(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 920 328 A1

(12) EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
08.12.2021 Bulletin 2021/49

(21) Application number: **19912442.1**

(22) Date of filing: **27.12.2019**

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

(86) International application number:
PCT/CN2019/129245

(87) International publication number:
WO 2020/155986 (06.08.2020 Gazette 2020/32)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **28.01.2019 CN 201920139308 U**

(71) Applicant: **Hangzhou Hikvision Digital Technology Co., Ltd.**
Hangzhou, Zhejiang 310051 (CN)

(72) Inventor: **LIU, Jie**
Hangzhou, Zhejiang 310051 (CN)

(74) Representative: **Epping - Hermann - Fischer Patentanwaltsgesellschaft mbH**
Schloßschmidstraße 5
80639 München (DE)

(54) DUAL-FREQUENCY ANTENNA

(57) The present application discloses a dual-frequency antenna, comprising: a PCB provided with a clearance area and a non-clearance area; a single-path metal conduction band which is arranged within the clearance area and a terminal end of which is electrically connected to a ground end of the PCB; and a capacitor connected between an excitation end and the terminal end of the single-path metal conduction band. The dual-frequency antenna can achieve dual-frequency resonance merely by means of a metal conduction band on which the capacitors are connected in series, thus avoiding the problems in the prior art that the space occupied by a multi-branch multi-path structure is large, its size is relatively large, and its resonant frequency band is difficult to adjust.

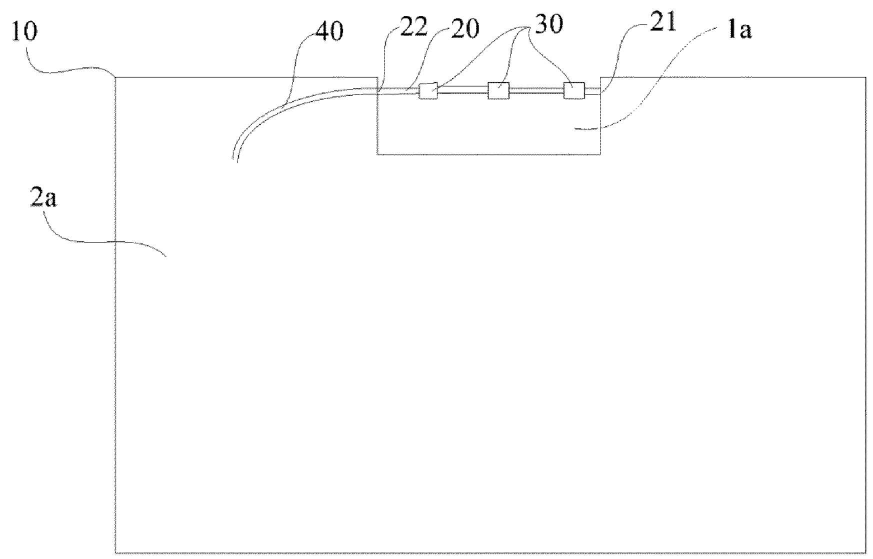

Fig. 1

Description

[0001] The present application claims the priority to a Chinese patent application No.201920139308.2, filed with the China National Intellectual Property Administration on January 28, 2019 and entitled "DUAL-FREQUENCY ANTENNA", which is incorporated herein by reference in its entirety.

Technical field

[0002] This application relates to the technical field of wireless local area networks, in particular to a dual-frequency antenna.

Background

[0003] The current antennas usually achieves dual-frequency resonance through multi-branch wires. Wiring of the antenna with this structure occupies a larger space on a PCB (Printed Circuit Board), which causes the overall size of antenna to be too large to satisfy the miniaturization design. Further, it is difficult to adjust the resonance frequency band of the antennas whose dual-frequency resonance is achieved through the multi-branch wires.

[0004] Accordingly, it is highly desirable to optimize the design of the dual-frequency antenna to provide a dual-frequency antenna with a small size and with a resonant frequency band easy to adjust.

