



US008169373B2

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

(10) **Patent No.:** **US 8,169,373 B2**
(45) **Date of Patent:** **May 1, 2012**

(54) **ANTENNAS WITH TUNING STRUCTURE FOR HANDHELD DEVICES**

(75) Inventors: **Robert W. Schlub**, Campbell, CA (US);
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(73) Assignee: **Apple Inc.**, Cupertino, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 853 days.

(21) Appl. No.: **12/205,829**

(22) Filed: **Sep. 5, 2008**

(65) **Prior Publication Data**

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

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

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,876,552	A *	10/1989	Zakman	343/702
5,184,143	A *	2/1993	Marko	343/749
6,011,517	A	1/2000	Skurski	
6,054,955	A	4/2000	Schlegel, Jr. et al.	
6,124,831	A *	9/2000	Rutkowski et al.	343/700 MS
6,348,894	B1	2/2002	Lahiti	
6,496,382	B1 *	12/2002	Ferguson et al.	361/767

6,861,990	B2 *	3/2005	Hung et al.	343/702
7,080,787	B2	7/2006	Wulff et al.	
7,164,387	B2	1/2007	Sievenpiper	
7,782,258	B2 *	8/2010	Lee et al.	343/700 MS
7,884,724	B2 *	2/2011	Tuttle et al.	340/572.7
2003/0124985	A1	7/2003	Shin et al.	
2004/0178957	A1	9/2004	Chang et al.	
2004/0223004	A1	11/2004	Lincke et al.	
2007/0135181	A1	6/2007	Ohki et al.	

FOREIGN PATENT DOCUMENTS

EP	1 445 824	A	8/2004
GB	2 434 697	A	8/2007
WO	03/044891	A	5/2003

* cited by examiner

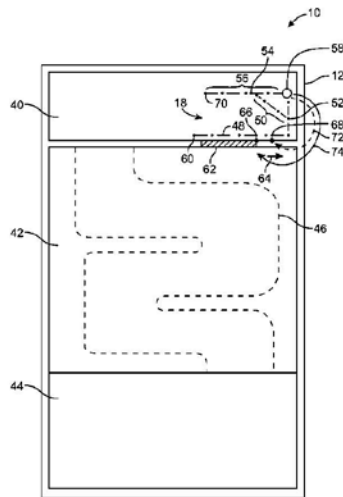
Primary Examiner — Tho G Phan

(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. The wireless communications circuitry may include antenna structures. To accommodate manufacturing variations, the antenna structures and handheld electronic devices may be characterized by performing measurements such as antenna performance measurements. Appropriate antenna adjustments may be made during manufacturing of a handheld electronic device based on the characterizing measurements. An antenna may be formed using an inverted-F design in which an antenna flex circuit is mounted to a dielectric antenna support structure. Cavities in the support may be selectively filled with dielectric material and dielectric patches may be added to the antenna flex circuit to adjust the dielectric loading of the antenna. The length of a ground return path in the antenna may be adjusted by appropriate positioning of an electrical connector within the ground return path.

27 Claims, 19 Drawing Sheets





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

(10) **Patent No.:** **US 8,169,374 B2**
(45) **Date of Patent:** **May 1, 2012**

(54) **ANTENNA FOR HANDHELD ELECTRONIC DEVICES WITH CONDUCTIVE BEZELS**

(75) Inventors: **Robert J. Hill**, Salinas, CA (US);
Robert W. Schlub, Campbell, CA (US);
Ruben Caballero, San Jose, CA (US)

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

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

(21) Appl. No.: **13/083,487**

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

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. 12/941,006, filed on Nov. 5, 2010, now Pat. No. 7,924,231, which is a continuation of application No. 12/564,803, filed on Sep. 22, 2009, now Pat. No. 7,843,396, which is a continuation of application No. 11/821,192, filed on Jun. 21, 2007, now Pat. No. 7,612,725.

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

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

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

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,942,263 A 6/1960 Baldwin
3,394,373 A * 7/1968 Makrancy 342/104

3,969,730 A 7/1976 Fuchser
4,894,663 A 1/1990 Urbish
4,980,694 A 12/1990 Hines
5,021,010 A 6/1991 Wright
5,041,838 A 8/1991 Liimatainen
5,048,118 A 9/1991 Brooks
5,061,943 A 10/1991 Rammos
5,408,241 A 4/1995 Shattuck
5,561,437 A 10/1996 Phillips
5,565,877 A 10/1996 Du et al.

(Continued)

FOREIGN PATENT DOCUMENTS

EP 1 286 413 2/2003

(Continued)

OTHER PUBLICATIONS

Hobson et al. U.S. Appl. No. 60/833,587, filed Jan. 5, 2007.

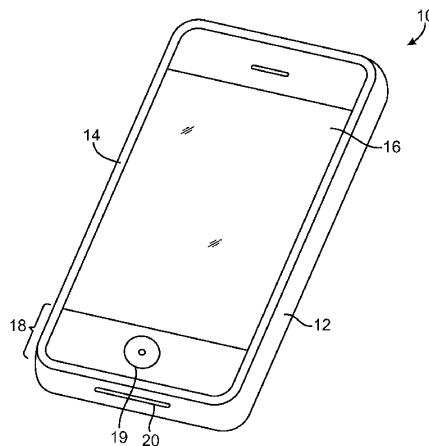
Primary Examiner — Tho G Phan

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

(57) **ABSTRACT**

A handheld electronic device may be provided that contains wireless communications circuitry. The handheld electronic device may have a housing and a display. The display may be attached to the housing using a conductive bezel. The handheld electronic device may have one or more antennas for supporting wireless communications. A ground plane in the handheld electronic device may serve as ground for one or more of the antennas. The ground plane and bezel may define an opening. A rectangular slot antenna or other suitable slot antenna may be formed from or within the opening. One or more antenna resonating elements may be formed above the slot. An electrical switch that bridges the slot may be used to modify the perimeter of the slot so as to tune the communications bands of the handheld electronic device.

20 Claims, 20 Drawing Sheets





US008174390B2

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

(10) **Patent No.:** **US 8,174,390 B2**
(45) **Date of Patent:** **May 8, 2012**

(54) **RADIO FREQUENCY IDENTIFICATION TAG AND ANTENNA FOR RADIO FREQUENCY IDENTIFICATION TAG**

(75) Inventors: **Jeong Seok Kim**, Daejeon (KR); **Won Kyu Choi**, Daejeon (KR); **Gil Young Choi**, Daejeon (KR); **Cheol Sig Pyo**, Daejeon (KR); **Jong-Suk Chae**, Daejeon (KR)

(73) Assignee: **Electronics and Telecommunications Research Institute**, Daejeon (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 959 days.

(21) Appl. No.: **12/176,757**

(22) Filed: **Jul. 21, 2008**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Dec. 6, 2007 (KR) 10-2007-0126292
Mar. 11, 2008 (KR) 10-2008-0022615

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

(52) **U.S. Cl.** **340/572.7**; 343/700 MS

(58) **Field of Classification Search** 340/572.7, 340/500, 540, 568.1, 572.1; 343/850, 852, 343/857, 860, 862

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,028,564 A 2/2000 Duan et al.
6,215,402 B1 4/2001 Rao Kodukula et al.
6,285,342 B1 9/2001 Brady et al.

6,353,443 B1 3/2002 Ying
6,535,175 B2 3/2003 Brady et al.
7,004,399 B2 2/2006 Maeda et al.
7,557,757 B2* 7/2009 Deavours et al. 343/700 MS
8,068,057 B2* 11/2011 Yamagajo et al. 343/700 MS

FOREIGN PATENT DOCUMENTS

JP 2003-087044 A 3/2003
(Continued)

OTHER PUBLICATIONS

Sung-Joo Kim; Byongkil Yu; Ho-Jun Lee; Myun-Joo Park; Harackiewicz, F.J.; Byungje Lee; , "RFID tag antenna mountable on metallic plates," Microwave Conference Proceedings, 2005. APMC 2005. Asia-Pacific Conference Proceedings , vol. 4, no., pp. 3 pp., Dec. 4-7, 2005 doi: 10.1109/APMC.2005.1606887.*

(Continued)

Primary Examiner — Brian Zimmerman

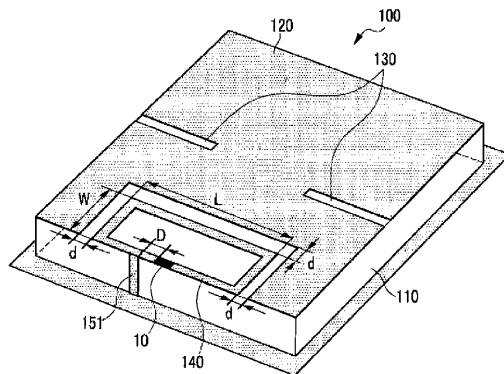
Assistant Examiner — Sara Samson

(74) *Attorney, Agent, or Firm* — Kile Park Goekjian Reed & McManus PLLC

(57) **ABSTRACT**

An RFID tag attached to an object and transmitting a signal that corresponds to identification information includes an RFID tag chip that modulates the signal according to the identification information and an RFID tag antenna that transmits the modulated signal. The RFID tag antenna includes a dielectric material, a radiating patch, and a slit. The dielectric material has a polyhedral shape and includes a first surface that contacts the object and a second surface that is parallel with the first surface, the radiating patch is formed on at least a part of the second surface and radiates electromagnetic to waves, and the slit is formed on at least a part of the radiating patch to expose the dielectric material.

17 Claims, 5 Drawing Sheets





US008174443B2

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

(10) **Patent No.:** **US 8,174,443 B2**

(45) **Date of Patent:** **May 8, 2012**

(54) **TRUE TIME DELAY SYSTEMS WITH ARRAY ANTENNA FOR THE SPATIALLY CHANGEABLE RADIATION PATTERN FOR MAXIMUM POWER ULTRA-WIDEBAND PULSES**

(75) Inventors: **Jung Markus**, Eicklingen (DE); **Jürgen Schmitz**, Gifhorn (DE); **Bernd Schünemann**, Bergen (DE); **Gerd-Walter Wollmann**, Celle (DE)

(73) Assignee: **Rheinmetall Waffe Munition GmbH**, Unterluss (DE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 204 days.

(21) Appl. No.: **12/677,084**

(22) PCT Filed: **Aug. 12, 2008**

(86) PCT No.: **PCT/EP2008/006639**

§ 371 (c)(1),
(2), (4) Date: **May 14, 2010**

(87) PCT Pub. No.: **WO2009/033541**

PCT Pub. Date: **Mar. 19, 2009**

(65) **Prior Publication Data**

US 2010/0277371 A1 Nov. 4, 2010

(30) **Foreign Application Priority Data**

Sep. 7, 2007 (DE) 10 2007 042 614

(51) **Int. Cl.**
H01Q 3/22 (2006.01)

(52) **U.S. Cl.** **342/375**

(58) **Field of Classification Search** **342/375**
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,109,203	A	4/1992	Zucker et al.	
5,313,056	A	5/1994	Kim et al.	
6,067,673	A *	5/2000	Paese et al.	4/623
6,515,622	B1 *	2/2003	Izadpanah et al.	342/368
7,051,636	B1	5/2006	Snow et al.	

(Continued)

FOREIGN PATENT DOCUMENTS

DE 19638 149 A1 3/1997

(Continued)

OTHER PUBLICATIONS

scholar.lib.vt.edu.online text, "Chapter 3, Antenna Arrays and Beamforming," pp. 29-52.

(Continued)

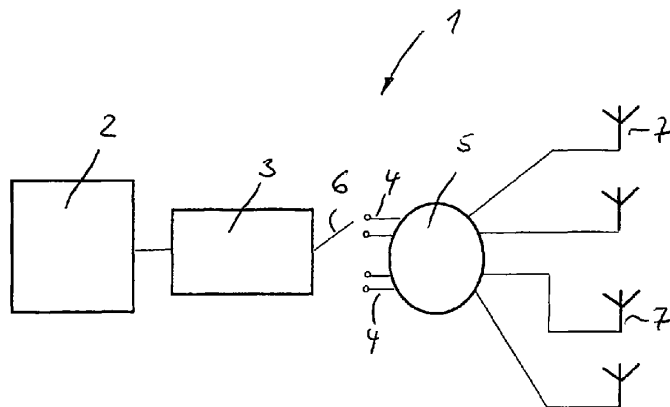
Primary Examiner — Harry Liu

(74) Attorney, Agent, or Firm — Griffin & Szipl, P.C.

(57) **ABSTRACT**

An HPEM module (1,10) is provided, wherein the output pulse or the trigger pulse is transmitted on a single input trigger pulse (Trigger 2, 11) with an intermediate TTD network (5, 14) in a phase-defined and time-defined manner independent of frequency depending on the selected input of the electromagnetic lens via the geometric form of the lens. The trigger signal defines the time point for the generation of an UWB pulse in the pulse generator (3, 16). The main lobe of an antenna array (1*n) of several antennae (7, 15) is thus altered in the same number of positions in a plane accordingly as the number of adjustable phase differences or time differences. For an m*n array the alignment of the antenna lobe is no longer restricted to the plane.

16 Claims, 1 Drawing Sheet





US008174450B2

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

(10) **Patent No.:** **US 8,174,450 B2**
(45) **Date of Patent:** **May 8, 2012**

(54) **BROADBAND MICROPATCH ANTENNA SYSTEM WITH REDUCED SENSITIVITY TO MULTIPATH RECEPTION**

6,091,373 A * 7/2000 Raguinet 343/778
6,211,824 B1 4/2001 Holden et al.
2007/0205945 A1 9/2007 Tatarnikov et al.

(75) Inventors: **Dmitry Tatarnikov**, Moscow (RU);
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Sergey Emelianov, Moscow (RU);
Anton Stepanenko, Dedovsk (RU)

FOREIGN PATENT DOCUMENTS
EP 0 481 417 4/1992
EP 1 684 381 10/2008
WO WO99/66594 12/1999
WO WO2005/117208 12/2005

(73) Assignee: **Topcon GPS, LLC**, Oakland, NJ (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 252 days.

