US 20190097308A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2019/0097308 A1**

CHEN et al. (43) **Pub. Date: Mar. 28, 2019**

(54) **ANTENNA STRUCTURE AND WIRELESS COMMUNICATION DEVICE USING SAME**

(71) Applicant: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

(72) Inventors: **JIN-BO CHEN**, New Taipei (TW); **CHENG-AN CHEN**, New Taipei (TW); **CHIH-WEI LIAO**, New Taipei (TW)

(21) Appl. No.: **16/051,018**

(22) Filed: **Jul. 31, 2018**

(30) **Foreign Application Priority Data**

Sep. 27, 2017 (CN) 201710890527.X

Publication Classification

(51) **Int. Cl.**

H01Q 1/24	(2006.01)
G06F 1/16	(2006.01)
H01Q 1/22	(2006.01)
H01Q 5/335	(2006.01)
H04M 1/02	(2006.01)

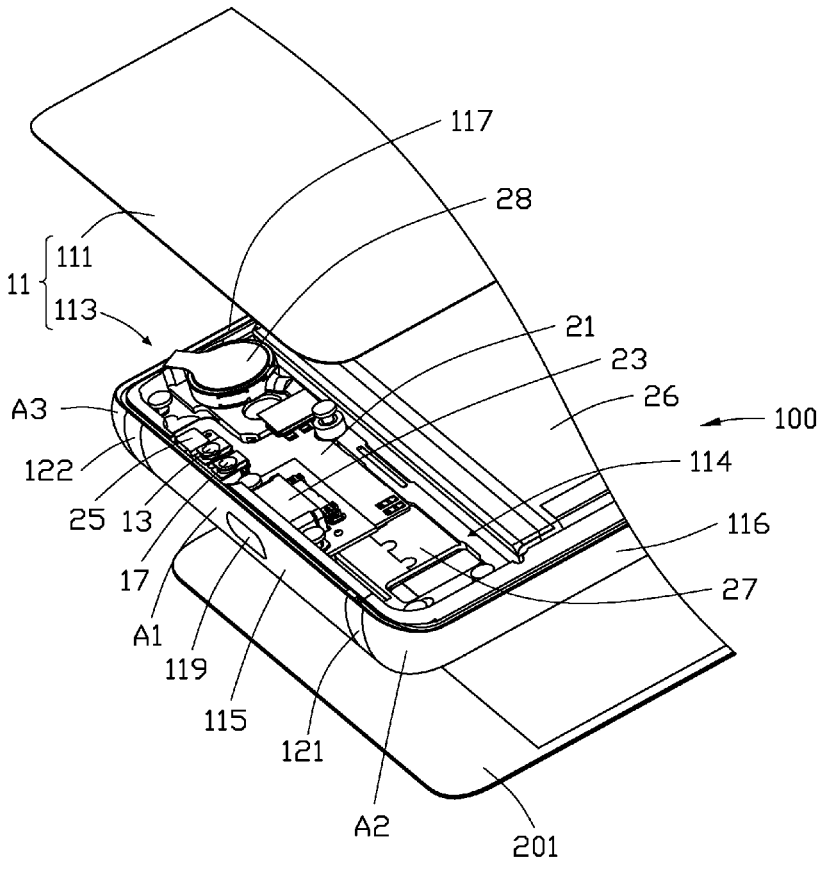
(52) **U.S. Cl.**

CPC ***H01Q 1/243*** (2013.01); ***G06F 1/1698*** (2013.01); ***H04M 1/026*** (2013.01); ***H01Q 5/335*** (2015.01); ***H01Q 1/2266*** (2013.01)

(57) **ABSTRACT**

An antenna structure includes a housing and a feeding source. The housing forms a radiating portion, a first coupling portion, and a second coupling portion. The first coupling portion and the second coupling portion are grounded. The feeding source is electrically connected to the radiating portion for feeding current to the radiating portion and divides the radiating portion into a first radiating section and a second radiating section. When the feeding source supplies current, the current flows through the first radiating section and is coupled to the first coupling portion to activate a first operation mode and a second operation mode. When the feeding source supplies current, the current flows through the second radiating section and is coupled to the second coupling portion to activate a third operation mode and a fourth operation mode.

