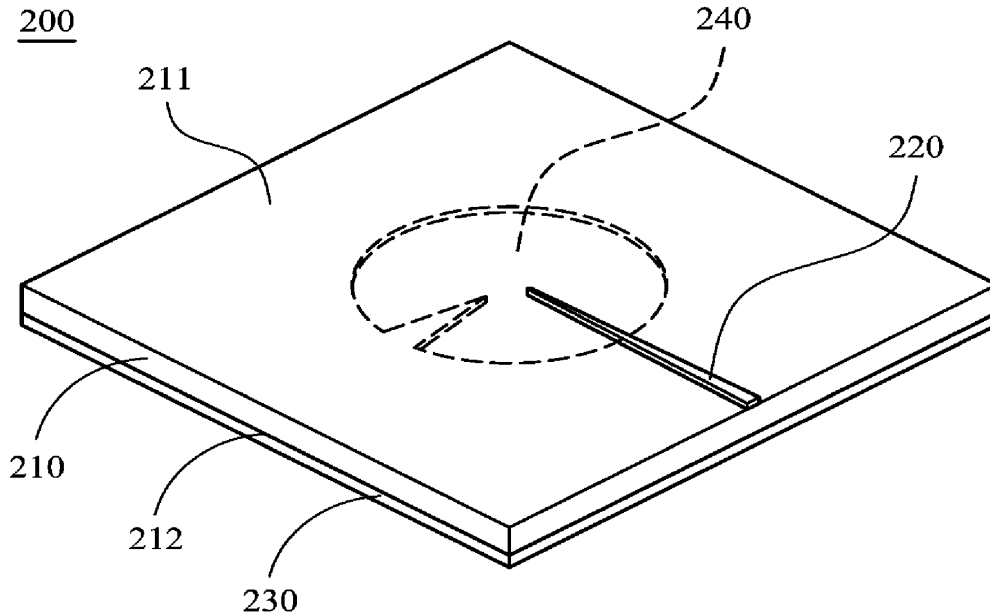
Primary Examiner — Jacob Y Choi
Assistant Examiner — Hasan Islam

(21) Appl. No.: **12/536,322**
(22) Filed: **Aug. 5, 2009**
(65) **Prior Publication Data**
US 2010/0194644 A1 Aug. 5, 2010
(30) **Foreign Application Priority Data**
Feb. 2, 2009 (TW) 98103203 A
(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 13/10 (2006.01)
(52) **U.S. Cl.** **343/700 MS; 343/767**
(58) **Field of Classification Search** **343/700 MS, 343/767**
See application file for complete search history.

(57) **ABSTRACT**

An aperture antenna for transmitting a circularly polarized signal is provided. The aperture antenna includes an antenna substrate, a feed conductor and an antenna ground layer. The feed conductor is microstrip-fed or coplanar-wave-guide-fed. The antenna ground layer has an aperture, the aperture has a feed portion, a signal turning point, a first edge and a second edge, the first edge connects the feed portion to the signal turning point in a first direction, and the second edge connects the feed portion to the signal turning point in a second direction, the first direction is opposite to the second direction. When the aperture antenna transmits the circularly polarized signal, a traveling wave travels on the first edge, and at least one standing wave is formed on the second edge.

11 Claims, 8 Drawing Sheets





US008362960B2

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

(10) **Patent No.:** **US 8,362,960 B2**
(45) **Date of Patent:** **Jan. 29, 2013**

(54) **HANDHELD DEVICE WITH TWO ANTENNAS, AND METHOD OF ENHANCING THE ISOLATION BETWEEN THE ANTENNAS**

(75) Inventors: **Josep Mumbru**, Barcelona (ES); **Jaume Anguera**, Castellon (ES); **Jordi Soler**, Girona (ES); **Carles Puente**, Barcelona (ES)

(73) Assignee: **Fractus, S.A.**, Barcelona (ES)

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

(21) Appl. No.: **13/341,051**

(22) Filed: **Dec. 30, 2011**

(65) **Prior Publication Data**
US 2012/0098719 A1 Apr. 26, 2012

Related U.S. Application Data
(63) Continuation of application No. 11/988,888, filed as application No. PCT/EP2006/007050 on Jul. 18, 2006, now Pat. No. 8,115,686.
(60) Provisional application No. 60/702,205, filed on Jul. 25, 2005.

(30) **Foreign Application Priority Data**
Jul. 21, 2005 (EP) 05106694

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

(52) **U.S. Cl.** **343/702; 343/846**

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

(58) **Field of Classification Search** **343/702, 343/700 MS, 846, 767, 848**

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,739,289	A	4/1988	Cripps
5,666,125	A	9/1997	Luxon
5,784,032	A	7/1998	Johnston
5,990,838	A	11/1999	Burns et al.
6,204,819	B1	3/2001	Hayes et al.
6,337,662	B1	1/2002	Cassel
6,424,300	B1	7/2002	Sanford
6,606,071	B2	8/2003	Cheng et al.
6,624,789	B1	9/2003	Kangasvieri et al.
6,985,108	B2	1/2006	Mikkola et al.
7,170,450	B2	1/2007	Chang

(Continued)

FOREIGN PATENT DOCUMENTS

EP	1401050	3/2004
EP	1445821	8/2004

(Continued)

OTHER PUBLICATIONS

FLOWS project—Antenna feasibility study on the printed antenna elements and the multiple input multiple output (MIMO) antenna topologies to be used in Flow mobile terminals, FLOWS project, Nov. 18, 2002.

(Continued)

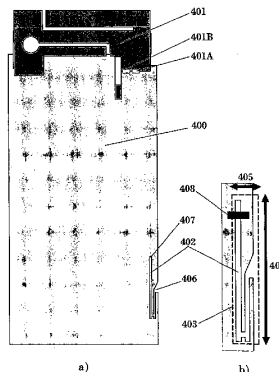
Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Winstead PC

(57) **ABSTRACT**

The invention relates to a handheld device comprising a first antenna (401, 701, 901, 931, 961, 1101, 1151, 1301, 1501) arranged to operate in at least a first frequency band, and a second antenna (402, 702, 902, 1102, 1302, 1502, 2210) arranged to operate in at least a second frequency band, wherein said second frequency band is different from said first frequency band. According to the invention, the second antenna comprises a slot antenna comprising at least one slot in at least one conductive layer. The invention also relates to enhancement of the isolation between first and second antennas in a handheld device.

20 Claims, 23 Drawing Sheets





US008362962B2

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

(10) **Patent No.:** **US 8,362,962 B2**
(45) **Date of Patent:** **Jan. 29, 2013**

(54) **ANTENNA AND METHOD FOR STEERING ANTENNA BEAM DIRECTION**

(56) **References Cited**

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

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

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

(21) Appl. No.: **13/029,564**

(22) Filed: **Feb. 17, 2011**

(65) **Prior Publication Data**

US 2011/0254748 A1 Oct. 20, 2011

Related U.S. Application Data

(63) Continuation of application No. 12/043,090, filed on Mar. 5, 2008, now Pat. No. 7,911,402.

(51) **Int. Cl.**
H01Q 9/38 (2006.01)

(52) **U.S. Cl.** **343/745**; 343/700 MS; 343/795; 343/815

(58) **Field of Classification Search** 343/700, 343/745, 795, 815

See application file for complete search history.

U.S. PATENT DOCUMENTS

3,971,031	A	7/1976	Burke	
5,235,343	A	8/1993	Audren	
5,568,155	A	10/1996	Tsunekawa	
5,598,169	A	1/1997	Drabek	
5,874,919	A	2/1999	Rawnick	
6,326,921	B1	12/2001	Egorov	
6,765,536	B2	7/2004	Phillips	
7,068,234	B2	6/2006	Sievenpiper	
7,081,854	B2*	7/2006	Ying et al.	343/702
7,132,989	B1*	11/2006	Poilasne	343/745
7,903,034	B2*	3/2011	Anguera et al.	343/702
2004/0027286	A1	2/2004	Poilasne	
2004/0227667	A1*	11/2004	Sievenpiper	343/700 MS
2005/0192727	A1	9/2005	Shostak	
2005/0275596	A1	12/2005	Harano	
2005/0285541	A1	12/2005	LeChevalier	
2006/0220966	A1	10/2006	Sarychev	
2007/0069958	A1	3/2007	Ozkar	
2007/0176824	A1	8/2007	Stumbo	
2008/0001829	A1	1/2008	Rahola	

* cited by examiner

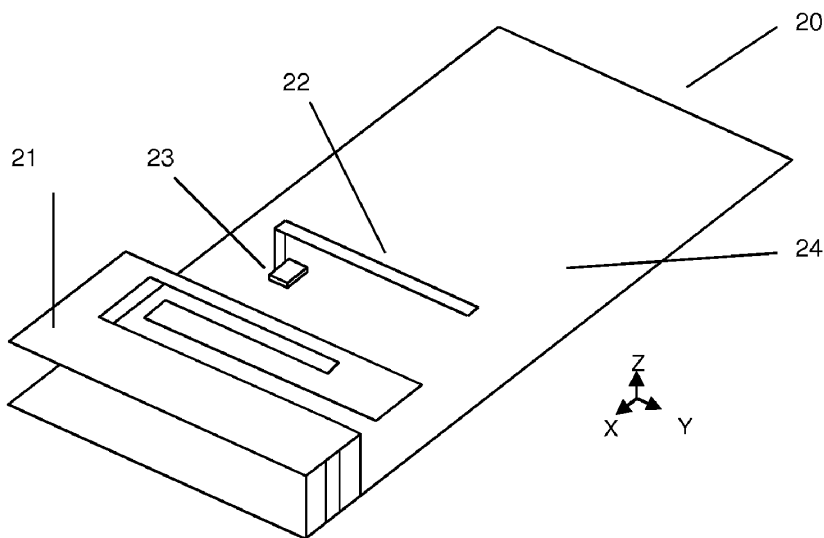
Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — Coastal Patent Agency; Joshua S. Schoonover

(57) **ABSTRACT**

An antenna comprising an IMD element, and one or more parasitic and active tuning elements is disclosed. The IMD element, when used in combination with the active tuning and parasitic elements, allows antenna operation at multiple resonant frequencies. In addition, the direction of antenna radiation pattern may be arbitrarily rotated in accordance with the parasitic and active tuning elements.

19 Claims, 13 Drawing Sheets





US008362968B2

(12) **United States Patent**
Fukuda

(10) **Patent No.:** **US 8,362,968 B2**
(45) **Date of Patent:** **Jan. 29, 2013**

(54) **ARRAY ANTENNA, RADIO COMMUNICATION APPARATUS, AND ARRAY ANTENNA CONTROL METHOD**

2005/0190110	A1	9/2005	Taromaru et al.	
2007/0040760	A1	2/2007	Nagaev et al.	
2008/0062049	A1*	3/2008	Soler Castany et al.	343/702
2010/0127951	A1*	5/2010	Robert et al.	343/876
2012/0046003	A1*	2/2012	Ying	455/90.2

(75) Inventor: **Junichi Fukuda**, Tokyo (JP)

(73) Assignee: **NEC Corporation**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 746 days.

(21) Appl. No.: **12/528,147**

(22) PCT Filed: **Dec. 11, 2007**

(86) PCT No.: **PCT/JP2007/073844**

§ 371 (c)(1),
(2), (4) Date: **Aug. 21, 2009**

(87) PCT Pub. No.: **WO2008/105126**

PCT Pub. Date: **Sep. 4, 2008**

(65) **Prior Publication Data**

US 2010/0117922 A1 May 13, 2010

(30) **Foreign Application Priority Data**

Feb. 28, 2007 (JP) 2007-050774

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

(52) **U.S. Cl.** **343/876; 343/702; 343/853**

(58) **Field of Classification Search** **343/702, 343/853, 876**

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,557,761	B2*	7/2009	Iwai et al.	343/702
8,098,756	B2*	1/2012	Yamamoto et al.	375/267
8,144,060	B2*	3/2012	Angell et al.	343/700 MS

FOREIGN PATENT DOCUMENTS

EP	1501211	A	1/2005
JP	2000252734	A	9/2000
JP	2001024431	A	1/2001
JP	2001036337	A	2/2001
JP	2001345633	A	12/2001
JP	2003258533	A	9/2003
JP	2004140815	A	5/2004
JP	2005136492	A	5/2005
JP	2006033305	A	2/2006

(Continued)

OTHER PUBLICATIONS

International Search Report for PCT/JP2007/073844 mailed Mar. 18, 2008.

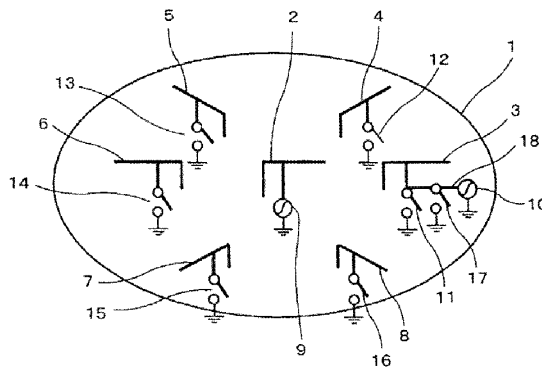
(Continued)

Primary Examiner — Tho G Phan

(57) **ABSTRACT**

An array antenna includes a group of antenna elements and a switching section. The group of antenna elements has a configuration in which a plurality of antenna elements is arranged. The switching section has a plurality of switch elements capable of individually switching the feeding points of the antenna elements included in the group of antenna elements. By switching of the switch elements, the group of antenna elements is converted into an antenna for MIMO communication to transmit and receive a plurality of signals in parallel, or into a directional array antenna to control the directivity towards the direction at which the signals arrive.

19 Claims, 6 Drawing Sheets





US008364212B2

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

(10) **Patent No.:** **US 8,364,212 B2**
(45) **Date of Patent:** ***Jan. 29, 2013**

- (54) **PORTABLE WIRELESS DEVICE**
- (75) Inventors: **Kenji Waku**, Kanagawa (JP); **Kunihiko Watanabe**, Kanagawa (JP); **Yasuhiro Abe**, Kanagawa (JP); **Tei Riku**, Kanagawa (JP)
- (73) Assignee: **Kyocera Corporation**, Kyoto (JP)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 587 days.

This patent is subject to a terminal disclaimer.

- (56) **References Cited**
- U.S. PATENT DOCUMENTS

7,268,731	B2 *	9/2007	Chiang et al.	343/702
7,991,147	B2 *	8/2011	Emmert	379/433.01
2002/0022459	A1 *	2/2002	Kobayashi	455/90
2009/0115668	A1 *	5/2009	Abe	343/702

- FOREIGN PATENT DOCUMENTS

JP	09-069798	3/1997
JP	11-274843	10/1999

- (Continued)

- (21) Appl. No.: **12/513,144**
- (22) PCT Filed: **Oct. 29, 2007**
- (86) PCT No.: **PCT/JP2007/071067**
§ 371 (c)(1),
(2), (4) Date: **Dec. 17, 2009**
- (87) PCT Pub. No.: **WO2008/053859**
PCT Pub. Date: **May 8, 2008**

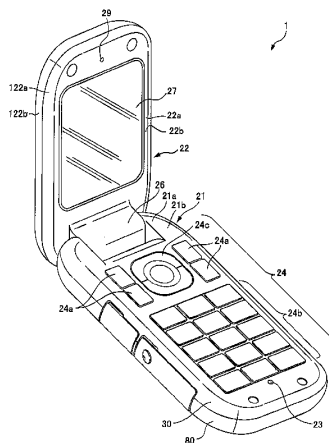
- OTHER PUBLICATIONS
- Japanese language office action dated May 8, 2012 and its English language translation issued in corresponding Japanese application 2006294691.
- Japanese language office action dated May 8, 2012 and its English language translation issued in corresponding Japanese application 2006294692.

Primary Examiner — Dominic E Rego
(74) *Attorney, Agent, or Firm* — DLA Piper (US) LLP

- (65) **Prior Publication Data**
US 2010/0093411 A1 Apr. 15, 2010
 - (30) **Foreign Application Priority Data**
Oct. 30, 2006 (JP) 2006-294691
Oct. 30, 2006 (JP) 2006-294692
 - (51) **Int. Cl.**
H04M 1/00 (2006.01)
 - (52) **U.S. Cl.** **455/575.1**; 455/347
 - (58) **Field of Classification Search** 455/347-349,
455/550.1, 575.1-575.8, 90.3; 361/616,
361/667, 724-727, 747, 769; 429/97, 100;
439/500; 403/166, 331
- See application file for complete search history.

- (57) **ABSTRACT**
- The present invention has an object of attaining further miniaturization and reducing the thickness of a portable wireless device with a built-in antenna. The cellular telephone device 1 according to the one embodiment of the present invention includes a case body 60 having a first case portion 62 which is arranged so as to cover the electronic components, along with being electrically conductive to the reference potential pattern, and a nonconductive second case portion 64 arranged to be continuous to the first case portion 62 along with being arranged in the outer periphery of the circuit substrate 70. In the portion that is arranged to be layered in the second case portion 64 in a flexible wiring substrate 50, an antenna element 66 is arranged.

