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(72) Inventors:

- **WU, Zubing**
Chengdu, Sichuan 610002 (CN)
- **WANG, Xinhui**
Chengdu, Sichuan 610002 (CN)
- **YE, Baobing**
Chengdu, Sichuan 610002 (CN)

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(74) Representative: **Caspary, Karsten**

Kroher-Strobel

Rechts- und Patentanwälte PartmbB

Bavariaring 20

80336 München (DE)

(71) Applicant: **Chengdu T-Ray Technology Co., Ltd.**
Chengdu, Sichuan 610002 (CN)

(54) **ANTENNA UNIT, FILTERING ANTENNA, AND TERMINAL DEVICE**

(57) The present application provides an antenna unit, a filtering antenna, and a terminal device, comprising: a first dielectric substrate, a second dielectric substrate, a third dielectric substrate, a radiation structure and at least one set of transmission unit. Each transmission unit includes a first feed structure, a second feed structure and a filtering structure; the second dielectric substrate is arranged between the first dielectric substrate and the third dielectric substrate; the radiation structure is arranged on a side of the first dielectric substrate away from the second dielectric substrate; the second feed structure is arranged on the second dielectric substrate; the filtering structure is arranged on the third dielectric substrate; the first feed structure is connected to the second feed structure and the filtering structure; the first feed structure is used for transmitting an electromagnetic wave signal; the second feed structure is used to couple feed signals to the radiation structure; and the filtering structure is used to perform signal filtering. By integrating the antenna and filter into a unified design, this innovation reduces the device size, offering advantage of low cost, high stability and excellent filtering characteristics.

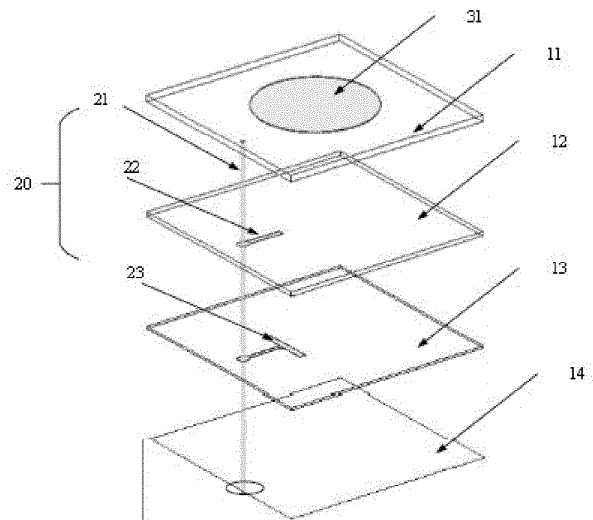


Fig. 1

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Description

FIELD OF THE DISCLOSURE

[0001] This application relates to the field of antennas, specifically, it relates to an antenna unit, a filtering antenna, and a terminal device.

BACKGROUND OF THE DISCLOSURE

[0002] With scientific advancements and social development, an increasing number of communication devices are being used in daily life. For example, satellite communication devices are widely applied in various industries. A crucial component in communication devices is the antenna, and the quality of the antenna directly affects the communication quality of the devices.

[0003] In current engineering applications, antennas and filters are often designed separately and then connected and debugged through additional matching circuits. This method usually fails to achieve optimal matching and can easily introduce significant insertion loss, sometimes even increasing the size of the equipment.

[0004] Therefore, how to design an antenna with filtering functionality that does not increase additional loss has become a pressing challenge for technicians in this field.

SUMMARY OF THE DISCLOSURE

[0005] The purpose of the present application is to provide an antenna unit, a filtering antenna, and a terminal device to at least partially alleviate the aforementioned problems.

[0006] To achieve the above objectives, the technical solutions adopted in the embodiments of the present application are as follows:

In a first aspect, an embodiment of the present application provides an antenna unit, which comprises: a first dielectric substrate, a second dielectric substrate, a third dielectric substrate, a radiation structure, and at least one transmission unit. The transmission unit comprises a first feeding structure, a second feeding structure, and a filtering structure.

[0007] The second dielectric substrate is arranged between the first dielectric substrate and the third dielectric substrate. The radiation structure is arranged on the side of the first dielectric substrate facing away from the second dielectric substrate. The second feeding structure is arranged on the side of the second dielectric substrate facing the first dielectric substrate or on the side of the first dielectric substrate facing the second dielectric substrate. The filtering structure is arranged on the side of the third dielectric substrate facing the second dielectric substrate or on the side of the second dielectric substrate facing the first dielectric substrate. The first feeding structure passes through the first, second, and third dielectric substrates and connects with the second feeding

structure and the filtering structure.