200



US 20190097314A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2019/0097314 A1**

Rajagopalan et al. (43) **Pub. Date: Mar. 28, 2019**

(54) **ELECTRONIC DEVICES HAVING MULTI-BAND SLOT ANTENNAS**

(71) Applicant: **Apple Inc.**, Cupertino, CA (US)

(72) Inventors: **Harish Rajagopalan**, San Jose, CA (US); **Pietro Romano**, Foster City, CA (US); **Umar Azad**, Santa Clara, CA (US); **David Garrido Lopez**, Campbell, CA (US); **Lu Zhang**, Shanghai (CN); **Rodney A. Gomez Angulo**, Santa Clara, CA (US); **Mario Martinis**, Cupertino, CA (US); **Carlo Di Nallo**, Belmont, CA (US); **Mattia Pascolini**, San Francisco, CA (US)

(21) Appl. No.: **15/716,363**

(22) Filed: **Sep. 26, 2017**

Publication Classification

(51) **Int. Cl.**

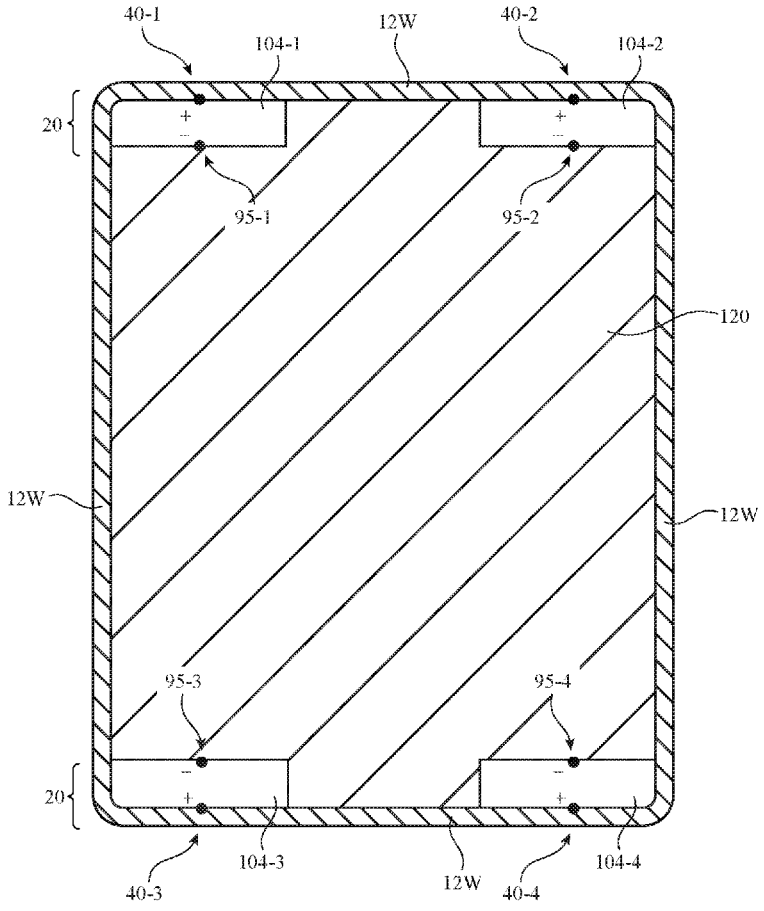
H01Q 1/52	(2006.01)
H01Q 13/10	(2006.01)
H01Q 5/30	(2006.01)
H01Q 1/24	(2006.01)
H01Q 5/50	(2006.01)

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

CPC ***H01Q 1/521*** (2013.01); ***H01Q 13/10*** (2013.01); *H04M 1/0266* (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 5/50*** (2015.01); ***H01Q 5/30*** (2015.01)

(57) **ABSTRACT**

An electronic device may have peripheral conductive structures and a conductive layer that define edges of a slot element for a slot antenna. The slot element may be configured to cover wireless communications in a 1575 MHz satellite navigation band and 2.4 GHz and 5 GHz wireless local area network bands. A tuning circuit may be coupled across the slot approximately half way across the length of the slot. The antenna tuning circuit may include an inductor coupled in series with a notch filter (in scenarios where the slot is long enough to cover the 1575 MHz satellite navigation band in its fundamental mode) or may include a capacitor coupled in series with a notch or low pass filter. The fundamental mode and one or more harmonic modes of the slot element may cover the satellite navigation and wireless local area network bands.



