



US008963780B2

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

(10) **Patent No.:** **US 8,963,780 B2**
(45) **Date of Patent:** **Feb. 24, 2015**

(54) **ANTENNA MODULE**

(75) Inventors: **Chien-Ming Hsu**, Taipei (TW);
Chiu-an-Jian Huang, Taipei (TW)

(73) Assignee: **ASUSTeK Computer Inc.**, Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 158 days.

(21) Appl. No.: **13/568,956**

(22) Filed: **Aug. 7, 2012**

(65) **Prior Publication Data**

US 2013/0044031 A1 Feb. 21, 2013

Related U.S. Application Data

(60) Provisional application No. 61/524,044, filed on Aug. 16, 2011.

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/24 (2006.01)
H01Q 5/00 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 5/0062** (2013.01)
USPC **343/700 MS**; 343/702; 343/848

(58) **Field of Classification Search**

USPC 343/700 MS, 702, 846, 848
See application file for complete search history.

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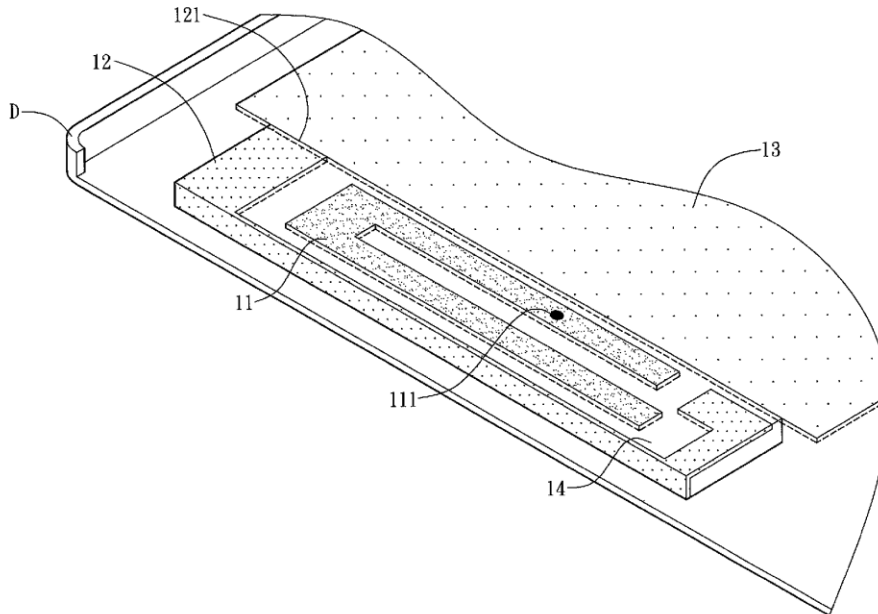
Primary Examiner — Hoang V Nguyen

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

(57) **ABSTRACT**

An antenna module is disclosed. The antenna module comprises a first conductive unit, a second conductive unit and a third conductive unit. The first conductive unit has a feeding point. The second conductive unit is disconnected with the first conductive unit electrically. The third conductive unit is disposed adjacent to the first conductive unit and electrically connected with the second conductive unit.

8 Claims, 6 Drawing Sheets





US008963782B2

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

(10) **Patent No.:** **US 8,963,782 B2**
(45) **Date of Patent:** **Feb. 24, 2015**

(54) **CAVITY-BACKED ANTENNA FOR TABLET DEVICE**

(75) Inventors: **Enrique Ayala Vazquez**, Watsonville, CA (US); **Robert W. Schlub**, Campbell, CA (US); **Yi Jiang**, Cupertino, CA (US); **Rodney Andres Gomez Angulo**, Sunnyvale, CA (US); **Ruben Caballero**, San Jose, CA (US); **Qingxiang Li**, Mountain View, CA (US)

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

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 298 days.

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(21) Appl. No.: **12/553,944**

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

(Continued)

(65) **Prior Publication Data**

US 2011/0050509 A1 Mar. 3, 2011

Primary Examiner — Graham Smith

(51) **Int. Cl.**

H01Q 1/24 (2006.01)
H01Q 1/22 (2006.01)
H01Q 1/38 (2006.01)
H01Q 1/42 (2006.01)
H01Q 13/18 (2006.01)

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

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

CPC **H01Q 1/2266** (2013.01); **H01Q 1/38** (2013.01); **H01Q 1/42** (2013.01); **H01Q 13/18** (2013.01)
USPC **343/702**

(57) **ABSTRACT**

(58) **Field of Classification Search**

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

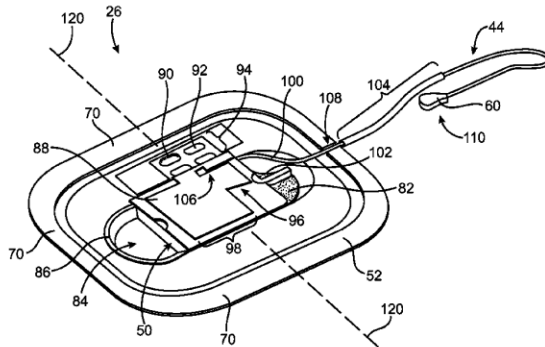
An electronic device may have a cavity antenna. The cavity antenna may have a logo-shaped dielectric window. An antenna resonating element for the cavity antenna may be formed from conductive traces on a printed circuit board. An antenna resonating element may be formed from the traces. The antenna resonating element may be mounted on an antenna support structure. A conductive cavity structure for the cavity antenna may have a planar lip that is mounted flush with an interior surface of a conductive housing wall. The cavity structure may have more than one depth. Shallower planar portions of the cavity structure may lie in a plane. The antenna resonating element may be located between the plane of the shallow cavity walls and an external surface of the conductive housing wall.

