United States Patent	12388181
Kind Code	B2
Date of Patent	August 12, 2025
Inventor(s)	Wu; Xiaopu

Antenna assembly and electronic device

Abstract

Provided is an antenna assembly and an electronic device. The antenna assembly includes the following. A first antenna including a first radiator and a first signal source electrically connected to the first radiator. A second antenna including a second radiator and a third radiator, one end of the second radiator is spaced apart from one end of the first radiator with a first coupling gap, and the other end of the second radiator is spaced apart from one end of the third radiator with a second coupling gap. The first radiator is configured to generate at least one resonant mode under excitation of the first signal source, and a part of the second radiator that is close to the second coupling gap is configured to generate at least one resonant mode under excitation of the first signal source through coupling of the first radiator.

Inventors: **Wu; Xiaopu (Guangdong, CN)**

Applicant: **GUANGDONG OPPO MOBILE TELECOMMUNICATIONS CORP., LTD.** (Guangdong, CN)

Family ID: **1000008752358**

Assignee: **GUANGDONG OPPO MOBILE TELECOMMUNICATIONS CORP., LTD. (Guangdong, CN)**

Appl. No.: **18/354475**

Filed: **July 18, 2023**

Prior Publication Data

Document Identifier	Publication Date
US 20230361470 A1	Nov. 09, 2023

Foreign Application Priority Data

CN	202110122572.7	Jan. 28, 2021

Related U.S. Application Data

continuation parent-doc WO PCT/CN2021/134511 20211130 PENDING child-doc US 18354475

Publication Classification

Int. Cl.: **H01Q5/335** (20150101); **H01Q1/22** (20060101)

U.S. Cl.:

CPC **H01Q5/335** (20150115); **H01Q1/22** (20130101);

Field of Classification Search

CPC: H01Q (5/342); H01Q (5/35); H01Q (1/241); H01Q (5/378); H01Q (5/40); H01Q (9/42); H01Q (1/36); H01Q (1/22); H01Q (1/521); H01Q (1/243); H01Q (5/335)

References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
11735809	12/2022	Wang	343/702	H01Q 9/42
2017/0279185	12/2016	Hung et al.	N/A	N/A
2019/0181555	12/2018	Lee	N/A	H01Q 3/247
2019/0252764	12/2018	Liao	N/A	H01Q 5/378
2020/0076059	12/2019	Hsiao	N/A	H01Q 1/1207
2020/0112080	12/2019	Wu et al.	N/A	N/A
2020/0373669	12/2019	Xue et al.	N/A	N/A
2021/0320392	12/2020	Hsu	N/A	H01Q 5/328
2022/0059931	12/2021	Xie	N/A	H01Q 5/328
2023/0344151	12/2022	Wu	N/A	H01Q 9/42
2023/0344152	12/2022	Wu	N/A	H01Q 1/521
2023/0352852	12/2022	Wu	N/A	H01Q 1/241

FOREIGN PATENT DOCUMENTS

Patent No.	Application Date	Country	CPC
105871407	12/2015	CN	N/A
106450662	12/2016	CN	N/A
108281767	12/2017	CN	N/A
108511881	12/2017	CN	N/A
108631041	12/2017	CN	N/A
208127429	12/2017	CN	N/A
109687111	12/2018	CN	N/A
111190500	12/2019	CN	N/A
111244616	12/2019	CN	N/A
112086753	12/2019	CN	N/A
212277399	12/2020	CN	N/A
4266494	12/2022	EP	N/A

OTHER PUBLICATIONS

EPO, Extended European Search Report for EP Application No. 21922510.9, Jun. 13, 2024. cited by applicant
WIPO, International Search Report and Written Opinion for International Application No. PCT/CN2021/134511, Feb. 16, 2022. cited by applicant
CNIPA, First Office Action for CN Application No. 202110122572.7, Oct. 8, 2022. cited by applicant
Li, "Evaluation of Multiple Antenna Systems in Compact Mobile Terminals," China Doctoral Dissertation Full-text Database Information Technology Series, 2013. cited by applicant
CNIPA, Second Office Action for CN Application No. 202110122572.7, May 4, 2023. cited by applicant
Xie et al., "A broadband miniaturized three-frequency PIFA antenna," Telegraph Science Journal, Chinese Journal of Radio Science, Dec. 2010, vol. 25, No. 6. cited by applicant
Wu et al., "Dual-Band MIMO System Based on Metal Frame for 5G Applications," 2019 IEEE Conference on Antenna Measurements & Applications (CAMA), 2020. cited by applicant
CNIPA, Notification to Grant Patent Right for Invention for CN Application No. 202110122572.7, Jun. 25, 2023. cited by applicant

---

Primary Examiner: Tran; Hai V

Attorney, Agent or Firm: Hodgson Russ LLP

Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION(S) (1) This application is a continuation of International Application No. PCT/CN2021/134511, filed Nov. 30, 2021, which claims priority to Chinese Patent Application No. 202110122572.7, filed Jan. 28, 2021, the entire disclosures of which are incorporated herein by reference.

TECHNICAL FIELD
(1) This application relates to the field of communication technologies, and in particular, to an antenna assembly and an electronic device.
BACKGROUND
(2) With the development of technologies, electronic devices such as mobile phones that have communication functions become more and more popular, and the functions become more and more powerful. An electronic device generally includes an antenna assembly to implement a communication function of the electronic device. How to improve communication quality of the electronic device and at the same time facilitate miniaturization of the electronic device becomes a technical problem to be solved.
SUMMARY
(3) Disclosed herein are an antenna assembly and an electronic device which can improve communication quality and facilitate overall miniaturization.
(4) In a first aspect, an antenna assembly is provided in implementations of the disclosure. The antenna assembly includes: a first antenna including a first radiator and a first signal source electrically connected to the first radiator, and a second antenna including a second radiator and a third radiator. One end of the second radiator is spaced apart from one end of the first radiator with a first coupling gap, and the other end of the second radiator is spaced apart from one end of the third radiator with a second coupling gap. The first radiator is configured to generate at least one

resonant mode under excitation of the first signal source, and a part of the second radiator that is close to the second coupling gap is configured to generate at least one resonant mode under excitation of the first signal source through coupling of the first radiator.
(5) In a second aspect, an electronic device is provided. The electronic device includes a frame and the antenna assembly. The first radiator, the second radiator, the third radiator, and the frame are integrated into a whole; or the first radiator, the second radiator, and the third radiator are formed on a surface of the frame; or the first radiator, the second radiator, and the third radiator are disposed on a flexible circuit board, and the flexible circuit board is attached to a surface of the frame. And/or, the frame includes multiple side edges connected end to end in sequence, and two adjacent side edges are intersected. The first coupling gap and the second coupling gap are respectively disposed on two intersected side edges of the frame; or, the first coupling gap and the second coupling gap are both disposed on a same side edge of the frame.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) To describe the technical solutions in the implementations of the disclosure more clearly, the following briefly introduces the accompanying drawings required for describing the implementations. Apparently, the accompanying drawings in the following description show merely some implementations of the disclosure, and a person of ordinary skill in the art may still derive other drawings from these accompanying drawings without creative efforts.
(2) FIG. **1** is a schematic structural diagram of an electronic device according to an implementation of the disclosure.
(3) FIG. **2** is an exploded view of the electronic device illustrated in FIG. **1**.
(4) FIG. **3** is a schematic structural diagram of a first type of antenna assembly according to an implementation of the disclosure.
(5) FIG. **4** is a schematic diagram of a first sub-resonant mode and a second sub-resonant mode according to an implementation of the disclosure.
(6) FIG. **5** is a schematic diagram of a first distribution of a first sub-resonant mode, a second sub-resonant mode, a third sub-resonant mode, and a fourth sub-resonant mode according to an implementation of the disclosure.
(7) FIG. **6** is a schematic diagram of a second distribution of a first sub-resonant mode, a second sub-resonant mode, a third sub-resonant mode, and a fourth sub-resonant mode according to an implementation of the disclosure.
(8) FIG. **7** is a schematic diagram of a third distribution of a first sub-resonant mode, a second sub-resonant mode, a third sub-resonant mode, and a fourth sub-resonant mode according to an implementation of the disclosure.
(9) FIG. **8** is a schematic diagram of a fourth distribution of a first sub-resonant mode, a second sub-resonant mode, a third sub-resonant mode, a fourth sub-resonant mode, and a fifth sub-resonant mode according to an implementation of the disclosure.
(10) FIG. **9** is a schematic structural diagram of a second type of antenna assembly according to an implementation of the disclosure.
(11) FIG. **10** is a schematic diagram of a sixth sub-resonant mode according to an implementation of the disclosure.
(12) FIG. **11** is a schematic diagram of a seventh sub-resonant mode according to an implementation of the disclosure.
(13) FIG. **12** is a schematic structural diagram of a third type of antenna assembly according to an implementation of the disclosure.
(14) FIG. **13** is a schematic diagram of movement of a sixth sub-resonant mode to different bands