US 20190097319A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2019/0097319 A1**

HSIEH et al. (43) **Pub. Date: Mar. 28, 2019**

(54) **MULTIBAND ANTENNA STRUCTURE AND WIRELESS COMMUNICATION DEVICE USING SAME**

(71) Applicant: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

(72) Inventors: **WEI-EN HSIEH**, New Taipei (TW); **CHIEN-HUA LI**, New Taipei (TW); **YIH-SHYANG HER**, New Taipei (TW)

(21) Appl. No.: **16/109,699**

(22) Filed: **Aug. 22, 2018**

(30) **Foreign Application Priority Data**

Sep. 27, 2017 (CN) 201710891620.2

Publication Classification

(51) **Int. Cl.**

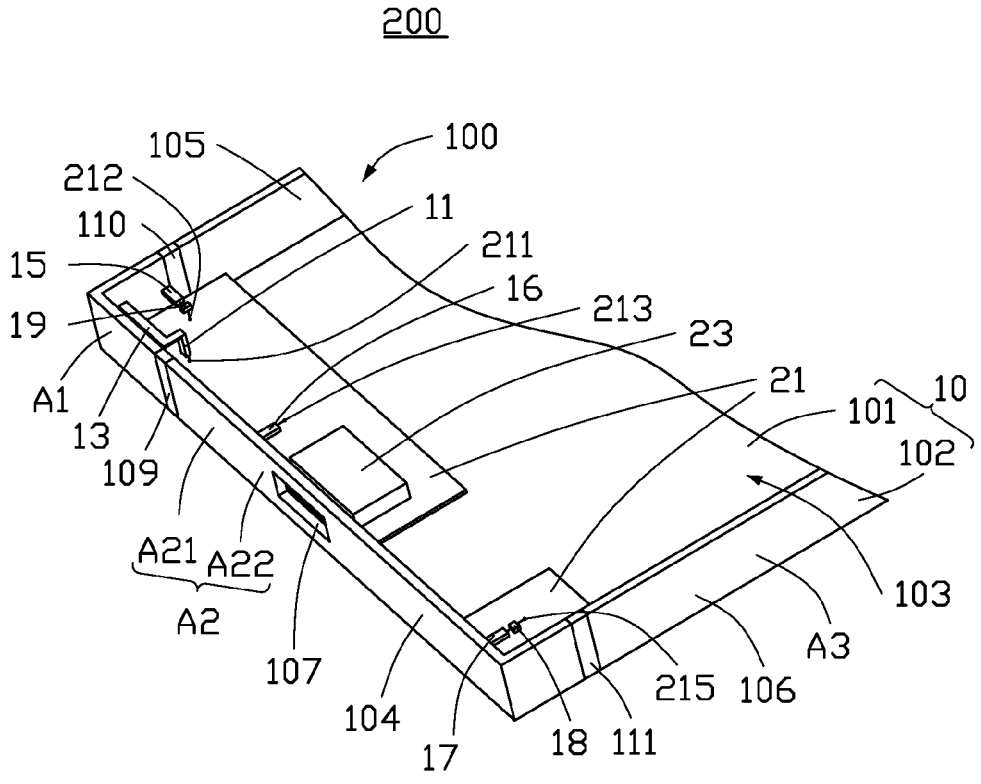
H01Q 5/30	(2006.01)
H01Q 7/00	(2006.01)
H01Q 1/24	(2006.01)

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

CPC ***H01Q 5/30*** (2015.01); ***H01Q 1/243*** (2013.01); ***H01Q 7/00*** (2013.01)

(57) **ABSTRACT**

An antenna structure includes a housing, a radiator, a first feed portion, and a first ground portion. The housing includes a coupling portion and a coupling section. The first feed portion, the first ground portion, and the radiator are all positioned in the housing. When a first feed point supplies current, the current flows through the first feed portion and the radiator, and is coupled to one of the coupling portion and the coupling section through the radiator. The current is further coupled to the other one of the coupling portion and the coupling section through the one of the coupling portion and the coupling section. The radiator, the coupling portion, and the coupling section activate three different operating modes. Each mode operating generates radiation signals in one of three different radiation frequency bands.



US 20190098750A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2019/0098750 A1**

WOO (43) **Pub. Date: Mar. 28, 2019**

(54) **ELECTRONIC DEVICE**

(71) Applicant: **LG ELECTRONICS INC.**, Seoul (KR)

(72) Inventor: **Seungmin WOO**, Seoul (KR)

(73) Assignee: **LG ELECTRONICS INC.**, Seoul (KR)

(21) Appl. No.: **16/141,841**

(22) Filed: **Sep. 25, 2018**

Related U.S. Application Data

(60) Provisional application No. 62/564,222, filed on Sep. 27, 2017.