[0008] The first feeding structure is used for transmitting electromagnetic wave signals.

[0009] The second feeding structure is used for coupling feeding to the radiation structure.

[0010] The filtering structure is used for filtering.

[0011] In a possible implementation, the projection of the second feeding structure and the radiation structure on the second dielectric substrate overlaps at least partially.

[0012] In a possible implementation, the filtering structure comprises a first filtering component and a second filtering component. One end of the first feeding structure connects with one end of the first filtering component, and the other end of the first filtering component connects with the second filtering component.

[0013] The first filtering component and the second filtering component form a T-shaped filtering structure.

[0014] In a possible implementation, the other end of the first filtering component connects to the midpoint of the second filtering component.

[0015] In a possible implementation, the length of the first filtering component is a first length, the width of the first filtering component is a first width, the length of the second filtering component is a second length, and the width of the second filtering component is a second width.

[0016] The first length, the second length, the first width, and the second width are matched with the radiation nulls of the antenna unit, which indicate the frequency bands to be filtered.

[0017] In a possible implementation, the angle between the projection of the first filtering component on the third dielectric substrate and the projection of the second feeding structure on the third dielectric substrate is a target rotation angle.

[0018] The target rotation angle is matched with the radiation nulls of the antenna unit, which indicate the frequency bands to be filtered.

[0019] In a possible implementation, when the number of transmission units is greater than one, the transmission units are uniformly distributed around the center point of the radiation structure.

[0020] In a possible implementation, the geometric shape of the radiation structure is circular, rectangular, or polygonal.

[0021] In a second aspect, an embodiment of the present application provides a filtering antenna, which comprises the aforementioned antenna unit.

[0022] In a third aspect, an embodiment of the present application provides a terminal device, which comprises the aforementioned filtering antenna.

[0023] Compared with the prior art, the antenna unit, filtering antenna, and terminal device provided in the embodiments of the present application include: a first dielectric substrate, a second dielectric substrate, a third dielectric substrate, a radiation structure, and at least one transmission unit. The transmission unit comprises a first feeding structure, a second feeding structure, and a

filtering structure. The second dielectric substrate is arranged between the first and third dielectric substrates. The radiation structure is arranged on the side of the first dielectric substrate facing away from the second dielectric substrate. The second feeding structure is arranged on the second dielectric substrate, and the filtering structure is arranged on the third dielectric substrate. The first feeding structure passes through the second and third dielectric substrates and connects with the second feeding structure and the filtering structure. The first feeding structure is used for transmitting electromagnetic wave signals. The second feeding structure is used for coupling feeding to the radiation structure. The filtering structure is used for filtering. By integrating the antenna and the filter, the device size is reduced, and the solution has low cost, high stability, and good filtering characteristics.

[0024] To make the aforementioned objectives, features, and advantages of the present application more apparent and understandable, the following detailed description is provided with reference to preferred embodiments and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] To more clearly illustrate the technical solution of the embodiments of the present application, the following is a brief introduction to the drawings required for the embodiments. It should be understood that the following drawings only show certain embodiments of the present application and should therefore not be regarded as limiting the scope. For ordinary technicians in the field, without exercising creative effort, other related drawings can also be obtained based on these drawings.

Figure 1 is a schematic diagram of an antenna unit provided by an embodiment of the present application;

Figure 2 is a schematic diagram comparing the filtering effects of a conventional antenna and a filtered antenna provided by an embodiment of the present application;

Figure 3 is a top view of the antenna unit provided by an embodiment of the present application;

Figure 4 is a side view of the antenna unit provided by an embodiment of the present application.

[0026] In the drawings: 11-first dielectric substrate; 12-second dielectric substrate; 13-third dielectric substrate; 14-antenna ground; 20-transmission unit; 21-first feeding structure; 22-second feeding structure; 23-filtering structure; 231-first filtering component; 232-second filtering component; 31-radiation structure.

