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

(11) EP 2 573 865 A1

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

(43) Date of publication:
27.03.2013 Bulletin 2013/13

(21) Application number: **11780211.6**

(22) Date of filing: **12.05.2011**

(51) Int Cl.:
H01P 3/08 *(2006.01)*

(86) International application number:
PCT/CN2011/073978

(87) International publication number:
WO 2011/140990 (17.11.2011 Gazette 2011/46)

(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

(30) Priority: **29.06.2010 CN 201010215927**

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(54) **FEED NETWORK AND ANTENNA**

(57) Embodiments of the present invention provide a feed network and an antenna, so as to reduce the passive intermodulation interference, and improve the reliability, stability, and mobile communication quality of the antenna. The feed network includes at least two separate radio frequency transmission areas. At least one of the radio frequency transmission areas includes at least two signal lines. The at least two separate radio frequency transmission areas are separated by a metal interlayer. One physical surface of the metal interlayer is exposed to one of the at le two separate radio frequency transmission areas, and the other physical surface of the metal interlayer is exposed to another one of the at least two separate radio frequency transmission areas. In the feed network of the present invention, the radio frequency transmission areas are separated by the metal interlayer without using any screw or rivet connection. Therefore, the passive intermodulation interference caused by the metal connection is reduced, which increases the reliability and stability of the antenna, enhances the RTWP or RSSI index of the system, and improves the mobile communication quality.

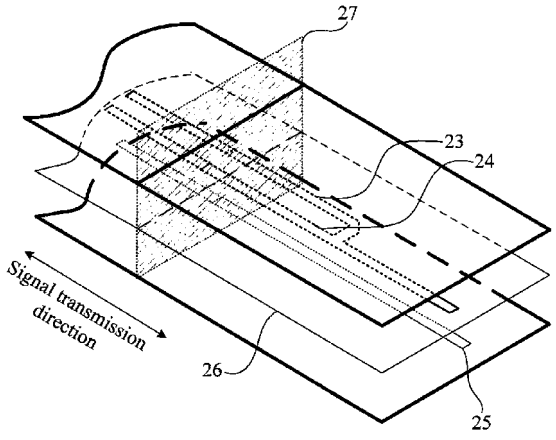

FIG. 2

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Description

[0001] This application claims priority to Chinese Patent Application No. 201010215927.9, filed with the Chinese Patent Office on June 29, 2010 and entitled "FEED NETWORK AND ANTENNA", which is incorporated herein by reference in its entirety.

FIELD OF TECHNOLOGY

[0002] The present invention relates to the field of wireless communication, and in particular, to a feed network and an antenna.

BACKGROUND

[0003] In wireless communication systems, as more and more voice and data information need to be transmitted within a fixed bandwidth, passive intermodulation (Passive InterModulation, PIM) becomes an important factor that limits the system capacity. PIM is a frequency interference caused by the non-linear characteristic of passive devices in an emission system. For example, in systems with great power and multiple channels, the non-linearity of the passive devices brings about higher harmonic waves relative to a working frequency. The mixture of the harmonic waves and the working frequency generates a new group of frequencies, which is similar to the generation of stray signals when two or more frequencies in an active device are mixed in a non-linear device. When a stray intermodulation signal falls in a receiving band of a base station, sensitivity of a receiver decreases, thereby decreasing voice quality or a system carrier-to-interface ratio (C/I), and reducing the capacity of a communication system. The PIM is caused by a lot of factors, including poor mechanical contact of a feed network.

[0004] A typical communication antenna includes several radiation elements, a feed network and a reflector. The function of the feed network is to allocate signals from a single connector to all dipole antennas. The feed network usually includes controlled impedance transmission lines.

[0005] For feed networks of multiband antennas and smart antennas, a method for separating multiple radio frequency transmission areas in the prior art is shown in FIG. 1. this method, a thin metal interlayer 2 and a thin interlayer 6 are used to separate adjacent radio frequency transmission area 7 and radio frequency transmission area 8. The metal interlayers are connected through a screw 11 and a screw 12.

[0006] With rapid development of the mobile communication market, the number of communication networks increases significantly, and operators have an increasingly stronger demand on multiband and multi-system shared antenna, and antenna miniaturization. The structure of the feed network of a multiband antenna and smart antenna is complex, and is critical to the reliability of the entire antenna. Therefore, a stable and reliable feed network with a compact structure is a necessary condition for ensuring multiband and multi-antenna performance.

