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

(11) EP 2 343 776 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
13.07.2011 Bulletin 2011/28

(51) Int Cl.:
H01Q 13/16 *(2006.01)*

(21) Application number: **10197121.6**

(22) Date of filing: **28.12.2010**

(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

(30) Priority: **07.01.2010 CN 201010001612**

(71) Applicant: **Huawei Device Co., Ltd.**
Shenzhen, Guangdong 518129 (CN)

(72) Inventors:
- **Zou, Yanyan**
  Shenzhen Guangdong 518129 (CN)
- **Lan, Yao**
  Shenzhen Guangdong 518129 (CN)
- **Sun, Shuhui**
  Shenzhen Guangdong 518129 (CN)
- **Lei, Ping**
  Shenzhen Guangdong 518129 (CN)
- **Li, Zhenghao**
  Shenzhen Guangdong 518129 (CN)
- **Ban, Yongling**
  Shenzhen Guangdong 518129 (CN)

(74) Representative: **Barth, Stephan Manuel**
Reinhard, Skuhra, Weise & Partner GbR
Patent- und Rechtsanwälte
Friedrichstrasse 31
80801 München (DE)

(54) Slot antenna, terminal and method for adjustment parameter of slot antenna

(57) This application belongs to the field of antenna, and discloses a slot antenna, a terminal and a method for adjusting a parameter of the slot antenna. The slot antenna includes a board, a coupling chip and a feed point. A semi-closed slot area is formed on one side of the board. The coupling chip is located in the semi-closed slot area, and forms a slot with a lower wall and a side wall of the semi-closed slot area. The feed point is located in the slot formed between the coupling chip and the side wall. The method includes: adjusting at least one of the size of the slot, the size of the semi-closed slot area, the size of the coupling chip, and the number of layers of the coupling chip so as to obtain the corresponding resonant frequency and bandwidth. The terminal includes the slot antenna. The present invention enables the uniform distribution of the current on the board, thus achieving better omni-directional radiation feature, and the antenna size is smaller, thus occupying smaller area on a baseboard and leaving more area for other components.

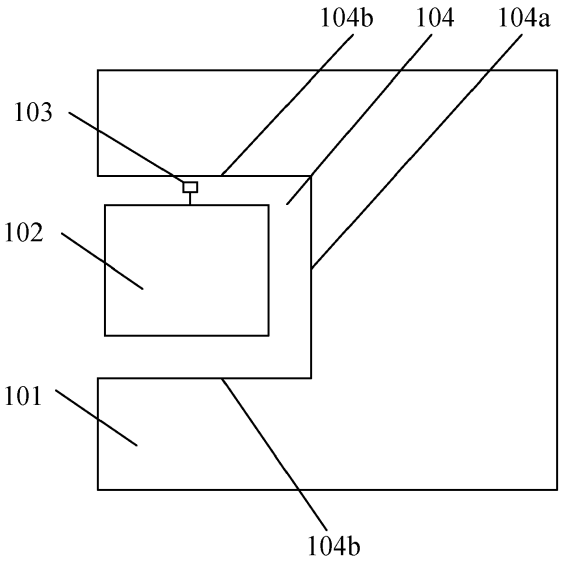

FIG. 2

EP 2 343 776 A1

Description

FIELD OF THE INVENTION

[0001] The present invention relates to the field of antenna, and more particularly to a slot antenna, a terminal and a method for adjusting a parameter of a slot antenna.

BACKGROUND OF THE INVENTION

[0002] A wireless terminal, especially a fixed Wireless Local Area Network (WLAN) Access Point (AP), Worldwide Interoperability for Microwave Access (WIMAX) terminal, a wireless fixed station and the like, needs an omni-directional small antenna.

[0003] Currently, an antenna formed by a slot cut out on the board is available, which is called a slot antenna. Referring to FIG. 1, a typical slot is rectangular, with the length of approximately half a wavelength, and the slot is generally located in the central part of the board, the area around slot is the board. A radio frequency electromagnetic field is excited on the slot, and the slot radiates electromagnetic waves. Upon measurement, a horizontal pattern view of the slot is roughly the same as the broken lines shown in FIG. 1.