Summary

[0005] An object of an embodiment of the present application is to provide a dual-frequency antenna, which can achieve dual-frequency resonance merely by means of one metal conduction band on which capacitors are connected in series, and can solve the problems that the space occupied by a multi-branch multi-path structure is large, its size is relatively large and its resonant frequency band is difficult to adjust. The specific technical solutions are as follows:

An embodiment of the present application provides a dual-frequency antenna, which includes:

a PCB provided with a clearance area and a non-clearance area;

a single-path metal conduction band which is arranged within the clearance area and a terminal end of which is electrically connected to a ground end of the PCB; and

a capacitor connected between an excitation end and the terminal end of the single-path metal conduction band.

[0006] Optionally, the dual-frequency antenna includes a plurality of capacitors connected in series on the single-path metal conduction band.

[0007] Optionally, the clearance area is arranged at an edge of the PCB, and the terminal end and the excitation end of the single-path metal conduction band are located near an opening side of the clearance area.

[0008] Optionally, the dual-frequency antenna further includes a microstrip line which is disposed in the non-clearance area and to which the excitation end of the single-path metal conduction band is electrically connected.

[0009] Optionally, the dual-frequency antenna further includes:

a test connector connected in series with the capacitor on the single-path metal conduction band and arranged close to the excitation end of the single-path metal conduction band.

[0010] Optionally, the test connector is a resistor which is connected in series on the single-path metal conduction band and whose resistance value is zero.

[0011] Optionally, the single-path metal conduction band is arranged within the clearance area in a stacked reciprocating manner.

[0012] It can be seen that, based on the above-mentioned embodiments, a dual-frequency antenna includes a PCB, a single-path metal conduction band, and a capacitor. The PCB is provided with a clearance area and a non-clearance area, wherein the clearance area is formed in an area without metal or wires and the like on the PCB, and the non-clearance area is located outside the clearance. The single-path metal conduction band refers to one metal conduction band which only forms one path without branches. The single-path metal conduction band is arranged within the clearance area, and a terminal end of the single-path metal conduction band is electrically connected to a ground end of the PCB to form a loop antenna, so that high-frequency resonance of the dual-frequency antenna can be realized. The capacitor is connected between an excitation end and the terminal end of the single-path metal conduction band, so that low-frequency resonance of the dual-frequency antenna can be realized.

[0013] Compared with a dual-frequency antenna realized though a multi-branch metal conduction band, the dual-frequency antenna can realize dual-frequency resonance through the single-path metal conduction band and capacitors, which is simple in structure and can adjust the high-frequency resonance by adjusting the length of the single-path metal conduction band and the area of the clearance area, and can adjust the low-frequency resonance by adjusting the capacitance value of the capacitor, which effectively simplifies the resonance adjustment of the antenna.

Brief Description of the Drawings

[0014] In order to illustrate the embodiments of the present application and the technical solutions of the prior art more clearly, the drawings used in the embodiments and the prior art are briefly described below. It is obvious that the drawings in the following description are merely some embodiments of the present application, and other drawings can be obtained by those skilled in the art based on to the drawings without creative efforts.

Fig. 1 is a schematic structural diagram of a dual-frequency antenna according to a specific embodiment of the present application;

Fig 2 is a return loss curve of a dual-frequency antenna according to a specific embodiment of the present application;

Fig. 3 is a schematic diagram illustrating the efficiency of a dual-frequency antenna according to a specific embodiment of the present application.

[0015] Reference signs: 10- PCB, 20- a single-path metal conduction band, 21- terminal end, 22- an excitation end, 30- a capacitor, 40- a microstrip line, 1a- a clearance area, 2a- a non-clearance area.

Detailed Description

[0016] In order to make the objects, technical solutions and advantages of the present application more apparent, the present application will be described in more details with reference to the accompanying drawings and embodiments below. It should be apparent that the described embodiments are only some of the embodiments of the present application instead of all of them. All other embodiments obtained by those skilled in the art based on the embodiments herein without creative efforts shall fall within the protection scope of this application.