DETAILED IMPLEMENTATION OF THE DISCLOSURE

[0027] To make the purpose, technical solutions, and advantages of the embodiments of the present applica-

tion clearer, a clear and complete description of the technical solutions in the embodiments of the present application will be provided below in conjunction with the accompanying drawings in the embodiments of the present application. It is evident that the described embodiments are part of the embodiments of the present application, not all of them. Generally, the components of the embodiments of the present application described and shown in the accompanying drawings herein can be arranged and designed in various configurations.

[0028] Therefore, the detailed description of the embodiments of the present application provided in the accompanying drawings below is not intended to limit the scope of the present application that is claimed for protection, but merely represents selected embodiments of the present application. Based on the embodiments of the present application, all other embodiments obtained by ordinary technicians in the field without creative effort belong to the scope of protection of the present application.

[0029] It should be noted that similar labels and letters indicate similar items in the following accompanying drawings. Therefore, once an item is defined in one drawing, it does not require further definition and explanation in subsequent drawings. Meanwhile, in the description of the present application, terms such as "first," "second," etc., are used only for distinction and cannot be understood as indicating or implying relative importance.

[0030] It should be clarified that, in this document, relational terms such as first and second are merely used to distinguish one entity or operation from another entity or operation, and do not necessarily require or imply any such actual relationship or sequence between these entities or operations. Moreover, the terms "include," "contain," or any other variations are intended to cover non-exclusive inclusions, such that a process, method, article, or device that comprises a series of elements not only comprises those elements but also comprises other elements not explicitly listed, or comprises elements that are inherent to such a process, method, article, or device. In the absence of further restrictions, elements defined by the phrase "including a ..." do not exclude the presence of additional identical elements in the process, method, article, or device that comprises the described elements.

[0031] In the description of the present application, it should be noted that terms such as "upper," "lower," "inner," "outer," etc., indicate orientation or positional relationships based on the orientation or positional relationship shown in the accompanying drawings or the customary orientation or positional relationship when the product is in use, merely for the convenience of describing the present application and simplifying the description, and should not be understood as limiting the present application.

[0032] In the description of the present application, it should also be noted that unless otherwise clearly defined and limited, the terms "set," "connect," should be broadly understood, for example, they can be fixed con-

nections, detachable connections, or integral connections; they can be mechanical connections or electrical connections; they can be directly connected or indirectly connected through intermediate media; they can be internal connections between two elements. For ordinary technicians in the field, the specific meanings of the above terms in the present application can be understood based on specific situations.

[0033] Below, some embodiments of the present application will be described in detail in conjunction with the accompanying drawings. The embodiments and features in the embodiments below can be combined with each other if there is no conflict.

[0034] In current engineering applications, antennas and filters are often designed separately and then connected and debugged through additional external matching circuits. This method usually cannot achieve optimal matching and easily introduces significant insertion loss, sometimes even increasing the size of the equipment.

[0035] Therefore, to reduce loss and achieve miniaturization, the inventor considers combining filtering characteristics with antennas to realize filtering characteristics of antennas. By directly cascading filters and antennas for integrated design, unnecessary external matching circuits are reduced, thereby reducing matching loss. However, insertion loss of the filter still exists.

[0036] To further reduce insertion loss, the inventor considers integrating filter and antenna design, so that the antenna has both radiation and filtering functions without additional insertion loss.

[0037] In the integrated design of filter-antennas, the antenna serves as the last resonator of the filter to achieve filtering functionality. By changing the antenna structure, such as etching slots, adding metal vias, or incorporating metamaterial structures, the transmission mode of the antenna is altered to generate transmission zeros, thereby achieving filtering functionality.

[0038] An embodiment of the present application provides an antenna unit. Please refer to Figure 1, which is a schematic diagram of an antenna unit provided by an embodiment of the present application. The antenna unit is used as a component of a filter-antenna. It should be noted that a filter-antenna can include multiple antenna units. For ease of illustration, only one antenna unit is shown in Figure 1.

[0039] As shown in Figure 1, the antenna unit comprises: a first dielectric substrate 11, a second dielectric substrate 12, a third dielectric substrate 13, a radiation structure 31, and at least one transmission unit 20. The transmission unit 20 comprises a first feeding structure 21, a second feeding structure 22, and a filtering structure 23.

[0040] It should be understood that one antenna unit can include multiple transmission units 20. For ease of illustration, only one transmission unit 20 is shown in Figure 1.