[0007] However, the complex and excessive metal connections in the feed network in the prior art easily cause the PIM index of the antenna to be unstable and unreliable, and deteriorate the received total wide band power (RTWP, Received Total Wide band Power) or received signal strength indication (RSSI, Received Signal Strength Indication) of the system.

SUMMARY

[0008] Embodiments of the present invention provide a feed network and an antenna, so as to reduce the passive intermodulation interference, and improve the reliability, stability, and mobile communication quality of the antenna.

[0009] Embodiment of the present invention provides a feed network, including: at least two separate radio frequency transmission areas, at least one of the radio frequency transmission areas including at least two signal lines, where the at least two separate radio frequency transmission areas are separated by a metal interlayer, one physical surface of the metal interlayer is exposed to one of the at least two separate radio frequency transmission areas, and the other physical surface of the metal interlayer is exposed to another one of the at least two separate radio frequency transmission areas.

[0010] An embodiment of the present invention provides an antenna, including a feed network provided in the foregoing embodiment of the present invention.

[0011] In the feed network provided in the embodiment of the present invention, the radio frequency transmission areas are separated by a metal interlayer without using any screw or rivet connection. Therefore, passive intermodulation interference caused by the metal connection is reduced, which increases the reliability and stability of the antenna, enhances the RTWP or RSSI index of the system, and improves the mobile communication quality.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] To illustrate the technical solutions in the embodiments of the present invention more clearly, the accompanying drawings required for describing the embodiments are briefly described in the following. Apparently, the accompanying drawings in the following description merely show some embodiments of the present invention, and persons of ordinary skill in the art may still derive other drawings from the accompanying drawings without creative efforts.

[0013] FIG. 1 is a cross-sectional schematic diagram of a feed network according to the prior art;

[0014] FIG. 2 is a three-dimensional schematic diagram of a feed network structure according to Embodiment 1 of the present invention;

[0015] FIG 3 is a schematic diagram of a cross section, orthogonal to a signal transmission direction, of the feed

network in FIG. 2;

[0016] FIG. 4 is a schematic diagram of a cross section, orthogonal to a signal transmission direction, of a feed network according to Embodiment 2 of the present invention;

[0017] FIG 5 is a schematic diagram of a cross section, orthogonal to a signal transmission direction, of a feed network according to Embodiment 3 of the present invention;

[0018] FIG. 6 is a schematic diagram of a cross section, orthogonal to a signal transmission direction, of a feed network according to Embodiment 4 of the present invention;

[0019] FIG. 7 is a schematic diagram of a cross section, orthogonal to a signal transmission direction, of a feed network according to Embodiment 5 of the present invention; and

[0020] FIG. 8 is a schematic assembly diagram of a miltiband antenna according to an embodiment of the present invention.

DETAILED DESCRIPTION

[0021] The technical solutions in the embodiments of the present invention are clearly and completely described in the following with reference to the accompanying drawings in the embodiments of the present invention. Apparently, the embodiments to be described are merely a part rather than all of the embodiments of the present invention. All other embodiments obtained by persons of ordinary skill in the art based on the embodiments of the present invention without creative efforts shall fall within the protection scope of the present invention.

[0022] Referring to FIG. 2, FIG. 2 is a three-dimensional schematic diagram of a feed network structure according to Embodiment 1 of the present invention, and FIG 3 is a schematic diagram of a cross section 27, orthogonal to a signal transmission direction, of the feed network in PIG. 2.

[0023] In the embodiment shown in FIG. 2 or FIG. 3, a feed network includes at least two separate radio frequency transmission areas, which are a radio frequency transmission area 21 and a radio frequency transmission area 22. Signal lines, such as a signal line 23, a signal line 24, and a signal line 25, are included in each radio frequency transmission area. At least one radio frequency transmission area includes at least two signal lines. For example, the signal line 23 and the signal line 24 are included in the radio frequency transmission area 21.

[0024] Unlike the prior art in which two metal interlayers are connected through rivets or screws, in the embodiment of the present invention, the at least two separate radio frequency transmission areas in the feed network are separated by a metal interlayer 26. In the embodiment of the present invention, the metal interlayer 26 has a certain thickness. Therefore, one physical surface of the metal interlayer is exposed to one of the at least two separate radio frequency transmission areas, and the other physical surface of the metal interlayer is exposed to another one of the at least two separate radio frequency transmission areas. For example, one physical surface 261 of the metal interlayer 26 is exposed to the radio frequency transmission area 21 and the other physical surface 262 is exposed to the radio frequency transmission area 22.