[0017] In order to describe a dual-frequency antenna provided in the present application in detail, the structure and operation principle of the dual-frequency antenna will be described in detail below with reference to the accompanying drawings.

[0018] As shown in Fig. 1, which is a schematic structural diagram of a dual-frequency antenna according to a specific embodiment of the present application.

[0019] In a specific embodiment, the present application provides a dual-frequency antenna comprising a PCB 10, a single-path metal conduction band 20 and a capacitor 30. As shown in Fig. 1, the PCB 10 is provided with a clearance area 1a and a non-clearance area 2a, wherein the clearance area 1a is formed in an area without metal or wires and the like on the PCB 10, and the non-clearance area 2a is outside the clearance area. The single-path metal conduction band 20 refers to one metal conduction band which only forms one path without branches. The single-path metal conduction band 20 is arranged within the clearance area 1a, and a terminal end of the single-path metal conduction band 20 is electrically connected to a ground end of the PCB 10 to form a loop antenna, so that high-frequency resonance of the dual-frequency antenna can be realized. The capacitor 30 is connected between an excitation end and the terminal end of the single-path metal conduction band 20, so that low-frequency resonance of the dual-frequency antenna can be realized.

[0020] Compared with a dual-frequency antenna realized though a multi-branch metal conduction band, the dual-frequency antenna can realize dual-frequency resonance through the single-path metal conduction band 20 and the capacitor 30, which is simple in structure.

[0021] The high-frequency resonance can be adjusted by adjusting the length of the single-path metal conduction band 20 and the area of the clearance area 1a. Specifically, the high-frequency resonance can be adjusted by increasing the length of the single-path metal conduction band 20 with the area of the clearance area 1a unchanged. For example, in the case that the terminal end 21 and the excitation end 22 of the single-path metal conduction band 20 are kept unchanged, the high-frequency resonance can be adjusted by increasing the length of the single-path metal conduction band 20, in which the single-path metal conduction band 20 is disposed within the clearance area 1a in a wave shape or in a stacked reciprocating manner.

[0022] The low-frequency resonance can be adjusted by adjusting the capacitance value of the capacitor 30, and the capacitance value of the capacitor 30 is set according to the required low-frequency resonance point in order to meet the requirements of different low-frequency resonance points, which effectively simplifies the resonance adjustment of the antenna.

[0023] Further, the dual-frequency antenna includes a plurality of capacitors 30, which are connected in series on the single-path metal conduction band 20.

[0024] In a specific embodiment, three capacitors 30 are connected in series on the single-path metal conduction band 20, as shown in Fig. 1. Preferably, a plurality of capacitors 30 are connected in series, so that the low-frequency resonance can be accurately adjusted, fine adjustments can be reliably realized, and the requirements on a low-frequency resonance point can be fully met.

[0025] As shown in Fig. 1, the clearance area 1a is arranged at an edge of the PCB 10, and the terminal end and the excitation end of the single-path metal conduction band 20 are located near an opening side of the clearance area 1a, so that a distance between the single-path metal conduction band 20 and the non-clearance area 2a in a direction perpendicular to the opening side can be increased, thereby the single-path metal conduction band 20 is located far away from the metal, further optimizing the operating performance of the antenna.

[0026] Fig. 1 only shows one specific shape of the clearance area 1a, and the shape of the clearance area 1a is not limited to the square shape in the figure, and can also be a semicircular shape, an irregular shape, etc., as long as the PCB 10 can be fully utilized and the utilization rate of the clearance area 1a can be optimized.

[0027] Further, as shown in Fig. 1, the dual-frequency antenna further includes a microstrip line 40 disposed in the non-clearance area 2a. The excitation end of the single-path metal conduction band 20 is electrically connected to the microstrip line 40, so as to be connected to a radio frequency chip or other devices through the microstrip line 40.