(30) **Foreign Application Priority Data**

Feb. 21, 2018 (KR) 10-2018-0020712

Publication Classification

(51) **Int. Cl.**

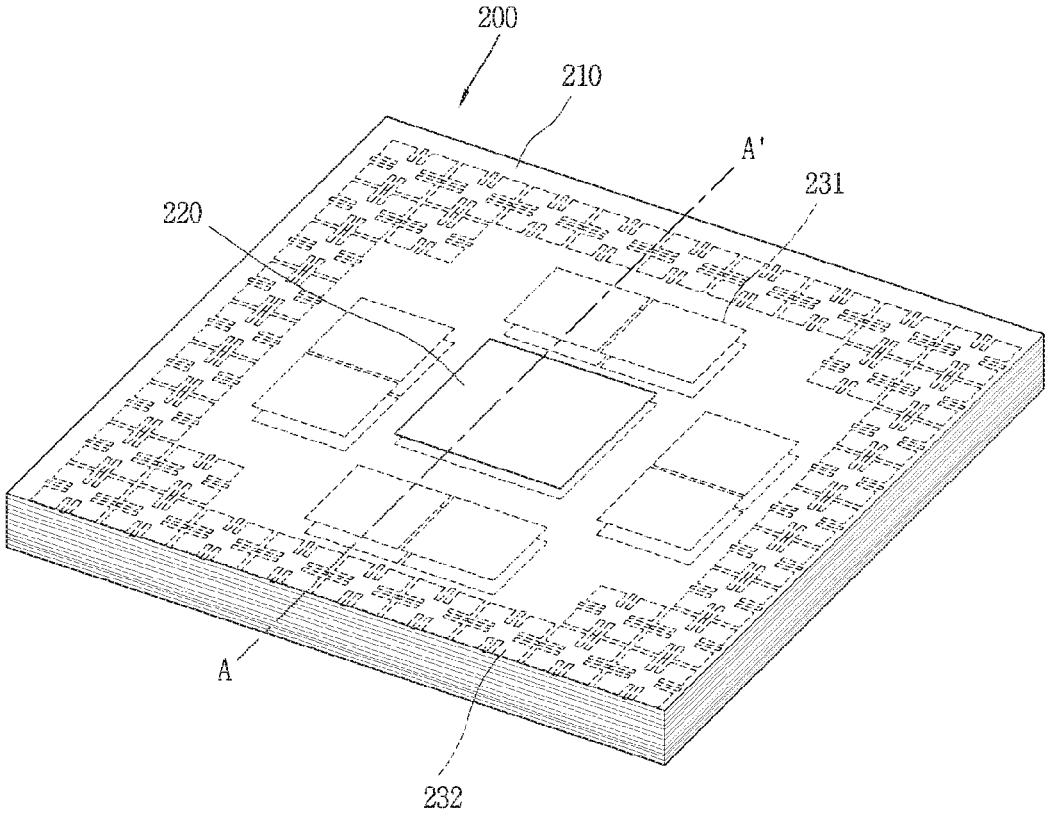
H05K 1/02	(2006.01)
H01Q 9/04	(2006.01)
H01Q 21/06	(2006.01)
H01Q 1/48	(2006.01)
H01Q 1/52	(2006.01)
H05K 1/18	(2006.01)
H05K 1/11	(2006.01)

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

CPC ***H05K 1/0271*** (2013.01); ***H01Q 9/045*** (2013.01); ***H01Q 21/065*** (2013.01); ***H01Q 1/48*** (2013.01); *H05K 2201/10098* (2013.01); ***H05K 1/0236*** (2013.01); ***H05K 1/181*** (2013.01); ***H05K 1/115*** (2013.01); ***H01Q 1/521*** (2013.01)

(57) **ABSTRACT**

The present disclosure relates to an electronic device, and the electronic device may include a circuit board provided within a main body of the electronic device, on which a conductive layer made of a conductive material and a dielectric layer made of an insulating material are alternately laminated; at least one or more patch antennas disposed on the circuit board; a core layer located at a central portion inside the circuit board, and configured with any one of the dielectric layers; a ground layer disposed below the core layer; and an EBG structure located inside the circuit board in a symmetrical shape at the top and bottom with respect to the core layer, and the EBG structure restricts operating frequency signals radiated from the respective patch antennas from being interfered with each other.



