



US 20170085000A1

(19) **United States**(12) **Patent Application Publication**
GIRARD(10) **Pub. No.: US 2017/0085000 A1**(43) **Pub. Date: Mar. 23, 2017**(54) **AN ANTENNA STRUCTURE WITH
DIELECTRIC LOADING****Publication Classification**(51) **Int. Cl.****H01Q 9/04** (2006.01)**H01Q 1/48** (2006.01)**H01Q 1/38** (2006.01)(52) **U.S. Cl.****CPC** **H01Q 9/0485** (2013.01); **H01Q 1/38**(2013.01); **H01Q 1/48** (2013.01); **H01Q****9/0421** (2013.01)(71) Applicant: **THOMSON LICENSING**, Issy de
Moulineaux (FR)(72) Inventor: **Henri GIRARD**, Indianapolis, IN (US)(21) Appl. No.: **15/124,689**(22) PCT Filed: **Mar. 20, 2015**(86) PCT No.: **PCT/US15/21712**

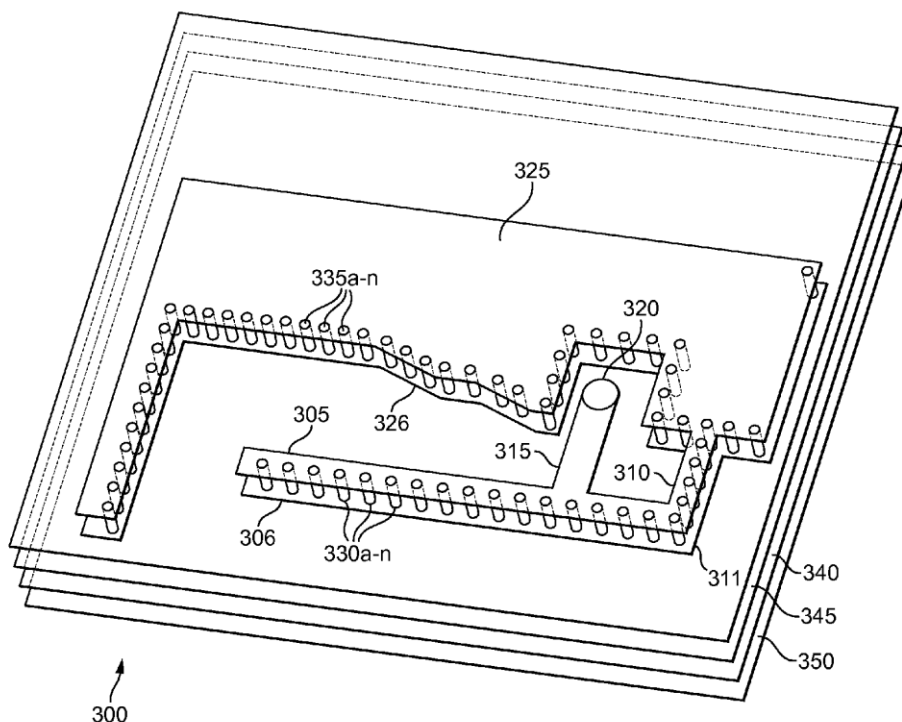
§ 371 (c)(1),

(2) Date: **Sep. 9, 2016****Related U.S. Application Data**(60) Provisional application No. 61/970,432, filed on Mar.
26, 2014.

(57)

ABSTRACT

An antenna structure is described. The antenna structure includes a first set of conductive elements that form a first portion of the antenna structure, the first set of conductive elements being formed on a first layer of a multi-layer printed circuit board, and a second set of conductive elements that form a second portion of the antenna structure, the second set of conductive elements being formed in parallel to the first set of conductive elements on a second layer of the multi-layer printed circuit board, wherein the first layer and the second layer are inner layers of the multilayer printed circuit board. An apparatus that uses the antenna structure is also described.





US 20170084981A1

(19) **United States**(12) **Patent Application Publication**
KIMURA et al.(10) **Pub. No.: US 2017/0084981 A1**(43) **Pub. Date: Mar. 23, 2017**(54) **WIRELESS COMMUNICATION DEVICE****Publication Classification**(71) Applicant: **Murata Manufacturing Co., Ltd.**,
Nagaokakyo-shi (JP)(72) Inventors: **Ikuhei KIMURA**, Nagaokakyo-shi
(JP); **Nobuo IKEMOTO**,
Nagaokakyo-shi (JP)(21) Appl. No.: **15/368,817**(22) Filed: **Dec. 5, 2016****Related U.S. Application Data**(63) Continuation of application No. 14/723,486, filed on
May 28, 2015, which is a continuation of application
No. 13/795,367, filed on Mar. 12, 2013, which is a
continuation of application No. PCT/JP2011/078263,
filed on Dec. 7, 2011.**Foreign Application Priority Data**

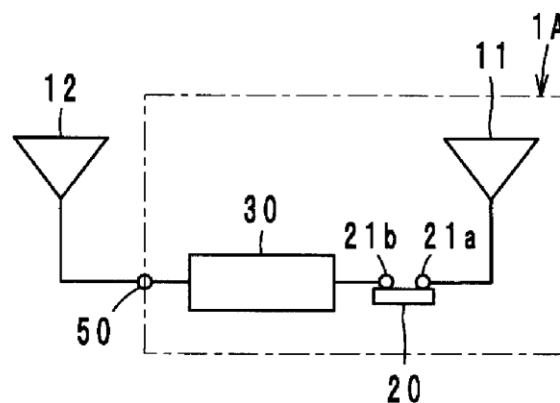
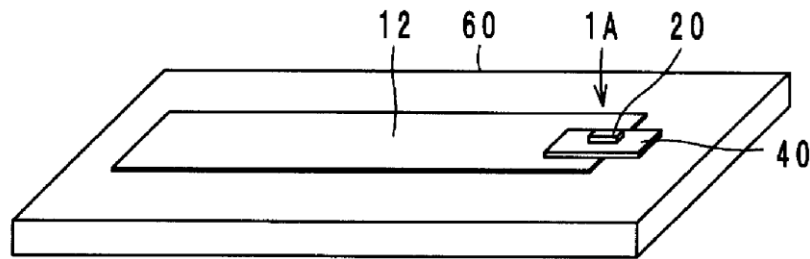
Jan. 5, 2011 (JP) 2011-000694

(51) **Int. Cl.****H01Q 1/22** (2006.01)**H01Q 9/06** (2006.01)**H01Q 1/38** (2006.01)(52) **U.S. Cl.**CPC **H01Q 1/2225** (2013.01); **H01Q 1/38**
(2013.01); **H01Q 9/065** (2013.01); **H04W**
4/008 (2013.01)

(57)

ABSTRACT

A compact wireless communication includes a first radiating element and a second radiating element, which define and function as a dipole antenna, a feeder circuit including a wireless IC chip coupled with the first and second radiating elements, and a feeder substrate that is provided with the wireless IC chip. The first radiating element is provided to the feeder substrate. The second radiating element is provided to a substrate other than the feeder substrate.