Gonzalez Miguel A et al., "Analysis of Cavity-Backed Multilayer Microstrip Patch Arrays on Continuous Dielectric Substrates by a Hybrid Modular Technique", European Microwave Conference, 2001, 31st IEEE, Piscataway, N.J., Oct. 1, 2001, pp. 1-4.
International Search Report corresponding to International Application No. PCT/IB2009/005405 filed Apr. 24, 2009, (4 pages).
Written Opinion of the International Searching Authority corresponding to International Application No. PCT/IB2009/005405 filed Apr. 24, 2009 (10 pages).

(21) Appl. No.: **12/418,656**

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

* cited by examiner

(65) **Prior Publication Data**
US 2009/0273522 A1 Nov. 5, 2009

Primary Examiner — Hoang V Nguyen
(74) *Attorney, Agent, or Firm* — Wolff & Samson PC

Related U.S. Application Data

(60) Provisional application No. 61/125,935, filed on Apr. 30, 2008.

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/42 (2006.01)

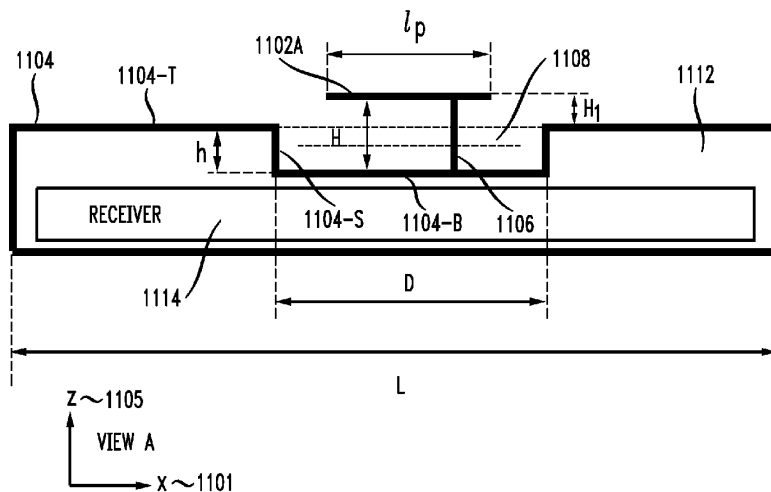
(57) **ABSTRACT**

(52) **U.S. Cl.** **343/700 MS**; 343/789; 343/846
(58) **Field of Classification Search** 343/700 MS, 343/789, 846
See application file for complete search history.

A micropatch antenna system with simultaneous high bandwidth and low sensitivity to multipath radiation is achieved by positioning a radiating element within a cavity in a ground plane. Bandwidth and sensitivity to multipath radiation may be varied by varying the height of the radiating element above the bottom of the cavity and above the top of the ground plane. The electromagnetic and physical characteristics of the antenna system may be further controlled by introducing dielectric solids or wave-slowing structures between the bottom of the cavity and the radiating element. A dual-band micropatch antenna system with simultaneous high bandwidth and low sensitivity to multipath radiation may be similarly configured by stacking a second radiating element on top of the first radiating element.

(56) **References Cited**
U.S. PATENT DOCUMENTS
5,990,835 A 11/1999 Kuntzsch et al.
6,049,309 A 4/2000 Timoshin et al.

24 Claims, 11 Drawing Sheets





US008174452B2

(12) **United States Patent**
Ayala Vazquez et al.

(10) **Patent No.:** **US 8,174,452 B2**
(45) **Date of Patent:** **May 8, 2012**

(54) **CAVITY ANTENNA FOR WIRELESS ELECTRONIC DEVICES**

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

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 391 days.

(21) Appl. No.: **12/238,384**

(22) Filed: **Sep. 25, 2008**

(65) **Prior Publication Data**
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(52) **U.S. Cl.** **343/702**; 343/700 MS
(58) **Field of Classification Search** 343/702,
343/700 MS, 895
See application file for complete search history.

(56) **References Cited**
U.S. PATENT DOCUMENTS
4,733,245 A 3/1988 Mussler
6,081,729 A 6/2000 Bauerschmidt et al.
6,225,959 B1 5/2001 Gordon
6,339,400 B1 1/2002 Flint et al.
6,369,771 B1 4/2002 Chiang et al.
6,380,930 B1 4/2002 Van Ruyambeke
6,653,983 B2 11/2003 Masuda et al.
6,670,923 B1 12/2003 Kadambi et al.
6,686,886 B2 2/2004 Flint et al.

6,741,214 B1 5/2004 Kadambi et al.
6,747,601 B2 6/2004 Boyle
6,774,852 B2 8/2004 Chiang et al.
6,791,497 B2* 9/2004 Winebrand et al. 343/702
6,853,336 B2 2/2005 Asano et al.
6,856,294 B2 2/2005 Kadambi et al.
6,879,293 B2 4/2005 Sato
6,888,510 B2 5/2005 Jo et al.
6,894,650 B2 5/2005 Darden et al.
6,922,175 B2 7/2005 Walton
6,950,069 B2 9/2005 Gaucher et al.
6,980,154 B2 12/2005 Vance et al.
7,027,838 B2 4/2006 Zhou et al.

(Continued)

OTHER PUBLICATIONS

Ayala Vazquez et al., U.S. Appl. No. 12/486,496, filed Jun. 17, 2009.

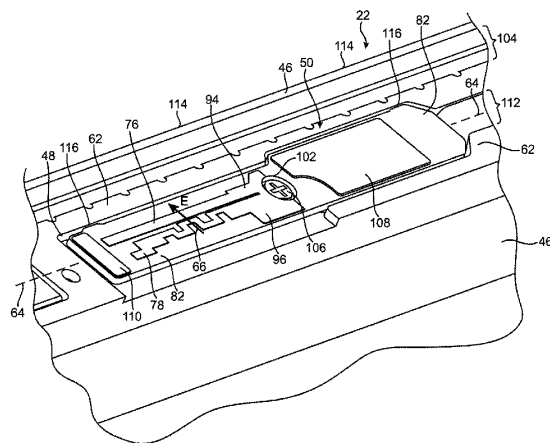
(Continued)

Primary Examiner — Hoanganh Le
(74) *Attorney, Agent, or Firm* — Treyz Law Group; David C. Kellogg; Louis R. Levenson

(57) **ABSTRACT**

Wireless portable electronic devices such as laptop computers are provided with cavity-backed monopole antennas. A wireless device may have a housing. Conductive portions of the housing such as a conductive outer metal layer and internal frame structures may form a cavity having conductive walls. An antenna resonating element structure may be formed from monopole antenna resonating element arms of dissimilar lengths. One of the arms may be straight and another of the arms may be implemented using a meandering path. The antenna resonating element may be mounted over the cavity to form a cavity-backed monopole antenna. A display within the device may be covered by a cover glass. An opaque bezel region around the periphery of the cover glass may cover the antenna and block it from view. The antenna resonating element arms may run parallel to the longitudinal axis of the cavity.

19 Claims, 10 Drawing Sheets





US008174453B2

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

(10) **Patent No.:** **US 8,174,453 B2**
(45) **Date of Patent:** **May 8, 2012**

(54) **FOLDER-TYPE MOBILE COMMUNICATION DEVICE**

(75) Inventors: **Kin-Lu Wong**, Taipei Hsien (TW);
Chao-An Lyu, Taipei Hsien (TW);
Cheng-Tse Lee, Taipei Hsien (TW)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 259 days.

(21) Appl. No.: **12/726,388**

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(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Dec. 24, 2009 (TW) 98144822 A

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H01Q 1/24 (2006.01)
H01Q 1/48 (2006.01)

(52) **U.S. Cl.** 343/722; 343/702; 343/846

(58) **Field of Classification Search** 343/702,
343/722, 846, 700 MS
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS
7,199,762 B2 * 4/2007 Liu et al. 343/702

2008/0100514 A1 * 5/2008 Abdul-Gaffoor et al. 343/702
2010/0007563 A1 * 1/2010 Varjonen 343/702
2010/0309063 A1 * 12/2010 Wong et al. 343/702

* cited by examiner

Primary Examiner — Jacob Y Choi

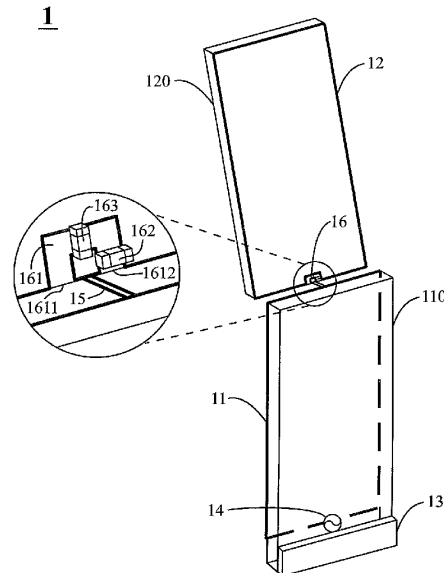
Assistant Examiner — Hasan Islam

(74) *Attorney, Agent, or Firm* — Alan Kamrath; Kamrath IP Lawfirm, PA

(57) **ABSTRACT**

The present invention is related to a folder-type mobile communication device. The device comprises a first dielectric substrate, a first ground plane disposed on the first dielectric substrate, a second dielectric substrate, a second ground plane disposed on the second dielectric substrate, an antenna element, a metal line, and a band-stop circuit. The antenna element is located near the first ground plane and is electrically connected to a source on the first dielectric substrate. The second ground plane is electrically connected to the first ground plane through the metal line. The band-stop circuit is located either on the first ground plane or on the second ground plane. The band-stop circuit includes a slit, a capacitive element, and an inductive element. The slit is near the metal line. The capacitive element is electrically connected to the two sides of the slit, and the inductive element is electrically connected to the two sides of the slit such that the inductive element and the capacitive element form a parallel LC resonant circuit. Therefore, the band-stop circuit generates a parallel resonance at a specified frequency.

10 Claims, 5 Drawing Sheets





US008174454B2

(12) **United States Patent**
Mayer

(10) **Patent No.:** **US 8,174,454 B2**
(45) **Date of Patent:** **May 8, 2012**

(54) **DUAL-BAND ANTENNA**
(75) Inventor: **Lukas W. Mayer**, Vienna (AT)
(73) Assignee: **Infineon Technologies AG** (DE)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1095 days.

7,158,033	B2 *	1/2007	Forster	.....	340/572.1
7,298,343	B2 *	11/2007	Forster et al.	.....	343/767
2001/0050651	A1 *	12/2001	Grangeat et al.	.....	343/767
2002/0000944	A1	1/2002	Sabet et al.	.....
2005/0093677	A1 *	5/2005	Forster et al.	.....	340/10.1
2006/0244676	A1 *	11/2006	Uesaka	.....	343/895

FOREIGN PATENT DOCUMENTS

EP 1336158 8/2003

OTHER PUBLICATIONS

Leong, K.S., et al., "Dual-frequency antenna design for RFID application," International Technical Conference on Circuits/Systems, Computers and Communications, Jul. 2006.

* cited by examiner

Primary Examiner — Jacob Y Choi

Assistant Examiner — Kyana R McCain

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

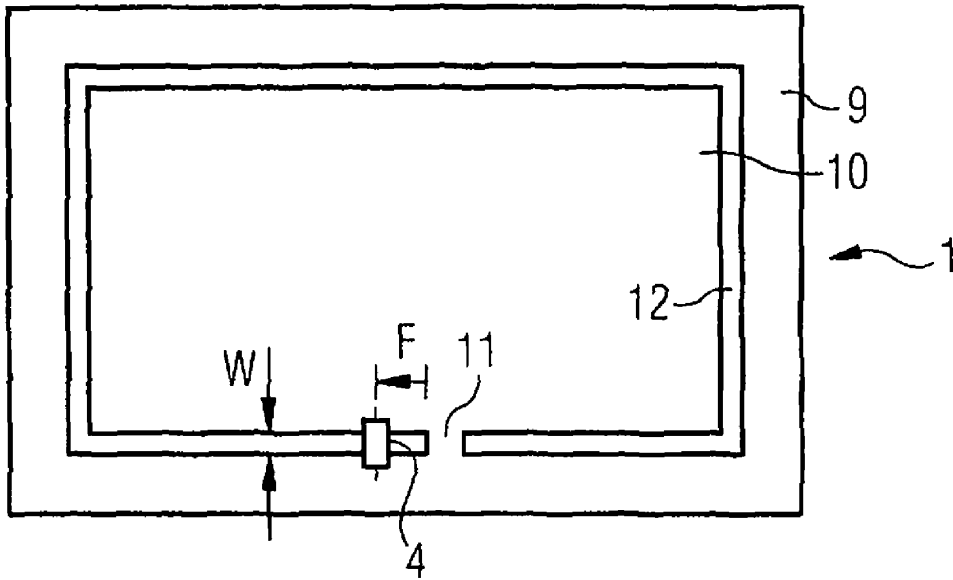
(21) Appl. No.: **11/745,385**
(22) Filed: **May 7, 2007**
(65) **Prior Publication Data**
US 2008/0278391 A1 Nov. 13, 2008
(51) **Int. Cl.**
H01Q 21/00 (2006.01)
(52) **U.S. Cl.** **343/725; 343/728**
(58) **Field of Classification Search** **343/767,**
343/769, 895; 340/572.1
See application file for complete search history.

(57) **ABSTRACT**

Dual-band antenna including a shorted loop slot antenna and a spiral antenna.

(56) **References Cited**
U.S. PATENT DOCUMENTS
4,032,921 A 6/1977 Sikina, Jr. et al.
6,121,936 A 9/2000 Hemming et al.
6,946,958 B2 * 9/2005 Gundlach et al. 340/539.21

33 Claims, 3 Drawing Sheets





US008174455B2

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

(10) **Patent No.:** **US 8,174,455 B2**
(45) **Date of Patent:** **May 8, 2012**

- (54) **ANTENNA ELEMENT WITH IMPROVED RADIATION CHARACTERISTICS**
- (75) Inventors: **Akira Miyoshi**, Tokyo (JP); **Kozo Shimizu**, Akita (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 241 days.

