



US008089411B2

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

(10) **Patent No.:** **US 8,089,411 B2**
(45) **Date of Patent:** ***Jan. 3, 2012**

(54) **INFORMATION EQUIPMENT WITH A PLURALITY OF RADIO COMMUNICATION ANTENNAS**

(75) Inventors: **Hiroshi Shimasaki**, Hamura (JP); **Masao Teshima**, Kunitachi (JP); **Satoshi Mizoguchi**, Ome (JP); **Anwar Sathath**, Ome (JP); **Toshiyuki Hirota**, Hino (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 200 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **12/274,711**

(22) Filed: **Nov. 20, 2008**

(65) **Prior Publication Data**
US 2009/0073060 A1 Mar. 19, 2009

Related U.S. Application Data

(63) Continuation of application No. 11/802,149, filed on May 21, 2007, now Pat. No. 7,522,109.

(30) **Foreign Application Priority Data**

May 29, 2006 (JP) 2006-148799

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

(52) **U.S. Cl.** **343/702**; 343/700 MS; 343/872

(58) **Field of Classification Search** 343/702, 343/720, 858, 876, 700 MS, 872; 455/455, 455/509, 552.1, 553.1

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,509,877	B2	1/2003	Masaki	
6,801,777	B2 *	10/2004	Rusch	455/452.2
7,043,209	B2	5/2006	Hirota	
7,133,646	B1 *	11/2006	Miao	455/73
7,398,068	B2 *	7/2008	Javor et al.	455/140
7,403,508	B1 *	7/2008	Miao	370/335
7,522,109	B2 *	4/2009	Shimasaki et al.	343/702
7,733,276	B2 *	6/2010	Levy et al.	343/702
2003/0022637	A1	1/2003	Hirota	
2006/0079290	A1	4/2006	Seto et al.	

FOREIGN PATENT DOCUMENTS

JP 08-149055 6/1996

(Continued)

OTHER PUBLICATIONS

Chinese Office Action dated Sep. 6, 2010 for Appln. No. 200710109259.x.

Primary Examiner — Douglas W Owens

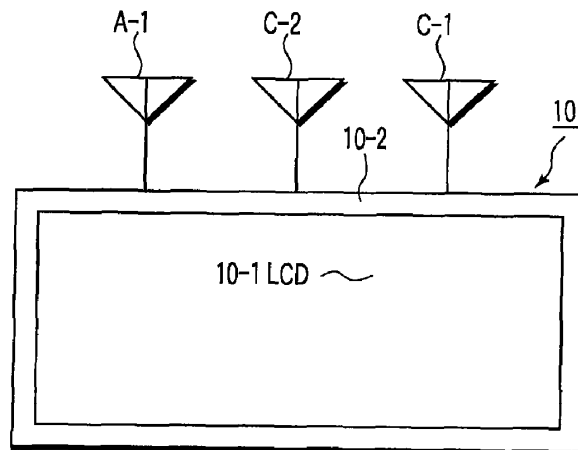
Assistant Examiner — Chuc Tran

(74) *Attorney, Agent, or Firm* — Pillsbury Winthrop Shaw Pittman, LLP

(57) **ABSTRACT**

Information equipment according to an embodiment includes a display housing with a display unit, a first radio communication antenna disposed at an end part of the display housing, a second radio communication antenna using a frequency band adjacent to or overlapped with that of the first radio communication antenna, and a third radio communication antenna disposed at an end part between the first and the second radio communication antennas, and uses a frequency band not adjacent to nor overlapped with those of the first and the second radio communication antennas.

9 Claims, 5 Drawing Sheets





US008089412B2

(12) **United States Patent**
Nishio

(10) **Patent No.:** **US 8,089,412 B2**
(45) **Date of Patent:** **Jan. 3, 2012**

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

(75) Inventor: **Masaki Nishio**, 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 351 days.

(21) Appl. No.: **12/289,093**

(22) Filed: **Oct. 20, 2008**

(65) **Prior Publication Data**

US 2009/0167617 A1 Jul. 2, 2009

(30) **Foreign Application Priority Data**

Dec. 27, 2007 (JP) 2007-336557

- (51) **Int. Cl.**
H01Q 1/24 (2006.01)
- (52) **U.S. Cl.** **343/702**
- (58) **Field of Classification Search** **343/702,**
343/876, 846, 818, 833-834
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,924,237	A *	5/1990	Honda et al.	.....	343/702
5,231,407	A *	7/1993	McGirr et al.	.....	343/700 MS
6,753,815	B2	6/2004	Okubora et al.	.....
6,888,504	B2 *	5/2005	Chiang et al.	.....	343/702
7,180,464	B2 *	2/2007	Chiang et al.	.....	343/833

7,439,918	B2 *	10/2008	Iwai et al.	.....	343/702
2004/0150568	A1 *	8/2004	Chiang et al.	.....	343/702
2005/0052324	A1 *	3/2005	Anderson et al.	.....	343/702
2007/0030108	A1	2/2007	Ishimoto et al.	.....

FOREIGN PATENT DOCUMENTS

JP	10-224142	8/1998
JP	11-298231	10/1999
JP	2002-261533	9/2002
JP	2002-353867	12/2002
JP	2006-032587	2/2006
WO	2007/084094	7/2007

OTHER PUBLICATIONS

Rebeiz, Gabriel M., et al., "MEMS Switch Reliability and Power Handling", RF MEMS Theory, Design and Technology, Chap. 7, Sec. 1, pp. 185-189, (2003).
Office Action dated Aug. 30, 2011 in Jp Application No. 2007-336557 and English-language translation thereof.

* cited by examiner

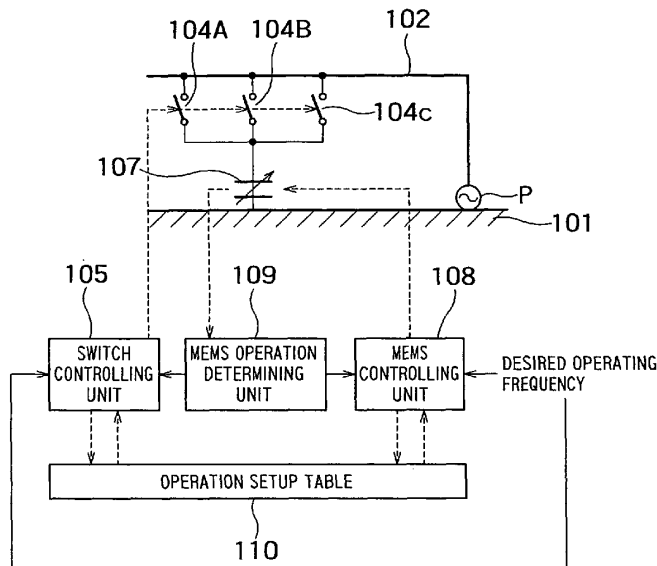
Primary Examiner — Huedung Mancuso

(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye, P.C.

(57) **ABSTRACT**

There is provided with an antenna device includes a conductive ground plane; an antenna including a radiating element; at least one variable capacitor having one end connected to the conductive ground plane; a plurality of switch elements having one ends connected to the other end of said at least one variable capacitor and other ends connected to the antenna at different locations; a switch controlling unit configured to control an ON/OFF state of each of the switch elements; and a capacitor controlling unit configured to control a capacitance of said at least one variable capacitor.

10 Claims, 13 Drawing Sheets





US008089413B2

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

(10) **Patent No.:** **US 8,089,413 B2**
(45) **Date of Patent:** **Jan. 3, 2012**

(54) **RADIO APPARATUS AND ANTENNA
ADAPTED FOR CONTACTLESS
COMMUNICATION**

(75) Inventors: **Takashi Minemura**, Tokyo (JP); **Naoto Ito**, 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 477 days.