[0041] The second dielectric substrate 12 is arranged between the first dielectric substrate 11 and the third

dielectric substrate 13. The radiation structure 31 is arranged on the side of the first dielectric substrate 11 away from the second dielectric substrate 12. The second feeding structure 22 is arranged on the side of the second dielectric substrate 12 closer to the first dielectric substrate 11 or on the side of the first dielectric substrate 11 closer to the second dielectric substrate 12. The filtering structure 23 is arranged on the side of the third dielectric substrate 13 closer to the second dielectric substrate 12 or on the side of the second dielectric substrate 12 closer to the third dielectric substrate 13. The first feeding structure 21 passes through the first dielectric substrate 11, the second dielectric substrate 12, and the third dielectric substrate 13, and connects with the second feeding structure 22 and the filtering structure 23.

[0042] Optionally, an antenna ground 14 is arranged on the side of the third dielectric substrate 13 away from the second dielectric substrate 12.

[0043] The first feeding structure 21 is used to transmit electromagnetic signals; the second feeding structure 22 is used to couple and feed the radiation structure; and the filtering structure 23 is used for filtering.

[0044] Optionally, the first feeding structure 21 is composed of metal or other conductor materials, such as metal vias. The first feeding structure 21 can be connected to a microstrip line to realize electromagnetic signal transmission.

[0045] Optionally, as shown in Figure 1, a specific metal pattern is covered on the side of the second dielectric substrate 12 closer to the first dielectric substrate 11 or on the side of the first dielectric substrate 11 closer to the second dielectric substrate 12 to form the second feeding structure 22. The second feeding structure 22 is used to couple and feed the radiation structure.

[0046] Optionally, as shown in Figure 1, a specific metal pattern is covered on the side of the third dielectric substrate 13 closer to the second dielectric substrate 12 or on the side of the second dielectric substrate 12 closer to the third dielectric substrate 13 to form the filtering structure 23. The filtering structure 23 is used to alter the transmission mode of the antenna to generate transmission zeros for filtering.

[0047] The antenna unit provided by an embodiment of the present application has a simple structure. By integrating the antenna and filter design, it can reduce device size while achieving low-pass, band-pass, high-pass, and band-stop filtering characteristics, with low cost, high stability, and good filtering characteristics.

[0048] In summary, the antenna unit provided by an embodiment of the present application comprises: a first dielectric substrate, a second dielectric substrate, a third dielectric substrate, a radiation structure, and at least one transmission unit. The transmission unit comprises a first feeding structure, a second feeding structure, and a filtering structure. The second dielectric substrate is arranged between the first dielectric substrate and the third dielectric substrate. The radiation structure is arranged on the side of the first dielectric substrate away from the

second dielectric substrate. The second feeding structure is arranged on the second dielectric substrate. The filtering structure is arranged on the third dielectric substrate. The first feeding structure passes through the second dielectric substrate and the third dielectric substrate and connects with the second feeding structure and the filtering structure. The first feeding structure is used to transmit electromagnetic signals; the second feeding structure is used to couple and feed the radiation structure; and the filtering structure is used for filtering. By integrating the antenna and filter design, the device size is reduced, with low cost, high stability, and good filtering characteristics.

[0049] Compared to the scheme of independently designing antenna units and filters, antennas that achieve good filtering characteristics require multiple laminations, have complex structures, and significantly increase the cost of the antenna. In the embodiments of this application, all components of the antenna unit are directly completed on the dielectric substrate, thus resulting in a simple structure, ease of manufacture, and convenience for PCB processing. It can be completed with only one lamination, achieving excellent filtering characteristics while keeping costs low. This has great significance for practical engineering applications.

[0050] Please refer to Figure 2, which is a comparison diagram of the filtering effects of a conventional antenna and a filtered antenna provided in the embodiments of this application. Assuming that the operating frequency band of the filtered antenna is 14GHz-14.5GHz, and it is necessary to filter out 10GHz-13GHz, with a transmission zero around 12.5GHz, the filtering characteristic of the filtered antenna is shown in Figure 2: The filtered antenna operates at 14GHz-14.55GHz, with a gain greater than 5dB across the entire frequency band. At 10GHz-13GHz, the antenna gain is less than -15dB, and the suppression across the entire frequency band is greater than 20dB. A radiation null is formed at 12.6GHz, achieving the required filtering effect. However, for a conventional non-filtered antenna at 10GHz-13GHz, the gain is less than 0dB, with only 5dB of suppression, far inferior to the filtering effect of the filtered antenna provided in the embodiments of this application.

