



US008493183B2

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

(10) **Patent No.:** **US 8,493,183 B2**
(45) **Date of Patent:** **Jul. 23, 2013**

(54) **WIRELESS TAG AND METHOD FOR
PRODUCING WIRELESS TAG**

340/572.5, 505, 568, 572; 343/764, 866,
343/730, 803, 846, 725, 741, 728, 732, 853,
343/855; 235/375, 385, 435, 492; 455/562.1,
455/575.7, 83, 562

(75) Inventors: **Takashi Yamagajp**, Kawasaki (JP);
Toru Maniwa, Kawasaki (JP)

See application file for complete search history.

(73) Assignee: **Fujitsu Limited**, Kawasaki (JP)

(56) **References Cited**

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 876 days.

U.S. PATENT DOCUMENTS

6,335,686	B1	1/2002	Goff et al.	
7,154,449	B2 *	12/2006	Liu et al.	343/867
7,545,328	B2 *	6/2009	Son et al.	343/700 MS
7,762,472	B2 *	7/2010	Kato	235/492
2002/0011967	A1	1/2002	Goff et al.	
2003/0206107	A1	11/2003	Goff et al.	

(Continued)

FOREIGN PATENT DOCUMENTS

CN	1312928	A	9/2001
CN	1835283	A	9/2006

(Continued)

OTHER PUBLICATIONS

European Office Action dated Dec. 2, 2010 in application No.
07790893.7.

(Continued)

Primary Examiner — Jennifer Mehmood

Assistant Examiner — Mirza Alam

(74) *Attorney, Agent, or Firm* — Smith, Gambrell & Russell,
LLP

(57) **ABSTRACT**

The wireless tag includes an antenna conductor; a first power-
supply conductor which is electromagnetic-inductively
coupled with the antenna conductor; and a second power-
supply conductor which is loop-shaped and which is electri-
cally coupled with the first power-supply conductor.

10 Claims, 16 Drawing Sheets

(21) Appl. No.: **12/648,675**

(22) Filed: **Dec. 29, 2009**

(65) **Prior Publication Data**

US 2010/0097191 A1 Apr. 22, 2010

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2007/064138,
filed on Jul. 18, 2007.

(51) **Int. Cl.**

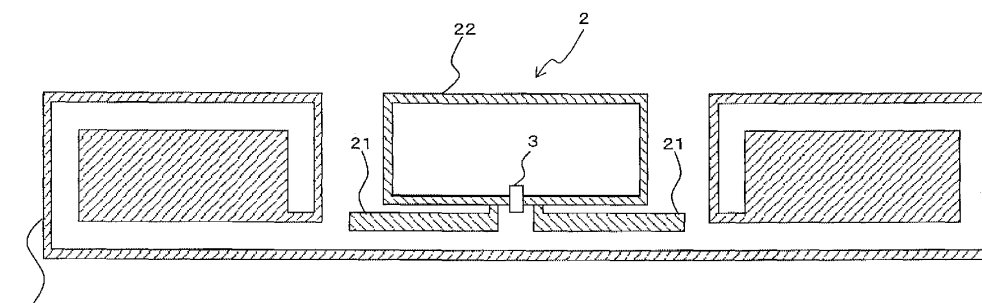
H04Q 5/22	(2006.01)
G08B 13/14	(2006.01)
G08B 23/00	(2006.01)
G08B 21/00	(2006.01)
H01Q 1/00	(2006.01)
H01Q 7/00	(2006.01)
H01Q 11/02	(2006.01)
H01Q 3/00	(2006.01)
H01Q 7/04	(2006.01)
G06K 19/06	(2006.01)

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

USPC **340/10.1**; 340/572.7; 340/573.1;
340/651; 343/730; 343/866; 343/803; 343/732;
343/748; 343/764; 343/842; 235/492

(58) **Field of Classification Search**

USPC 340/10.1, 572.1, 572.7, 572.8, 10.2,



1: ANTENNA PATTERN





US008493215B2

(12) **United States Patent**
Tada

(10) **Patent No.:** **US 8,493,215 B2**

(45) **Date of Patent:** **Jul. 23, 2013**

(54) **COMMUNICATION ANTENNA, RFID TAG, NON-CONTACT COMMUNICATION DEVICE, AND NON-CONTACT COMMUNICATION METHOD**

(75) Inventor: **Nobuyuki Tada**, Kanagawa (JP)

(73) Assignee: **FUJIFILM 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 585 days.

(21) Appl. No.: **12/641,331**

(22) Filed: **Dec. 18, 2009**

(65) **Prior Publication Data**

US 2010/0164726 A1 Jul. 1, 2010

(30) **Foreign Application Priority Data**

Dec. 26, 2008 (JP) 2008-334495

(51) **Int. Cl.**
G08B 13/14 (2006.01)

(52) **U.S. Cl.**
USPC **340/572.7; 343/803**

(58) **Field of Classification Search**
USPC 340/572.7, 572.6, 572.8, 568.1;
343/725-730, 793, 795, 803
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,682,143 A * 10/1997 Brady et al. 340/572.7
7,225,992 B2 * 6/2007 Forster 340/572.7
7,427,957 B2 * 9/2008 Zeinolabedin Rafi
et al. 343/770
7,538,738 B2 * 5/2009 Kai et al. 343/803
7,804,411 B2 * 9/2010 Copeland 340/572.7

7,928,921 B2 * 4/2011 Kai et al. 343/803
2009/0033462 A1 2/2009 Kitayoshi et al.
2010/0283694 A1 * 11/2010 Kato 343/730

FOREIGN PATENT DOCUMENTS

JP 2004-220141 A 8/2004
JP 2005-278139 10/2005
JP 2005-284331 A 10/2005
JP 2005-328259 A 11/2005
JP 2008-519500 T 6/2008

OTHER PUBLICATIONS

Partial English language translation of the following: Office action dated Oct. 2, 2012 from the Japanese Patent Office in a Japanese patent application corresponding to the instant patent application. This office action translation is submitted now in order to supplement the understanding of patent document JP 2005-278139 which is cited in the office action and is being disclosed in the instant Information Disclosure Statement.

* cited by examiner

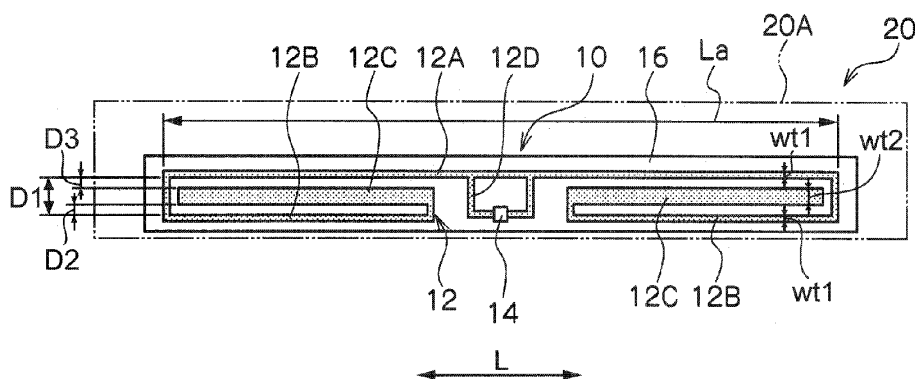
Primary Examiner — John A Tweel, Jr.

(74) *Attorney, Agent, or Firm* — SOLARIS Intellectual Property Group, PLLC

(57) **ABSTRACT**

A communication antenna has a rectangular radiating section, and has a structure that emits an electric field of linear polarized waves only in a vicinity of the radiating section of the antenna. An RFID tag has an IC chip and a tag antenna that is long in a predetermined direction. The tag antenna has a main antenna portion that is rectilinear and extends over substantially an entire length in a longitudinal direction of the tag antenna, and folded-over antenna portions at which currents induced by an external electric field offset one another due to portions that extend in mutually different orientations in the longitudinal direction. A parallel interval between the main antenna portion and a first folded-over antenna portion exceeds a width of the radiating section of the communication antenna.

8 Claims, 16 Drawing Sheets





US008493269B2

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

(10) **Patent No.:** **US 8,493,269 B2**
(45) **Date of Patent:** **Jul. 23, 2013**

(54) **MAGNETODIELECTRIC SUBSTRATE AND ANTENNA APPARATUS USING THE SAME**

(75) Inventors: **Soo-Yong Jang**, Daegu (KR); **Austin Kim**, Gyeonggi-do (KR); **Jae-Ho Lee**, Gyeonggi-do (KR); **Young-Soon Lee**, Gyeongbuk (KR); **Ui-Jung Kim**, Gyeongbuk (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 407 days.

(21) Appl. No.: **12/878,268**

(22) Filed: **Sep. 9, 2010**

(65) **Prior Publication Data**

US 2011/0068991 A1 Mar. 24, 2011

(30) **Foreign Application Priority Data**

Sep. 23, 2009 (KR) 10-2009-0089954

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

(52) **U.S. Cl.**
USPC 343/700 MS; 343/702; 343/787

(58) **Field of Classification Search**

USPC 343/702, 700 MS, 787
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,477,813 A * 10/1984 Weiss 343/700 MS

FOREIGN PATENT DOCUMENTS

CN 101510630 A * 8/2009

* cited by examiner

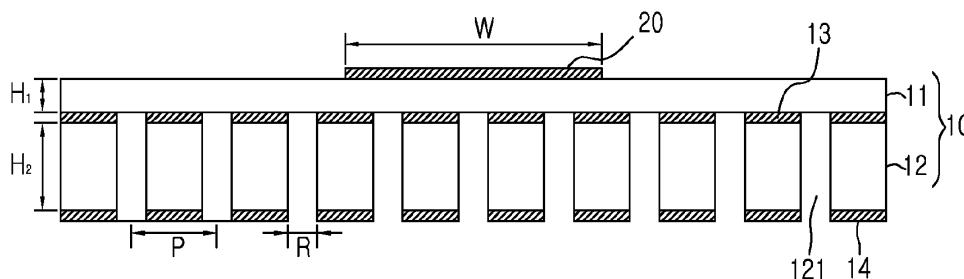
Primary Examiner — Dieu H Duong

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

(57) **ABSTRACT**

A magnetodielectric substrate includes a first dielectric layer, a second dielectric layer, conductive patterns, and a plurality of air vias. The first dielectric layer has a predetermined height, and the second dielectric layer is stacked on the first dielectric layer. Conductive patterns are coated on an upper surface and a lower surface of one of the first and second dielectric layers. A plurality of air vias is formed with a predetermined diameter and a predetermined interval such that they pass through up to the conductive patterns of the upper and lower surfaces from the dielectric layer on which the conductive patterns are coated.

15 Claims, 9 Drawing Sheets





US008493274B2

(12) **United States Patent**
Raura

(10) **Patent No.:** **US 8,493,274 B2**
(45) **Date of Patent:** **Jul. 23, 2013**

(54) **SLOT ANTENNA AND PORTABLE WIRELESS TERMINAL**

375/267; 342/368; 235/380; 370/329, 335,
370/280; 455/550.1, 452.2; 439/108

See application file for complete search history.

(75) Inventor: **Toru Raura**, Tokyo (JP)

(56) **References Cited**

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

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 195 days.

2,570,824 A * 10/1951 Lindenblad 343/767
3,701,161 A * 10/1972 Gregory 343/770

(Continued)

(21) Appl. No.: **12/094,248**

FOREIGN PATENT DOCUMENTS

(22) PCT Filed: **Nov. 16, 2006**

CA 2416437 1/2002
EP 1307947 5/2003

(86) PCT No.: **PCT/JP2006/322807**

(Continued)

§ 371 (c)(1),

(2), (4) Date: **May 19, 2008**

OTHER PUBLICATIONS

International Search Report PCT/ISA/210 of PCT/JP2006/322807.

