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(54) PHASED-ARRAY ANTENNA AND ANTENNA MODULE

(57) The present disclosure, which relates to the field of antenna technology, provides a phased array antenna and an antenna module. The phased array antenna comprises an antenna array, a control system, a power supply system, a feed system and a transceiver module, the antenna array, the control system, the power supply system, the feed system and the transceiver module all being integrated on a same printed circuit board and arranged in layers, the antenna array and the control system being connected via a metal ground, the power supply system and the feed system being also connected via a metal ground, wherein the feed system is connected to the transceiver module, wherein the antenna array, the control system and the power supply system each are provided with a metallic hole penetrating to the transceiver module, the metallic hole being arranged at a distance from the metal ground, and wherein the antenna array, the control system and the power supply system each are connected to the transceiver module through the metallic hole. The phased array antenna and the antenna module provided in the present disclosure have the advantages of higher integration, smaller size, and lower cost.

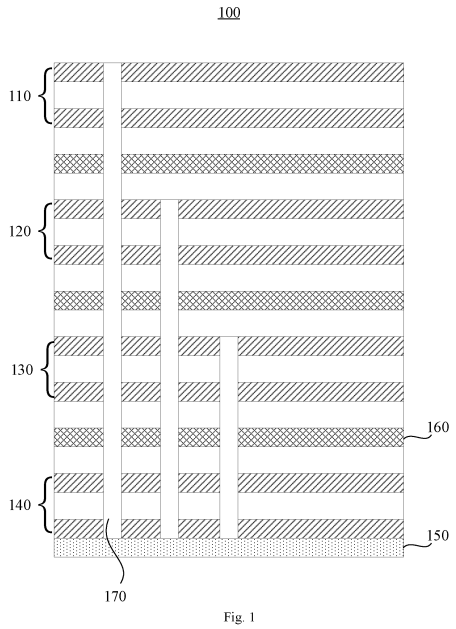

Fig. 1

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Description

FIELD OF THE DISCLOSURE

[0001] The present disclosure relates to the field of antenna technology, and more particularly to a phased array antenna and an antenna module.

BACKGROUND OF THE DISCLOSURE

[0002] With the rapid development of satellite Internet at home and abroad, there is an increasing demand for phased array antennas, and at the same time, higher requirements are placed on the cost and size of phased array antennas.

[0003] A conventional phased array antenna consists of an antenna array, a transceiver module, a feed system, a calibration system, a power supply system and a control system, these modules being designed independently of each other but connected to each other through connectors. However, such connection results in low integration, large size, high cost and low reliability of the phased array antenna, which is not conducive to its widespread popularization.

[0004] In summary, prior art phased array antennas suffer from low integration, large size, and high cost.

SUMMARY OF THE DISCLOSURE

[0005] An object of the present disclosure is to provide a phased array antenna and an antenna module, so as to address the problems of low integration, large size and high cost of phased array antennas existing in the prior art.

[0006] In order to achieve the object above, the technical solutions employed in the embodiments of the present disclosure are as follows.

[0007] On the one hand, the present disclosure provides a phased array antenna, the phased array antenna comprising an antenna array, a control system, a power supply system, a feed system and a transceiver module, the antenna array, the control system, the power supply system, the feed system and the transceiver module all being integrated on a same printed circuit board and arranged in layers, the antenna array and the control system being connected via a metal ground, and the power supply system and the feed system being also connected via a metal ground.

[0008] In the antenna, the feed system is connected to the transceiver module, the antenna array, the control system and the power supply system each are provided with a metallic hole penetrating to the transceiver module, the metallic hole being arranged at a distance from the metal ground, and the antenna array, the control system and the power supply system each are connected to the transceiver module through the metallic hole.

[0009] Optionally, the antenna array, the control system, the power supply system, the feed system and the transceiver module are provided layer by layer.

[0010] Optionally, the antenna array, the power supply system, the control system, the feed system and the transceiver module are provided layer by layer, the antenna array and the power supply system are connected via a metal ground, and the control system and the feed system are connected via a metal ground.

[0011] Optionally, the power supply system and the feed system are connected via a metal ground.

[0012] Optionally, the phased array antenna further comprises a calibration system, the calibration system being also integrated on the printed circuit board, and the calibration system being connected to the transceiver module.

[0013] Optionally, the calibration system is located between the feed system and the power supply system, the calibration system and the power supply system being connected via a metal ground, the calibration system and the feed system being also connected via a metal ground, and the calibration system is provided with a metallic hole penetrating to the transceiver module.

[0014] Optionally, the calibration system is located on a same layer as the feed system.

[0015] Optionally, an outer side of the metallic hole is covered with a non-metallic layer so that the metallic hole is arranged at a distance from the metal ground.

[0016] Optionally, the antenna array, the control system, the power supply system and the feed system each comprise one or more metal layers, an end of the metallic hole connected to the metal layers.