12 Claims, 10 Drawing Sheets





US008368597B2

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

(10) **Patent No.:** **US 8,368,597 B2**
(45) **Date of Patent:** **Feb. 5, 2013**

(54) **ANTENNA PATTERN FRAME AND METHOD OF MANUFACTURING THE SAME**

(75) Inventors: **Jae Suk Sung**, Gyunggi-Do (KR); **Dae Seong Jeon**, Gyunggi-Do (KR); **Hyun Kil Nam**, Gyunggi-Do (KR); **Sung Eun Cho**, Gyunggi-Do (KR); **Tae Sung Kim**, Seoul (KR); **Chan Gwang An**, Gyunggi-Do (KR); **Hyun Do Park**, Gyunggi-Do (KR); **Chang Mok Han**, Chungcheongnam-Do (KR); **Byung Hwa Lee**, Gyunggi-Do (KR); **Jung Eun Noh**, Gyunggi-Do (KR)

(73) Assignee: **Samsung Electro-Mechanics Co., Ltd.**, Gyunggi-do (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 521 days.

(21) Appl. No.: **12/645,992**

(22) Filed: **Dec. 23, 2009**

(65) **Prior Publication Data**
US 2010/0271283 A1 Oct. 28, 2010

(30) **Foreign Application Priority Data**
Apr. 23, 2009 (KR) 10-2009-0035636

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
(52) **U.S. Cl.** **343/700 MS; 343/702; 29/600**
(58) **Field of Classification Search** **343/700 MS, 343/702; 29/600**
See application file for complete search history.

(56) **References Cited**
U.S. PATENT DOCUMENTS
6,285,324 B1 9/2001 Korisch et al.
6,396,444 B1 5/2002 Goward et al.

6,822,609 B2 * 11/2004 Mendolia et al. 343/700 MS
2003/0045324 A1 * 3/2003 Nagumo et al. 455/550
2007/0040755 A1 2/2007 Na et al.
2008/0278401 A1 11/2008 Yu
2009/0015507 A1 1/2009 Hong et al.

(Continued)

FOREIGN PATENT DOCUMENTS

DE 102006033192 A1 3/2007
DE 102008031934 A1 1/2009

(Continued)

OTHER PUBLICATIONS

JP Office Action 2009-295743 dated Sep. 13, 2011.

(Continued)

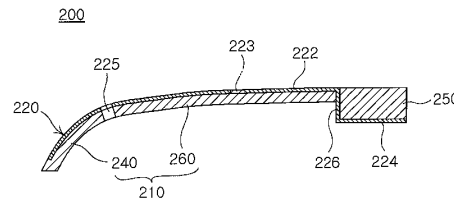
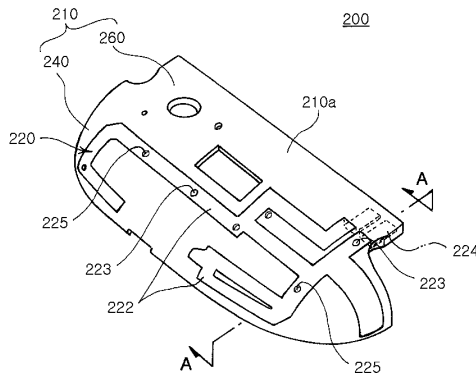
Primary Examiner — Tan Ho

(74) *Attorney, Agent, or Firm* — Lowe Hauptman Ham & Berner LLP

(57) **ABSTRACT**

An antenna pattern frame according to an aspect of the invention may include: a radiator having an antenna pattern portion transmitting and receiving a signal and a connection terminal portion allowing the signal to be transmitted to and received from a circuit board of an electronic device; a connection portion partially forming the radiator and connecting the antenna pattern portion and the connection terminal portion to be arranged in different planes; a radiator frame manufactured by injection molding on the radiator so that the antenna pattern portion may be provided on one side of the radiator frame and the connection terminal portion may be provided on the other side thereof, while the antenna pattern portion is embedded in the electronic device case; and a contact surface extension provided on the radiator to prevent the radiator from being loosened from the radiator frame during injection molding of the radiator frame, and increasing a contact area with respect to the radiator frame.

18 Claims, 19 Drawing Sheets





US008368598B2

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

(10) **Patent No.:** **US 8,368,598 B2**
(45) **Date of Patent:** **Feb. 5, 2013**

(54) **MULTIBAND ANTENNA**

(75) Inventors: **Chang-Hsin Kuo**, Tu-Cheng (TW);
Shih-Tsung Kan, Tu-Cheng (TW)

(73) Assignee: **Chi Mei 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 368 days.

(21) Appl. No.: **12/784,504**

(22) Filed: **May 21, 2010**

(65) **Prior Publication Data**
US 2011/0193748 A1 Aug. 11, 2011

(30) **Foreign Application Priority Data**
Feb. 5, 2010 (TW) 99103514

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
(52) **U.S. Cl.** **343/700 MS; 343/702**
(58) **Field of Classification Search** **343/700 MS, 343/702**
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS
7,362,277 B2 * 4/2008 Su 343/702
8,188,925 B2 * 5/2012 DeJean 343/700 MS
2002/0175866 A1 * 11/2002 Gram 343/702
2007/0247372 A1 * 10/2007 Huang 343/700 MS

* cited by examiner

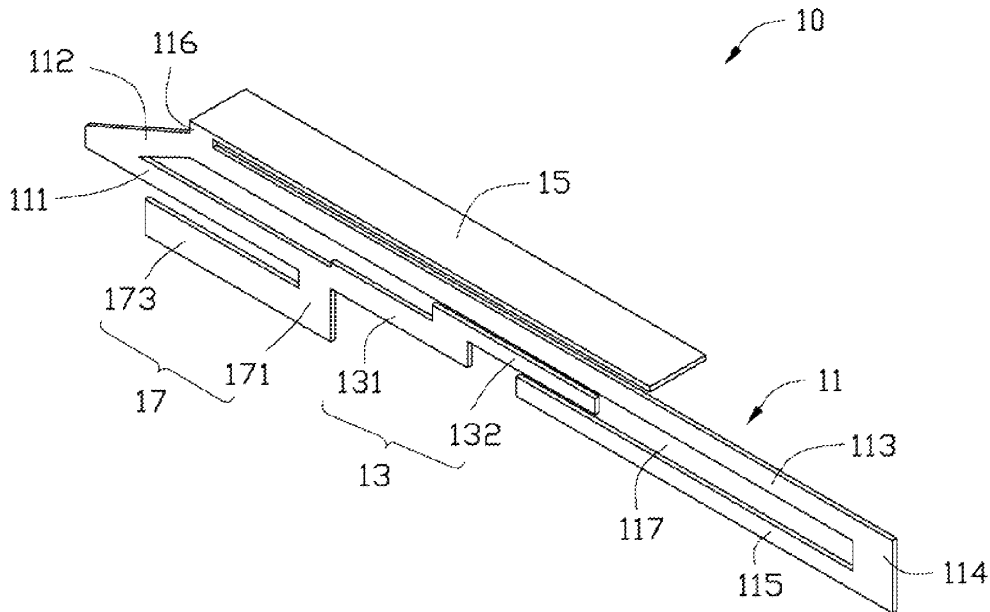
Primary Examiner — Tan Ho

(74) *Attorney, Agent, or Firm* — Altis Law Group, Inc.

(57) **ABSTRACT**

A multiband antenna used for a portable communication device includes a first antenna unit, a second antenna unit, a third antenna unit, and feed member. The first antenna unit, the second antenna unit and the third antenna unit are capable of receiving and/or sending wireless signals. The second antenna unit is connected to the first antenna unit, the third antenna unit is connected to the first antenna unit, and the feed member is electrically connected to the first antenna unit and the second antenna unit. The feed member receives wireless signals and transmits the wireless signals through the first antenna, the second antenna unit and the third antenna unit to generate corresponding current paths, and the first antenna unit is located between the second antenna unit and the third antenna unit to isolate the second antenna unit and the third antenna unit to avoid coupling interference of their resonant frequencies.

18 Claims, 3 Drawing Sheets





US008368599B2

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

(10) **Patent No.:** **US 8,368,599 B2**
(45) **Date of Patent:** **Feb. 5, 2013**

(54) **SIMPLY FABRICABLE SMALL ZERO-ORDER RESONANT ANTENNA WITH EXTENDED BANDWIDTH AND HIGH EFFICIENCY**

(58) **Field of Classification Search** 343/702, 343/749, 750, 700 MS
See application file for complete search history.

(75) Inventors: **Sungjoon Lim**, Gyeonggi-Do (KR);
Taehee Jang, Gyeonggi-Do (KR)

(56) **References Cited**

U.S. PATENT DOCUMENTS

(73) Assignee: **Chung-Ang University Industry-Academy Cooperation Foundation**, Seoul (KR)

2008/0143607 A1* 6/2008 Jung et al. 343/700 MS
2010/0214180 A1* 8/2010 Krogerus 343/702
2012/0032862 A1* 2/2012 Ying 343/749

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 336 days.

* cited by examiner

Primary Examiner — Don Le

(74) *Attorney, Agent, or Firm* — Ladas & Parry LLP

(21) Appl. No.: **12/807,176**

(57) **ABSTRACT**

(22) Filed: **Aug. 30, 2010**

Provided is a simply fabricable small zeroth-order resonant antenna with extended bandwidth and high efficiency. The zeroth-order resonant antenna includes a feeding patch, a transmission line, and a pair of ground patches. The feeding patch is disposed on a top surface of a substrate having a mono-layer structure, and is configured to receive a signal from the outside. The transmission line includes a unit cell disposed on the top surface of the substrate and is configured to transmit a signal delivered from the feeding patch. The pair of ground patches is longitudinally disposed on the top surface of the substrate in the same direction as a longitudinal direction of the transmission line around the transmission line. The unit cell includes an upper patch and an inductor unit. The upper patch is disposed on the top surface of the substrate and is configured to receive a signal.

(65) **Prior Publication Data**

US 2011/0050505 A1 Mar. 3, 2011

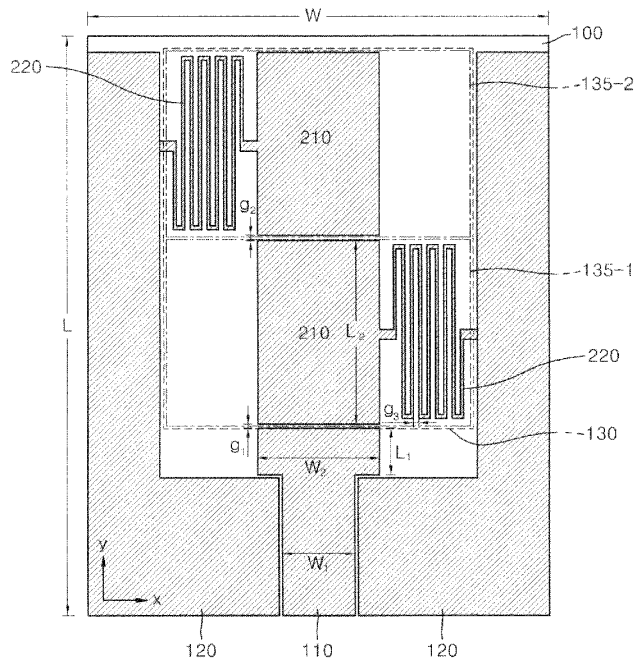
(30) **Foreign Application Priority Data**

Sep. 1, 2009 (KR) 10-2009-0081727

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

(52) **U.S. Cl.** 343/700 MS; 343/749

20 Claims, 23 Drawing Sheets





US008368600B2

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

(10) **Patent No.:** **US 8,368,600 B2**
(45) **Date of Patent:** **Feb. 5, 2013**

(54) **DUAL-BAND ANTENNA AND WIRELESS NETWORK DEVICE HAVING THE SAME**

(75) Inventors: **Yu-Jen Wang**, Taipei (TW); **Wei-Bin Lee**, Taipei (TW)

(73) Assignee: **Cameo Communications Inc** (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 346 days.

(21) Appl. No.: **12/807,601**

(22) Filed: **Sep. 8, 2010**

(65) **Prior Publication Data**

US 2011/0001669 A1 Jan. 6, 2011

(30) **Foreign Application Priority Data**

Jun. 9, 2010 (TW) 99210940 U

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

(52) **U.S. Cl.** **343/700 MS; 343/702**

(58) **Field of Classification Search** **343/700 MS, 343/702**

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,639,558 B2 * 10/2003 Kellerman et al. 343/700 MS
6,982,672 B2 * 1/2006 Lin et al. 343/700 MS

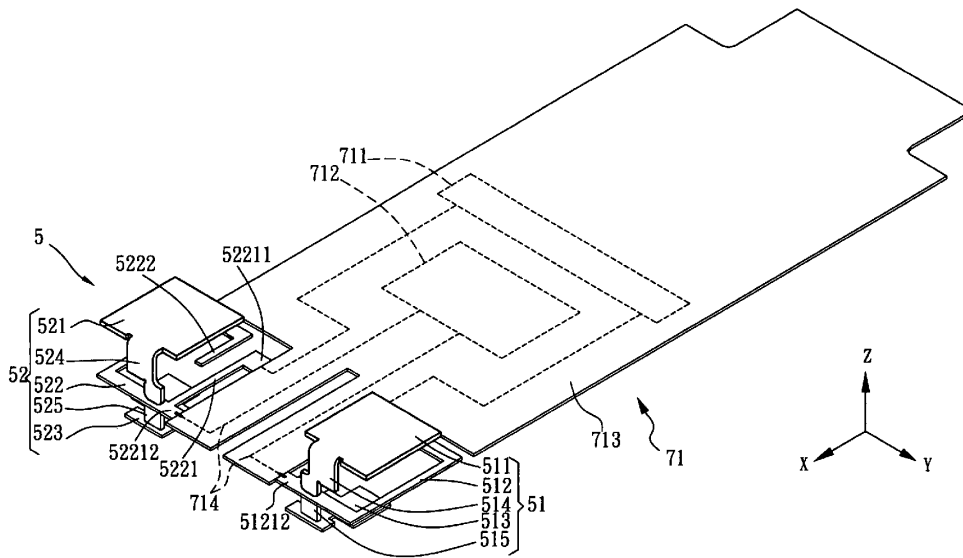
* cited by examiner

Primary Examiner — Hoang V Nguyen

(57) **ABSTRACT**

A dual-band antenna for use in a wireless network device comprises first, second, and third radiators. The first and second radiators are connected by a stand portion. The second radiator is a generally C-shaped plate having a connecting section and a free-end portion. A ground end and an input end are provided at predetermined positions of the connecting section and are respectively and electrically connected to a grounding portion and a control circuit of a substrate. The free-end portion overlaps with the orthogonal projection of the first radiator and is parallel to the first radiator. The third radiator is electrically connected to the second radiator via a conductive post and is parallel to the second radiator. The second and third radiators are provided on the substrate while the first radiator is provided outside the substrate. The first, second, and third radiators are parallel to and spaced apart from one another.

10 Claims, 12 Drawing Sheets





US008368601B2

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

(10) **Patent No.:** **US 8,368,601 B2**
(45) **Date of Patent:** **Feb. 5, 2013**

(54) **MULTIPROTOCOL ANTENNA STRUCTURE AND METHOD FOR SYNTHESIZING A MULTIPROTOCOL ANTENNA PATTERN**

(75) Inventors: **Seong-Youp Suh**, San Jose, CA (US); **Salih Yarga**, Columbus, OH (US); **Anand S Konanur**, Sunnyvale, CA (US); **Songnan Yang**, San Jose, CA (US); **Ulun Karacaoglu**, San Diego, CA (US)

(73) Assignee: **Intel Corporation**, Santa Clara, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 536 days.

(21) Appl. No.: **12/536,132**

(22) Filed: **Aug. 5, 2009**

(65) **Prior Publication Data**

US 2011/0032157 A1 Feb. 10, 2011

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

(52) **U.S. Cl.** **343/702; 343/700 MS**

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,418,543 A 5/1995 Bolton
7,095,374 B2 8/2006 Chen et al.
7,864,116 B2 1/2011 Kurashima et al.
8,059,039 B2* 11/2011 Ayala Vazquez et al. 343/702
2004/0196187 A1 10/2004 Yeh

2006/0066487 A1 3/2006 Park et al.
2008/0287171 A1 11/2008 Qi et al.
2009/0174608 A1 7/2009 Park et al.
2010/0060526 A1* 3/2010 Cheng 343/700 MS
2010/0201578 A1* 8/2010 Parsche 343/700 MS
2011/0025566 A1 2/2011 Suh et al.

FOREIGN PATENT DOCUMENTS

EP 100909656 B1 7/2009
WO WO-2011014378 A2 2/2011
WO WO-2011016976 A2 2/2011

OTHER PUBLICATIONS

"International Application Serial No. PCT/US2010/042396 , Search Report and Written Opinion mailed Feb. 24, 2011", 5 pgs.