[0004] During the conception of the present invention, the inventor finds that the prior art has at least the following drawbacks. The omni-directional radiation feature of the current slot antenna is poor, and the size of the slot antenna is big, occupying a large area of the baseboard.

SUMMARY OF THE INVENTION

[0005] To improve the omni-directional radiation feature of the antenna and decrease the size of the antenna, the present invention is directed to a slot antenna, a terminal and a method for adjusting a parameter of the slot antenna. The technical solutions are described as follows.

[0006] A slot antenna is provided, which includes a board, a coupling chip, and a feed point; where

a semi-closed slot area is formed on one side of the board;
the coupling chip is in the semi-closed slot area and forms a slot with a side wall and a lower wall of the semi-closed slot area; and
the feed point is located in the slot formed between the coupling chip and the side wall.

[0007] A terminal is provided, which includes a slot antenna, and the slot antenna includes a board, a coupling chip, and a feed point; where

a semi-closed slot area is formed on one side of the board;
the coupling chip is in the semi-closed slot area and forms a slot with a side wall and a lower wall of the semi-closed slot area; and
the feed point is located in the slot formed between the coupling chip and the side wall.

[0008] A method for adjusting a parameter a slot antenna is provided, where the method includes:

obtaining a parameter of the slot antenna, and the parameter includes resonant frequency and/or bandwidth;
adjusting, according to the resonant frequency, at least one of a size of the slot, a size of the semi-closed slot area, a size of the coupling chip, and the number of layers of the coupling chip; and
adjusting, according the bandwidth, at least one of the size of the slot and the number of layers of the coupling chip.

[0009] The technical solutions according to the present invention have the following benefits.

[0010] By opening a semi-closed slot area on the board and setting a coupling chip in the semi-closed slot area, a slot is formed between the edges around the coupling chip and the board, so that the uniform distribution of the current on the board and better omni-directional radiation feature are achieved. The semi-closed slot area is at the edge of the board, and therefore the antenna is smaller. In addition, when the current slot antenna intends to obtain a low resonant frequency, the slot has to be enlarged, that is, the size of the antenna has to be increased, however, the present invention can achieve obtaining the low resonant frequency as well as decreasing the size of the antenna by enlarging the coupling chip, increasing the number of layers of the coupling chip, and/or diminishing the slot when the size of the semi-closed slot area is kept unchanged or is smaller, thus occupying a smaller area on a baseboard and leaving more area for other components.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

FIG. 1 is a schematic structural view and a directional diagram of a slot antenna in the prior art;
FIG. 2 is a schematic structural view of a slot antenna according to an embodiment of the present invention;
FIG. 3 is a separated schematic structural view of a slot antenna with multilayer coupling chip according to an embodiment of the present invention;
FIG. 4 is a directional diagram of a slot antenna according to an embodiment of the present invention; and
FIG. 5 is a flow chart of a method for adjusting a parameter of a slot antenna according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0012] In order to make the objectives, technical solution and merits of the present invention clearer, a detailed description of the present invention is given below with reference to the accompanying drawings.

[0013] Referring to FIG. 2, the present invention provides a slot antenna, which includes a board 101, a coupling 102, and a feeding 103; where

a semi-closed slot area 104 is formed on one side of the board 101;

the coupling chip 102 is located in the semi-closed slot area 104 and forms a slot with a lower wall 104a and a side wall 104b of the semi-closed slot area;

where the edge of the semi-closed slot area 104 opposite to an opening of the semi-closed slot area 104 is called the lower wall 104a, and the edge of the semi-closed slot area 104 that is extended from the lower wall 104a to the two flanks is called the side wall 104b; and

the feed point 103 is located in the slot formed between the coupling chip 102 and the side wall 104b.

[0014] The present invention provides a slot antenna. By opening a semi-closed slot area on the board and setting a coupling chip in the semi-closed slot area, a slot is formed between the edges of the coupling chip and the board, so that the uniform distribution of the current on the board and better omni-directional radiation feature is achieved. The semi-closed slot area is at the edge of the board, and therefore the antenna is smaller, occupying a smaller area on a baseboard and leaving more area for other components.