according to an implementation of the disclosure;
(15) FIG. **14** is a schematic structural diagram of a radio frequency link from a second signal source to a second radiator according to an implementation of the disclosure.
(16) FIG. **15** is a schematic structural diagram of a first type of first matching circuit according to an implementation of the disclosure.
(17) FIG. **16** is a schematic structural diagram of a second type of first matching circuit according to an implementation of the disclosure.
(18) FIG. **17** is a schematic structural diagram of a third type of first matching circuit according to an implementation of the disclosure.
(19) FIG. **18** is a schematic structural diagram of a fourth type of first matching circuit according to an implementation of the disclosure.
(20) FIG. **19** is a schematic structural diagram of a fifth type of first matching circuit according to an implementation of the disclosure.
(21) FIG. **20** is a schematic structural diagram of a sixth type of first matching circuit according to an implementation of the disclosure.
(22) FIG. **21** is a schematic structural diagram of a seventh type of first matching circuit according to an implementation of the disclosure.
(23) FIG. **22** is a schematic structural diagram of an eighth type of first matching circuit according to an implementation of the disclosure.
(24) FIG. **23** is a schematic structural diagram of a fourth type of antenna assembly according to an implementation of the disclosure.
(25) FIG. **24** is a schematic structural diagram of the third type of antenna assembly arranged in an electronic device according to an implementation of the disclosure.
(26) FIG. **25** is another schematic structural diagram of the third type of antenna assembly arranged in an electronic device according to an implementation of the disclosure.
(27) FIG. **26** is a schematic structural diagram of a fifth type of antenna assembly according to an implementation of the disclosure.
(28) FIG. **27** is a schematic structural diagram of a sixth type of antenna assembly according to an implementation of the disclosure;
(29) FIG. **28** is a schematic structural diagram of a seventh type of antenna assembly according to an implementation of the disclosure.
(30) FIG. **29** is a schematic structural diagram of an eighth type of antenna assembly according to an implementation of the disclosure.
(31) FIG. **30** is a schematic structural diagram of a ninth type of antenna assembly according to an implementation of the disclosure.
(32) FIG. **31** is a schematic structural diagram of a tenth type of antenna assembly according to an implementation of the disclosure.
(33) FIG. **32** is a schematic structural diagram of an eleventh type of antenna assembly according to an implementation of the disclosure.

DETAILED DESCRIPTION

(34) The following clearly and completely describes the technical solutions in implementations of the disclosure with reference to the accompanying drawings in the implementations of the disclosure. Apparently, the described implementations are merely a part rather than all of the implementations of the disclosure. The implementations described herein can be combined with each other appropriately.
(35) Please refer to FIG. **1**, FIG. **1** is a schematic structural diagram of an electronic device according to an implementation of the disclosure. The electronic device **1000** may be a device capable of transmitting and receiving an electromagnetic wave signal(s), such as a telephone, a television, a tablet computer, a mobile phone, a camera, a personal computer, a notebook computer, a vehicle-mounted device, an earphone, a watch, a wearable device, a base station, a vehicle-

mounted radar, and a customer premise equipment (CPE). Taking the electronic device **1000** as a mobile phone as an example, for ease of description, the electronic device **1000** is described by taking the electronic device **1000** at a first view angle as a reference, a width direction of the electronic device **1000** is defined as an X direction, a length direction of the electronic device **1000** is defined as a Y direction, and a thickness direction of the electronic device **1000** is defined as a Z direction. A direction indicated by an arrow is a forward direction.

(36) Please refer to FIG. **2**, the electronic device **1000** includes an antenna assembly **100**, which is configured to transmit and receive a radio frequency signal, so as to implement a communication function of the electronic device **1000**. At least some components of the antenna assembly **100** are disposed on the main board **200** of the electronic device **1000**. It can be understood that, the electronic device **1000** further includes a display screen **300**, a battery **400**, a housing **500**, a camera, a microphone, a receiver, a speaker, a face recognition module, a fingerprint recognition module, and other components that can implement basic functions of a mobile phone, which are not described again in this implementation.

(37) The antenna assembly **100** is a built-in antenna of the electronic device **1000**. The antenna assembly **100** is disposed in the housing of the electronic device **1000**. The specific position of the antenna assembly **100** is described in the following.

(38) Please refer to FIG. **3**, the antenna unit **100** includes a first antenna **10** and a second antenna **20**, where the first antenna **10** and the second antenna **20** are antennas excited by different signal sources. This disclosure does not limit the specific frequency bands (in the following, “band(s)” for short) of the first antenna **10** and the second antenna **20**, for example, the first antenna **10** and the second antenna **20** are classified according to transmission/reception (in the following, “T/R” for short) bands, and the first antenna **10** and the second antenna **20** may both be low-frequency antennas supporting low-frequency signals; alternatively, one of the first antenna **10** and the second antenna **20** is a middle high-frequency antenna supporting a middle high-frequency signal, and the other is a low-frequency antenna supporting low-frequency signals; alternatively, both of the first antenna **10** and the second antenna **20** are middle high-ultra high-frequency antennas supporting middle high-ultra high-frequency signals. The low band (LB) refers to a band with a frequency less than 1000 MHz, and the middle high-ultra high band refers to a band covered by a middle high band (MHB) and an ultra-high band (UHB). The middle-high band is 1000 MHz-3000 MHz, and the ultra-high band is 3000 MHz-10000 MHz. This is one classification method, but the disclosure is not limited thereto.

(39) The low band is at least one of 4G long term evolution (LTE) and 5G new radio (NR). For example, specific application bands include but are not limited to B28, B20, B5, B8, N28, N20, N5, and N8. Definitely, in the low band, a 4G LTE signal may be loaded separately, or a 5G NR signal may be loaded separately, or a 4G LTE signal and a 5G NR signal may be loaded at the same time, that is, a dual connection (LTE NR double connect, EN-DC) between a 4G wireless access network and a 5G-NR is achieved.

(40) The middle-high band is at least one of 4G LTE, 5G NR, GPS-L1, GPS-L5, WIFI-2.4G, WIFI-5G, and the like. For example, specific application bands include but are not limited to B32, B3, B39, B1, B40, B41, N78, N79, and the like. Definitely, in the middle-high band, a 4G LTE signal may be separately loaded, or a 5G NR signal may be separately loaded, or a 4G LTE signal and a 5G NR signal may be loaded at the same time, that is, EN-DC between a 4G wireless access network and a 5G-NR is implemented.

(41) The low band and the middle high-ultra high band transmitted and received by the antenna assembly **100** provided in the implementation may also be obtained by aggregating multiple carriers (carriers are radio waves of a specific frequency), i. e. realizing carrier aggregation (CA), so as to increase a transmission bandwidth and improve a signal transmission rate.

(42) Please refer to FIG. **3**, the first antenna **10** includes a first radiator **11** and a first signal source **12** electrically connected to the first radiator **11**.

(43) Please refer to FIG. **3**, the second antenna **20** includes a second radiator **21** and a third radiator **23**. Optionally, the second antenna **20** further includes a second signal source **22** configured to feed the second radiator **21**. A first coupling gap **41** is disposed between one end of the second radiator **21** and one end of the first radiator **11**. A second coupling gap **42** is disposed between the other end of the second radiator **21** and one end of the third radiator **23**. The shape of the first radiator **11**, the shape of the second radiator **21**, and the shape of the third radiator **23** are not specifically limited in the disclosure, and include, but are not limited to, strips, sheets, rods, coatings, and films. In this implementation, that the first radiator **11**, the second radiator **21**, and the third radiator **23** are all strip-shaped is used as an example for description, but an extending direction of the first radiator **11**, the second radiator **21**, and the third radiator **23** is not limited, and therefore, the foregoing radiators may all have a linear shape, a curved shape, a multi-segment bend shape, or the like. On the extending trajectory, the above-mentioned radiator may be a strip with a uniform width, and may also be a strip with a gradually changed width or a different width such as having a widened region.
(44) The first coupling gap **41** is a split between a first end of the first radiator **11** and a first end of the second radiator **21**. For example, a width of the split is 0.5-2 mm, but is not limited to this size. The first radiator **11** and the second radiator **21** can be in capacitive coupling through the first coupling gap **41**. "Capacitive coupling" means that an electric field is generated between the first radiator **11** and the second radiator **21**, a signal of the first radiator **11** can be transmitted to the second radiator **21** through the electric field, and a signal of the second radiator **21** can be transmitted to the first radiator **11** through the electric field, so that the first radiator **11** and the second radiator **21** can achieve electrical signal conduction even in a disconnected state. The second coupling gap **42** is a split between a second end of the second radiator **21** and a first end of the third radiator **23**, and a width of the split is 0.5˜2 mm, but is not limited to this size. The second radiator **21** and the third radiator **23** can be in capacitive coupling through the second coupling gap **42**. In addition, the second end of the first radiator **11** is grounded, and the second end of the third radiator **23** is grounded.
(45) Grounding of the radiators of the antenna assembly **100** is described below. Optionally, the antenna assembly **100** itself has a reference ground GND. Specific forms of the reference ground GND include, but are not limited to, a metal plate directly exposed outside, a metal layer formed inside a flexible circuit board, and the like. The radiator of the antenna assembly **100** is electrically connected to the reference ground GND of the antenna assembly **100**. When the antenna assembly **100** is disposed in the electronic device **1000**, the reference ground GND of the antenna assembly **100** is electrically connected to the reference ground GND of the electronic device **1000**. Still alternatively, the antenna assembly **100** itself has no reference ground GND, and the radiator of the antenna assembly **100** is electrically connected to the reference ground GND of the electronic device **1000** or the reference ground GND of an electronic element within the electronic device **1000** directly or indirectly via an intermediate conductive connector.
(46) The first signal source **12** is a radio frequency transceiver chip for transmitting a radio frequency signal or a feeder electrically connected to the radio frequency transceiver chip for transmitting a radio frequency signal.
(47) The first radiator **11** is configured to generate, under excitation of the first signal source **12**, at least one resonant mode. The first radiator **11** is further configured to excite through the first coupling gap **41**, under excitation of the first signal source **12**, a part of the second radiator **21** which is close to the second coupling gap **42** to generate at least one resonant mode. The resonant mode characterizes that the electromagnetic wave transmission efficiency of the antenna assembly **100** at the resonant frequency of the resonant mode is high. That is to say, the second radiator **21** has high T/R efficiency at a certain resonant frequency under excitation of the first signal source **12**, and can further support T/R of an electromagnetic wave signal of a band near the resonant frequency.