[0051] Please continue to refer to Figure 1. Regarding how to ensure the performance of the antenna unit, this application embodiment also provides a possible implementation. The projection of the second feeding structure 22 and the radiating structure 31 on the second dielectric substrate 12 at least partially overlap.

[0052] It should be understood that the size of the overlapping area is related to the preset operating frequency.

[0053] Optionally, one end of the second feeding structure 22 is connected to the first feeding structure 21, and the other end of the second feeding structure 22 points to the geometric center of the projection of the radiating structure 31 on the second dielectric substrate 12.

[0054] Please refer to Figure 3, which is a top view of the antenna unit provided in the embodiments of this application. As shown in Figure 3, in one possible implementation, the filtering structure 23 comprises a first filtering component 231 and a second filtering component 232. The first feeding structure 21 is connected to one end of the first filtering component 231, and the other end of the first filtering component 231 is connected to the second filtering component 232.

[0055] The first filtering component 231 and the second filtering component 232 form a T-shaped filtering structure.

[0056] In one possible implementation, the end of the first filtering component 231 away from the first feeding structure 21 is in contact with the second filtering component 232 along the direction of length L2.

[0057] Optionally, the first filtering component 231 and the second filtering component 232 are arranged on the side of the third dielectric substrate 13 close to the second dielectric substrate 12 or the side of the second dielectric substrate 12 close to the third dielectric substrate 13.

[0058] It should be noted that the first filtering component 231 and the second filtering component 232 are not limited to straight lines and can also be curved with amplitude.

[0059] In one possible implementation, to enhance the filtering effect, the other end of the first filtering component 231 is connected to the midpoint of the second filtering component 232.

[0060] Please continue to refer to Figure 3. The length of the first filtering component is the first length L1, the width of the first filtering component is the first width W1, the length of the second filtering component is the second length L2, and the width of the second filtering component is the second width W2.

[0061] The first length L1, the first width W1, the second length L2, and the second width W2 match the radiation null of the antenna unit, which indicates the frequency band to be filtered.

[0062] For example, as shown in Figure 2, the radiation null is at 12.6GHz, which can achieve a filtering effect on the frequency band of 10GHz-13GHz.

[0063] It should be noted that by adjusting the dimensions of L1, L2, W1, and W2 in the T-shaped filtering structure, the position of the radiation null of the antenna can be changed. Therefore, during the antenna design process, it is necessary to ensure that the first length L1, the first width W1, the second length L2, and the second width W2 match the radiation null of the antenna unit.

[0064] Please continue to refer to Figure 3. In one possible implementation, the angle between the projection of the first filtering component 231 and the second feeding structure 22 on the third dielectric substrate 13 is the target rotation angle.

[0065] The target rotation angle matches the radiation null of the antenna unit, which indicates the frequency band to be filtered.

[0066] It should be understood that rotating the T-

shaped filtering structure around the first feeding structure 21 can change the position of the radiation null of the antenna. Therefore, during the antenna design process, the target rotation angle needs to be determined beforehand. The target rotation angle matches the radiation null of the antenna unit.

[0067] In one possible implementation, when the number of transmission units 20 is greater than 1, the transmission units 20 are uniformly distributed around the center point of the radiating structure 31.

[0068] For example, when the number of transmission units 20 is 2, based on the center point of the radiating structure 31, they can be rotated by 90°, 180°, or 270°.

[0069] When the number of transmission units 20 is 3, the transmission units 20 can be circularly distributed around the center point of the radiating structure 31, with each of the 3 transmission units 20 rotated by 120° around the center point of the radiating structure 31.

[0070] When the number of transmission units 20 is 3, the transmission units 20 can be non-uniformly distributed around the center point of the radiating structure 31. Assuming that the angle of one of the transmission units 20 is 0°, the other transmission units 20 have three rotation combinations around the center point of the radiating structure 31: the first is 90°, 180°; the second is 90°, 270°; and the third is 180°, 270°.

[0071] When the number of transmission units 20 is 4, the transmission units 20 can be uniformly distributed around the center point of the radiating structure 31, with each of the 4 transmission units 20 rotated by 90° around the center point of the radiating structure 31.

[0072] In one possible implementation, the geometric shape of the radiating structure 31 is circular, rectangular, or polygonal.

[0073] Optionally, the first feeding structure 21, the second feeding structure 22, and the filtering structure 23 are metallic structures.