[0015] The shape of the coupling chip 102 may be rectangle, hexagon and other forms, and is not limited in this embodiment. The coupling chip may have one layer or more, and when the coupling chip has multiple layers, the different layers of the coupling chip may be identical or different. FIG. 3 is a separated schematic structural view of a multilayer coupling chip, and when being assembled, the first layer of coupling chip 1021 and the second layer of coupling chip 1022 are overlapped, with a certain interval there-between vertically. When the couplings chips have different shapes, the radiation feature of the slot antenna is better.

[0016] A distance from the feed point 103 to the edge of the opening of the semi-closed slot area 104 is shorter than three-fifths of a distance of one side of the coupling chip 102 extending from the edge of the opening to the lower wall 104a, and such a structure is beneficial to the radiation feature of the antenna. In addition, the feeding modes of the slot antenna through the feed point 103 include, but are not limited to, connecting the feed point 103 with the coupling chip 102 and the feed line respectively, or feeding, at the feed point 103, through a transmission line that straddles the slot.

[0017] The shape of the semi-closed slot area 104 may include rectangle, semicircle, U-shape, V-shape and other shapes, and is not limited in this embodiment.

[0018] In another embodiment, the slot antenna may include matching components that may be respectively connected with the feed point 103 and a feed line, and/or, respectively connected with the coupling chip 102 and the board 101.

[0019] In another embodiment, the slot antenna may be set on a baseboard, and the baseboard may specifically be a Printed Circuit Board (PCB).

[0020] The present invention provides a slot antenna. By opening a semi-closed slot area on the board and setting a coupling chip in the semi-closed slot area, a slot is formed between the edges of the coupling chip and the board, so that the uniform distribution of the current on the board is achieved. FIG. 4 shows a directional diagram of measurement or emulation, and compared with the prior art, the antenna according to the present invention has better omni-directional radiation feature. When the current slot antenna intends to obtain a low resonant frequency, the slot has to be enlarged, that is, the size of the antenna has to be increased, however, the present invention can achieve obtaining the low resonant frequency as well as decreasing the size of the antenna by enlarging the coupling chip, increasing the number of layers of the coupling chip, and/or diminishing the slot when the size of the semi-closed slot area is kept unchanged or is smaller. Meanwhile, the slot is set at the edge of the board according to the present invention so that the antenna is smaller, and thus the antenna occupies a smaller area on a baseboard, and leaving more area for other components. Moreover, the present invention provides a slot antenna. The slot may be set wide, and multiple resonant modes could be achieved by slot coupling. The slot antenna possesses an ultra-bandwidth feature, and thus has a lower demand for the processing precision and thickness, has good consistency, and is easy to debug.

[0021] In another embodiment, the present invention further provides a terminal, which includes a slot antenna according to the present invention. As for the slot antenna and the technical effect of the slot antenna, the detailed descriptions are made foregoing, and the details will not be described herein again. Moreover, the terminal may include a wireless gateway, a fixed station, or a network card.

[0022] Referring to FIG. 5, based on the slot antenna according to an embodiment of the present invention, the present invention further provides a parameter adjustment method of the slot antenna, where the method includes:

201: obtaining parameters of the slot antenna, where the parameters include resonant frequency and/or bandwidth;

202: adjusting, according to the resonant frequency, at least one of a size of slot, a size of the semi-closed slot area, a size of the coupling chip, and the number

of layers of the coupling chip; adjusting, according the bandwidth, at least one of the size of the slot and the number of layers of the coupling chip.

[0023] The lower the resonant frequency of the slot antenna is demanded, the bigger the proportion of the semi-closed slot area 104 may be set, and at this time, if the slot is enlarged with the size of the coupling chip kept unchanged, the resonant frequency will be higher, however, since the proportion of the semi-closed slot area poses a greater effect on the resonant frequency of the antenna, the resonant frequency as a whole is still lowered. Accordingly, the higher the resonant frequency of the slot antenna is demanded, the smaller the proportion of the semi-closed area 104 may be set.

[0024] The lower the resonant frequency of the slot antenna is demanded, the bigger the area of the coupling chip 102 may be set. Accordingly, the higher the resonant frequency is demanded, the smaller the area of the coupling chip 102 may be set.