[0017] On the other hand, the embodiments of the present disclosure also provide an antenna module comprising a phased array antenna as described above.

[0018] Relative to the prior art, the present disclosure enjoys the following beneficial effects.

[0019] The present disclosure provides a phased array antenna and an antenna module, the phased array antenna comprising an antenna array, a control system, a power supply system, a feed system and a transceiver module, the antenna array, the control system, the power supply system, the feed system and the transceiver module all being integrated on a same printed circuit board and arranged in layers, the antenna array and the control system being connected via a metal ground, the power supply system and the feed system being also connected via a metal ground, wherein the feed system is connected to the transceiver module, wherein the antenna array, the control system and the power supply system each are provided with a metallic hole penetrating to the transceiver module, the metallic hole being arranged at a distance from the metal ground, and wherein the antenna array, the control system and the power supply system each are connected to the transceiver module through the metallic hole. Using the phased array antenna provided by the present disclosure, it is possible to integrate multiple systems on a same printed circuit board, thereby eliminating the need for independent design while achieving higher integration, smaller size, and effectively

reduced cost.

[0020] In order to make the above objects, features and advantages of the present disclosure more apparent, preferred embodiments are exemplified below, and are described in detail as follows in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] In order to more clearly illustrate the technical solutions of the embodiments of the present disclosure, the accompanying drawings to be used in the embodiments will be briefly introduced below. It should be understood that the following figures are only illustrative of certain embodiments of the present disclosure, and therefore should not be regarded as limiting to its scope. For those skilled in the art, other related drawings could also be obtained from these drawings without exercise of any ingenuity.

FIG. 1 is a first sectional diagram of a phased array antenna as provided in an embodiment of the present disclosure.

FIG. 2 shows circuitry of a transceiver module and a feed system as provided in an embodiment of the present disclosure.

FIG. 3 is a second sectional diagram of a phased array antenna as provided in an embodiment of the present disclosure.

FIG. 4 is a third sectional diagram of a phased array antenna as provided in an embodiment of the present disclosure.

[0022] Reference numbers in the figures: 100-phased array antenna; 110-antenna array; 120-control system; 130-power supply system; 140-feed system; 150-transceiver module; 160-metal ground; 170-metallic hole; 180-calibration system.

DETAILED IMPLEMENTATION OF THE DISCLOSURE

[0023] In order to make the objects, technical solutions and advantages of the embodiments of the present disclosure clearer, the technical solutions in the embodiments of the present disclosure will be clearly and completely described below in conjunction with the accompanying drawings. Apparently, the embodiments described herein are some, but not all, embodiments of the present disclosure. The components in the embodiments of the present disclosure described and illustrated herein may generally be arranged and designed in a variety of different configurations.

[0024] Accordingly, the following detailed description of the embodiments of the present disclosure as provided in the accompanying drawings is not intended to limit the scope of the present disclosure, but merely to indicate selected embodiments of the present disclosure. Based on the embodiments in the present disclosure, all other embodiments obtained without exercise of ingenuity by a person of ordinary skill in the art fall within the scope of protection of the present disclosure.

[0025] It should be noted that like reference numerals and letters refer to like items in the following figures, and thus, once an item is defined in one figure, it need not be further defined and explained in subsequent ones. Moreover, the terms "first", "second" and the like, if any, are used solely to distinguish one from another and are not to be construed as indicating or implying relative importance.

[0026] It should be noted that relational terms such as "first", "second" herein are used only to distinguish one entity or operation from another, and it does not necessarily require or imply the existence of any such actual relationship or order between these entities or operations. Furthermore, the terms "comprising", "including", or any other variant thereof, are intended to encompass a non-exclusive inclusion, such that a process, method, article, or apparatus comprising a list of elements not only includes those elements, but also includes other elements not expressly listed or inherent to such process, method, article or apparatus. Without further limitations, an element defined by "comprising a ..." does not preclude the presence of additional identical elements in the process, method, article or apparatus that comprises the element.

[0027] In the description of the present disclosure, it should be noted that an orientation or a positional relationship indicated by such terms as "upper", "lower", "inner" and "outer", if any, is based on that shown in the drawings, or that of the product of the present disclosure as it is in use. This is only for ease and simplicity of description, without indicating or implying that the device or the element referred to must have a specific orientation, or be constructed and operated in a particular orientation, and thus it should not be construed as limiting to the present disclosure.

[0028] In the description of the present disclosure, it should also be noted that, unless otherwise expressly specified or defined, the terms "provided" and "connected" and the like are to be understood in a broad sense. For example, it may be a fixed connection, a detachable connection, or an integral connection; it may be a mechanical connection or an electrical connection; it may be a direct connection, or an indirect connection through an intermediary, or an internal communication of two elements. For a person of ordinary skill in the art, the specific meanings of these terms in the present disclosure may be understood in specific contexts.