(87) PCT Pub. No.: **WO2007/058230**

PCT Pub. Date: **May 24, 2007**

(Continued)

Primary Examiner — Robert Karacsony

Assistant Examiner — Hasan Islam

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

(65) **Prior Publication Data**

US 2009/0231215 A1 Sep. 17, 2009

(57) **ABSTRACT**

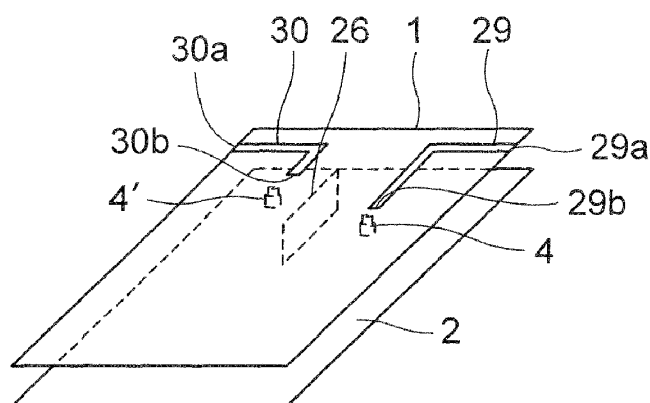
(30) **Foreign Application Priority Data**

Nov. 18, 2005 (JP) 2005-334952
Sep. 21, 2006 (JP) 2006-256304
Sep. 21, 2006 (JP) 2006-256305

A slot antenna is provided with at least two conductive plates arranged to face each other. A slot is arranged on one of or both of the facing conductive plates and has a long and narrow opening shape. A power feeding unit is arranged between the facing conductive plates and is electrically and physically connected with the facing conductive plates, respectively. When power is fed to the power feeding unit, the power is fed between the facing conductive plates by the power feeding unit. Thus, excitation with a frequency dependent on the electrical length of the slot is induced at the slot, and a current excited at the slot is distributed entirely over one conductive plate, the current becomes a radiation source, and an electromagnetic wave is radiated from the one conductive plate. At this time, the other conductive plate operates as the reflecting plate of the electromagnetic wave.

17 Claims, 49 Drawing Sheets

(51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 1/24 (2006.01)
(52) **U.S. Cl.**
USPC 343/767; 343/702; 343/770
(58) **Field of Classification Search**
USPC 343/727, 768, 840, 906, 713, 880,
343/911 R, 873, 702, 767, 700 MS, 770;





US008493279B2

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

(10) **Patent No.:** **US 8,493,279 B2**
(45) **Date of Patent:** **Jul. 23, 2013**

(54) **ANTENNA FEED SYSTEM**

(56) **References Cited**

(75) Inventors: **Robert J. Pera**, San Jose, CA (US);
John R. Sanford, Encinitas, CA (US)

U.S. PATENT DOCUMENTS

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

5,523,768 A * 6/1996 Hemmie et al. 343/840
5,666,126 A * 9/1997 Lange 343/781 R
6,127,987 A * 10/2000 Maruyama et al. 343/835
6,320,553 B1 * 11/2001 Ergene 343/781 P
6,326,922 B1 * 12/2001 Hegendoerfer 343/700 MS
6,429,827 B1 * 8/2002 Hsueh et al. 343/820
7,696,940 B1 * 4/2010 MacDonald 343/724
2007/0075909 A1 * 4/2007 Flynn et al. 343/840

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 180 days.

* cited by examiner

Primary Examiner — Michael C Wimer

Assistant Examiner — Amal Patel

(74) *Attorney, Agent, or Firm* — Anteco & Tormey LLP;
Peter Tormey

(21) Appl. No.: **12/477,986**

(22) Filed: **Jun. 4, 2009**

(57) **ABSTRACT**

(65) **Prior Publication Data**

US 2010/0309085 A1 Dec. 9, 2010

A microwave system comprises an antenna, antenna feed, a radio transceiver, and appropriate cabling among the aforementioned. Cost, performance and reliability improvements are achieved with further integration of these elements and with design improvements in the antenna feed. One improvement is the integration of the radio transceiver with the antenna feed. This improvement has many benefits including the to elimination of RF cables and connectors. Another improvement is the incorporation of parasitic radiators and sub-reflectors as part to of the antenna feed. The entire antenna, including the feed design is optimized with 3D finite element method (FEM) software and numerical optimization software. Another improvement is the utilization of the digital cable to power the integrated radio transceiver and a center fed parabolic reflector.

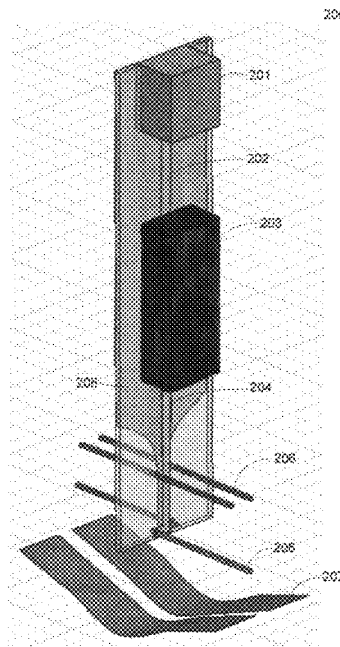
(51) **Int. Cl.**
H01Q 19/12 (2006.01)
H01Q 19/10 (2006.01)

(52) **U.S. Cl.**
USPC **343/840**; 343/833; 343/834

(58) **Field of Classification Search**
USPC 343/840, 833, 834, 779, 786, 757,
343/761, 754, 758, 795, 837, 781 P, 781 R,
343/781 CA; 455/90.3

See application file for complete search history.

10 Claims, 7 Drawing Sheets





US008493280B2

(12) **United States Patent**
Soler Castany et al.

(10) **Patent No.:** **US 8,493,280 B2**
(45) **Date of Patent:** **Jul. 23, 2013**

(54) **ANTENNA STRUCTURE FOR A WIRELESS
DEVICE WITH A GROUND PLANE SHAPED
AS A LOOP**

(75) Inventors: **Jordi Soler Castany**, Barcelona (ES);
Carles Puente Baliarda, 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.: **13/282,767**

(22) Filed: **Oct. 27, 2011**

(65) **Prior Publication Data**

US 2012/0038536 A1 Feb. 16, 2012

Related U.S. Application Data

(63) Continuation of application No. 12/834,177, filed on
Jul. 12, 2010, now Pat. No. 8,077,110, which is a
continuation of application No. 11/719,151, filed as
application No. PCT/EP2005/055959 on Nov. 14,
2005, now Pat. No. 7,782,269.

(60) Provisional application No. 60/627,653, filed on Nov.
12, 2004.

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

(52) **U.S. Cl.**
USPC **343/846**

(58) **Field of Classification Search**
USPC 343/700 MS, 702, 846, 848
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,843,468 A	6/1989	Drewery
5,363,114 A	11/1994	Shoemaker
5,557,293 A	9/1996	McCoy
5,666,125 A	9/1997	Luxon et al.
5,784,032 A	7/1998	Johnston et al.
5,886,669 A	3/1999	Kita

(Continued)

FOREIGN PATENT DOCUMENTS

DE	10345230 A1	4/2005
EP	0323664 A2	7/1989

(Continued)

OTHER PUBLICATIONS

Bhavsar, Samir A.: Letter: *Fractus v. Samsung et al.*, Case No. 6:09-cv-00203-LED: Disclosure of Material Information to the USPTO; Oct. 28, 2009.

(Continued)

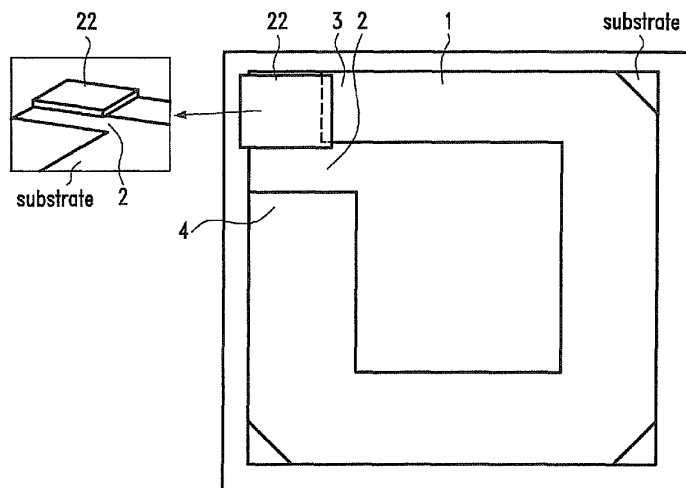
Primary Examiner — Tan Ho

(74) Attorney, Agent, or Firm — Kenyon & Kenyon LLP

(57) **ABSTRACT**

This invention refers to an antenna structure for a wireless device comprising a ground plane and an antenna element, wherein the ground plane has the shape of an open loop. The invention further refers to an antenna structure for a wireless device, such as a light switch or a wrist sensor or wristwatch, comprising an open loop ground plane having a first end portion and a second end portion, the open loop ground plane defining an opening between the first end portion and the second end portion; and an antenna component positioned within the opening defined between the first end portion and the second end portion and overlapping at least one of the first end portion or the second end portion. Further the invention refers to a corresponding wireless device and to a method for integrating such an antenna structure in a wireless device.

20 Claims, 21 Drawing Sheets





US008497806B2

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

(10) **Patent No.:** **US 8,497,806 B2**
(45) **Date of Patent:** **Jul. 30, 2013**

(54) **MOBILE WIRELESS DEVICE WITH MULTI-BAND LOOP ANTENNA WITH ARMS DEFINING A SLOTTED OPENING AND RELATED METHODS**

(75) Inventors: **Chun Kit Lai**, Sunrise, FL (US); **Soo Liam Ooi**, Sunrise, FL (US); **Qiwu Tan**, Sunrise, FL (US)

(73) Assignee: **Research In Motion Limited**, Waterloo, Ontario (CA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 361 days.

(21) Appl. No.: **13/005,326**

(22) Filed: **Jan. 12, 2011**

(65) **Prior Publication Data**

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Related U.S. Application Data

(60) Provisional application No. 61/367,083, filed on Jul. 23, 2010.

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

(52) **U.S. Cl.**
USPC **343/702**; 343/729; 343/700 MS

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,664,931 B1 12/2003 Nguyen et al. 343/767
6,717,551 B1 4/2004 Desclos et al. 343/700

6,822,611 B1 11/2004 Kontogeorgakis et al. 343/702
7,050,014 B1 5/2006 Chen et al. 343/795
7,564,411 B2 7/2009 Piisila et al. 343/702
7,626,551 B2 12/2009 Chien et al. 343/700
7,671,804 B2 * 3/2010 Zhang et al. 343/700 MS
2005/0151689 A1 * 7/2005 Vesterinen 343/702
2005/0270242 A1 12/2005 Qi et al. 343/702
2005/0280587 A1 * 12/2005 Svirgelj et al. 343/702
2008/0231530 A1 9/2008 Rao et al. 343/767
2009/0073048 A1 3/2009 Kim 343/700 MS
2009/0124215 A1 5/2009 Nysen 455/90.1
2009/0179801 A1 7/2009 Tsai et al. 343/700 MS
2009/0201209 A1 * 8/2009 Boyle 343/702
2012/0032857 A1 * 2/2012 Lai et al. 343/700 MS
2012/0032863 A1 * 2/2012 Lai et al. 343/767
2012/0188141 A1 * 7/2012 Islam 343/860

FOREIGN PATENT DOCUMENTS

EP 2026407 2/2009
WO WO00/03452 1/2000
WO WO2005/043674 5/2005
WO WO2008/122112 10/2008

* cited by examiner

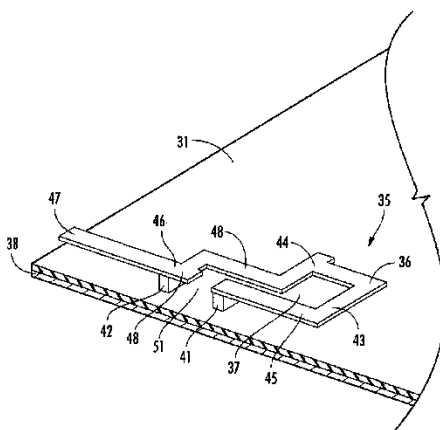
Primary Examiner Trinh Dinh

(74) *Attorney, Agent, or Firm* — Allen, Dyer, Doppelt, Milbrath & Gilchrist, P.A.