[0025] The lower the resonant frequency of the slot antenna and the wider the bandwidth are demanded, the more the number of layers of the coupling chip 102 may be set. Accordingly, the higher the resonant frequency and narrower the bandwidth are demanded, the less the number of layers of the coupling chip 102 may be set.

[0026] The higher the resonant frequency of the slot antenna and the wider the bandwidth are demanded, the bigger the slot may be set. Accordingly, the lower the resonant frequency of the slot antenna and the narrower the bandwidth are demanded, the smaller the slot may be set.

[0027] Compared with the current slot antenna, which achieves obtaining low resonant frequency only by enlarging the slot, that is, increasing the size of the antenna, the method according to the present invention achieves obtaining low resonant frequency as well as decreasing the size of the antenna by enlarging the coupling chip, increasing the number of layers of the coupling chip, and/or diminishing the slot when the semi-closed slot area is kept unchanged or is smaller, thus occupying a smaller area on the baseboard and leaving more area for other components.

[0028] The above descriptions are merely some exemplary embodiments of the present invention, but are not intended to limit the present invention. Any modification, equivalent replacement, or improvement made without departing from the principle of the present invention shall fall within the scope of the present invention.

Claims

1. A slot antenna, comprising a board, a coupling chip, and a feed point, wherein
   a semi-closed slot area is formed on one side of the board;
   the coupling chip is in the semi-closed slot area and forms a slot with a side wall and a lower wall of the semi-closed slot are; and
   the feed point is located in the slot formed between the coupling chip and the side wall.

2. The slot antenna according to claim 1, wherein a distance from the feed point to an edge of an opening of the semi-closed slot area is shorter than three-fifths of a distance of one side of the coupling chip extending from the edge of the opening to the lower wall.

3. The slot antenna according to claim l, wherein the coupling chip has one layer or more, and when the coupling chip has multiple layers, the different layers of the coupling chip have identical or different shapes.

4. The slot antenna according to claim l, wherein the slot antenna further comprises matching components, and
   the matching components are respectively connected with the feed point and a feed line, and/or the matching components are respectively connected with the coupling chip and the board.

5. A terminal, comprising a slot antenna, wherein the slot antenna comprises a board, a coupling chip, and a feed point;
   a semi-closed slot area is formed on one side of the board;
   the coupling chip is in the semi-closed slot area and forms a slot with a side wall and a lower wall of the semi-closed slot area; and
   the feed point is located in the slot formed between the coupling chip and the side wall.

6. The terminal according to claim 5, wherein a distance from the feed point to an edge of an opening of the semi-closed slot area is shorter than three-fifths of a distance of one side of the coupling chip extending from the edge of the opening to the lower wall.

7. The terminal according to claim 5, wherein the coupling chip has one layer or more, and when the coupling chip has multiple layers, the different layers of the coupling chip have identical or different shapes.

8. The terminal according to claim 5, wherein the slot antenna further comprises matching components, and
   the matching components are respectively connected with the feed point and a feed line, and/or the matching components are respectively connected with the coupling chip and the board.

9. The terminal according to claim 5, wherein the terminal comprises a wireless gateway, a fixed station,

or a network card.

10. A method for adjusting a parameter of a slot antenna according to any one of claims 1 to 9, the method comprising:

obtaining parameters of the slot antenna, wherein the parameters comprise resonant frequency and/or bandwidth;
adjusting, according to the resonant frequency, at least one of a size of the slot, a size of the semi-closed slot area, a size of the coupling chip, and the number of layers of the coupling chip; and
adjusting, according the bandwidth, at least one of the size of the slot and the number of layers of the coupling chip.