(21) Appl. No.: **12/402,647**

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

(65) **Prior Publication Data**
US 2010/0052999 A1 Mar. 4, 2010

(30) **Foreign Application Priority Data**
Aug. 29, 2008 (JP) 2008-222699

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

(52) **U.S. Cl.** 343/702; 343/742; 343/867

(58) **Field of Classification Search** 343/702, 343/741, 866, 867

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2005/0040997 A1* 2/2005 Akiho et al. 343/866
2006/0114159 A1* 6/2006 Yoshikawa et al. 343/702
2008/0252551 A1* 10/2008 Kubo et al. 343/867

FOREIGN PATENT DOCUMENTS

JP 2005-026865 A 1/2005
JP 2005-134942 A 5/2005

* cited by examiner

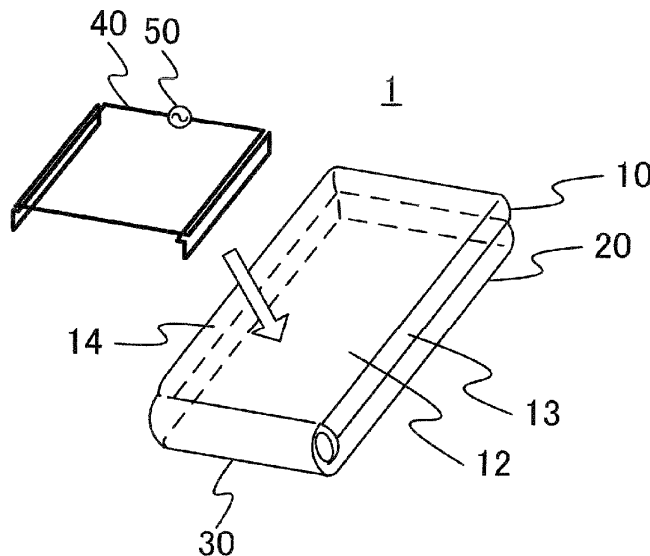
Primary Examiner — Hoanganh Le

(74) *Attorney, Agent, or Firm* — Holtz, Holtz, Goodman & Chick, PC

(57) **ABSTRACT**

A radio apparatus having a casing and an antenna is provided. The casing has first, second and third faces. The second face and the third face correspond to a side face and another side face of the first face, respectively. The antenna is formed by a conductive line in such a way that the conductive line forms a first loop shape, a second loop shape and a third loop shape, that the first loop shape includes a first portion and a second portion positioned adjacent to a third portion of the second loop shape and a fourth portion of the third loop shape, respectively, that directions of currents distributed on the first portion and the third portion if the antenna is fed are almost same, and that directions of currents distributed on the second portion and the fourth portion if the antenna is fed are almost same.

12 Claims, 4 Drawing Sheets





US008089414B2

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

(10) **Patent No.:** **US 8,089,414 B2**
(45) **Date of Patent:** ***Jan. 3, 2012**

(54) **WALL-MOUNTED ELECTRICAL DEVICE WITH MODULAR ANTENNA BEZEL FRAME**

(75) Inventors: **George Feldstein**, Cresskill, NJ (US); **Stan Wisniewski**, Pompton Plains, NJ (US); **Philip Bellingham**, White Plains, NY (US); **Krunoslav Draganovic**, Nyack, NY (US)

(73) Assignee: **Crestron Electronics Inc.**, Rockleigh, NJ (US)

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

5,239,205	A	8/1993	Hoffman et al.
5,736,965	A	4/1998	Mosebrook et al.
5,818,128	A	10/1998	Hoffman et al.
5,905,442	A	5/1999	Mosebrook et al.
5,909,087	A	6/1999	Bryde et al.
5,949,200	A	9/1999	Ference et al.
5,982,103	A	11/1999	Mosebrook et al.
6,000,807	A	12/1999	Moreland
6,120,262	A	9/2000	McDonough et al.
6,183,101	B1	2/2001	Chien
6,339,400	B1	1/2002	Flint et al.
6,444,906	B1	9/2002	Lewis
D465,460	S	11/2002	Mayo et al.
6,578,980	B1	6/2003	Chen et al.
6,660,948	B2	12/2003	Clegg et al.
6,969,959	B2	11/2005	Black et al.
6,970,097	B2	11/2005	Welles et al.
7,080,787	B2	7/2006	Wulff et al.
7,106,261	B2*	9/2006	Nagel et al. 343/702
7,190,125	B2	3/2007	McDonough et al.
7,274,117	B1	9/2007	Viola et al.

(Continued)

(21) Appl. No.: **13/037,709**

(22) Filed: **Mar. 1, 2011**

(65) **Prior Publication Data**
US 2011/0248893 A1 Oct. 13, 2011

Related U.S. Application Data
(63) Continuation of application No. 12/757,407, filed on Apr. 9, 2010, now Pat. No. 7,928,917.

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
(52) **U.S. Cl.** **343/702**
(58) **Field of Classification Search** 343/702,
343/700 MS, 745-748, 907
See application file for complete search history.

(56) **References Cited**
U.S. PATENT DOCUMENTS
4,478,468 A 10/1984 Schoen et al.
4,864,588 A 9/1989 Simpson et al.
5,189,412 A 2/1993 Mehta et al.

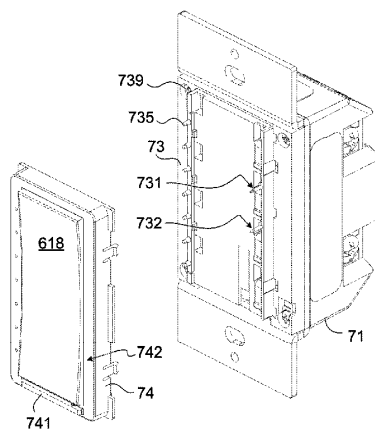
OTHER PUBLICATIONS

European Search Report dated Dec. 1, 2010.
(Continued)

Primary Examiner — Huedung Mancuso

(57) **ABSTRACT**
An electrical device comprises a bezel frame that is configured to fit within a faceplate. The bezel frame includes an antenna element. The electrical device further comprises a radio frequency circuitry component in electrical communication with the antenna element and configured to receive a control signal from the antenna element and a housing, which includes a housing cover. The housing cover is located between the antenna element and the radio frequency circuitry component. The electrical device further comprises one or more connectors configured to place the antenna element and the radio frequency circuitry component in electrical communication. The one or more connectors protrude through the housing cover.

20 Claims, 11 Drawing Sheets





US008089416B2

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

(10) **Patent No.:** **US 8,089,416 B2**
(45) **Date of Patent:** **Jan. 3, 2012**

(54) **DIPOLE ANTENNA**

(75) Inventors: **Shyh-Jong Chung**, Hsinchu (TW);
Ching-Wei Ling, Tainan County (TW);
Yi-Shiang Ma, Changhua County (TW)

(73) Assignee: **Industrial Technology Research Institute**, Hsinchu (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 386 days.

(21) Appl. No.: **12/371,900**

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

(65) **Prior Publication Data**

US 2010/0156736 A1 Jun. 24, 2010

(30) **Foreign Application Priority Data**

Dec. 23, 2008 (TW) 97150318 A

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

(52) **U.S. Cl.** **343/793; 343/822**

(58) **Field of Classification Search** 343/793, 343/795, 822

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,548,167	B2 *	6/2009	Yamagajo et al.	340/572.8
7,659,863	B2 *	2/2010	Kai et al.	343/795
7,750,862	B2 *	7/2010	Hilgers	343/726
2005/0024287	A1	2/2005	Jo et al.	
2005/0093678	A1	5/2005	Forster et al.	
2010/0134292	A1 *	6/2010	Deavours	340/572.7

OTHER PUBLICATIONS

Authored by Ukkonen, et al., article titled "Operability of Folded Microstrip Patch-Type Tag Antenna in the UHF RFID Bands Within 865-928 MHz," adopted from Antennas Wireless Propagation Letter, vol. 5, No. 1, pp. 414-417, Dec. 2006.

Authored by Subramanian, et al., article titled "Progress toward development of all-printed RFID tags: materials, processes, and devices," adopted from Proceedings of the IEEE, vol. 93, No. 7, Jul. 2005, pp. 1330-1338.

Authored by Son, H.W., et al., article titled "Design of RFID tag antennas using an inductively coupled feed," adopted from Electronics Letters, vol. 41, No. 18, pp. 994-996, Sep. 2005.