(57) **ABSTRACT**

A mobile wireless communications device may include a housing, a printed circuit board (PCB) carried by the housing. The device may also include an antenna coupled to wireless transceiver circuitry carried by the PCB. The antenna may include first and second feed legs extending upwardly from the PCB, a loop conductor spaced above the PCB and having a gap therein defining first and second ends, and a first conductor arm spaced above the PCB and extending between the first feed leg and the first end. The antenna may further include a second conductor arm spaced above the PCB and having a proximal portion between the second feed leg and the second end, and having a distal portion extending outwardly from the second feed leg. The first conductor arm and the proximal portion may define a slotted opening into an interior of the loop conductor.

23 Claims, 9 Drawing Sheets





US008497808B2

(12) **United States Patent**
Wang

(10) **Patent No.:** **US 8,497,808 B2**
(45) **Date of Patent:** **Jul. 30, 2013**

(54) **ULTRA-WIDEBAND MINIATURIZED OMNIDIRECTIONAL ANTENNAS VIA MULTI-MODE THREE-DIMENSIONAL (3-D) TRAVELING-WAVE (TW)**

7,545,335 B1 6/2009 Wang
8,264,410 B1 * 9/2012 Wang 343/700 MS
2008/0316124 A1 12/2008 Ilook

OTHER PUBLICATIONS

(75) Inventor: **Johnson J. H. Wang**, Marietta, GA (US)

(73) Assignee: **Wang Electro-Opto Corporation**,
Marietta, GA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 292 days.

(21) Appl. No.: **13/082,744**

(22) Filed: **Apr. 8, 2011**

(65) **Prior Publication Data**
US 2012/0256799 A1 Oct. 11, 2012

(51) **Int. Cl.**
H01Q 11/02 (2006.01)

(52) **U.S. Cl.**
USPC **343/737; 343/834**

(58) **Field of Classification Search**
USPC 343/737, 729, 834, 846
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,112,431 A	9/1978	Wild
5,313,216 A	5/1994	Wang et al.
5,453,752 A	9/1995	Wang et al.
5,546,096 A *	8/1996	Wada 343/771
5,589,842 A	12/1996	Wang et al.
5,621,422 A	4/1997	Wang
6,137,453 A	10/2000	Wang et al.
6,509,873 B1 *	1/2003	Nalbandian et al. ... 343/700 MS
6,972,729 B2 *	12/2005	Wang 343/833
7,106,270 B2	9/2006	Igusa et al.

Chu, L. J., "Physical Limitations of Omnidirectional Antennas," J. Appl. Phys. vol. 19, Dec. 1948.
Deschamps, G. A., "Impedance Properties of Complementary Multiterminal Planar Structure," IEEE Trans. Antennas and Prop., vol. 7, No. 5, pp. S371-S378, Dec. 1969.
DuHamel, H. D. and Scherer, J. P., "Frequency Independent Antennas," in Antenna Engineering Handbook, 3rd. Edition, R. C. Johnson, Editor, McGraw-Hill, New York, 1993.
Goubau, G., "Multi-Element Monopole Antennas," Proc. Army ECOM-ARO, Workshop on Electrically Small Antennas, Ft. Monmouth, NJ., pp. 63-67, May 1976.

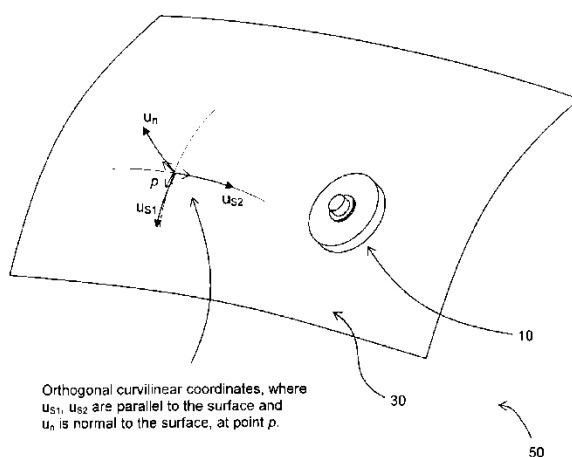
(Continued)

Primary Examiner — Ahshik Kim
(74) Attorney, Agent, or Firm — Thomas | Horstemeyer, LLP

(57) **ABSTRACT**

A class of ultra-wideband miniaturized traveling-wave (TW) antennas comprising a conducting ground surface at the base, a plurality of TW structures having at least one ultra-wideband low-profile two-dimensional (2-D) surface-mode TW structure, a frequency-selective coupler placed between adjacent TW structures, and a feed network. In one embodiment, a 2-D surface-mode TW structure is positioned above the conducting ground surface, a normal-mode TW structure placed on top with an external frequency-selective coupler placed in between; continuous octaval bandwidth of 14:1 and size reduction by a factor of 3 to 5 are achievable. In other embodiments using at least two 2-D TW structures and a dual-band feed network, a continuous bandwidth over 100:1, and up to 140:1 or more, is reachable. In yet another embodiment, ultra-wideband multi-band performance over an octaval operating bandwidth up to 2000:1 or more is feasible.

24 Claims, 13 Drawing Sheets



Orthogonal curvilinear coordinates, where u_{s1} , u_{s2} are parallel to the surface and u_n is normal to the surface, at point p .



US008497811B2

(12) **United States Patent**
Huang

(10) **Patent No.:** **US 8,497,811 B2**
(45) **Date of Patent:** **Jul. 30, 2013**

(54) **PRINTED DUAL-BAND ANTENNA FOR
ELECTRONIC DEVICE**

(75) Inventor: **Hsiao-Ting Huang**, Taichung County
(TW)

(73) Assignee: **Ralink Technology Corp.**, Jhuei,
Hsinchu County (TW)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
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(21) Appl. No.: **12/895,803**

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

(65) **Prior Publication Data**

US 2011/0115687 A1 May 19, 2011

(51) **Int. Cl.**
H01Q 11/00 (2006.01)

(52) **U.S. Cl.**
USPC **343/843**; 343/893; 343/853; 343/810

(58) **Field of Classification Search**
None

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,053,856 B2 * 5/2006 O'Sullivan 343/866
2007/0236400 A1 * 10/2007 Rentz 343/753
2007/0285334 A1 * 12/2007 Tsutsumi et al. 343/893
2011/0291895 A1 * 12/2011 Zaila et al. 343/702

* cited by examiner

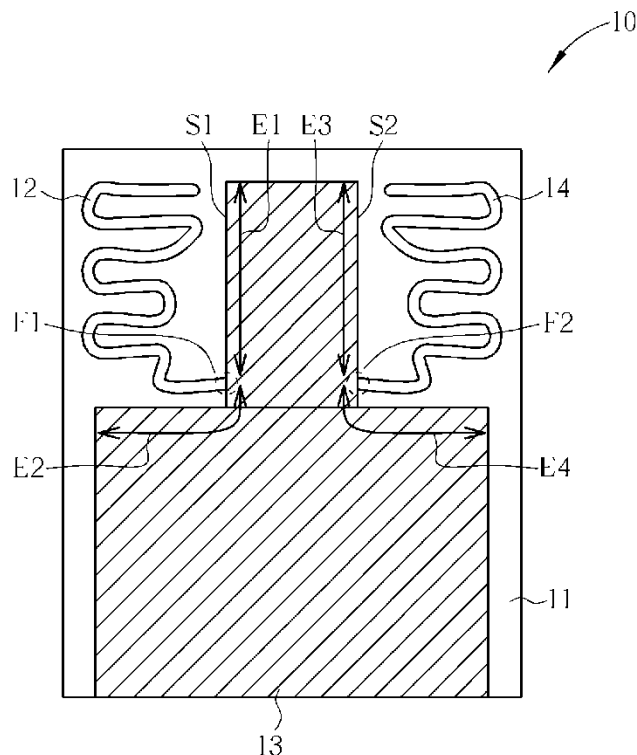
Primary Examiner — Trinh Dinh

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

(57) **ABSTRACT**

A printed dual-band antenna for an electronic device includes a substrate, a first monopole antenna and a grounding metal sheet. The first monopole antenna is formed on the substrate, and has an electrical length approximating to a quarter wavelength of a first frequency band and a three quarter wavelength of a second frequency band. The grounding metal sheet is formed on the substrate to be a ground of the first monopole antenna. A feeding terminal of the first monopole antenna, formed at a first side of the grounding metal sheet, divides the first side into a first edge and a second edge. Lengths of the first edge and the second edge approximate to a quarter wavelength of the second frequency band.

11 Claims, 13 Drawing Sheets





US008498182B1

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

(10) **Patent No.:** **US 8,498,182 B1**
(45) **Date of Patent:** **Jul. 30, 2013**

(54) **WRAP-AROUND ANTENNA DESIGN FOR
IMPROVED PERFORMANCE IN
THERMALLY-ASSISTED MAGNETIC
RECORDING**

(75) Inventors: **Hamid Balamane**, Portola Valley, CA
(US); **Jordan A. Katine**, Mountain
View, CA (US); **Neil L. Robertson**, Palo
Alto, CA (US); **Matteo Staffaroni**,
Pleasanton, CA (US); **Barry C. Stipe**,
San Jose, CA (US)

(73) Assignee: **HGST Netherlands B.V.**, Amsterdam
(NL)

(*) 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.: **13/490,283**

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

(51) **Int. Cl.**
G11B 11/00 (2006.01)

(52) **U.S. Cl.**
USPC **369/13.33**; 369/13.2; 369/13.02;
360/59

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,999,384	B2	2/2006	Stancil et al.	
7,652,954	B2	1/2010	Fontana, Jr. et al.	
7,852,587	B2 *	12/2010	Albrecht et al.	360/59
7,880,996	B2	2/2011	Stipe	
8,031,561	B2 *	10/2011	Hellwig et al.	369/13.01
2008/0149809	A1	6/2008	Hamann et al.	
2008/0151360	A1	6/2008	Stipe	
2009/0258186	A1	10/2009	Fontana, Jr. et al.	
2010/0163521	A1	7/2010	Balamane et al.	
2010/0165499	A1	7/2010	Stipe	
2011/0303637	A1	12/2011	Araki et al.	
2013/0064514	A1 *	3/2013	Peng	385/124