[0028] Based on the above embodiments, the dual-frequency antenna further includes a test connector, which is connected in series with the capacitor 30 on the single-path metal conduction band 20 and is arranged close to the excitation end of the single-path metal conduction band 20.

[0029] In a specific embodiment, the test connector is a resistor with a resistance value of zero. The resistor is used to form the connection end for testing the dual-frequency antenna.

[0030] Based on the above structure, the dual-frequency antenna can achieve dual-frequency resonance merely by means of a metal conduction band on which capacitors 30 are connected in series, and can solve the problems in the prior art that the space occupied by a multi-branch multi-path structure is large, its size is relatively large, and its resonant frequency band is difficult to adjust.

[0031] The performance of the dual-frequency antenna in the specific embodiment of the present invention is described below with reference to Figs. 2 and 3. Fig. 2 is a return loss curve of the dual-frequency antenna in the specific embodiment of the present invention, and Fig. 3 is a schematic diagram illustrating the efficiency of a dual-frequency antenna in an specific embodiment of the present application.

[0032] As shown in Fig. 2, the dual-frequency antenna with the above structure can achieve good electrical performance in a frequency band of 2.4 GHz-2.5 GHz and a frequency band of 5 GHz-5.8 GHz. As shown in Fig. 3, the efficiency of the dual-frequency antenna according to the present application can reach more than 80% in the frequency band of 2.4 GHz-2.5 GHz, and more than 40% in the frequency band of 5 GHz-5.8 GHz.

[0033] It should be noted that, in this application, relational terms such as first and second, and the like are merely used to distinguish one entity or operation from another entity or operation without necessarily requiring or implying any such actual relationship or order between such entities or operations. Also, the terms "comprise", "include," or any other variation thereof, are intended to cover a non-exclusive inclusion, such that a process, method, article, or apparatus that comprises a list of elements does not include only those elements but can include other elements not expressly listed or include elements inherent to inherent to such process, method, article, or apparatus. Without further limitation, an element defined by the phrase "comprising a ..." does not exclude the presence of other identical elements in the process, method, article, or apparatus that comprises said element.

[0034] The above description is only preferred embodiments of the present application and should not intended to limit the present application, and any modifications, equivalents, improvements and the like made within the spirit and principle of the present application should be included in the scope of the present application.

Claims

1. A dual-frequency antenna, comprising:

   a PCB provided with a clearance area and a non-clearance area;
   a single-path metal conduction band which is arranged within the clearance area and a terminal end of which is electrically connected to a ground end of the PCB; and
   a capacitor connected between an excitation end and the terminal end of the single-path metal conduction band.

2. The dual-frequency antenna of claim 1, wherein the dual-frequency antenna comprises a plurality of capacitors connected in series on the single-path metal conduction band.

3. The dual-frequency antenna of claim 1, wherein the clearance area is arranged at an edge of the PCB, and the terminal end and the excitation end of the single-path metal conduction band are located near an opening side of the clearance area.

4. The dual-frequency antenna of claim 1, wherein the dual-frequency antenna further comprises a microstrip line which is disposed in the non-clearance area and to which the excitation end of the single-path metal conduction band is electrically connected.

5. The dual-frequency antenna of any one of claims 1 to 4, wherein the dual-frequency antenna further comprises:
   a test connector connected in series with the capacitor on the single-path metal conduction band and arranged close to the excitation end of the single-path metal conduction band.

6. The dual-frequency antenna of claim 5, wherein the test connector is a resistor which is connected in series on the single-path metal conduction band and whose resistance value is zero.

7. The dual-frequency antenna of claim 1, wherein the single-path metal conduction band is arranged within the clearance area in a stacked reciprocating manner.