Authored by Li Yang, et al., article titled "Design and development of novel inductively coupled RFID antennas," adopted from Proc. in Antennas and Propagation Society International Symposium, Jul. 9-14, 2006, pp. 1035-1038.

Authored by C. Cho, et al., article titled "Broadband RFID tag antenna with quasi-isotropic radiation pattern," adopted from Electronics Letters, vol. 41, No. 20, pp. 1091-1092, Sep. 2005.

"Office Action of Taiwan Counterpart Application", issued on Sep. 9, 2011, p. 1-p. 6, in which the listed references were cited.

Björninen et al., "Design and RFID Signal Analysis of a Meander Line UHF RFID Tag Antenna", Antennas and Propagation Society International Symposium, Jul. 5-11, 2008, pp. 1-4.

* cited by examiner

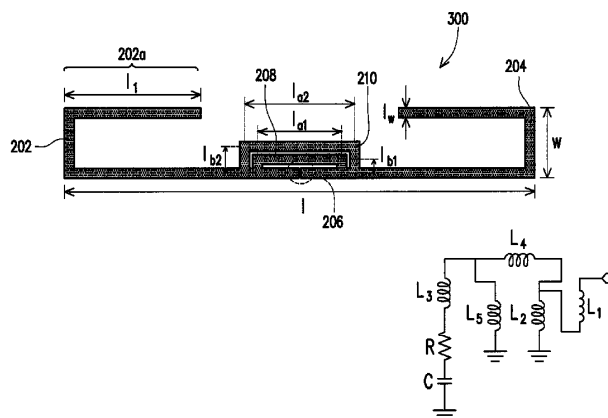
Primary Examiner — Tan Ho

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

(57) **ABSTRACT**

A dipole antenna used in an operation frequency includes a dipole radiation main body, a first semi-loop metal line and a second semi-loop metal line is provided. The dipole radiation main body has a first radiation line arm and a second radiation line arm aligned in a straight line, wherein a gap exists therebetween to form a feeding terminal. The first semi-loop metal line has two ends respectively connected to the first radiation line arm and the second radiation line arm to form a first matching loop covering the feeding terminal. The second semi-loop metal line has two ends respectively connected to the first radiation line arm and the second radiation line arm to form a second matching loop, which is larger than the first matching loop.

17 Claims, 11 Drawing Sheets





US008090329B2

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

(10) **Patent No.:** **US 8,090,329 B2**
(45) **Date of Patent:** **Jan. 3, 2012**

(54) **SELF-INSTALLABLE SWITCHABLE ANTENNA**

(75) Inventors: **Dorin G. Viorel**, Calgary (CA); **Ronald G. Murias**, Calgary (CA); **Jagan N. Seshadri**, Calgary (CA)

(73) Assignee: **Wi-LAN, Inc.** (CA)

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

(21) Appl. No.: **12/852,247**

(22) Filed: **Aug. 6, 2010**

(65) **Prior Publication Data**
US 2010/0315312 A1 Dec. 16, 2010

Related U.S. Application Data

- (63) Continuation of application No. 11/609,722, filed on Dec. 12, 2006, now Pat. No. 7,792,559.
- (60) Provisional application No. 60/749,401, filed on Dec. 12, 2005, provisional application No. 60/763,196, filed on Jan. 27, 2006, provisional application No. 60/774,428, filed on Feb. 17, 2006.

- (51) **Int. Cl.**
H04B 7/02 (2006.01)
- (52) **U.S. Cl.** **455/101**; 370/208
- (58) **Field of Classification Search** 455/101, 455/423, 67.13; 370/208, 210
See application file for complete search history.

- (56) **References Cited**
U.S. PATENT DOCUMENTS
4,062,015 A 12/1977 Litva et al.
5,065,449 A 11/1991 Gordon et al.
5,117,236 A 5/1992 Chang et al.
5,697,075 A 12/1997 Kim

5,809,405 A	9/1998	Yamaura	
6,453,176 B1	9/2002	Lopes et al.	
6,907,272 B2	6/2005	Roy	
7,352,801 B2*	4/2008	Ramakrishnan et al.	375/150
7,649,833 B2*	1/2010	Sadri et al.	370/208
2004/0140929 A1*	7/2004	Toda et al.	342/372
2005/0090205 A1	4/2005	Catreux-Erceg et al.	
2005/0136844 A1*	6/2005	Giesberts et al.	455/67.13
2005/0179607 A1	8/2005	Gorsuch et al.	
2005/0287962 A1	12/2005	Mehta et al.	

FOREIGN PATENT DOCUMENTS

EP	1294154	3/2003
FR	2780584	12/1999
WO	95/33312	12/1995
WO	02/071637	9/2002

OTHER PUBLICATIONS

Siavash M. Alamouti, "A Simple Transmit Diversity Technique for Wireless Communications", IEEE Journal on Select Areas in Communications, vol. 16, No. 8, pp. 1451-1458, Oct. 1998.
International Search Report from PCT Patent Application No. PCT/CA2006/001979, dated Apr. 27, 2007, 13 pages.
Extended European Search Report issued on Mar. 28, 2011, in corresponding European patent application No. 06840432.6, 11 pages.

* cited by examiner

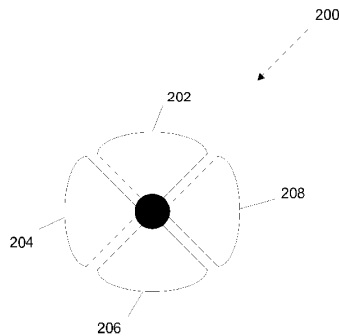
Primary Examiner — Tu X Nguyen

(74) *Attorney, Agent, or Firm* — Procopio, Cory, Hargreaves & Savitch LLP

(57) **ABSTRACT**

A system, method, and apparatus for selecting a set of antennas, for use during operation of a radio system, from a plurality of antennas. The system, method and apparatus may include selecting one antenna that is part of an array of antennas. Then measuring characteristics of radio signals received at the antenna. The selection and measuring of characteristic is repeated for a desired number of antennas in the array. Then, the measurements are combined, and the combinations of antennas are ranked based upon the combined measurement. From the ranking combinations of antennas are selected for use during operation of a radio system.

32 Claims, 8 Drawing Sheets





US008090407B2

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

(10) **Patent No.:** **US 8,090,407 B2**
(45) **Date of Patent:** **Jan. 3, 2012**

- (54) **CONTACTLESS SMART SIM**
- (75) Inventors: **Oded Bashan**, Rosh-Pina (IL); **Ronnie Gilboa**, Moshav Beit Hilel (IL); **Guy Shafran**, Rosh-Pina (IL)
- (73) Assignee: **On Track Innovations Ltd.**, Rosh-Pina (IL)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1119 days.

- 4,776,509 A 10/1988 Pitts et al.
- 5,025,550 A 6/1991 Zirbes et al.
- 5,186,378 A 2/1993 Alfaro
- 5,223,851 A 6/1993 Hadden et al.
- 5,240,166 A 8/1993 Fontana et al.
- 5,250,759 A 10/1993 Watson
- 5,285,191 A 2/1994 Reeb
- 5,378,857 A 1/1995 Swailes
- 5,448,110 A 9/1995 Tuttle et al.
- 5,572,410 A 11/1996 Gustafson
- 5,606,488 A 2/1997 Gustafson
- 5,606,791 A 3/1997 Fougere et al.
- 5,623,138 A 4/1997 Lee
- 5,705,852 A 1/1998 Orihara et al.

(Continued)

(21) Appl. No.: **11/890,909**

(22) Filed: **Aug. 6, 2007**

(65) **Prior Publication Data**

US 2009/0005117 A1 Jan. 1, 2009

(30) **Foreign Application Priority Data**

Jun. 27, 2007 (IL) 184260

- (51) **Int. Cl.**
H04B 1/38 (2006.01)
- (52) **U.S. Cl.** **455/558**; 455/575.1; 455/575.2;
455/575.3; 455/575.4; 455/575.5
- (58) **Field of Classification Search** 455/575.1,
455/575.2, 575.3, 575.4, 575.5
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

- 3,674,914 A 7/1972 Burr
- 3,823,403 A 7/1974 Walter et al.
- 3,981,076 A 9/1976 Nicolas et al.
- 4,065,850 A 1/1978 Burr et al.
- 4,417,413 A 11/1983 Hoppe et al.
- 4,450,623 A 5/1984 Burr

FOREIGN PATENT DOCUMENTS

AT 193136 6/2000

(Continued)

OTHER PUBLICATIONS

R.S. Keogh, "Automated fabrication of high precision planar coils", Electrical Electronics Insulation, Conference, 1995 and Electrical Manufacturing & Coil Winding Conference, Proc. pp. 517-519, Sep. 18-21, 1995.