* cited by examiner

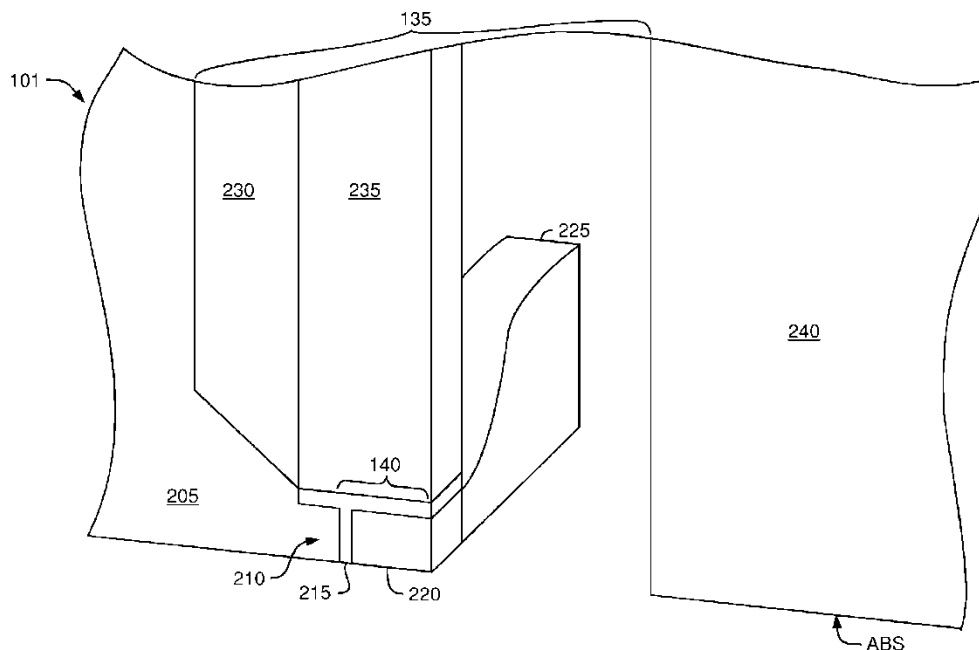
Primary Examiner — Muhammad N Edun

(74) *Attorney, Agent, or Firm* Patterson & Sheridan, LLP

(57) **ABSTRACT**

The presented embodiments generally relate to designing an antenna of an optical transducer (e.g., a near-field transducer or near-field optical source) that focuses the optical energy of a radiation source (e.g., a laser) onto a magnetic media, thereby heating the media. Specifically, the antenna is designed to wrap-around an aperture of the optical transducer such that at least a portion of the antenna is between a main pole of a write head and a surface of the aperture that faces the main pole. Moreover, the antenna may wrap-around the aperture such that it directly contacts the main pole.

20 Claims, 7 Drawing Sheets





US008498656B2

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

(10) **Patent No.:** **US 8,498,656 B2**
(45) **Date of Patent:** **Jul. 30, 2013**

(54) **ELECTRONIC DEVICE WITH IDLE MODE
ANTENNA SWITCHING**

(75) Inventors: **Syed A. Mujtaba**, Santa Clara, CA
(US); **Kee-Bong Song**, Santa Clara, CA
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(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 214 days.

(21) Appl. No.: **13/098,947**

(22) Filed: **May 2, 2011**

(65) **Prior Publication Data**

US 2012/0282982 A1 Nov. 8, 2012

(51) **Int. Cl.**
H04W 68/00 (2009.01)

(52) **U.S. Cl.**
USPC **455/458**

(58) **Field of Classification Search**
USPC **455/458**
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,239,306	A	8/1993	Siwiak et al.	
5,430,769	A	7/1995	Patsiokas et al.	
5,530,926	A *	6/1996	Rozanski	455/277.2
6,009,307	A	12/1999	Granata et al.	
6,009,310	A *	12/1999	Motohashi	340/7.43
6,023,615	A *	2/2000	Bruckert et al.	348/14.08
6,778,815	B1 *	8/2004	Enoki	455/277.2
7,616,158	B2	11/2009	Mak et al.	
7,701,410	B2	4/2010	Li et al.	
7,711,076	B2 *	5/2010	Cho	375/347
7,877,067	B2 *	1/2011	Hwang et al.	455/132
7,929,921	B2 *	4/2011	Love et al.	455/101

8,031,622	B2 *	10/2011	Padovani et al.	370/252
8,036,710	B2 *	10/2011	Walton et al.	455/562.1
8,055,313	B2 *	11/2011	Behzad et al.	455/574
8,086,195	B2 *	12/2011	Thomas et al.	455/132
8,254,861	B2 *	8/2012	Dominguez Romero et al.	455/140

(Continued)

FOREIGN PATENT DOCUMENTS

EP	0210792	2/1987
GB	2360911	10/2001
WO	0159945	8/2001

OTHER PUBLICATIONS

Ileath et al. "Multimode Antenna Selection for Spatial Multiplexing Systems With Linear Receivers", IEEE Transactions on Signal Processing, vol. 53, No. 8, 2005 pp. 3042-3056.
Syed A. Mujtaba, U.S. Appl. No. 13/099,081, filed May 2, 2011.

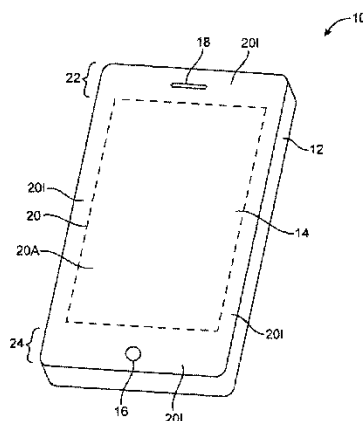
Primary Examiner — Nathan Mitchell

(74) *Attorney, Agent, or Firm* — Treyz Law Group; G. Victor Treyz; Jason Tsai

(57) **ABSTRACT**

Electronic devices may be provided that contain wireless communication circuitry. The wireless communication circuitry may include radio-frequency transceiver circuitry coupled to multiple antennas. An electronic device may alternate between a sleep mode and a wake mode. During wake mode, the electronic device may monitor a paging channel in a wireless network for incoming paging signals. The device may use a selected one of the multiple antennas in monitoring the paging channel. If received signal quality is satisfactory, the device may maintain use of the selected one of the multiple antennas for subsequent wake period monitoring of the paging channel. If received signal quality falls below a threshold or is otherwise indicated to not be satisfactory, the device may switch to use of a different one of the multiple antennas in monitoring the paging channel. Other criteria may also be used in controlling the switching between antennas for paging channel monitoring.

18 Claims, 4 Drawing Sheets





US008502734B2

(12) **United States Patent**
Motta Cruz et al.

(10) **Patent No.:** **US 8,502,734 B2**
(45) **Date of Patent:** **Aug. 6, 2013**

(54) **PRINTED ANTENNA HAVING A DUAL-BEAM DIAGRAM**

(75) Inventors: **Eduardo Motta Cruz**, Saint Herblain (FR); **Jean Philippe Dessarce**, Palanges (FR); **Mohamed Himdi**, Rennes (FR); **Franck Colombel**, Montfort sur Meu (FR)

(73) Assignee: **Bouygues Telecom**, Boulogne Billancourt (FR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 787 days.

(21) Appl. No.: **12/362,335**

(22) Filed: **Jan. 29, 2009**

(65) **Prior Publication Data**
US 2009/0224980 A1 Sep. 10, 2009

(30) **Foreign Application Priority Data**
Jan. 30, 2008 (FR) 08 50581

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
(52) **U.S. Cl.**
USPC **343/700 MS; 343/749**
(58) **Field of Classification Search**
USPC **343/700 MS**
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS
4,887,089 A * 12/1989 Shibata et al. 343/700 MS
5,872,542 A * 2/1999 Simons et al. 343/700 MS

6,118,406 A * 9/2000 Josypenko 343/700 MS
6,252,553 B1 * 6/2001 Solomon 343/700 MS
6,320,542 B1 11/2001 Yamamoto et al.
7,505,002 B2 * 3/2009 Surittikul et al. 343/700 MS
2006/0139212 A1 6/2006 Reuss
2007/0268188 A1 * 11/2007 Guha et al. 343/700 MS

FOREIGN PATENT DOCUMENTS

WO WO 01/86754 A1 11/2001

OTHER PUBLICATIONS

Kraus, John D. Capacitors and Capacitance. Electromagnetics: Second Edition. McGraw Hill, 1973, pp. 49-50.*
Liang, X.-L., Zhong, S.-S. and Wang, W. (2005), Design of a dual-polarized microstrip patch antenna with excellent polarization purity. Microw. Opt. Technol. Lett., 44: 329-331. doi: 10.1002/mop.20625.*

* cited by examiner

Primary Examiner — Michael C Wimer

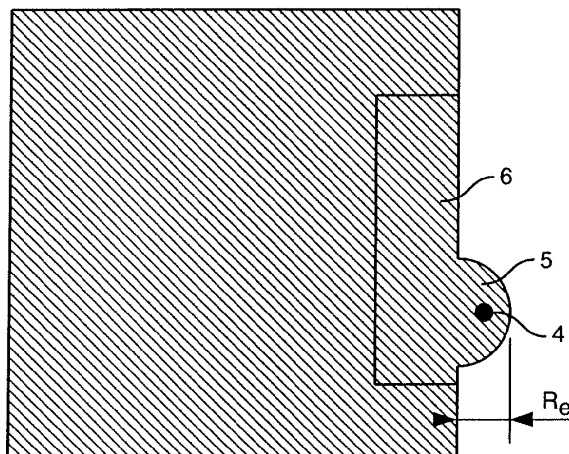
Assistant Examiner — Amal Patel

(74) *Attorney, Agent, or Firm* — Blakely Sokoloff Taylor & Zafman

(57) **ABSTRACT**

The invention relates to a printed antenna comprising a ground plane, a substrate stacked to the ground plane, a metal deposit made on the substrate in order to form therein a resonating patch (3), and a means of supplying to excite the resonating patch, characterized in that the patch has dimensions that are adapted for the patch to be able to radiate in both upper electromagnetic modes TM_{02} and TM_{20} , and in that the means of supplying makes it possible to excite the patch on an excitation point (4) arranged along the patch so that the patch resonates in a single of said upper electromagnetic modes, by inducing this way a dual-beam radiation diagram with, in the same plane orthogonal to the patch, two main misaligned and symmetric lobes in relation to the normal to the patch.

8 Claims, 6 Drawing Sheets





US008502737B2

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

(10) **Patent No.:** **US 8,502,737 B2**

(45) **Date of Patent:** **Aug. 6, 2013**

(54) **COMMUNICATION DEVICE**

(56) **References Cited**

(75) Inventors: **Toshihiko Kawata**, Funabashi (JP);
Shinichi Nakada, Yamato (JP); **Masaki**
Noji, Kawasaki (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 740 days.

(21) Appl. No.: **12/294,873**

(22) PCT Filed: **Mar. 28, 2007**

(86) PCT No.: **PCT/JP2007/056641**

§ 371 (c)(1),
(2), (4) Date: **May 28, 2010**

(87) PCT Pub. No.: **WO2007/114165**

PCT Pub. Date: **Oct. 11, 2007**

(65) **Prior Publication Data**

US 2010/0231459 A1 Sep. 16, 2010

(30) **Foreign Application Priority Data**

Mar. 28, 2006 (JP) 2006-087466
Mar. 28, 2006 (JP) 2006-087467

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

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

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

U.S. PATENT DOCUMENTS

6,476,767 B2 * 11/2002 Aoyama et al. 343/700 MS
6,873,292 B2 * 3/2005 Yoo et al. 343/702
7,280,075 B2 * 10/2007 Koyama et al. 343/702
7,301,499 B2 * 11/2007 Shin et al. 343/700 MS
8,174,452 B2 * 5/2012 Ayala Vazquez et al. 343/702

FOREIGN PATENT DOCUMENTS

JP 09064764 A 3/1997
JP 09289471 A 11/1997
JP 10126146 A 5/1998
JP 10173434 A 6/1998

(Continued)

OTHER PUBLICATIONS

Japanese language office action dated Aug. 17, 2010 and its English
language translation for corresponding Japanese application
2006087466 lists the references above.