(48) In other words, the radiator of the second antenna **20** can also be used by the first antenna **10** as a radiator of the first antenna **10** to generate a resonant mode, so that the band of the antenna assembly **100** is expanded. For an uncoupled antenna assembly **100**, in order to achieve the described bandwidth, a longer first radiator **11** needs to be provided, or a segment of radiator needs to be added in addition to the first radiator **11**, such that the overall stack size of the antenna assembly **100** is larger, and for an electronic device **1000** with extremely limited space, the antenna assembly **100** with a larger size is not beneficial to the miniaturization of the electronic device **1000**.
(49) According to the antenna assembly **100** and the electronic device **1000** provided in implementations of the disclosure, the radiator of the first antenna **10** and the radiator of the second antenna **20** are designed to be in capacitive coupling through the first coupling gap **41**. The signal source of the first antenna **10** is capable of exciting, through coupling of the first radiator **11**, the radiator of the second antenna **20** to transmit and receive electromagnetic wave signals of corresponding bands. In this way, the radiator of the second antenna **20** can be used as the radiator of the first antenna **10**. As a result, the space for stacking the radiator of the first antenna **10** and the radiator of the second antenna **20** is saved, and the overall size of the antenna assembly **100** is reduced. The second coupling gap **42** is disposed in the radiator of the second antenna **20**, so that the second radiator **21** can generate at least one resonant mode close to the second coupling gap **42** under excitation of the signal source of the first antenna **10**, or generate at least one resonant mode close to the first coupling gap **41** and generate at least one resonant mode close to the second coupling gap **42**. In this way, the number of positions where resonant modes are generated by the antenna assembly **100** can be increased, and the number of resonant modes generated by the antenna assembly **100** can be increased, thereby further increasing the bandwidths for transmitting and receiving signals of the antenna assembly **100**.
(50) The resonant frequency of the resonant mode generated by the first radiator **11** under excitation of the first signal source **12** is different from the resonant frequency of the resonant mode generated by the second radiator **21** under excitation through coupling of the first radiator **11**.
(51) In other words, in the antenna assembly **100**, the first signal source **12** is configured to excite the first radiator **11** to generate a resonant mode at one frequency, the first signal source **12** is also configured to excite the second radiator **21** to generate a resonant mode at another frequency since energy can be transferred through capacitive coupling between the first radiator **11** and the second radiator **21**. Since the resonant mode generated by the first radiator **11** has a frequency different from the resonant mode generated by the second radiator **21**, the band covered by the first radiator **11** under excitation of the first signal source **12** is different from the band covered by the second radiator **21** under excitation of the first signal source **12**, and these bands are combined together, so that the band width supported by the antenna assembly **100** is increased, thereby improving the transmission rate.
(52) In this implementation, the first signal source **12** is a middle high-ultra high-frequency excitation signal source, where the first signal source **12** is configured to excite both the first radiator **11** and the second radiator **21** to generate middle high-ultra high-frequency electromagnetic wave signals. In other implementations, the first signal source **12** may be a signal source for exciting a low-frequency signal, so as to excite the first radiator **11** and the second radiator **21** to generate a low-frequency electromagnetic wave signal.
(53) Further, by designing the length of the first radiator **11** or a matching circuit of the first radiator **11**, the frequency interval between the at least two resonant modes is relatively large, and the overlapping range of adjacent resonant modes is reduced, so as to further improve the band width supported by the first radiator **11**. The difference between the resonant frequency of the resonant mode generated by the first radiator **11** under excitation of the first signal source **12** and the resonant frequency of the resonant mode generated by the second radiator **21** under excitation of the first signal source **12** is a first preset value, for example, the first preset value is 500 MHz-

5000 MHz, but is not limited thereto. The bandwidth of each resonant mode is not specifically limited in the disclosure. The resonant modes generated by the first radiator **11** and the second radiator **21** under excitation of the first signal source **12** are adjacent and continuous resonant modes, and may also be discontinuous resonant modes. When the resonant modes generated by the first radiator **11** and the second radiator **21** under excitation of the first signal source **12** are adjacent resonant modes and are continuous with each other, the bands supported by the first radiator **11** and the second radiator **21** may be aggregated into a relatively wide band by means of carrier aggregation, thereby improving the transmission rate. For example, a band supported by the first radiator **11** is 1500 MHz-2000 MHz, and a band supported by the second radiator **21** is 2000 MHz-2500 MHz. A band of 1500 MHz-2500 MHz can be formed through carrier aggregation, thereby realizing a 1000 MHz bandwidth.

(54) Alternatively, referring to FIG. **4**, the first radiator **11** is configured to excite through the first coupling gap **41**, under excitation of the first signal source **12**, a part of the second radiator **21** close to the first coupling gap **41** and a part of the second radiator **21** close to the second coupling gap **42** to generate at least one resonant mode. The at least one resonant mode includes a first sub-resonant mode a and a second sub-resonant mode b. In other words, the resonant modes generated by the second radiator **21** under excitation through the coupling of the first radiator **11** (namely, under excitation of the first signal source **12**) include at least the first sub-resonant mode a and the second sub-resonant mode b. The resonant frequency of the first sub-resonant mode a is less than the resonant frequency of the second sub-resonant mode b. In other words, the second radiator **21** is configured to generate at least two resonant modes under excitation of the first signal source **12**. The at least two resonant modes may all be generated by the second radiator **21** close to the first coupling gap **41**. Alternatively, the at least two resonant modes may all be generated by the second radiator **21** close to the second coupling gap **42**. Alternatively, part of the at least two resonant modes is generated by the second radiator **21** at a position close to the first coupling gap **41**, and the other part of the at least two resonant modes is generated by the second radiator **21** at a position close to the second coupling gap **42**.

(55) In other words, one of the first sub-resonant mode a and the second sub-resonant mode b is generated by the part of the second radiator **21** close to the first coupling gap **41**, and the other one of the first sub-resonant mode a and the second sub-resonant mode b is generated by the part of the second radiator **21** close to the second coupling gap **42**. Alternatively, both the first sub-resonant mode a and the second sub-resonant mode b are generated by the part of the second radiator **21** close to the second coupling gap **42**. Alternatively, both the first sub-resonant mode a and the second sub-resonant mode b are generated by the part of the second radiator **21** close to the first coupling gap **41**.

(56) By setting the second radiator **21** to generate at least two resonant modes, on the one hand, the width of the band covered through excitation of the first signal source **12** is larger, on the other hand, the first antenna **10** has a higher utilization rate for the second radiator **21**. The utilization rate of the first antenna **10** for the second radiator **21** is improved while higher bandwidth is achieved, therefore, the stack size of the antenna assembly **100** is further reduced, and thus promote miniaturization design of the electronic device **1000** to ensure high bandwidth.

(57) In implementations of the disclosure, the first sub-resonant mode a is generated by the part of the second radiator **21** close to the first coupling gap **41**, and the second sub-resonant mode b is generated by the part of the second radiator **21** close to the second coupling gap **42**. In this way, the first sub-resonant mode a and the second sub-resonant mode b do not affect each other.

(58) Optionally, the length of the part of the second radiator **21** that generates the first sub-resonant mode a is set to be different from the length of the part of the second radiator **21** that generates the second sub-resonant mode b, as such, the first sub-resonant mode a and the second sub-resonant mode b have different frequencies, so as to cover a relatively wide bandwidth.