FOREIGN PATENT DOCUMENTS

EP	1 758 204	7/2006
JP	2006-261941	9/2006
JP	2008-66979	3/2008
WO	WO 2008/054803	5/2008

OTHER PUBLICATIONS

Alsiety, M.K., et al., "A Study of Ground-Plane-Level and Vehicle-Level Radiation Patterns of GPS Antenna in Telematics Applications.", IEEE Antennas and Wireless Propagation Letters, vol. 6, 2007, pp. 130-133.
 Kokotoff, D.M., et al., "Annular ring coupled circular patch with enhanced performance.", Antennas and Propagation, IEEE Transaction, 45, pp. 2000-2001.

- (21) Appl. No.: **12/477,379**
- (22) Filed: **Jun. 3, 2009**

(Continued)

- (65) **Prior Publication Data**
US 2009/0303143 A1 Dec. 10, 2009

Primary Examiner — Jacob Y Choi
Assistant Examiner — Amal Patel
 (74) *Attorney, Agent, or Firm* — Whitham Curtis Christofferson & Cook, PC

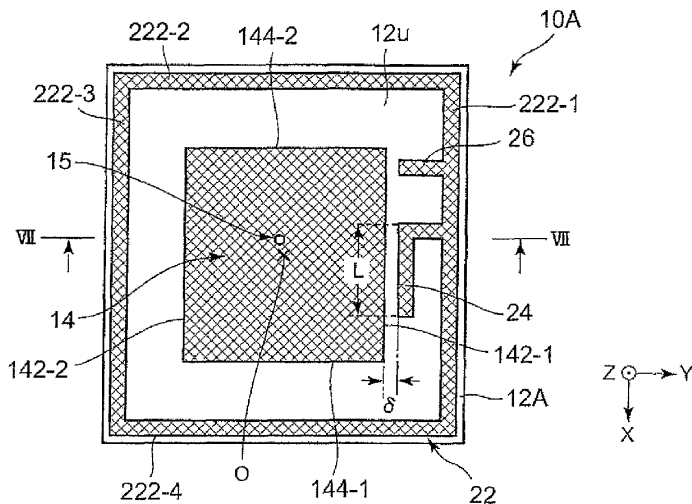
- (30) **Foreign Application Priority Data**
Jun. 4, 2008 (JP) P2008-147182

(57) **ABSTRACT**
 An antenna element is disclosed. A substrate is made of dielectric material and has a first face. A first antenna element is made of conductive material and is provided on the first face. A first power feeding portion is made of conductive material and is disposed on the first antenna element. A second antenna element is made of conductive material, is provided on the first face, and forms a loop surrounding the first antenna element with a gap. A second power feeding portion is made of conductive material. The second power feeding portion is extended from the second antenna element toward the first antenna element and is arranged to form an electromagnetic coupling with the first antenna element. A perturbation element is made of conductive material and is extended from the second antenna element. A length of loop is twice a circumferential length of the first antenna element.

- (51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 21/00 (2006.01)
- (52) **U.S. Cl.** **343/728**; 343/700 MS; 343/855
- (58) **Field of Classification Search** 343/700 MS, 343/728, 732, 855, 857, 743, 866
See application file for complete search history.

- (56) **References Cited**
U.S. PATENT DOCUMENTS
 6,104,348 A * 8/2000 Karlsson et al. 343/700 MS
 7,042,399 B2 5/2006 Noro et al.
 7,084,816 B2 8/2006 Watanabe
 7,126,539 B2 10/2006 Sampo
 7,129,899 B2 10/2006 Jecko et al.
 2006/0103576 A1* 5/2006 Mahmoud et al. 343/700 MS

11 Claims, 6 Drawing Sheets





US008174457B1

(12) **United States Patent**
Lam

(10) **Patent No.:** **US 8,174,457 B1**
(45) **Date of Patent:** **May 8, 2012**

(54) **BROADBAND TELEVISION ANTENNA**

(75) Inventor: **Alan M. L. Lam**, Hong Kong (HK)

(73) Assignee: **RadioShack, Corporation**, Fort Worth, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 668 days.

(21) Appl. No.: **12/358,316**

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

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

(52) **U.S. Cl.** **343/828**; 343/829; 343/846

(58) **Field of Classification Search** 343/702, 343/720, 825, 826, 828-830, 845, 846, 847
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,821,710	A	1/1958	Hale	
3,261,019	A	7/1966	Lundy	
3,587,105	A *	6/1971	Neilson	343/710
4,293,861	A *	10/1981	Winegard et al.	343/766

6,856,287	B2	2/2005	Rao et al.	
7,319,432	B2 *	1/2008	Andersson	343/702
7,330,153	B2	2/2008	Rentz	
7,535,431	B2 *	5/2009	Rowell	343/846
2001/0050636	A1	12/2001	Weinberger	

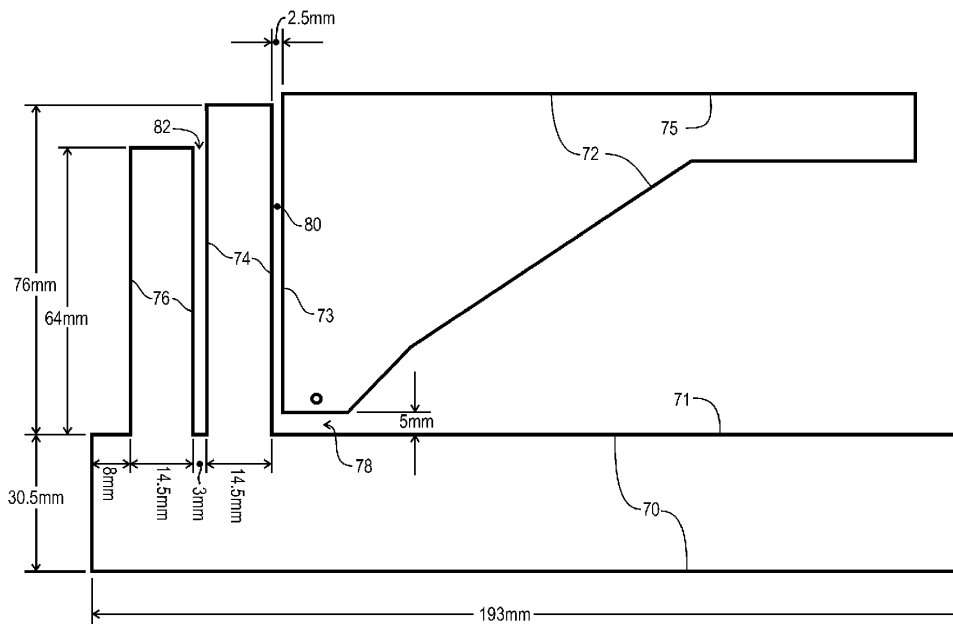
* cited by examiner

Primary Examiner — Michael C Wimer
(74) *Attorney, Agent, or Firm* — Dan Brown Law Office; Daniel R. Brown

(57) **ABSTRACT**

A broadband antenna apparatus that is generally disposed along a plane. The antenna apparatus includes a ground plate with an edge and an inverted "L" antenna that has a base leg and an elongated leg, which define an interior corner. The interior corner is filled with a triangulated portion for broadening the bandwidth of the antenna. There is an antenna feed point at a distal end of the base leg. The antenna is oriented so that the distal end of the base leg is adjacent to the edge, forming a first dielectric gap therebetween, and further oriented with the elongated leg parallel to the edge. A first parasitic ground element extends from the edge and is positioned adjacent to the base leg, forming a second dielectric gap therebetween. The antenna apparatus also includes a second parasitic ground element extending from the edge of the ground plate.

28 Claims, 12 Drawing Sheets





US008174458B2

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

(10) **Patent No.:** **US 8,174,458 B2**
(45) **Date of Patent:** **May 8, 2012**

- (54) **DUAL-FEED ANTENNA**
- (75) Inventors: **Jui-Hung Chou**, Taichung (TW);
Saou-Wen Su, Taipei (TW)
- (73) Assignees: **Silitek Electronics (Guangzhou) Co., Ltd.**, Guangzhou (CN); **Lite-On Technology Corporation**, Taipei (TW)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 451 days.
- (21) Appl. No.: **12/574,034**
- (22) Filed: **Oct. 6, 2009**
- (65) **Prior Publication Data**
US 2010/0265151 A1 Oct. 21, 2010
- (30) **Foreign Application Priority Data**
Apr. 16, 2009 (CN) 2009 1 0038776
- (51) **Int. Cl.**
H01Q 5/00 (2006.01)
H01Q 21/00 (2006.01)
H01Q 1/48 (2006.01)
- (52) **U.S. Cl.** **343/843**; 343/893; 343/846
- (58) **Field of Classification Search** 343/843, 343/893, 846, 702, 700 MS, 848, 829
See application file for complete search history.

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

6,448,932	B1	9/2002	Stoiljkovic et al.	
6,542,123	B1*	4/2003	Chen	343/700 MS
6,970,137	B1*	11/2005	Maslovski et al.	343/702
6,982,673	B2*	1/2006	Yuanzhu	343/700 MS
7,202,826	B2*	4/2007	Grant et al.	343/713
7,482,978	B2*	1/2009	Yang et al.	343/700 MS
7,969,361	B2*	6/2011	Castaneda et al.	343/700 MS

- FOREIGN PATENT DOCUMENTS

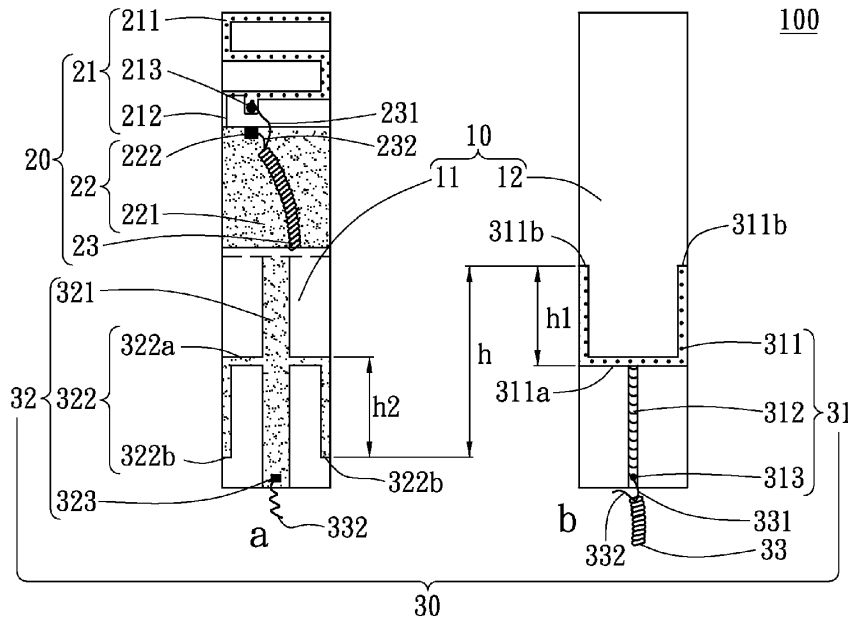
TW	I255588	5/2006
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- * cited by examiner
- Primary Examiner* — Huedung Mancuso
- (74) *Attorney, Agent, or Firm* — Rabin & Berdo, P.C.

(57) **ABSTRACT**

The invention relates to a dual-feed antenna. The dual-feed antenna includes a substrate, a first antenna unit and a second antenna unit. The second antenna unit includes a second radiating unit and a second grounding unit. The second radiating unit includes a second radiator which has a first groove. The first groove has a first bottom and a pair of first arms. The second grounding unit includes a first sub-grounding-area and a second sub-grounding-area. The second sub-grounding-area has a second groove which includes a second bottom and a pair of second arms. The first sub-grounding-area is cross-wise connected with the second sub-grounding-area at the bottom of the groove, and the second arms symmetrically distribute to both sides of the first sub-grounding-area, and the first groove has an opening direction opposite to the opening direction of the second groove.

20 Claims, 9 Drawing Sheets





US008174459B2

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

(10) **Patent No.:** **US 8,174,459 B2**
(45) **Date of Patent:** **May 8, 2012**

(54) **COPLANAR ANTENNA UNIT AND COPLANAR ANTENNA**

(75) Inventors: **Fu-Chiarng Chen**, Hsinchu (TW);
Cheng-Lung Kao, Hsinchu (TW)
(73) Assignee: **National Chiao Tung University**,
Hsinchu (TW)
(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 440 days.

(21) Appl. No.: **12/603,845**

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

(65) **Prior Publication Data**
US 2011/0037675 A1 Feb. 17, 2011

(30) **Foreign Application Priority Data**
Aug. 14, 2009 (TW) 98127509 A

(51) **Int. Cl.**
H01Q 1/48 (2006.01)
H01Q 1/38 (2006.01)
H01Q 5/00 (2006.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.** **343/848**; 343/700 MS; 343/846;
343/845

(58) **Field of Classification Search** 343/847-9
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,420,596	A *	5/1995	Burrell et al.	343/700 MS
5,760,746	A *	6/1998	Kawahata	343/702
6,281,848	B1 *	8/2001	Nagumo et al.	343/700 MS
6,476,767	B2 *	11/2002	Aoyama et al.	343/700 MS
6,700,543	B2 *	3/2004	Konishi et al.	343/700 MS
6,753,813	B2 *	6/2004	Kushihi	343/700 MS
6,891,507	B2 *	5/2005	Kushihi et al.	343/702
2010/0315303	A1 *	12/2010	Kearney et al.	343/767
2011/0210898	A1 *	9/2011	Choi et al.	343/749
2011/0227806	A1 *	9/2011	Wong et al.	343/848
2012/0001815	A1 *	1/2012	Wong et al.	343/749

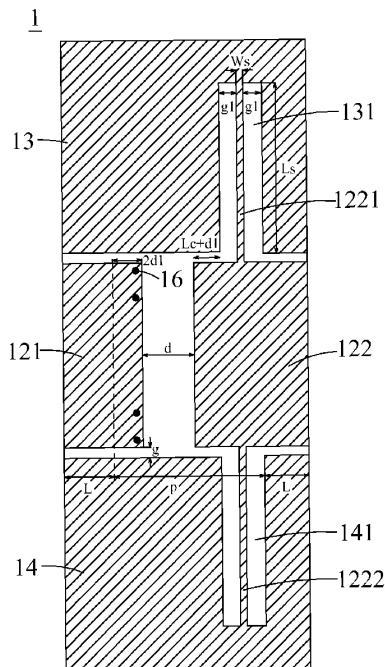
* cited by examiner

Primary Examiner — Douglas W Owens
Assistant Examiner — Jennifer F Hu
(74) *Attorney, Agent, or Firm* — WPAT, P.C.; Anthony King

(57) **ABSTRACT**

The present invention is related to a coplanar antenna unit and a coplanar antenna. By utilizing the unique properties of meta-material to design 1-D balanced CRLH leaky-wave antenna. The antenna can be realized with the coplanar antenna unit consisting of MIM capacitor and grounded inductor. In this invention, all proposed elements are implemented by planar print circuit board, so the full-space switched beam scanning antenna has shorter length of leaky-wave antenna and good radiation performance.