(Continued)

Primary Examiner — Tho G Phan

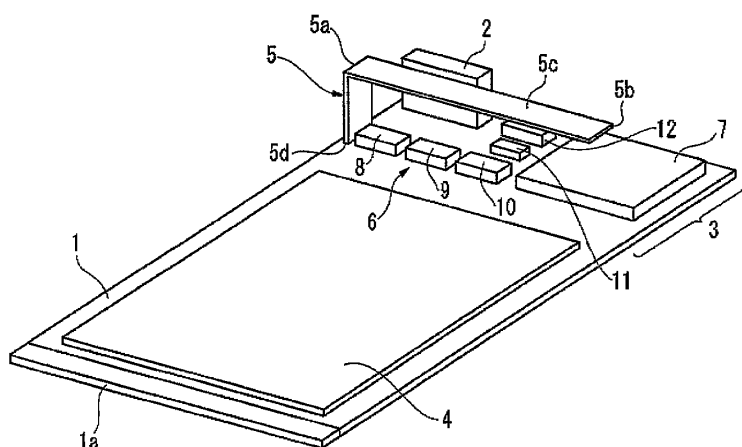
(74) *Attorney, Agent, or Firm* — DLA Piper LLP (US)

(57)

ABSTRACT

A communication device which solves a new problem, that is,
a power amplifier has oscillation caused by providing a con-
ductive body which reduces the effects of the noise on a chip
antenna, includes: a chip antenna which catches radio waves
of a desired frequency; an RF circuit which is implemented on
a printed wiring board and which converts received signals
input from the chip antenna to a low frequency; a digital
circuit which is implemented on the printed wiring board and
which demodulates the received signals in a low frequency
input from the RF circuit; a conductive body which is
extended between the chip antenna and the digital circuit
while being maintained at a certain height from the printed
wiring board, and which has an end connected to a ground
conductive body of the printed wiring board; and a radio wave
absorption body which is attached to the conductive body.

6 Claims, 7 Drawing Sheets





US008502739B2

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

(10) **Patent No.:** **US 8,502,739 B2**
(45) **Date of Patent:** ***Aug. 6, 2013**

(54) **ANTENNA ARRANGEMENT**

(56) **References Cited**

(75) Inventors: **Jani Ollikainen**, Helsinki (FI); **Harri A. Lasarov**, Espoo (FI); **Pekka Kilpi**, Helsinki (FI); **Jussi Rahola**, Espoo (FI); **Lassi Hyvonen**, Helsinki (FI); **Anssi Vanska**, Helsinki (FI); **Joonas Krogerus**, 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 592 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **12/665,479**

(22) PCT Filed: **Jun. 22, 2007**

(86) PCT No.: **PCT/IB2007/002780**

§ 371 (c)(1),

(2), (4) Date: **May 3, 2010**

(87) PCT Pub. No.: **WO2009/001158**

PCT Pub. Date: **Dec. 31, 2008**

(65) **Prior Publication Data**

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H01Q 1/24 (2006.01)

(52) **U.S. Cl.**
USPC **343/702**

(58) **Field of Classification Search**
USPC 343/702, 895, 753, 844, 793
See application file for complete search history.

U.S. PATENT DOCUMENTS

4,460,899	A *	7/1984	Schmidt et al.	343/841
5,952,978	A *	9/1999	VanVoorhies	343/742
6,259,407	B1 *	7/2001	Tran	343/700 MS
6,469,675	B1 *	10/2002	Jo et al.	343/744
7,330,156	B2	2/2008	Arkko et al.	343/702
7,439,935	B1 *	10/2008	Rodenbeck	343/895
8,134,506	B2 *	3/2012	Leisten	343/702
2002/0101298	A1	8/2002	Jinushi	333/134
2002/0180651	A1 *	12/2002	Hareyama	343/702
2004/0051669	A1 *	3/2004	Rutfors et al.	343/702

(Continued)

FOREIGN PATENT DOCUMENTS

EP	1 701 406	A1	9/2006
WO	WO 2005/074070	A1	8/2005
WO	WO 2006/031170	A1	3/2006
WO	WO 2007/043941	A1	4/2007

OTHER PUBLICATIONS

Chiou, et al., "Designs of compact microstrip antennas with a slotted ground plane", IEEE, Ant. and Prop. Soc. Int. Symp. 2001 (IEEE AP-S 2001), vol. 2, Jul. 8-13, 2001 pp. 732-735.

(Continued)

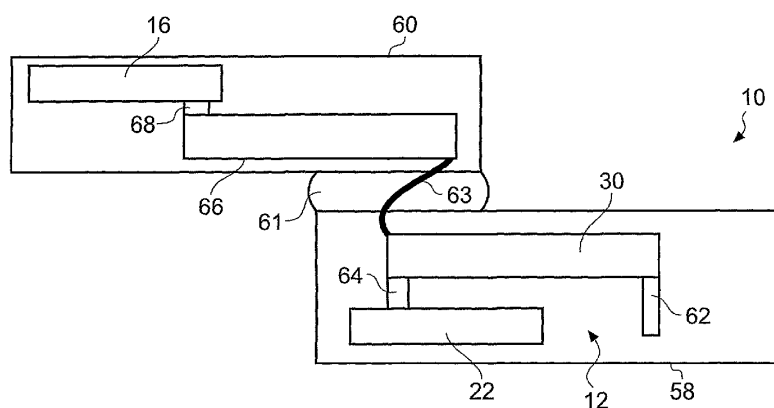
Primary Examiner — Huedung Mancuso

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

(57) **ABSTRACT**

An antenna arrangement including a ground plane having an electrical length; an antenna element positioned for coupling with the ground plane; a first conductive element; an interconnecting mechanism, connected to the ground plane and to the first conductive element, having a first configuration and a second configuration, wherein the ground plane has a first electrical length when the interconnecting mechanism is in the first configuration and a second electrical length, different to the first electrical length, when the interconnecting mechanism is in the second configuration.

20 Claims, 5 Drawing Sheets





US008502741B2

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

(10) **Patent No.:** **US 8,502,741 B2**
(45) **Date of Patent:** **Aug. 6, 2013**

(54) **STRUCTURE FOR ADJUSTING AN EM WAVE
PENETRATION RESPONSE AND ANTENNA
STRUCTURE FOR ADJUSTING AN EM WAVE
RADIATION CHARACTERISTIC**

(75) Inventors: **Hung-Hsuan Lin**, Taipei (TW);
Chun-Yih Wu, Taichung (TW);
Ken-Huang Lin, Kaohsiung (TW);
Hsin-Lung Su, Kaohsiung (TW); **Yi-Jen
Wang**, Tainan County (TW)

(73) Assignees: **Industrial Technology Research
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Yat-sen University**, Kaohsiung (TW)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 401 days.

(21) Appl. No.: **13/012,805**

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

(65) **Prior Publication Data**

US 2012/0105295 A1 May 3, 2012

(30) **Foreign Application Priority Data**

Nov. 2, 2010 (TW) 99137645 A

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

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

(58) **Field of Classification Search**
USPC 343/702, 700 MS, 841, 846
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,559,803 B2 5/2003 Shinichi
6,657,595 B1 12/2003 Phillips et al.

6,798,168 B1 9/2004 Annamalai et al.
6,958,737 B2 10/2005 Lee et al.
7,382,319 B2 * 6/2008 Kawahata et al. 343/700 MS
7,554,496 B2 6/2009 Qi et al.
7,672,698 B2 3/2010 Kang
2002/0196192 A1 * 12/2002 Nagumo et al. 343/700 MS
2010/0113111 A1 5/2010 Wong et al.

OTHER PUBLICATIONS

Jianqing Wnag et al., "Effects of Ferrite Sheet Attachment to Portable Telephone in Reducing Electromagnetic Absorption in Human Head", issued on Aug. 2-6, 1999 in Seattle, WA, USA. p. 822-p. 825.
Sang Il Kwak et al., "SAR reduction on a mobile phone antenna using the EBG structures", Microwave Conference, 2008. EuMC 2008. 38th European, issued on Oct. 27-31, 2008 in Amsterdam, Netherlands. p. 1308-p. 1311.
Jiunn-Nan Hwang et al., "Reduction of the Peak SAR in the Human Head With Metamaterials", IEEE Transactions on Antennas and Propagation, vol. 54, No. 12, issued on Dec. 2006 in St. Petersburg, Russia. p. 3763-p. 3770.

* cited by examiner

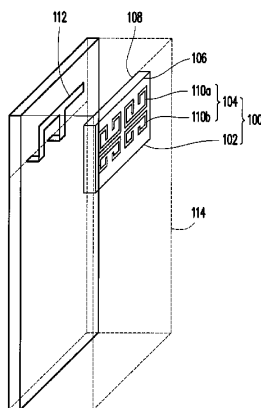
Primary Examiner — Hoanganh Le

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

(57) **ABSTRACT**

A structure for adjusting electromagnetic wave (EM wave) penetration response includes a plurality of structure units and a dielectric substrate with an upper surface and a lower surface. The structure units are disposed on the upper surface and/or the lower surface. The structure unit consists of metal lines or complementary slits so as to enable an EM wave penetration response of the structure to include a pass band and a stop band. The frequency of the stop band is higher than that of the pass band. If a distance between the structure and an object with a high dielectric constant is longer than a predetermined distance, the pass band covers a radiation frequency of an antenna. If the distance between the structure and the object with the high dielectric constant is within the predetermined distance, the stop band covers the radiation frequency of the antenna.

16 Claims, 22 Drawing Sheets





US008502745B2

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

(10) **Patent No.:** **US 8,502,745 B2**
(45) **Date of Patent:** **Aug. 6, 2013**

(54) **ANTENNA APPARATUS**

(56) **References Cited**

(75) Inventors: **Se Hyun Park**, Suwon-si (KR); **Byung Tae Yoon**, Suwon-si (KR); **Dong-Jin Kim**, Seoul (KR); **Seong-Ook Park**, Daejeon (KR); **Rashid A. Bhatti**, Daejeon (KR); **Viet Anh Nguyen**, Daejeon (KR); **Mingoo Choi**, Daejeon (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 877 days.

(21) Appl. No.: **12/371,684**

(22) Filed: **Feb. 16, 2009**

(65) **Prior Publication Data**

US 2010/0045557 A1 Feb. 25, 2010

(30) **Foreign Application Priority Data**

Aug. 19, 2008 (KR) 10-2008-0081019

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

(52) **U.S. Cl.**
USPC 343/770; 343/893; 343/867; 343/850

(58) **Field of Classification Search**
USPC 343/770, 876, 893, 850
See application file for complete search history.

U.S. PATENT DOCUMENTS

7,557,765	B2 *	7/2009	Lai et al.	343/770
2003/0011519	A1 *	1/2003	Breglia et al.	343/700 MS
2003/0030588	A1	2/2003	Kalis et al.	
2004/0130494	A1 *	7/2004	Fukushima et al.	343/702
2005/0093753	A1 *	5/2005	Masaki	343/702
2007/0035463	A1 *	2/2007	Hirabayashi	343/824
2007/0123181	A1 *	5/2007	Bit-Babik et al.	455/101
2007/0285322	A1 *	12/2007	Nyshadham et al.	343/703
2008/0139136	A1	6/2008	Shtrom et al.	

FOREIGN PATENT DOCUMENTS

JP	1993-152830	6/1993
JP	2006-340234	12/2006
JP	2006-340235	12/2006
KP	10-2008-0006427	1/2008
KR	10-2005-0098896	10/2005
KR	10-2008-047874	5/2008
WO	WO 2004/015810 A1	2/2004

OTHER PUBLICATIONS

European Search Report issued Apr. 21, 2009 in counterpart European Patent Application No. 03153557.5 (6 pages, in English).