(Continued)

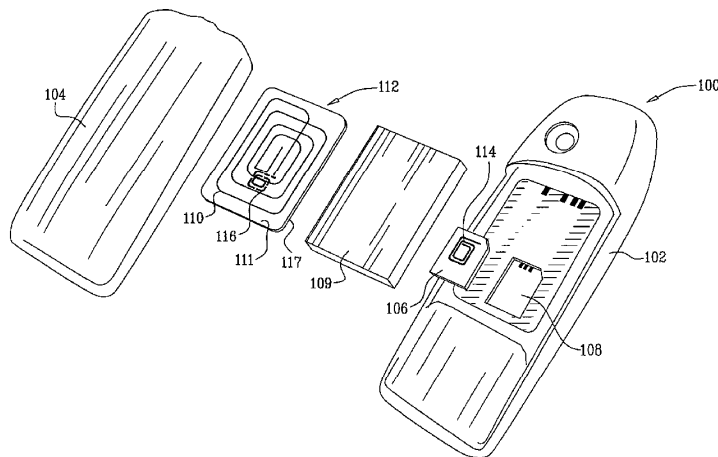
Primary Examiner — Nimesh Patel

(74) *Attorney, Agent, or Firm* — Abelman Frayne & Schwab

(57) **ABSTRACT**

A mobile communicator including a housing including a main portion and a removable portion, cellular telephone circuitry located within the main portion of the housing, a SIM card mounted in the main portion of the housing, a battery mounted between the removable portion of the housing and the SIM card and a contactless functionality antenna mounted intermediate the removable portion and the battery and communicating with the SIM card.

3 Claims, 9 Drawing Sheets





US008090408B2

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

(10) **Patent No.:** **US 8,090,408 B2**
(45) **Date of Patent:** **Jan. 3, 2012**

- (54) **PORTABLE WIRELESS DEVICE**
- (75) Inventors: **Takahiro Ochi**, Sendai (JP); **Haruhiko Kakitsu**, Sendai (JP)
- (73) Assignee: **Panasonic Corporation**, Osaka (JP)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 185 days.

7,768,462	B2 *	8/2010	Zhang et al.	343/702
7,876,274	B2 *	1/2011	Hobson et al.	455/575.7
2001/0006902	A1	7/2001	Ito	

FOREIGN PATENT DOCUMENTS

JP	10-154909	A	6/1998
JP	2001-195553	A	7/2001
JP	2003-006603	A	1/2003
JP	2004-363848	A	12/2004
JP	2005-033773	A	2/2005
JP	2005-252876	A	9/2005
JP	2006-222873	A	8/2006

OTHER PUBLICATIONS

International Search Report mailed Sep. 4, 2007, in corresponding International Patent Application No. PCT/JP2007/065746, filed Aug. 10, 2007.

* cited by examiner

Primary Examiner — Quochien B Vuong

(74) *Attorney, Agent, or Firm* — Seed IP Law Group PLLC

- (21) Appl. No.: **12/672,988**
- (22) PCT Filed: **Aug. 10, 2007**
- (86) PCT No.: **PCT/JP2007/065746**
§ 371 (c)(1),
(2), (4) Date: **Feb. 10, 2010**
- (87) PCT Pub. No.: **WO2009/022387**
PCT Pub. Date: **Feb. 19, 2009**
- (65) **Prior Publication Data**
US 2011/0063779 A1 Mar. 17, 2011

- (51) **Int. Cl.**
H04M 1/00 (2006.01)
H04B 1/38 (2006.01)
- (52) **U.S. Cl.** **455/558; 455/575.7**
- (58) **Field of Classification Search** 455/90.3,
455/558, 575.1, 575.7, 575.8, 347
See application file for complete search history.

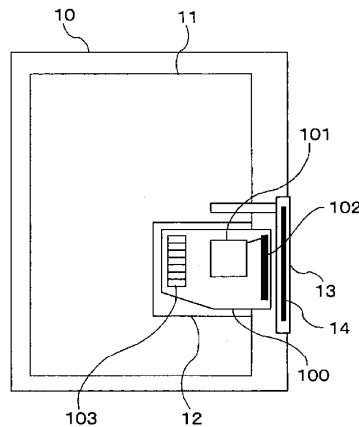
- (56) **References Cited**
U.S. PATENT DOCUMENTS
6,522,299 B2 * 2/2003 Beard et al. 455/575.7
6,834,810 B2 12/2004 Maruyama
7,505,072 B2 * 3/2009 Saitoh 455/296

(57) **ABSTRACT**

A portable wireless device has no externally projecting part even when a card type functional medium has been therein inserted, and allows downsizing and obtaining high antenna performance.

The portable wireless device includes a card slot (12) in a substrate (11) of a lower housing (10), and includes a slot cover (13) that can block an opening portion of the card slot (12). The slot cover (13) is integrally provided with a parasitic element (14). The parasitic element (14) is, when an SDIO card (100) is inserted, arranged so as to be in proximity substantially parallel with the antenna element (102) of the SDIO card (100), has an electrical length which is approximately one-half wavelength of a driving frequency of an RF circuit (101) of the SDIO card (100), and electromagnetically couples with the antenna element (102) to operate as a parasitic element.

7 Claims, 5 Drawing Sheets





US008090419B2

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

(10) **Patent No.:** **US 8,090,419 B2**
(45) **Date of Patent:** **Jan. 3, 2012**

- (54) **FOLDING PORTABLE WIRELESS APPARATUS**
- (75) Inventors: **Yutaka Isoda**, Kanagawa (JP);
Nobuharu Mashima, Toyama (JP);
Akito Sakamoto, Kanagawa (JP)
- (73) Assignee: **Panasonic Corporation**, Osaka (JP)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1097 days.
- (21) Appl. No.: **11/569,881**
- (22) PCT Filed: **Jun. 2, 2005**
- (86) PCT No.: **PCT/JP2005/010153**
§ 371 (c)(1),
(2), (4) Date: **Dec. 1, 2006**
- (87) PCT Pub. No.: **WO2005/120021**
PCT Pub. Date: **Dec. 15, 2005**

(65) **Prior Publication Data**
US 2009/0181732 A1 Jul. 16, 2009

(30) **Foreign Application Priority Data**
Jun. 4, 2004 (JP) 2004-167138

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

(52) **U.S. Cl.** **455/575.3; 455/575.1; 455/575.7; 455/272**

(58) **Field of Classification Search** **455/575.3; 455/73, 269, 277.1, 272, 575; 343/702, 893; 361/600-837**

See application file for complete search history.