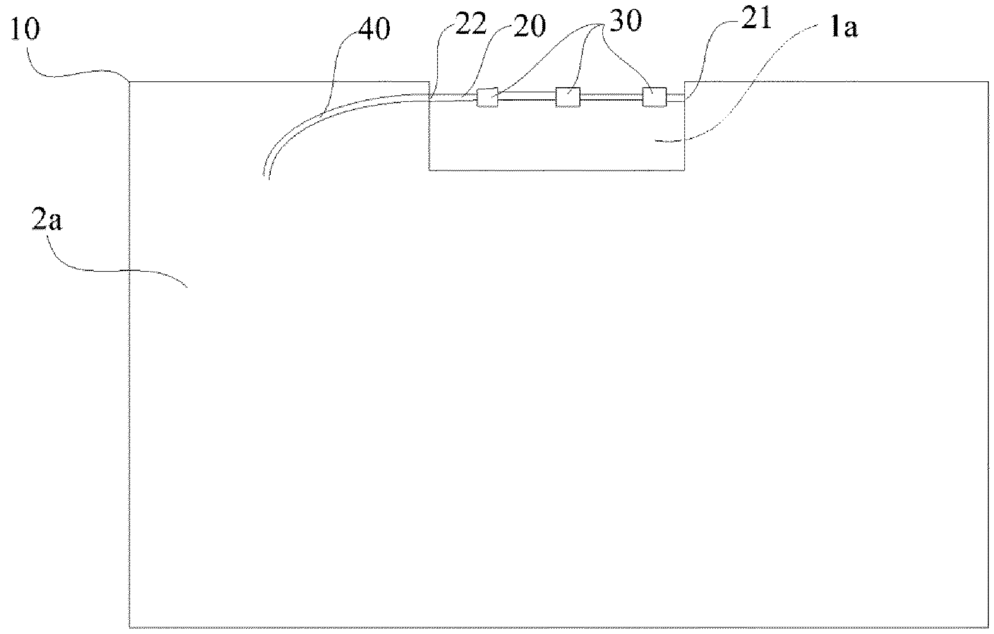

Fig. 1

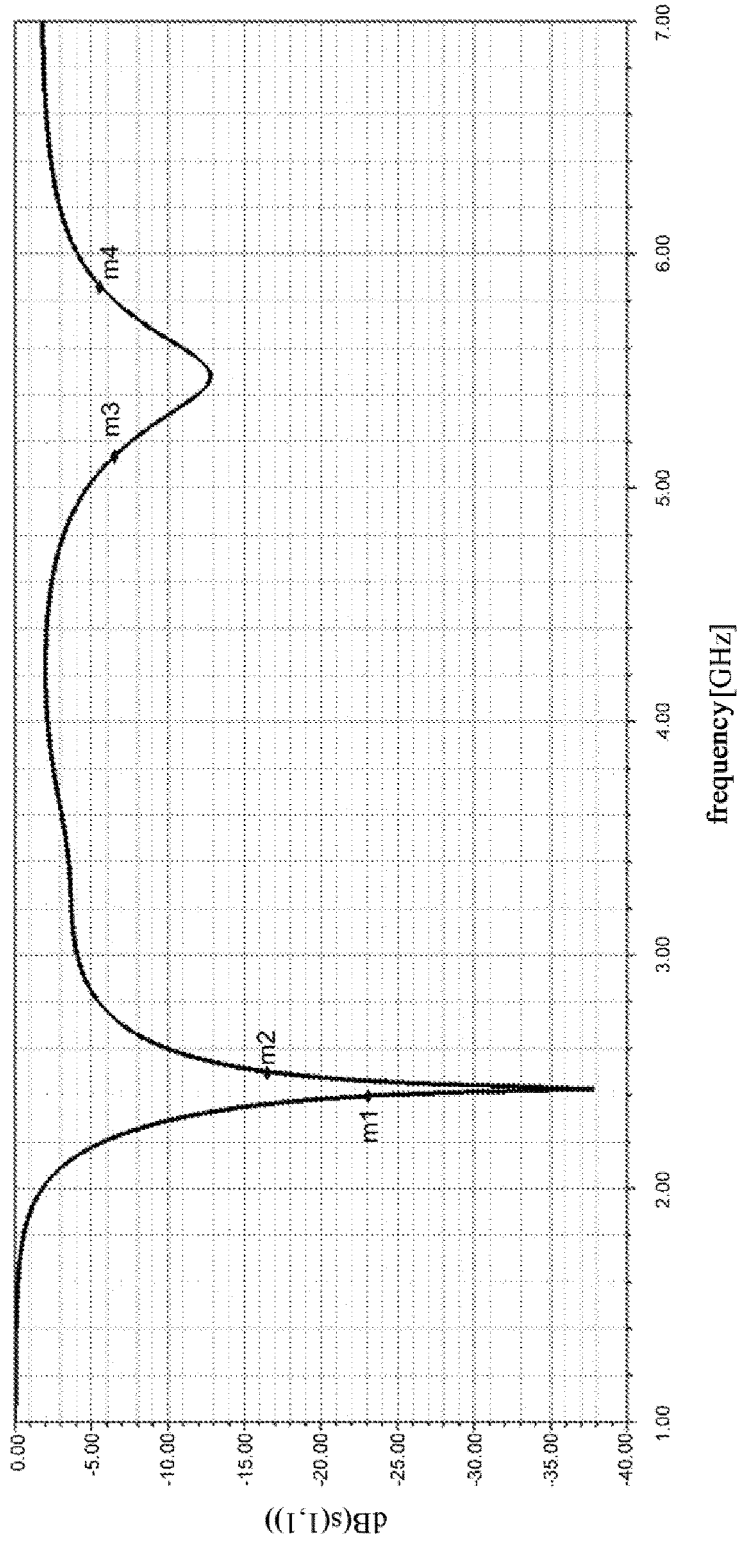
m1
m2
m3
m4
frequency[GHz]
dB(s(1,1))
1.00
2.00
3.00
4.00
5.00
6.00
7.00
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
-35.00
-40.00