US 20190103886A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2019/0103886 A1**

Svendsen et al. (43) **Pub. Date: Apr. 4, 2019**

(54) **ANTENNA BANDWIDTH ENHANCEMENT FOR AN ELECTRONIC DEVICE**

(71) Applicant: **INTEL CORPORATION**, Santa Clara, CA (US)

(72) Inventors: **Simon Svendsen**, Aalborg (DK); **Ole Jagielski**, Viborg (DK)

(73) Assignee: **INTEL CORPORATION**, Santa Clara, CA (US)

(21) Appl. No.: **15/719,781**

(22) Filed: **Sep. 29, 2017**

Publication Classification

(51) **Int. Cl.**

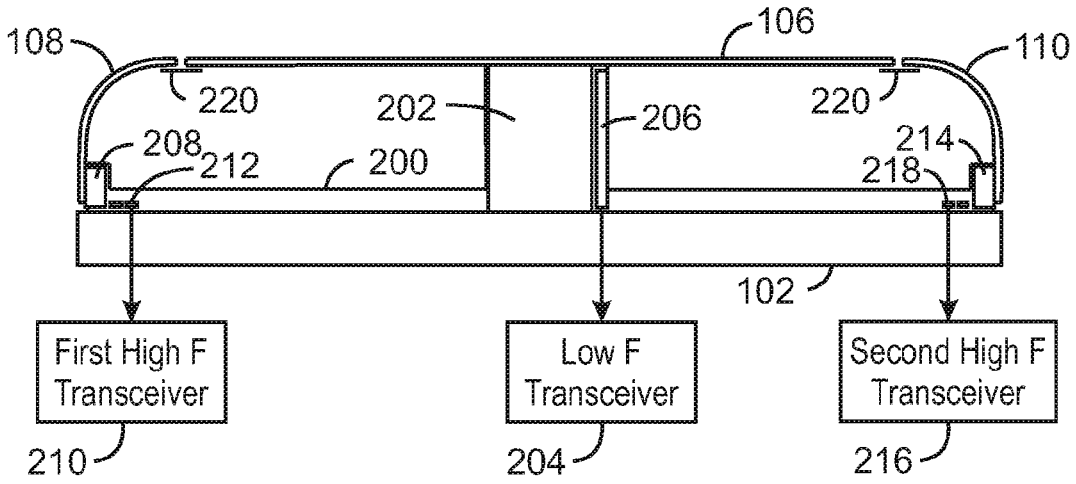
H04B 1/00	(2006.01)
H04B 1/401	(2006.01)
H01Q 5/50	(2006.01)
H01Q 1/24	(2006.01)

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

CPC ***H04B 1/0064*** (2013.01); ***H04B 1/401*** (2013.01); *H01Q 1/38* (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 5/50*** (2015.01)

(57) **ABSTRACT**

Techniques are disclosed for configuring a broadband antenna system. An example electronic device includes a first antenna operating at a first frequency range and coupled to a first transceiver via a first signal path comprising a first indirect feed. The electronic device also includes a second antenna operating at a second frequency range and coupled to a second transceiver via a second signal path comprising a second indirect feed, wherein the first frequency range is lower than the first frequency range. The electronic device also includes a third antenna operating at the second frequency range and coupled to a third transceiver via a second signal path comprising a third indirect feed. Additionally, the first antenna is coupled to the first antenna and the second antenna by a capacitive coupling element.



US 20190109366A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2019/0109366 A1**

CHENG (43) **Pub. Date: Apr. 11, 2019**

(54) **DOUBLE-FED TUNABLE TERMINAL ANTENNA BASED ON METAL REAR SHELL**

(71) Applicant: **ZTE CORPORATION**, Shenzhen (CN)

(72) Inventor: **Xiaoqi CHENG**, Shenzhen (CN)