[0074] It should be noted that the characteristics of the three layers of microwave dielectric substrates (including relative permittivity, loss tangent, and thickness) can be the same or different, and are not limited herein.

[0075] Optionally, the characteristics of the microwave dielectric substrate will affect the size, shape, area, etc., of the radiating structure 31 and the feeding structure. For example, a higher permittivity results in a smaller radiating structure area and a smaller intersection area between the second feeding structure 22 and the radiating structure 31; a higher loss tangent reduces the gain of the antenna.

[0076] For ease of understanding, this application embodiment also provides a side view of the antenna unit, as shown specifically in Figure 4.

[0077] This application embodiment also provides a filtered antenna, which comprises the above-mentioned antenna unit. In this application scheme, the number of antenna units in the filtered antenna is not limited.

[0078] This application embodiment also provides a terminal device, which comprises the above-mentioned

filtered antenna. The terminal device can be a satellite communication base station.

[0079] The above description is merely the preferred embodiments of this application and is not intended to limit the scope of this application. For those skilled in the art, this application may be subject to various modifications and variations. Any modifications, equivalent substitutions, improvements, etc., made within the spirit and principles of this application, shall be included within the scope of protection of this application.

[0080] It is obvious to those skilled in the art that this application is not limited to the details of the aforementioned exemplary embodiments, and can be implemented in other specific forms without departing from the spirit or basic characteristics of this application. Therefore, from any perspective, the embodiments should be regarded as exemplary and non-limiting. The scope of this application is defined by the appended claims rather than the above description, and is intended to encompass all variations within the meaning and scope of the equivalent elements of the claims. No reference signs in the claims shall be construed as limiting the claims concerned.

Claims

1. An antenna unit **characterized by** comprising: a first dielectric substrate, a second dielectric substrate, a third dielectric substrate, a radiation structure, and at least one set of transmission unit, wherein each transmission unit comprises a first feeding structure, a second feeding structure, and a filtering structure;

Wherein, the second dielectric substrate is arranged between the first dielectric substrate and the third dielectric substrate; the radiation structure is arranged on the side of the first dielectric substrate away from the second dielectric substrate; the second feeding structure is arranged on a side of the second dielectric substrate close to the first dielectric substrate or on a side of the first dielectric substrate close to the second dielectric substrate; the filtering structure is arranged on a side of the third dielectric substrate close to the second dielectric substrate or on a side of the second dielectric substrate close to the third dielectric substrate; the first feeding structure passes through the first dielectric substrate, the second dielectric substrate, and the third dielectric substrate, and is connected to the second feeding structure and the filtering structure;

the first feeding structure is used for transmitting electromagnetic wave signals;

the second feeding structure is used for coupling feeding to the radiation structure; and

the filtering structure is used for filtering.

2. The antenna unit according to claim 1, **characterized in that** projections of the second feeding structure and the radiation structure on the second dielectric substrate overlap at least partially.
3. The antenna unit according to claim 1, **characterized in that** the filtering structure comprises a first filtering component and a second filtering component, one end of the first feeding structure is connected to the first filtering component, and the other end of the first filtering component is connected to the second filtering component; the first filtering component and the second filtering component form a T-shaped filtering structure.
4. The antenna unit according to claim 3, **characterized in that** the other end of the first filtering component is connected to a midpoint of the second filtering component.
5. The antenna unit according to claim 3, **characterized in that:**
 - the length of the first filtering component is a first length, and the width of the first filtering component is a first width;
 - the length of the second filtering component is a second length, and the width of the second filtering component is a second width;
 - the first length, the second length, the first width, and the second width are matched with radiation nulls of the antenna unit, wherein the radiation nulls are used to indicate frequency bands to be filtered.
6. The antenna unit according to claim 3, **characterized in that:**
 - an angle between a projection of the first filtering component and a projection of the second feeding structure on the third dielectric substrate is a target rotation angle;
 - the target rotation angle is matched with radiation nulls of the antenna unit, and the radiation nulls are used to indicate frequency bands to be filtered.
7. The antenna unit according to claim 1, **characterized in that:**
 - when a number of the transmission units is greater than one, the transmission units are uniformly distributed around a center point of the radiation structure.
8. The antenna unit according to claim 1, **characterized in that:**
 - a geometric shape of the radiation structure is circular, rectangular, or polygonal.
9. A filtering antenna **characterized by** comprising: the antenna unit according to any one of claims 1-8.
10. A terminal device **characterized in that:** it comprises: the filtering antenna according to claim 9.