Fig. 2

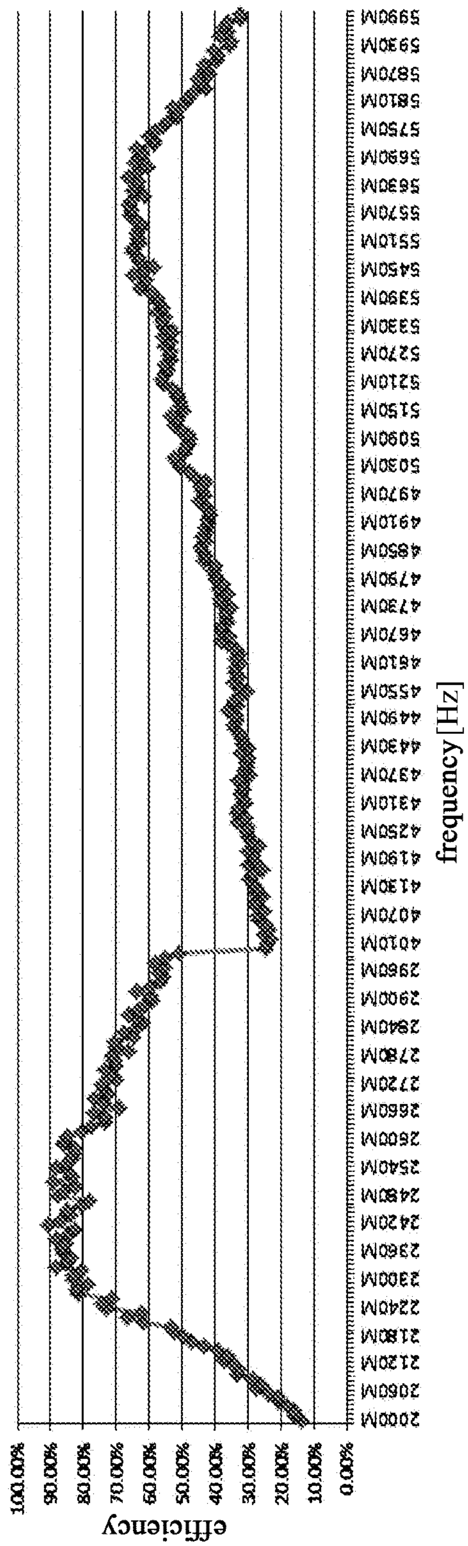
efficiency
100.00%
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
2000M
2060M
2120M
2180M
2240M
2300M
2360M
2420M
2480M
2540M
2600M
2660M
2720M
2780M
2840M
2900M
2960M
4010M
4070M
4130M
4190M
4250M
4310M
4370M
4430M
4490M
4550M
4610M
4670M
4730M
4790M
4850M
4910M
4970M
5030M
5090M
5150M
5210M
5270M
5330M
5390M
5450M
5510M
5570M
5630M
5690M
5750M
5810M
5870M
5930M
5990M
frequency [Hz]