22 Claims, 8 Drawing Sheets





US008174460B2

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

(10) **Patent No.:** **US 8,174,460 B2**
(45) **Date of Patent:** **May 8, 2012**

(54) **VARIABLE ANTENNA MATCHING NETWORK FOR AN IMPLANTABLE ANTENNA**

(75) Inventors: **Dennis E. Larson**, White Bear Lake, MN (US); **Prashant Rawat**, Blaine, MN (US); **Daniel Kollmann**, Andover, MN (US)

(73) Assignee: **Cardiac Pacemakers, Inc.**, St. Paul, MN (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 951 days.

(21) Appl. No.: **12/182,964**

(22) Filed: **Jul. 30, 2008**

(65) **Prior Publication Data**
US 2008/0288028 A1 Nov. 20, 2008

Related U.S. Application Data

(63) Continuation of application No. 11/668,622, filed on Jan. 30, 2007, now Pat. No. 7,409,245.

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

(52) **U.S. Cl.** **343/861; 343/860; 607/36; 607/60**

(58) **Field of Classification Search** **343/850, 343/860, 861; 607/36, 60, 61**
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,697,958 A * 12/1997 Paul et al. 607/31
5,778,308 A 7/1998 Sroka et al.

5,861,019 A	1/1999	Sun et al.	
6,456,256 B1	9/2002	Amundson et al.	
6,574,510 B2	6/2003	Von Arx et al.	
6,614,406 B2*	9/2003	Amundson et al.	343/873
6,675,045 B2	1/2004	Mass et al.	
6,708,065 B2	3/2004	Von Arx et al.	
6,809,701 B2	10/2004	Amundson et al.	
6,889,084 B2	5/2005	Thompson et al.	
6,978,126 B1	12/2005	Blaker et al.	
7,047,076 B1*	5/2006	Li et al.	607/36
7,209,792 B1*	4/2007	Parramon et al.	607/120
7,392,091 B2*	6/2008	Bruinsma	607/60
2005/0010265 A1	1/2005	Baru et al.	
2006/0247737 A1	11/2006	Olson et al.	
2007/0010702 A1	1/2007	Wang et al.	
2007/0100385 A1	5/2007	Rawat et al.	
2009/0046030 A1*	2/2009	Song et al.	343/852

* cited by examiner

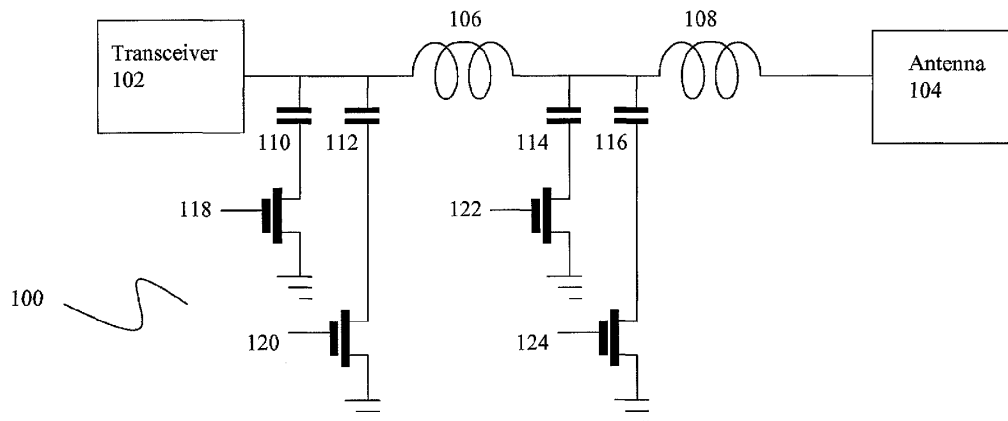
Primary Examiner — Tho G Phan

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

(57) **ABSTRACT**

An implantable medical device can include an implantable antenna for communication with external devices or other internal devices. Changes in the patient's body position, weight, composition or other factors may change the efficiency of the implantable antenna and hinder communication. The disclosed circuit can calculate a value for a matching network for an implantable telemetry circuit to decrease an impedance difference between the implantable telemetry circuit and the implantable antenna or increase or maximize a communication power transfer value associated with the implantable medical device.

21 Claims, 3 Drawing Sheets





US008175524B2

(12) **United States Patent**
Sathath

(10) **Patent No.:** **US 8,175,524 B2**
(45) **Date of Patent:** **May 8, 2012**

(54) **INFORMATION PROCESSING APPARATUS
HAVING A SHARED ANTENNA ELEMENT**

(75) Inventor: **Anwar Sathath, Ome (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 690 days.

JP	2000-031879	1/2000
JP	2000165273	6/2000
JP	2001257511	9/2001
JP	2001292073	10/2001
JP	2002300051	10/2002
JP	2003198408	7/2003
JP	2005-073199	3/2005
JP	2005217909	11/2005
WO	WO2004093346	10/2004

OTHER PUBLICATIONS

Japanese Office Action dated Jun. 10, 2008 for application No. 2006-148472 (U.S. Appl. No. 11/787,465), entitled Information Processing Apparatus. (English Translation).
Chinese Patent Application No. 200710102664.9, The First Office Action, mailed Nov. 27, 2009 (English translation).

* cited by examiner

(21) Appl. No.: **11/787,465**

(22) Filed: **Apr. 16, 2007**

(65) **Prior Publication Data**

US 2007/0275660 A1 Nov. 29, 2007

(30) **Foreign Application Priority Data**

May 29, 2006 (JP) 2006-148472

Primary Examiner — Kamran Afshar

Assistant Examiner — Marisol Fahnert

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

(51) **Int. Cl.**
H04B 7/14 (2006.01)

(52) **U.S. Cl.** **455/19; 455/82; 455/269; 455/13.4; 370/297; 370/302**

(58) **Field of Classification Search** **455/13.4, 455/19, 82, 83, 269, 280; 370/297, 302; 343/702; 333/126**
See application file for complete search history.

(57) **ABSTRACT**

According to one embodiment, an information processing apparatus includes an antenna element, a first wireless communication module including a printed circuit board and a wireless communication circuit which is provided on the printed circuit board, and a second wireless communication module. A diplexer is provided on the printed circuit board of the first wireless communication module, and includes a first terminal which is connected to the antenna element via a first antenna connector provided on the printed circuit board and a first cable, a second terminal which is connected to the wireless communication circuit via a wiring pattern on the printed circuit board, and a third terminal which is connected to a second antenna connector provided on the printed circuit board. The second wireless communication module is connected to the second antenna connector via a second cable.

(56) **References Cited**

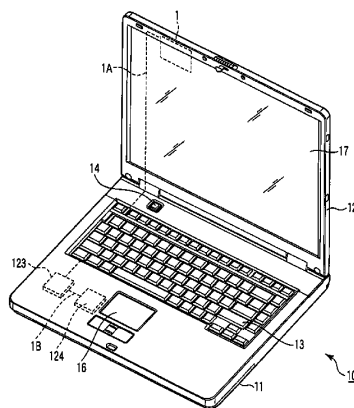
U.S. PATENT DOCUMENTS

6,591,086	B1	7/2003	Pleasant	
2003/0042994	A1*	3/2003	Rosenbaum	333/126
2003/0080906	A1*	5/2003	Miyasaka	343/702
2005/0062657	A1*	3/2005	Lin	343/702
2006/0128333	A1*	6/2006	Kenoun et al.	455/193.2
2007/0082646	A1*	4/2007	Behzad et al.	455/339

FOREIGN PATENT DOCUMENTS

JP	09-321646	12/1997
JP	10-257002	9/1998
JP	11251803	9/1999

12 Claims, 5 Drawing Sheets





US008179322B2

(12) **United States Patent**
Nissinen

(10) **Patent No.:** **US 8,179,322 B2**
(45) **Date of Patent:** **May 15, 2012**

- (54) **DUAL ANTENNA APPARATUS AND METHODS**
- (75) Inventor: **Pertti Nissinen, Kempele (FI)**
- (73) Assignee: **Pulse Finland Oy, Kempele (FI)**
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 852 days.

- 6,738,022 B2 5/2004 Klaavo et al.
- 6,862,441 B2 3/2005 Ella
- 6,903,692 B2 6/2005 Kivekas et al.
- 7,057,560 B2 6/2006 Erkocevic
- 7,142,824 B2 11/2006 Kojima et al.
- 7,148,849 B2 12/2006 Lin
- 7,148,851 B2 12/2006 Takaki et al.
- 7,170,464 B2 1/2007 Tang et al.
- 7,176,838 B1 2/2007 Kinezos

(Continued)

- (21) Appl. No.: **12/009,009**
- (22) Filed: **Jan. 15, 2008**

FOREIGN PATENT DOCUMENTS
CN 1747234 A 3/2006

(Continued)

- (65) **Prior Publication Data**
US 2008/0204328 A1 Aug. 28, 2008

OTHER PUBLICATIONS

"A Novel Approach of a Planar Multi-Band Hybrid Series Feed Network for Use in Antenna Systems Operating at Millimeter Wave Frequencies," by M.W. Elsallal and B.L. Hauck, Rockwell Collins, Inc., pp. 15-24, waelsall@rockwellcollins.com and blhauck@rockwellcollins.com.

(Continued)

- (30) **Foreign Application Priority Data**
Sep. 28, 2007 (FI) 20075687

- (51) **Int. Cl.**
H01Q 1/38 (2006.01)
- (52) **U.S. Cl.** **343/700 MS**
- (58) **Field of Classification Search** **343/700 MS,**
343/702, 829, 846

Primary Examiner — Huedung Mancuso
(74) *Attorney, Agent, or Firm* — Gazdzinski & Associates, PC

See application file for complete search history.

(57) **ABSTRACT**

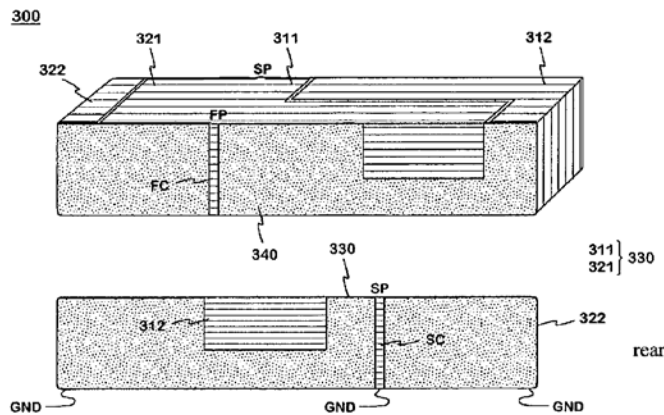
A dielectric dual antenna apparatus intended for applications such as small-sized radio frequency devices. The dual antenna comprises a first partial antenna which implements the lower operating band of the antenna and another partial antenna implementing the upper operating band. The partial antennas have a shared substrate, which together with the radiators constitutes an integrated antenna component. The matching of the dual antenna can be improved in either operating band without degrading it in the other operating band at the same time. Methods of operating the aforementioned apparatus are also disclosed.

- (56) **References Cited**

41 Claims, 6 Drawing Sheets

U.S. PATENT DOCUMENTS

- 5,043,738 A * 8/1991 Shapiro et al. 343/700 MS
- 5,389,937 A * 2/1995 Kaloi 343/700 MS
- 5,557,292 A 9/1996 Nygren et al.
- 6,100,849 A 8/2000 Tsubaki et al.
- 6,133,879 A 10/2000 Grangeat et al.
- 6,147,650 A 11/2000 Kawahata et al.
- 6,177,908 B1 1/2001 Kawahata
- 6,316,975 B1 11/2001 O'Toole et al.
- 6,407,171 B1 * 6/2002 Agarwal et al. 525/191
- 6,473,056 B2 10/2002 Annamaa
- 6,606,016 B2 8/2003 Takamine et al.
- 6,614,400 B2 9/2003 Egorov





US008179323B2

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

(10) **Patent No.:** **US 8,179,323 B2**
(45) **Date of Patent:** **May 15, 2012**

(54) **LOW COST INTEGRATED ANTENNA ASSEMBLY AND METHODS FOR FABRICATION THEREOF**

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

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

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

(21) Appl. No.: **12/337,639**

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

(65) **Prior Publication Data**

US 2009/0231206 A1 Sep. 17, 2009

Related U.S. Application Data

(60) Provisional application No. 61/037,298, filed on Mar. 17, 2008.