(21) Appl. No.: **16/089,657**

(22) PCT Filed: **May 24, 2016**

(86) PCT No.: **PCT/CN2016/083152**

§ 371 (c)(1),
(2) Date: **Sep. 28, 2018**

(30) **Foreign Application Priority Data**

Mar. 29, 2016 (CN) 201610188108.7

Publication Classification

(51) **Int. Cl.**

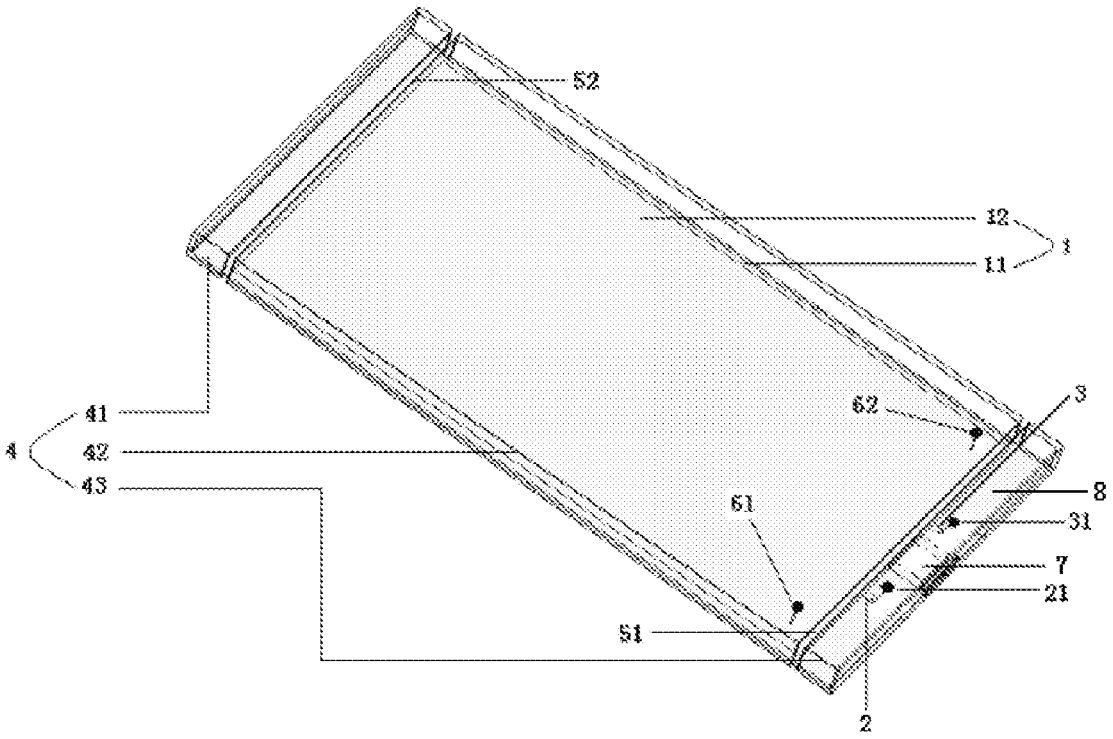
H01Q 1/24	(2006.01)
H01Q 5/35	(2006.01)
H01Q 1/38	(2006.01)
H01Q 1/48	(2006.01)
H01Q 1/40	(2006.01)
H04M 1/02	(2006.01)

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

CPC ***H01Q 1/243*** (2013.01); ***H01Q 5/35*** (2015.01); ***H04M 1/0274*** (2013.01); ***H01Q 1/48*** (2013.01); ***H01Q 1/40*** (2013.01); ***H01Q 1/38*** (2013.01)

(57) **ABSTRACT**

A double-fed tunable terminal antenna based on a metal rear shell is provided. The antenna includes: a Printed Circuit Board (PCB); a metal rear shell, on which two gaps are set, and the two gaps divide the metal rear shell into three parts, one of three parts serves as an antenna radiation unit; a grounding element, connected with the metal rear shell; and two feed matching networks and corresponding two feed points, the two feed matching networks are fed into the antenna radiation unit through the corresponding two feed points.



US 20190109387A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2019/0109387 A1**

Samadi Taheri et al. (43) **Pub. Date: Apr. 11, 2019**

(54) **COLLOCATED END-FIRE ANTENNA AND LOW-FREQUENCY ANTENNA SYSTEMS, DEVICES, AND METHODS**

(71) Applicant: **wiSpry, Inc.**, Irvine, CA (US)

(72) Inventors: **Mohammad Mehdi Samadi Taheri**, Tehran (IR); **Shuai Zhang**, Aalborg SV (DK); **Gert Frølund Pedersen**, Storvorde (DK)

(21) Appl. No.: **16/157,683**

(22) Filed: **Oct. 11, 2018**

Related U.S. Application Data

(60) Provisional application No. 62/570,930, filed on Oct. 11, 2017.