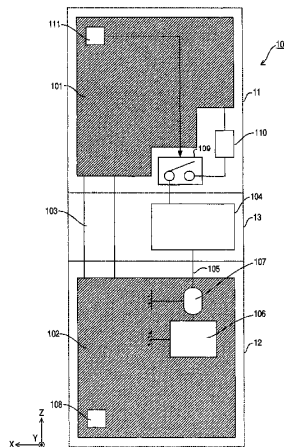
- (56) **References Cited**
- U.S. PATENT DOCUMENTS
- 5,432,676 A * 7/1995 Satoh et al. 361/752
- 6,026,280 A * 2/2000 Yokomura 455/78
- 6,247,947 B1 * 6/2001 Knoernschild et al. 439/159
- (Continued)

- FOREIGN PATENT DOCUMENTS
- EP 474490 A1 * 3/1992
- (Continued)

- OTHER PUBLICATIONS
- European Search Report.
- Primary Examiner* — Lester Kincaid
- Assistant Examiner* — Daniel Lai
- (74) *Attorney, Agent, or Firm* — Seed IP Law Group, PLLC

(57) **ABSTRACT**
An object of the invention is to provide a folding-type portable wireless equipment which can obtain good antenna characteristics in each of opened and closed states with a simple configuration without spoiling miniaturization. A folding-type portable wireless equipment (100) having a first case (11) and a second case (12) includes a first circuit board (101) disposed at the first case (11), a second circuit board (102) disposed at the second case (12), a bendable coupling portion (103) which mechanically couples the first case (11) and the second case (12), a flexible coupling element (103) which electrically couples the first circuit board (101) and the second circuit board (102), an antenna element (104) coupled to the radio circuit portion (106) provided at the second circuit board (102), an antenna element (104) coupled to the radio circuit portion (106) via a feeder line (105), and a switching portion (109) which selectively connects and disconnects between the first circuit board (101) and the antenna element (104) in accordance with an opened/closed state of the folding-type portable wireless equipment (100), wherein the antenna element (104) and the feeder line 105 are disposed at positions almost along the coupling portion (103).

10 Claims, 4 Drawing Sheets





US008090423B2

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

(10) **Patent No.:** US 8,090,423 B2
(45) **Date of Patent:** Jan. 3, 2012

(54) **MOBILE TERMINAL**

(75) Inventors: **Young Soo NA**, Seoul (KR); **Chang Il Kim**, Seoul (KR)

(73) Assignee: **LG Electronics Inc.**, Seoul (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 487 days.

(21) Appl. No.: **12/409,206**

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

(65) **Prior Publication Data**
US 2010/0137042 A1 Jun. 3, 2010

(30) **Foreign Application Priority Data**
Nov. 28, 2008 (KR) 10-2008-0119542

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

(52) **U.S. Cl.** **455/575.5; 455/117**

(58) **Field of Classification Search** 455/117, 455/550.1, 575.1, 575.5, 575.7, 575.8

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,389,129	B2 *	6/2008	Shoji	455/575.5
2009/0093286	A1 *	4/2009	Zhu et al.	455/575.5
2010/0113111	A1 *	5/2010	Wong et al.	455/575.5
2010/0234081	A1 *	9/2010	Wong et al.	455/575.5

FOREIGN PATENT DOCUMENTS

CA	2633391	A1	9/2008
WO	WO 2005/004277	A1	1/2005
WO	WO 2009/033616	A1	3/2009

* cited by examiner

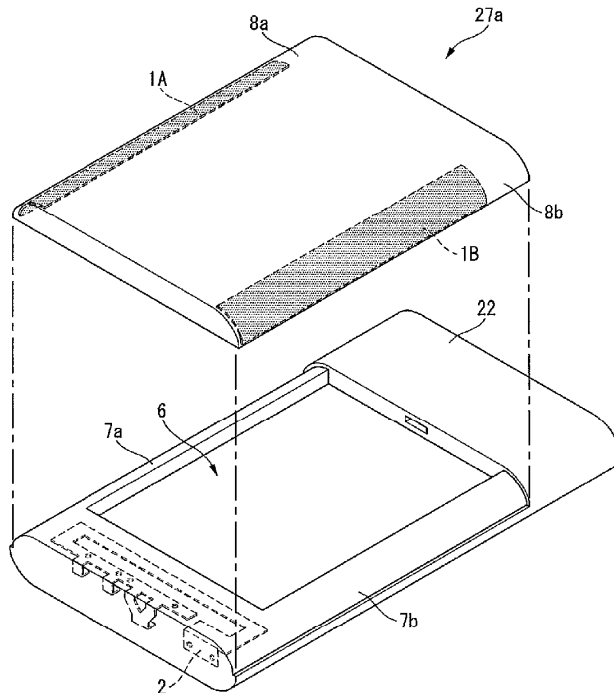
Primary Examiner — Don Le

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

(57) **ABSTRACT**

A mobile terminal comprises a front case and a rear case which are fastened with a printed circuit board (PCB) and an antenna connected with the PCB interposed therebetween; a battery protection cover opening and closing a battery receiving space provided on the rear case; and a conductive coupling element formed on one of the rear case and the battery protection cover such that the conductive coupling element is overlapped with at least one of one edge and the other edge of the antenna.

20 Claims, 9 Drawing Sheets





US008094076B2

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

(10) **Patent No.:** **US 8,094,076 B2**
(45) **Date of Patent:** **Jan. 10, 2012**

(54) **MULTIBAND ANTENNA**

(75) Inventors: **Chong Zhang**, Shenzhen (CN); **Cho-Ju Chung**, Taipei Hsien (TW)

(73) Assignees: **Ambit Microsystems (Shanghai) Ltd.**, Shanghai (CN); **Hon Hai Precision Industry Co., Ltd.**, Tu-Cheng, 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 345 days.

(21) Appl. No.: **12/582,783**

(22) Filed: **Oct. 21, 2009**

(65) **Prior Publication Data**
US 2011/0032166 A1 Feb. 10, 2011

(30) **Foreign Application Priority Data**
Aug. 6, 2009 (CN) 2009 2 0307494 U

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
(52) **U.S. Cl.** **343/700 MS**; 343/824; 343/826;
343/846; 343/829; 343/752
(58) **Field of Classification Search** None
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,552,686	B2 *	4/2003	Ollikainen et al.	343/700 MS
7,050,010	B2 *	5/2006	Wang et al.	343/702
7,180,463	B2	2/2007	Chung	
7,576,698	B2 *	8/2009	Cheng	343/700 MS
7,755,545	B2 *	7/2010	Takei et al.	343/702
7,825,863	B2 *	11/2010	Martiskainen et al.	343/702
7,973,726	B2 *	7/2011	Tseng et al.	343/702
7,986,274	B2 *	7/2011	Yang et al.	343/700 MS

* cited by examiner

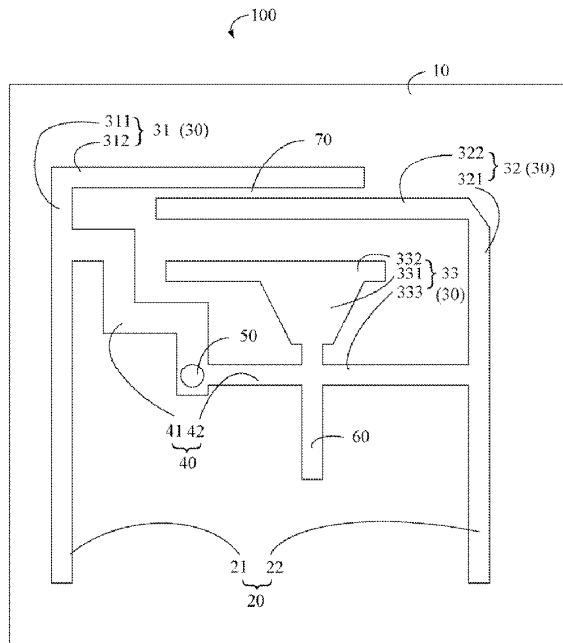
Primary Examiner — Trinh Dinh

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

(57) **ABSTRACT**

A multiband antenna includes a feed portion, a radiating portion, and a ground via. The feed portion includes a first feed section and a second feed section paralleled to each other. The radiating portion includes a first radiator, a second radiator and a third radiator. The first radiator is L shaped with a free end. The second radiator is L shaped with a free end. The free ends of the second radiator and the first radiator extend toward to each other and partially overlap to define a slot therebetween. The third radiator includes a trapezoid section and a connecting section. The short portion includes a first short section and a second short section. The first short section connects the first radiator to the ground via, and the second short section connects the second radiator and the third radiator to the ground via.