[0025] The metal interlayer separates the radio frequency transmission without using any screw or rivet. Therefore, the feed network provided in the embodiment of the present invention is devoid of unstable PIM index caused by unreliable connection.

[0026] In consideration of information exchange required between two adjacent radio frequency transmission areas or coupling required between two radio frequency transmission areas, the exchange or coupling being either in a wireless manner or a wired manner, Embodiment 2 of the present invention provides another feed network.

[0027] Referring to FIG. 4, FIG. 4 is a schematic diagram of a cross section, orthogonal to a signal transmission direction, of a feed network according to Embodiment 2 of the present invention. In this embodiment, a metal interlayer includes several physically continuous metal interlayers, where a gap is between the several physically continuous metal interlayers. For example, in the feed network shown in FIG. 4, the metal interlayer 26 shown in FIG. 2 may be replaced by a metal interlayer 461 and a metal interlayer 462 that are physically continuous. The term "physically continuous" refers to that, although the metal interlayer 26 shown in FIG. 2 may be replaced by the metal interlayer 461 and the metal interlayer 462, the metal interlayer 461 and metal interlayer 462 are on the same plane, and may be regarded as one metal interlayer if a gap between the interlayers is filled. Because there is a gap between the interlayers, a signal line or signal may run through the gap, thereby implementing information exchange between two adjacent radio frequency transmission areas or coupling between two radio frequency transmission areas.

[0028] The feed network shown in FIG. 4 has an alternative solution, which is shown in FIG. 5. a feed network shown FI . 5, a metal interlayer 56 is still one metal interlayer, but different from the metal interlayer 26 shown in FIG. 2, the metal interlayer 56 includes a hole (indicated by the dashed line in FIG. 5), and a signal line or signal may also run through the hole, thereby still implementing information exchange between two adjacent radio frequency transmission areas or coupling between two radio frequency transmission areas.

[0029] In order to adjust an electrical property of a signal, for example, to adjust a resonance frequency, a metal object such as a aluminum alloy object, a zinc alloy object, or a copper object may be set in the gap (or hole) of the feed network shown in FIG. 4 (or FIG. 5); alternatively, a dielectric part such as FR4 material, microwave sheet material, PS (polystyrene), PTFE (polytetrafluor-

oethylene), PE (polyethylene), PA66 (polyamide) or POM (polyformaldehyde) is set in the gap (or hole). One part of the metal object or dielectric part is in one of the two separate radio frequency transmission areas, and the other part is in the other one of the two separate radio frequency transmission areas.

[0030] Taking the feed network shown in FIG. 4 as an example, a metal object or dielectric part may be set in the gap, as shown in FIG. 6. In the feed network shown in FIG. 6, one part of a metal object or dielectric part 69 is in the radio frequency transmission area 21, and the other part is in the radio frequency transmission area 22. Setting a metal object or dielectric part in the hole of the feed network shown in FIG. 5 is similar to setting a metal object or dielectric part in the gap of the feed network in FIG. 4, which is not described in detail.

[0031] To protect signals in the radio frequency transmission from interference or prevent signals in the radio frequency transmission area from interfering external signals, for example, generating electromagnetic leakage, the feed network shown in FIG. 2 to FIG. 6 may be made into a closed or semi-closed structure. For example, the radio frequency transmission area, except two ends of the signal transmission direction, is completely closed or partially closed. As shown in FIG. 7, the radio frequency transmission area 21 is partially closed, and the radio frequency transmission area 22 is completely closed.

[0032] In the feed network provided in the embodiment of the present invention, the radio frequency transmission areas are separated by the metal interlayer without using any screw or rivet connection, thereby reducing passive intermodulation interference caused by the metal connection, increasing the reliability and stability of the antenna, enhancing the RTWP or RSSI index of the system, and improving the mobile communication quality. Meanwhile, because the metal interlayer is a continuous material layer, no extra size is needed for connection. Therefore, the feed network provided in the present invention has a compact structure, establishes a necessary technical foundation for implementing miniaturization of antennas, especially for miniaturization of multiband and multi-system antennas, reduces the volume and wind load of the antenna, and lowers the requirement on the installation environment of the antenna.