(Continued)

Primary Examiner — Jacob Y Choi

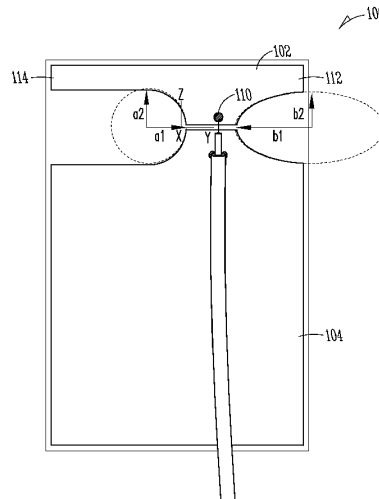
Assistant Examiner — Hasan Islam

(74) *Attorney, Agent, or Firm* — Schwegman, Lundberg & Woessner, P.A.; Gregory J. Gorrie

(57) **ABSTRACT**

Embodiments of a planar asymmetric antenna structure with shifted feed position for multi-protocol operations are disclosed. The antenna structure includes two elliptically tapering right and left arms, each with a different radius, and an off-center feed point positioned between the right and left arms. One arm has a smaller elliptical tapering than the other arm and the feed point is positioned closer to one arm than the other arm. A method of synthesizing a multiprotocol antenna pattern is also disclosed. The method includes providing substantially equally surface currents on both arms of an antenna structure to generate a near-horizontal pattern in far-field at a lower frequency band, providing greater surface currents on the right arm to generate a far-field pattern with a large horizontal component at a higher frequency band, and providing greater surface currents on the left arm to generate an asymmetric far-field pattern at a middle frequency band.

18 Claims, 8 Drawing Sheets





US008368602B2

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

(10) **Patent No.:** **US 8,368,602 B2**
(45) **Date of Patent:** **Feb. 5, 2013**

(54) **PARALLEL-FED EQUAL CURRENT DENSITY
DIPOLE ANTENNA**

(75) Inventors: **Robert J. Hill**, Salinas, 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 315 days.

(21) Appl. No.: **12/793,641**

(22) Filed: **Jun. 3, 2010**

(65) **Prior Publication Data**
US 2011/0300907 A1 Dec. 8, 2011

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 13/10 (2006.01)
(52) **U.S. Cl.** **343/702; 343/767**
(58) **Field of Classification Search** **343/702, 343/767, 768, 700 MS, 846**
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,130,822 A	12/1978	Conroy
4,590,614 A	5/1986	Erat
4,682,180 A	7/1987	Gans
4,853,704 A	8/1989	Diaz et al.
4,873,529 A	10/1989	Gibson
4,876,552 A	10/1989	Zakman
4,903,326 A	2/1990	Zakman et al.
5,274,391 A	12/1993	Connolly
5,568,159 A	10/1996	Pelton et al.
5,581,266 A	12/1996	Peng et al.
5,966,101 A	10/1999	Haub et al.
6,054,952 A	4/2000	Shen et al.

6,057,804 A	5/2000	Kaegebein
6,266,538 B1	7/2001	Waldron
6,281,850 B1	8/2001	Klostermann
6,292,153 B1	9/2001	Aiello et al.
6,452,552 B1	9/2002	Ishitobi et al.
6,466,176 B1	10/2002	Maoz et al.

(Continued)

FOREIGN PATENT DOCUMENTS

EP	1 351 334	10/2003
EP	1 401 050	3/2004

(Continued)

OTHER PUBLICATIONS

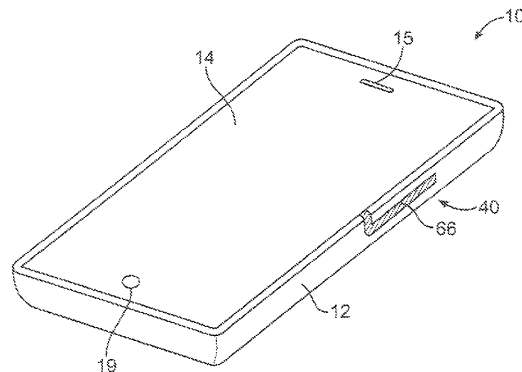
G. Lee et al. "Size reduction of microstrip-fed slot antenna by inductive and capacitive loading", Jun. 2003 IEEE Antennas and Propagation Society International Symposium, pp. 312-315.

Primary Examiner — Hoang V Nguyen
(74) *Attorney, Agent, or Firm* — Treyz Law Group; G. Victor Treyz; Chih-Yun Wu

(57) **ABSTRACT**

Electronic devices such as handheld devices may have wireless communications circuitry. The wireless communications circuitry may include a broadband antenna and circuitry that covers multiple communications bands. The broadband antenna may be formed from a parallel-fed dipole. The antenna may have first and second antenna resonating element regions on opposing sides of a slot. The slot may be an open slot that has one open end and one closed end. The slot may be formed from an opening in conductive housing structures in a conductive housing for an electronic device. The conductive housing structures may include sidewall structures, rear housing wall structures, and other conductive structures. The antenna may have a feed with a feed line that crosses the slot. An interposed dielectric substrate member may separate the feed line from the conductive structures. The feed line may have sections with different widths to minimize feed line length.

19 Claims, 20 Drawing Sheets





US008368612B2

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

(10) **Patent No.:** **US 8,368,612 B2**
(45) **Date of Patent:** **Feb. 5, 2013**

(54) **EMBEDDED ANTENNA APPARATUS**

(56) **References Cited**

(75) Inventors: **Sang Jin Eom**, Incheon (KR); **Austin Kim**, Seongnam-si (KR); **Young Eil Kim**, Suwon-si (KR); **Jun Seok Yang**, Seoul (KR)

U.S. PATENT DOCUMENTS

2003/0174092	A1 *	9/2003	Sullivan et al.	343/702
2008/0079642	A1 *	4/2008	Ishizuka et al.	343/702
2008/0129612	A1 *	6/2008	Wang et al.	343/702
2009/0002243	A1 *	1/2009	Dahlstrom et al.	343/702
2009/0262028	A1 *	10/2009	Mumburu et al.	343/702
2009/0275370	A1 *	11/2009	Schlub et al.	455/575.7
2009/0303140	A1 *	12/2009	Sato et al.	343/702
2011/0273343	A1 *	11/2011	Qi et al.	343/702

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

* cited by examiner

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 364 days.

Primary Examiner — Huedung Mancuso

(74) Attorney, Agent, or Firm — The Farrell Law Firm, P.C.

(21) Appl. No.: **12/765,392**

(22) Filed: **Apr. 22, 2010**

(57) **ABSTRACT**

(65) **Prior Publication Data**

US 2010/0271282 A1 Oct. 28, 2010

An embedded antenna apparatus of a communication terminal is provided. The antenna apparatus includes a plate board having a feeding pad disposed on a side of the board; a device carrier mounted on a side of the board to expose the feeding pad; a radiation device including at least two radiation lines extending from the feeding pad to a surface of the device carrier along different paths, the at least two radiation lines radiating at a preset frequency band when electric power is fed through the feeding pad; and a ground plate having a flat plate shape mounted in an edge of the side of the board and disposed perpendicular to the side of the board, and contacting one end each of the at least two radiation lines to ground the radiation device.

(30) **Foreign Application Priority Data**

Apr. 22, 2009 (KR) 10-2009-0035085

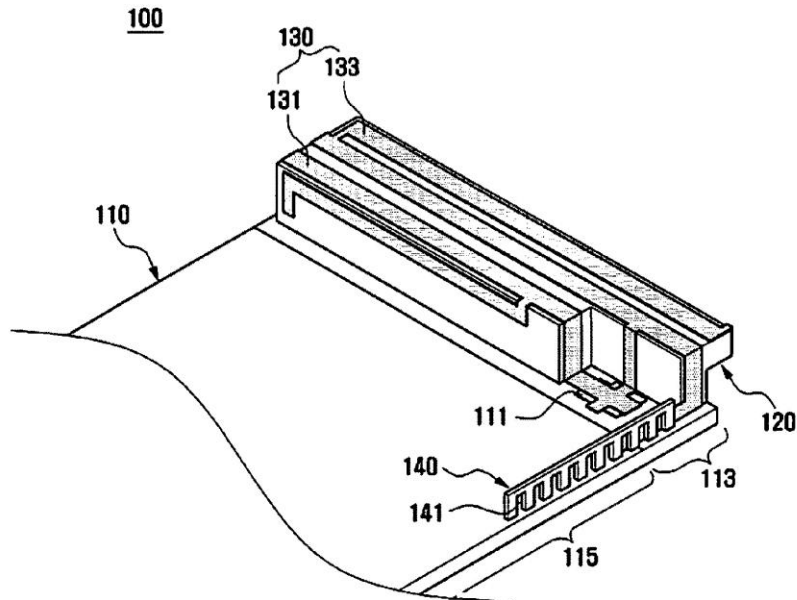
10 Claims, 11 Drawing Sheets

(51) **Int. Cl.**
H01Q 1/40 (2006.01)

(52) **U.S. Cl.** **343/873**

(58) **Field of Classification Search** **343/873,**
343/702, 700 MS

See application file for complete search history.





US008368613B2

(12) **United States Patent**
Hornung

(10) **Patent No.:** **US 8,368,613 B2**
(45) **Date of Patent:** **Feb. 5, 2013**

- (54) **WIRELESS COMMUNICATION SYSTEM**
- (75) Inventor: **Craig Warren Hornung**, Harrisburg, PA (US)
- (73) Assignee: **Tyco Electronics Corporation**, Berwyn, PA (US)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 457 days.

- (21) Appl. No.: **12/776,790**
- (22) Filed: **May 10, 2010**
- (65) **Prior Publication Data**
US 2011/0273339 A1 Nov. 10, 2011

- (51) **Int. Cl.**
H01Q 1/50 (2006.01)
 - (52) **U.S. Cl.** **343/906; 343/702**
 - (58) **Field of Classification Search** 343/906,
343/702; 439/63, 581, 98
- See application file for complete search history.

(56) **References Cited**

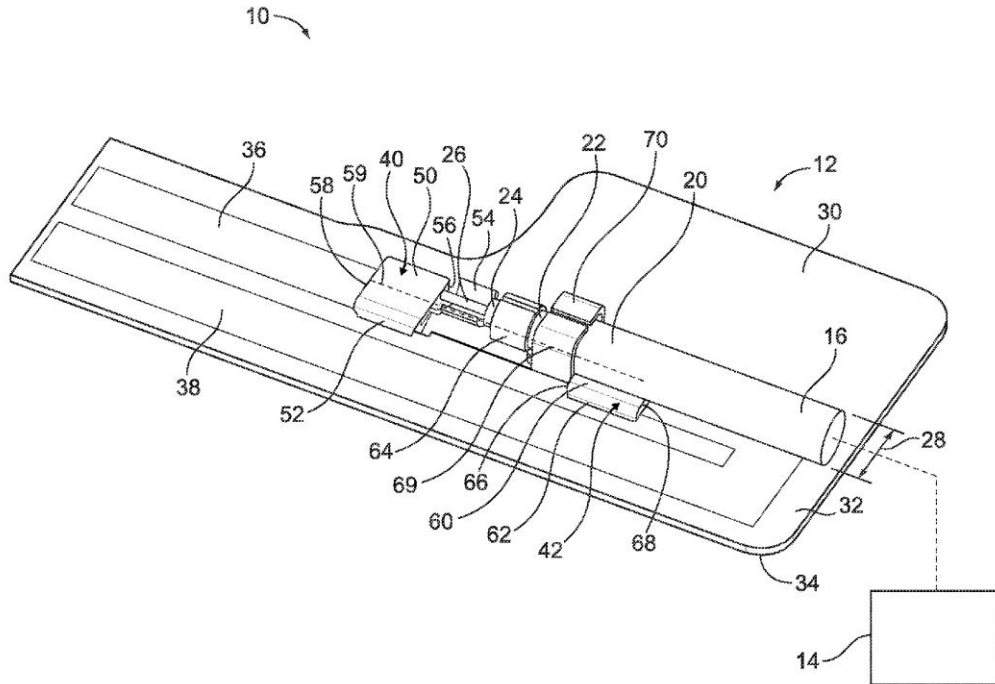
U.S. PATENT DOCUMENTS

5,738,529 A *	4/1998	Wedell et al.	439/63
7,198,509 B2	4/2007	Takasu	
7,782,273 B2 *	8/2010	Morikawa	343/906
8,242,969 B2 *	8/2012	Lutman et al.	343/906
2008/0143635 A1 *	6/2008	Lin et al.	343/906
2008/0246691 A1 *	10/2008	Yoshie	343/906

* cited by examiner
Primary Examiner — Dieu H Duong

(57) **ABSTRACT**
An antenna includes a flexible film substrate having a signal element and a ground element. A signal contact is mounted to the flexible film substrate. The signal contact is electrically connected to the signal element by a compression connection and the signal contact includes a wire termination configured to be terminated to a center conductor of a coaxial cable. A ground contact is mounted to the flexible film substrate. The ground contact is electrically connected to the ground element by a compression connection and includes a wire termination configured to be terminated to a cable braid of the coaxial cable.

20 Claims, 5 Drawing Sheets





US008369796B2

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

(10) **Patent No.:** **US 8,369,796 B2**
(45) **Date of Patent:** **Feb. 5, 2013**

(54) **MULTI-BAND TUNABLE FREQUENCY RECONFIGURABLE ANTENNAS USING HIGHER ORDER RESONANCES**

(75) Inventors: **Helen K. Pan**, Portland, OR (US);
Songnan Yang, Knoxville, TN (US);
Debabani Choudhury, Thousand Oaks, CA (US); **Vijay K. Nair**, Mesa, AZ (US)

(73) Assignee: **Intel Corporation**, Santa Clara, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1268 days.

(21) Appl. No.: **11/644,741**

(22) Filed: **Dec. 22, 2006**

(65) **Prior Publication Data**

US 2008/0150830 A1 Jun. 26, 2008

(51) **Int. Cl.**
H04B 1/44 (2006.01)

(52) **U.S. Cl.** **455/78**; 455/575.7; 455/552.1; 455/82; 455/121; 455/115.1; 455/123; 455/226.1; 455/101; 455/277.2; 455/83; 343/702; 343/876; 343/846; 343/810; 343/818

(58) **Field of Classification Search** 455/78, 455/575.7, 552.1, 82, 83, 121, 115.1, 123, 455/226.1, 101, 277.2; 343/876, 702, 700, 343/846, 810, 818

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,021,317 A * 2/2000 Irvin 455/78
6,061,024 A * 5/2000 McGirr et al. 343/700 MS

6,166,694	A *	12/2000	Ying	343/700	MS
6,204,819	B1	3/2001	Hayes et al.		
6,529,749	B1 *	3/2003	Hayes et al.	455/575.7	
6,662,028	B1	12/2003	Hayes et al.		
6,950,065	B2 *	9/2005	Ying et al.	343/700	MS
7,136,020	B2	11/2006	Yamaki		
7,180,465	B2 *	2/2007	Lynch et al.	343/833	
7,276,990	B2 *	10/2007	Sievenpiper	333/101	
7,292,201	B2 *	11/2007	Nagaev et al.	343/818	
7,321,335	B2 *	1/2008	Egorov et al.	343/702	
7,411,554	B2 *	8/2008	Jung et al.	343/700	MS
2003/0219035	A1 *	11/2003	Schmidt	370/478	
2004/0135649	A1	7/2004	Sievenpiper		
2006/0001123	A1 *	1/2006	Heck et al.	257/528	
2006/0097918	A1	5/2006	Oshiyama et al.		
2007/0273606	A1 *	11/2007	Mak et al.	343/876	

FOREIGN PATENT DOCUMENTS

JP	2003258523	9/2003
JP	2006054639	2/2006
JP	2006-086630 A	3/2006
JP	2007520955	7/2007
KR	1020060096693	9/2006
WO	2004047223	6/2004

OTHER PUBLICATIONS

Japan Office Action Patent Application No. 2009-542779, mailing date Feb. 14, 2012, 4 pages.

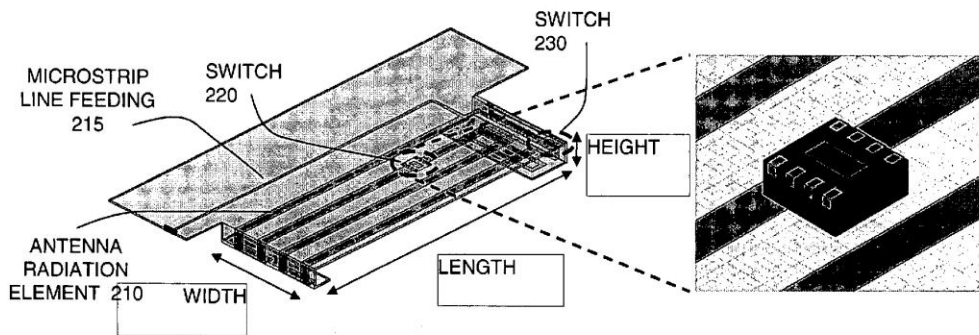
* cited by examiner

Primary Examiner — Matthew Anderson
Assistant Examiner — Ganiyu A Hanidu
(74) *Attorney, Agent, or Firm* — Kacvinsky Daisak PLLC

(57) **ABSTRACT**

A wireless device using natural higher order harmonics on multi-band reconfigurable antenna designs where the antenna higher order resonance is used to build a multi-band to multi-band frequency reconfigurable antenna.

14 Claims, 8 Drawing Sheets



200



US008373597B2

(12) **United States Patent**
Schadler

(10) **Patent No.:** **US 8,373,597 B2**
(45) **Date of Patent:** **Feb. 12, 2013**

(54) **HIGH-POWER-CAPABLE CIRCULARLY POLARIZED PATCH ANTENNA APPARATUS AND METHOD**

(75) Inventor: **John L. Schadler**, Raymond, ME (US)

(73) Assignee: **SPX Corporation**, Charlotte, NC (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 938 days.