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

(52) **U.S. Cl.** **343/700 MS; 343/702; 343/824; 343/893; 343/895; 235/462.45**

(58) **Field of Classification Search** **343/700 MS, 343/824, 829, 846, 853, 893, 702, 895; 235/462.45**
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,010,771	A *	1/2000	Isen et al.	428/209
6,094,179	A *	7/2000	Davidson	343/895
6,396,444	B1 *	5/2002	Goward et al.	343/702
6,603,432	B2 *	8/2003	Hill et al.	343/702
6,822,609	B2 *	11/2004	Mendolia et al.	343/700 MS
6,947,008	B2 *	9/2005	Tillery et al.	343/824
7,080,787	B2 *	7/2006	Wulff et al.	235/462.45
7,113,136	B2 *	9/2006	Marx	343/703
7,354,001	B2 *	4/2008	Wulff et al.	235/462.45
7,486,243	B2 *	2/2009	Wulff et al.	343/702
2002/0000940	A1 *	1/2002	Moren et al.	343/702

* cited by examiner

Primary Examiner — Douglas W Owens

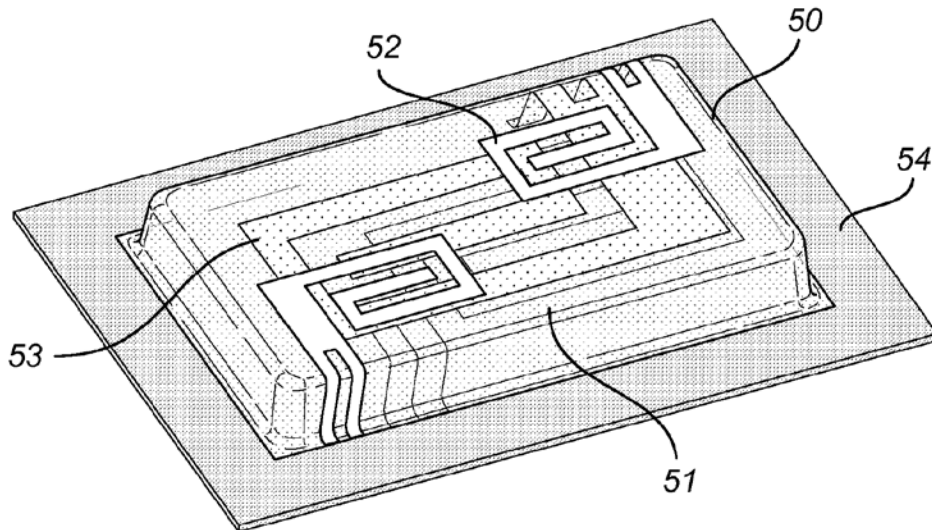
Assistant Examiner — Chuc Tran

(74) *Attorney, Agent, or Firm* — Costal Patent Agency

(57) **ABSTRACT**

A conductive layer is applied to a thermoformed plastic component to form an integrated antenna assembly. The conductive layer is on a flexible layer and adhered or attached to the rigid thermoformed plastic carrier. Features are designed into the thermoformed plastic carrier to provide electrical contacts from the conductive layer to the circuit board of the communication device and to mechanically attach the carrier to the circuit board. Multiple conductive layers can be applied to a multi-layered thermoformed structure to form a multi-antenna assembly.

16 Claims, 9 Drawing Sheets





US008179324B2

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

(10) **Patent No.:** **US 8,179,324 B2**
(45) **Date of Patent:** **May 15, 2012**

(54) **MULTIPLE INPUT, MULTIPLE OUTPUT ANTENNA FOR HANDHELD COMMUNICATION DEVICES**

7,038,627 B2 5/2006 Ikuta et al.
7,109,923 B2 9/2006 Ollikainen et al.
7,283,097 B2 10/2007 Wen et al.
7,289,068 B2* 10/2007 Fujio et al. 343/700 MS
(Continued)

(75) Inventors: **Qinjiang Rao**, Waterloo (CA); **Dong Wang**, Waterloo (CA)

FOREIGN PATENT DOCUMENTS

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

EP 1077505 A2 2/2001
(Continued)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 396 days.

OTHER PUBLICATIONS

(21) Appl. No.: **12/364,932**

Christian Waldschmidt and Werner Wiesbeck, "Compact Wide-Band Multimode Antennas for MIMO and Diversity," IEEE Transactions on Antennas and Propagation, vol. 52, No. 8, pp. 1963-1969, Aug. 2004.

(22) Filed: **Feb. 3, 2009**

(Continued)

(65) **Prior Publication Data**

US 2010/0194642 A1 Aug. 5, 2010

Primary Examiner — Jacob Y Choi
Assistant Examiner — Shawn Buchanan
(74) *Attorney, Agent, or Firm* — Hamilton & Terrile, LLP; Stephen A. Terrile

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

(52) **U.S. Cl.** **343/700 MS; 343/702; 343/845; 343/846; 343/848; 343/893**

(57) **ABSTRACT**

(58) **Field of Classification Search** **343/700 MS, 343/702, 845-846, 848, 893, 914**
See application file for complete search history.

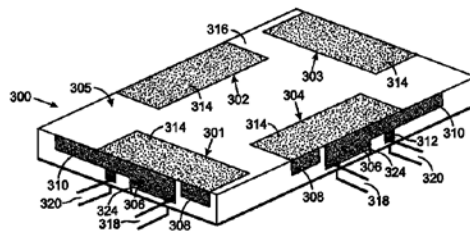
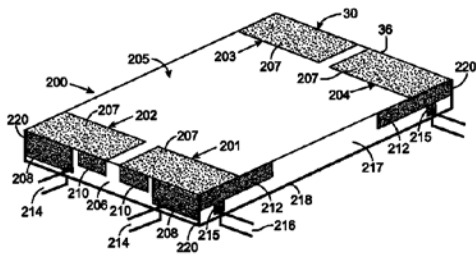
An antenna assembly for a mobile wireless communication device has a support with a first surface and a second surface between which a third surface and a fourth surface extend. A conductive ground plane is formed on the second surface. An antenna includes an electrically conductive patch located on the first surface, and first and second electrically conductive legs and an electrically conductive stripe all abutting the patch. In one version the first and second legs and the stripe are all on the third surface. In another version the first and second legs are on the third surface and the strip is on the fourth surface that is orthogonal to the third surface. A first signal port is adapted to apply a first signal to the first leg and a second signal port is adapted to apply a second signal to the third leg.

(56) **References Cited**

U.S. PATENT DOCUMENTS

- 5,547,100 A 8/1996 Johnson
- 5,633,646 A * 5/1997 Strickland 343/700 MS
- 6,448,933 B1 9/2002 Hill et al.
- 6,515,627 B2* 2/2003 Lopez et al. 343/700 MS
- 6,593,887 B2 7/2003 Luk et al.
- 6,614,401 B2* 9/2003 Onaka et al. 343/702
- 6,650,294 B2 11/2003 Ying et al.
- 6,856,286 B2* 2/2005 Farrar et al. 343/700 MS
- 6,950,071 B2 9/2005 Wen et al.
- 7,023,387 B2 4/2006 Wen et al.

20 Claims, 4 Drawing Sheets





US008179325B2

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

(10) **Patent No.:** **US 8,179,325 B2**
(45) **Date of Patent:** **May 15, 2012**

(54) **PLANAR TRIPOLAR ANTENNA**
(76) Inventors: **David J. Edwards**, Oxfordshire (GB); **Tong Hao**, Oxfordshire (GB); **Wasim Q Malik**, Oxfordshire (GB); **Christopher J. Stevens**, Oxfordshire (GB)

7,151,500 B2 * 12/2006 Su et al. 343/795
7,307,590 B1 * 12/2007 Tonn 343/700 MS
7,532,114 B2 * 5/2009 Stilp 340/539.22
2006/0071870 A1 4/2006 Saito et al.
2007/0139273 A1 * 6/2007 Durham et al. 343/700 MS

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

FOREIGN PATENT DOCUMENTS
WO WO 2006/049382 A1 5/2006

(21) Appl. No.: **12/521,595**
(22) PCT Filed: **Jan. 2, 2008**
(86) PCT No.: **PCT/GB2008/050004**
§ 371 (c)(1),
(2), (4) Date: **Sep. 15, 2010**
(87) PCT Pub. No.: **WO2008/081200**
PCT Pub. Date: **Jul. 10, 2008**

OTHER PUBLICATIONS

Nabar et al., "Performance of Multi-Antenna Signaling Strategies Using Dual-Polarized Antennas: Measurement Results and Analysis," *Wireless Personal Communications* 23: 31-44 (2002).

* cited by examiner

Primary Examiner — Tho G Phan
(74) *Attorney, Agent, or Firm* — Myers Bigel Sibley & Sajovec, P.A.

(65) **Prior Publication Data**
US 2011/0006960 A1 Jan. 13, 2011

(57) **ABSTRACT**

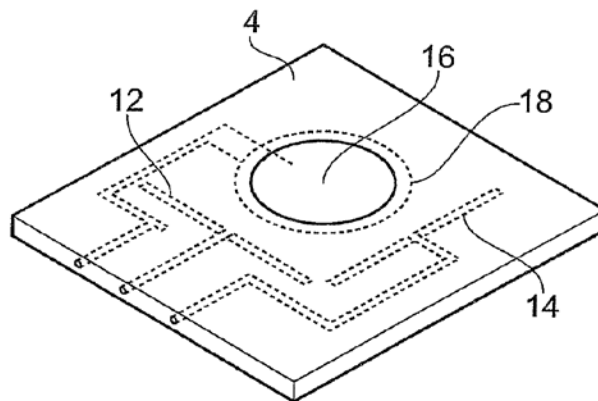
A tripolar antenna is described having at least two electromagnetic signal transmitting/receiving elements arranged such that their axes of signal transmission/reception sensitivity are not parallel, wherein said elements are provided on or at least partially in a substrate of dielectric material so portions of said at least two elements are coplanar and dielectrically isolated from one another. In a preferred arrangement, two dipoles are provided on the substrate in perpendicular orientation and in the plane containing of the surface of said dielectric material. Most preferably a further third element is provided so as to render the antenna tripolar, said third element comprising a first circular disk element secured to an upper surface of the dielectric material, and a second slightly larger circular disk element, concentrically positioned on the corresponding opposite and lower surface of the dielectric.

(30) **Foreign Application Priority Data**
Jan. 6, 2007 (GB) 0700218.1

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
(52) **U.S. Cl.** **343/700 MS**; 343/725; 343/795
(58) **Field of Classification Search** 343/700,
343/725, 727, 795
See application file for complete search history.

(56) **References Cited**
U.S. PATENT DOCUMENTS
5,068,669 A * 11/1991 Koert et al. 343/700 MS
6,400,332 B1 6/2002 Tsai et al.

14 Claims, 3 Drawing Sheets





US008180412B2

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

(10) **Patent No.:** **US 8,180,412 B2**
(45) **Date of Patent:** **May 15, 2012**

(54) **MOBILE WIRELESS COMMUNICATIONS DEVICE HAVING FREQUENCY SELECTIVE GROUNDING AND RELATED METHOD**

(75) Inventors: **Joshua Kwan Ho Wong**, Waterloo (CA); **Adrian M. Cooke**, Kitchener (CA)

(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 58 days.

(21) Appl. No.: **12/868,763**

(22) Filed: **Aug. 26, 2010**

(65) **Prior Publication Data**

US 2012/0052916 A1 Mar. 1, 2012

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

(52) **U.S. Cl.** **455/575.1**; 455/114.1; 455/347; 455/550.1

(58) **Field of Classification Search** 455/575.1, 455/550.1; 361/56
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2004/0203488	A1*	10/2004	Sullivan et al.	455/90.1
2005/0243486	A1	11/2005	Wingfield et al.	361/56
2006/0038635	A1*	2/2006	Richiuso et al.	333/177
2009/0256758	A1	10/2009	Schlub et al.	343/702
2010/0090921	A1	4/2010	Kim et al.	343/848
2010/0194647	A1	8/2010	Man et al.	343/702

FOREIGN PATENT DOCUMENTS

JP	11-355022	12/1999
JP	2010-122525	6/2010
WO	2008/078144	7/2008

* cited by examiner

Primary Examiner — Vladimir Magloire

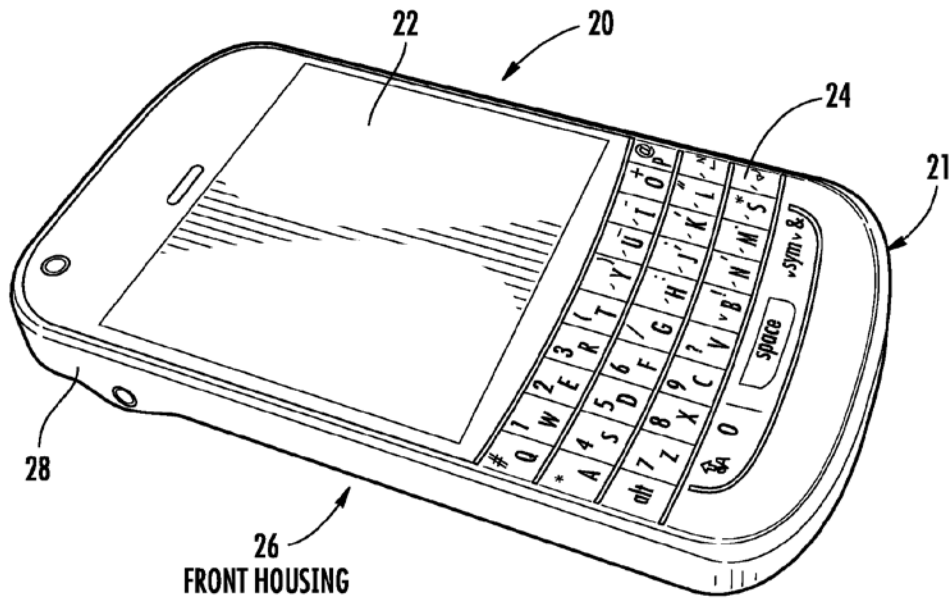
Assistant Examiner — Gerald Johnson

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

(57) **ABSTRACT**

A mobile wireless communications device includes a portable housing having a metallic front housing forming a peripheral sidewall as a metallic ring. A circuit board is carried by the portable housing and forms a chassis ground plane. A wireless communications circuit is carried by a circuit board. An antenna circuit is carried by a circuit board and connected to the wireless communications circuit. A frequency selective grounding circuit is positioned at a selected grounding location at the chassis ground plane and metallic front housing and forms a harmonic trap that responds to a specific range of frequencies.