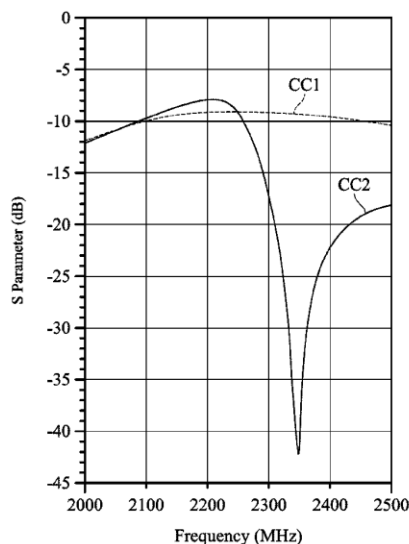
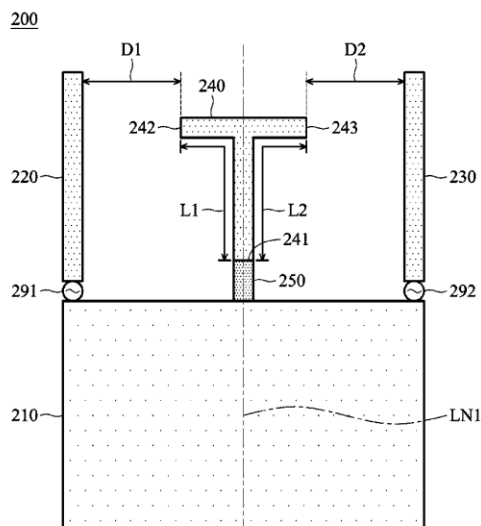
US 20170084985A1

(19) **United States**(12) **Patent Application Publication**
KU et al.(10) **Pub. No.: US 2017/0084985 A1**(43) **Pub. Date: Mar. 23, 2017**(54) **ANTENNA SYSTEM**(71) Applicant: **Wistron NeWeb Corp.**, Hsinchu (TW)(72) Inventors: **Kuang-Yuan KU**, Hsinchu (TW);
Cheng-Geng JAN, Hsinchu (TW);
Huang-Tse PENG, Hsinchu (TW)(21) Appl. No.: **15/135,289**(22) Filed: **Apr. 21, 2016**(30) **Foreign Application Priority Data**

Sep. 23, 2015 (TW) 104131374

Publication Classification(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01P 3/00 (2006.01)
H03H 7/38 (2006.01)
H01Q 1/50 (2006.01)
H01Q 1/52 (2006.01)(52) **U.S. Cl.**CPC **H01Q 1/243** (2013.01); **H01Q 1/50**
(2013.01); **H01Q 1/526** (2013.01); **H03H 7/38**
(2013.01); **H01P 3/003** (2013.01)(57) **ABSTRACT**

An antenna system includes a ground metal element, a first signal source, a first antenna, a second signal source, a second antenna, an isolation metal element, and a matching circuit. The first signal source is connected to the ground metal element. The first antenna is connected to the first signal source. The first signal source is configured to excite the first antenna. The second signal source is connected to the ground metal element. The second antenna is connected to the second signal source. The second signal source is configured to excite the second antenna. The isolation metal element is disposed between the first antenna and the second antenna, and is configured to improve the isolation between the first antenna and the second antenna. The matching circuit is connected between the isolation metal element and the ground metal element.





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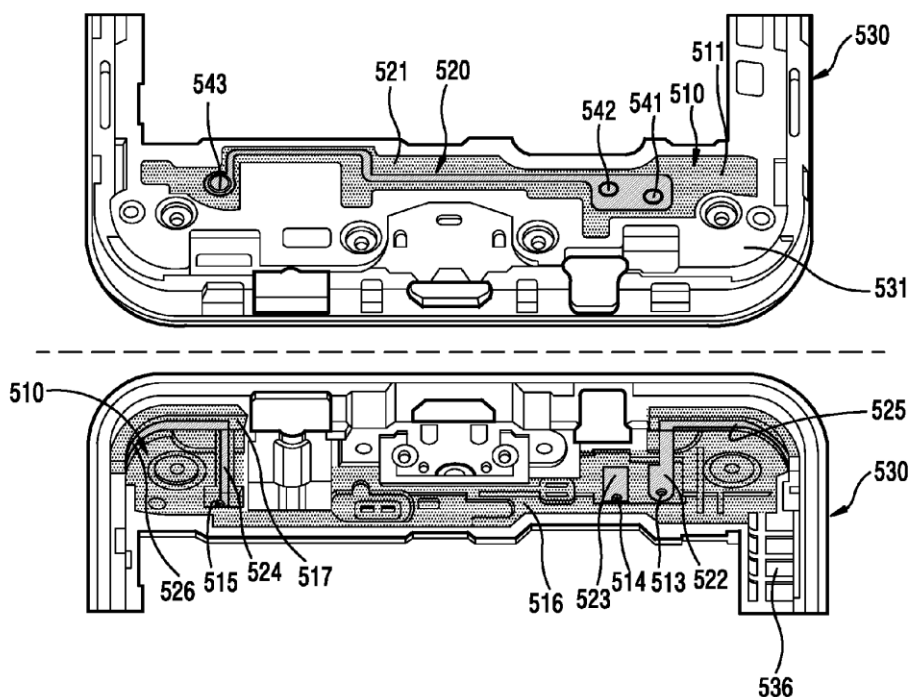
(19) **United States**(12) **Patent Application Publication**
GANG et al.(10) **Pub. No.: US 2017/0084986 A1**(43) **Pub. Date: Mar. 23, 2017**(54) **HOUSING INCLUDING ANTENNA,
MANUFACTURING METHOD OF HOUSING,
AND ELECTRONIC DEVICE HAVING
HOUSING****Publication Classification**

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/38 (2006.01)
H05K 5/02 (2006.01)
(52) **U.S. Cl.**
CPC *H01Q 1/243* (2013.01); *H05K 5/0247*
(2013.01); *H01Q 1/38* (2013.01)

(71) Applicant: **Samsung Electronics Co., Ltd.**,
Gyeonggi-do (KR)(72) Inventors: **Gi-Uk GANG**, Gyeonggi-do (KR);
Byeonghwan YOUM, Gyeonggi-do
(KR); **Kyung Bin KIM**, Gyeonggi-do
(KR)(57) **ABSTRACT**(21) Appl. No.: **15/255,568**(22) Filed: **Sep. 2, 2016**(30) **Foreign Application Priority Data**

Sep. 23, 2015 (KR) 10-2015-0134934

Disclosed is an electronic device having a housing and including an antenna device, and a method of manufacturing the housing. When the antenna device requiring a plating process is applied to the housing, the housing has an antenna and provides exterior deposition and visual enhancement to the electronic device.