[0029] Some embodiments of the present disclosure are described in detail below in conjunction with the accompanying drawings. The following embodiments and features therein may be combined with each other in the absence of conflicts.

[0030] As mentioned in the background section, a conventional phased array antenna consists of an antenna

array, a transceiver module, a feed system, a calibration system, a power supply system, and a control system, these modules being designed independently of each other but connected to each other through connectors. For example, a printed circuit board may be configured for the feed system, another printed circuit board may be configured for the power supply system, and yet another independent printed circuit board may also be configured for the control system. Consequently, the entire phased array antenna suffers from such problems as low integration, large size, and high cost.

[0031] In view of the above, in order to solve said problems, the present disclosure provides a phased array antenna, which achieves the purpose of reducing the size and cost of the phased array antenna by integrating a plurality of modules on a same printed circuit board.

[0032] The phased array antenna provided by the present disclosure is exemplified as follows.

[0033] As an implementation, referring to FIG. 1, a phased array antenna 100 includes an antenna array 110, a control system 120, a power supply system 130, a feed system 140 and a transceiver module 150, which are all integrated on a same printed circuit board and arranged in layers, the antenna array 110 and the control system 120 being connected via a metal ground 160, and the power supply system 130 and the feed system 140 being also connected via a metal ground 160. The feed system 140 is connected to the transceiver module 150, and the antenna array 110, the control system 120 and the power supply system 130 each are provided with a metallic hole 170 penetrating to the transceiver module 150, the metallic hole 170 being disposed at a distance from the metal ground 160, via which metallic hole 170 the antenna array 110, the control system 120 and the power supply system 130each are connected to the transceiver module 150.

[0034] Through this implementation, all systems are integrated on a same printed circuit board, thereby achieving the effects of high integration, small size, low cost and good reliability.

[0035] Optionally, the antenna array 110 provided in the present disclosure takes the form of a micro strip antenna, and the micro strip patch antenna has the advantages of small size, light weight, low profile, easy processing and easy integration with other modules. The antenna array 110 enables the reception and transmission of radio frequency (RF) signals, and transmits the received signals to the transceiver module 150.

[0036] Referring to FIG. 2, the transceiver module 150 selects and adopts a multifunctional and low-cost microwave radio frequency chip with multiple RF channels to realize functions such as amplification, amplitude modulation, phase modulation, power detection of RF signals, and at the same time, external digital signals can be used to control the chip. That is, the transceiver module 150 includes a plurality of microwave RF chips, each of which is connected to the antenna array 110. In addition, five channel numbers are conventionally selected for the transceiving, namely, 1 channel, 2 channels, 4 channels, 8 channels, and 16 channels.

[0037] The feed system 140 employs a power division network in the form of micro strips or strip lines to realize the division or synthesis of RF signals. As one implementation, the transceiver module 150 is welded on the feed system 140. The power supply system 130 enables power supply to the transceiver module 150 by etching specific lines on the printed circuit board to ensure normal operation of the transceiver module 150. The control system 120 realizes such functions of the transceiver module 150 as amplitude modulation, phase modulation and power detection by etching specific lines on the printed circuit board.

[0038] In one possible implementation, the transceiver module 150 is provided with a control interface and a power interface, which interfaces are connected to each microwave radio frequency chip in the transceiver module 150 respectively, and at the same time, the power supply system 130 and the control system 120 are connected to the transceiver module 150 through metallic holes 170, thereby realizing power supply and control of each microwave radio frequency chip.

[0039] As one embodiment, the antenna array 110, the control system 120, the power supply system 130, the feed system 140 and the transceiver module 150 are provided layer by layer. In order to eliminate interactions between these modules, in this embodiment, a metal ground 160is provided between the antenna array 110 and the control system 120, and a metal ground 160 is provided between the power supply system 130 and the feed system 140.

[0040] As another embodiment, referring to FIG. 3, the antenna array 110, the power supply system 130, the control system 120, the feed system 140 and the transceiver module 150 are provided layer by layer. On this basis, the antenna array 110 and the power supply system 130 are connected via a metal ground 160, and the control system 120 and the feed system 140 are connected via a metal ground 160.

[0041] Due to the relatively low impact between the power supply system 130 and the control system 120, a metal ground 160 may be provided therebetween, or the power supply system 130 and the control system 120 may be directly connected without a metal ground 160. The present disclosure does not set any limitation on this.