(59) Please refer to FIG. **5**, the resonant modes generated by the first radiator **11** under excitation of

the first signal source **12** at least include a third sub-resonant mode c and a fourth sub-resonant mode d. Where the resonant frequency of the third sub-resonant mode c is less than the resonant frequency of the fourth sub-resonant mode d. In other words, the first radiator **11** can generate at least two resonant modes under action of the first signal source **12**, and resonant bands of the at least two resonant modes are different, so as to increase a band width supported by the first radiator **11**. In addition, a length of the first radiator **11** or a matching circuit of the first radiator is designed, so that a frequency interval between the at least two resonant modes is relatively large, and an overlapping range of adjacent resonant modes is reduced, so as to further improve a band width supported by the first radiator **11**.

(60) The resonant frequency of the sub-resonant mode can be adjusted by adjusting the length of each part of the first radiator **11** and the second radiator **21** for generating the sub-resonant mode or by adjusting the matching circuit. The magnitude of the resonant frequency of the first sub-resonant mode a, the second sub-resonant mode b, the third sub-resonant mode c, and the fourth sub-resonant mode d is not limited. The following implementations are exemplified.

(61) In some possible implementations, referring to FIG. **5**, the resonant frequency of the second sub-resonant mode b is less than the resonant frequency of the third sub-resonant mode c. In other words, the resonance frequency of the first sub-resonant mode a, the resonance frequency of the second sub-resonant mode b, the resonance frequency of the third sub-resonant mode c, and the resonance frequency of the fourth sub-resonant mode d are sequentially increased.

(62) In this implementation, the first signal source **12** is configured to send a high-frequency signal, and the second signal source **22** is configured to send a low-frequency signal, therefore, the length of the first radiator **11** is relatively small, and the length of the second radiator **21** is relatively large. Due to the above size difference, when designing the first signal source **12** to excite to cover the high band, the relatively long second radiator **21** can support a relatively low band, in this way, it is convenient to design that the resonant frequency of the resonant mode generated by the first radiator **11** is greater than the resonant frequency of the resonant mode generated by the second radiator **21**. In this way, the length of the second antenna **20** for the second radiator **21** is increased, and the utilization rate of the second radiator **21** is increased.

(63) Alternatively, the magnitude of the resonant frequency may be inversely proportional to the length of the radiator generating the resonant mode.

(64) In some possible implementations, referring to FIG. **6**, the resonant frequency of the second sub-resonant mode b is greater than the resonant frequency of the third sub-resonant mode c and less than the resonant frequency of the fourth sub-resonant mode d, and the resonant frequency of the first sub-resonant mode a is less than or greater than the resonant frequency of the third sub-resonant mode c.

(65) In this implementation, the length of each of the radiation segments of the first radiator **11** for generating the third sub-resonant mode c and the fourth sub-resonant mode d are designed. When the band covered by the third sub-resonant mode c is discontinuous with the band covered by the fourth sub-resonant mode d, and a band between the band covered by the third sub-resonant mode c and the band covered by the fourth sub-resonant mode d needs to be used in practical use, the length of the part of the second radiator **21** for generating each sub-resonant mode or the matching circuit can be designed, so that the resonant frequency of the second sub-resonant mode b is between the resonant frequency of the third sub-resonant mode c and the resonant frequency of the fourth sub-resonant mode d, so that the second sub-resonant mode b covers the band between the band covered by the third sub-resonant mode c and the band covered by the fourth sub-resonant mode d. When the bandwidth between the band covered by the third sub-resonant mode c and the band covered by the fourth sub-resonant mode d is relatively large, and the band covered by the second sub-resonant mode b is insufficient to cover the bandwidth, the resonant frequency of the first sub-resonant mode a may also be designed to be between the resonant frequency of the third sub-resonant mode c and the resonant frequency of the fourth sub-resonant mode d, so that the

band covered by the third sub-resonant mode c, the band covered by the first sub-resonant mode a, the band covered by the second sub-resonant mode b, and the band covered by the fourth sub-resonant mode d form a continuous or near-continuous band, or cover the required band, so as to improve the correspondence between the band range supported by the electronic device **1000** and the band range provided by the operator, and improve the communication quality of the electronic device **1000**.
(66) In some possible implementations, referring to FIG. **7**, the resonant frequency of the second sub-resonant mode b is greater than the resonant frequency of the fourth sub-resonant mode d, and the resonant frequency of the first sub-resonant mode a is less than the resonant frequency of the third sub-resonant mode c. In other implementations, the resonant frequency of the second sub-resonant mode b is greater than the resonant frequency of the fourth sub-resonant mode d, and the resonant frequency of the first sub-resonant mode a is greater than the resonant frequency of the third sub-resonant mode c and less than the resonant frequency of the fourth sub-resonant mode d or the resonant frequency of the first sub-resonant mode a is greater than the resonant frequency of the fourth sub-resonant mode d.
(67) In this implementation, the length of each part of the first radiator **11** or the second radiator **21** for generating respective sub-resonant modes or the matching circuit is adjusted. If the first antenna **10** needs to support a higher band signal and the size of the second radiator **21** cannot be further reduced, the length of the part of the second radiator **21** that generates the sub-resonant mode or the matching circuit can be adjusted, such that the second radiator **21** can generate a second sub-resonant mode b of a higher band, and the first antenna **10** can support signals of a higher band.
(68) Optionally, referring to FIG. **8**, the resonant modes generated by the first radiator **11** under excitation of the first signal source **12** further includes a fifth sub-resonant mode e. The resonant frequency of the fifth sub-resonant mode e, the resonant frequency of the first sub-resonant mode a, the resonant frequency of the second sub-resonant mode b, the resonant frequency of the third sub-resonant mode c, and the resonant frequency of the fourth sub-resonant mode d increase sequentially. The fifth sub-resonant mode e is a resonant mode in which the first radiator **11** operates in high-order resonance. The third sub-resonant mode c is a resonant mode in which the first radiator **11** operates in a ground state.
(69) Specifically, the resonant frequency of the fifth sub-resonant mode e is relatively low in the resonant frequencies in the resonant modes generated under excitation of the first signal source **12**, so as to implement relatively low frequency coverage in the band covered by the first antenna **10**. Because the length of the first radiator **11** is relatively small, the resonant mode in the ground state cannot support the relatively low band, therefore, the signal transmitted by the first signal source **12** is fed into the first radiator **11** by means of capacitive coupling feed, so as to excite the first radiator **11** to generate a high-order resonance, thereby exciting a relatively low band on the relatively short first radiator **11**, improving the utilization rate of the first radiator **11** and increasing the supporting bandwidth of the first antenna **10**.
(70) It can be understood that, in any one of the foregoing implementations, the first sub-resonant mode a, the second sub-resonant mode b, the third sub-resonant mode c, the fourth sub-resonant mode d, and the fifth sub-resonant mode e may all be aggregated in a carrier aggregation manner, so as to form a band with relatively wide bandwidth and improve the signal transmission rate.
(71) Optionally, the first signal source **12** is a signal source for transmitting a middle high-ultra high-frequency signal. A bandwidth of a band formed through combination of a band covered by a resonant mode generated by the first radiator **11** under excitation of the first signal source **12** and a band covered by a resonant mode generated by the second radiator **21** under excitation of the first signal source **12** is 500 MHz-5000 MHz. That is, the bands covered by the fifth sub-resonant mode e, the first sub-resonant mode a, the second sub-resonant mode b, the third sub-resonant mode c, and the fourth sub-resonant mode d are combined into a relatively large band bandwidth through carrier aggregation, for example, 500 MHz-5000 MHz, but the disclosure is not limited thereto.