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27 Claims, 14 Drawing Sheets





US008963783B2

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

(10) **Patent No.:** **US 8,963,783 B2**
(45) **Date of Patent:** **Feb. 24, 2015**

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

(75) Inventors: **Young Boo Vin**, Hwasung-si (KR); **Dong Hyun Lee**, Suwon-si (KR); **Soon Ho Hwang**, Seoul (KR); **Hae Yeon Kim**, Suwon-si (KR); **Bum Jin Cho**, Hwasung-si (KR); **Se Hyun Park**, Suwon-si (KR); **Joon Ho Byun**, Seongnam-si (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 382 days.

(21) Appl. No.: **13/343,863**

(22) Filed: **Jan. 5, 2012**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Aug. 22, 2011 (KR) 10-2011-0083212

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/22 (2006.01)
H01Q 1/44 (2006.01)
H01Q 5/00 (2006.01)
H01Q 9/42 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/22** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/44** (2013.01); **H01Q 5/0055** (2013.01); **H01Q 9/42** (2013.01)
USPC **343/702**; 343/700 MS

(58) **Field of Classification Search**

CPC H01Q 1/22; H01Q 1/243; H01Q 1/44; H01Q 9/42; H01Q 5/55
USPC 343/700, 702, 767, 829, 846, 906
See application file for complete search history.

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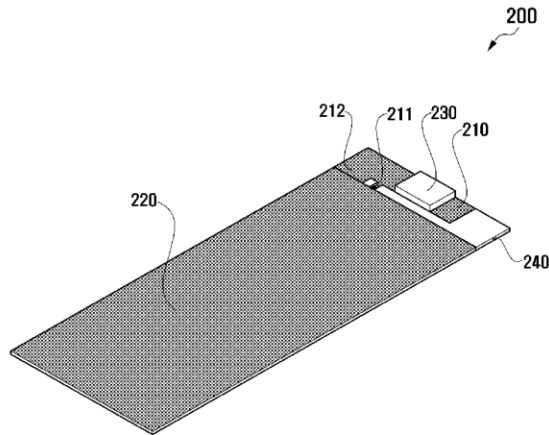
Primary Examiner — Tho G Phan

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

(57) **ABSTRACT**

An antenna device of a mobile terminal having improved performance by utilizing a metal object located in proximity to the antenna device as an antenna radiator is provided. The antenna device includes an antenna pattern connected to a feeder and a ground line, and a metal component positioned on the antenna pattern and including a metal that forms an antenna radiator.

12 Claims, 11 Drawing Sheets





US008963784B2

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

(10) **Patent No.:** **US 8,963,784 B2**
(45) **Date of Patent:** **Feb. 24, 2015**

(54) **ANTENNA WITH FOLDED MONOPOLE AND LOOP MODES**

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2011/0050508 A1 3/2011 Guterman et al.

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

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(21) Appl. No.: **13/402,831**

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

(22) Filed: **Feb. 22, 2012**

(65) **Prior Publication Data**

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(57) **ABSTRACT**

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

Electronic devices may be provided that contain wireless communications circuitry. The wireless communications circuitry may include radio-frequency transceiver circuitry and antennas. An antenna may have an antenna ground that is configured to form a cavity for the antenna. The antenna ground may be formed on a support structure. The antenna ground may have an opening. The support structure may have a planar surface on which the opening is formed. A folded monopole antenna resonating element and an L-shaped conductive antenna element may be formed in the opening and may be capacitively coupled. The folded monopole antenna resonating element may have an end at which a positive antenna feed terminal is formed. A ground antenna feed terminal may be formed on the antenna ground. A segment of the antenna ground may extend between the ground antenna feed terminal and an end of the L-shaped conductive antenna element.

(52) **U.S. Cl.**
USPC **343/702**; 343/846; 343/848

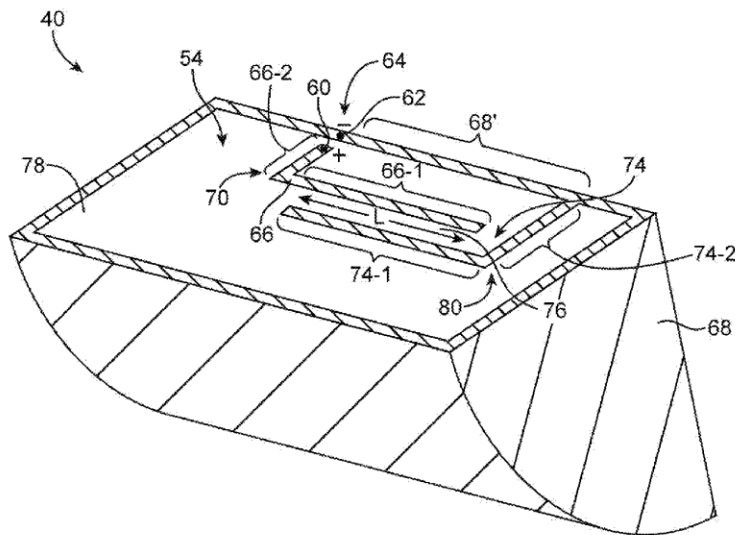
(58) **Field of Classification Search**
USPC 343/702, 833, 834, 841, 846, 848
See application file for complete search history.