[0042] It should be noted that, in the actual fabrication process, the metallic holes 170 are generally made by first drilling holes in the phased array antenna, and then plating is performed to the inner wall of the holes, thereby forming the metallic holes 170. In order to facilitate the connection between the other modules and the transceiver module 150, the present disclosure uniformly adopts metallic holes 170 as means of connection. However, since a metal ground 160 may be provided between two adjacent modules or systems, if the metallic holes 170 are connected to the metal ground 160, the metallic holes 170 will be shorted, making signal transmission

impossible. For example, the power supply system 130 is connected to the transceiver module 150 through the metallic hole 170, and the metal ground 160 is provided between the power supply system 130 and the feed system 140, so that if the metallic hole 170 is connected to the metal ground 160, the power supply system 130 will be shorted, and thus be unable to properly power the transceiver module 150.

[0043] In view of this, as a possible implementation of the present disclosure, an outer side of the metallic hole 170 is covered with a non-metallic layer, such that the metallic hole 170 and the metal ground 160are arranged at a distance from each other. In other words, after drilling a hole in the phased array antenna, an inner wall of the hole can firstly be coated with a non-metallic layer before being plated, thereby realizing no contact between the metallic hole 170 and the metal ground 160. Of course, in some other embodiments, the non-contact between the metallic hole 170 and the metal ground 160 may be realized in other ways; for example, when drilling, by making the diameter of a hole in the metal ground 160 larger than that of metallic hole 170, the metallic hole 170 is not in contact with the metal ground 160.

[0044] In addition, in order to realize self-calibration of the phased array antenna while monitoring whether the transceiver module 150 is normal or not, the phased array antenna further comprises a calibration system 180, which is integrated to the printed circuit board as well, and connected to the transceiver module 150.

[0045] As an implementation, referring to FIG. 4, the calibration system 180 is located between the feed system 140 and the power supply system 130, and the calibration system 180 and the power supply system 130 are connected via a metal ground 160.On such basis, the calibration system 180 and the feed system 140 are also connected via a metal ground 160, and the calibration system 180 is provided with a metallic hole170 penetrating to the transceiver module 150.

[0046] As an alternative implementation, the calibration system 180 is located on a same layer as the feed system 140. On this basis, the calibration system 180 may be directly connected to the transceiver module 150 without a metallic hole 170.

[0047] Moreover, it is noted that the antenna array 110, the control system 120, the power supply system 130, the calibration system 180 and the feed system 140 each include one or more metal layers, to which layers an end of the metallic hole 170is connected. In other words, the number of layers of the antenna array 110, the control system 120, the power supply system 130, the calibration system 180 and the feed system 140 may all be greater than or equal to 1.

[0048] Meanwhile, the metal layers described in the present disclosure are copper layers, filled with a dielectric therebetween. For the antenna array 110, the calibration system 180 and the feed system 140, a microwave dielectric is used, which dielectric has a relative permittivity in the range of from 2 to 100, and a loss tangent in the range of from 10-4 to 10-2.

[0049] Based on the above implementations, the present disclosure also provides an antenna module that includes the phased array antenna described above.

[0050] In summary, the present disclosure provides a phased array antenna and an antenna module, the phased array antenna comprising an antenna array, a control system, a power supply system, a feed system and a transceiver module, the antenna array, the control system, the power supply system, the feed system and the transceiver module all being integrated on a same printed circuit board and arranged in layers, the antenna array and the control system being connected via a metal ground, the power supply system and the feed system being also connected via a metal ground, wherein the feed system is connected to the transceiver module, wherein the antenna array, the control system and the power supply system each are provided with a metallic hole penetrating to the transceiver module, the metallic hole being arranged at a distance from the metal ground, and wherein the antenna array, the control system and the power supply system each are connected to the transceiver module through the metallic hole. Using the phased array antenna provided by the present disclosure, it is possible to integrate multiple systems on a same printed circuit board, thereby eliminating the need for independent design while achieving higher integration, smaller size, and effectively reduced cost.

[0051] The foregoing are only preferred embodiments of the present disclosure, which are not intended to limit the present disclosure but are subject to various modifications or changes for those skilled in the art. Any modifications, equivalent substitutions, improvements or the like made within the spirit and principle of the present disclosure shall be included in the scope of present disclosure.

[0052] It is apparent to those skilled in the art that the present disclosure is not limited to the details of the exemplary embodiments described above, and that the present disclosure may be otherwise enabled in other specific forms without departing from the spirit or essential features of the present disclosure. Accordingly, the embodiments are to be regarded as exemplary and non-limiting in each and every point of view, and the scope of the present disclosure is defined by the appended claims and not by the foregoing description, and is therefore intended to encompass all changes falling within the meaning and scope of equivalents to the claims. Any reference sign in a claim should not be construed as limiting the claim concerned.

Claims

1. A phased array antenna, the phased array antenna comprising an antenna array, a control system, a power supply system, a feed system and a transceiver module, the antenna array, the control sys-

tem, the power supply system, the feed system and the transceiver module all being integrated on a same printed circuit board and arranged in layers, the antenna array and the control system being connected via a metal ground, the power supply system and the feed system being also connected via a metal ground,
wherein the feed system is connected to the transceiver module, wherein the antenna array, the control system and the power supply system each are provided with a metallic hole penetrating to the transceiver module, the metallic hole being arranged at a distance from the metal ground, and wherein the antenna array, the control system and the power supply system each are connected to the transceiver module through the metallic hole.