[0033] The present invention also provides a wireless communication system antenna using the foregoing feed network, for example, a multiband antenna, a dual-polarized antenna, a long term evolution (Long Term Evolution, LTE) antenna, or a smart antenna. Referring to FIG. 8, FIG. 8 is an assembly schematic view of a multiband according to an embodiment of the present invention. To facilitate description, only the parts related to the present invention are shown. The antenna includes several radiation/receiving units 801, a feed network 803 provided in the embodiment of the present invention, a calibration network 804 and a dielectric part substrate 805. The radiation/receiving unit 801 are configured to radiate wireless signals to the outside or receive external wireless signals. The feed network 803 may be printed on the dielectric part substrate 805 and configured to allocate signals from a single connector to each of the radiation/receiving units 801. The calibration network 804 is configured to perform real-time calibration on an amplitude and a phase of each radiation/receiving unit 801 during operation of the antenna system.

[0034] In the feed network provided in the present invention, the radio frequency transmission areas are separated by a metal interlayer without using any screw or rivet connection, thereby reducing passive intermodulation interference caused by the metal connection, increasing the reliability and stability of the antenna, enhancing the RTWP or RSSI index of the system, and improving the mobile communication quality. Meanwhile, because the metal interlayer is a continuous material layer, no extra size is needed for connection. Therefore, the feed network, provided in the present invention has a compact structure, establishes a necessary technical foundation for implementing miniaturization of antennas, especially for miniaturization of multiband and multi-system antennas, reduces the volume and wind load of the antenna, and lowers the requirement on the installation environment of the antenna.

[0035] A feed network and an antenna provided in the embodiments of the present invention are described in detail. Specific cases are used for illustrating principles and embodiments of the present invention. The above descriptions of the embodiments are merely provided for better understanding of the method and core ideas of the present invention. Meanwhile, persons of ordinary skill in the art may make modifications to the embodiments and the application scope according to the idea of the present invention. In conclusion, the content of the specification shall not be construed as a limitation to the present invention.

Claims

1. A feed network, comprising: at least two separate radio frequency transmission areas, at least one of the radio frequency transmission comprising at least two signal lines, wherein the at least two separate radio frequency transmission areas are separated by a metal interlayer, one physical surface of the metal interlayer is exposed to one of the at least two separate radio frequency transmission areas, and the other physical surface of the metal interlayer is exposed to another one of the at least two separate radio frequency transmission areas.

2. The feed network according to claim 1, wherein the radio frequency transmission areas are completely closed except for two ends of a signal transmission direction.

3. The feed network according to claim 1, wherein the radio frequency transmission areas are partially closed except for two ends of a signal transmission direction.

4. The feed network according to claim 1, wherein the metal interlayer comprises several physically continuous metal interlayers, and a gap is between the several physically continuous metal interlayers.

5. The feed network according to claim 4, wherein a metal object is in the gap, one part of the metal object is in one of the at least two separate radio frequency transmission areas, and the other part is in another one of the at least two separate radio frequency transmission areas.

6. The feed network according to claim 4, wherein a dielectric part is in the gap, one part of the dielectric part is in one of the at least two separate radio frequency transmission areas, and the other part is in another one of the at least two separate radio frequency transmission areas.

7. The feed network according to claim 4, wherein the metal interlayer comprises a hole.

8. The feed network according to claim 7, wherein a metal object is in the hole, one part of the metal object is in one of the at least two separate radio frequency transmission areas, and the other part is in another one of the at least two separate radio frequency transmission areas.

9. The feed network according to claim 7, wherein a dielectric part is in the hole, one part of the dielectric part is in one of the at least two separate radio frequency transmission areas, and the other part is in another one of the at least two separate radio frequency transmission areas.