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No. **PCT/CN2019/129245**

A. CLASSIFICATION OF SUBJECT MATTER

H01Q 1/38(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H01Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNPAT, CNKI, WPI, EPODOC: 天线, 地, 导线, 金属, 电容, 馈电, 馈入, 馈点, 双频, antenna, ground+, line, metal, capacitance, capacitor, feed+, dual, double, frequency, band

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 209329151 U (HANGZHOU HIKVISION DIGITAL TECTECHNOLOGY CO., LTD.) 30 August 2019 (2019-08-30) claims 1-7	1-7
X	CN 102771008 A (QUALCOMM INC.) 07 November 2012 (2012-11-07) description, paragraphs [0029]-[0038] and figure 1	1-7
A	CN 104795628 A (SHANGHAI AMPHENOL AIRWAVE COMMUNICATION ELECTRONICS CO., LTD) 22 July 2015 (2015-07-22) entire document	1-7
A	CN 103441333 A (LIU, Yang) 11 December 2013 (2013-12-11) entire document	1-7
A	CN 202487756 U (HUIZHOU TCL MOBILE COMMUNICATION CO., LTD.) 10 October 2012 (2012-10-10) entire document	1-7
A	CN 102055076 A (WU, Guangxiu) 11 May 2011 (2011-05-11) entire document	1-7
A	US 2010026596 A1 (KABUSHIKI KAISHA TOSHIBA) 04 February 2010 (2010-02-04) entire document	1-7

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed
- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
03 March 2020	**26 March 2020**
Name and mailing address of the ISA/CN **China National Intellectual Property Administration (ISA/CN) No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088 China**	Authorized officer
Facsimile No. **(86-10)62019451**	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2019/129245

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	209329151	U	30 August 2019	None			
CN	102771008	A	07 November 2012	TW	201203694	A	16 January 2012
				KR	20150018757	A	24 February 2015
				KR	20110093598	A	18 August 2011
				TW	201203693	A	16 January 2012
				CN	102771009	A	07 November 2012
				KR	20150018756	A	24 February 2015
				KR	20110093599	A	18 August 2011
				CN	102696146	A	26 September 2012
				KR	20110093597	A	18 August 2011
				TW	201203692	A	16 January 2012
				WO	2011099692	A2	18 August 2011
				WO	2011099693	A2	18 August 2011
				WO	2011099694	A2	18 August 2011
				WO	2011099673	A1	18 August 2011
				US	2011193762	A1	11 August 2011
				US	2014062820	A1	06 March 2014
				US	2011193757	A1	11 August 2011
				US	2011210898	A1	01 September 2011
				US	2014035788	A1	06 February 2014
				KR	20110113576	A	17 October 2011
				KR	20170057221	A	24 May 2017
CN	104795628	A	22 July 2015	None			
CN	103441333	A	11 December 2013	None			
CN	202487756	U	10 October 2012	None			
CN	102055076	A	11 May 2011	None			
US	2010026596	A1	04 February 2010	JP	2010041071	A	18 February 2010

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- CN 201920139308 **[0001]**