(21) Appl. No.: **11/882,383**

(22) Filed: **Aug. 1, 2007**

(65) **Prior Publication Data**
US 2008/0036665 A1 Feb. 14, 2008

Related U.S. Application Data

(60) Provisional application No. 60/836,398, filed on Aug. 9, 2006.

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

(52) **U.S. Cl.** **343/700 MS; 343/833**

(58) **Field of Classification Search** **343/700 MS, 343/846, 833, 834, 835, 829, 830, 826, 844**
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,367,474 A * 1/1983 Schaubert et al. 343/700 MS
6,067,053 A * 5/2000 Runyon et al. 343/797

6,239,750 B1 * 5/2001 Snygg 343/700 MS
6,396,442 B1 * 5/2002 Kawahata et al. 343/700 MS
6,462,710 B1 * 10/2002 Carson et al. 343/700 MS
6,806,845 B2 * 10/2004 Fund et al. 343/853
6,943,737 B2 * 9/2005 Ryken et al. 343/700 MS
6,989,793 B2 1/2006 Van Der Poel
7,209,080 B2 * 4/2007 Crouch et al. 343/700 MS
2004/0145526 A1 * 7/2004 Puente Baliarda et al. ... 343/700 MS

OTHER PUBLICATIONS

Richard C. Johnson, ed., *Antenna Engineering Handbook*, Third Edition, 1993, pp. 28.21-28.24, McGraw-Hill, Inc.

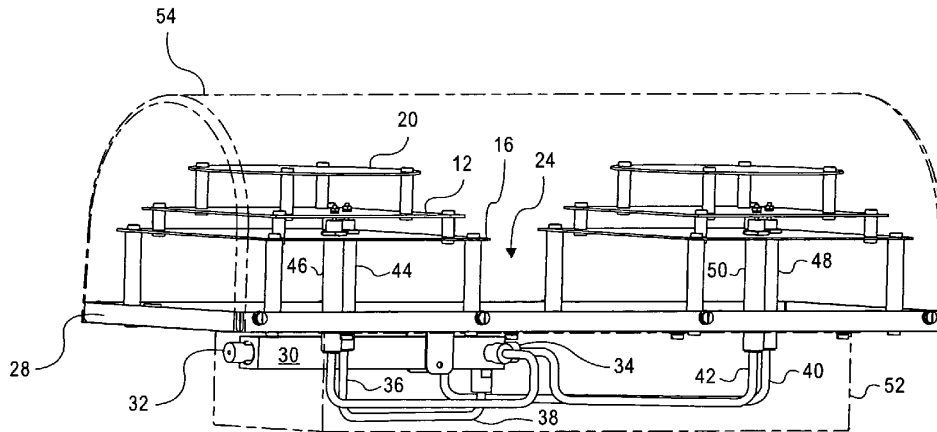
* cited by examiner

Primary Examiner — Robert Karacsony
(74) *Attorney, Agent, or Firm* — Baker & Hostetler, LLP

(57) **ABSTRACT**

A circularly polarized patch antenna uses a square quarter-wavelength conductive plate, spaced away from a slightly larger backing conductor. Excitation uses a coaxial feed stem pair, whereof respective inner conductors join the patch at orthogonal locations on a reference circle, and outer conductors intrude past points of joining to the backing conductor to establish gaps that interact with patch and backing conductor size and spacing to jointly establish terminal impedance. A parasitic element in the propagation path broadens bandwidth, while a frame behind serves to define a cavity reflector. A power divider behind the frame converts a single applied broadcast signal into two equal signals with orthogonal phase, which signals are delivered to the feed stems with equal-length coaxial lines.

11 Claims, 8 Drawing Sheets





US008373598B2

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

(10) **Patent No.:** **US 8,373,598 B2**
(45) **Date of Patent:** **Feb. 12, 2013**

(54) **ANTENNA DEVICE AND DUAL-BAND ANTENNA**

(75) Inventors: **Tiao-Hsing Tsai**, Yunghe (TW);
Chieh-Ping Chiu, Erlun Township,
Yunlin County (TW); **I-Ping Yen**,
Yonghe (TW); **Feng-Jen Weng**, Tao
Yuan Shien (TW)

(73) Assignee: **Quanta Computer, Inc.**, Tao Yuan Shien
(TW)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 448 days.

(21) Appl. No.: **12/709,785**

(22) Filed: **Feb. 22, 2010**

(65) **Prior Publication Data**

US 2011/0084889 A1 Apr. 14, 2011

(30) **Foreign Application Priority Data**

Oct. 8, 2009 (TW) 98134112 A

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

(52) **U.S. Cl.** **343/700 MS**; 343/702; 343/846

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,950,065	B2 *	9/2005	Ying et al.	343/700 MS
7,541,984	B2 *	6/2009	Peng et al.	343/700 MS
7,728,783	B2 *	6/2010	Su et al.	343/846
7,868,831	B2 *	1/2011	Hung et al.	343/700 MS
7,928,916	B2 *	4/2011	Hung et al.	343/702
8,284,106	B2 *	10/2012	Guan	343/700 MS
2004/0090377	A1 *	5/2004	Dai et al.	343/700 MS
2011/0032170	A1 *	2/2011	Chiang et al.	343/860

* cited by examiner

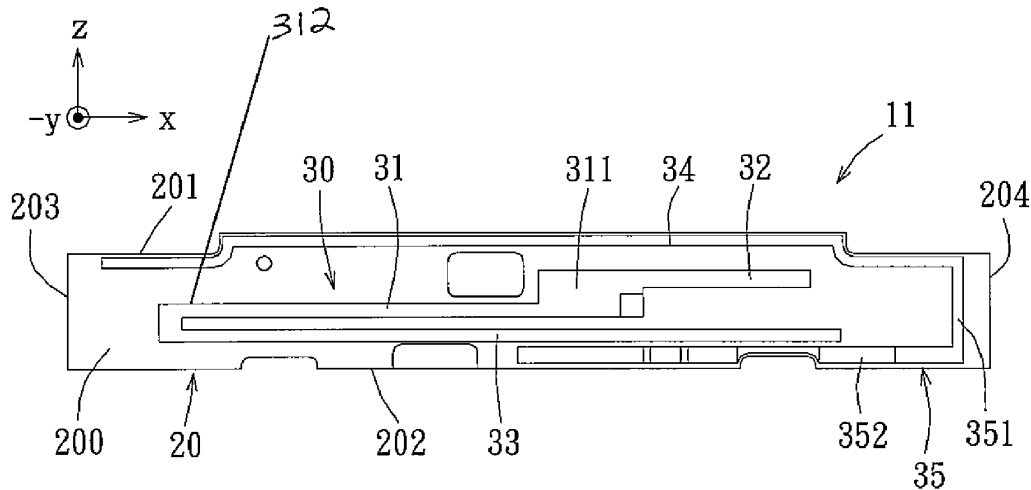
Primary Examiner — Trinh Dinh

(74) *Attorney, Agent, or Firm* — Berenato & White, LLC

(57) **ABSTRACT**

An antenna device includes a substrate, and a dual-band antenna disposed on a surface of the substrate. The dual-band antenna includes a feed-in section, a first radiator arm, a second radiator arm, a third radiator arm, and a ground section. The feed-in section is for signal feed-in, and has opposite first and second ends. The first radiator arm extends from the first end of the feed-in section and is parallel to the feed-in section. The second radiator arm is connected to the second end of the feed-in section and extends parallel to the feed-in section. The third radiator arm is disposed adjacent to and extends parallel to the first radiator arm in a manner that the feed-in section is disposed between the third radiator arm and the second radiator arm. The ground section is connected to the third radiator arm.

13 Claims, 8 Drawing Sheets





US008373599B2

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

(10) **Patent No.:** **US 8,373,599 B2**
(45) **Date of Patent:** **Feb. 12, 2013**

(54) **ANTENNA MODULE, WIRELESS COMMUNICATION DEVICE USING THE ANTENNA MODULE AND METHOD FOR ADJUSTING A PERFORMANCE FACTOR OF THE ANTENNA MODULE**

(52) **U.S. Cl.** **343/700 MS; 343/702 MS**
(58) **Field of Classification Search** 343/700 MS, 343/702, 893
See application file for complete search history.

(75) Inventors: **Shih-Chieh Lin**, Taoyuan (TW);
Chin-Hung Ma, Taoyuan (TW)

(56) **References Cited**

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

U.S. PATENT DOCUMENTS

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 408 days.

6,567,048 B2 * 5/2003 McKinzie et al. 343/700 MS
6,724,345 B2 * 4/2004 Tran 343/700 MS
2003/0020655 A1 * 1/2003 McKinzie et al. 343/700 MS
2003/0197646 A1 * 10/2003 Tran 343/700 MS
2004/0027291 A1 * 2/2004 Zhang et al. 343/700 MS
2006/0092079 A1 * 5/2006 de Rochemont 343/700 MS
2012/0154234 A1 * 6/2012 Geiler et al. 343/787

* cited by examiner

(21) Appl. No.: **12/788,436**

Primary Examiner — Don Le

(22) Filed: **May 27, 2010**

(74) *Attorney, Agent, or Firm* — Altis Law Group, Inc.

(65) **Prior Publication Data**

US 2011/0156964 A1 Jun. 30, 2011

(57) **ABSTRACT**

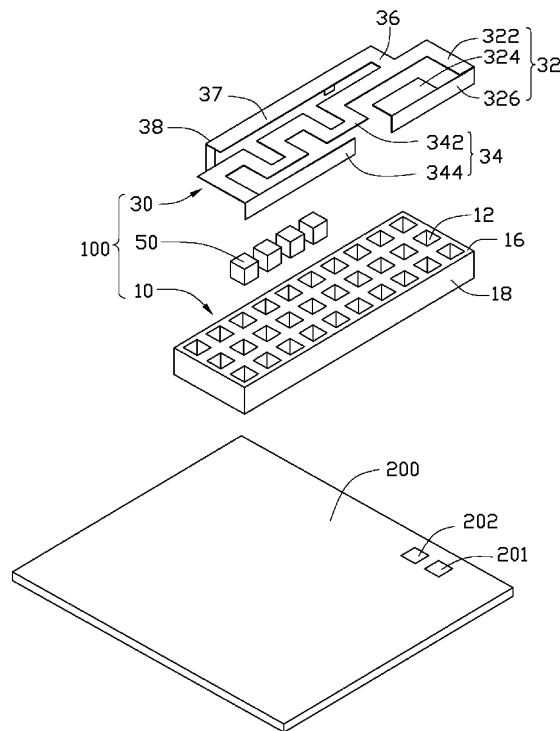
(30) **Foreign Application Priority Data**

Dec. 30, 2009 (TW) 98146032 A

An antenna module includes an antenna, a substrate defining a plurality of notches, and a plurality of filling blocks. The antenna is attached to the substrate. The filling blocks have a permittivity higher than the substrate and are received in a portion of the notches covered by the antenna to raise the permittivity of the substrate.

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

19 Claims, 8 Drawing Sheets





US008373600B2

(12) **United States Patent**
Chang

(10) **Patent No.:** **US 8,373,600 B2**
(45) **Date of Patent:** **Feb. 12, 2013**

- (54) **SINGLE-BAND ANTENNA**
- (75) Inventor: **Jin-Su Chang**, Hsinchu County (TW)
- (73) Assignee: **Arcadyan Technology Corporation**, Hsinchu (TW)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 344 days.
- (21) Appl. No.: **12/896,208**
- (22) Filed: **Oct. 1, 2010**
- (65) **Prior Publication Data**
US 2011/0080324 A1 Apr. 7, 2011
- (30) **Foreign Application Priority Data**
Oct. 2, 2009 (TW) 98133580 A
- (51) **Int. Cl.**
H01Q 1/38 (2006.01)
- (52) **U.S. Cl.** **343/700 MS; 343/895; 343/702**

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,345,647	B1	3/2008	Rodenbeck	
7,345,650	B2 *	3/2008	Bae et al.	343/895
2003/0080904	A1 *	5/2003	Chen	343/700 MS
2003/0214441	A1 *	11/2003	Back et al.	343/700 MS
2005/0122267	A1 *	6/2005	Sim et al.	343/702

* cited by examiner

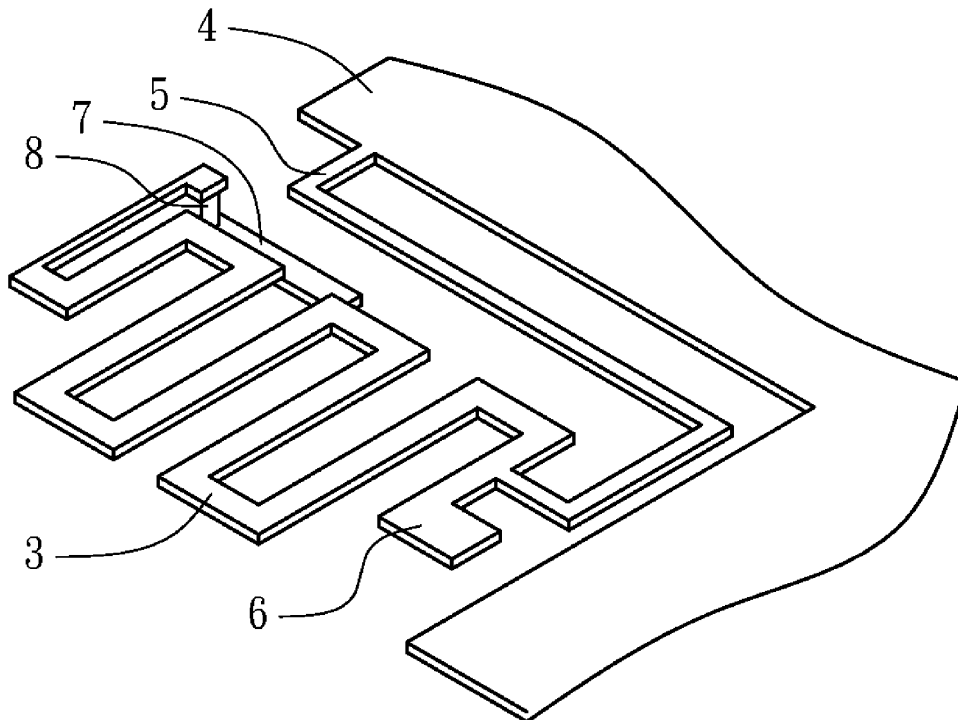
Primary Examiner — Trinh Dinh

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

(57) **ABSTRACT**

A single-band antenna, comprising: a substrate; a first radiation unit; a conductive material; an impedance matching circuit; a signal feed-in terminal; a second radiation unit; and a wire connecting unit. Therefore, the single-band antenna can be miniaturized to be installed with or inside a compact wireless transmission device with enhanced transceiving performance.

13 Claims, 10 Drawing Sheets





US008373601B2

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

(10) **Patent No.:** **US 8,373,601 B2**
(45) **Date of Patent:** **Feb. 12, 2013**

(54) **MULTI-BAND ANTENNA**

(75) Inventors: **Chao-Hsu Wu**, Luzhu Township (TW);
Chi-Yin Fang, Pingtung (TW)

(73) Assignee: **Quanta Computer Inc.**, Tao Yuan Shien (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 335 days.

(21) Appl. No.: **12/939,066**

(22) Filed: **Nov. 3, 2010**

(65) **Prior Publication Data**
US 2011/0316760 A1 Dec. 29, 2011

(30) **Foreign Application Priority Data**
Jun. 23, 2010 (TW) 99120422 A

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/24 (2006.01)
(52) **U.S. Cl.** **343/700 MS; 343/702**
(58) **Field of Classification Search** **343/700 MS, 343/702**

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS
6,864,841 B2 * 3/2005 Dai et al. 343/700 MS
7,161,543 B2 * 1/2007 Cheng et al. 343/702
2011/0128185 A1 * 6/2011 Tsai et al. 343/700 MS

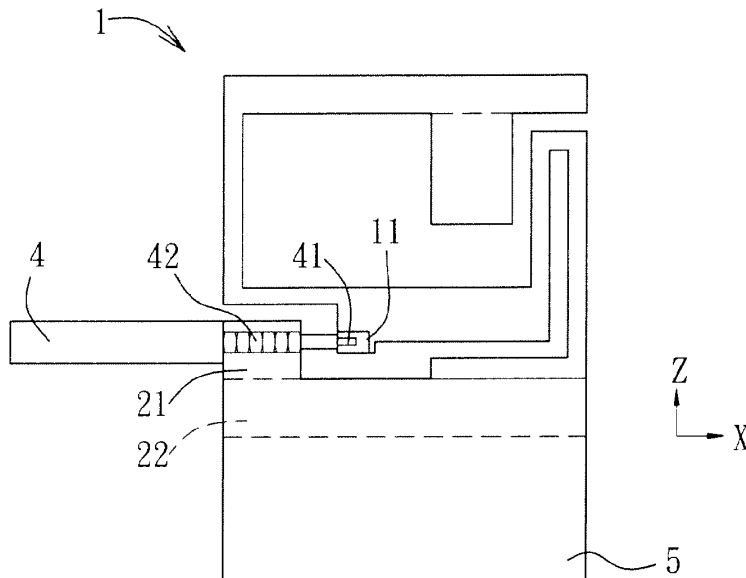
* cited by examiner

Primary Examiner — Hoang V Nguyen
(74) *Attorney, Agent, or Firm* — Steptoe & Johnson LLP

(57) **ABSTRACT**

A multi-band antenna includes a connecting conductor, first and second conducting arms, and a loop conductor. The connecting conductor has a feed-in end and a connecting end. The first conducting arm is connected to the connecting end of the connecting conductor. The second connecting arm is connected to the connecting end of the connecting conductor and is substantially perpendicular to the first connecting arm. The loop conductor has first and second radiator sections, each adjacent and substantially parallel to a respective one of the first and second conducting arms. The loop conductor forms a substantially L-shaped gap with the first and second conducting arms, further has a grounding end adjacent to the feed-in end, and extends from the grounding end to the feed-in end.