(56) **References Cited**

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24 Claims, 9 Drawing Sheets





US008963785B2

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

(10) **Patent No.:** **US 8,963,785 B2**
(45) **Date of Patent:** **Feb. 24, 2015**

(54) **ANTENNA STRUCTURE FOR USING WITH A METAL FRAME OF A MOBILE PHONE**

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

(72) Inventors: **Chao Dong**, Pa-Te (TW); **Bo Zhou**, Pa-Te (TW); **Chia-Lun Tang**, Pa-Te (TW)

(73) Assignee: **Auden Techno. Corp.**, Pa-Te, Taoyuan Hsien (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 284 days.

(21) Appl. No.: **13/728,587**

(22) Filed: **Dec. 27, 2012**

(65) **Prior Publication Data**

US 2014/0184449 A1 Jul. 3, 2014

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 13/10 (2006.01)
H01Q 21/30 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 13/106** (2013.01); **H01Q 21/30** (2013.01)
USPC **343/702**; 343/770; 343/767

(58) **Field of Classification Search**
CPC H01Q 13/10; H01Q 13/106; H01Q 5/00; H01Q 5/001; H01Q 5/0003
USPC 343/702, 767, 770, 872
See application file for complete search history.

(56) **References Cited**

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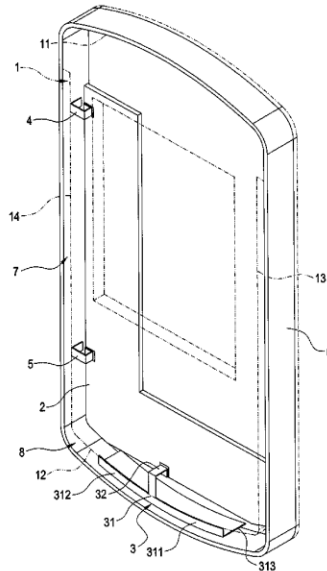
Primary Examiner — Hoang V Nguyen

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

(57) **ABSTRACT**

An antenna structure includes a carrier body, a circuit board, a metal coupling sheet, a first grounding part, a second grounding part, and a metal frame. A first slot and a second slot are between the metal frame and the carrier body after the parts mentioned above are assembled. The metal coupling sheet, the first grounding part, and the first slot form a first communication path. The first communication path forms a low-frequency resonance and a high-frequency resonance as well, so that the antenna structure is applied to a four bands GSM850/900/1800/1900. The metal coupling sheet, the second grounding part, and the second slot form a second communication path. The second communication path forms the WCDMA2100 resonance, so that the antenna structure is applied to a five bands 850/900/1800/1900/2100.

17 Claims, 5 Drawing Sheets





US008970433B2

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

(10) **Patent No.:** **US 8,970,433 B2**
(45) **Date of Patent:** **Mar. 3, 2015**

(54) **ANTENNA ASSEMBLY THAT IS OPERABLE IN MULTIPLE FREQUENCIES FOR A COMPUTING DEVICE**

(75) Inventors: **Robert Kenoun**, San Jose, CA (US);
Joselito dela Cruz Gavilan, San Jose, CA (US)

(73) Assignee: **QUALCOMM Incorporated**, 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 211 days.

(21) Appl. No.: **13/306,128**

(22) Filed: **Nov. 29, 2011**

(65) **Prior Publication Data**

US 2013/0135150 A1 May 30, 2013

(51) **Int. Cl.**

H01Q 1/38 (2006.01)
H01Q 5/00 (2006.01)
H01Q 9/04 (2006.01)
H01Q 1/48 (2006.01)
H01Q 9/42 (2006.01)

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

CPC **H01Q 9/42** (2013.01)
USPC **343/700 MS; 343/846**

(58) **Field of Classification Search**

CPC H01Q 9/42; H01Q 9/26; H01Q 23/00;
H01Q 9/0421; H01Q 9/0442; H01Q 5/00;
H01Q 5/0034
USPC 343/700 MS, 702, 876
See application file for complete search history.

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Primary Examiner — Dameon E Levi

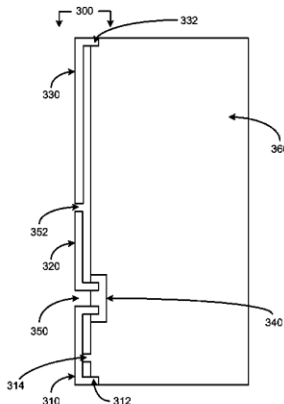
Assistant Examiner — Ricardo Magallanes

(74) *Attorney, Agent, or Firm* — Mahamedi Paradice LLP

(57) **ABSTRACT**

An antenna assembly for a computing device is disclosed. The antenna assembly includes a first radiating element coupled to a feed point and a first ground point of a printed circuit board, and a second radiating element coupled to a second ground point of the printed circuit board. The first radiating element is positioned adjacent to the printed circuit board so as to form a first gap that extends between the first radiating element and the printed circuit board along at least a portion of the length of the first radiating element. The second radiating element is positioned adjacent to the printed circuit board so as to form a second gap that extends between the second radiating element and the printed circuit board along at least a portion of the length of the second radiating element. The two radiating elements are spaced apart by a third gap.