(72) And/or, a band covered by the resonant mode generated by the first radiator **11** under excitation of the first signal source **12** and a band covered by the resonant mode generated by the second radiator **21** under excitation of the first signal source **12** are both greater than 1000 MHz.
(73) Further, a band formed through combination of the band covered by the resonant mode generated by the first radiator **11** under excitation of the first signal source **12** and the band covered by the resonant mode generated by the second radiator **21** under excitation of the first signal source **12** covers 1000 MHz-600 MHz. As such, the first antenna **10** can support at least one of the middle high-ultra high band in 4G LTE, the middle high-ultra high band in 5G NR, GPS-L1, GPS-L5, WiFi-2.4G, WiFi-5G, and/or the like.
(74) Specific structures of the first antenna **10** and the second antenna **20** are not specifically limited in the disclosure, and specific structures of the first antenna **10** and the second antenna **20** are illustrated in the following implementations.
(75) Optionally, referring to FIG. **9**, the first radiator **11** is in a strip shape. The first radiator **11** includes a first ground end A, a first coupling end **111**, and a first feeding point B located between the first ground end A and the first coupling end **111**. The first ground end A and the first coupling terminal **111** are opposite ends of the first radiator **11**. The first ground end A is grounded, and specifically, the first ground end A is electrically connected to the reference ground GND of the antenna assembly **100** or electrically connected to the reference ground GND of the electronic device **1000**. The first feeding point B is a position where a signal is fed into the first radiator **11**.
(76) The first coupling end **111** is an end of the first radiator **11** where the first coupling gap **41** if formed.
(77) Please refer to FIG. **9**, the first antenna **10** further includes a first matching circuit M**1**, and one end of the first matching circuit M**1** is electrically connected to the first signal source **12**. The other end of the first matching circuit M**1** is electrically connected to the first feeding point B.
(78) Specifically, referring to FIG. **9**, the first signal source **12** is configured to generate or transmit an excitation signal. The first matching circuit M**1** is configured to filter the clutter in the excitation signal transmitted by the first signal source **12**, and transfer the excitation signal to the first radiator **11**, so that the first radiator **11** generates the third sub-resonant mode c, the fourth sub-resonant mode d, and the fifth sub-resonant mode e under excitation of the excitation signal. When the first radiator **11** generates a resonant mode, it indicates that the first radiator **11** has a better T/R efficiency at a certain resonant frequency, and further indicates that the first radiator **11** has a better T/R efficiency in a certain band range with the resonant frequency as a central frequency, in other words, the first radiator **11** can support the above band range under action of the first signal source **12**.
(79) Please refer to FIG. **8** and FIG. **9** together, the first radiator **11** between the first ground end A and the first coupling end **111** is configured to generate the third sub-resonant mode c under action of the first signal source **12**. Specifically, an impedance of the first matching circuit M**1** is low impedance with respect to the resonant frequency of the third sub-resonant mode c. The first matching circuit M**1** excites, with a low impedance feed, the first radiator **11** between the first ground end A and the first coupling end **111** to generate a ¼ wavelength resonant mode. The ¼ wavelength resonant mode is also a ground state resonant mode. This mode correspondingly has relatively high T/R efficiency. In this case, the effective electrical length of the first radiator **11** between the first ground end A and the first coupling end **111** is ¼ of the wavelength corresponding to the resonant frequency of the third sub-resonant mode c, or, under the tuning of the matching circuit, the equivalent effective electrical length of the first radiator **11** between the first ground end A and the first coupling end **111** is ¼ of the wavelength corresponding to the resonant frequency of the third sub-resonant mode c. In this way, the third sub-resonant mode c generated by the first radiator **11** has higher T/R efficiency, and the antenna assembly **100** has better performance in a band with the resonant frequency of the third sub-resonant mode c as the central frequency.
(80) Please refer to FIG. **8** and FIG. **9** together, the first radiator **11** between the first feeding point

B and the first coupling end **111** is configured to generate the fourth sub-resonant mode d under action of the first signal source **12**. Specifically, the impedance of the first matching circuit M**1** is low impedance with respect to the resonant frequency of the fourth sub-resonant mode d. The first matching circuit M**1** excites, with a low impedance feed, the first radiator **11** between the first feeding point B and the first coupling end **111** to generate a ¼ wavelength resonant mode. The ¼ wavelength resonant mode is also a ground state resonant mode, which correspondingly has high T/R efficiency. In this case, the effective electrical length of the first radiator **11** between the first feeding point B and the first coupling end **111** is ¼ of the wavelength corresponding to the resonant frequency of the fourth sub-resonant mode d, or, under the tuning of the matching circuit, the equivalent effective electrical length of the first radiator **11** between the first feeding point B and the first coupling end **111** is ¼ of the wavelength corresponding to the resonant frequency of the fourth sub-resonant mode d. In this way, the fourth sub-resonant mode d generated by the first radiator **11** has higher T/R efficiency, and the antenna assembly **100** has better performance in a band with the resonant frequency of the fourth sub-resonant mode d as the central frequency.

(81) Please refer to FIG. **8** and FIG. **9** together, the first radiator **11** between the first ground end A and the first coupling terminal **111** generates the fifth sub-resonant mode e under a capacitive coupling feed effect of the first signal source **12**. Specifically, the resonant frequency of the impedance of the first matching circuit M**1** with respect to that of the fifth sub-resonant mode e is high impedance, and the first matching circuit M**1** excites, with high impedance feed, the first radiator **11** between the first ground end A and the first coupling terminal **111** to generate a ⅛ wavelength resonant mode. In this case, the effective electrical length of the first radiator **11** between the first ground end A and the first coupling end **111** is ⅛ of the wavelength corresponding to the resonant frequency of the fifth sub-resonant mode e, or, under the tuning of the matching circuit, the equivalent effective electrical length of the first radiator **11** between the first ground end A and the first coupling end **111** is ⅛ of the wavelength corresponding to the resonant frequency of the fifth sub-resonant mode e. In this way, the fifth sub-resonant mode e generated by the first radiator **11** has higher T/R efficiency, and the antenna assembly **100** has better performance in a band with the resonant frequency of the fifth sub-resonant mode e as a central frequency. A ⅛ wavelength resonant mode is excited on the first radiator **11** between the first ground end A and the first coupling end **111**, so that a relatively small band is excited on the small-sized first radiator **11**, thereby further expanding a bandwidth.

(82) The first radiator **11** generates the third sub-resonant mode c, the fourth sub-resonant mode d, and the fifth sub-resonant mode e under excitation of the first signal source **12**, multiple resonant modes are generated by one radiator, and the resonant modes have different frequencies. A band with a wide bandwidth can be formed on a small-sized antenna through carrier aggregation of these resonant modes, thereby the first antenna **10** can support multiple different types of network communication signals.

(83) Please refer to FIG. **9**, the second radiator **21** includes a second coupling end **211**, a third coupling end **212**, and a first resonant point C, a second feeding point E, and a second resonant point F that are disposed between the second coupling end **211** and the third coupling end **212** in sequence.

(84) Please refer to FIG. **9**, the third radiator **23** includes a fourth coupling end **213** and a second ground end G, where the second ground end G is grounded.

(85) The second coupling end **211** is an end of the second radiator **21** where the first coupling gap **41** is formed. The second radiator **21** is in a long strip shape. The second coupling end **211** and the third coupling end **212** are opposite ends of the second radiator **21**. The first coupling end **111** and the second coupling end **211** are opposite to each other and spaced apart with the first coupling gap **41**. The third coupling end **212** is an end where the second coupling gap **42** is formed. The second coupling gap **42** is formed between the third coupling end **212** and the fourth coupling end **213**. The second feeding point E is a position where a signal is fed into the second radiator **21**.

(86) Please refer to FIG. **9**, the second antenna **20** further includes a second matching circuit M**2**, a third matching circuit M**3**, and a fourth matching circuit M**4**. One end of the second matching circuit M**2** is grounded, and the other end of the second matching circuit M**2** is electrically connected to the first resonant point C. One end of the third matching circuit M**3** is grounded, and the other end of the third matching circuit M**3** is electrically connected to the second resonant point F. One end of the fourth matching circuit M**4** is electrically connected to the second signal source **22**, and the other end of the fourth matching circuit M**4** is electrically connected to the second feeding point E.

(87) In this implementation, referring to FIG. **8** and FIG. **9** together, because the first radiator **11** and the second radiator **21** are in capacitive coupling through the first coupling gap **41**, the excitation energy of the first signal source **12** is transferred to the second radiator **21** through the first radiator **11**, and the second radiator **21** between the first resonant point C and the second coupling end **211** generates the first sub-resonant mode a under excitation through the coupling of the first radiator **11**. Specifically, the impedance of the first matching circuit M**1** is low impedance with respect to the resonant frequency of the first sub-resonant mode a, and the second radiator **21** between the first resonant point C and the second coupling end **211** is excited with a low impedance feed to generate a ¼ wavelength resonant mode, where the ¼ wavelength resonant mode is also a ground state resonant mode, and the mode correspondingly has relatively high T/R efficiency. In this case, the impedance of the second matching circuit M**2** is in a low impedance state with respect to the frequency of the first sub-resonant mode a, so that the signal of the first sub-resonant mode a passes through the second matching circuit M**2** to the ground with low impedance. The effective electrical length of the second radiator **21** between the first resonant point C and the second coupling end **211** is ¼ of the wavelength corresponding to the resonant frequency of the first sub-resonant mode a, or, under the tuning of the matching circuit, the equivalent effective electrical length of the second radiator **21** between the first resonant point C and the second coupling end **211** is ¼ of the wavelength corresponding to the resonant frequency of the first sub-resonant mode a. In this way, the first sub-resonant mode a generated by the second radiator **21** has high T/R efficiency, and the antenna assembly **100** has good performance in a band with the resonant frequency of the first sub-resonant mode a as the central frequency.

(88) In this implementation, referring to FIG. **8** and FIG. **9** together, because the first radiator **11** and the second radiator **21** are in capacitive coupling through the first coupling gap **41**, the excitation energy of the first signal source **12** is transferred to the second radiator **21** through the first radiator **11**, and the second radiator **21** between the second resonant point F and the third coupling end **212** generates the second sub-resonant mode b under excitation through the coupling of the first radiator **11**. Specifically, the impedance of the first matching circuit M**1** is low impedance relative to the resonant frequency of the second sub-resonant mode b, and the second radiator **21** between the second resonant point F and the third coupling end **212** is excited with low impedance feed to generate a ¼ wavelength resonant mode, where the ¼ wavelength resonant mode is also a ground state resonant mode, and the mode correspondingly has high T/R efficiency. In this case, the impedance of the third matching circuit M**3** is in a low impedance state relative to the frequency of the second sub-resonant mode b, so that the signal of the second sub-resonant mode b passes through the third matching circuit M**3** to the ground with low impedance. The effective electrical length of the second radiator **21** between the second resonant point F and the third coupling end **212** is ¼ of the wavelength corresponding to the resonant frequency of the second sub-resonant mode b, or, under the tuning of the matching circuit, the equivalent effective electrical length of the second radiator **21** between the second resonant point F and the third coupling end **212** is ¼ of the wavelength corresponding to the resonant frequency of the second sub-resonant mode b. In this way, the second sub-resonant mode b generated by the second radiator **21** has higher T/R efficiency, and the antenna assembly **100** has better performance in a band with the resonant frequency of the second sub-resonant mode b as the central frequency.