2. The phased array antenna according to claim 1, wherein the antenna array, the control system, the power supply system, the feed system and the transceiver module are provided layer by layer.

3. The phased array antenna according to claim 1, wherein the antenna array, the power supply system, the control system, the feed system and the transceiver module are provided layer by layer, the antenna array and the power supply system being connected via a metal ground, and the control system and the feed system being connected via a metal ground.

4. The phased array antenna according to claim 2 or 3, wherein the power supply system and the feed system are connected via a metal ground.

5. The phased array antenna according to claim 1, wherein the phased array antenna further comprises a calibration system, the calibration system being integrated on the printed circuit board as well and connected to the transceiver module.

6. The phased array antenna according to claim 5, wherein the calibration system is disposed between the feed system and the power supply system, the calibration system and the power supply system being connected via a metal ground, the calibration system and the feed system being also connected via a metal ground, and wherein the calibration system is provided with a metallic hole penetrating to the transceiver module.

7. The phased array antenna according to claim 5, wherein the calibration system is located on a same layer as the feed system.

8. The phased array antenna according to claim 1, wherein an outer side of the metallic hole is covered with a non-metallic layer, such that the metallic hole is arranged at a distance from the metal ground.

9. The phased array antenna according to claim 1, wherein the antenna array, the control system, the power supply system and the feed system comprise one or more metal layers, to which layers an end of the metallic hole is connected.