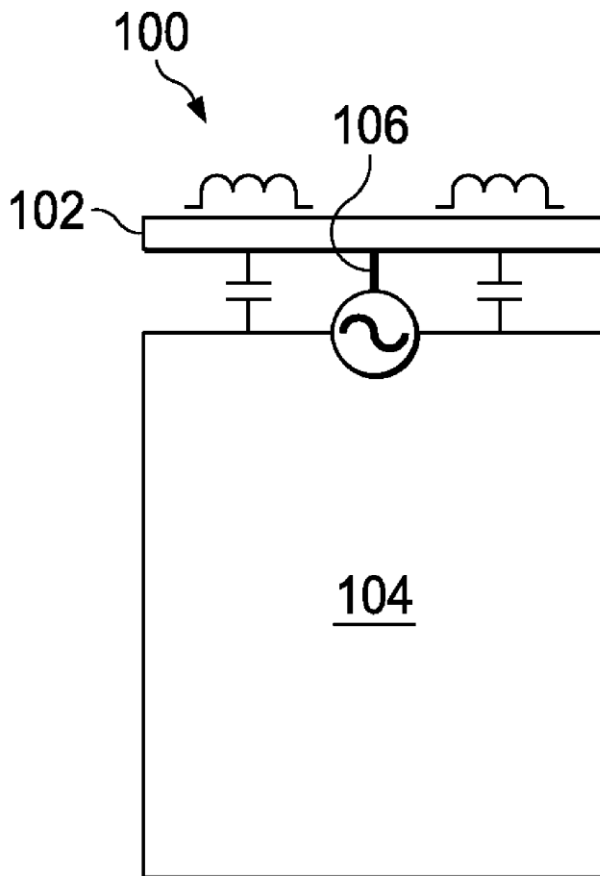
US 20170084989A1

(19) **United States**(12) **Patent Application Publication**
Shi et al.(10) **Pub. No.: US 2017/0084989 A1**(43) **Pub. Date: Mar. 23, 2017**(54) **SYSTEM AND METHOD FOR ADAPTIVE
APERTURE TUNABLE ANTENNA**(52) **U.S. CL.**CPC *H01Q 1/52* (2013.01); *H01Q 1/50*
(2013.01)(71) Applicant: **Futurewei Technologies, Inc.**, Plano,
TX (US)

(57)

ABSTRACT(72) Inventors: **Ping Shi**, San Diego, CA (US); **Navid
Nader**, San Diego, CA (US)(21) Appl. No.: **14/861,744**(22) Filed: **Sep. 22, 2015****Publication Classification**(51) **Int. Cl.***H01Q 1/52* (2006.01)*H01Q 1/50* (2006.01)

An antenna's resonance frequency is detuned when a part of a human body approaches or contacts the antenna and consequently results in efficiency loss. The antenna may be tuned by changing its total load capacitance such that the antenna's total load capacitance falls within a reference capacitance range of a reference capacitance, where the antenna can operate at or near its pre-determined operating resonance frequency. A tunable capacitor may be coupled to the antenna for tuning the total load capacitance of the antenna.





US 20170084990A1

(19) **United States**(12) **Patent Application Publication****LE THUC et al.**(10) **Pub. No.: US 2017/0084990 A1**(43) **Pub. Date: Mar. 23, 2017**(54) **ANTENNA SYSTEM FOR REDUCING THE ELECTROMAGNETIC COUPLING BETWEEN ANTENNAS****Publication Classification**(51) **Int. Cl.****H01Q 1/52** (2006.01)**H01Q 1/38** (2006.01)**H01Q 1/24** (2006.01)**H01Q 1/48** (2006.01)**H01Q 9/04** (2006.01)(52) **U.S. Cl.**CPC **H01Q 1/521** (2013.01); **H01Q 1/48**(2013.01); **H01Q 1/526** (2013.01); **H01Q****9/0421** (2013.01); **H01Q 1/243** (2013.01);**H01Q 1/38** (2013.01)(71) Applicants: **CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE**, Paris (FR); **UNIVERSITE DE NICE SOPHIA ANTIPOLIS**, Nice (FR)(72) Inventors: **Philippe LE THUC**, Grasse (FR); **Robert STARAJ**, Saint Paul (FR); **Aliou DIALLO**, Nice (FR); **Michael JEANGEORGES**, Nice (FR)(73) Assignees: **CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE**, Paris (FR); **UNIVERSITE DE NICE SOPHIA ANTIPOLIS**, Nice (FR)(21) Appl. No.: **15/312,352**(22) PCT Filed: **May 19, 2015**(86) PCT No.: **PCT/EP2015/061025**

§ 371 (c)(1),

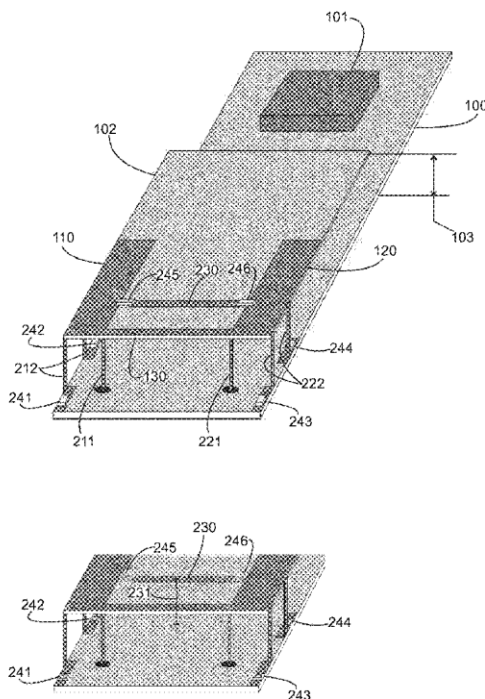
(2) Date: **Nov. 18, 2016**(30) **Foreign Application Priority Data**

May 19, 2014 (FR) 1454478

(57)

ABSTRACT

Antenna system comprising at least two radiating elements, a first line for neutralising electromagnetic coupling between the at least two radiating elements, at least one radiofrequency power supply line for each radiating element and at least one short-circuiting line to a ground plane of the antenna system per radiating element, characterised in that the antenna system further comprises: at least one second line for neutralising electromagnetic coupling between said at least two radiating elements; elements for activating at least some of the neutralisation lines; and in that the activation elements are configured to selectively activate or deactivate at least some of the neutralisation lines, in such a way that depending on the activation/deactivation thereof the neutralisation lines provide a maximum neutralisation of the electromagnetic coupling of the radiating elements for a plurality of different frequencies.