11 Claims, 3 Drawing Sheets





US008094078B2

(12) **United States Patent**
Huang

(10) **Patent No.:** **US 8,094,078 B2**
(45) **Date of Patent:** **Jan. 10, 2012**

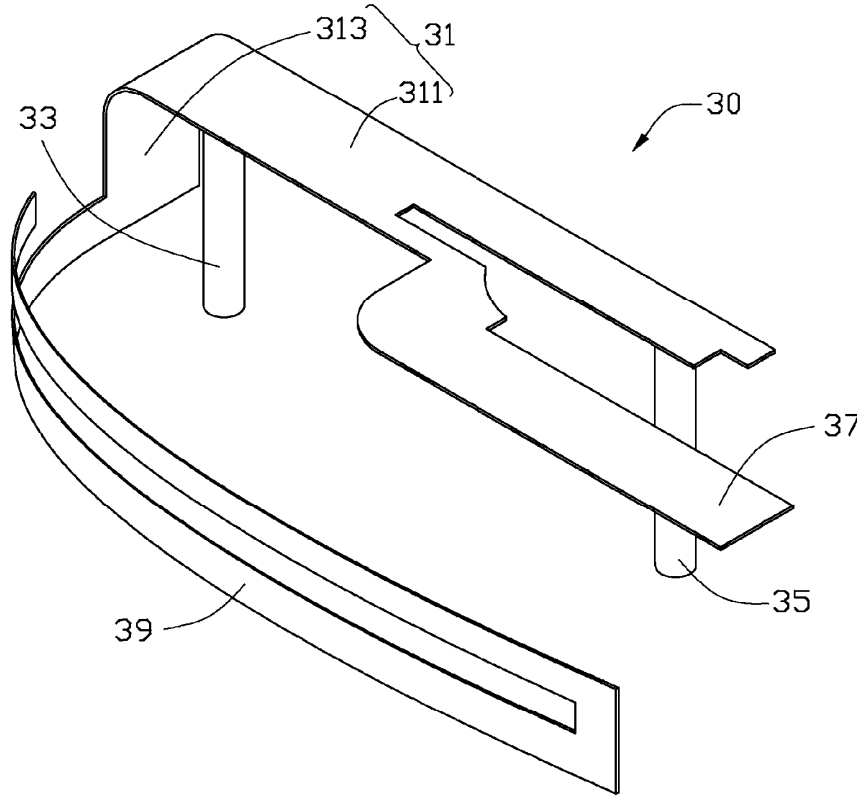
- (54) **MONOPOLE ANTENNA**
 - (75) Inventor: **Chang-Ching Huang**, Tu-Cheng (TW)
 - (73) Assignee: **Chi Mei Communication Systems, Inc.**, Tu-Cheng, New Taipei (TW)
 - (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 455 days.
 - (21) Appl. No.: **12/401,728**
 - (22) Filed: **Mar. 11, 2009**
 - (65) **Prior Publication Data**
US 2010/0123638 A1 May 20, 2010
 - (30) **Foreign Application Priority Data**
Nov. 18, 2008 (CN) 2008 1 0305618
 - (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
- See application file for complete search history.

- (56) **References Cited**
- U.S. PATENT DOCUMENTS
- 2004/0233109 A1 * 11/2004 Ying et al. 343/700 MS
- 2006/0262016 A1 * 11/2006 Hung et al. 343/702
- 2009/0109097 A1 * 4/2009 Peng et al. 343/700 MS
- 2010/0117907 A1 * 5/2010 Su et al. 343/700 MS
- * cited by examiner
- Primary Examiner* — Hoanganh Le
- (74) *Attorney, Agent, or Firm* — Altis Law Group, Inc.

(57) **ABSTRACT**

The invention discloses a monopole antenna for assembly within a wireless communication device to transmit and exchange data signals. The monopole antenna includes a main body, a feed portion, a grounding portion, a first transmitting body and a second transmitting body. The feed portion and the grounding portion are disposed on the main body. A first transmitting body is a high frequency path extending outwardly from the main body and a second transmitting body is a low frequency path extending outwardly from the main body.

11 Claims, 6 Drawing Sheets





US008094079B2

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

(10) **Patent No.:** **US 8,094,079 B2**
(45) **Date of Patent:** ***Jan. 10, 2012**

(54) **HANDHELD ELECTRONIC DEVICES WITH ISOLATED ANTENNAS**
(75) Inventors: **Robert W. Schlub**, Campbell, CA (US); **Robert J. Hill**, Salinas, CA (US); **Juan Zavala**, Watsonville, CA (US); **Ruben Caballero**, San Jose, CA (US)

4,980,694 A 12/1990 Hines
4,987,421 A 1/1991 Sunahara et al.
5,021,010 A 6/1991 Wright
5,041,838 A 8/1991 Liimatainen et al.
5,048,118 A 9/1991 Brooks et al.
5,561,437 A 10/1996 Phillips et al.
5,754,143 A 5/1998 Warnagiris et al.
5,798,984 A 8/1998 Koch

(Continued)

(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 23 days.
This patent is subject to a terminal disclaimer.

FOREIGN PATENT DOCUMENTS
EP 0 851 530 7/1998
(Continued)

OTHER PUBLICATIONS
Hobson et al. U.S. Appl. No. 60/883,587, filed Jan. 5, 2007.
(Continued)

(21) Appl. No.: **12/541,874**

(22) Filed: **Aug. 14, 2009**

(65) **Prior Publication Data**
US 2009/0303139 A1 Dec. 10, 2009

Related U.S. Application Data
(63) Continuation of application No. 11/650,071, filed on Jan. 4, 2007, now Pat. No. 7,595,759.

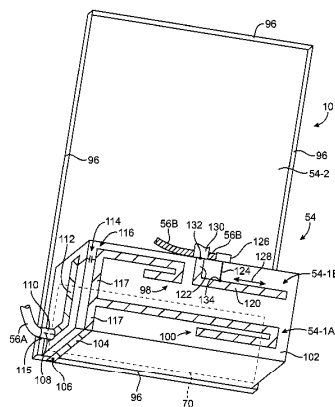
(51) **Int. Cl.** **H01Q 1/24** (2006.01)
(52) **U.S. Cl.** **343/702**; 343/700 MS; 343/846
(58) **Field of Classification Search** 343/702, 343/700 MS, 725, 767, 846
See application file for complete search history.

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

(57) **ABSTRACT**
Handheld electronic devices are provided that contain wireless communications circuitry having at least first and second antennas. An antenna isolation element reduces signal interference between the antennas, so that the antennas may be used in close proximity to each other. A planar ground element may be used as a ground by the first and second antennas. The first antenna may be formed using a hybrid planar-inverted-F and slot arrangement in which a planar resonating element is located above a rectangular slot in the planar ground element. The second antenna may be formed from an L-shaped strip. The planar resonating element of the first antenna may have first and second arms. The first arm may resonate at a common frequency with the second antenna and may serve as the isolation element. The second arm may resonate at approximately the same frequency as the slot portion of the hybrid antenna.

(56) **References Cited**
U.S. PATENT DOCUMENTS
2,947,987 A 8/1960 Dodington
4,641,366 A 2/1987 Yokoyama et al.
4,894,663 A 1/1990 Urbish et al.

15 Claims, 12 Drawing Sheets





US008094080B2

(12) **United States Patent**
Komura

(10) **Patent No.:** **US 8,094,080 B2**
(45) **Date of Patent:** **Jan. 10, 2012**

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

(75) Inventor: **Ryo Komura**, Kanazawa (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 340 days.

(21) Appl. No.: **12/542,731**

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

(65) **Prior Publication Data**

US 2009/0295653 A1 Dec. 3, 2009

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2008/051506, filed on Jan. 31, 2008.

(30) **Foreign Application Priority Data**

Mar. 23, 2007 (JP) 2007-076659

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

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

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,748,149 A 5/1998 Kawahata
5,903,240 A 5/1999 Kawahata et al.
6,614,398 B2* 9/2003 Kushihi et al. 343/700 MS
6,873,299 B2 3/2005 Dakeya et al.
7,119,749 B2* 10/2006 Miyata et al. 343/702

7,161,536 B2 1/2007 Hilgers
2002/0126049 A1 9/2002 Okabe et al.
2002/0190907 A1* 12/2002 Konishi et al. 343/702
2003/0071757 A1 4/2003 Yamaki
2004/0085245 A1 5/2004 Miyata et al.
2005/0243001 A1 11/2005 Miyata et al.
2007/0257850 A1 11/2007 Onaka et al.
2009/0303144 A1* 12/2009 Hirano 343/750

FOREIGN PATENT DOCUMENTS

DE 696 04 145 T2 2/2000
DE 697 15 698 T2 5/2003
DE 102 47 297 A1 4/2004
EP 1 267 441 A2 12/2002
EP 1 453 139 A1 9/2004
EP 1 505 689 A1 2/2005

(Continued)

OTHER PUBLICATIONS

Official Communication issued in International Patent Application No. PCT/JP2008/051506, mailed on Apr. 8, 2008.