24 Claims, 13 Drawing Sheets





US008180414B2

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

(10) **Patent No.:** **US 8,180,414 B2**
(45) **Date of Patent:** **May 15, 2012**

(54) **PORTABLE RADIO DEVICE**

(75) Inventors: **Hiroyuki Uejima**, Sendai (JP); **Shingo Sumi**, Sendai (JP); **Hideki Hayama**, Yokohama (JP); **Haruhiko Kakitsu**, Sendai (JP); **Yukari Yamazaki**, 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 135 days.

(21) Appl. No.: **12/681,370**

(22) PCT Filed: **Sep. 30, 2008**

(86) PCT No.: **PCT/JP2008/002747**
§ 371 (c)(1),
(2), (4) Date: **Apr. 1, 2010**

(87) PCT Pub. No.: **WO2009/057247**
PCT Pub. Date: **May 7, 2009**

(65) **Prior Publication Data**
US 2010/0240424 A1 Sep. 23, 2010

(30) **Foreign Application Priority Data**
Oct. 31, 2007 (JP) 2007-283437
Jun. 10, 2008 (JP) 2008-151977

(51) **Int. Cl.**
H04M 1/00 (2006.01)
(52) **U.S. Cl.** **455/575.3; 455/575.1; 455/575.7; 343/702; 343/893**
(58) **Field of Classification Search** **455/575.1, 455/575.3, 575.7; 343/702, 893**
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS
7,423,596 B2 * 9/2008 Maniwa et al. 343/700 MS
2008/0143609 A1 * 6/2008 Mashima et al. 343/702

FOREIGN PATENT DOCUMENTS
JP 2003-060759 A 2/2003
JP 3596774 B1 12/2004
JP 2005-006096 A 1/2005
JP 2005-216158 A 8/2005
JP 2006-166370 A 6/2006
JP 2006-254092 A 9/2006
JP 2007-122195 A 5/2007
WO 20061057350 A1 6/2006
WO 20071018146 A1 2/2007
WO 20071050666 A1 5/2007

OTHER PUBLICATIONS
International Search Report, mailed Oct. 28, 2008, issued in corresponding International Application No. PCT/JP2008/002747, filed Sep. 30, 2008.

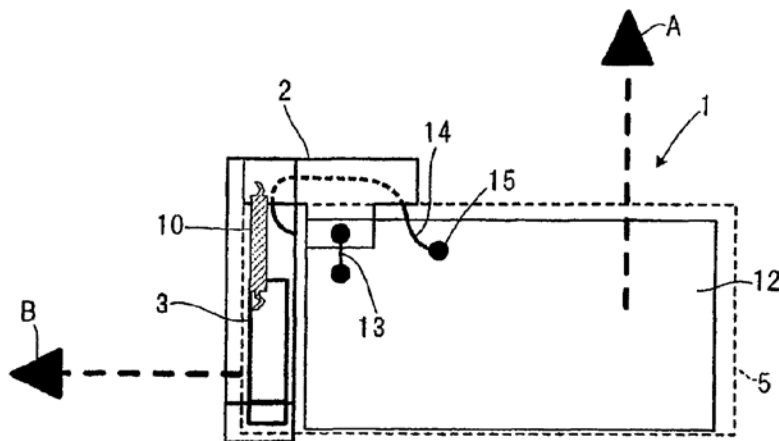
* cited by examiner

Primary Examiner — Tuan H Nguyen
(74) Attorney, Agent, or Firm — Seed IP Law Group PLLC

(57) **ABSTRACT**

There is adopted an enclosure dipole antenna structure including antenna elements respectively provided in a lower enclosure and an upper enclosure. There is also adopted a structure in which the lower structure and the upper structure are rotatably joined together along two axes of hinges. The enclosures thereby become openable and closable in two directions including a vertical direction and a horizontal direction. There can be implemented high antenna performance without use of an external antenna even regardless of whether the enclosures are opened in the vertical direction or the horizontal direction. A feeding section and a connection section are separated from each other by a distance of 1/20 or more of a wavelength corresponding to an operating frequency. Power can well be fed to the antenna elements.

7 Claims, 8 Drawing Sheets





US008184054B2

(12) **United States Patent**
Tsujimura

(10) **Patent No.:** **US 8,184,054 B2**
(45) **Date of Patent:** **May 22, 2012**

(54) **PORTABLE TERMINAL AND BUILT-IN ANTENNA**

(75) Inventor: **Akihiro Tsujimura**, Kokubunji (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 425 days.

(21) Appl. No.: **12/512,240**

(22) Filed: **Jul. 30, 2009**

(65) **Prior Publication Data**

US 2010/0149047 A1 Jun. 17, 2010

(30) **Foreign Application Priority Data**

Dec. 12, 2008 (JP) 2008-317006

(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

6,437,745 B1* 8/2002 Vaisanen et al. 343/702
7,570,218 B2 8/2009 Tsujimura et al.
8,098,204 B2 1/2012 Tsujimura et al.

2008/0203174 A1* 8/2008 Watanabe 235/492
2010/0081489 A1* 4/2010 Ohba et al. 455/575.3
2011/0156962 A1* 6/2011 Jeong et al. 343/700 MS

FOREIGN PATENT DOCUMENTS

JP 5-44047 A 2/1993
JP 2005-295578 A 10/2005
JP 2007-288360 A 11/2007

OTHER PUBLICATIONS

Japanese Office Action dated Mar. 6, 2012 (and English translation thereof) in counterpart Japanese Application No. 2008-317006.

* cited by examiner

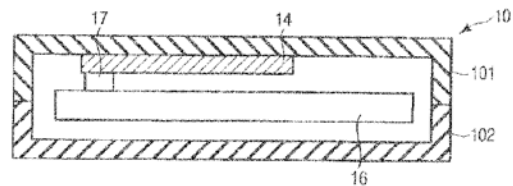
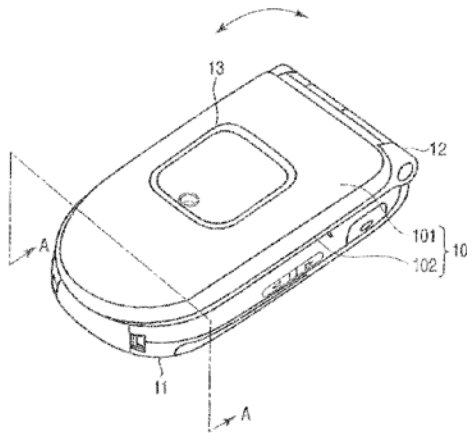
Primary Examiner — Tan Ho

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

(57) **ABSTRACT**

A portable terminal includes a non-conductive resin chassis that is formed by molding a molding material and internally provided with a printed circuit board on which a wireless circuit is formed, and an antenna pattern that is disposed on a wall surface of the chassis and in a region excluding a eject pin track formed when the chassis electrically connected with the printed circuit board is formed, wherein the antenna pattern is constituted by sequentially laminating a copper layer, a nickel layer and a gold layer by electroless plating, and the nickel layer is rendered amorphous.

18 Claims, 6 Drawing Sheets





US008184063B2

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

(10) **Patent No.:** **US 8,184,063 B2**
(45) **Date of Patent:** ***May 22, 2012**

- (54) **BALANCED DIPOLE ANTENNA**
- (75) Inventors: **Yihong Qi**, Waterloo (CA); **Perry Jarmuszewski**, Waterloo (CA); **Paul Dullaert**, Kitchener (CA)
- (73) Assignee: **Research In Motion Limited**, Waterloo (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.

This patent is subject to a terminal disclaimer.

5,929,820	A *	7/1999	Caulfield et al.	343/761
5,936,590	A	8/1999	Funder	
5,977,842	A	11/1999	Brown	
6,239,755	B1	5/2001	Klemens	
6,778,099	B1	8/2004	Meyer et al.	
6,940,264	B2	9/2005	Ryken et al.	
7,053,852	B2 *	5/2006	Timofeev et al.	343/797

FOREIGN PATENT DOCUMENTS

GB 1092407 A 11/1967

OTHER PUBLICATIONS

Brouwer, *On Continuous Vector Distributions on Surfaces*, Koninklijke Nederlandsche Akademie van Wetenschappen Proceedings, vol. 11, p. 850-858, Mar. 27, 1909.

Hansel, *Polarization Errors of Radio Direction Finders*, a Proposed Classification, Proceedings of the IRE (Correspondence), p. 970, Aug. 1951.

Mathis, *On Isotropic Antennas*, Proceedings of the IRE (Correspondence), vol. 42, p. 1810, Dec. 1954.

Roberts, *A New Wide-Band Balun*, Proceedings of the IRE, vol. 45, pp. 1628-1631, Dec. 1957.

* cited by examiner

Primary Examiner — Hoanganh Le

(74) *Attorney, Agent, or Firm* — Ridout & Maybee LLP

- (21) Appl. No.: **12/544,657**
- (22) Filed: **Aug. 20, 2009**
- (65) **Prior Publication Data**
US 2009/0315800 A1 Dec. 24, 2009

Related U.S. Application Data

- (63) Continuation of application No. 11/725,733, filed on Mar. 20, 2007, now Pat. No. 7,586,457, which is a continuation of application No. 10/984,699, filed on Nov. 9, 2004, now Pat. No. 7,193,579.

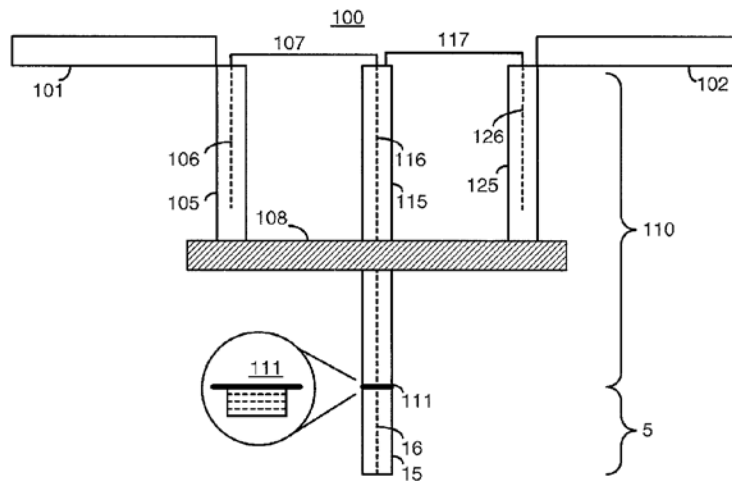
- (51) **Int. Cl.**
H01Q 9/16 (2006.01)
- (52) **U.S. Cl.** **343/821; 343/793; 343/820**
- (58) **Field of Classification Search** **343/793, 343/795, 820, 821, 822, 823**
See application file for complete search history.

- (56) **References Cited**
U.S. PATENT DOCUMENTS
2,473,328 A 6/1949 Brown
4,319,249 A 3/1982 Evans et al.

(57) **ABSTRACT**

A balanced dipole antenna, comprising: a left dipole arm having a center end, a right dipole arm having a center end, a coaxial cable having an outer conductor and a single inner conductor and a top end electrically located between the center ends of the left and right dipole arms, a left stub coupling the left dipole arm and the coaxial cable, and a right stub coupling the right dipole arm and the coaxial cable, wherein the inner conductor of the coaxial cable is connected to one of the left and right dipole arms, and the outer conductor of the coaxial cable is connected to the other of the left and right dipole arms.

18 Claims, 4 Drawing Sheets





US008185061B2

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

(10) **Patent No.:** **US 8,185,061 B2**
(45) **Date of Patent:** **May 22, 2012**

(54) **WIRELESS TERMINAL WITH FREQUENCY SWITCHING CIRCUITS FOR CONTROLLING AN OPERATING FREQUENCY**

(75) Inventors: **Koichi Sato**, Tachikawa (JP); **Satoshi Mizoguchi**, Ome (JP); **Isao Ohba**, Hachioji (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 249 days.

(21) Appl. No.: **12/724,669**

(22) Filed: **Mar. 16, 2010**

(65) **Prior Publication Data**

US 2011/0070843 A1 Mar. 24, 2011

(30) **Foreign Application Priority Data**

Sep. 24, 2009 (JP) 2009-218701

(51) **Int. Cl.**

H04B 1/40 (2006.01)
H04B 1/00 (2006.01)
H04B 15/00 (2006.01)
H04B 1/44 (2006.01)
H04B 1/18 (2006.01)
H04M 1/00 (2006.01)
G06F 3/033 (2006.01)

(52) **U.S. Cl.** **455/75**; 455/63.3; 455/78; 455/83; 455/192.1; 455/575.5; 455/130

(58) **Field of Classification Search** 455/78, 455/83, 63.3, 75, 182.1, 192.1, 82, 130, 575.5
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,269,440 B2 9/2007 Ueda
7,348,926 B2 3/2008 Ueda
2004/0217914 A1* 11/2004 Yamashita et al. 343/850
2006/0118951 A1* 6/2006 Ogawa et al. 257/728
2009/0069062 A1 3/2009 Suzuki et al.

FOREIGN PATENT DOCUMENTS

JP 2003-332938 A 11/2003
JP 2008-086194 A 4/2008
JP 2009-071513 A 4/2009
WO 2007/143616 A2 12/2007

OTHER PUBLICATIONS

Japanese Office Action dated May 24, 2011, issued in counterpart Japanese Application No. 2009-218701, and English translation thereof.