US 20170084997A1

(19) **United States**(12) **Patent Application Publication****WU et al.**(10) **Pub. No.: US 2017/0084997 A1**(43) **Pub. Date: Mar. 23, 2017**(54) **ANTENNA MODULE**(71) Applicant: **PEGATRON CORPORATION,**
TAIPEI CITY (TW)(72) Inventors: **Chien-Yi WU,** TAIPEI CITY (TW);
Chao-Hsu WU, TAIPEI CITY (TW);
Shih-Keng HUANG, TAIPEI CITY
(TW); **Chia-Chi CHANG,** TAIPEI
CITY (TW)(21) Appl. No.: **15/218,088**(22) Filed: **Jul. 25, 2016**(30) **Foreign Application Priority Data**

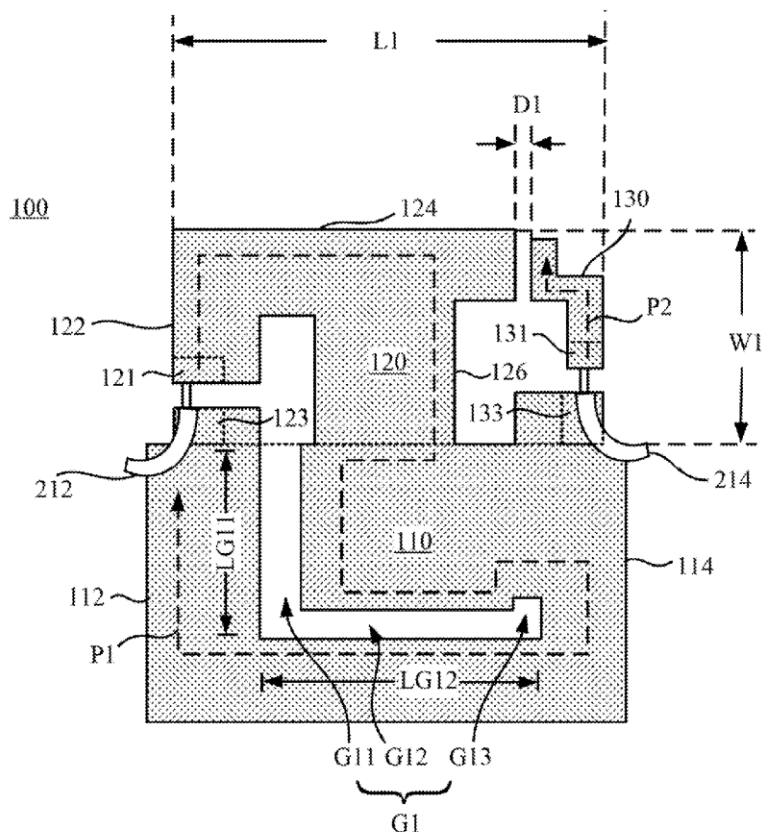
Sep. 22, 2015 (TW) 104131295

Publication Classification(51) **Int. Cl.**
H01Q 5/10 (2006.01)
H01Q 1/50 (2006.01)**H01Q 5/314** (2006.01)**H01Q 1/48** (2006.01)(52) **U.S. Cl.**CPC **H01Q 5/10** (2015.01); **H01Q 1/48**
(2013.01); **H01Q 1/50** (2013.01); **H01Q 5/314**
(2015.01)

(57)

ABSTRACT

An antenna module includes a first ground structure, a first radiation portion and a second radiation portion. The first ground structure includes a first ground portion, a second ground portion and a third ground portion. The first radiation portion is configured to generate a first resonant mode accompanied with the first ground structure, including a first feeding terminal configured to send and receive a first antenna signal, and a first grounding terminal coupled to the first ground portion. The second radiation portion is configured to generate a second resonant mode in a manner of coupling with the first radiation portion, including a second feeding terminal configured to send and receive a second antenna signal, and a second grounding terminal coupled to the second ground portion.

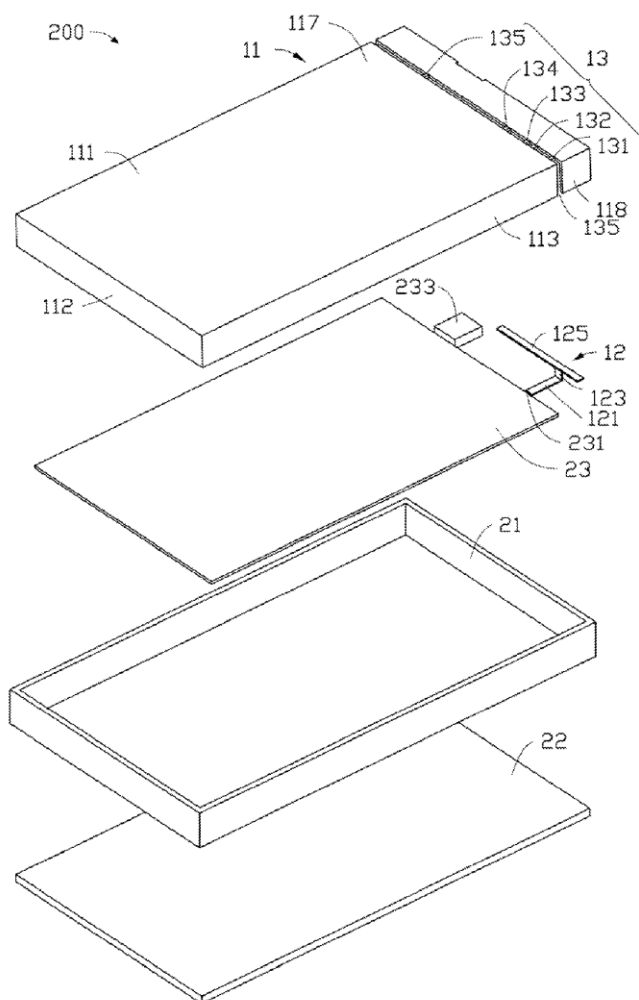




US 20170093020A1

(19) **United States**(12) **Patent Application Publication**
LIOU et al.(10) **Pub. No.: US 2017/0093020 A1**(43) **Pub. Date: Mar. 30, 2017**(54) **ANTENNA MODULE AND WIRELESS
COMMUNICATION DEVICE USING SAME**(52) **U.S. Cl.**CPC **H01Q 1/243** (2013.01); **H01Q 1/50**
(2013.01)(71) Applicant: **Chiun Mai Communication Systems,
Inc.**, New Taipei (TW)(72) Inventors: **GENG-HONG LIOU**, New Taipei
(TW); **YEN-HUI LIN**, New Taipei
(TW)(21) Appl. No.: **14/868,551**(22) Filed: **Sep. 29, 2015****Publication Classification**(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/50 (2006.01)(57) **ABSTRACT**

An antenna module includes a metallic member and a first radiating portion. The metallic member defines a slot. The slot is configured to divide the metallic member into a first metallic portion and a second metallic portion. The second metallic portion is spaced apart from the first metallic portion. The first radiating portion is positioned in the second metallic portion and is spaced apart from the second metallic portion. The first metallic portion is grounded. The first radiating portion is configured to receive a current signal and couple the current signal to the second metallic portion. The second metallic portion and the first metallic portion are configured to cooperatively activate a plurality of resonating modes through the slot.