12 Claims, 5 Drawing Sheets





US008373602B2

(12) **United States Patent**
Hsu

(10) **Patent No.:** **US 8,373,602 B2**
(45) **Date of Patent:** **Feb. 12, 2013**

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

(58) **Field of Classification Search** 343/700 MS, 343/702, 793, 795, 846
See application file for complete search history.

(75) Inventor: **Cho-Kang Hsu**, Taipei (TW)

(56) **References Cited**

(73) Assignee: **Chi Mei Communication Systems, Inc.**, Tu-Cheng, New Taipei (TW)

U.S. PATENT DOCUMENTS

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 468 days.

6,094,170 A * 7/2000 Peng 343/700 MS
2008/0018539 A1 * 1/2008 Jung et al. 343/700 MS
2010/0060526 A1 * 3/2010 Cheng 343/700 MS

* cited by examiner

(21) Appl. No.: **12/617,358**

Primary Examiner — Robert Karacsony

(74) *Attorney, Agent, or Firm* — Altis Law Group, Inc.

(22) Filed: **Nov. 12, 2009**

(57) **ABSTRACT**

(65) **Prior Publication Data**

US 2010/0328165 A1 Dec. 30, 2010

An antenna mounted on a baseboard including a first surface and a second surface opposite to the first surface includes a feed portion, two radiating portions, a ground portion and a coupling portion. The feed portion and the two radiating portions are disposed on the first surface, and the two radiating portions are connected to the feed portion. The ground portion and the coupling portion are disposed on the second surface, and the coupling portion is connected to the ground portion. The coupling portion passes through the baseboard and couples with two radiating portions.

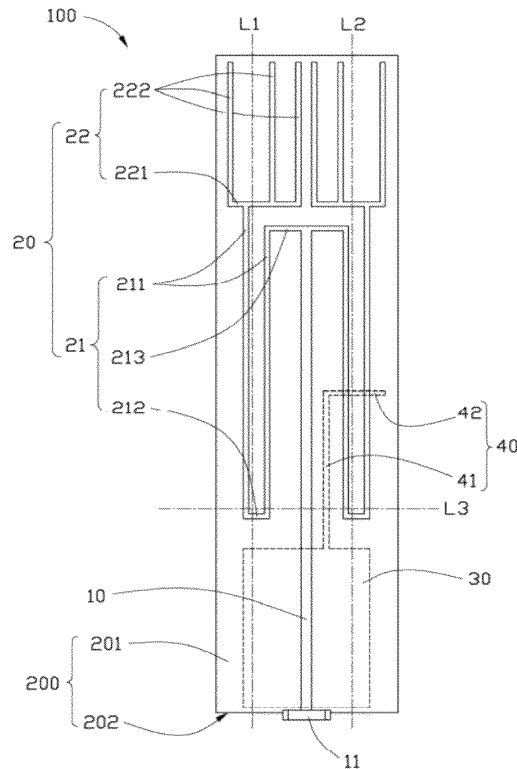
(30) **Foreign Application Priority Data**

Jun. 25, 2009 (CN) 2009 1 0303679

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

(52) **U.S. Cl.** **343/702; 343/700 MS**

11 Claims, 4 Drawing Sheets





US008373603B2

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

(10) **Patent No.:** **US 8,373,603 B2**
(45) **Date of Patent:** **Feb. 12, 2013**

(54) **DUAL FEED ANTENNA**

(75) Inventors: **Mark T. Montgomery**, Melbourne Beach, FL (US); **Paul A. Tornatta**, Melbourne, FL (US)

(73) Assignee: **SkyCross, Inc.**, Viera, FL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 653 days.

(21) Appl. No.: **12/644,718**

(22) Filed: **Dec. 22, 2009**

(65) **Prior Publication Data**

US 2010/0156726 A1 Jun. 24, 2010

Related U.S. Application Data

(60) Provisional application No. 61/140,370, filed on Dec. 23, 2008.

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

(52) **U.S. Cl.** **343/702; 343/700 MS**

(58) **Field of Classification Search** **343/700 MS, 343/702, 895**

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,313,809 B1	11/2001	Gabriel et al.	
6,888,510 B2	5/2005	Jo et al.	
7,265,718 B2	9/2007	Tsai	
2002/0183013 A1*	12/2002	Auckland et al.	455/73
2004/0140942 A1	7/2004	Gottl	

2007/0164906 A1	7/2007	Tsai	
2008/0024378 A1	1/2008	Kanno et al.	
2008/0143613 A1	6/2008	Iwai et al.	
2008/0174508 A1	7/2008	Iwai et al.	
2009/0156118 A1*	6/2009	Schadler	455/25
2010/0007572 A1	1/2010	Jones et al.	

FOREIGN PATENT DOCUMENTS

KR	10-2006-0099601	9/2006
WO	WO-2004-100315 A1	11/2004
WO	WO-2008-131157 A1	10/2008

OTHER PUBLICATIONS

Famdie et al., "Numerical Analysis Of Characteristic Modes On The Chassis Of Mobile Phones" Antennas and Propagation, 2006, EuCAP 2006.
International Search Report and Written Opinion for PCT/US2009/069225 dated Jul. 1, 2010.
International Search Report and Written Opinion for PCT/US2009/069233 dated Jun. 30, 2010.

* cited by examiner

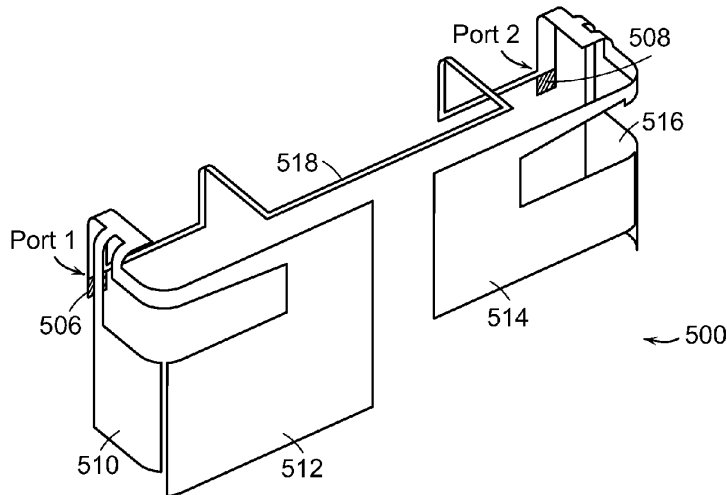
Primary Examiner — Tan Ho

(74) *Attorney, Agent, or Firm* — Rajesh Vallabh; Foley Hoag LLP

(57) **ABSTRACT**

A multi-port antenna structure for a wireless-enabled communications device includes a coupler-antenna having a first antenna port for transmitting electromagnetic signals and a second antenna port for receiving electromagnetic signals. The coupler-antenna is positioned on a chassis of the wireless enabled communications device to transmit energy between the chassis and the first and second antenna ports. Resonant modes of the chassis for one antenna port are orthogonal to resonant modes of the chassis for the other antenna port, such that the first and second antenna ports are isolated from each other.

20 Claims, 10 Drawing Sheets





US008373604B2

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

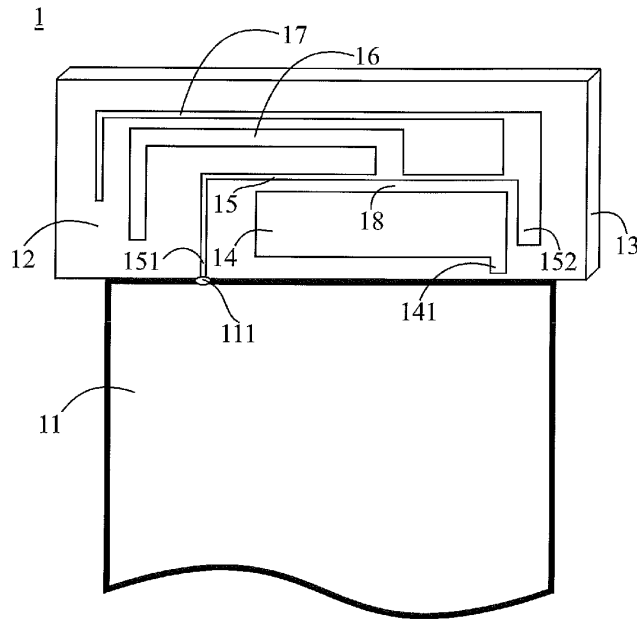
(10) **Patent No.:** **US 8,373,604 B2**
(45) **Date of Patent:** **Feb. 12, 2013**

- (54) **MULTIBAND MOBILE COMMUNICATION DEVICE AND ANTENNA THEREOF**
- (75) Inventors: **Kin-Lu Wong**, Taipei Hsien (TW);
Wei-Yu Chen, Taipei Hsien (TW)
- (73) Assignee: **Acer Inc.**, Taipei Hsien (TW)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 390 days.
- (21) Appl. No.: **12/648,341**
- (22) Filed: **Dec. 29, 2009**
- (65) **Prior Publication Data**
US 2011/0095949 A1 Apr. 28, 2011
- (30) **Foreign Application Priority Data**
Oct. 26, 2009 (TW) 98136192 A
- (51) **Int. Cl.**
H01Q 1/24 (2006.01)
- (52) **U.S. Cl.** **343/702**
- (58) **Field of Classification Search** 343/700 MS,
343/702, 846
See application file for complete search history.

- (56) **References Cited**
U.S. PATENT DOCUMENTS
2008/0180333 A1 * 7/2008 Martiskainen et al. 343/722
2010/0328164 A1 * 12/2010 Huynh 343/702
* cited by examiner
Primary Examiner — Robert Karacsony
(74) *Attorney, Agent, or Firm* — Alan Kamrath; Kamrath IP Lawfirm, PA

(57) **ABSTRACT**
A multiband mobile communication device has a ground plane and an antenna. The antenna is disposed on a dielectric substrate. The antenna includes a monopole, a shorted radiating portion, a first radiating branch, and a second radiating branch. The monopole includes a feeding end, and the feeding end is the feeding point of the antenna. The shorted radiating portion has a shorting end electrically connected to the ground plane, and its other end is left open. The shorted radiating portion is extended along the monopole and has a coupling gap to the monopole. The first radiating branch has an end electrically connected to the shorted radiating portion, and its other end is left open. The first radiating branch is extended toward the shorting end of the shorted radiating portion and located on the opposite side of the monopole. The second radiating branch has an end electrically connected to the shorted radiating portion, and its other end is left open. The second radiating branch is extended along the first radiating branch, with the first radiating branch located between the second radiating branch and the shorted radiating portion.

9 Claims, 5 Drawing Sheets





US008373606B2

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

(10) **Patent No.:** **US 8,373,606 B2**
(45) **Date of Patent:** **Feb. 12, 2013**

(54) **SLIM MOBILE COMMUNICATION DEVICE AND ANTENNA STRUCTURE THEREOF**

(75) Inventors: **Kin-Lu Wong**, Taipei Hsien (TW);
Wei-Yu Chen, Taipei Hsien (TW)

(73) Assignee: **Acer Inc.**, Taipei Hsien (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 455 days.

(21) Appl. No.: **12/789,903**

(22) Filed: **May 28, 2010**

(65) **Prior Publication Data**

US 2011/0215972 A1 Sep. 8, 2011

(30) **Foreign Application Priority Data**

Mar. 5, 2010 (TW) 99106538 A

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

(52) **U.S. Cl.** **343/702**; 343/700 MS; 343/846

(58) **Field of Classification Search** 343/700 MS, 343/702, 829, 846

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,040,060	A *	8/1977	Kaloi	.....	343/700 MS
5,173,711	A *	12/1992	Takeuchi et al.	.....	343/700 MS
6,111,544	A *	8/2000	Dakeya et al.	.....	343/700 MS
6,369,771	B1 *	4/2002	Chiang et al.	.....	343/795
7,098,852	B2 *	8/2006	Ikuta et al.	.....	343/700 MS
7,649,501	B2 *	1/2010	Wong et al.	.....	343/702

* cited by examiner

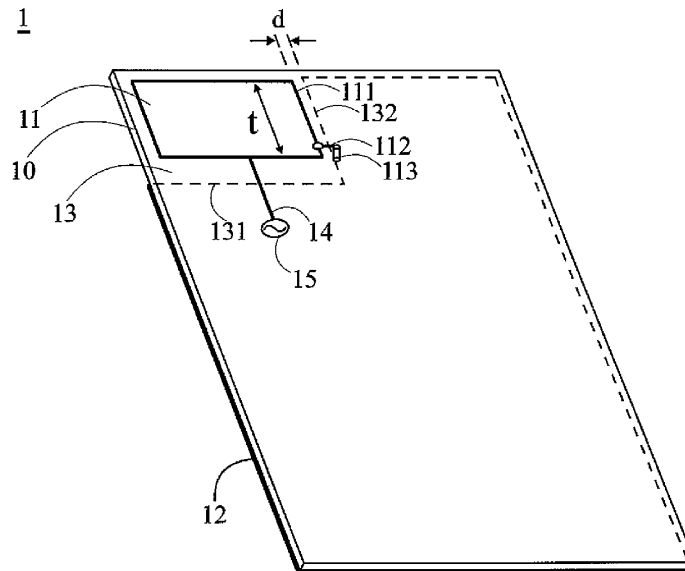
Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — Alan Kamrath; Kamrath IP Lawfirm, P.A.

(57) **ABSTRACT**

A slim mobile communication device includes an antenna structure. The antenna structure includes a dielectric substrate, a ground element, an antenna element, and a feeding line. The antenna element is a planar structure and is disposed on a no-ground portion of the dielectric substrate. At least two edges of the no-ground portion are surrounded by a ground element of the dielectric substrate, wherein one of the edges used as a feeding edge and the other edges are non-feeding edges. A distance between the non-feeding side edge of the antenna element and the second edge of the no-ground portion is smaller than 3 mm. A length of the non-feeding side edge of the antenna element is at least 5 mm. The non-feeding side edge of the antenna element is short-circuited to the ground element. The feeding line is coupled to the feeding side edge of the antenna element.

15 Claims, 4 Drawing Sheets





US008373607B2

(12) **United States Patent**
Chiang

(10) **Patent No.:** **US 8,373,607 B2**
(45) **Date of Patent:** **Feb. 12, 2013**

(54) **TUNABLE ANTENNA STRUCTURE HAVING A VARIABLE CAPACITOR**

(75) Inventor: **Chi-Ming Chiang**, Bade (TW)

(73) Assignee: **Auden Techno Corp.**, Taoyuan County (TW)

(*) 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.: **12/856,070**

(22) Filed: **Aug. 13, 2010**

(65) **Prior Publication Data**

US 2012/0038528 A1 Feb. 16, 2012

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

(52) **U.S. Cl.** **343/745; 343/700 MS; 343/860**

(58) **Field of Classification Search** **343/745, 343/860, 846, 702, 828, 829, 831, 700 MS**

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2008/0122712 A1 * 5/2008 Chen 343/745
2010/0231472 A1 * 9/2010 Tran 343/742
2011/0032170 A1 * 2/2011 Chiang et al. 343/860

* cited by examiner

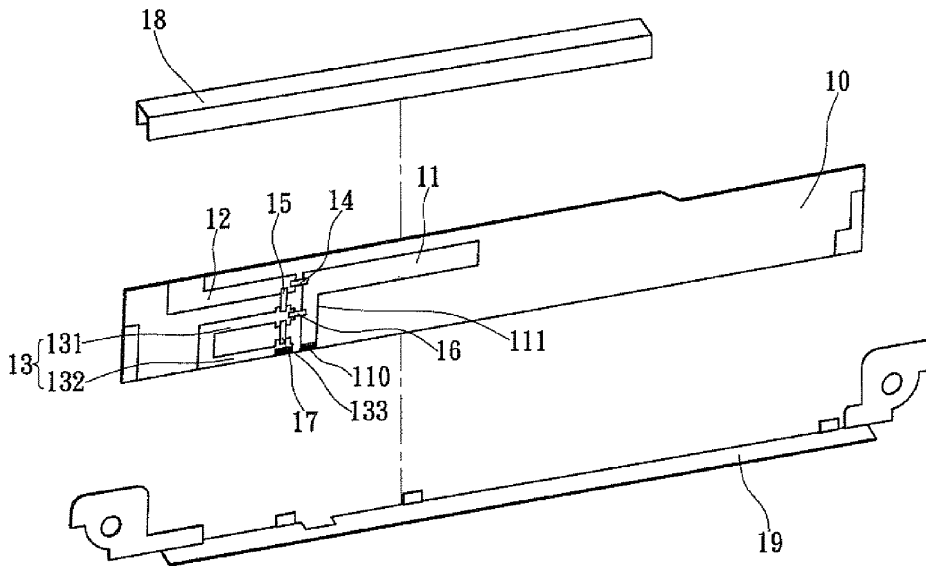
Primary Examiner — Daniel D Chang

(74) *Attorney, Agent, or Firm* — Houtteman Law LLC

(57) **ABSTRACT**

A tunable antenna structure having a variable capacitor includes a substrate, a first metal strip, a second metal strip and a third metal strip formed on the substrate, a variable capacitor element located between the first metal strip and the second metal strip, an inductor element located between the second metal strip and the third metal strip, a first capacitor element located between the first metal strip and the third metal strip, and a second capacitor element located on the third metal strip.