* cited by examiner

Primary Examiner — Temesgh Ghebretinsae

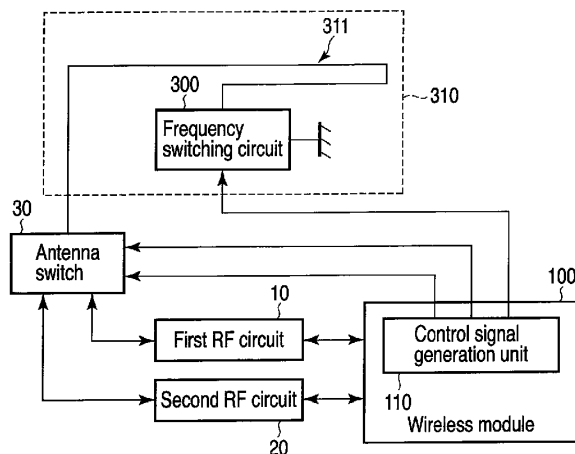
Assistant Examiner — Devan Sandiford

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

(57) **ABSTRACT**

A wireless terminal includes an antenna which comprises an antenna element and at least one frequency switching circuit to control an operating frequency of the antenna element in accordance with a frequency control signal, a plurality of RF circuits to perform an RF signal processing, an antenna switch to connect the antenna to one of the plurality of RF circuits in accordance with a connection control signal, and a generation unit configured to generate the frequency control signal and the connection control signal in accordance with switching between a plurality of wireless communication systems or switching between transmission and reception.

4 Claims, 7 Drawing Sheets





US008185166B2

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

(10) **Patent No.:** **US 8,185,166 B2**
(45) **Date of Patent:** **May 22, 2012**

(54) **THERMAL SPRAY COATING FOR SEAMLESS AND RADIO-TRANSPARENT ELECTRONIC DEVICE HOUSING**

(75) Inventors: **Douglas Weber**, Arcadia, CA (US); **Naoto Matsuyuki**, Okazaki (JP); **David A. Pakula**, San Francisco, CA (US); **Evans Hankey**, San Francisco, CA (US)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 552 days.

(21) Appl. No.: **12/343,335**

(22) Filed: **Dec. 23, 2008**

(65) **Prior Publication Data**

US 2010/0103612 A1 Apr. 29, 2010

Related U.S. Application Data

(60) Provisional application No. 61/108,460, filed on Oct. 24, 2008.

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

(52) **U.S. Cl.** **455/575.1**; 455/575.7; 455/575.8; 361/679.56; 361/705; 361/807; 361/815

(58) **Field of Classification Search** 455/575.1, 455/575.5, 575.7, 575.8
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,817,604	A *	12/1957	Louis	.....	427/108
4,570,166	A *	2/1986	Kuhn et al.	.....	343/872
4,586,115	A *	4/1986	Zimmerman et al.	...	362/217.08
5,327,149	A *	7/1994	Kuffer	.....	343/720
5,355,144	A *	10/1994	Walton et al.	.....	343/713
5,382,383	A *	1/1995	Hirai et al.	.....	252/501.1

5,748,155	A *	5/1998	Kadunce et al.	.....	343/713
6,270,853	B1 *	8/2001	Brown et al.	.....	427/470
6,334,938	B2 *	1/2002	Kida et al.	.....	204/298.13
6,388,621	B1 *	5/2002	Lynch	.....	343/700 MS
6,399,903	B1	6/2002	Stevenson		
7,005,404	B2 *	2/2006	He	.....	502/325
2004/0036646	A1 *	2/2004	Suzuki et al.	.....	342/70
2007/0008227	A1	1/2007	Napoles et al.		
2009/0135015	A1 *	5/2009	Dobson et al.	.....	340/572.9

OTHER PUBLICATIONS

Search Report dated Dec. 4, 2009 from International Application No. PCT/US2009/056393.

Written Opinion dated Dec. 4, 2009 from International Application No. PCT/US2009/056393.

U.S. Appl. No. 10/884,172, filed Jul. 2, 2004.

U.S. Appl. No. 11/501,184, filed Aug. 7, 2006.

* cited by examiner

Primary Examiner — Kent Chang

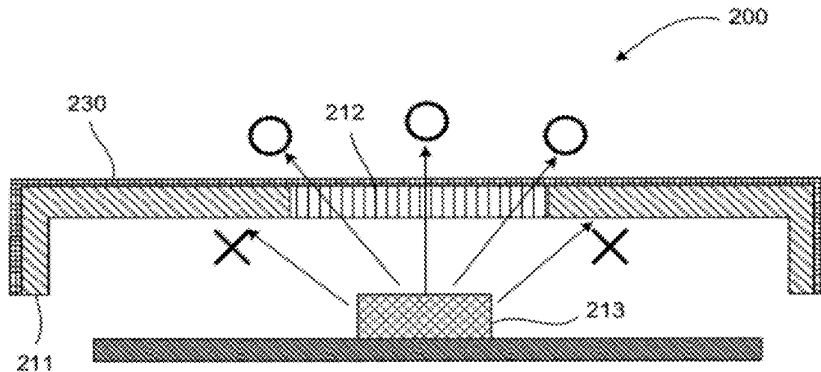
Assistant Examiner — Magdi Elhag

(74) *Attorney, Agent, or Firm* — Beyer Law Group LLP

(57) **ABSTRACT**

Electronic devices and other apparatuses adapted to receive electromagnetic wave communications are disclosed. An outer housing encloses various device components, including at least an internal antenna located fully therewithin and adapted to receive/send communications from/to an outside source via RF or other electromagnetic waves. A ceramic coating can be a thermal spray coating that covers at least a portion of the outer surface proximate to the internal antenna, and can be "RF transparent"—adapted to allow communications to/from the internal antenna via electromagnetic waves. The outer housing can be plastic, metal or a combination thereof. For metal or other non-RF transparent housings, an RF-transparent insert can be fitted into a window in the housing to permit communications to the internal antenna. The ceramic coating covers some or all of the metal, plastic and/or insert that comprise the outer housing and surface for a final aesthetic finish to the device.

27 Claims, 4 Drawing Sheets





US008188925B2

(12) **United States Patent**
DeJean

(10) **Patent No.:** **US 8,188,925 B2**

(45) **Date of Patent:** **May 29, 2012**

(54) **BENT MONOPOLE ANTENNA WITH SHARED SEGMENTS**

(75) Inventor: **Gerald R. DeJean**, Redmond, WA (US)

(73) Assignee: **Microsoft Corporation**, Redmond, WA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 413 days.

(21) Appl. No.: **12/267,480**

(22) Filed: **Nov. 7, 2008**

(65) **Prior Publication Data**

US 2010/0117909 A1 May 13, 2010

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

(52) **U.S. Cl.** **343/700 MS; 343/702; 343/893**

(58) **Field of Classification Search** **343/702, 343/700 MS, 793, 893**

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,239,765	B1 *	5/2001	Johnson et al.	343/795
6,683,570	B2	1/2004	Skladany et al.	
6,734,825	B1 *	5/2004	Guo et al.	343/700 MS
6,956,530	B2	10/2005	Kadambi et al.	
7,053,844	B2	5/2006	Gaucher et al.	
7,286,094	B2	10/2007	Ratni et al.	
7,522,104	B2 *	4/2009	Sugiyama	343/700 MS
2008/0150830	A1	6/2008	Pan et al.	
2008/0158067	A1	7/2008	Mei	

OTHER PUBLICATIONS

John, et al., "Printed Triband Terminal Antenna", Wideband and Multi-band Antennas and Arrays, 2005. IEE (Ref. No. 2005/11059), Publication Date: Sep. 7, 2005, pp. 19-24.

Chou, et al., "Switchable Printed Monopole Antenna with Frequency Diversity for Wifi/2.6 Ghz Wimax/3.5 Ghz Wimax Applications", TENCON 2007—2007 IEEE Region 10 Conference, Dated: Oct. 30, 2007-Nov. 2, 2007, pp. 1-3.

Lee, et al., "A Compact Printed Hook-Shaped Monopole Antenna for 2.4/5-Ghz Wlan Applications", Microwave and Optical Technology Letters/ vol. 48, No. 2, Dated: Feb. 2006, pp. 327-329.

Chen, et al., "Novel Design of Printed Monopole Antenna for WLAN/WiMAX Applications", 2007 IEEE Antennas and Propagation Society International Symposium, Dated: Jun. 9-15, 2007 pp. 3281-3284.

Onat, et al., "Design and Implementation of a Triple-Band Re-Configurable Microstrip Antenna", The 9th European Conference on Wireless Technology, 2006, Dated: Sep. 10-12, 2006, pp. 326-329.

Liang, et al., "Printed S-Shaped Monopole Antenna for Tri-Band WLAN Application", 7th International Symposium on Antennas, Propagation & EM Theory, 2006. ISAPE apos;06, Dated: Oct. 2006 pp. 1-3.

(Continued)

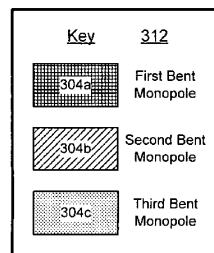
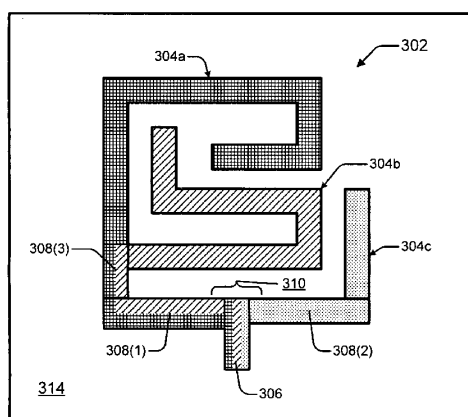
Primary Examiner — Trinh Dinh

(74) *Attorney, Agent, or Firm* — Joseph R. Kelly; Westman, Champlin & Kelly, P.A.

(57) **ABSTRACT**

A bent monopole antenna with shared segments is capable of tri-band communication. In an example embodiment, an antenna assembly includes a substrate, a first bent monopole, a second bent monopole, and a third bent monopole. The first, second, and third bent monopoles are disposed on the substrate. The first bent monopole includes a feedline segment and a first segment. The second bent monopole includes the feedline segment and the first segment. The third bent monopole includes the feedline segment and a second segment. The first, second, and third bent monopoles share the feedline segment, while the first and second bent monopoles also share the first segment. A T-junction is formed by the feedline segment, the first segment, and the second segment. In an example implementation, the first segment has a first width, and the second segment has a second width, with the first width being greater than the second width.

16 Claims, 8 Drawing Sheets





US008188926B2

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

(10) **Patent No.:** **US 8,188,926 B2**
(45) **Date of Patent:** **May 29, 2012**

(54) **FOLDED ANTENNA STRUCTURES FOR PORTABLE DEVICES**

(75) Inventors: **Nisha Ganwani**, Austin, TX (US);
Jonathan D. Pearce, London (GB);
Greg Allan Hodgson, Austin, TX (US);
Aaron Blank, Elgin, TX (US)

(73) Assignee: **Silicon Laboratories, Inc.**, Austin, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 666 days.

5,557,293 A	9/1996	McCoy et al.	343/867
6,008,774 A	12/1999	Wu	343/828
6,054,955 A	4/2000	Schlegel, Jr. et al.	343/702
6,124,831 A	9/2000	Rutkowski et al.	343/700
6,300,910 B1	10/2001	Kim	343/702
6,674,405 B2	1/2004	Wang	343/700
6,794,727 B2*	9/2004	Leduc et al.	257/531
7,109,927 B2	9/2006	Gilbert et al.	343/700
7,271,772 B2	9/2007	Qi et al.	343/702
7,408,512 B1	8/2008	Rodenbeck et al.	343/700
7,528,779 B2	5/2009	Stutzke	343/700
7,554,490 B2	6/2009	Baliarda et al.	343/700
7,598,921 B2	10/2009	Ge et al.	343/806
2007/0159339 A1*	7/2007	Matsuura et al.	340/572.8

* cited by examiner

(21) Appl. No.: **12/317,031**

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

(65) **Prior Publication Data**

US 2010/0109970 A1 May 6, 2010

Related U.S. Application Data

(60) Provisional application No. 61/198,010, filed on Oct. 31, 2008.

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

(52) **U.S. Cl.** **343/700 MS**; 343/702; 343/895

(58) **Field of Classification Search** 343/700 MS, 343/702, 895, 713

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,337,061 A	8/1994	Pye et al.	343/702
5,508,709 A	4/1996	Krenz et al.	343/702

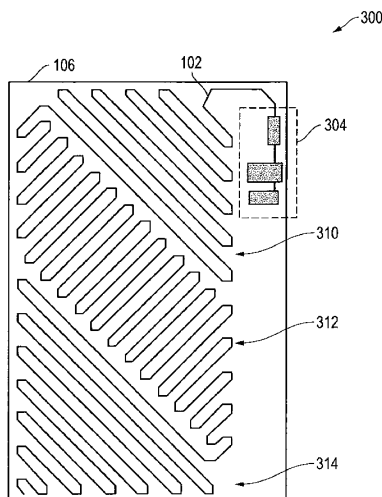
Primary Examiner — Dieu H Duong

(74) *Attorney, Agent, or Firm* — O'Keefe, Egan, Peterman & Enders, LLP

(57) **ABSTRACT**

Methods and systems are disclosed for folded antenna structures that allow for receive and/or transmit antennas to be used for portable or other devices. The folded antennas described herein can be configured, for example, to fit the design constraints and considerations for portable devices. The folded antenna structures can be implemented using relatively flat flexible printed circuits (e.g., flex circuits) and can be placed in available spaces within the portable device, such as above or behind a battery, while still providing good performance characteristics. Still further, the folded antenna structures can be implemented on a printed circuit board and/or as part of plastic materials and pieces included as part of a portable device.

20 Claims, 6 Drawing Sheets





US008188929B2

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

(10) **Patent No.:** **US 8,188,929 B2**
(45) **Date of Patent:** **May 29, 2012**

- (54) **SELF-RESONATING ANTENNA**
- (75) Inventors: **Sung-Hoon Oh**, Plantation, FL (US);
Soo Won Hong, Vernon Hills, IL (US);
Mattia Pascolini, Plantation, FL (US)
- (73) Assignee: **Motorola Mobility, Inc.**, Libertyville, IL (US)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 914 days.