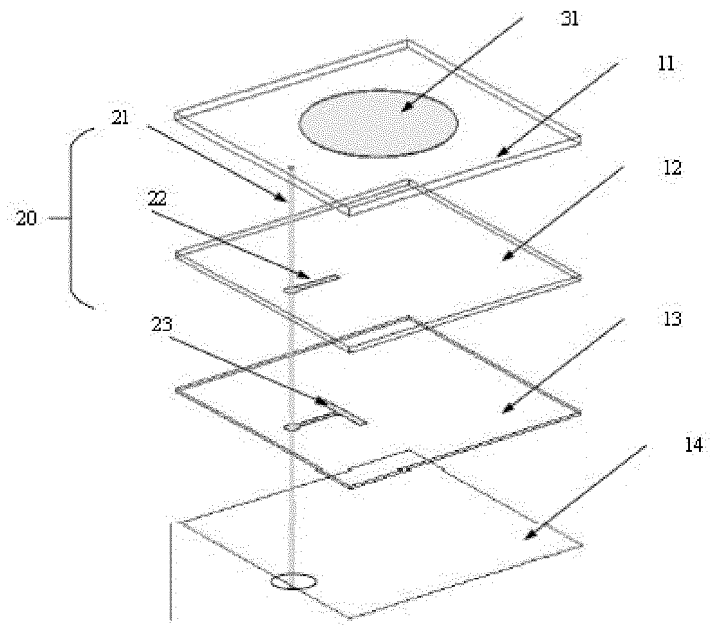


Fig. 1

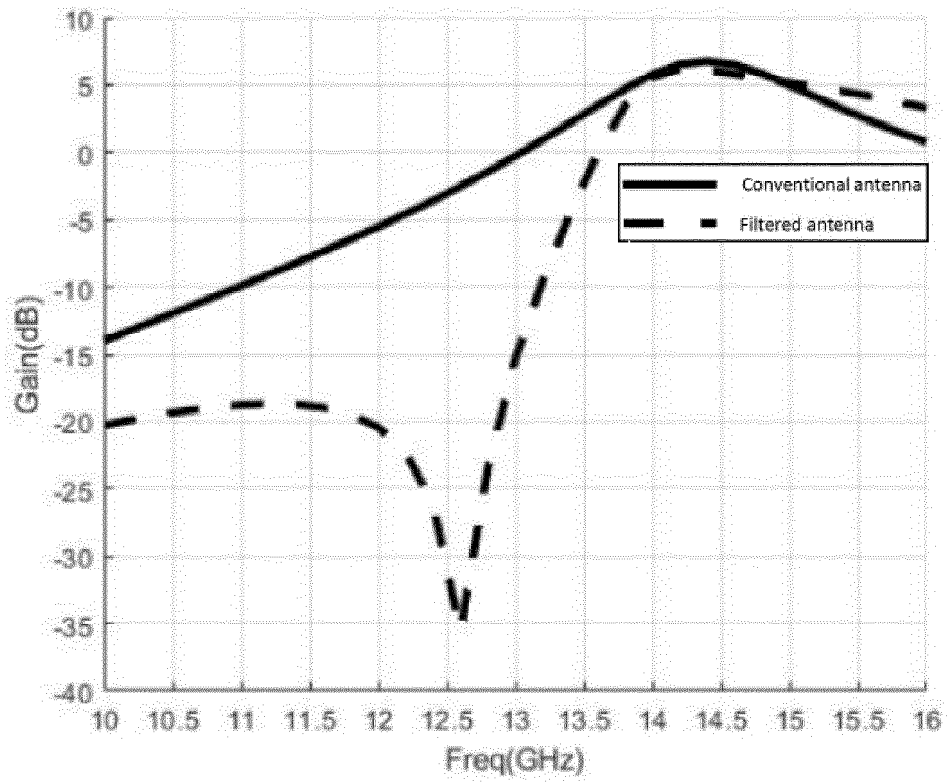


Fig.2

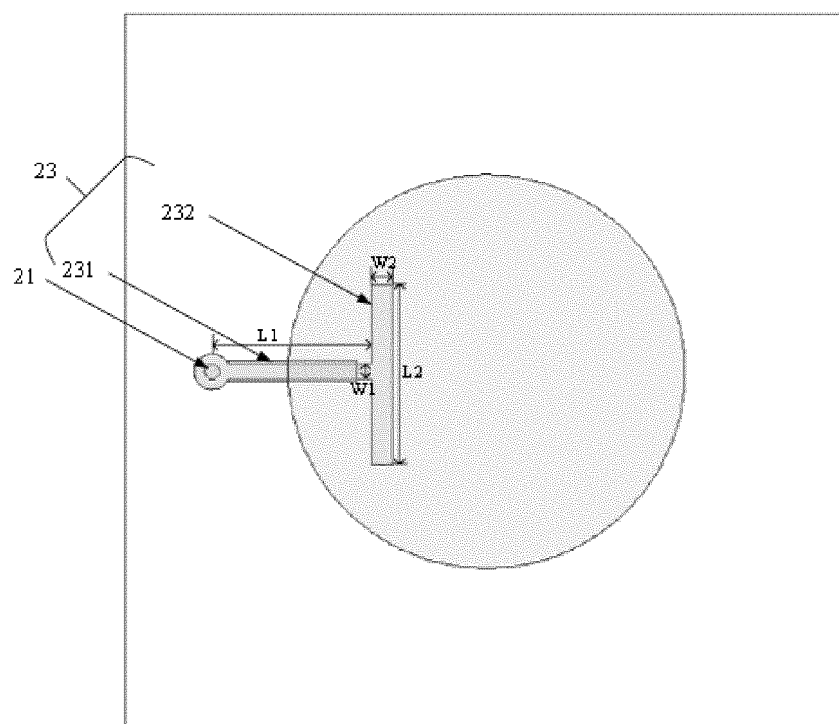


Fig. 3

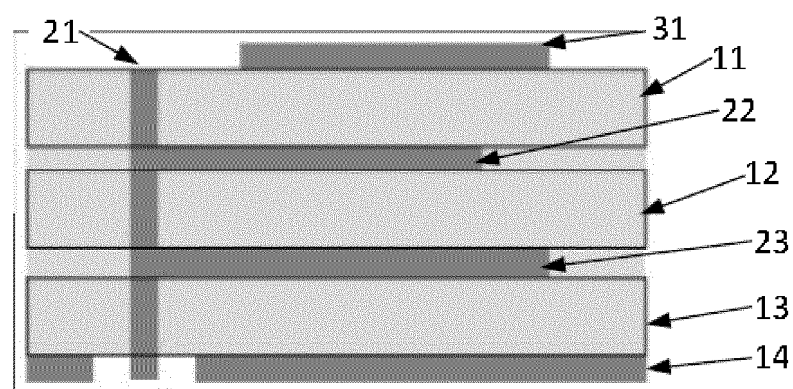


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2022/133128

A. CLASSIFICATION OF SUBJECT MATTER

H01Q1/36(2006.01)i;H01Q1/38(2006.01)i;H01Q1/50(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)

IPC: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, CNKI, IEEE: 天线, 滤波, 电介质, 馈电, 耦合, 贴片, 微带, 层叠, Antenna, filtering, dielectric, feed, coupling, patch, microstrip, stack-up

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 115173041 A (CHENGDU T-RAY TECHNOLOGY CO., LTD.) 11 October 2022 (2022-10-11) description, paragraphs [0005]-[0080], and figures 1-4	1-10
X	CN 211126042 U (SOUTH CHINA UNIVERSITY OF TECHNOLOGY) 28 July 2020 (2020-07-28) description, paragraphs [0004]-[0053], and figures 1-9	1-10
X	CN 112072267 A (SOUTH CHINA UNIVERSITY OF TECHNOLOGY) 11 December 2020 (2020-12-11) description, paragraphs [0005]-[0057], and figures 1-4	1-10
A	CN 205621854 U (SOUTH CHINA UNIVERSITY OF TECHNOLOGY) 05 October 2016 (2016-10-05) entire document	1-10
A	CN 206834330 U (SOUTH CHINA UNIVERSITY OF TECHNOLOGY) 02 January 2018 (2018-01-02) entire document	1-10

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

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Date of the actual completion of the international search

01 March 2023

Date of mailing of the international search report

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Name and mailing address of the ISA/CN

China National Intellectual Property Administration (ISA/
CN)China No. 6, Xitucheng Road, Jimenqiao, Haidian District,
Beijing 100088

Facsimile No. (86-10)62019451

Authorized officer

Telephone No.

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International application No.

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