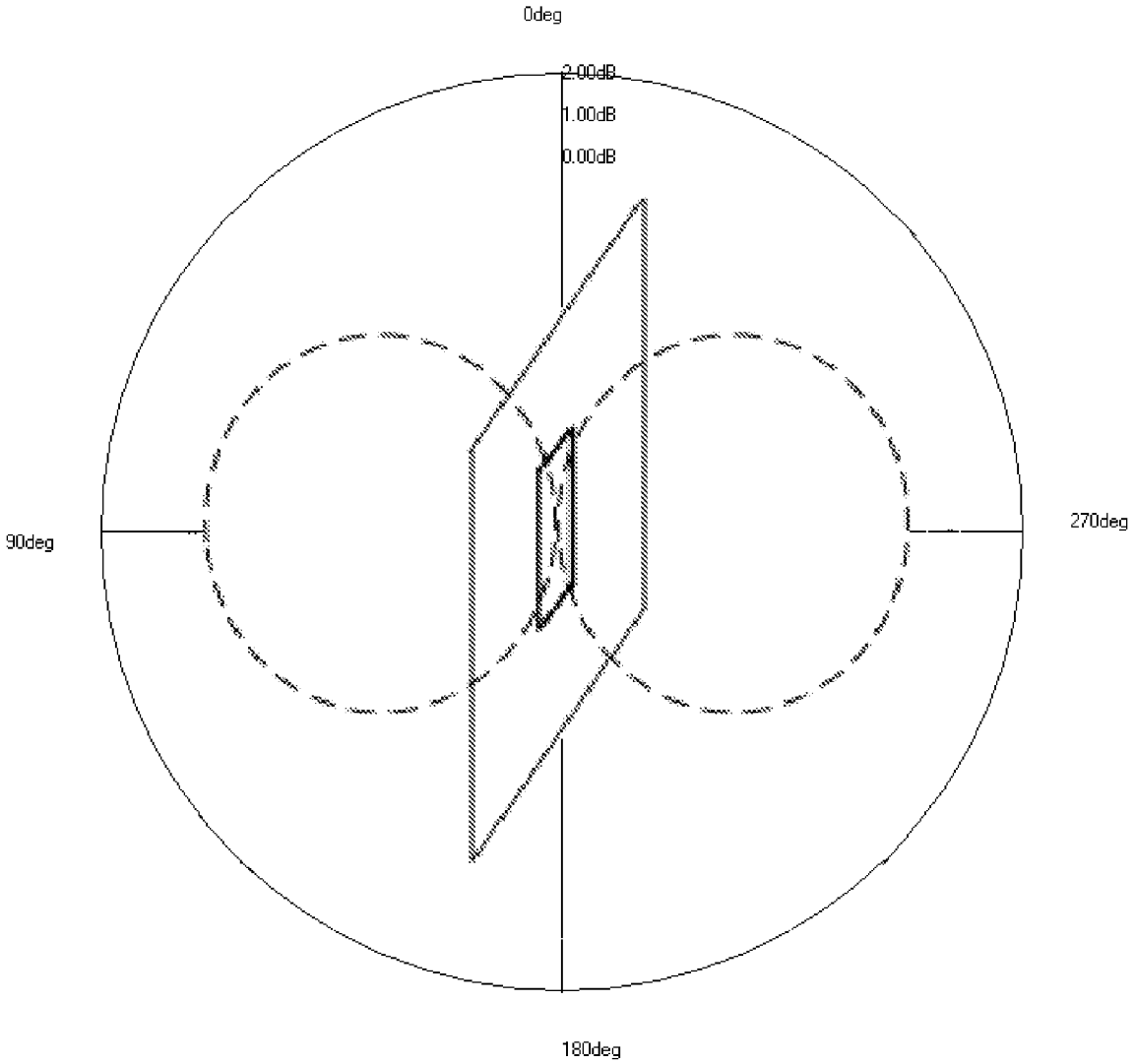

FIG. 1

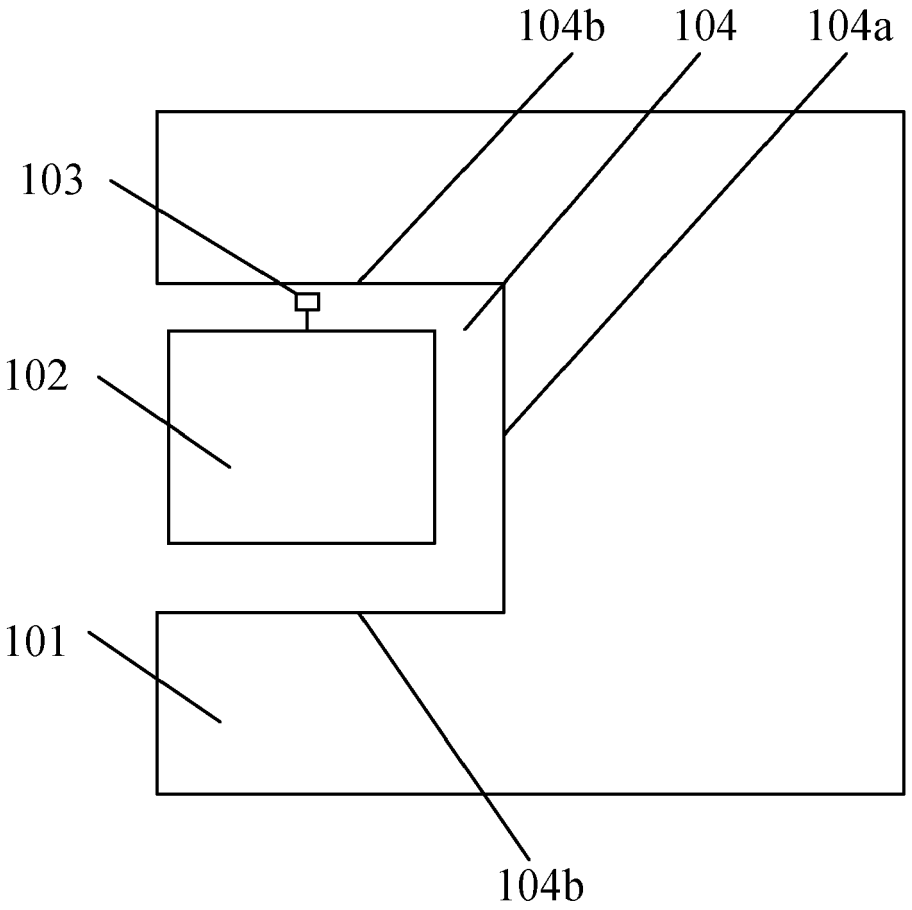

FIG. 2