10. An antenna, comprising the feed network according to any one of claims 1 to 9.

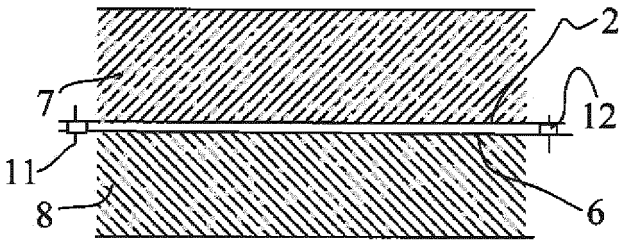

FIG. 1

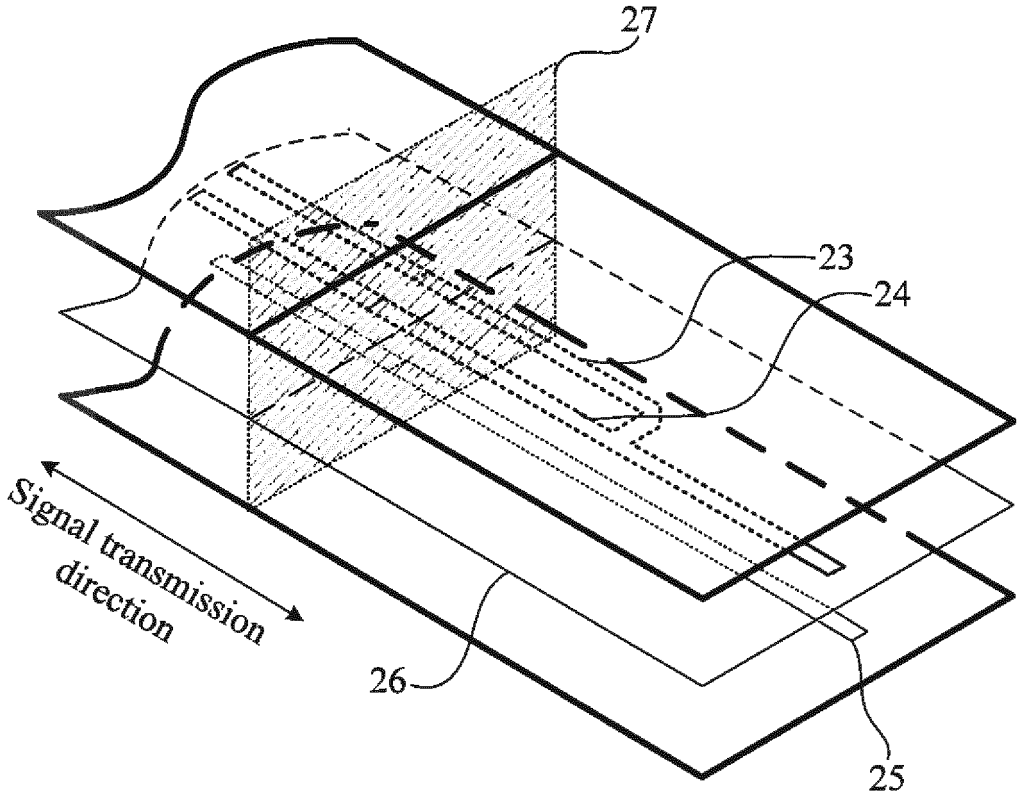

FIG. 2

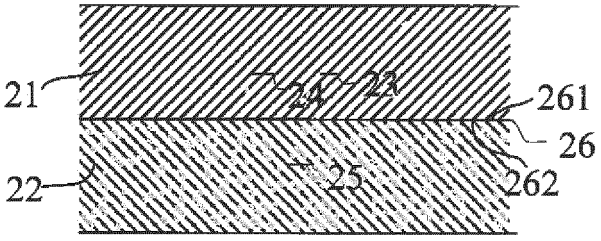

FIG. 3

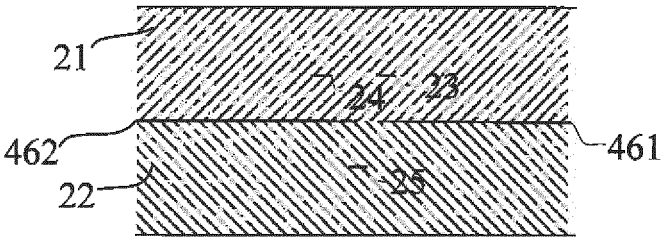

FIG. 4

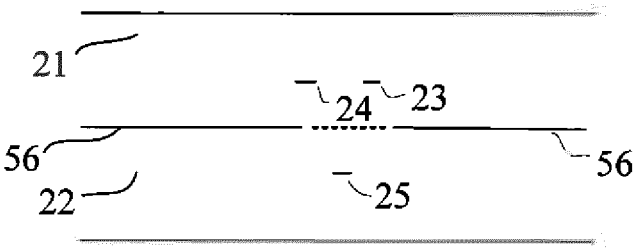

FIG. 5

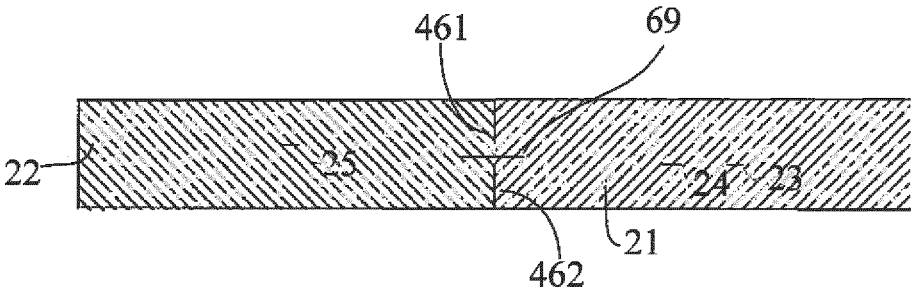

FIG. 6

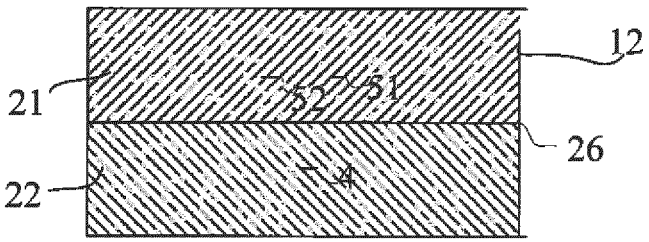

FIG. 7

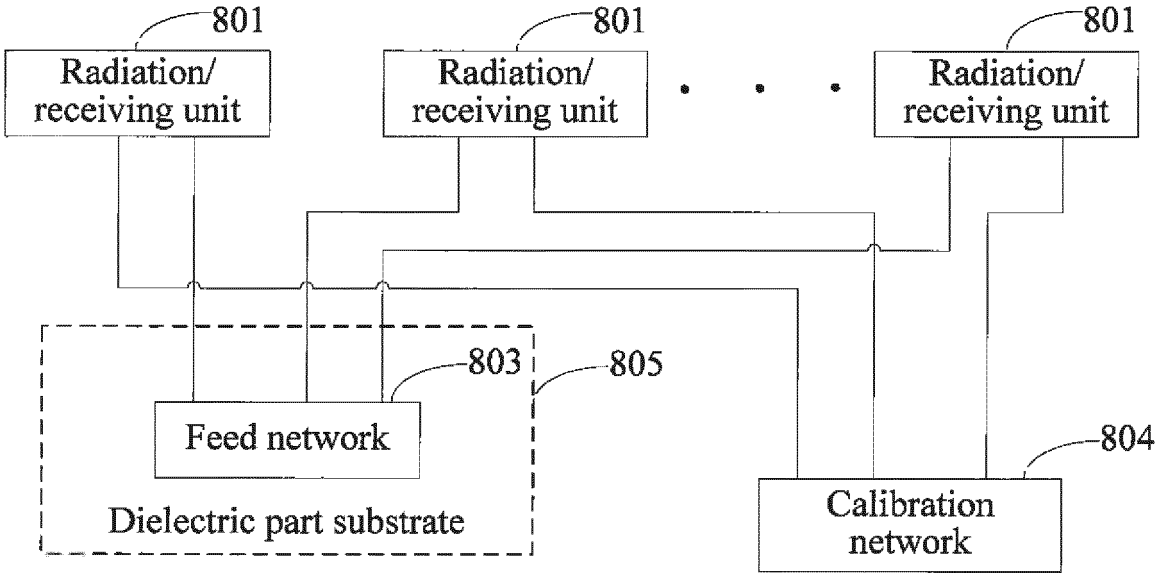
801
Radiation/
receiving unit
801
Radiation/
receiving unit
801
Radiation/
receiving unit
803
805
Feed network
Dielectric part substrate
804
Calibration
network

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2011/073978

A. CLASSIFICATION OF SUBJECT MATTER

H01P3/08 (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)

IPC：H01P

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)

WPI，EPODOC，VEN：feeder, network, radio, frequency, signal, line, metal, interlayer, separate, surface
CNKI, CNPAT, CNABS：

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN1431857A(SHARP KK) 23 July 2003(23.07.2003) description page 7, lines 12-19, figure 7	1-10

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

* Special categories of cited documents:

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"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
13 July 2011(13.07.2011)	**21 Jul. 2011 (21.07.2011)**
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer WU, Xunxun Telephone No. (86-10)62411512

Form PCT/ISA /210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2011/073978

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN1431857A	23.07.2003	JP2003204128A	18.07.2003
		CN1204787C	01.06.2005
		TW200304345A	16.09.2003
		JP2006279086A	12.10.2006
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		US7378599B2	27.05.2008
		JP4005105B2	07.11.2007
		TW591986B	11.06.2004

Form PCT/ISA /210 (patent family annex) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 201010215927 **[0001]**