US 20170093022A1

(19) **United States**(12) **Patent Application Publication****CAI et al.**(10) **Pub. No.: US 2017/0093022 A1**(43) **Pub. Date: Mar. 30, 2017**(54) **ELECTRONIC DEVICE AND ANTENNA OF THE SAME****Publication Classification**(71) Applicant: **BYD COMPANY LIMITED**,
Shenzhen, Guangdong (CN)(72) Inventors: **Qinyang CAI**, Shenzhen, Guangdong (CN); **Yijin WANG**, Shenzhen, Guangdong (CN); **Wensong WANG**, Shenzhen, Guangdong (CN); **Munyong CHOI**, Shenzhen, Guangdong (CN)(73) Assignee: **BYD COMPANY LIMITED**,
Shenzhen, Guangdong (CN)(21) Appl. No.: **15/313,033**(22) PCT Filed: **May 26, 2015**(86) PCT No.: **PCT/CN2015/079774**

§ 371 (c)(1),

(2) Date: **Nov. 21, 2016**(30) **Foreign Application Priority Data**

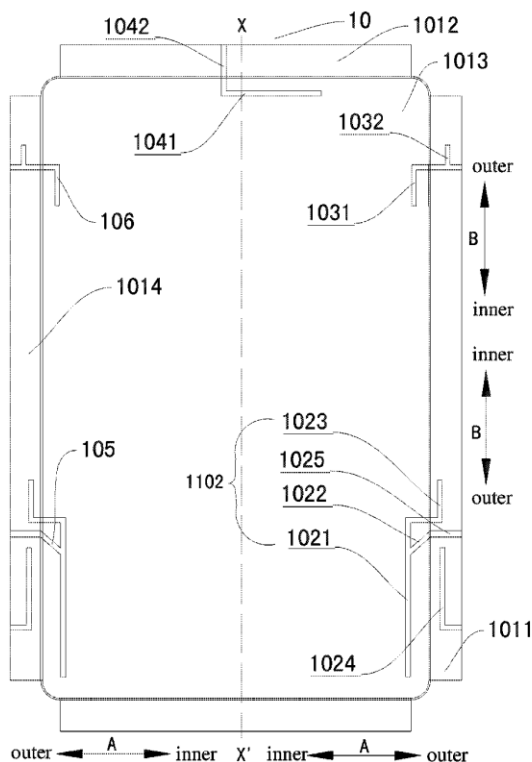
May 26, 2014 (CN) 201410225498.1

(51) **Int. Cl.****H01Q 1/24** (2006.01)**H01Q 9/04** (2006.01)**H01Q 1/36** (2006.01)**H01Q 13/10** (2006.01)(52) **U.S. Cl.**CPC **H01Q 1/243** (2013.01); **H01Q 13/10**(2013.01); **H01Q 9/0485** (2013.01); **H01Q****1/36** (2013.01)

(57)

ABSTRACT

An electric device includes a metal shell having a back metal shell part and a first side metal shell part, and a first antenna which includes: a first radiating surface formed by the back metal shell part and the first side metal shell part and having a variant T-shaped group of slots and a first L-shaped slot, a part of the variant T-shaped group of slots being formed in the back metal shell part, and the other part thereof being formed in the first side metal shell part, the first L-shaped slot being formed in the first side metal shell part; a first dielectric sheet disposed on a front surface of the back metal shell part; and a first L-shaped feeder disposed on a front surface of the first dielectric sheet.





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(19) **United States**

(12) **Patent Application Publication**
KANAZAWA

(10) **Pub. No.: US 2017/0098886 A1**

(43) **Pub. Date: Apr. 6, 2017**

(54) **ANTENNA DEVICE AND INFORMATION
PROCESSING APPARATUS**

H01Q 13/08 (2006.01)

H01Q 1/48 (2006.01)

(71) Applicant: **FUJITSU LIMITED**, Kawasaki-shi
(JP)

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

CPC *H01Q 1/243* (2013.01); *H01Q 1/48*
(2013.01); *H01Q 1/50* (2013.01); *H01Q*
13/085 (2013.01)

(72) Inventor: **MASARU KANAZAWA**, Kawasaki
(JP)

(73) Assignee: **FUJITSU LIMITED**, Kawasaki-shi
(JP)

(57)

ABSTRACT

(21) Appl. No.: **15/262,492**

(22) Filed: **Sep. 12, 2016**

(30) **Foreign Application Priority Data**

Oct. 6, 2015 (JP) 2015-198438

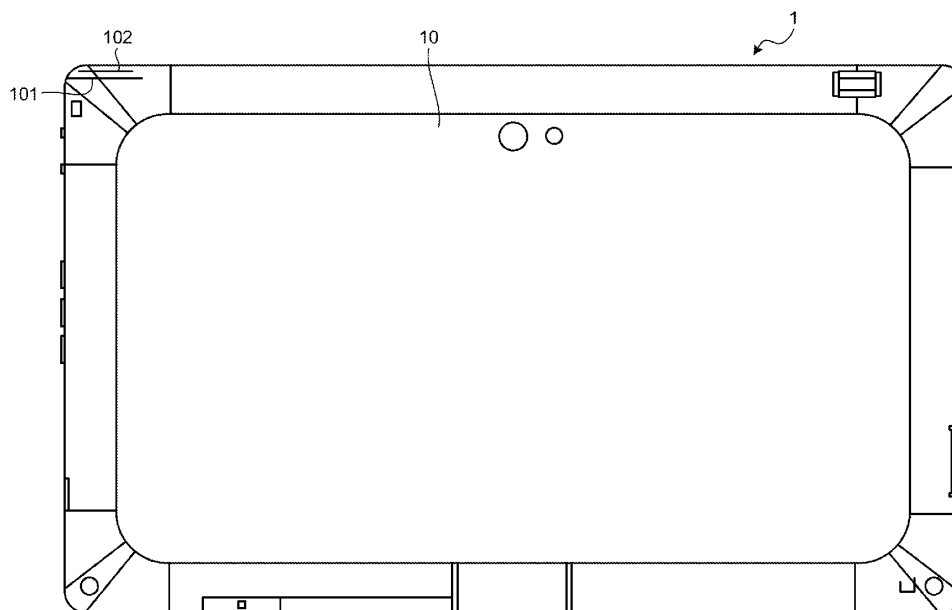
Publication Classification

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 1/50 (2006.01)

A notch antenna is a bored-through groove formed on a housing, is open on one end at an edge of the housing, and is closed on the other end. A slot antenna is a bored-through groove closed on both ends, is adjacent to the notch antenna on the housing, and extends in the extending direction of the other end of the notch antenna. A feeding point is disposed in the vicinity of the slot antenna on the housing on the opposite side to the other end portion of the notch antenna. An outer conductor is disposed in the vicinity of the other end of the notch antenna on the housing on the opposite side to the slot antenna.