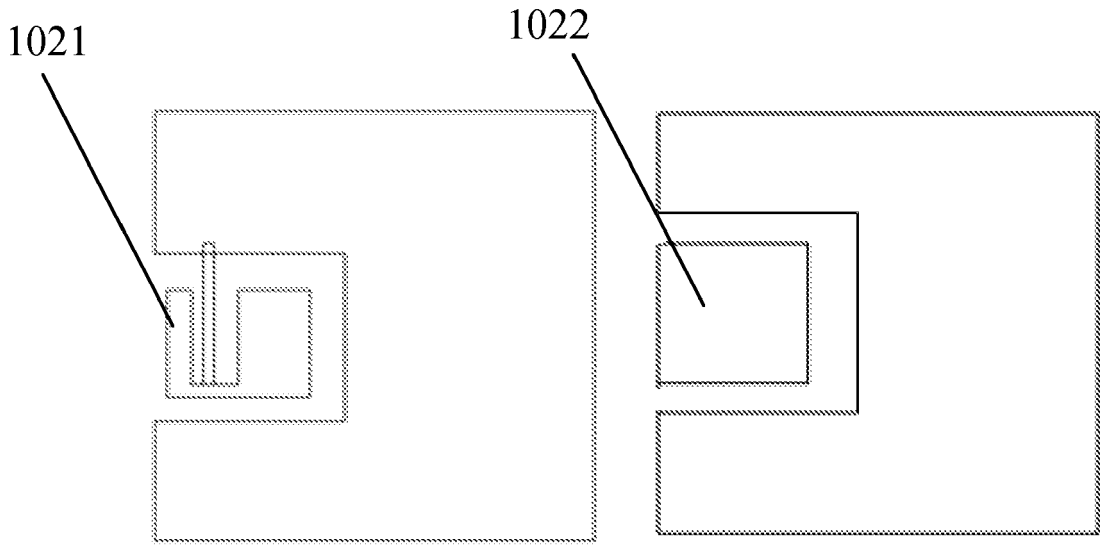

FIG. 3

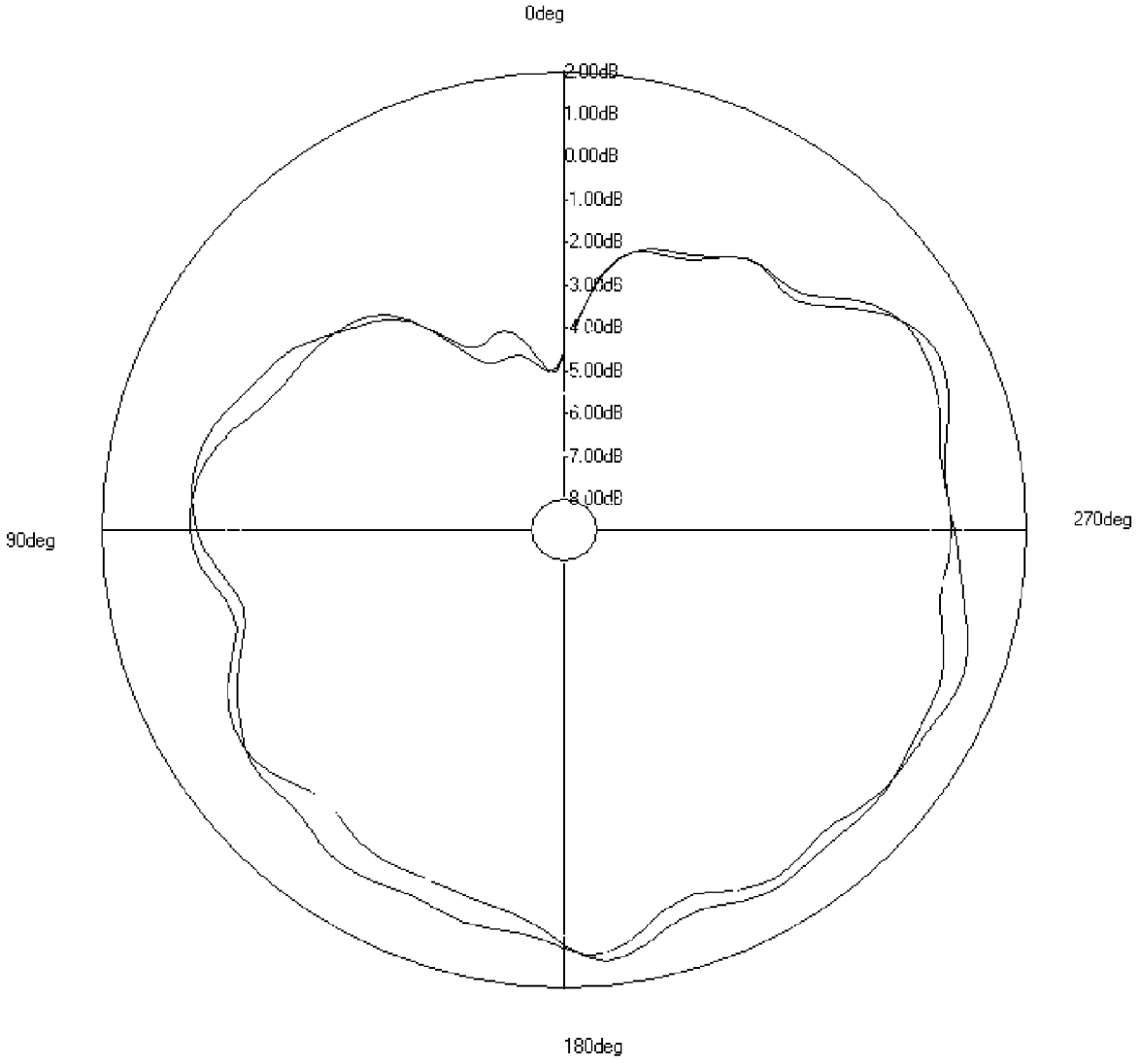
0deg
2.00dB
1.00dB
0.00dB
-1.00dB
-2.00dB
-3.00dB
-4.00dB
-5.00dB
-6.00dB
-7.00dB
-8.00dB
90deg
270deg
180deg