10 Claims, 3 Drawing Sheets





US008373610B2

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

(10) **Patent No.:** **US 8,373,610 B2**
(45) **Date of Patent:** **Feb. 12, 2013**

(54) **MICROSLOT ANTENNAS FOR ELECTRONIC DEVICES**

(75) Inventors: **Bing Chiang**, Cupertino, CA (US);
Gregory Allen Springer, Sunnyvale, CA (US);
Douglas B. Kough, San Jose, CA (US);
Enrique Ayala, Watsonville, CA (US);
Matthew Ian McDonald, 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 930 days.

(21) Appl. No.: **11/958,988**

(22) Filed: **Dec. 18, 2007**

(65) **Prior Publication Data**

US 2009/0153409 A1 Jun. 18, 2009

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

(52) **U.S. Cl.** **343/770**

(58) **Field of Classification Search** **343/767,**
343/770, 771

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
6,369,771	B1	4/2002	Chiang et al.		
6,670,923	B1	12/2003	Kadambi et al.		
6,741,214	B1	5/2004	Kadambi et al.		
6,747,601	B2	6/2004	Boyle		
6,774,852	B2	8/2004	Chiang et al.		
6,856,294	B2	2/2005	Kadambi et al.		
6,888,510	B2	5/2005	Jo et al.		
6,980,154	B2	12/2005	Vance et al.		
7,027,838	B2	4/2006	Zhou et al.		
7,116,267	B2	10/2006	Lee		
7,119,747	B2	10/2006	Lin et al.		
7,123,208	B2	10/2006	Baliarda et al.		

7,239,290	B2	7/2007	Poilasne et al.		
7,397,439	B2 *	7/2008	Kanno et al.	.....	343/767
2003/0107518	A1	6/2003	Li et al.		
2004/0056812	A1 *	3/2004	Sabet et al.	.....	343/725
2004/0145521	A1	7/2004	Hebron et al.		
2005/0017914	A1 *	1/2005	Huang	.....	343/770
2005/0146475	A1 *	7/2005	Bettner et al.	.....	343/767
2005/0200545	A1 *	9/2005	Bancroft	.....	343/770
2006/0055606	A1	3/2006	Boyle		
2006/0284778	A1 *	12/2006	Sanford et al.	.....	343/770

OTHER PUBLICATIONS

Hill et al. U.S. Appl. No. 11/650,187, filed Jan. 4, 2007.
Hill et al. U.S. Appl. No. 11/821,192, filed Jun. 21, 2007.
Hill et al. U.S. Appl. No. 11/897,033, filed Aug. 28, 2007.
Zhang et al. U.S. Appl. No. 11/895,053, filed Aug. 22, 2007.
Chiang et al. U.S. Appl. No. 11/702,039, filed Feb. 1, 2007.
R. Bancroft "A Commercial Perspective on the Development and Integration of an 802.11a/b/g HiperLan/WLAN Antenna into Laptop Computers", IEEE Antennas and Propagation Magazine, vol. 48, No. 4, Aug. 2006, pp. 12-18. B. Chiang et al. "Invasion of Inductor and Capacitor Chips in the Design of Antennas and Platform Integration", IEEE International Conference on Portable Information Devices, May 2007, pp. 1-4.
A. Lai et al. "Infinite Wavelength Resonant Antennas With Monopolar Radiation Pattern Based on Periodic Structures", IEEE Transactions on Antennas and Propagation, vol. 55, No. 3, Mar. 2007, pp. 868-876.

* cited by examiner

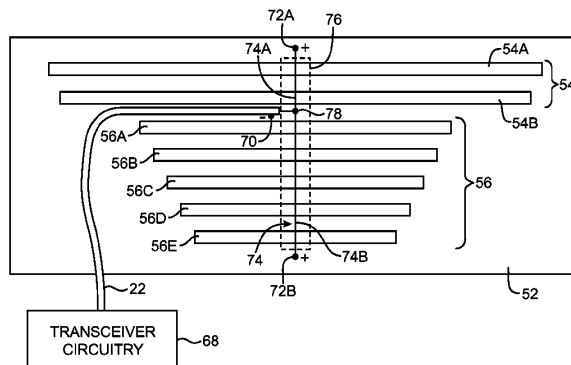
Primary Examiner — Robert Karacsony

(74) *Attorney, Agent, or Firm* — Treyz Law Group; G. Victor Treyz; David C. Kellogg

(57) **ABSTRACT**

Microslot antennas may be provided for electronic devices such as portable electronic devices. The microslot antennas may have dielectric-filled microslots that are formed in a ground plane element. The ground plane element may be formed from part of a conductive device housing. The microslots may be narrow enough that they are not readily noticeable to the naked eye. The microslots may have lengths that allow the microslot antenna to provide antenna coverage in one or more communications bands. A first group of the microslots may be used to provide coverage in a first communications band and a second group of the microslots may be used to provide coverage in a second communications band.

18 Claims, 8 Drawing Sheets





US008378892B2

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

(10) **Patent No.:** **US 8,378,892 B2**
(45) **Date of Patent:** **Feb. 19, 2013**

(54) **ANTENNA COMPONENT AND METHODS**

(75) Inventors: **Juha Sorvala**, Oulu (FI); **Petteri Annamaa**, Oulunsalo (FI); **Kimmo Koskiniemi**, Oulu (FI)

(73) Assignee: **Pulse Finland Oy**, Kempele (FI)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 909 days.

(21) Appl. No.: **11/901,611**

(22) Filed: **Sep. 17, 2007**

(65) **Prior Publication Data**

US 2008/0088511 A1 Apr. 17, 2008

Related U.S. Application Data

(63) Continuation of application No. PCT/FI2005/050401, filed on Nov. 8, 2005.

(30) **Foreign Application Priority Data**

Mar. 16, 2005 (WO) PCT/FI2005/050089
Jun. 28, 2005 (WO) PCT/FI2005/050247

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

(52) **U.S. Cl.** **343/700 MS**

(58) **Field of Classification Search** 343/700 MS,
343/702, 833, 907, 908
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,764,190 A 6/1998 Murch
6,002,369 A * 12/1999 Richard 343/700 MS
6,100,849 A * 8/2000 Tsubaki et al. 343/702
6,147,650 A 11/2000 Kawahata
6,177,908 B1* 1/2001 Kawahata et al. 343/700 MS
6,323,811 B1 11/2001 Tsubaki
6,421,014 B1* 7/2002 Sanad 343/700 MS

6,456,249 B1 9/2002 Johnson
6,501,425 B1 * 12/2002 Nagumo et al. 343/700 MS
6,614,400 B2 9/2003 Egorov
6,650,295 B2 11/2003 Ollikainen
6,683,573 B2 1/2004 Park
6,950,066 B2 9/2005 Hendlar
7,095,372 B2 * 8/2006 Soler Castany et al. 343/700 MS
7,126,546 B2 10/2006 Annamaa
7,136,019 B2 11/2006 Mikkola
7,205,942 B2 4/2007 Wang
2002/0019247 A1 2/2002 Egorov
2002/0145569 A1 10/2002 Onaka

(Continued)

FOREIGN PATENT DOCUMENTS

EP 0 766 341 2/1997
EP 0 831 547 A2 3/1998

(Continued)

Primary Examiner — Jacob Y Choi

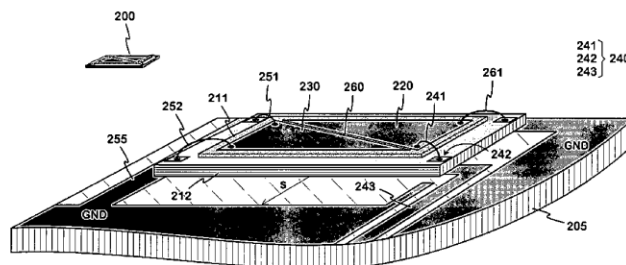
Assistant Examiner — Robert Karacsony

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

(57) **ABSTRACT**

An antenna component (200) with a dielectric substrate and two radiating antenna elements. The elements are located on the upper surface of the substrate and there is a narrow slot (260) between them. The antenna feed conductor (241) is connected to the first antenna element (220), which is connected also to the ground by a short-circuit conductor (261). The second antenna element (230) is parasitic; it is galvanically connected only to the ground. The component is preferably manufactured by a semiconductor technique by growing a metal layer e.g. on a quartz substrate and removing a part of it so that the antenna elements remain. In this case the component further comprises supporting material (212) of the substrate chip. The antenna component is very small-sized because of the high dielectricity of the substrate to be used and mostly because the slot between the antenna elements is narrow. The efficiency of an antenna made by the component is high.

24 Claims, 5 Drawing Sheets





US008378894B2

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

(10) **Patent No.:** **US 8,378,894 B2**

(45) **Date of Patent:** **Feb. 19, 2013**

(54) **ANTENNA DEVICE**

(75) Inventors: **Masato Kikuchi**, Tokyo (JP); **Shunsuke Mochizuki**, Tokyo (JP); **Masahiro Yoshioka**, Tokyo (JP); **Ryosuke Araki**, Tokyo (JP); **Masaki Handa**, Tokyo (JP); **Takashi Nakanishi**, Tokyo (JP); **Hiroto Kimura**, Tokyo (JP); **Seiji Wada**, Kanagawa (JP); **Hiroshi Ichiki**, Kanagawa (JP); **Tetsujiro Kondo**, Tokyo (JP)

(73) Assignee: **Sony Corporation**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 363 days.

(21) Appl. No.: **12/273,038**

(22) Filed: **Nov. 18, 2008**

(65) **Prior Publication Data**

US 2009/0153405 A1 Jun. 18, 2009

(30) **Foreign Application Priority Data**

Dec. 18, 2007 (JP) 2007-326392

(51) **Int. Cl.**

H01Q 1/38 (2006.01)
H01Q 5/00 (2006.01)
H01Q 9/04 (2006.01)
H01Q 1/48 (2006.01)

(52) **U.S. Cl.** **343/700 MS**; 343/846

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,170,013 A * 10/1979 Black 343/700 MS
6,211,825 B1 4/2001 Deng

6,778,141 B1 * 8/2004 Yeh 343/700 MS
2004/0001021 A1 1/2004 Choo et al.
2005/0253756 A1 11/2005 Kuroda et al.
2007/0200767 A1 8/2007 Yoshioka et al.

FOREIGN PATENT DOCUMENTS

JP 2005-278067 10/2005
WO WO 2005/038984 A1 4/2005

OTHER PUBLICATIONS

“Antenna Theory: A Review,” Balanis, Proc. IEEE, vol. 80, No. 1, Jan. 1992.*

“Antenna Frequency Scaling,” The ARRL Antenna Book, published by The American Radio Relay League, Copyright 1988, pp. 2-24 to 2-25.*

“Theory of Models of Electromagnetic Systems,” George Sinclair, Proceedings of The IRE, vol. 36, issue 11, Nov. 1948, pp. 1364 to 1370.*

U.S. Appl. No. 12/324,980, filed Nov. 28, 2008, Yoshioka, et al.
Ban-Leong Ooi, “A Double II Stub Proximity Feed U-Slot Patch Antenna,” IEEE Transactions on Antennas and Propagation, IEEE Service Center, Piscataway, NJ, USA, vol. 52, No. 9, Sep. 1, 2004, pp. 2491-2496.

European Search Report mail dated Apr. 6, 2011. Supplementary European Search Report in European application EP 08 17 2149.

U.S. Appl. No. 13/217,539, filed Aug. 25, 2011, Ichiki.

* cited by examiner

Primary Examiner — Jacob Y Choi

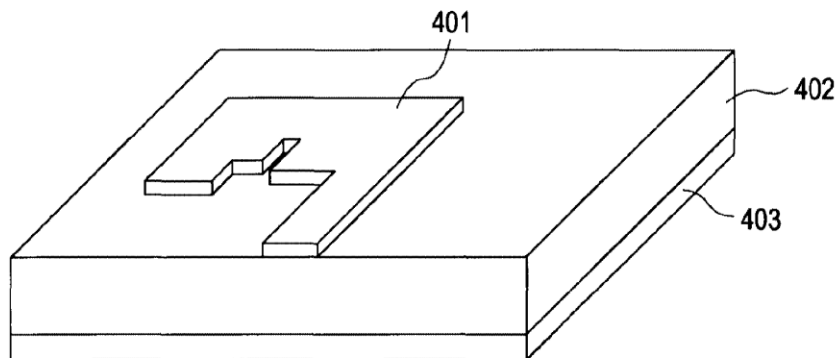
Assistant Examiner — Graham Smith

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

(57) **ABSTRACT**

A planar antenna device includes a dielectric layer and two conductor layers vertically sandwiching the dielectric layer. The lower conductor layer is used as a ground, and the upper conductor layer forms a radiating element having a structure in which four or more radiating element pieces of different sizes are connected to a feeder line.

6 Claims, 14 Drawing Sheets





US008378896B2

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

(10) **Patent No.:** **US 8,378,896 B2**
(45) **Date of Patent:** **Feb. 19, 2013**

(54) **WIDE BAND ANTENNA**

(75) Inventors: **Chih-Yuan Yang**, Taipei Hsien (TW);
Shih-Yen Peng, Taipei Hsien (TW);
Chien-Tang Lin, Taipei Hsien (TW);
Hung-Chang Ko, Taipei Hsien (TW)

(73) Assignee: **Hon Hai Precision Industry Co., Ltd.**,
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 335 days.

(21) Appl. No.: **12/841,185**

(22) Filed: **Jul. 22, 2010**

(65) **Prior Publication Data**

US 2011/0156961 A1 Jun. 30, 2011

(30) **Foreign Application Priority Data**

Dec. 25, 2009 (CN) 2009 1 0312285

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

(52) **U.S. Cl.** **343/700 MS; 343/702; 343/846**

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,019,709 B2 * 3/2006 Fukushima et al. 343/846
8,106,834 B2 * 1/2012 Copeland 343/700 MS

* cited by examiner

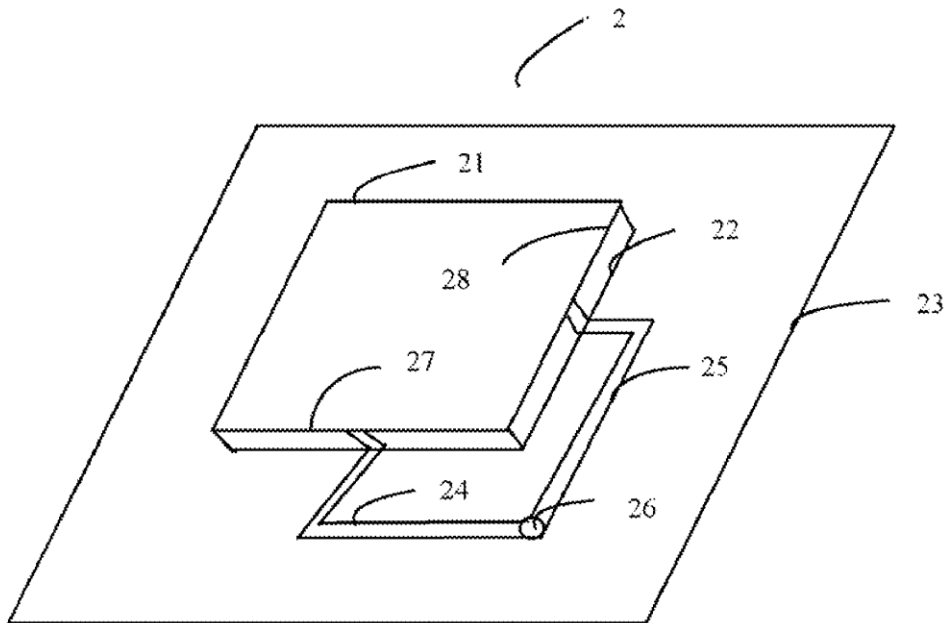
Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Altis Law Group, Inc.

(57) **ABSTRACT**

A wide band antenna includes a radiation element, a ground surface, a dielectric element, a connector; a first microstrip feeder and a second microstrip feeder. The radiation element is a rectangle shaped and includes a first side and a second side. The lengths of the first side and the second side are not equal. The dielectric element is positioned between the radiation element and the ground surface. One end of the first microstrip feeder is connected to the first side of the radiation element. One end of the second microstrip feeder is connected to the second side of the radiation element, the other ends of the first and second microstrip feeder are connected to the connector.

4 Claims, 4 Drawing Sheets





US008378897B2

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

(10) **Patent No.:** **US 8,378,897 B2**
(45) **Date of Patent:** **Feb. 19, 2013**

(54) **PLANAR MULTI-BAND ANTENNA**

(75) Inventors: **Ming-Iu Lai**, Taipei (TW);
Chun-Hsiung Wang, 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 310 days.