(89) The part of the second radiator **21** between the second coupling end **211** and the first resonant point C and the part of the second radiator **21** between the second resonant point F and the third coupling end **212** may be used by the first antenna **10** when transmitting and receiving a middle high-band and ultra high-band, as such, the first antenna **10** and the second antenna **20** are integrated. Compared with a non-integrated antenna, the size of the radiator in the antenna assembly **100** is greatly reduced, it is beneficial to the miniaturization of the electronic device **1000**. The described five resonant modes are generated by the first radiator **11** and the second radiator **21**, as a result, the bandwidth of transmitting/receiving the middle high-ultra high-frequency signal by the first antenna **10** is greatly increased.
(90) Specifically, the second signal source **22** is configured to generate or transmit an excitation signal, and the fourth matching circuit M**4** is configured to filter the clutter in the excitation signal transmitted by the second signal source **22** and transmit the excitation signal to the second radiator **21**. The second radiator **21** and the third radiator **23** are in capacitive coupling through the second coupling gap **42**, and the second radiator **21** and the third radiator **23** are configured to generate a resonant mode under excitation of the excitation signal.
(91) The second radiator **21** is configured to generate at least one resonant mode under excitation of the second signal source **22**, where a band covered by the resonant mode generated by the second radiator **21** under excitation of the second signal source **22** is less than 1000 MHz. In other words, the second radiator **21** covers a low band when excited by the second signal source **22**.
(92) In this implementation, the second radiator **21** has two functions, can serve as a radiator of the first antenna **10** to transmit and receive a middle high-ultra high-frequency signal, and can also serve as a radiator of the second antenna **20** to transmit and receive a low-frequency signal, thereby increasing the utilization rate of the second radiator **21** and further reducing the overall size of the antenna assembly **100**.
(93) Optionally, referring to FIG. **10**, the second radiator **21** between the first resonant point C and the third coupling end **212** is configured to generate at least one resonant mode under excitation of the second signal source **22**. For ease of description, the resonant mode generated by the second radiator **21** between the first resonant point C and the third coupling end **212** under excitation of the second signal source **22** is defined as a sixth sub-resonant mode f.
(94) Specifically, the impedance of the fourth matching circuit M**4** is low impedance with respect to the resonant frequency of the sixth sub-resonant mode f, and the second radiator **21** between the first resonant point C and the third coupling end **212** is excited with the low impedance feed to generate a ¼ wavelength resonant mode, where the ¼ wavelength resonant mode is also a ground state resonant mode, and the mode correspondingly has high T/R efficiency. In this case, the impedance of the second matching circuit M**2** is in a low impedance state with respect to the frequency of the sixth sub-resonant mode f, so that the signal of the sixth sub-resonant mode f passes through the second matching circuit M**2** to the ground with low impedance. The effective electrical length of the second radiator **21** between the first resonant point C and the third coupling end **212** is ¼ of the wavelength corresponding to the resonant frequency of the sixth sub-resonant mode f, or, under the tuning of the matching circuit, the equivalent effective electrical length of the second radiator **21** between the first resonant point C and the third coupling end **212** is ¼ of the wavelength corresponding to the resonant frequency of the sixth sub-resonant mode f. In this way, the sixth sub-resonant mode f generated by the second radiator **21** has higher T/R efficiency, and the antenna assembly **100** has better performance in a band with the resonant frequency of the sixth sub-resonant mode f as the central frequency.
(95) Optionally, referring to FIG. **11**, the second radiator **21** between the second resonant point F and the second coupling end **211** is configured to generate at least one resonant mode under excitation of the second signal source **22**. For ease of description, the resonant mode generated by the second radiator **21** between the second resonant point F and the second coupling end **211** under excitation of the second signal source **22** is defined as a seventh sub-resonant mode g.

(96) Specifically, the impedance of the fourth matching circuit M**4** is low impedance relative to the resonant frequency of the seventh sub-resonant mode g, and the second radiator **21** between the second resonant point F and the second coupling end **211** is excited with a low impedance feed to generate a ¼ wavelength resonant mode, where the ¼ wavelength resonant mode is also a ground state resonant mode, and the mode has relatively high T/R efficiency. In this case, the impedance of the third matching circuit M**3** is in a low impedance state with respect to the frequency of the seventh sub-resonant mode g, so that the signal of the seventh sub-resonant mode g passes through the third matching circuit M**3** to the ground with low impedance. The effective electrical length of the second radiator **21** between the second resonant point F and the second coupling end **211** is ¼ of the wavelength corresponding to the resonant frequency of the seventh sub-resonant mode g, or, under the tuning of the matching circuit, the equivalent effective electrical length of the second radiator **21** between the second resonant point F and the second coupling end **211** is ¼ of the wavelength corresponding to the resonant frequency of the seventh sub-resonant mode g. In this way, the seventh sub-resonant mode g generated by the second radiator **21** has higher T/R efficiency, and the antenna assembly **100** has better performance in a band with the resonant frequency of the seventh sub-resonant mode g as the central frequency.
(97) Optionally, the antenna assembly **100** may be configured to control the second radiator **21** to generate one of the sixth sub-resonant mode f and the seventh sub-resonant mode g to support a low band. where the resonant frequency of the sixth sub-resonant mode f may be greater than, less than, or equal to the resonant frequency of the seventh sub-resonant mode g.
(98) Please refer to FIG. **12**, the second radiator **21** further includes a frequency tuning point D, where the frequency tuning point D is located between the first resonant point C and the second feeding point E. The second antenna **20** further includes a fifth matching circuit M**5**. One end of the fifth matching circuit M**5** is grounded, and the other end of the fifth matching circuit M**5** is electrically connected to the frequency tuning point D. At least one of the second matching circuit M**2**, the third matching circuit M**3**, the fifth matching circuit M**5**, and the fourth matching circuit M**4** is configured to adjust a resonant frequency of a resonant mode generated by the second radiator **21** under excitation of the second signal source **22**. In this implementation, any one of the second matching circuit M**2**, the third matching circuit M**3**, the fifth matching circuit M**5**, and the fourth matching circuit M**4** may be configured to adjust the resonant frequency of the resonant mode generated by the second radiator **21** under excitation of the second signal source **22**, so that the resonant frequency of the resonant mode generated by the second radiator **21** under excitation of the second signal source **22** changes towards a low band or changes towards a high band, so that the resonant frequency of the resonant mode generated by the second radiator **21** under excitation of the second signal source **22** can cover a low band of 500 MHz to 1000 MHz in different time periods, to cover B28, B20, B5, B8, N28, N20, N5, N8 and other application bands.
(99) For example, referring to FIG. **13**, the resonant frequency of the resonant mode generated by the second radiator **21** under excitation of the second signal source **22** is 780 MHz, which may support a band of 740 MHz-820 MHz. By adjusting any one of the second matching circuit M**2**, the third matching circuit M**3**, the fifth matching circuit M**5**, and the fourth matching circuit M**4**, the sixth sub-resonant mode f generated by the second radiator **21** under excitation of the second signal source **22** can support a band of 500 MHz-580 MHz, a band of 580 MHz-660 MHz, a band of 660 MHz-740 MHz, a band of 820 MHz-900 MHz, a band of 900 MHz-980 MHz, etc.
(100) In addition, a tuning manner for the high-frequency signal generated by the first antenna **10** includes, but is not limited to, an implementation in which the first sub-resonant mode a may be tuned by the second matching circuit M**2** and the second sub-resonant mode b may be tuned by the third matching circuit M**3**. The third sub-resonant mode c, the fourth sub-resonant mode d, and the fifth sub-resonant mode e may be tuned by the first matching circuit M**1**.
(101) The first matching circuit M**1** to the fifth matching circuit M**5** all have the function of changing the impedance of the radiator, and the structures of the first matching circuit M**1** to the