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(19) **United States**

(12) **Patent Application Publication**
Chen

(10) **Pub. No.: US 2017/0098887 A1**

(43) **Pub. Date: Apr. 6, 2017**

(54) **ANTENNA MODULE HAVING HOLDER
FORMED WITH HOLLOW**

H01Q 5/10 (2006.01)

H04B 1/3827 (2006.01)

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

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

CPC *H01Q 1/245* (2013.01); *H04B 1/3838*
(2013.01); *H01Q 9/04* (2013.01); *H01Q 5/10*
(2015.01)

(72) Inventor: **Yung-Jinn Chen**, Hsinchu (TW)

(21) Appl. No.: **14/874,480**

(22) Filed: **Oct. 5, 2015**

Publication Classification

(51) **Int. Cl.**

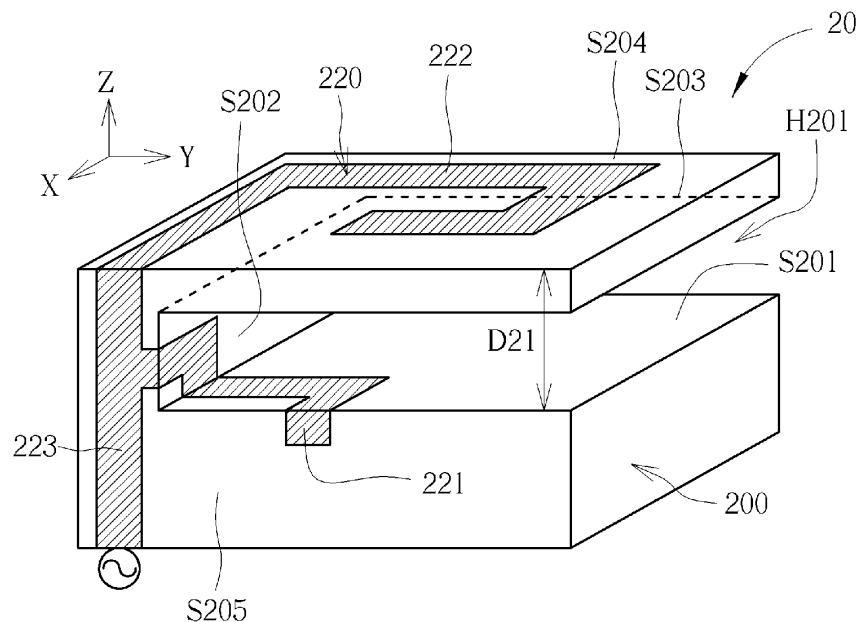
H01Q 1/24 (2006.01)

H01Q 9/04 (2006.01)

(57)

ABSTRACT

An antenna module for a wireless communication device includes an antenna including a first arm for resonating wireless signals in a high frequency band and a second arm for resonating wireless signals in a low frequency band, and a holder formed with at least one hollow, wherein the at least one hollow is adjacent to a first surface of the holder, a second surface of the holder and a third surface of the holder, the first surface is adjacent to the second surface, and the second surface is adjacent to the third surface.

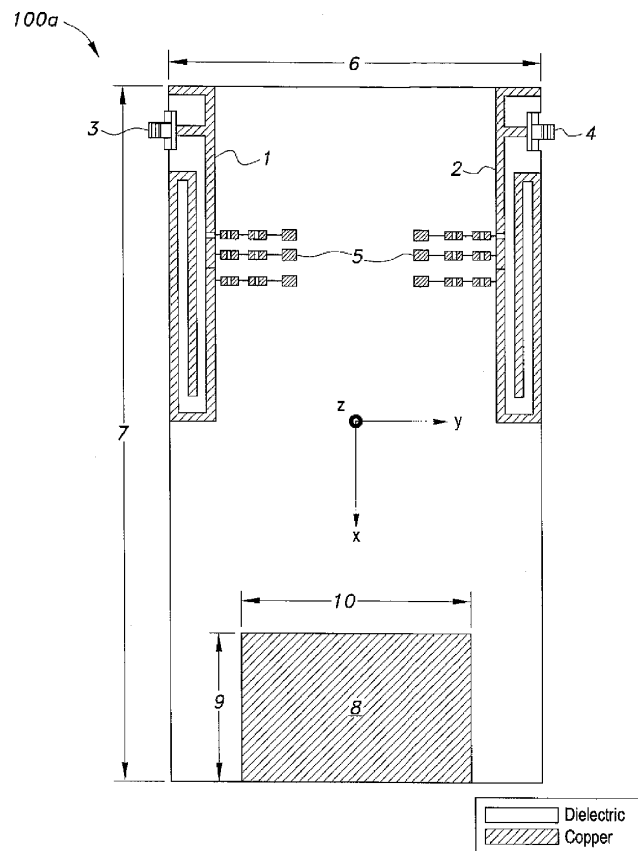




US 20170098897A1

(19) **United States**(12) **Patent Application Publication**
SHARAWI et al.(10) **Pub. No.: US 2017/0098897 A1**(43) **Pub. Date: Apr. 6, 2017**(54) **RECONFIGURABLE MIMO AND SENSING
ANTENNA SYSTEM**(52) **U.S. Cl.**CPC **H01Q 21/28** (2013.01); **H01Q 5/314**
(2015.01); **H01Q 5/20** (2015.01)(71) Applicant: **KING FAHD UNIVERSITY OF
PETROLEUM AND MINERALS,**
DHAHRAN (SA)(57) **ABSTRACT**(72) Inventors: **MOHAMMAD SAID SHARAWI,**
DHAHRAN (SA); **RIFAQAT**
HUSSAIN, DHAHRAN (SA)

The reconfigurable MIMO and sensing antenna system combines a 2-element reconfigurable MIMO antenna system with a UWB element. The complete setup is suitable for CR platforms that require sensing UWB band availability. The design is planar in structure and includes a pair of PIFAs disposed on a dielectric substrate top surface. The UWB sensing element is disposed on the dielectric substrate bottom surface. An F-head portion of each PIFA has two arms extending to a longer peripheral edge of the substrate. An F-tail portion of each PIFA extends from the substrate's shorter peripheral edge. The two PIFAs are mirror images of each other. For each PIFA, three diode circuits include a PIN diode in combination with a varactor diode connected to and extending away from the F-tail portion of the PIFA, thereby creating separate radiating branches of the PIFA.