(21) Appl. No.: **12/908,491**

(22) Filed: **Oct. 20, 2010**

(65) **Prior Publication Data**

US 2011/0095952 A1 Apr. 28, 2011

(30) **Foreign Application Priority Data**

Oct. 26, 2009 (TW) 98136236 A

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

(52) **U.S. Cl.** **343/700 MS; 343/702**

(58) **Field of Classification Search** **343/700 MS, 343/702, 846, 848**

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,525,490 B2 4/2009 Hung et al.
2002/0000949 A1 1/2002 Nishino et al.
2004/0239442 A1 12/2004 Wilcox
2005/0110692 A1* 5/2005 Andersson 343/702

2006/0109175 A1 5/2006 Yeh
2007/0069958 A1* 3/2007 Ozkar 343/700 MS
2007/0285321 A1 12/2007 Chung et al.
2008/0180330 A1 7/2008 Wei-Shan et al.
2009/0195473 A1* 8/2009 Ke et al. 343/846
2010/0253581 A1* 10/2010 Tsou 343/702
2011/0032170 A1* 2/2011 Chiang et al. 343/860

FOREIGN PATENT DOCUMENTS

CN 1795617 A 6/2006
CN 201004480 Y 1/2008

* cited by examiner

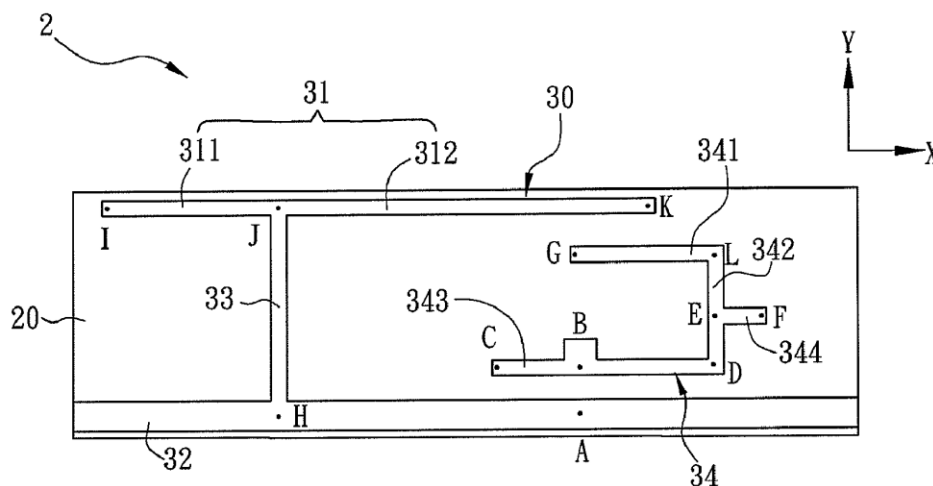
Primary Examiner — Hoanganh Le

(74) Attorney, Agent, or Firm — Muncy, Geissler, Olds & Lowe, PLLC

(57) **ABSTRACT**

A planar multi-band antenna includes a substrate and a metal pattern. The metal pattern includes a first metal wire, a second metal wire, a third metal wire and a fourth metal wire. The second metal wire is disposed opposite to the first metal wire and has a grounding point. Two ends of the third metal wire are connected to the first metal wire and second metal wire, respectively, and the first metal wire is divided into a first radiation portion and a second radiation portion. The fourth metal wire is partially located between the second radiation portion and the second metal wire and forms multiple bends, and has a first impedance matching portion and a feed point, and part of the fourth metal wire coincides with the second radiation portion in a projection direction. By the activation of the feeding point and the grounding point associates with the impedance matching portion, the antenna has plural bands.

16 Claims, 6 Drawing Sheets





US008378899B2

(12) **United States Patent**
Galeev

(10) **Patent No.:** **US 8,378,899 B2**
(45) **Date of Patent:** **Feb. 19, 2013**

(54) **WIRELESS COMMUNICATION TERMINAL WITH A MULTI-BAND ANTENNA THAT EXTENDS BETWEEN SIDE SURFACES THEREOF**

(75) Inventor: **Roustem Galeev**, Lund (SE)

(73) Assignee: **Sony Ericsson Mobile Communications AB**, Lund (SE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 623 days.

(21) Appl. No.: **12/613,843**

(22) Filed: **Nov. 6, 2009**

(65) **Prior Publication Data**
US 2011/0109514 A1 May 12, 2011

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

(52) **U.S. Cl.** **343/702**; 343/872

(58) **Field of Classification Search** 343/702,
343/872, 873
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,903,686	B2	6/2005	Vance et al.	
6,909,402	B2	6/2005	Vance	
6,943,733	B2	9/2005	Vance	
7,109,924	B2	9/2006	Vance	
2004/0075613	A1*	4/2004	Jarmuszewski et al.	..... 343/702
2011/0057843	A1*	3/2011	Hallivuori	..... 343/700 MS

FOREIGN PATENT DOCUMENTS

EP	1 684 379	A1	7/2006
EP	1 950 833	A1	7/2008
KR	10-2007-0097835		10/2007
WO	WO 2005/043674	A1	5/2005

OTHER PUBLICATIONS

Notification of Transmittal of the International Search Report and the Written Opinion of the International Searching Authority, or the Declaration; International Search Report; Written Opinion of the International Searching Authority corresponding to International Application No. PCT/IB2010/002583; Date of Mailing: Dec. 30, 2010; 12 pages.

* cited by examiner

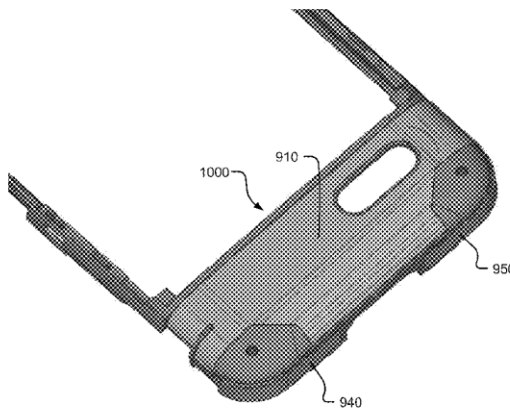
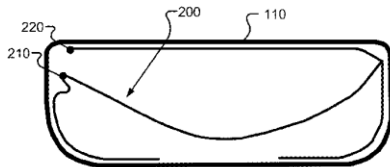
Primary Examiner — Robert Karacsony

(74) *Attorney, Agent, or Firm* — Myers Bigel Sibley & Sajovec, P.A.

(57) **ABSTRACT**

A wireless communications terminal can include a housing having an interior surface that is configured to enclose at least a controller circuit, a transceiver circuit, and a RF feed circuit and to at least partially enclose a display device and a user input interface. The housing extends between opposing top and bottom surfaces, between opposing first and second side surfaces, and between opposing front and back surfaces. A first radiator line is connected on distal ends to a feed node and to a ground node and extends in a loop across at least a majority of a width of the housing between the first and second side surfaces. The first radiator line resonates in a first frequency range responsive to first electromagnetic radiation coupled to the feed and ground nodes. A second radiator line is connected to the feed node and extends away from an adjacent portion of the first radiator line, and resonates in a second frequency range responsive to second electromagnetic radiation coupled to the feed and ground nodes. A third radiator line is connected to the first radiator line at a branch node that is spaced apart from the feed node and the ground node, and extends away from an adjacent portion of the first radiator line and resonates in a third frequency range responsive to third electromagnetic radiation coupled to the feed and ground nodes.

16 Claims, 4 Drawing Sheets





US008378900B2

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

(10) **Patent No.:** **US 8,378,900 B2**
(45) **Date of Patent:** **Feb. 19, 2013**

- (54) **ANTENNA ARRANGEMENT**
- (75) Inventors: **Lassi Pentti Olavi Hyvönen**, Helsinki (FI); **Jussi Olavi Rahola**, Espoo (FI)
- (73) Assignee: **Nokia Corporation**, Espoo (FI)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 319 days.

2005/0151689 A1 7/2005 Vesterinen
 2006/0145931 A1 7/2006 Ranta
 2006/0170601 A1 8/2006 Fang

FOREIGN PATENT DOCUMENTS

EP 0 622 864 A1 11/1994
 EP 1 329 985 A2 7/2003
 EP 1 562 259 A1 8/2005
 EP 2 040 328 A1 3/2009
 WO WO 2006/018711 A1 2/2006

OTHER PUBLICATIONS

Supplementary European Search Report for Application No. EP 07 82 5282 dated May 9, 2012.
 International Search Report for International Application No. PCT/IB2007/002961 completed Jan. 22, 2009.
 Pertti Vainikainen; Jani Ollikainen; Outi Kivekäs; Iikka Kelande; Resonator-Based Analysis of the Combination of Mobile Handset Antenna and Chassis; IEEE Transactions on Antennas and Propagation, vol. 50, No. 10, Oct. 2002; pp. 1433-1444.
 Peter Lindberg; Erik Öjefors; A Bandwidth Enhancement Technique for Mobile Handset Antennas Using Wavetraps; IEEE Transactions on Antennas and Propagation, vol. 54, No. 8, Aug. 2006; pp. 2226-2233.
 Office Action for European Application No. 07 825 282.2 dated Oct. 30, 2012.

* cited by examiner

Primary Examiner — Hoang V Nguyen
 (74) *Attorney, Agent, or Firm* — Alston & Bird LLP

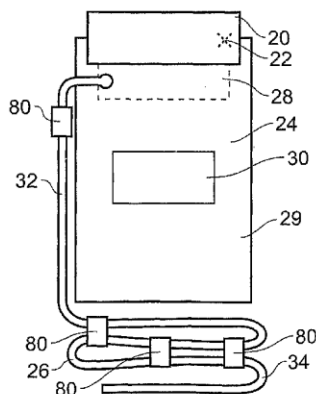
(57) **ABSTRACT**

An antenna arrangement operable at a first resonant frequency f having a corresponding resonant wavelength λ the antenna arrangement comprising: an antenna comprising a feed; a ground plane coupled to the antenna comprising a first region and a second region; and a grounded conductive structure coupled to the first region of the ground plane, wherein the second region of the ground plane is configured such that, at the first resonant frequency f the current flows predominantly in the grounded conductive structure compared to the second region of the ground plane.

19 Claims, 6 Drawing Sheets

- (21) Appl. No.: **12/669,329**
- (22) PCT Filed: **Jul. 18, 2007**
- (86) PCT No.: **PCT/IB2007/002961**
 § 371 (c)(1),
 (2), (4) Date: **Jun. 14, 2010**
- (87) PCT Pub. No.: **WO2009/027763**
 PCT Pub. Date: **Mar. 5, 2009**
- (65) **Prior Publication Data**
 US 2010/0245183 A1 Sep. 30, 2010
- (51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/48 (2006.01)
H01Q 9/00 (2006.01)
- (52) **U.S. Cl.** **343/702; 343/846; 343/745**
- (58) **Field of Classification Search** **343/702, 343/700 MS, 846, 745, 749**
 See application file for complete search history.

- (56) **References Cited**
 U.S. PATENT DOCUMENTS
 6,961,022 B1 11/2005 Tay et al.
 7,330,156 B2* 2/2008 Arkko et al. 343/702
 7,362,271 B2* 4/2008 Iwai et al. 343/700 MS
 2004/0204006 A1 10/2004 Zhou et al.
 2005/0057414 A1 3/2005 Poilasne et al.





US008378901B2

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

(10) **Patent No.:** **US 8,378,901 B2**
(45) **Date of Patent:** **Feb. 19, 2013**

(54) **HANDHELD ELECTRONIC DEVICE**

(75) Inventors: **Wei-Yang Wu**, Taoyuan (TW);
Ying-Cong Deng, Taoyuan (TW);
Chung-Ting Hung, Taoyuan (TW);
Kuo-Cheng Chen, Taoyuan (TW)

(73) Assignee: **HTC Corporation**, Taoyuan, Taoyuan
County (TW)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 500 days.

(21) Appl. No.: **12/694,432**

(22) Filed: **Jan. 27, 2010**

(65) **Prior Publication Data**

US 2010/0315300 A1 Dec. 16, 2010

(30) **Foreign Application Priority Data**

Jun. 15, 2009 (TW) 98119958 A

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

(52) **U.S. Cl.** **343/702; 343/841**

(58) **Field of Classification Search** 343/702,
343/741, 846; 381/315, 322

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,366,247	B1	4/2002	Sawamura et al.	
6,697,025	B2 *	2/2004	Koyanagi et al.	343/741
2002/0018021	A1	2/2002	Koyanagi et al.	
2004/0090372	A1 *	5/2004	Nallo et al.	343/700 MS
2004/0164910	A1 *	8/2004	Kuroda	343/702
2005/0007292	A1	1/2005	Lee et al.	
2006/0140428	A1	6/2006	Qi et al.	
2008/0158065	A1	7/2008	Wee	
2009/0111541	A1	4/2009	Kim et al.	
2009/0124306	A1	5/2009	Kim et al.	
2010/0052998	A1	3/2010	Teng et al.	

FOREIGN PATENT DOCUMENTS

CN	1284762	A	2/2001
EP	1 788 663	A1	5/2007
EP	2161779	A1	3/2010
WO	WO-02/21633	A1	3/2002
WO	WO 2007/039071	A2	4/2007

* cited by examiner

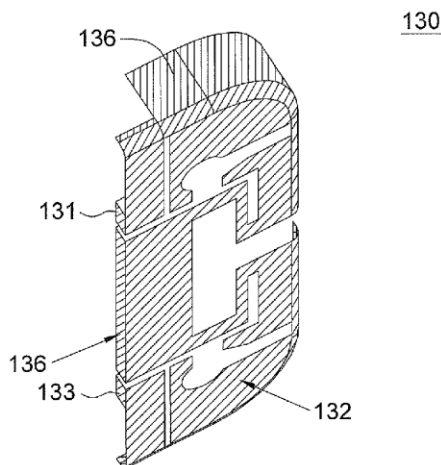
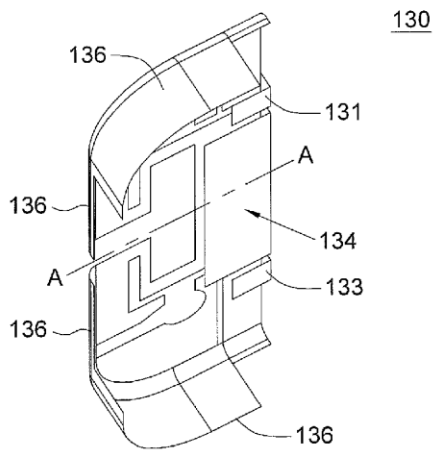
Primary Examiner — Hoanganh Le

(74) *Attorney, Agent, or Firm* — Rabin & Berdo, P.C.

(57) **ABSTRACT**

A handheld electronic device comprises a housing, a receiver, a balance antenna and a body. The housing comprises a top end and a bottom end. The receiver is located in the housing and near the top end, and the balance antenna is located in the housing and near the bottom end. The body is located in the housing and electrically couples to the receiver and the balance antenna.

8 Claims, 6 Drawing Sheets





US008378902B2

(12) **United States Patent**
Lee

(10) **Patent No.:** **US 8,378,902 B2**
(45) **Date of Patent:** **Feb. 19, 2013**

- (54) **ANTENNA OF PORTABLE ELECTRONIC DEVICES**
 - (75) Inventor: **Yi-Chieh Lee, Tu-Cheng (TW)**
 - (73) Assignee: **Chi Mei 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 499 days.
 - (21) Appl. No.: **12/696,156**
 - (22) Filed: **Jan. 29, 2010**
 - (65) **Prior Publication Data**
US 2011/0001675 A1 Jan. 6, 2011
 - (30) **Foreign Application Priority Data**
Jul. 1, 2009 (CN) 2009 1 0303906
 - (51) **Int. Cl.**
H01Q 1/24 (2006.01)
 - (52) **U.S. Cl.** **343/702; 343/700 MS; 343/729**
 - (58) **Field of Classification Search** **343/700 MS, 343/702, 725, 729**
- See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,204,819	B1 *	3/2001	Hayes et al.	343/702
7,839,341	B2 *	11/2010	Seo	343/702
2003/0189719	A1 *	10/2003	Saito et al.	358/1.14
2005/0190108	A1 *	9/2005	Lin et al.	343/702
2007/0008222	A1 *	1/2007	Wang et al.	343/700 MS
2008/0007467	A1 *	1/2008	Seo	343/702
2009/0009401	A1 *	1/2009	Suzuki et al.	343/700 MS
2010/0065647	A1 *	3/2010	Ritamaki et al.	235/492
2010/0277376	A1 *	11/2010	Chakam et al.	343/702
2010/0315297	A1 *	12/2010	Wu et al.	343/702

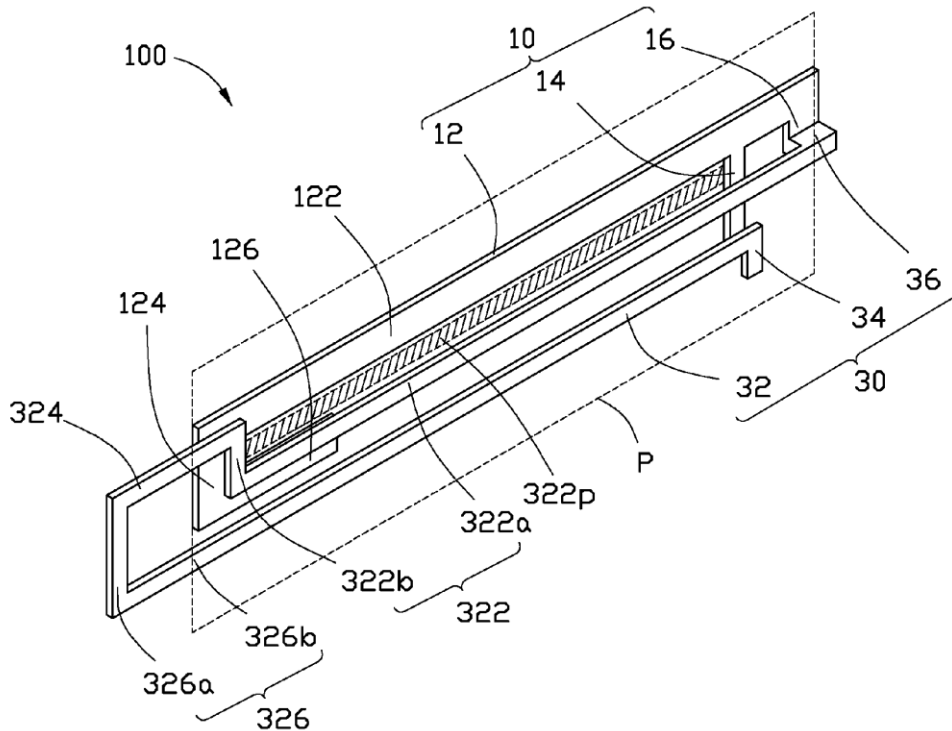
* cited by examiner

Primary Examiner — Hoanganh Le
(74) *Attorney, Agent, or Firm* — Altis Law Group, Inc.