fifth matching circuit M**5** are not specifically limited in the disclosure. Optionally, the first matching circuit M**1** to the fifth matching circuit M**5** each include, but are not limited to, capacitors, inductors, and resistors that are connected in series and/or in parallel. Specifically, the first matching circuit M**1** may include multiple branches formed by a capacitor, an inductor, and a resistor that are connected in series and/or in parallel and a switch that controls on/off of the multiple branches. By controlling the on-off of different branches, frequency selection parameters (including a resistance value, an inductance value, and a capacitance value) of the first matching circuit M**1** can be adjusted, and then the impedance of the first matching circuit M**1** is adjusted, so that the transmission impedance of the feeding branch matches the impedance of the first radiator **11**, thereby improving the T/R efficiency of the first radiator **11**. At the same time, the first matching circuit M**1** can also adjust the impedance thereof to adjust the effective electrical length of the first radiator **11**, and then adjust the resonant frequency of the resonant mode generated by the first radiator **11** to move towards a high frequency direction or a low frequency direction, so as to adjust the band range covered by the first radiator **11** and increase the supportable bandwidth range.
(102) Furthermore, optionally, the first matching circuit M**1** further includes an adjustable capacitor, and the adjustable capacitor can adjust the capacitance value thereof, and then adjust the impedance value of the first matching circuit M**1**, so that the transmission impedance of the feeding branch matches the impedance of the first radiator **11**, thereby improving the T/R efficiency of the first radiator **11**; and adjust a resonant frequency of a resonant mode generated by the first radiator **11** to move towards a high frequency direction or a low frequency direction, so as to adjust a band range covered by the first radiator **11**, thereby increasing a supportable bandwidth range.
(103) Similarly, for structures of the second matching circuit M**2** to the fifth matching circuit M**5**, reference may be made to structures and adjustment manners of the first matching circuit M**1**, so as to achieve impedance matching and improve T/R efficiency of the antenna assembly **100**, and a band range covered by the radiator can be adjusted, so as to increase a supportable bandwidth range. Details are not redundantly described herein.
(104) For the first matching circuit M**1** and the fourth matching circuit M**4**, the first matching circuit M**1** and the fourth matching circuit M**4** also have a filtering function, so as to increase the isolation between the first antenna **10** and the second antenna **20**. For example, the first signal source **12** and the second signal source **22** are the same signal source. The first matching circuit M**1** is provided with a high frequency band-pass branch which is electrically connected between the first signal source **12** and the first radiator **11**, so as to transfer the high-frequency signal from the first signal source **12** to the first radiator **11**. The fourth matching circuit M**4** is provided with a low frequency band-pass branch which is electrically connected between the second signal source **22** and the second radiator **21**, so as to transfer the low-frequency signal from the second signal source **22** to the second radiator **21**. Since the first matching circuit M**1** and the second matching circuit M**2** respectively filter out the high-frequency signal and the low-frequency signal, and the high-frequency signal and the low-frequency signal have a good isolation due to the frequency difference, so that the first antenna **10** and the second antenna **20** has small mutual interference and high isolation.
(105) Further, the fourth matching circuit M**4** may also be provided with a clutter filter circuit, so as to reduce interference of the clutter on the second antenna **20** and the first antenna **10**.
(106) Specifically, referring to FIG. **14**, the second antenna **20** further includes a middle-high frequency band-pass branch **214**, where one end of the middle-high frequency band-pass branch **214** is grounded. The other end of the middle-high frequency band-pass branch **214** is electrically connected to a fourth matching circuit M**4**. The middle-high frequency band-pass branch **214** includes an inductor and a capacitor which are arranged in series. One end of the capacitor is electrically connected to the fourth matching circuit M**4**, the other end of the capacitor is electrically connected to one end of the inductor, and the other end of the inductor is grounded. The

middle-high frequency band-pass branch **214** connected in parallel to the ground is disposed in the fourth matching circuit M**4** to filter out the high frequency clutter in the second signal source **22**, so that the second antenna **20** is not interfered by the high frequency clutter, and the high frequency clutter in the second antenna **20** will not interfere with the first signal source **12**, thereby improving the isolation between the first antenna **10** and the second antenna **20**.
(107) Accordingly, the first matching circuit M**1** may be provided with a grounded low frequency band-pass branch to filter out the low frequency clutter in the first signal source **12**, so as to prevent the low frequency clutter from interfering with the signal T/R of the first antenna **10**, and at the same time, prevent the low frequency clutter from interfering with the signal T/R of the second antenna **20**, thereby increasing the isolation between the first antenna **10** and the second antenna **20**.
(108) Please refer to FIG. **15**-FIG. **22** together, FIG. **15**-FIG. **22** are schematic diagrams of the first matching circuit M**1** according to various implementations. The first matching circuit M**1** includes one or more of the following circuits.
(109) Please refer to FIG. **15**, the first matching circuit M**1** includes a band-pass circuit formed by an inductor L**0** and a capacitor C**0** connected in series.
(110) Please refer to FIG. **16**, the first matching circuit M**1** includes a band-stop circuit formed by an inductor L**0** and a capacitor C**0** connected in parallel.
(111) Please refer to FIG. **17**, the first matching circuit M**1** includes an inductor L**0**, a first capacitor C**1**, and a second capacitor C**2**. The inductor L**0** is connected in parallel to the first capacitor C**1**, and the second capacitor C**2** is electrically connected to a point where the inductor L**0** is electrically connected to the first capacitor C**1**.
(112) Please refer to FIG. **18**, the first matching circuit M**1** includes a capacitor C**0**, a first inductor L**1**, and a second inductor L**2**. The capacitor C**0** is connected in parallel to the first inductor L**1**, and the second inductor L**2** is electrically connected to a point where the capacitor C**0** is electrically connected to the first inductor L**1**.
(113) Please refer to FIG. **19**, the first matching circuit M**1** includes an inductor L**0**, a first capacitor C**1**, and a second capacitor C**2**. The inductor L**0** is connected in series with the first capacitor C**1**, one end of the second capacitor C**2** is electrically connected to a first end of the inductor L**0** that is not connected to the first capacitor C**1**, and the other end of the second capacitor C**2** is electrically connected to one end of the first capacitor C**1** that is not connected to the inductor L**0**.
(114) Please refer to FIG. **20**, the first matching circuit M**1** includes a capacitor C**0**, a first inductor L**1**, and a second inductor L**2**. The capacitor C**0** is connected in series to the first inductor L**1**, one end of the second inductor L**2** is electrically connected to one end of the capacitor C**0** that is not connected to the first inductor L**1**, and the other end of the second inductor L**2** is electrically connected to one end of the first inductor L**1** that is not connected to the capacitor C**0**.
(115) Please refer to FIG. **21**, the first matching circuit M**1** includes a first capacitor C**1**, a second capacitor C**2**, a first inductor L**1**, and a second inductor L**2**. The first capacitor C**1** is connected in parallel to the first inductor L**1**, the second capacitor C**2** is connected in parallel to the second inductor L**2**, and one end of the circuit formed by the second capacitor C**2** and the second inductor L**2** connected in parallel is electrically connected to one end of the circuit formed by the first capacitor C**1** and the first inductor L**1** connected in parallel.
(116) Please refer to FIG. **22**, the first matching circuit M**1** includes a first capacitor C**1**, a second capacitor C**2**, a first inductor L**1**, and a second inductor L**2**. The first capacitor C**1** and the first inductor L**1** are connected in series to form a first unit **101**, the second capacitor C**2** and the second inductor L**2** are connected in series to form a second unit **102**, and the first unit **101** and the second unit **102** are connected in parallel.
(117) The first matching circuit M**1** exhibits different band-pass and band-stop characteristics in different bands.
(118) The antenna assembly **100** further includes a first controller **61**. The first controller is

configured to determine a radiation mode of the second radiator **21** according to whether the first coupling gap **41** and the second coupling gap **42** are in a free radiation scenario or a blocked radiation scenario. The free radiation scenario means that the first coupling gap **41** and the second coupling gap **42** are not blocked by a conductor or an object with static electricity. The blocked radiation scenario means that the first coupling gap **41** and the second coupling gap **42** are blocked by a conductor or an object with static electricity, for example, the first coupling gap **41** and the second coupling gap **42** are covered by the operator's hand.
(119) The details are as follows.
(120) The first controller is configured to determine, according to that the first coupling gap **41** is in the free radiation scenario and the second coupling gap **42** is in the blocked radiation scenario, that the second radiator **21** is in a first radiation mode, where in the first radiation mode, the first signal source **12** is configured to excite the second radiator **21** between the second resonant point F and the second coupling end **211** to generate at least one resonant mode.
(121) The first controller is further configured to determine, according to that the first coupling gap **41** is in the blocked radiation scenario and the second coupling gap **42** is in the free radiation scenario, that the second radiator **21** is in a second radiation mode, where in the second radiation mode, the first signal source **12** is configured to excite the second radiator **21** between the first resonant point C and the third coupling end **212** to generate at least one resonant mode under excitation of the second signal source **22**.
(122) The first controller is further configured to determine that the second radiator **21** is in the first radiation mode or the second radiation mode when the first coupling gap **41** and the second coupling gap **42** are both in the free radiation scenario.
(123) The disclosure does not limit the specific structure of the first controller controlling the second radiator **21** to switch the radiation mode. The following implementations are exemplified.
(124) Please refer to FIG. **23**, the second matching circuit M**2** includes at least one first selection switch **311**, a first high-impedance branch **312**, and a first low-impedance branch **313**. The first selection switch **311** is configured to select one of the first high-impedance branch **312** and the first low-impedance branch **313** to be electrically connected to the first resonant point C. The first selection switch **311** is a single-pole double-throw switch, a first end of the first selection switch **311** is electrically connected to the first resonant point C of the second radiator **21**, a second end of the first selection switch **311** is electrically connected to one end of the first high-impedance branch **312**, and the other end of the first high-impedance branch **312** is grounded, a third end of the first selection switch **311** is electrically connected to one end of the first low-impedance branch **313**, and the other end of the first low-impedance branch **313** is grounded. The first controller is electrically connected to a control end of the first selection switch **311**, so as to control the first selection switch **311** to select the first high-impedance branch **312** or the first low-impedance branch **313** to be electrically connected to the first resonant point C. Certainly, the first selecting switch **311** can further include two sub-switches, where one of the two sub-switches connects the first resonant point C to the first high-impedance branch **312** and the other one connects the first resonant point C to the first low-impedance branch **313**. Definitely, the second matching circuit M**2** can further include impedance branches.
(125) The first high-impedance branch **312** has high impedance relative to the resonant frequency of the resonant mode generated by the second radiator **21** under excitation of the second signal source **22**, and the first low-impedance branch **313** has low impedance relative to the resonant frequency of the resonant mode generated by the second radiator **21** under excitation of the second signal source **22**.
(126) For example, the first high-impedance branch **312** includes, but is not limited to, a large capacitor and the like. The first low-impedance branch **313** includes, but is not limited to, direct grounding, a small inductor, and the like.
(127) Please refer to FIG. **23**, the third matching circuit M**3** includes at least one second selection