20 Claims, 9 Drawing Sheets





US008970436B2

(12) **United States Patent**
Yang

(10) **Patent No.:** **US 8,970,436 B2**
(45) **Date of Patent:** **Mar. 3, 2015**

(54) **SURFACE MOUNT DEVICE
MULTI-FREQUENCY ANTENNA MODULE**

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

(71) Applicant: **Cirocomm Technology Corp.**, Tainan (TW)

(56) **References Cited**

(72) Inventor: **Tsai-Yi Yang**, Tainan (TW)

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(73) Assignee: **Circomm Technology Corp.**, Tainan (TW)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 230 days.

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Primary Examiner — Hoang V Nguyen

(21) Appl. No.: **13/828,916**

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

(22) Filed: **Mar. 14, 2013**

(57) **ABSTRACT**

(65) **Prior Publication Data**

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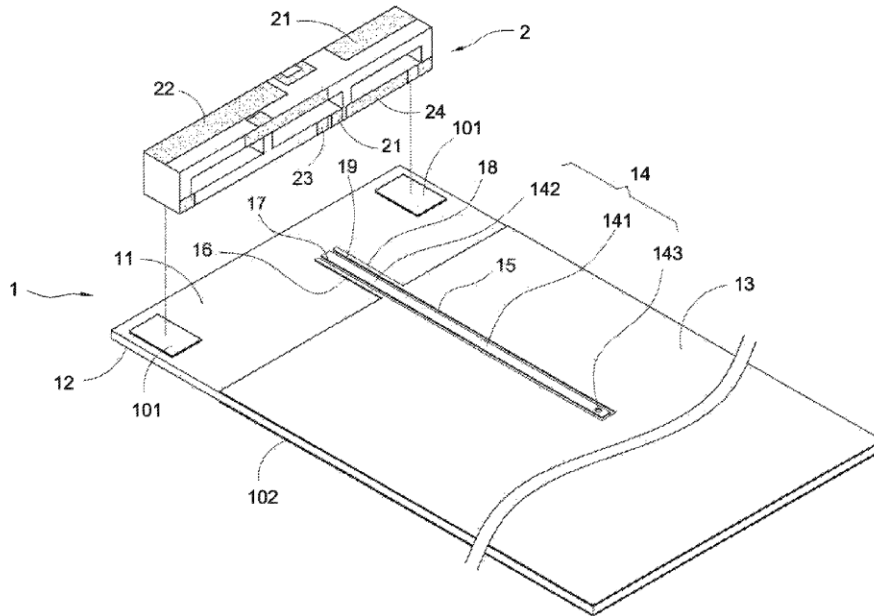
A surface mount device multi-frequency antenna module includes a base plate, a carrier, a first ground layer, a first signal feed-in line, a second signal feed-in line, and a third signal feed-in line, wherein the last four parts are arranged on the base plate. The carrier includes a first radiator, a second radiator, a third radiator, and a fourth radiator. The first radiator is electrically connected to the second radiator. The first radiator is not electrically connected to the third radiator and the fourth radiator. A contact connecting the first radiator and the second radiator is electrically connected to the first signal feed-in line when the carrier is electrically connected to the base plate. The third radiator is electrically connected to the second signal feed-in line. The fourth radiator is electrically connected to the third signal feed-in line.

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/24 (2006.01)
H01Q 5/00 (2006.01)
H01Q 9/42 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 5/0058** (2013.01); **H01Q 5/0065** (2013.01); **H01Q 9/42** (2013.01)
USPC **343/700 MS**; 343/702

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/38; H01Q 5/0065

10 Claims, 10 Drawing Sheets





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

(10) **Patent No.:** **US 8,981,997 B2**
(45) **Date of Patent:** **Mar. 17, 2015**

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

- (75) Inventors: **Kengo Onaka**, Yokohama (JP);
Kunihiro Komaki, Hakusan (JP);
Takashi Ishihara, Machide (JP);
Takuya Murayama, Ishikawa-ken (JP);
Tsuyoshi Mukai, Hakusan (JP)
- (73) Assignee: **Murata Manufacturing Co., Ltd.**,
Kyoto-fu (JP)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 899 days.

(21) Appl. No.: **12/957,032**

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

(65) **Prior Publication Data**

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Related U.S. Application Data

- (63) Continuation of application No. PCT/JP2009/055101, filed on Mar. 17, 2009.

(30) **Foreign Application Priority Data**

Jun. 6, 2008 (JP) 2008-149652

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

- (52) **U.S. Cl.**
CPC **H01Q 1/38** (2013.01); **H01Q 1/243** (2013.01); **H01Q 5/0037** (2013.01); **H01Q 5/0068** (2013.01); **H01Q 7/00** (2013.01)
USPC **343/700 MS**; 343/895; 343/702; 343/844; 343/853; 343/742

- (58) **Field of Classification Search**
USPC 343/700 MS, 702, 749, 895, 844, 853, 343/742

See application file for complete search history.