(Continued)

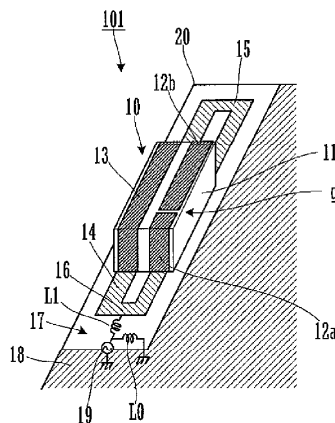
Primary Examiner — Dieu H Duong

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

(57) **ABSTRACT**

An antenna includes linear electrodes disposed on a surface of a substrate. A surface-mount antenna element including a capacitor is disposed in a non-ground region of a mount board. The capacitor is arranged such that portions of at least one of two linear electrodes face each other with a predetermined distance therebetween. The non-ground region includes a first radiation electrode and linear electrode portions of a second radiation electrode. The linear electrodes of the surface-mount antenna element are individually connected to the radiation electrodes. A chip reactive element is disposed at the first radiation electrode and the linear electrode portions of the second radiation electrode as appropriate.

12 Claims, 16 Drawing Sheets





US008094082B2

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

(10) **Patent No.:** **US 8,094,082 B2**
(45) **Date of Patent:** **Jan. 10, 2012**

- (54) **POLARIZATION DIVERSITY MULTI-ANTENNA SYSTEM**
- (75) Inventors: **Lionel Rudant**, Grenoble (FR);
Christophe Delaveaud, Saint Jean de Moirans (FR)
- (73) Assignee: **Commissariat a l'Energie Atomique**, Paris (FR)
- (*) 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.: **12/439,750**
- (22) PCT Filed: **Sep. 3, 2007**
- (86) PCT No.: **PCT/EP2007/059197**
§ 371 (c)(1),
(2), (4) Date: **Mar. 6, 2009**
- (87) PCT Pub. No.: **WO2008/028892**
PCT Pub. Date: **Mar. 13, 2008**
- (65) **Prior Publication Data**
US 2009/0273528 A1 Nov. 5, 2009
- (30) **Foreign Application Priority Data**
Sep. 4, 2006 (FR) 06 53562
- (51) **Int. Cl.**
H01Q 21/24 (2006.01)
- (52) **U.S. Cl.** **343/725; 343/700 MS; 343/767**
- (58) **Field of Classification Search** **343/700 MS, 343/725, 727, 767, 846**
See application file for complete search history.

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

4,893,126	A *	1/1990	Evans	342/175
5,241,321	A *	8/1993	Tsao	343/700 MS
5,977,874	A *	11/1999	Konstandelos	340/554
6,424,300	B1	7/2002	Sanford et al.	
7,109,921	B2 *	9/2006	Leelaratne	343/700 MS
2004/0021605	A1	2/2004	Kouam et al.	

- FOREIGN PATENT DOCUMENTS

EP	1 225 654	A1	7/2002
EP	1 401 050	A1	3/2004
WO	98/37593	A1	8/1998
WO	2004/102744	A1	11/2004
WO	2007/028448	A1	3/2007

OTHER PUBLICATIONS

Michishita et al; "A polarization diversity antenna by printed dipole and a patch with a hole", published in Proc. of IEEE Antennas and Propagation Society International Symposium, vol. No. 3, May 2001, pp. 368-371.

Kuga et al; "A patch-slot composite antenna for VH-polarization diversity base stations", published in Proc. of Asia-Pacific Microwave Conference, Dec. 2000.

Garg et al; "Expressions for wavelength and impedance of a slotline" published in the IEEE Trans. on Microwave Theory, Aug. 1976, p. 532.

International Search Report for PCT/EP2007/059197.

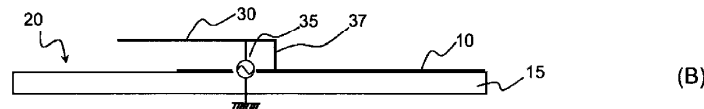
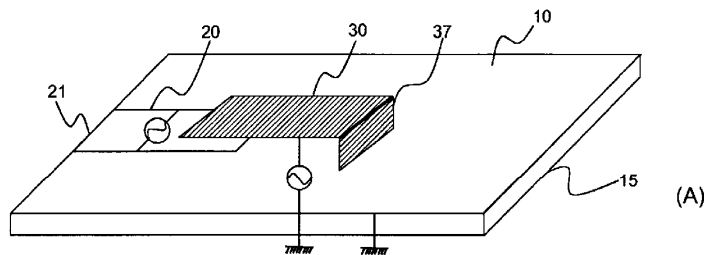
* cited by examiner

Primary Examiner — Tho G Phan
(74) *Attorney, Agent, or Firm* — Pearne & Gordon LLP

(57) **ABSTRACT**

The invention relates to a polarization diversity multi-antenna system comprising a first slot type antenna (20) and at least one second patch type antenna (30), said first and second antennas sharing the same ground plane (10), the slot of the first antenna being laid out in said ground plane and the patch of the second antenna being at least partly plumb with said slot.

10 Claims, 10 Drawing Sheets





US008094088B2

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

(10) **Patent No.:** **US 8,094,088 B2**
(45) **Date of Patent:** **Jan. 10, 2012**

(54) **ANTENNA APPARATUS**

(75) Inventors: **Tomohiro Shinkawa**, Tokyo (JP);
Masaaki Miyata, Tokyo (JP);
Hisamatsu Nakano, 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 459 days.

(21) Appl. No.: **12/372,222**

(22) Filed: **Feb. 17, 2009**

(65) **Prior Publication Data**

US 2009/0207086 A1 Aug. 20, 2009

(30) **Foreign Application Priority Data**

Feb. 18, 2008 (JP) P2008-036551
Dec. 18, 2008 (JP) P2008-321757

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

(52) **U.S. Cl.** **343/895; 343/700 MS; 343/793**

(58) **Field of Classification Search** **343/700 MS, 343/895, 793, 821, 713**

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2004/0169614 A1* 9/2004 Desclos et al. 343/803
2009/0303143 A1* 12/2009 Miyoshi et al. 343/728

FOREIGN PATENT DOCUMENTS

JP 2001-339232 12/2001
JP 2003-218632 7/2003
JP 2006-13696 1/2006
JP 2001-235460 9/2007

* cited by examiner

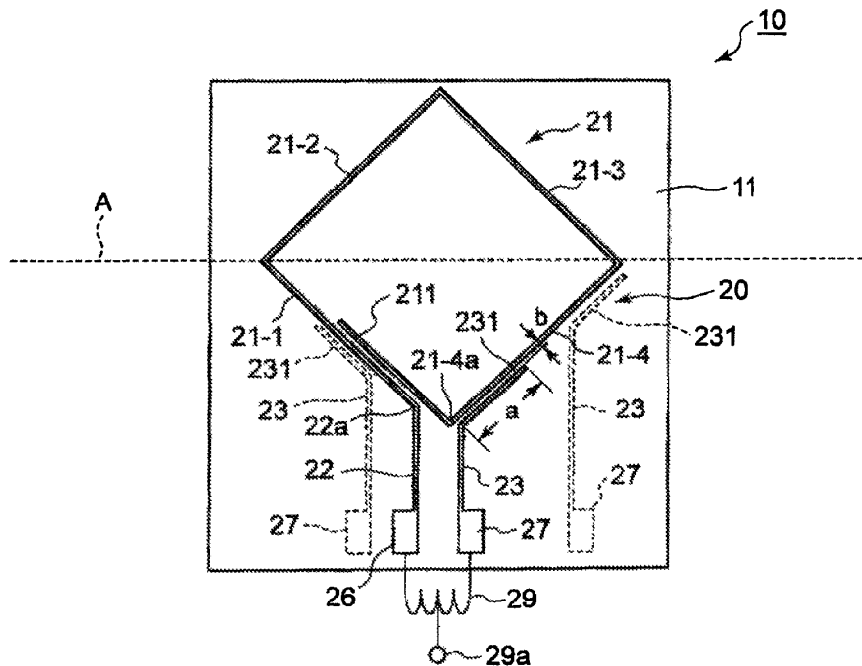
Primary Examiner — Tan Ho

(74) *Attorney, Agent, or Firm* — Whitham Curtis Christofferson & Cook, PC

(57) **ABSTRACT**

In an antenna apparatus, a radiation element includes a perturbation element. A first power feeding line has a first end connected to the radiation element and is configured to feed power to the radiation element. A second power feeding line has a first end configured to feed power to the radiation element through electromagnetic coupling. The radiation element, the first power feeding line and the second power feeding line are arranged on a same plane to constitute a balance type antenna.