FIG. 4

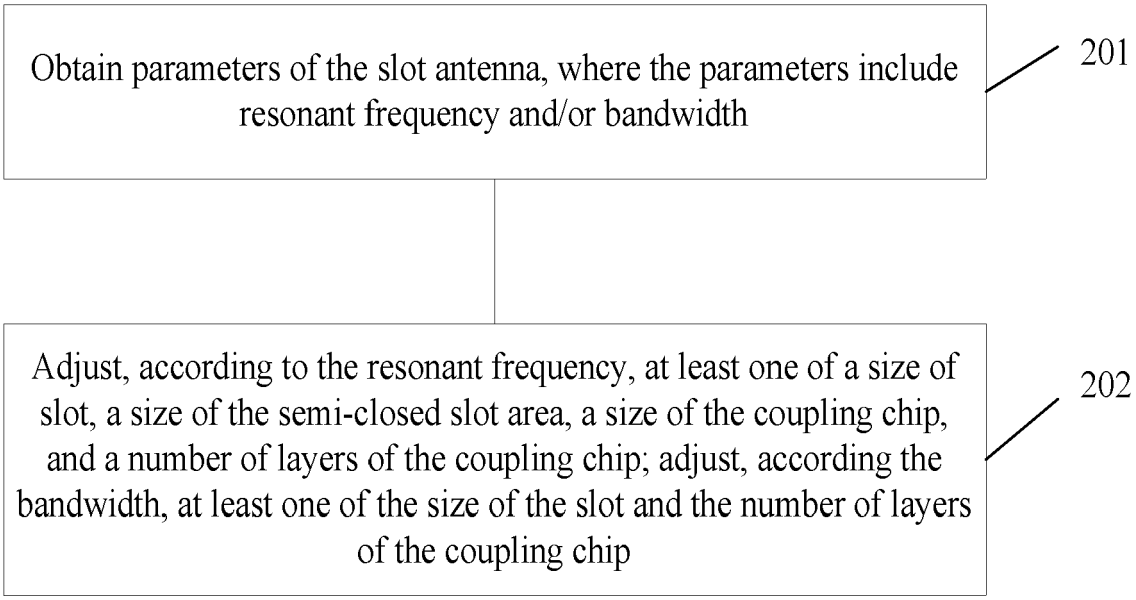
Obtain parameters of the slot antenna, where the parameters include resonant frequency and/or bandwidth
201
Adjust, according to the resonant frequency, at least one of a size of slot, a size of the semi-closed slot area, a size of the coupling chip, and a number of layers of the coupling chip; adjust, according the bandwidth, at least one of the size of the slot and the number of layers of the coupling chip
202

FIG. 5

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 10 19 7121

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2008/169989 A1 (LI QIAN [US] ET AL) 17 July 2008 (2008-07-17) * figure 2 * * paragraph [0026] - paragraph [0032] *	1-10	INV. H01Q13/16
X	US 5 404 146 A (RUTLEDGE DAVID B [US]) 4 April 1995 (1995-04-04) * figures 1,2 * * column 2, line 50 - column 3, line 29 *	1,3,5,7, 9,10	
X	US 2008/174498 A1 (JEAN JIN-TSANG [TW]) 24 July 2008 (2008-07-24) * figure 4 * * paragraph [0024] *	1,3,5, 7-9	
A	US 2001/050651 A1 (GRANGEAT CHRISTOPHE [FR] ET AL) 13 December 2001 (2001-12-13) * figure 1 * * paragraph [0047] - paragraph [0057] *	1-10	
A	US 6 097 345 A (WALTON ERIC K [US]) 1 August 2000 (2000-08-01) * figure 2 * * column 2, line 61 - column 4, line 37 *	1-10	TECHNICAL FIELDS SEARCHED (IPC) H01Q

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	18 February 2011	Unterberger, Michael

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 10 19 7121

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

18-02-2011

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2008169989 A1	17-07-2008	NONE	
US 5404146 A	04-04-1995	NONE	
US 2008174498 A1	24-07-2008	CN 101227202 A	23-07-2008
US 2001050651 A1	13-12-2001	AT 339018 T	15-09-2006
		AU 3125799 A	09-12-1999
		CA 2272007 A1	28-11-1999
		CN 1237807 A	08-12-1999
		DE 69933085 T2	12-04-2007
		EP 0961344 A1	01-12-1999
		FR 2779276 A1	03-12-1999
		JP 4118449 B2	16-07-2008
		JP 2000068731 A	03-03-2000
		TW 431028 B	21-04-2001
US 6097345 A	01-08-2000	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82