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Primary Examiner — Sue A Purvis

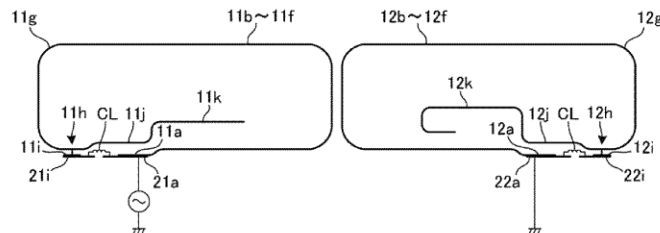
Assistant Examiner — Jae Kim

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

(57) **ABSTRACT**

An antenna includes an antenna element in which a predetermined electrode is provided on a dielectric base member and a substrate in which a predetermined electrode is provided on a base. A feed-terminal connecting electrode to which a feed terminal provided on the lower surface of the antenna element, an external-terminal connecting electrode to which an external electrode is connected, and a ground-terminal connecting electrode to which a ground terminal provided on the lower surface of the antenna element are provided on the upper surface of an ungrounded area of the substrate. A chip inductor is connected between the external-terminal connecting electrode and the feed-terminal connecting electrode, and a chip inductor is connected between the external-terminal connecting electrode and the ground-terminal connecting electrode. The shortcut of a current route achieved by each of the chip inductors is provided.

8 Claims, 8 Drawing Sheets





US008981999B2

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

(10) **Patent No.:** **US 8,981,999 B2**
(45) **Date of Patent:** **Mar. 17, 2015**

(54) **BROADBAND ANTENNA ELEMENT**

(71) Applicants: **Chien-Chang Liu**, New Taipei (TW);
Yen-Hui Lin, New Taipei (TW)

(72) Inventors: **Chien-Chang Liu**, New Taipei (TW);
Yen-Hui Lin, New Taipei (TW)

(73) Assignee: **Hon Hai Precision Industry Co., Ltd.**,
New Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 95 days.

(21) Appl. No.: **13/689,782**

(22) Filed: **Nov. 30, 2012**

(65) **Prior Publication Data**

US 2014/0055318 A1 Feb. 27, 2014

(30) **Foreign Application Priority Data**

Aug. 27, 2012 (CN) 101131081

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

(52) **U.S. Cl.**
CPC **H01Q 21/00** (2013.01)
USPC **343/700 MS; 343/795**

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

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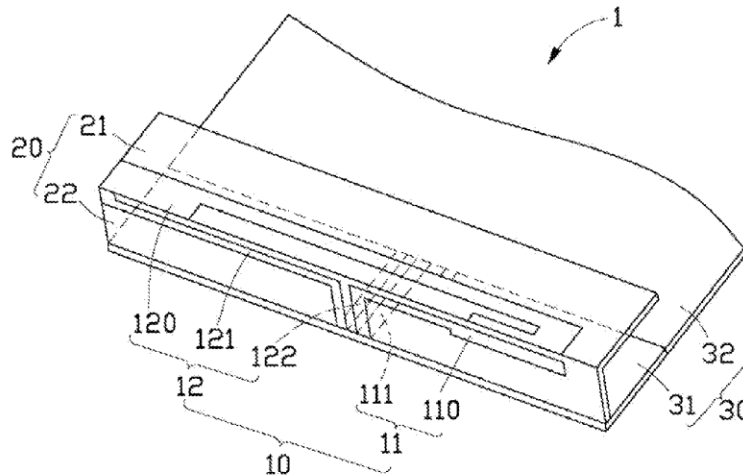
Primary Examiner — Tan Ho

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

(57) **ABSTRACT**

A broadband antenna element includes a circuit board, an antenna carrier connected to the circuit board, and a broadband antenna. The broadband antenna includes a first antenna and a second antenna which are conductive bent strips of metal. The first antenna includes a first feed terminal and a second feed terminal. The second antenna includes a third feed terminal and a coupling ground terminal. The second feed terminal and the coupling ground terminal are mounted on the circuit board keeping a first predetermined distance away from each other. The first feed terminal is mounted on the antenna carrier/circuit board being connected to the second feed terminal, and the third feed terminal is mounted on the antenna carrier being connected to the coupling ground terminal.

9 Claims, 4 Drawing Sheets





US008982000B2

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

(10) **Patent No.:** **US 8,982,000 B2**
(45) **Date of Patent:** **Mar. 17, 2015**

(54) **WATCH TYPE MOBILE TERMINAL AND ANTENNA THEREOF**

(75) Inventors: **Changil Kim**, Gyeonggi-Do (KR);
Jaehyuk Kang, Gyeonggi-Do (KR);
Kyunghack Yi, Seoul (KR); **Jonghun Kwon**, 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 310 days.

(21) Appl. No.: **12/832,916**

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

(65) **Prior Publication Data**
US 2011/0012796 A1 Jan. 20, 2011

(30) **Foreign Application Priority Data**
Jul. 15, 2009 (KR) 10-2009-0064669

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/27 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/273** (2013.01)
USPC **343/702**; 343/718; 343/895

(58) **Field of Classification Search**
CPC H01Q 1/273
USPC 343/718, 895; 455/39; 700/94; 368/10; 345/168

See application file for complete search history.