(21) Appl. No.: **14/873,171**(22) Filed: **Oct. 1, 2015****Publication Classification**(51) **Int. Cl.****H01Q 21/28** (2006.01)**H01Q 5/20** (2006.01)**H01Q 5/314** (2006.01)



US 20170104261A1

(19) **United States**(12) **Patent Application Publication**
WONG et al.(10) **Pub. No.: US 2017/0104261 A1**(43) **Pub. Date: Apr. 13, 2017**(54) **COMMUNICATION DEVICE**(52) **U.S. CL.**(71) Applicant: **Acer Incorporated**, New Taipei City
(TW)CPC **H01Q 1/243** (2013.01); **H01Q 5/20**
(2015.01)(72) Inventors: **Kin-Lu WONG**, New Taipei City
(TW); **Chih-Yu TSAI**, New Taipei City
(TW)

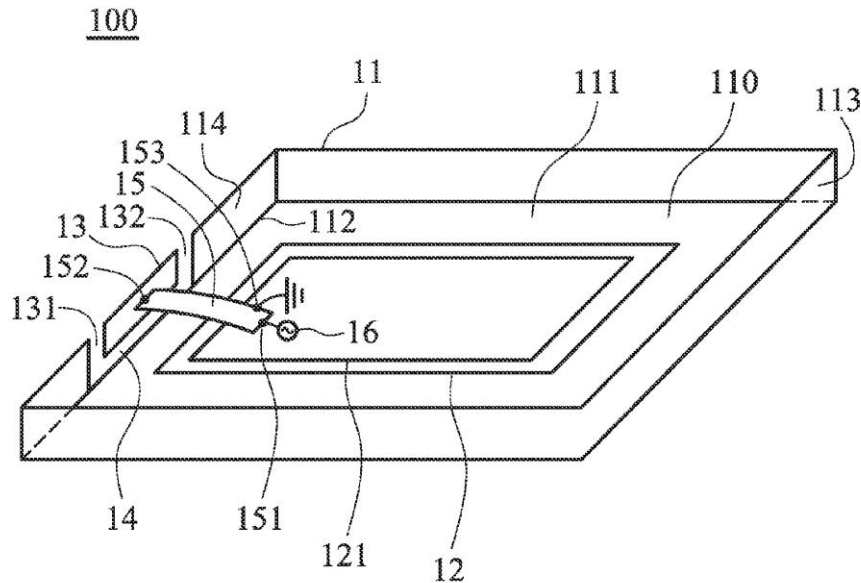
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ABSTRACT(21) Appl. No.: **14/937,025**(22) Filed: **Nov. 10, 2015**(30) **Foreign Application Priority Data**

Oct. 8, 2015 (TW) 104133163

Publication Classification(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/20 (2006.01)

A communication device includes a housing, a system circuit board, and an antenna element. A metal plane of the housing is disposed on a back surface of the housing. An edge of the metal plane is aligned with an edge of the back surface. The antenna element includes a metal piece and a printed circuit board. The metal piece is disposed on a side surface of the housing. The metal piece extends along the edge of the metal plane. The metal piece is also separated from the edge of the metal plane by a nonconductive region. The printed circuit board includes a circuit. The printed circuit board has a first connection point and a second connection point. The first connection point is coupled to a signal source. The second connection point is coupled to the metal piece, and is used as a feeding point of the antenna element.





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(19) **United States**

(12) **Patent Application Publication**
Ramachandran

(10) **Pub. No.: US 2017/0104266 A1**

(43) **Pub. Date: Apr. 13, 2017**

(54) **MULTI-TAP FREQUENCY SWITCHABLE
ANTENNA APPARATUS, SYSTEMS AND
METHODS**

(71) Applicant: **Pulse Finland OY**, Oulunsalo (FI)

(72) Inventor: **Prasadh Ramachandran**, Oulu (FI)

(21) Appl. No.: **14/877,393**

(22) Filed: **Oct. 7, 2015**

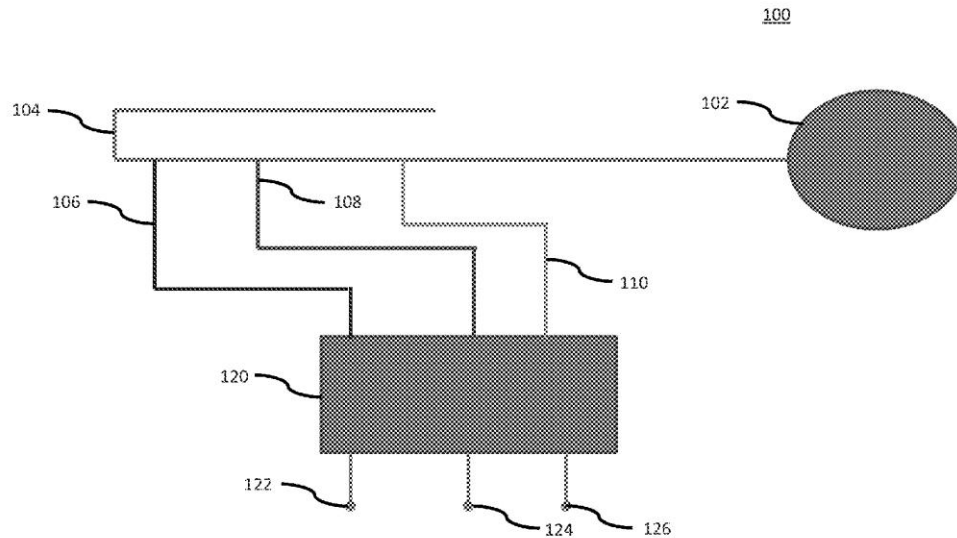
Publication Classification

(51) **Int. Cl.**
H01Q 1/50 (2006.01)
H04M 1/02 (2006.01)
H01Q 5/20 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/50** (2013.01); **H01Q 5/20**
(2015.01); **H04M 1/026** (2013.01)

(57) **ABSTRACT**

Multi-tap switchable antenna apparatus for use with mobile devices and other applications, and methods of utilizing the same. In one embodiment, the multi-tap switchable antenna apparatus includes a main radiator coupled to an antenna feed or source. Galvanically connected to the main radiator is a plurality of switchable antenna radiators which are in turn connected to an nPmT switch. The output of the nPmT switch can be connected to a variety of differing electronic component impedances. By altering the state of the nPmT switch, the operational length of the antenna (and hence, the operational frequency band of the antenna) can be varied. Performance characteristics associated with a given implementation of the multi-tap switchable apparatus are also disclosed.





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(19) **United States**

(12) **Patent Application Publication**
HUNG et al.