13 Claims, 8 Drawing Sheets





US008094457B2

(12) **United States Patent**
Fujii

(10) **Patent No.:** **US 8,094,457 B2**
(45) **Date of Patent:** **Jan. 10, 2012**

(54) **ELECTRONIC APPARATUS**
(75) Inventor: **Tomoharu Fujii**, Nagano (JP)
(73) Assignee: **Shinko Electric Industries Co., Ltd.**,
Nagano-shi (JP)
(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 351 days.

2003/0143958	A1*	7/2003	Elias et al.	455/73
2003/0161200	A1*	8/2003	Fujiwara	365/200
2004/0222924	A1*	11/2004	Dean et al.	343/700 MS
2005/0003199	A1*	1/2005	Takaya et al.	428/413
2005/0090300	A1*	4/2005	Zhang et al.	455/575.7
2005/0117312	A1*	6/2005	Kimura et al.	361/746
2006/0035613	A1*	2/2006	Miya et al.	455/276.1
2006/0221591	A1*	10/2006	Kong	361/818
2009/0046028	A1*	2/2009	Han et al.	343/787

(21) Appl. No.: **11/847,796**
(22) Filed: **Aug. 30, 2007**
(65) **Prior Publication Data**
US 2008/0259585 A1 Oct. 23, 2008

FOREIGN PATENT DOCUMENTS

JP	2035803	2/1990
JP	10-93332	4/1998
JP	2002217638	8/2002
JP	2003347834	12/2003
JP	2004-159287	6/2004
JP	2005005797	1/2005
JP	2005005866	1/2005
JP	2005051576	2/2005
JP	2005-191827	7/2005

(30) **Foreign Application Priority Data**
Sep. 27, 2006 (JP) 2006-263083

* cited by examiner

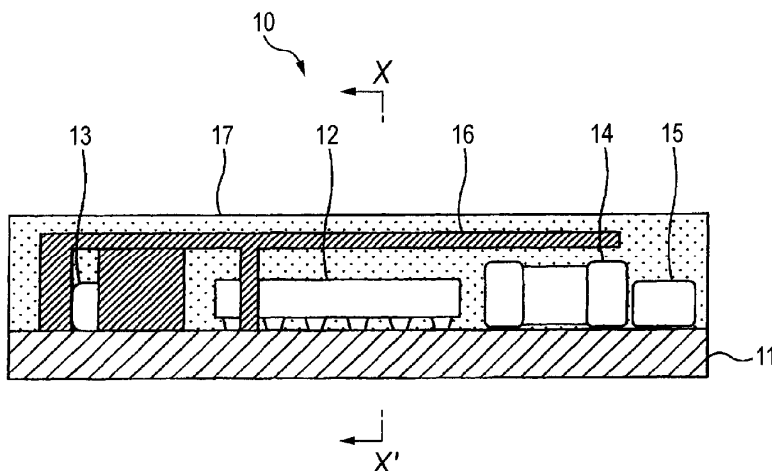
(51) **Int. Cl.**
H05K 5/00 (2006.01)
(52) **U.S. Cl.** **361/750**; 361/816; 361/818; 257/789;
257/795; 257/796
(58) **Field of Classification Search** 361/750,
361/818; 257/789, 795, 796; 347/742, 702,
347/867
See application file for complete search history.

Primary Examiner — Yuriy Semenenko
Assistant Examiner — Andargie M Aychillhum
(74) *Attorney, Agent, or Firm* — Rankin, Hill & Clark LLP

(56) **References Cited**
U.S. PATENT DOCUMENTS
5,154,973 A * 10/1992 Imagawa et al. 428/325
7,363,017 B2 * 4/2008 Miya et al. 455/300
7,435,625 B2 * 10/2008 Condie et al. 438/124

(57) **ABSTRACT**
An electronic apparatus includes a substrate, electronic components mounted on the substrate, an antenna mounted on the substrate, and a resin material containing a dielectric constant adjusting material added therein, and sealing the electronic components and the antenna.

16 Claims, 4 Drawing Sheets





US008095085B2

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

(10) **Patent No.:** **US 8,095,085 B2**
(45) **Date of Patent:** **Jan. 10, 2012**

(54) **AUTOMATIC ANTENNA TUNING UNIT FOR SOFTWARE-DEFINED AND COGNITIVE RADIO**

6,747,956 B1 6/2004 Darack et al. 370/252
7,180,467 B2 2/2007 Fabrega-Sanchez et al. . 343/861
2005/0215281 A1 9/2005 Oodaira 455/553.1

(75) Inventors: **Hang Song**, Tempe, AZ (US); **James T. Aberle**, Tempe, AZ (US); **Bertan Bakkaloglu**, Scottsdale, AZ (US)

FOREIGN PATENT DOCUMENTS
EP 1 475 889 A2 11/2004
WO WO 2004/098076 11/2004

(73) Assignee: **Arizona Board of Regents for and on Behalf of Arizona State University**, Scottsdale, AZ (US)

OTHER PUBLICATIONS

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 807 days.

Aberle and Oh, "Reconfigurable Antenna Technology for VHF/UHF Applications," *Technical Report: General Dynamics Decision System*, Oct. 2004.

(21) Appl. No.: **12/134,438**

Aberle et al., "Automatically Tuning Antenna for Software-Defined and Cognitive Radio," *Proceedings of the 2005 Software Defined Radio Technical Conference*, Nov. 2005.

(22) Filed: **Jun. 6, 2008**

Aberle et al., "Reconfigurable Antennas for Portable Wireless Devices," *IEEE Antennas and Propagation Magazine*, 45 (6): 148-154, 2003.

(65) **Prior Publication Data**

(Continued)

US 2009/0046030 A1 Feb. 19, 2009

Related U.S. Application Data

Primary Examiner — Lee Nguyen

(60) Provisional application No. 60/942,776, filed on Jun. 8, 2007.

(74) *Attorney, Agent, or Firm* — Fulbright & Jaworski L.L.P.

(51) **Int. Cl.**

H03C 1/52 (2006.01)
H04K 3/00 (2006.01)

(57) **ABSTRACT**

(52) **U.S. Cl.** **455/107**; 455/126

(58) **Field of Classification Search** 455/107,
455/115.1, 120-121, 125-126; 333/17.3,
333/32; 343/860-861

See application file for complete search history.

A closed-loop controlled antenna tuning unit (ATU) system includes a return loss detector connected to sample an RF signal generated by a signal source to provide a return loss signal. A matching state searching circuit is connected to receive the return loss signal and, in response, selectively store a return loss value and an impedance matching state. A central controller is connected to provide a switch control signal and apply an optimum matching state to the impedance synthesizer at the conclusion of the matching state search. An impedance synthesizer is responsive to the switch control signal for coupling a radio frequency signal and matching the impedance of an antenna to a signal source.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,041,395 A * 8/1977 Hill 455/115.4
5,778,308 A 7/1998 Sroka et al. 455/115
6,029,051 A 2/2000 Osterberg et al. 455/115
6,710,651 B2 * 3/2004 Forrester 330/129

20 Claims, 11 Drawing Sheets