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Primary Examiner — Sue A Purvis

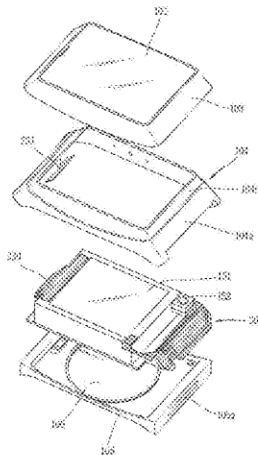
Assistant Examiner — Jae Kim

(74) *Attorney, Agent, or Firm* — Lee, Hong, Degerman, Kang & Waimey

(57) **ABSTRACT**

A watch type mobile terminal includes a first case which includes a window; a second case coupled to the first case and having an area for mounting a plurality of components; and a third case coupled to the second case such that the plurality of components are positioned between the second case and the third case. The mobile terminal further includes an antenna positioned at a side portion of a case including the first case, the second case, and the third case. The antenna includes a first conductor which is attached to the plurality of components, substantially covered by the second case, and connected to a signal feeding portion; and a second conductor which is positioned to be separated from the first conductor such that the second conductor is electrically coupled with the first conductor and connected to a ground feeding unit to be connected to a ground.

18 Claims, 8 Drawing Sheets





US008982002B2

(12) **United States Patent**
Bevelacqua

(10) **Patent No.:** **US 8,982,002 B2**
(45) **Date of Patent:** **Mar. 17, 2015**

(54) **DYNAMICALLY ADJUSTABLE ANTENNA SUPPORTING MULTIPLE ANTENNA MODES**

(75) Inventor: **Peter Bevelacqua**, Cupertino, CA (US)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 151 days.

(21) Appl. No.: **13/118,276**

(22) Filed: **May 27, 2011**

(65) **Prior Publication Data**

US 2012/0299785 A1 Nov. 29, 2012

(51) **Int. Cl.**

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H01Q 1/24 (2006.01)
H01Q 5/00 (2006.01)
H01Q 9/42 (2006.01)
H01Q 13/10 (2006.01)

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

CPC **H01Q 1/243** (2013.01); **H01Q 5/0037** (2013.01); **H01Q 9/42** (2013.01); **H01Q 13/10** (2013.01)
USPC **343/702**; 343/745; 343/861; 343/725

(58) **Field of Classification Search**

CPC H01Q 13/10; H01Q 1/243; H01Q 5/0037; H01Q 9/42
USPC 343/702
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Robert Karacsony

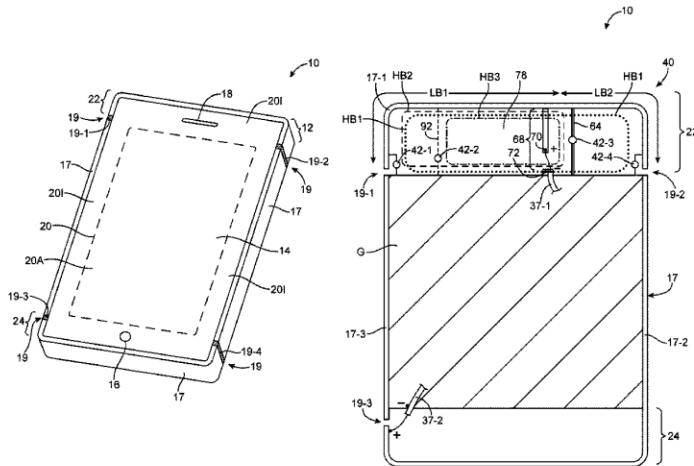
Assistant Examiner — Amal Patel

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

(57) **ABSTRACT**

Electronic devices may be provided that contain wireless communications circuitry. The wireless communications circuitry may include radio-frequency transceiver circuitry coupled to an adjustable antenna. The adjustable antenna may contain conductive antenna structure such as conductive electronic device housing structures. Electrical components such as switches and resonant circuits may be used in configuring the antenna to operate in two or more different antenna modes at different respective communications bands. Control circuitry may be used in controlling the switches. The antenna may be configured to operate as an inverted-F antenna in one mode of operation and a slot antenna in a second mode of operation.

8 Claims, 12 Drawing Sheets





US008982003B2

(12) **United States Patent**
Taura

(10) **Patent No.:** **US 8,982,003 B2**
(45) **Date of Patent:** **Mar. 17, 2015**

(54) **SLOT ANTENNA, ELECTRONIC APPARATUS, AND METHOD FOR MANUFACTURING SLOT ANTENNA**

(75) Inventor: **Toru Taura**, Tokyo (JP)
(73) Assignee: **NEC Corporation**, Tokyo (JP)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 706 days.

(21) Appl. No.: **13/148,904**

(22) PCT Filed: **Feb. 19, 2010**

(86) PCT No.: **PCT/JP2010/001084**

§ 371 (c)(1),
(2), (4) Date: **Aug. 10, 2011**

(87) PCT Pub. No.: **WO2010/116589**

PCT Pub. Date: **Oct. 14, 2010**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Mar. 30, 2009 (JP) 2009-081476

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/22 (2006.01)
H01Q 13/10 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 13/10** (2013.01); **H01Q 1/2266**
(2013.01); **H01Q 1/243** (2013.01); **Y10T**
29/49018 (2013.01)
USPC **343/702**; **343/700**

(58) **Field of Classification Search**
USPC **343/702, 700, 736, 803**
See application file for complete search history.