* cited by examiner

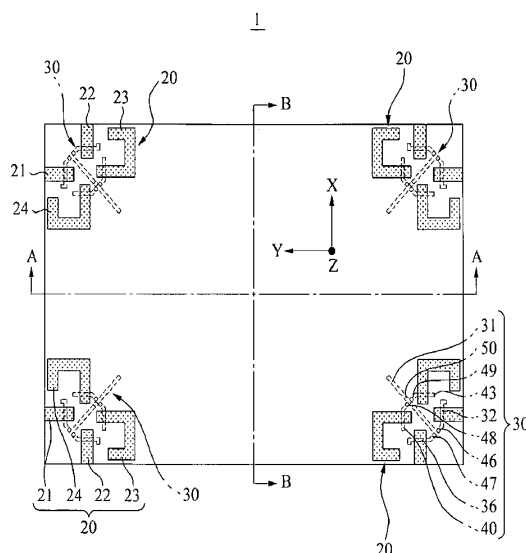
Primary Examiner — Dieu H Duong

(74) *Attorney, Agent, or Firm* — NSIP Law

(57) **ABSTRACT**

An antenna apparatus that may be adapted to various environments. The antenna apparatus includes a radiation unit to transmit and receive in a 360° radius including a plurality of radiators, each radiator configured to radiate a main emission pattern in different direction; and a switch unit configured to selectively operate each of the plurality of radiators.

19 Claims, 6 Drawing Sheets





US008502746B2

(12) **United States Patent**
Huang

(10) **Patent No.:** **US 8,502,746 B2**
(45) **Date of Patent:** **Aug. 6, 2013**

(54) **PLANAR DIRECTIONAL ANTENNA**

(75) Inventor: **Huan-Chu Huang**, Taoyuan County
(TW)

(73) Assignee: **HTC Corporation**, 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 487 days.

(21) Appl. No.: **12/618,795**

(22) Filed: **Nov. 16, 2009**

(65) **Prior Publication Data**

US 2011/0063187 A1 Mar. 17, 2011

(30) **Foreign Application Priority Data**

Sep. 14, 2009 (TW) 98130911 A

(51) **Int. Cl.**
H01Q 19/30 (2006.01)
H01Q 19/00 (2006.01)
H01Q 19/12 (2006.01)

(52) **U.S. Cl.**
USPC **343/819**; 343/833; 343/840

(58) **Field of Classification Search**
USPC 343/700 MS, 793, 818, 819, 833,
343/834, 840, 846

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,046,703 A * 4/2000 Wang et al. 343/795
6,567,055 B1 * 5/2003 Oglesby 343/795
2006/0061513 A1 * 3/2006 Sato 343/767
2009/0079653 A1 * 3/2009 Semonov et al. 343/793

FOREIGN PATENT DOCUMENTS

WO 2009038739 3/2009

OTHER PUBLICATIONS

"Search Report of European Counterpart Application" issued on Jan.
27, 2010, p. 1-p. 4.

* cited by examiner

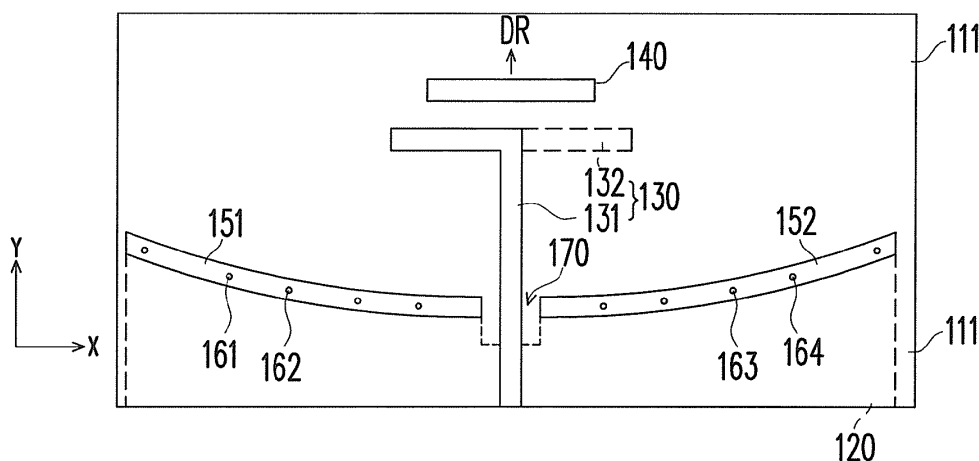
Primary Examiner — Robert Karacsony

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

(57) **ABSTRACT**

A planar directional antenna including a substrate, a metal layer, a master antenna, and an auxiliary antenna is provided. The substrate has a first surface and a second surface. The metal layer is disposed on the second surface of the substrate, and an upper edge of the metal layer forms a concave parabolic curve. The master antenna is disposed on the substrate and located within a predetermined range of the focus of the concave parabolic curve. The auxiliary antenna is disposed on the substrate and opposite to the master antenna so that the planar directional antenna generates a beam toward a radiation direction.

9 Claims, 6 Drawing Sheets





US008502747B2

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

(10) **Patent No.:** **US 8,502,747 B2**
(45) **Date of Patent:** **Aug. 6, 2013**

(54) **DIPOLE ANTENNA ASSEMBLY**

(56) **References Cited**

(75) Inventors: **Sheng-Che Chang**, Tu-Cheng (TW);
Chang-Ching Lin, Tu-Cheng (TW);
Chun-Chieh Tseng, Tu-Cheng (TW);
Yun-Cheng Hou, Tu-Cheng (TW); **John**
Chow, Saratoga, CA (US)

(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 331 days.

(21) Appl. No.: **12/906,180**

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

(65) **Prior Publication Data**

US 2011/0279341 A1 Nov. 17, 2011

(30) **Foreign Application Priority Data**

May 12, 2010 (TW) 099208859

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

(52) **U.S. Cl.**
USPC **343/822**; 343/795; 343/700 MS

(58) **Field of Classification Search**
USPC 343/820, 821, 822, 700 MS, 795,
343/79, 793

See application file for complete search history.

U.S. PATENT DOCUMENTS
4,860,019 A * 8/1989 Jiang et al. 343/795
7,095,382 B2 * 8/2006 Surducan et al. 343/793
7,501,955 B2 * 3/2009 Forster et al. 340/572.7
7,564,423 B2 7/2009 Ke et al.
7,659,863 B2 * 2/2010 Kai et al. 343/795
2004/0140941 A1 * 7/2004 Joy et al. 343/795
2006/0022888 A1 * 2/2006 Cheng 343/795

* cited by examiner

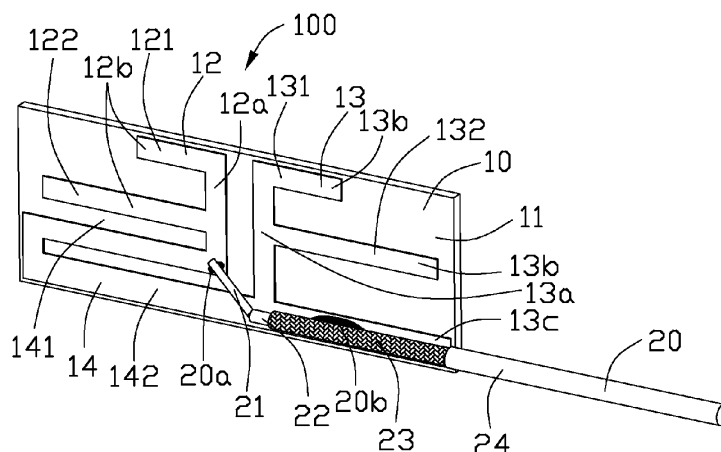
Primary Examiner — Hoanganh Le

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

(57) **ABSTRACT**

A dipole antenna assembly (100, 200) includes a dipole
antenna (10, 30) and a feeding element (20, 40) connecting
with the dipole antenna. The dipole antenna includes a radiation
portion (12, 32), a ground portion (13, 33) and a circuit
(14, 34). The feeding element includes a central conductor
(21, 41) soldered on the radiation portion at a first position,
and a shielding layer (23, 43) soldered on the ground portion
at a second position. The circuit includes one end connecting
with the radiation portion at the first position, and another end
connecting with the ground position at the second position for
impedance matching.

7 Claims, 6 Drawing Sheets





US008502748B2

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

(10) **Patent No.:** **US 8,502,748 B2**
(45) **Date of Patent:** **Aug. 6, 2013**

(54) **THREE-DIMENSIONAL DUAL-BAND ANTENNA**

(75) Inventors: **Mao-Tse Liang**, Hsinchu (TW);
Shih-Chieh Cheng, Tainan County (TW); **Kuo-Chang Lo**, Miaoli County (TW)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 349 days.

(21) Appl. No.: **12/870,298**

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

(65) **Prior Publication Data**
US 2011/0050523 A1 Mar. 3, 2011

(30) **Foreign Application Priority Data**
Aug. 28, 2009 (TW) 98129023 A

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

(52) **U.S. Cl.**
USPC **343/860**; 343/702; 343/729; 343/792

(58) **Field of Classification Search**
USPC 343/700 MS, 702, 770, 846, 820, 343/844, 850, 860, 893, 914
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,242,352	B2 *	7/2007	Tavassoli Hozouri	343/700 MS
7,403,160	B2 *	7/2008	Chiang et al.	343/702
7,705,791	B2 *	4/2010	Ollikainen	343/702
7,920,095	B2 *	4/2011	Wei	343/700 MS
2005/0057400	A1 *	3/2005	Yuanzhu	343/700 MS

FOREIGN PATENT DOCUMENTS

CN	101527387 A	9/2009
TW	M286998 U	2/2006

* cited by examiner

Primary Examiner — Shawki Ismail

Assistant Examiner — Christopher Lo

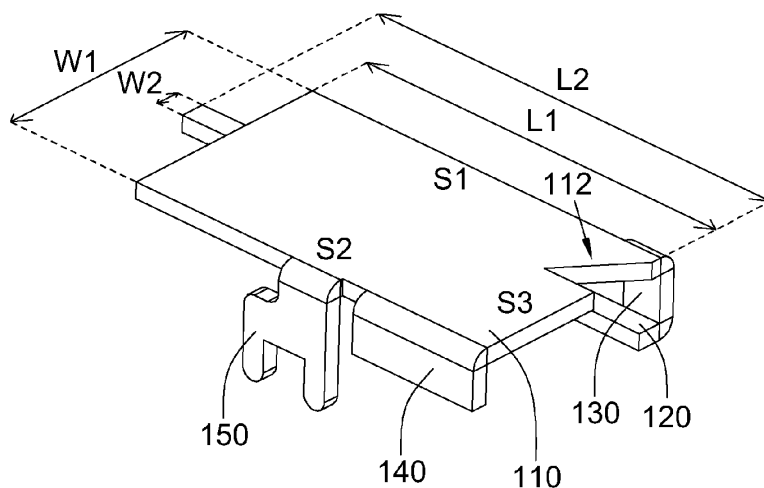
(74) *Attorney, Agent, or Firm* — Rabin & Berdo, P.C.

(57) **ABSTRACT**

A three-dimensional dual-band antenna including a first radiation portion, a second radiation portion, a connection portion, an impedance matching portion and a feeding portion is provided. The second radiation portion is located under the radiation portion and parallel with the first radiation portion. The connection portion is connected to the first side of the first radiation portion and extended downward vertically, for connecting the first radiation portion and the second radiation portion. The impedance matching portion is connected to a second side of the first radiation portion and extended downward vertically. The first side and the second side are opposite. The feeding portion is connected to the second side and extended downward vertically. The feeding portion receives a feeding signal. The first and the second radiation portion are operated at the first and the second bandwidth respectively, wherein the second bandwidth is in higher frequency than the first bandwidth.

19 Claims, 8 Drawing Sheets

100





US008508416B2

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

(10) **Patent No.:** **US 8,508,416 B2**
(45) **Date of Patent:** **Aug. 13, 2013**

(54) **CAP ASSEMBLY**

(56) **References Cited**

(75) Inventors: **Laurian P. Chirila**, Irvine, CA (US);
Iain C. Roy, Mississauga (CA)
(73) Assignee: **Psion Inc.**, Mississauga, Ontario (CA)
(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 438 days.