(10) **Pub. No.: US 2017/0104273 A1**

(43) **Pub. Date: Apr. 13, 2017**

(54) **HYBRID ANTENNA**

(71) Applicant: **MediaTek Inc.**, Hsin-Chu (TW)

(72) Inventors: **Kuo-Fong HUNG**, Changhua City (TW); **Chia-Wei CHI**, Taipei City (TW)

(21) Appl. No.: **15/384,828**

(22) Filed: **Dec. 20, 2016**

Related U.S. Application Data

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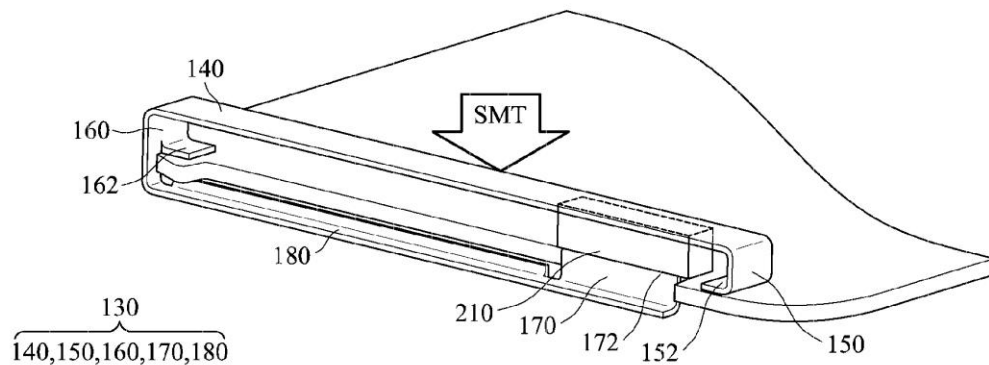
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CPC **H01Q 9/42** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 5/357** (2015.01)

(57) **ABSTRACT**

A hybrid antenna (and related method for manufacturing the antenna) includes a dielectric substrate and a stamping element. The stamping element includes a main radiator, a first holder, a second holder, a feeding element, an extension branch, a first trace, and a first via. The main radiator is substantially disposed above the dielectric substrate. The first holder is coupled to a first end of the main radiator. The second holder is coupled to a second end of the main radiator. The feeding element is coupled to a signal source. The extension branch is substantially disposed below the dielectric substrate, and is coupled between the second holder and the feeding element. The first trace is disposed on a second surface of the dielectric substrate, and the first via is formed through the dielectric substrate, and coupled between an end of the first trace and the first holder.

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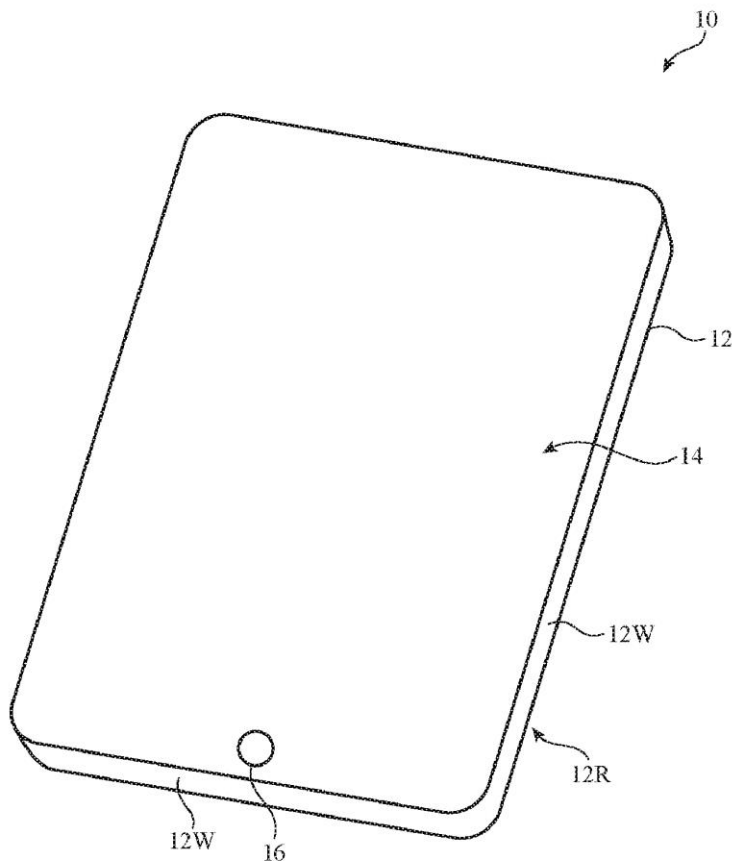




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Ouyang et al.(10) **Pub. No.: US 2017/0110787 A1**(43) **Pub. Date: Apr. 20, 2017**(54) **ELECTRONIC DEVICES WITH
MILLIMETER WAVE ANTENNAS AND
METAL HOUSINGS**(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 21/28**
(2013.01)(71) Applicant: **Apple Inc.**, Cupertino, CA (US)(57) **ABSTRACT**(72) Inventors: **Yuehui Ouyang**, Sunnyvale, CA (US);
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An electronic device may be provided with wireless circuitry. The wireless circuitry may include one or more antennas. The antennas may include millimeter wave antenna arrays. Non-millimeter-wave antennas such as cellular telephone antennas may have conductive structures separated by a dielectric gap. In a device with a metal housing, a plastic-filled slot may form the dielectric gap. The conductive structures may be slot antenna structures, inverted-F antenna structures such as an inverted-F antenna resonating element and a ground, or other antenna structures. The plastic-filled slot may serve as a millimeter wave antenna window. A millimeter wave antenna array may be mounted in alignment with the millimeter wave antenna window to transmit and receive signals through the window. Millimeter wave antenna windows may also be formed from air-filled openings in a metal housing such as audio port openings.

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City (TW)(51) **Int. Cl.**
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H01Q 21/00 (2006.01)(72) Inventors: **Yu-Shen Mai**, Taipei City (TW);
Zhao-Wei Han, Taipei City (TW);
Han-Wei Li, Taipei City (TW)(52) **U.S. Cl.**
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13/10 (2013.01)(73) Assignee: **ASUSTeK COMPUTER INC.**, Taipei
City (TW)(21) Appl. No.: **15/291,082**(57) **ABSTRACT**(22) Filed: **Oct. 12, 2016****Related U.S. Application Data**(60) Provisional application No. 62/242,262, filed on Oct.
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An antenna module suited for a portable electronic device is provided. The antenna module includes a heat dissipation unit, a first antenna and a second antenna. The heat dissipation unit contacts a heat source of the portable electronic device. The first antenna and the second antenna are disposed at different side portions of the heat dissipation unit. The heat dissipation unit has a slot with at least one bending portion. An orthogonal projection of at least one of the first antenna and the second antenna on a projection plane of the heat dissipation unit is partly overlapped with an orthogonal projection of the slot on the projection plane.