10. An antenna module comprising a phased array antenna according to any one of claims 1 to 9.

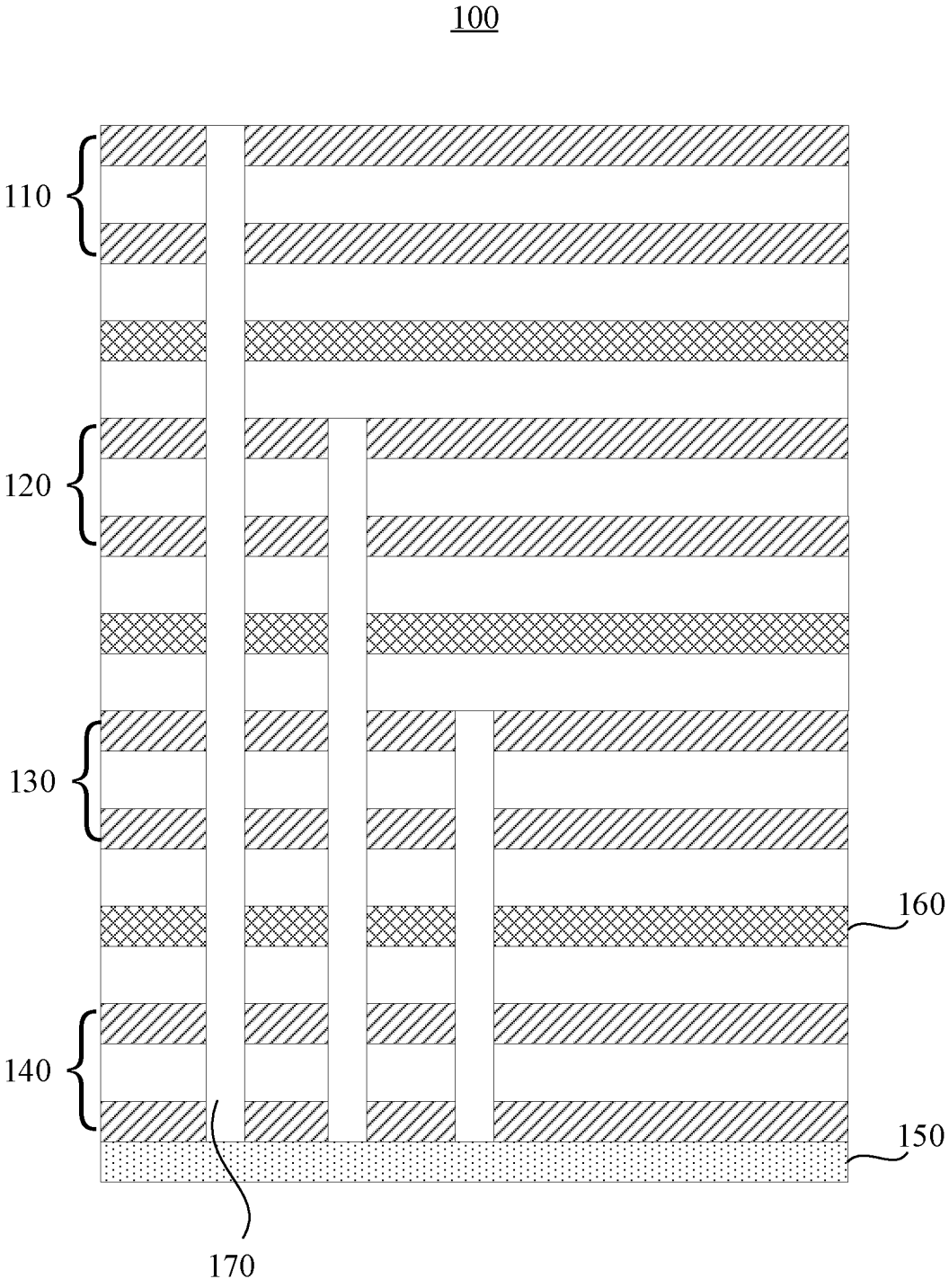

Fig. 1

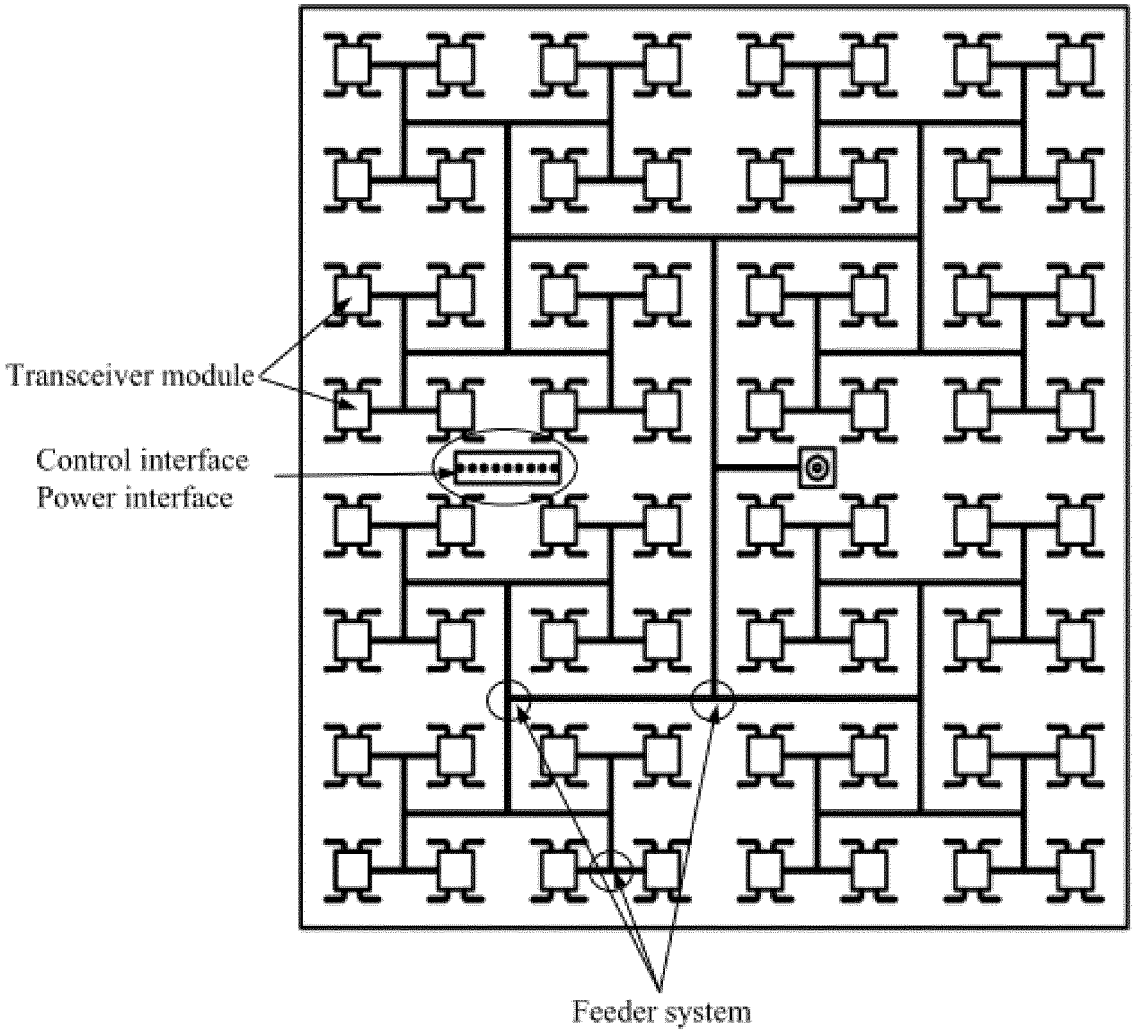
Transceiver module
Control interface
Power interface
Feeder system