U.S. PATENT DOCUMENTS
5,841,402 A * 11/1998 Dias et al. 343/702
6,195,053 B1 * 2/2001 Kodukula et al. 343/702
6,333,716 B1 * 12/2001 Pontoppidan 343/702
6,749,121 B2 * 6/2004 Connolly et al. 235/472.01
7,232,072 B1 * 6/2007 Bunte et al. 235/462.45
2006/0232484 A1 * 10/2006 Wulff et al. 343/702
2007/0007353 A1 * 1/2007 Danielson et al. 235/462.46
2009/0262030 A1 * 10/2009 Zweers 343/702
2009/0295567 A1 * 12/2009 Bellows 340/539.11

* cited by examiner

(21) Appl. No.: **12/766,264**

(22) Filed: **Apr. 23, 2010**

Primary Examiner — Hoanganh Le

(65) **Prior Publication Data**

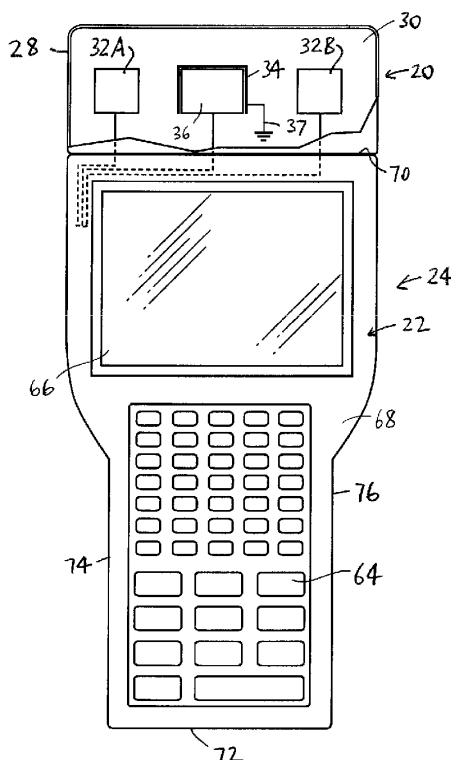
US 2011/0260930 A1 Oct. 27, 2011

(57) **ABSTRACT**

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
(52) **U.S. Cl.**
USPC **343/702; 343/841**
(58) **Field of Classification Search**
USPC 343/702, 718, 841, 872; 455/347,
455/348, 556.1, 556.2; 235/439, 454, 462.01,
235/462.45, 462.46, 462.47, 472.01, 472.02
See application file for complete search history.

A cap assembly attachable to a main housing of a handheld device. The cap assembly includes a cap body at least partially defining one or more cavities therein, and one or more WAN antennas receivable in the cavity. In addition, the cap assembly includes an electromagnetic shield receivable in the cavity for providing each WAN antenna with a predetermined electromagnetic environment in which the impedances of the WAN antenna and the electromagnetic shield are substantially matched.

20 Claims, 8 Drawing Sheets





US008508417B2

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

(10) **Patent No.:** **US 8,508,417 B2**
(45) **Date of Patent:** **Aug. 13, 2013**

(54) **ANTENNA AND RADIO COMMUNICATION
DEVICE**

(75) Inventors: **Kengo Onaka**, Kanagawa-ken (JP);
Takashi Ishihara, Tokyo-to (JP);
Munehisa Watanabe, Shiga-ken (JP);
Takuya Murayama, Ishikawa-ken (JP)

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

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 423 days.

(21) Appl. No.: **12/816,113**

(22) Filed: **Jun. 15, 2010**

(65) **Prior Publication Data**

US 2010/0321256 A1 Dec. 23, 2010

(30) **Foreign Application Priority Data**

Jun. 18, 2009 (JP) 2009-144954

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

(52) **U.S. Cl.**
USPC **343/702**; 343/741; 343/846

(58) **Field of Classification Search**
USPC 343/702, 741, 828, 831, 833, 846
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,950,072 B2 * 9/2005 Miyata et al. 343/702
7,298,340 B2 * 11/2007 Ohba 343/702
7,375,695 B2 * 5/2008 Ishizuka et al. 343/745
7,538,732 B2 5/2009 Ishihara et al.

FOREIGN PATENT DOCUMENTS

CN	1497774 A	5/2004
CN	101099265 A	1/2008
JP	H10-56314 A	2/1998
JP	2001-223519 A	8/2001
JP	2001-339226 A	12/2001

OTHER PUBLICATIONS

Japanese Office Action "Notification of Reasons for Rejection" dated
Oct. 18, 2011; Japanese Patent Application No. 2009-144954 with
translation.

The First Office Action issued on Nov. 20, 2012, from the State
Intellectual Property Office of People's Republic of China, which
corresponds to Chinese Patent Application No. 201010202598.4 and
is related to U.S. Appl. No. 12/816,113 with partial translation.

* cited by examiner

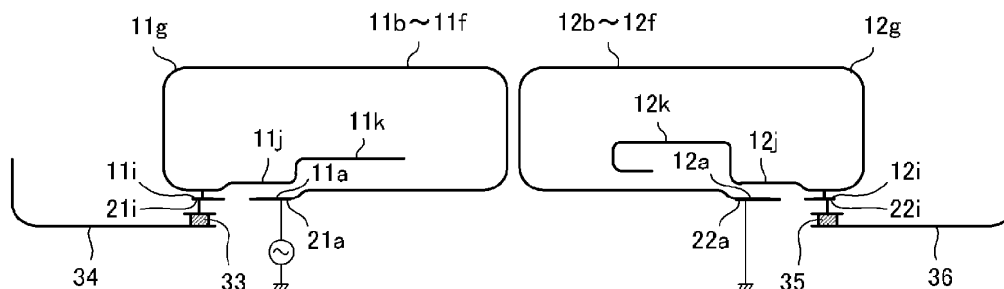
Primary Examiner — James H Cho

(74) *Attorney, Agent, or Firm* — Studebaker & Brackett PC

(57) **ABSTRACT**

A dielectric base of an antenna element has a first external
terminal at a position substantially corresponding to a node of
voltage-distribution distribution of a harmonic wave distrib-
uted in a feeding radiation electrode and a second external
terminal at a position substantially corresponding to a node of
voltage-distribution distribution of a harmonic wave distrib-
uted in a non-feeding radiation electrode. A substrate has a
ground electrode and a first external-terminal electrode to
which the first external terminal is connected. An extension
element extends from the first external-terminal electrode so
as to be separated from the ground electrode.

16 Claims, 8 Drawing Sheets





US008508418B2

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

(10) **Patent No.:** **US 8,508,418 B2**
(45) **Date of Patent:** **Aug. 13, 2013**

(54) **ANTENNAS FOR ELECTRONIC DEVICES
WITH CONDUCTIVE HOUSING**

(75) Inventors: **Douglas B. Kough**, San Jose, CA (US);
Gregory A. Springer, Sunnyvale, CA
(US); **Bing Chiang**, Melbourne, FL
(US); **Enrique Ayala Vazquez**,
Watsonville, CA (US); **Hao Xu**,
Cupertino, CA (US)

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

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

(21) Appl. No.: **13/619,614**

(22) Filed: **Sep. 14, 2012**

(65) **Prior Publication Data**
US 2013/0009833 A1 Jan. 10, 2013

Related U.S. Application Data

(62) Division of application No. 12/490,286, filed on Jun.
23, 2009, now Pat. No. 8,269,675.

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

(52) **U.S. Cl.**
USPC **343/702; 343/767**

(58) **Field of Classification Search**
USPC **343/702, 767, 770**
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,258,892 A 11/1993 Stanton et al.
5,608,413 A 3/1997 Macdonald

6,272,356 B1 8/2001 Dolman et al.
6,339,400 B1 1/2002 Flint et al.
6,380,930 B1 4/2002 Van Ruyambeke
6,392,610 B1 5/2002 Braun et al.
6,396,444 B1 5/2002 Goward et al.
6,414,643 B2 7/2002 Cheng et al.
6,421,029 B1 7/2002 Tanabe
6,448,942 B2 9/2002 Weinberger et al.
6,509,877 B2 1/2003 Masaki
6,539,608 B2 4/2003 McKinnon et al.
6,570,538 B2 5/2003 Vaisanen et al.
6,636,181 B2* 10/2003 Asano et al. 343/702
6,640,113 B1 10/2003 Shim et al.

(Continued)

OTHER PUBLICATIONS

Chiang et al, United States Patent Application No. 11/959,191, filed
Dec. 18, 2007.

(Continued)

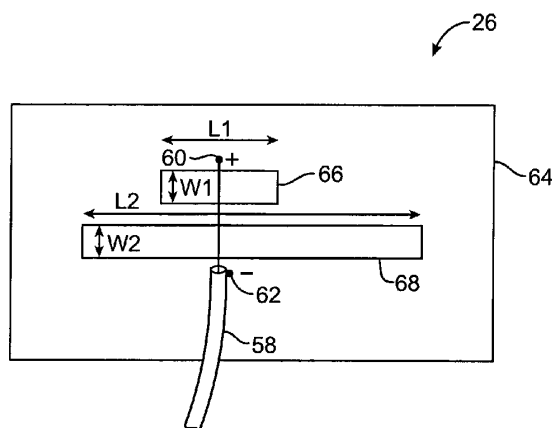
Primary Examiner — Hoanganh Le

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

(57) **ABSTRACT**

An electronic device may be provided with a conductive
housing. The conductive housing may be formed from a
metal. Slots may be formed in the housing. The slots may
serve as an antenna and may be fed using an antenna feed
structure within the electronic device housing. The electronic
device may have a frame to which housing structures are
attached and may have a stand or other support structure. The
frame may be used to mount a display, to support housing
walls, to support clutch barrel structures, etc. The slots may be
formed in the frame or in a space between the frame and the
housing walls. The slots or other antenna structures may also
be formed in the stand. Multiple slots may be used together to
support operations in two or more communications bands.
There may be multiple dual slot antennas in the electronic
device.

18 Claims, 17 Drawing Sheets





US008508420B2

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

(10) **Patent No.:** **US 8,508,420 B2**
(45) **Date of Patent:** ***Aug. 13, 2013**

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

(75) Inventors: **Shigeyuki Fujieda**, Hakusan (JP);
Kazunari Kawahata, Yokohama (JP);
Kenichi Ishizuka, Yokohama (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 133 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **12/352,888**

(22) Filed: **Jan. 13, 2009**

(65) **Prior Publication Data**

US 2009/0115674 A1 May 7, 2009

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2007/058312, filed on Apr. 17, 2007.

(30) **Foreign Application Priority Data**

Jul. 13, 2006 (JP) 2006-192433

(51) **Int. Cl.**
H01Q 9/00 (2006.01)
H01Q 1/24 (2006.01)
H01Q 21/00 (2006.01)
H01Q 1/38 (2006.01)

(52) **U.S. Cl.**
USPC **343/745**; 343/702; 343/750; 343/826;
343/853; 343/700 MS

(58) **Field of Classification Search**
USPC 343/702, 745, 750, 826, 853, 700 MS
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,462,716 B1 * 10/2002 Kushihi 343/860
2003/0117325 A1 * 6/2003 Jo et al. 343/702

(Continued)

FOREIGN PATENT DOCUMENTS

JP 2002-158529 5/2002
JP 2004-165965 6/2004

(Continued)

OTHER PUBLICATIONS

"Capacitors and Capacitance," John D. Kraus, Electromagnetics, Second Edition, McGraw Hill, 1973.*

(Continued)

Primary Examiner — Jacob Y Choi

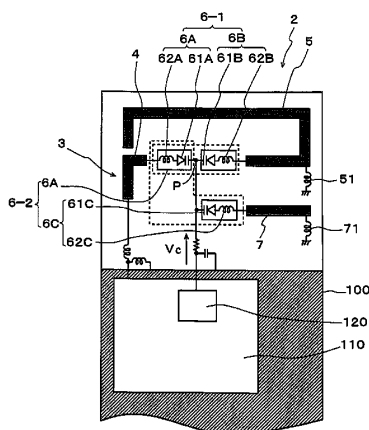
Assistant Examiner — Graham Smith

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

(57) **ABSTRACT**

An antenna device and a wireless communication apparatus that are capable of obtaining a plurality of resonant frequencies and varying the plurality of resonant frequencies over a wide range are provided. A first antenna unit of an antenna device includes a feed electrode, a first radiation electrode, and a first frequency-variable circuit. The first frequency-variable circuit includes first and second reactance circuits each including a variable-capacitance diode. A control voltage is applied to the first frequency-variable circuit, and the resonant frequency of the first antenna unit can thus be varied. A second antenna unit includes the feed electrode, a second radiation electrode, and a second frequency-variable circuit. The second frequency-variable circuit includes first and third reactance circuits each including a variable-capacitance diode. A control voltage is applied to the second frequency-variable circuit, and the resonant frequency of the second antenna unit can thus be varied.