(57) **ABSTRACT**

An antenna used in portable electronic devices includes a first antenna unit shaped as a planar inverted-F antenna (PIFA) and a second antenna unit shaped as a loop antenna and connected to the first antenna unit. The first antenna unit receives/sends wireless signals at relatively higher frequencies, the second antenna unit receives/sends wireless signals at relatively lower frequencies, and the first antenna unit is coupled with the second antenna unit to regulate the working frequency band of the antenna.

12 Claims, 3 Drawing Sheets





US008378909B2

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

(10) **Patent No.:** **US 8,378,909 B2**
(45) **Date of Patent:** **Feb. 19, 2013**

(54) **ANTENNA AND WIRELESS COMMUNICATION APPARATUS**
(75) Inventors: **Jin Sato**, Beijing (CN); **Yuji Kaminishi**, Ishikawa-gun (JP)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 435 days.

(21) Appl. No.: **12/548,753**

(22) Filed: **Aug. 27, 2009**

(65) **Prior Publication Data**
US 2009/0303140 A1 Dec. 10, 2009

Related U.S. Application Data
(63) Continuation of application No. PCT/JP2008/056467, filed on Apr. 1, 2008.

(30) **Foreign Application Priority Data**
Apr. 5, 2007 (JP) 2007-099579

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 19/00 (2006.01)
(52) **U.S. Cl.** 343/725; 343/702; 343/833
(58) **Field of Classification Search** 343/700 MS, 343/702, 833, 725
See application file for complete search history.

(56) **References Cited**
U.S. PATENT DOCUMENTS
4,907,006 A * 3/1990 Nishikawa et al. 343/700 MS
6,614,401 B2 * 9/2003 Onaka et al. 343/702
2002/0145569 A1 10/2002 Onaka et al.
2005/0128162 A1 * 6/2005 Takagi et al. 343/895

2005/0190107 A1 9/2005 Takagi et al.
2005/0275596 A1 * 12/2005 Harano 343/702
2006/0017621 A1 * 1/2006 Okawara et al. 343/700 MS
2007/0057849 A1 3/2007 Moon et al.

FOREIGN PATENT DOCUMENTS

EP 1 860 732 A1 11/2007
JP 06-303021 A 10/1994
JP 2002-252515 A 9/2002
JP 2002-314330 A 10/2002
JP 2002-344222 A 11/2002
JP 2002-368535 A 12/2002
JP 2004-274445 A 9/2004
JP 2005-244553 A 9/2005
JP 2007-049249 A 2/2007
JP 2007-082170 A 3/2007
WO 2006/098089 A1 9/2006

OTHER PUBLICATIONS

Official Communication issued in International Patent Application No. PCT/JP2008/056467, mailed on Jul. 8, 2008.
Official Communication issued in corresponding Japanese Patent Application No. 2009-509261, mailed on Apr. 3, 2012.

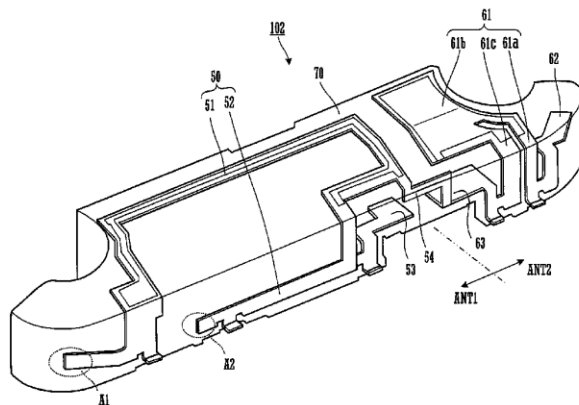
* cited by examiner

Primary Examiner — Robert Karacsony
(74) *Attorney, Agent, or Firm* — Keating & Bennett, LLP

(57) **ABSTRACT**

In an antenna, a first type radiation electrode and a second type radiation electrode are provided on the surface of a dielectric base, which has a predetermined external shape, or embedded in the dielectric base. The first type radiation electrode is provided with an open terminal at one end thereof and a feeding terminal at the other end thereof so as to constitute a monopole type antenna. The second type radiation electrode is provided with a capacitive-coupling feeding electrode at one end thereof and a ground connection terminal at the other end thereof so as to constitute a capacitive feed antenna. The one end of the first type radiation electrode is located opposite to the feeding electrode of the second type radiation electrode when viewed in the direction of the length of the dielectric base.

7 Claims, 7 Drawing Sheets





US008378910B2

(12) **United States Patent**
Wolf

(10) **Patent No.:** **US 8,378,910 B2**
(45) **Date of Patent:** **Feb. 19, 2013**

(54) **SLOT ANTENNAS, INCLUDING MEANDER
SLOT ANTENNAS, AND USE OF SAME IN
CURRENT FED AND PHASED ARRAY
CONFIGURATION**

2005/0024287 A1 * 2/2005 Jo et al. 343/822
2005/0057412 A1 * 3/2005 Hwang et al. 343/767
2008/0316115 A1 * 12/2008 Hill et al. 343/702

(75) Inventor: **Forrest Wolf**, Reno, NV (US)

FOREIGN PATENT DOCUMENTS
JP 2005110332 A 4/1993
JP 2005223879 A 8/2005
JP 2006527941 A 12/2006
KR 1020050026334 A 3/2005

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 512 days.

OTHER PUBLICATIONS

Search Report and Written Opinion mailed Jan. 4, 2010 for Application No. PCT/US2009/058471, 9 pages.

(21) Appl. No.: **12/567,535**

* cited by examiner

(22) Filed: **Sep. 25, 2009**

Primary Examiner — Huedung Mancuso

(65) **Prior Publication Data**

US 2010/0085262 A1 Apr. 8, 2010

(74) *Attorney, Agent, or Firm* — Holland & Hart LLP

Related U.S. Application Data

(60) Provisional application No. 61/100,156, filed on Sep. 25, 2008.

(57) **ABSTRACT**

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

In one embodiment, a meander slot antenna includes a conducting sheet having a meander slot defined therein. The meander slot has a closed area defined by the conducting sheet. An electrical microstrip feed line crosses the meander slot. The electrical microstrip feed line and meander slot provide a magnetically coupled LC resonance element. A dielectric material has at least one conductive via therein. The at least one conductive via electrically connects the electrical microstrip feed line and the conducting sheet at a side of the meander slot. The dielectric material otherwise separates the conducting sheet from the electrical microstrip feed line. Other embodiments are also disclosed.

(52) **U.S. Cl.** **343/768**

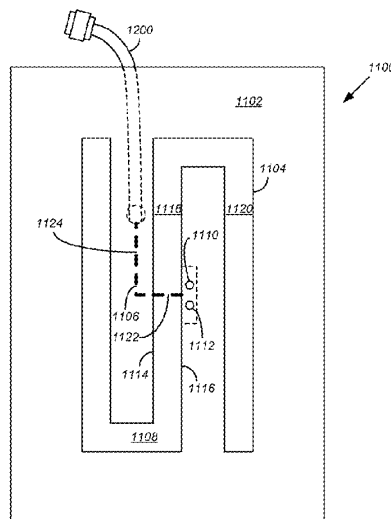
(58) **Field of Classification Search** 343/868,
343/860, 822, 895, 700 MS, 702, 768
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,754,143 A * 5/1998 Warnagiris et al. 343/767
7,924,231 B2 * 4/2011 Hill et al. 343/702
2001/0015703 A1 8/2001 Nieminen

41 Claims, 33 Drawing Sheets





US008378913B2

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

(10) **Patent No.:** **US 8,378,913 B2**
(45) **Date of Patent:** **Feb. 19, 2013**

- (54) **DUAL-BAND ANTENNA UNIT**
- (75) Inventors: **Wen-Szu Tao**, Hsinchu (TW); **Sy-Been Wang**, Hsinchu County (TW)
- (73) Assignee: **Arcadyan Technology Corporation**, Hsinchu (TW)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 323 days.
- (21) Appl. No.: **12/967,173**
- (22) Filed: **Dec. 14, 2010**
- (65) **Prior Publication Data**
US 2011/0140989 A1 Jun. 16, 2011
- (30) **Foreign Application Priority Data**
Dec. 15, 2009 (TW) 98142878 A
- (51) **Int. Cl.**
H01Q 9/04 (2006.01)
- (52) **U.S. Cl.** **343/790; 343/791**

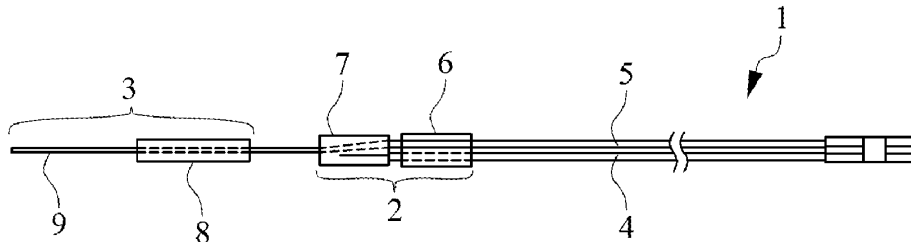
(58) **Field of Classification Search** 343/790,
343/791, 792, 893
See application file for complete search history.

- (56) **References Cited**
U.S. PATENT DOCUMENTS
6,836,256 B2 * 12/2004 Hung 343/790
6,947,006 B2 * 9/2005 Diximus et al. 343/790
7,064,728 B1 * 6/2006 Lin et al. 343/792

* cited by examiner
Primary Examiner — Tan Ho
(74) *Attorney, Agent, or Firm* — Morris Manning & Martin LLP; Tim Tingkang Xia, Esq.

(57) **ABSTRACT**
A dual-band antenna unit, comprising: a first radiation unit; a second radiation unit; a first signal feed-in unit electrically connected to the first radiation unit; and a second signal feed-in unit, electrically connected to the second radiation unit; wherein the first radiation unit, the second radiation unit, the first signal feed-in unit and the second signal feed-in unit are disposed in the dual-band antenna unit. Therefore, the number of antennas can be reduced to achieve lower cost while remaining the signal transmission quality.

17 Claims, 21 Drawing Sheets





US008378914B2

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

(10) **Patent No.:** **US 8,378,914 B2**
(45) **Date of Patent:** **Feb. 19, 2013**

(54) **DIPOLE ANTENNA**

(75) Inventors: **Chang-Jung Lee**, Taoyuan County (TW); **Jian-Jhih Du**, Taipei (TW)

(73) Assignee: **Arcadyan Technology Corporation**, Hsinchu (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 277 days.

(21) Appl. No.: **12/647,288**

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

(65) **Prior Publication Data**
US 2010/0164825 A1 Jul. 1, 2010

(30) **Foreign Application Priority Data**
Dec. 25, 2008 (TW) 97150710 A

(51) **Int. Cl.**
H01Q 9/16 (2006.01)
(52) **U.S. Cl.** **343/795; 343/807; 343/822**
(58) **Field of Classification Search** 343/700 MS, 343/793, 795, 807, 822, 846
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS
5,867,130 A * 2/1999 Tay et al. 343/795
7,839,336 B2 * 11/2010 Koshiji et al. 343/700 MS
2008/0180342 A1 * 7/2008 Kerselaers 343/795

FOREIGN PATENT DOCUMENTS
CN 101167214 A 4/2008
GB 2347792 A 9/2000

* cited by examiner

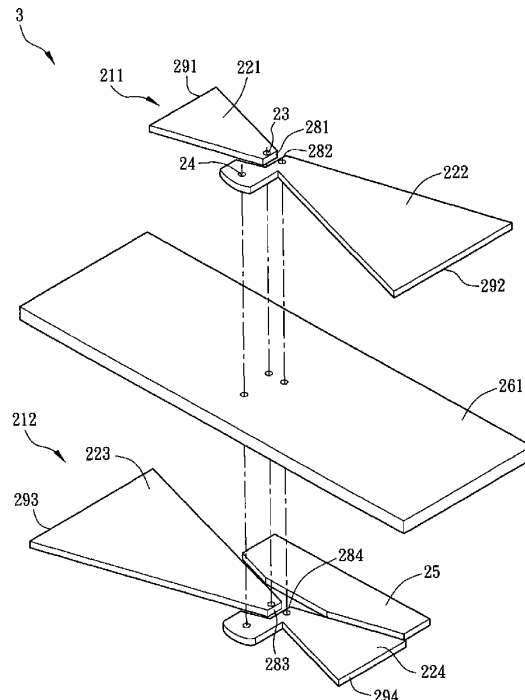
Primary Examiner — Robert Karacsony

(74) *Attorney, Agent, or Firm* — Muncy, Geissler, Olds & Lowe, PLLC

(57) **ABSTRACT**

A dipole antenna includes a first radiating body and a second radiating body. The first radiating body has a first radiating part and a second radiating part. The area of the second radiating part is larger than that of the first radiating part. The second radiating body is disposed opposite to the first radiating body and has a third radiating part and a fourth radiating part. The area of the third radiating part is larger than that of the first radiating part. The area of the second radiating part is larger than that of the fourth radiating part. The first radiating part or the third radiating part has a feeding point. The second radiating part or the fourth radiating part has a ground point. The first radiating part is electrically connected to the third radiating part. The second radiating part is electrically connected to the fourth radiating part.

18 Claims, 7 Drawing Sheets





US008378915B2

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

(10) **Patent No.:** **US 8,378,915 B2**
(45) **Date of Patent:** **Feb. 19, 2013**

(54) **ANTENNA ASSEMBLY**

(75) Inventors: **Per-Anders Arvidsson**, Solna (SE);
Mario Arias, Vallentuna (SE); **Michael Beausang**, Bergsharman (SE); **Jesper Uddin**, Stockholm (SE); **Annika Hu**, Akersberga (SE)

(73) Assignee: **Powerwave Technologies Sweden AB**, Kista (SE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 238 days.

(21) Appl. No.: **12/759,582**

(22) Filed: **Apr. 13, 2010**

(65) **Prior Publication Data**

US 2010/0265150 A1 Oct. 21, 2010

Related U.S. Application Data

(60) Provisional application No. 61/170,204, filed on Apr. 17, 2009.

(30) **Foreign Application Priority Data**

Apr. 17, 2009 (SE) 0900515

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

(52) **U.S. Cl.** **343/836; 343/837; 343/912**

(58) **Field of Classification Search** 343/836, 343/837, 838, 912

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,518,969	A *	5/1985	Bogner	.....	343/819
5,872,544	A *	2/1999	Schay	.....	343/727
6,034,649	A	3/2000	Wilson et al.		
6,040,802	A *	3/2000	Smith et al.	.....	343/700 MS
6,995,724	B2	2/2006	Teshirogi et al.		
7,023,398	B2	4/2006	Gottl et al.		
7,573,434	B2 *	8/2009	Le Bayon et al.	.....	343/797
7,868,843	B2 *	1/2011	Borau et al.	.....	343/844
2010/0013729	A1 *	1/2010	Harel et al.	.....	343/837

OTHER PUBLICATIONS

PCT International Search Report pertaining to Swedish Patent Application No. 0900515-8 mailed Oct. 8, 2009.

* cited by examiner

Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — OC Patent Law Group

(57) **ABSTRACT**

An antenna assembly and a method of mounting such an assembly are disclosed. A first and a second assembly portion are joined together, wherein the assembly portions each comprise an elongated reflector body serving as a reflector for electromagnetic power radiated by the antenna assembly portion, and a set of antenna element receiving means located in a linear row along a longitudinal direction of the reflector body for respectively receiving an antenna element, and side portions along the long sides of the said reflector body. The assembly method comprises the step of fastening the first and second assembly portions to each other along a respective side portion of the said assembly portions so as to form a dual array antenna assembly.

15 Claims, 4 Drawing Sheets