(56) **References Cited**

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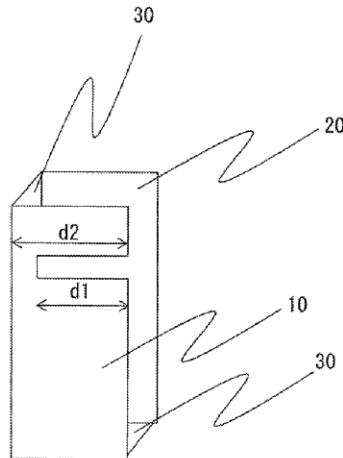
Primary Examiner — Karl D Frech

(74) *Attorney, Agent, or Firm* — Sughrue Mion, PLLC

(57) **ABSTRACT**

The present invention aims to provide a slot antenna, an electronic apparatus, and a method for manufacturing a slot antenna which are capable of obtaining multiple resonances with a small mounting space. The slot antenna according to the present invention includes three conductor plates: a rectangular conductor plate **10** having a notch with an open end formed at one side of the conductor plate; a rectangular conductor plate **20** disposed to face the conductor plate **10**; a third conductor plate connecting the conductor plates **10** and **20** on a side opposite to the open end of the conductor plate **10**; and a feeder **40** connecting a core wire **41** and a ground **42** at two points across the notch of the conductor plate **10**.

10 Claims, 12 Drawing Sheets





US008982005B2

(12) **United States Patent**
Tu

(10) **Patent No.:** **US 8,982,005 B2**
(45) **Date of Patent:** **Mar. 17, 2015**

(54) **MONOPOLE SLOT ANTENNA STRUCTURE**

(56) **References Cited**

(75) Inventor: **Shu-Yang Tu**, New Taipei (TW)

U.S. PATENT DOCUMENTS

(73) Assignees: **Inventec Appliances (Pudong) Corporation**, Shanghai (CN); **Inventec Appliances Corp.**, New Taipei (TW); **Inventec Appliances (Jiangning) Corporation**, Nanjing (CN)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 265 days.

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Primary Examiner — Huedung Mancuso

(21) Appl. No.: **13/452,930**

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

(22) Filed: **Apr. 22, 2012**

(57) **ABSTRACT**

(65) **Prior Publication Data**

US 2012/0326936 A1 Dec. 27, 2012

A monopole slot antenna structure including a dielectric substrate, a monopole slot antenna and a feed element is provided. The monopole slot antenna is disposed on one side of the dielectric substrate and has a slot including a first slot section, a tuning slot section and a second slot section. One end of the first slot section is located at one edge of the monopole slot antenna with the other end of the first slot section being extended towards internal portions of the monopole slot antenna and being connected to the tuning slot section. One end of the second slot section is connected to the tuning slot section with the other end of the second slot section being extended away from the first slot section. The feed element is disposed correspondingly to the second slot section, and excites the monopole slot antenna to generate two operating frequency bands.

(30) **Foreign Application Priority Data**

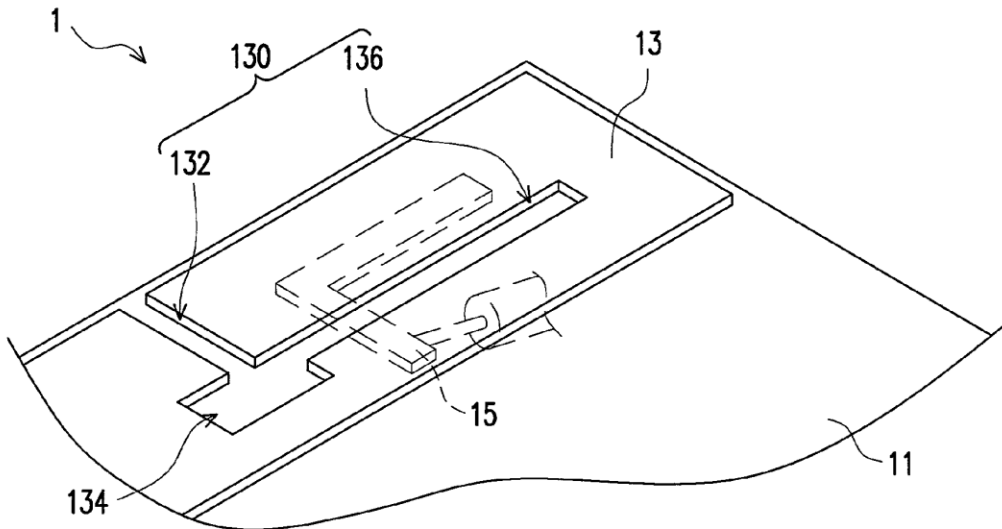
Jun. 21, 2011 (CN) 2011 1 0166829

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

(52) **U.S. Cl.**
CPC **H01Q 13/10** (2013.01)
USPC **343/767**

(58) **Field of Classification Search**
CPC H01Q 13/10; H01Q 13/085; H01Q 1/38; H01Q 13/18; H01Q 13/106
USPC 343/767, 700 MS, 702, 845–848
See application file for complete search history.