Publication Classification

(51) **Int. Cl.**

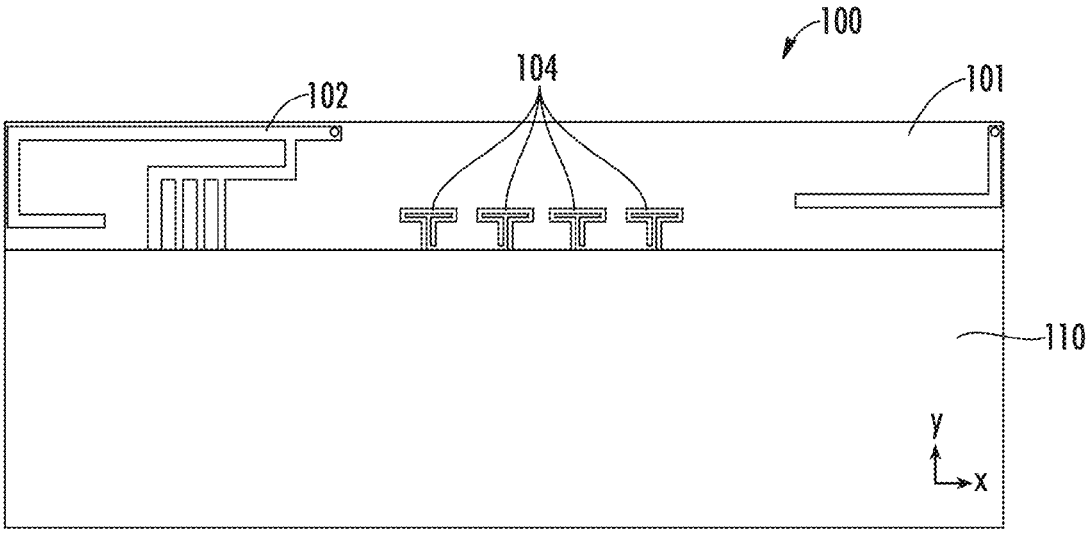
H01Q 21/30	(2006.01)
H01Q 19/10	(2006.01)
H01Q 5/15	(2006.01)
H01Q 19/185	(2006.01)
H01Q 5/48	(2006.01)
H01Q 5/307	(2006.01)
H01Q 21/06	(2006.01)

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

CPC ***H01Q 21/30*** (2013.01); ***H01Q 19/108*** (2013.01); ***H01Q 5/15*** (2015.01); *H01Q 9/16* (2013.01); ***H01Q 5/48*** (2015.01); ***H01Q 5/307*** (2015.01); ***H01Q 21/062*** (2013.01); ***H01Q 19/185*** (2013.01)

(57) **ABSTRACT**

Antenna systems, devices, and methods for providing both end-fire mm-wave high-frequency signals and low-frequency RF signals from a collocated antenna array in which at least one high-frequency antenna element and a low-frequency antenna element are spaced apart from one another. Grating strips are positioned between the high-frequency antenna elements and the low-frequency antenna element, the grating strips being spaced apart from one another by a defined spacing. The grating strips are configured such that a signal wave from the high-frequency antenna element propagates through the low-frequency antenna element.



US 20190109622A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2019/0109622 A1

Wang et al. (43) Pub. Date: Apr. 11, 2019

(54) **MULTI-BAND ANTENNAS AND MIMO ANTENNA ARRAYS FOR ELECTRONIC DEVICE**

(71) Applicants: **Dong Wang**, Waterloo (CA); **Enliang Wang**, Waterloo (CA)

(72) Inventors: **Dong Wang**, Waterloo (CA); **Enliang Wang**, Waterloo (CA)

(21) Appl. No.: **15/726,842**

(22) Filed: **Oct. 6, 2017**

Publication Classification

(51) **Int. Cl.**
H04B 7/04 (2006.01)
H04B 7/0452 (2006.01)

(52) **U.S. Cl.**
CPC ***H04B 7/0434*** (2013.01); *H04B 7/0465* (2013.01); ***H04B 7/0452*** (2013.01)

(57) **ABSTRACT**

Antennas and MIMO antenna arrays in a housing of an electronic device are described. The MIMO antenna array includes a plurality of antennas. At least one of the antennas has operating frequency ranges of 700 MHz-900 MHz, 1700 MHz-2100 MHz, and 3 GHz-5 GHz. The MIMO antenna array may include 8 or 10 antennas.