7,319,432 B2 *	1/2008	Andersson	343/702
7,973,726 B2 *	7/2011	Tseng et al.	343/702
2007/0120745 A1	5/2007	Yihong et al.	

FOREIGN PATENT DOCUMENTS

DE	32 46 365 A1	6/1984
JP	11/150415 A	6/1999
WO	99/43037	8/1999
WO	02/50948	12/2001
WO	2004/001898	6/2003
WO	2008/059509	11/2007

OTHER PUBLICATIONS

ISR of PCT/US09144620.

* cited by examiner

- (21) Appl. No.: **12/128,681**
- (22) Filed: **May 29, 2008**

Primary Examiner — Tho G Phan
(74) *Attorney, Agent, or Firm* — Mayback & Hoffman, P.A.;
Gregory L. Mayback; Thomas Bethea

- (65) **Prior Publication Data**
US 2009/0295646 A1 Dec. 3, 2009

- (51) **Int. Cl.**
H01Q 1/24 (2006.01)
- (52) **U.S. Cl.** **343/702; 343/700 MS; 343/767**
- (58) **Field of Classification Search** **343/700, 343/702, 749, 767**
See application file for complete search history.

(57) **ABSTRACT**

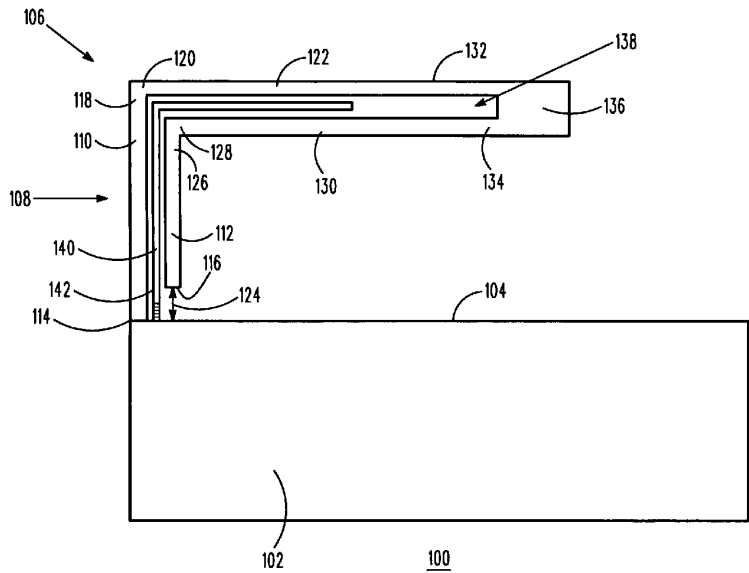
An antenna includes a U-shaped radiator portion having a first extending arm and a second extending arm parallel and adjacent the first extending arm and coupled to the first extending arm by a junction portion, where the first and second extending arms and the junction portion defining a slot. The antenna further includes a ground plane physically coupled only to the first extending arm and a distributed feed element disposed at least partially within the slot and operable to radiate electromagnetic signals within a first frequency range and electrically excite at least portions of the radiator portion at at least a second frequency range having frequencies outside the first frequency range, thereby causing the radiator portion to radiate electromagnetic signals within the second frequency range.

- (56) **References Cited**

U.S. PATENT DOCUMENTS

2,505,751 A *	5/1950	Bolljahn	343/708
3,050,730 A *	8/1962	Lamberty	343/792.5
6,191,740 B1	2/2001	Kates et al.	
6,215,447 B1	4/2001	Johnson	
6,650,301 B1 *	11/2003	Zimmerman	343/803
6,677,909 B2	1/2004	Sun et al.	
7,081,857 B2 *	7/2006	Kinnunen et al.	343/702

14 Claims, 13 Drawing Sheets





US008188930B2

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

(10) **Patent No.:** **US 8,188,930 B2**

(45) **Date of Patent:** **May 29, 2012**

(54) **ANTENNA DEVICE OF MOBILE TERMINAL**

(56) **References Cited**

(75) Inventors: **Sang Bong Sung**, Gumi-si (KR); **In Jin Hwang**, Gumi-si (KR); **Seung Hwan Kim**, Suwon-si (KR); **Jae Ho Lee**, Yongin-si (KR)

U.S. PATENT DOCUMENTS

6,028,555	A *	2/2000	Harano	343/702
7,746,280	B2	6/2010	Kim et al.	
2004/0027295	A1 *	2/2004	Huber et al.	343/702
2011/0193752	A1 *	8/2011	Wang et al.	343/702

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

FOREIGN PATENT DOCUMENTS

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 526 days.

KR	1020060022485	3/2006
KR	1020060062969	6/2006
KR	1020070122101	12/2007
KR	1020080008687	1/2008

* cited by examiner

(21) Appl. No.: **12/489,044**

Primary Examiner — Hoanganh Le

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

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

(65) **Prior Publication Data**

US 2009/0315789 A1 Dec. 24, 2009

(57) **ABSTRACT**

(30) **Foreign Application Priority Data**

Jun. 20, 2008 (KR) 10-2008-0058619

An antenna device of a mobile terminal that can secure radiation performance is provided. The antenna device having a battery cover composed of a metal material includes a radiation unit for transmitting and receiving a signal, a feeding unit formed at an end portion of a first side of the radiation unit for electrically connecting the radiation unit to a Printed Circuit Board (PCB), and a ground part disposed a predetermined distance from the feeding unit and formed at a second side of the radiation unit. When the battery cover is fastened to the mobile terminal, the ground part contacts a first side of the battery cover.

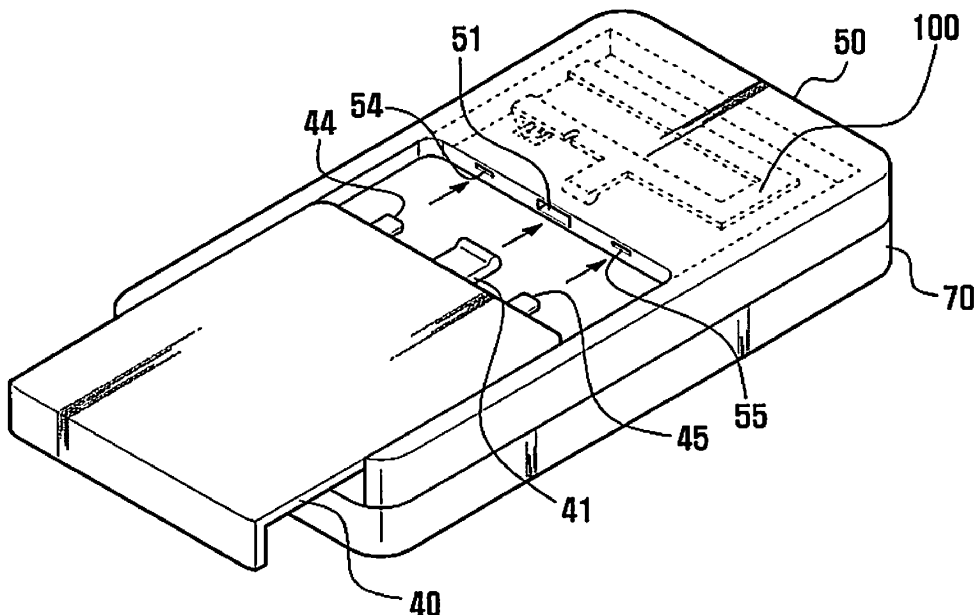
(51) **Int. Cl.**
H01Q 1/24 (2006.01)

(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.

13 Claims, 7 Drawing Sheets





US008190104B2

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

(10) **Patent No.:** **US 8,190,104 B2**
(45) **Date of Patent:** **May 29, 2012**

(54) **MIMO ANTENNA APPARATUS CHANGING ANTENNA ELEMENTS BASED ON TRANSMISSION CAPACITY**
(75) Inventors: **Atsushi Yamamoto**, Kyoto (JP); **Hiroshi Iwai**, Osaka (JP); **Tsutomu Sakata**, Osaka (JP); **Yoshio Koyanagi**, Ishikawa (JP); **Toshiteru Hayashi**, 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 792 days.

(21) Appl. No.: **12/361,770**

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

(65) **Prior Publication Data**
US 2009/0196371 A1 Aug. 6, 2009

(30) **Foreign Application Priority Data**
Jan. 29, 2008 (JP) 2008-017538

(51) **Int. Cl.**
H04B 1/44 (2006.01)
(52) **U.S. Cl.** **455/101; 455/562.1; 375/267**
(58) **Field of Classification Search** 455/73, 455/550.1, 562.1, 101, 102, 133, 134, 277.1, 455/277.2; 375/267, 347; 343/702, 750
See application file for complete search history.

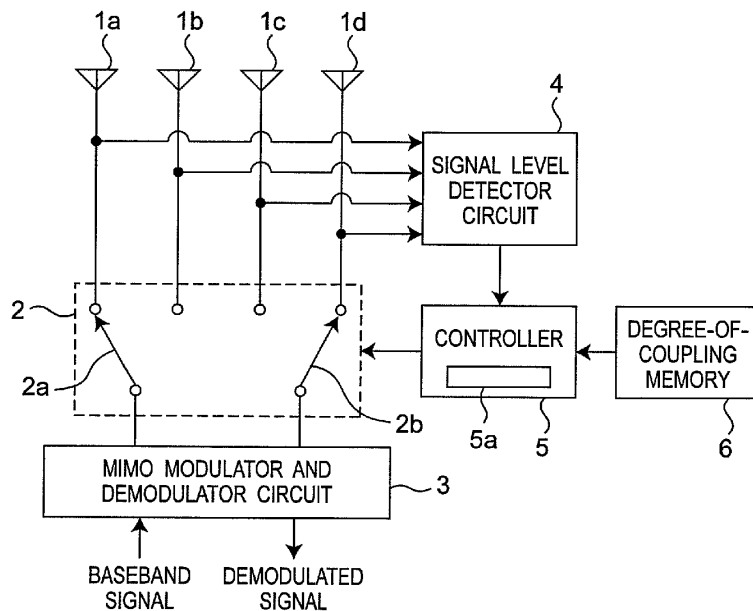
(56) **References Cited**
U.S. PATENT DOCUMENTS
2005/0085196 A1* 4/2005 Amano 455/101
2010/0009638 A1* 1/2010 Saito 455/73
2011/0254749 A1* 10/2011 Amari et al. 343/750

FOREIGN PATENT DOCUMENTS
JP 2004-40554 2/2004
JP 2004-289407 10/2004
* cited by examiner

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

(57) **ABSTRACT**
A controller of a MIMO antenna apparatus calculates a current transmission capacity based on signal levels detected by a signal level detector circuit. The controller calculates an estimated transmission capacity assuming that at least one of antenna elements currently connected to a MIMO modulator and demodulator circuit is changed to a further antenna element not connected to the MIMO modulator and demodulator circuit, based on the detected signal levels and degrees of electromagnetic coupling stored in a degree-of-coupling memory. The controller controls a switch circuit to connect the further antenna element to the MIMO modulator and demodulator circuit when the current transmission capacity becomes lower than the estimated transmission capacity.

19 Claims, 12 Drawing Sheets





US008190112B2

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

(10) **Patent No.:** **US 8,190,112 B2**

(45) **Date of Patent:** ***May 29, 2012**

(54) **MOBILE WIRELESS COMMUNICATIONS DEVICE WITH REDUCED MICROPHONE NOISE FROM RADIO FREQUENCY COMMUNICATIONS CIRCUITRY**

(75) Inventors: **Michael Corrigan**, Waterloo (CA);
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Lizhong Zhu, Waterloo (CA)

(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 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **13/009,314**

(22) Filed: **Jan. 19, 2011**

(65) **Prior Publication Data**

US 2011/0111810 A1 May 12, 2011

Related U.S. Application Data

(63) Continuation of application No. 12/128,710, filed on May 29, 2008, now Pat. No. 7,899,427, which is a continuation of application No. 11/064,702, filed on Feb. 24, 2005, now Pat. No. 7,398,072.

(60) Provisional application No. 60/605,751, filed on Aug. 31, 2004.

(51) **Int. Cl.**
H04B 1/10 (2006.01)

(52) **U.S. Cl.** **455/301**; 455/575.8; 455/300

(58) **Field of Classification Search** 455/575.1, 455/575.8, 300, 301; 379/433.03

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,187,481	A	2/1980	Boutros	333/182
5,165,055	A	11/1992	Metsler	333/12
5,333,205	A	7/1994	Bogut et al.	381/172
5,621,363	A	4/1997	Ogden et al.	333/12
5,633,786	A	5/1997	Matuszewski et al.	361/818
5,682,418	A	10/1997	Ide	379/58
5,764,693	A	6/1998	Taylor et al.	375/222
5,911,121	A	6/1999	Andrews	455/418
5,937,361	A *	8/1999	Smith	455/575.1
5,963,588	A	10/1999	Yatim et al.	375/222
6,108,415	A	8/2000	Andrea	379/433
6,160,896	A *	12/2000	Macaluso et al.	381/386
6,307,944	B1	10/2001	Garratt et al.	381/312
6,397,044	B1	5/2002	Nash et al.	455/73
6,594,155	B2	7/2003	Kuroda	361/807
6,628,508	B2	9/2003	Lieu et al.	361/680
6,647,367	B2	11/2003	McArthur et al.	704/226
7,027,841	B2	4/2006	Ishii	455/569.1
7,239,899	B2 *	7/2007	Lin	455/575.1
7,349,723	B2 *	3/2008	MacIntosh et al.	455/575.1

(Continued)

FOREIGN PATENT DOCUMENTS

EP 0856977 5/1998

(Continued)

Primary Examiner — Christian Hannon

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

(57) **ABSTRACT**

A mobile wireless communications device includes a housing and circuit board in the housing and having radio frequency (RF) circuitry and a power amplifier and microphone mounted thereon. An antenna is carried within the housing and operative with the RF circuitry. An RF shield surrounds and isolates the microphone from the RF circuitry, power amplifier and antenna and shields the microphone from radiated energy generated from the RF circuitry, antenna or power amplifier.

19 Claims, 12 Drawing Sheets