Fig.2

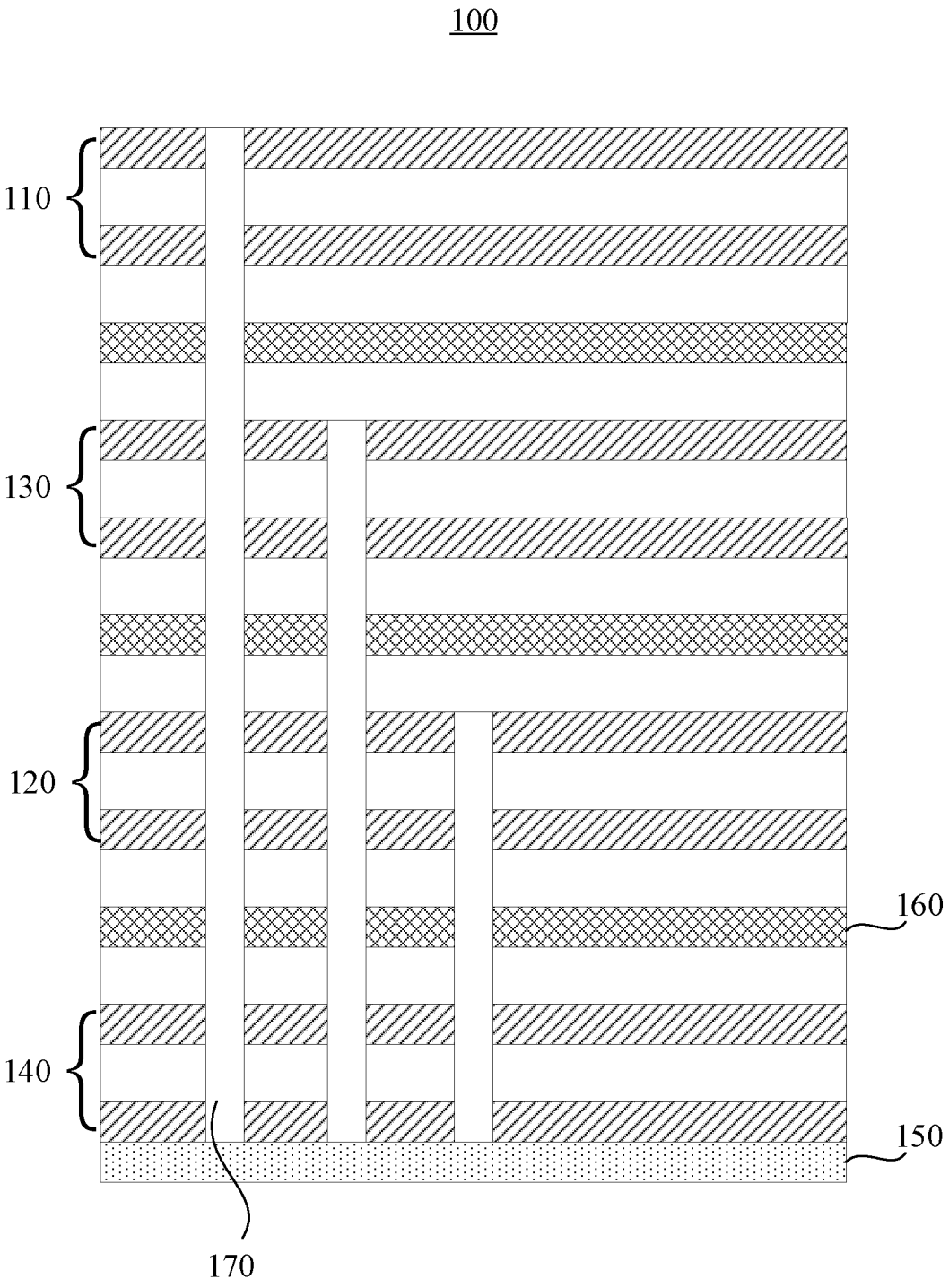

Fig. 3

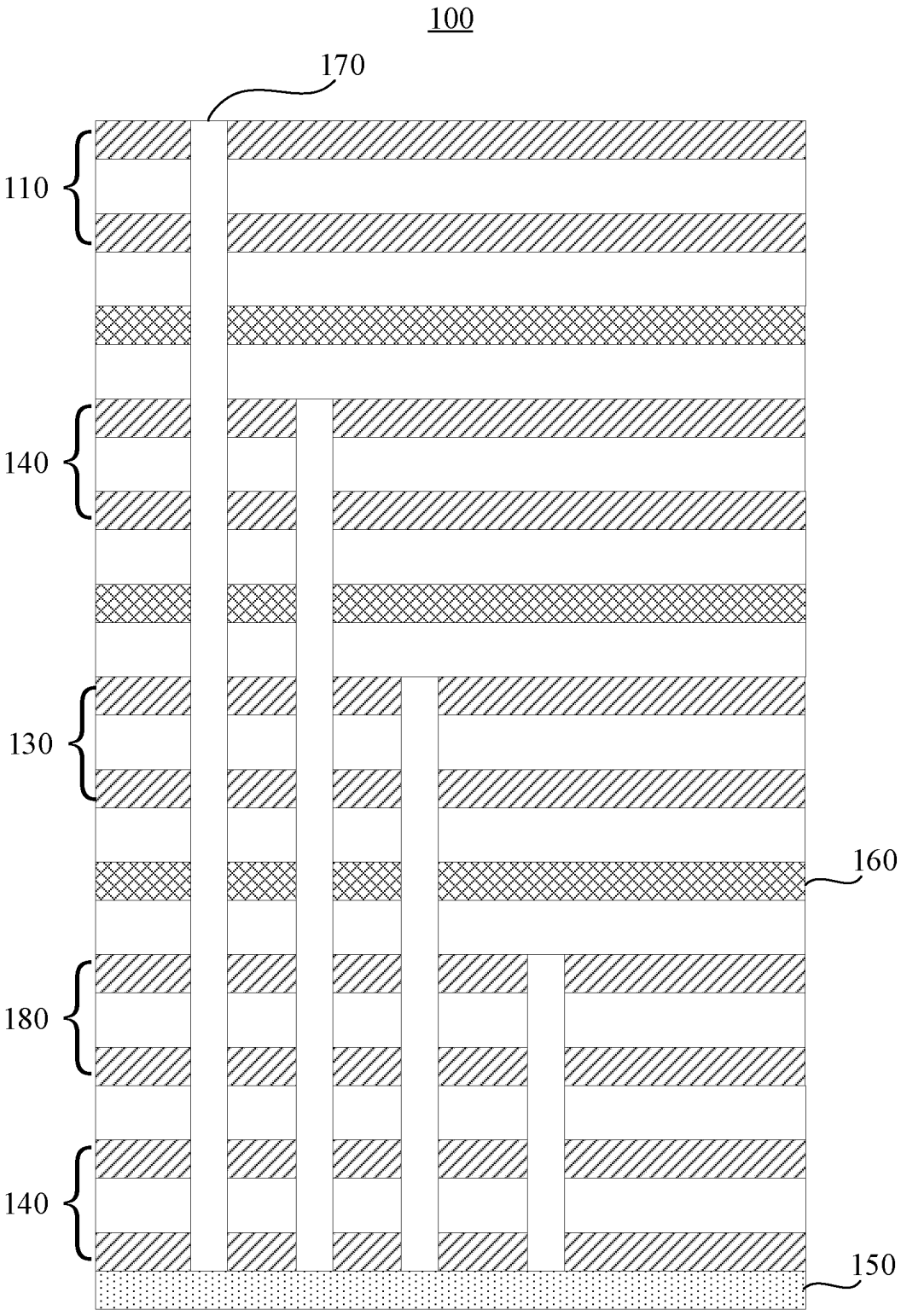

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2022/079213

A. CLASSIFICATION OF SUBJECT MATTER

H01Q 1/38(2006.01)i; H01Q 1/48(2006.01)i; H01Q 1/50(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)

CNABS, CNTXT, VEN, USTXT, EPTXT, WOTXT, IEEE, CNKI: chip, array, phase, integrated, via, 芯片, 阵列, 相位, 集成, 一体, 金属孔, 通孔, 过孔

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 214153199 U (CHENGDU T-RAY TECHNOLOGY CO., LTD.) 07 September 2021 (2021-09-07) description, paragraphs [0009]-[0055], and figures 1-4	1-10
PX	CN 112713397 A (CHENGDU T-RAY TECHNOLOGY CO., LTD.) 27 April 2021 (2021-04-27) description, paragraphs [0009]-[0051], and figures 1-3	1-10
X	CN 109980365 A (NO.38 RESEARCH INSTITUTE OF CHINA ELECTRONICS TECHNOLOGY GROUP CORPORATIONE) 05 July 2019 (2019-07-05) description, paragraphs [0006]-[0062], and figures 1-4	1-4, 8-10
Y	CN 109980365 A (NO.38 RESEARCH INSTITUTE OF CHINA ELECTRONICS TECHNOLOGY GROUP CORPORATIONE) 05 July 2019 (2019-07-05) description, paragraphs [0006]-[0062], and figures 1-4	5-7
Y	CN 112332111 A (CHONGQING LIANGJIANG SATELLITE MOBILE COMMUNICATIONS CO., LTD.) 05 February 2021 (2021-02-05) description, paragraphs [0003]-[0043], and figures 1-4	1-10

☑ 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
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"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
06 May 2022	**17 May 2022**
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** Facsimile No. **(86-10)62019451**	Authorized officer Telephone No.

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2022/079213

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
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