6 Claims, 9 Drawing Sheets





US008508423B2

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

(10) **Patent No.:** **US 8,508,423 B2**

(45) **Date of Patent:** **Aug. 13, 2013**

(54) **ANTENNA DEVICE**

(75) Inventors: **Tomohiro Suetsuna**, Kanagawa (JP);
Makoto Higaki, Kanagawa (JP);
Kouichi Harada, Tokyo (JP); **Seichi**
Suenaga, Kanagawa (JP); **Mitsuru**
Ishibashi, Kanagawa (JP); **Maki**
Yonetsu, Tokyo (JP)

(73) Assignee: **Kabushiki Kaisha Toshiba**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1043 days.

(21) Appl. No.: **12/410,768**

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

(65) **Prior Publication Data**

US 2009/0295662 A1 Dec. 3, 2009

(30) **Foreign Application Priority Data**

May 30, 2008 (JP) 2008-141856

(51) **Int. Cl.**

H01Q 1/00 (2006.01)

H01Q 19/10 (2006.01)

H01Q 1/38 (2006.01)

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

USPC **343/787**; 343/818; 343/700 MS

(58) **Field of Classification Search**

USPC 343/818

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,320,080 A * 3/1982 Esper et al. 419/32
5,563,616 A * 10/1996 Dempsey et al. 343/753
6,323,810 B1 * 11/2001 Poilasne et al. 343/700 MS

7,285,329 B2 * 10/2007 Kaneko et al. 428/403
2008/0150825 A1 6/2008 Higaki et al.
2008/0220231 A1 9/2008 Suetsuna et al.
2009/0040112 A1 2/2009 Sekine et al.

FOREIGN PATENT DOCUMENTS

JP 07-221536 8/1995
JP 2006-222873 8/2006
JP 2007-124696 5/2007

OTHER PUBLICATIONS

"Reflection and Transmission," Advanced Engineering Electromagnetics, Constantine Balanis, John Wiley and Sons, 1989, pp. 180 to 243.*

"Capacitors and Capacitance," John D Kraus, Electromagnetics, Second Edition, McGraw Hill, 1973.*

U.S. Appl. No. 12/623,749, filed Nov. 23, 2009, Inoue, et al.

U.S. Appl. No. 12/351,235, filed Jan. 9, 2009, Makoto Higaki, et al.

(Continued)

Primary Examiner — Jacob Y Choi

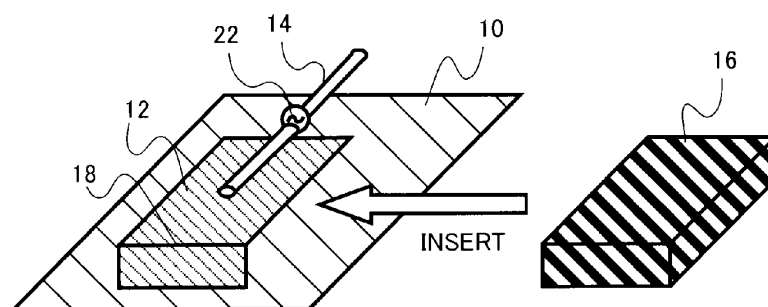
Assistant Examiner — Graham Smith

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

(57) **ABSTRACT**

The present invention provides a small antenna device realizing both miniaturization including lower profile and a broader band in a frequency band of hundreds MHz to 5 GHz and which can be mounted on a small device such as a cellular phone. An antenna device includes: a finite ground plane; a rectangular conductor plate provided above the finite ground plane, whose one side is connected to the finite ground plane, and having a bent portion substantially parallel with the one side; an antenna disposed substantially parallel with the finite ground plane above the finite ground plane, extending in a direction substantially perpendicular to the one side, and having a feeding point positioned near the other side facing the one side of the rectangular conductor plate; and a magnetic material provided in at least a part of space between the finite ground plane and the antenna.

20 Claims, 7 Drawing Sheets





US008508425B2

(12) **United States Patent**
Aizawa

(10) **Patent No.:** **US 8,508,425 B2**
(45) **Date of Patent:** **Aug. 13, 2013**

(54) **PATCH ANTENNA, ANTENNA UNIT AND ANTENNA APPARATUS**

(75) Inventor: **Toshiaki Aizawa**, Tokyo (JP)

(73) Assignee: **Mitsumi Electric, Co., Ltd.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 321 days.

(21) Appl. No.: **13/075,328**

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

(65) **Prior Publication Data**

US 2011/0241961 A1 Oct. 6, 2011

(30) **Foreign Application Priority Data**

Mar. 31, 2010 (JP) 2010-080177

(51) **Int. Cl.**
H01Q 19/06 (2006.01)

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

(58) **Field of Classification Search**
USPC 343/833, 834, 841, 867, 872, 700,
343/702, 711, 712, 713, 715, 725, 727, 728,
343/729, 742; 455/344, 374

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,042,399 B2 * 5/2006 Noro et al. 343/700 MS
2012/0242533 A1 * 9/2012 Shiba 342/146

FOREIGN PATENT DOCUMENTS

JP 2006-237813 A 9/2006

* cited by examiner

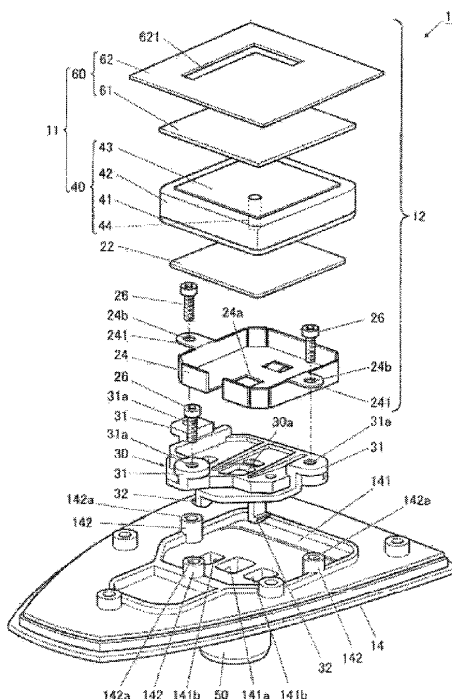
Primary Examiner — Karl D Frech

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

(57) **ABSTRACT**

Provided is a patch antenna, an antenna unit and an antenna apparatus that can increase the directional gain of a patch antenna at a high angle of elevation and that can make the directional gain of a patch antenna at a given angle of elevation uniform at all azimuth angles. Patch antenna **11** has patch antenna main body **40** having antenna electrode **43** on its top surface, and a waveguide **60** mounted on the top surface of patch antenna main body **40**. Waveguide **60** has top plate **62** having a larger flat surface than patch antenna main body **40** and having L-shaped slot **621** on the flat surface, and spacer **61** provided between the top surface of patch antenna main body **40** and top plate **62** and separating antenna electrode **43** and top plate **62** a predetermined distance apart.

3 Claims, 5 Drawing Sheets





US008508426B2

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

(10) **Patent No.:** **US 8,508,426 B2**
(45) **Date of Patent:** **Aug. 13, 2013**

(54) **VARIABLE DIRECTIONAL ANTENNA**

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(58) **Field of Classification Search**
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See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

H26 H *	2/1986	Dinger	342/372
5,576,718 A *	11/1996	Buralli et al.	343/700 MS
6,320,542 B1 *	11/2001	Yamamoto et al.	343/700 MS
7,242,366 B2 *	7/2007	Shibata	343/893
7,773,035 B2 *	8/2010	Murata et al.	343/700 MS
2008/0036662 A1	2/2008	Iwata et al.	
2008/0088510 A1	4/2008	Murata et al.	

FOREIGN PATENT DOCUMENTS

JP	07058539	3/1995
JP	3439723	6/2003
JP	200660772	3/2006
JP	200737162	2/2007
WO	9112637	8/1991

OTHER PUBLICATIONS

"Shaped-Beam Microstrip Arrays Antennas", the Institute of Electronics, Information and Communication Engineers (IEICE), p. 250; 2002.
International Search Report dated Nov. 20, 2007, in corresponding International Application No. PCT/JP2007/000860.

(Continued)

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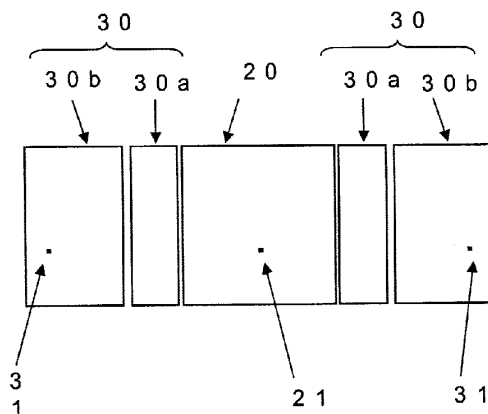
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(57) **ABSTRACT**

A variable directional antenna by means of a microstrip antenna and reactance change. The variable directional antenna has a structure to reduce sidelobes occurring when an element interval is reduced, and is structured in a three-element plane, having a feeding element and non-feeding elements provided at both sides of the feeding element. Each of the non-feeding elements provided at both sides of the feeding element has two split non-feeding elements two-divided into sizes of 1:2 in the lateral direction. The split non-feeding element divided into the size 1 is provided closer to the feeding element, and a reactance variable part is connected with the split non-feeding element divided into the size of 2. Alternatively, each of the non-feeding elements provided at both sides of the feeding element has two split non-feeding elements two-divided into sizes of 2:1 in the lateral direction. The split non-feeding element divided into the size 2 is provided closer to the feeding element, and the reactance variable part is connected either with the split non-feeding element divided into the size of 2 or the split non-feeding element divided into the size 1.

8 Claims, 11 Drawing Sheets





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(12) **United States Patent**
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(54) **ANTENNA ARRANGEMENT**

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See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,181,287	B1 *	1/2001	Beigel	343/741
6,621,466	B2	9/2003	Kuck	343/846
7,616,158	B2 *	11/2009	Mak et al.	343/700 MS
7,701,350	B2 *	4/2010	Sakama et al.	340/572.7
8,179,333	B2 *	5/2012	Rajanish et al.	343/795
2004/0203529	A1	10/2004	Hong et al.	455/90.3
2006/0258414	A1	11/2006	Vance et al.	455/575.7
2008/0180254	A1 *	7/2008	Kajander	340/572.7

FOREIGN PATENT DOCUMENTS

WO WO 2006/057275 A1 1/2006

* cited by examiner

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(57) **ABSTRACT**

An antenna arrangement including a partitioned ground plane including at least a first part and a second part that are interconnected by a component having a predetermined impedance; and an inductive coupling element positioned adjacent the component.

20 Claims, 5 Drawing Sheets