8 Claims, 5 Drawing Sheets





US008982006B2

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

(10) **Patent No.:** US 8,982,006 B2
(45) **Date of Patent:** Mar. 17, 2015

(54) **DIPOLE ANTENNA AND RADIO-FREQUENCY DEVICE**

(71) Applicant: **Wistron NeWeb Corporation**, Hsinchu (TW)

(72) Inventors: **Chih-Ming Wang**, Hsinchu (TW);
Kuan-Chung Chen, Hsinchu (TW);
Yu-Yu Chiang, Hsinchu (TW)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 162 days.

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(22) Filed: **Jan. 24, 2013**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Nov. 9, 2012 (TW) 101141711 A

(51) **Int. Cl.**
H01Q 9/16 (2006.01)
H01Q 1/22 (2006.01)
H01Q 5/00 (2006.01)
H01Q 9/28 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/2266** (2013.01); **H01Q 5/0055** (2013.01); **H01Q 5/0058** (2013.01); **H01Q 9/285** (2013.01)

USPC **343/821**; 343/795

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

(56) **References Cited**

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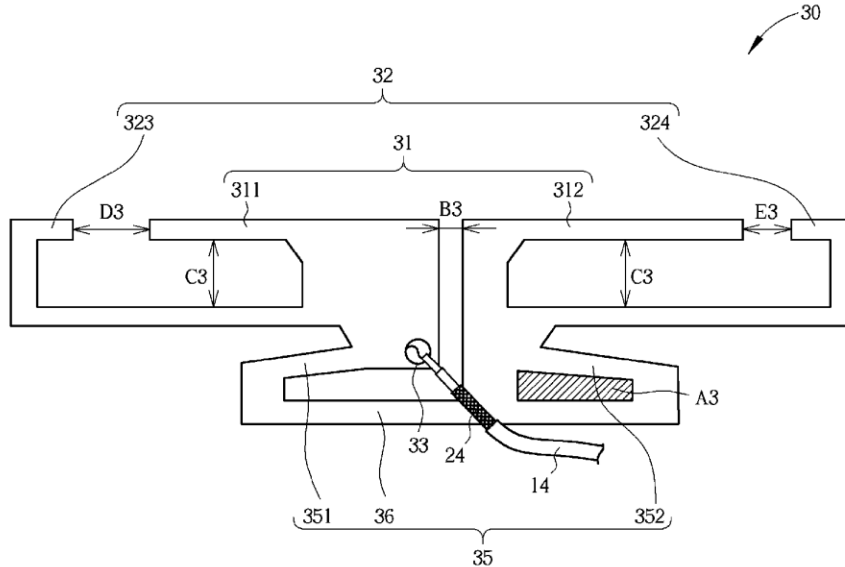
Primary Examiner — Tan Ho

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

(57) **ABSTRACT**

A dipole antenna is disclosed. The dipole antenna includes a feed-in terminal, a balun, a first radiator and a second radiator. The feed-in terminal is used for feeding in a radio-frequency signal. The balun is electrically connected to the feed-in terminal for driving out a return current of the dipole antenna to balance a feed-in impedance of the dipole antenna. The first radiator is electrically connected to the feed-in terminal and the balun for radiating the radio-frequency signal in a first frequency band. The second radiator is electrically connected to the first radiator, the feed-in terminal and the balun for radiating the radio-frequency signal in a second frequency band.

14 Claims, 7 Drawing Sheets





US008982009B2

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

(10) **Patent No.:** **US 8,982,009 B2**
(45) **Date of Patent:** **Mar. 17, 2015**

(54) **ANTENNA PATTERN FRAME, METHOD AND MOLD FOR MANUFACTURING THE SAME, AND ELECTRONIC DEVICE**

(58) **Field of Classification Search**
CPC H01Q 1/40; H01Q 1/243
USPC 343/872, 873
See application file for complete search history.

(75) Inventors: **Jae Suk Sung**, Gyeonggi-Do (KR); **Ki Won Chang**, Gyeonggi-Do (KR); **Ha Ryong Hong**, Gyeonggi-Do (KR); **Chang Mok Han**, Chungcheongnam-Do (KR); **Chan Gwang An**, Gyeonggi-Do (KR); **Duk Woo Lee**, Gyeonggi-Do (KR); **Hyun Kil Nam**, Gyeonggi-Do (KR); **Dae Kyu Lee**, Gyeonggi-Do (KR); **Sang Woo Bae**, Gyeonggi-Do (KR); **Byung Hwa Lee**, Gyeonggi-Do (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1083 days.

(21) Appl. No.: **12/649,820**

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

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

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H01Q 1/24 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **B29C 45/14639** (2013.01); **B29C 45/14065** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/40** (2013.01); **H01Q 5/0058** (2013.01);
(Continued)

Primary Examiner — Robert Karacsony
(74) *Attorney, Agent, or Firm* — McDermott Will & Emery LLP

(57) **ABSTRACT**

An antenna pattern frame according to an aspect of the invention may include: a radiator having an antenna pattern portion transmitting and receiving a signal; a ground portion extending from the antenna pattern portion; a connection portion connecting the antenna pattern portion and the ground portion to be arranged in different planes; and a radiator frame manufactured by injection molding on the radiator so that the antenna pattern portion may be provided on one side of the radiator frame and the connection terminal portion may be provided on the other side thereof, the radiator frame allowing the antenna pattern portion to be embedded in the electronic device case.

4 Claims, 19 Drawing Sheets