switch **314**, a second high-impedance branch **315**, and a second low-impedance branch **316**. The second selection switch **314** is configured to select one of the second high-impedance branch **315** and the second low-impedance branch **316** to be electrically connected to the second resonant point F. The second selection switch **314** is a single-pole double-throw switch, and a first end of the second selection switch **314** is electrically connected to the second resonant point F of the second radiator **21**, a second end of the second selection switch **314** is electrically connected to one end of the second high-impedance branch **315**, and the other end of the second high-impedance branch **315** is grounded, a third end of the second selection switch **314** is electrically connected to one end of the second low-impedance branch **316**, and the other end of the second low-impedance branch **316** is grounded. The first controller is electrically connected to a control end of the second selection switch **314**, so as to control the second selection switch **314** to select the second high-impedance branch **315** or the second low-impedance branch **316** to be electrically connected to the second resonant point F. Certainly, the second selection switch **314** can further include two sub-switches, where one of the two sub-switches connects the second resonant point F to the second high-impedance branch **315** and the other one connects the second resonant point F to the second low-impedance branch **316**. Definitely, the second matching circuit M**2** can further include other impedance branches.

(128) The second high-impedance branch **315** has high impedance relative to the resonant frequency of the resonant mode generated by the second radiator **21** under excitation of the second signal source **22**, and the second low-impedance branch **316** has low impedance relative to the resonant frequency of the resonant mode generated by the second radiator **21** under excitation of the second signal source **22**.

(129) For example, the first high-impedance branch **312** includes, but is not limited to, a large capacitor and the like, and the first low-impedance branch **313** includes, but is not limited to, direct grounding, a small inductor, and the like.

(130) The first controller is electrically connected to the first selection switch **311** and the second selection switch **314**. The first controller is configured to control, according to that the first coupling gap **41** is in the free radiation scenario and the second coupling gap **42** is in the blocked radiation scenario, the first selection switch **311** to connect the first high-impedance branch **312** to the first resonant point C, and control the second selection switch **314** to connect the second low-impedance branch **316** to the second resonant point F.

(131) The first controller is further configured to control, according to that the first coupling gap **41** is in the blocked radiation scenario and the second coupling gap **42** is in the free radiation scenario, the first selection switch **311** to connect the first low-impedance branch **313** to the first resonant point C, and control the second selection switch **314** to connect the second high-impedance branch **315** to the second resonant point F.

(132) In this implementation, the second antenna **20** has two paths to generate the low-frequency resonant mode: one is that the second signal source **22** excites the second radiator **21** between the first resonant point C and the third coupling end **212**, this path does not involve the first coupling gap **41**, and the other is that the second signal source **22** excites the second radiator **21** between the second resonant point F and the second coupling end **211**, this path does not involve the second coupling gap **42**.

(133) When the antenna assembly **100** is applied to the electronic device **1000** and the radiator is disposed on the housing of the electronic device **1000**, the operator may block the first coupling gap **41** or the second coupling gap **42** when holding the electronic device **1000**. In the disclosure, when a first coupling gap **41** is blocked, the first controller controls the second signal source **22** to excite the second radiator **21** between the first resonant point C and the third coupling end **212** to generate the sixth sub-resonant mode f, so that the second antenna **20** can still excite the second radiator **21** to generate a low-frequency signal. For a high-frequency signal, since the first coupling gap **41** is blocked and the second coupling gap **42** can still work normally, the second sub-resonant

mode b can still be generated, and the second sub-resonant mode b is tuned through the third matching circuit M**3**, so that the first coupling gap **41** of the antenna assembly **100** can still be used effectively in low frequency and middle high-ultra high frequency when being blocked. In the disclosure, when the second coupling gap **42** is blocked, the first controller controls the second signal source **22** to excite the second radiator **21** between the second resonant point F and the second coupling end **211** to generate the seventh sub-resonant mode g, so that the second antenna **20** can still excite the second radiator **21** to generate a low-frequency signal. For a high-frequency signal, because the second coupling gap **42** is blocked and the first coupling gap **41** can still work normally, therefore, the first sub-resonant mode a, the third sub-resonant mode c, the fourth sub-resonant mode d, and the fifth sub-resonant mode e may still be generated, the above resonant modes are tuned through the first and second matching circuits M**1** and M**2**, so that the second coupling gap **42** of the antenna assembly **100** can still be used effectively in low frequency, middle high-ultra high frequency when being blocked.

(134) The specific structure of the antenna assembly **100** is illustrated above by way of example, and in some implementations, the antenna assembly **100** is disposed in the electronic device **1000**. The following describes an implementation in which the antenna assembly **100** is disposed in the electronic device **1000** in examples. For the electronic device **1000**, the antenna assembly **100** is at least partially integrated on the housing **500** or fully received in the housing **500**.

(135) Please refer to FIG. **2**, the housing **500** includes a frame **51** and a back cover **52**. One side of the frame **51** surrounds and is connected a periphery of the back cover **52**. The other side of the frame **51** surrounds and is connected to the periphery of the display screen, and the frame **51** includes multiple side edges connected end to end in turn.

(136) When the electronic device **1000** is a mobile phone, the surface where the display screen is located is the front surface of the electronic device **1000**, and the frame **51** forms four side surfaces of the electronic device **1000**. When the user faces the front surface of the electronic device **1000**, the electronic device **1000** has the upper, lower, left, and right surfaces, and the surface where the back cover **52** is located is the rear surface of the electronic device **1000**.

(137) Optionally, at least part of the radiator of the antenna assembly **100** is integrated with the frame **51**. For example, the frame **51** is made of a metal material. The first radiator **11**, the second radiator **21**, the third radiator **23**, and the frame **51** are integrated into one piece, and of course, the radiators may also be integrated into the back cover **52**. In other words, the first radiator **11**, the second radiator **21** and the third radiator **23** are integrated as part of the housing **500**.

(138) Specifically, referring to FIG. **24**, the frame **51** includes multiple metal segments **511** and an insulation segment **512** filled between two adjacent metal segments **511**. The insulation segment **512** is used for insulating and connecting two adjacent metal segments **511**.

(139) The multiple metal segments **511** or parts of the metal segments **511** form the first radiator **23**, the second radiator **21**, and the third radiator **23** respectively, where the insulation segment **512** between the first radiator **11** and the second radiator **21** is filled in the first coupling gap **41**, and the insulation segment **512** between the second radiator **21** and the third radiator **23** is filled in the second coupling gap **42**.

(140) Optionally, when the radiator is used as a carrier for sensing proximity of an electric field of a human body, an insulating film having a high transmittance for an electromagnetic wave may be disposed on a surface of the frame **51**, and the film is used for forming a capacitor when the metal frame **51** is close to the skin of the human body and will not affect signal T/R of the antenna assembly **100**.

(141) Specifically, the reference ground GND, the first signal source **12**, the second signal source **22**, the first to fifth matching circuits M**1**-M**5**, etc. of the antenna assembly **100** are all arranged on a circuit board.

(142) Optionally, the first radiator **11**, the second radiator **21**, and the third radiator **23** are formed on a surface of the frame **51**. Specifically, the first radiator **11**, the second radiator **21**, and the third

radiator **23** are formed on the inner surface of the frame **51** through processes such as laser direct structuring (LDS) and print direct structuring (PDS). In this implementation, the frame **51** may be made of a non-conductive material. The radiator may also be disposed on the back cover **52**.
(143) Alternatively, the first radiator **11**, the second radiator **21**, and the third radiator **23** are disposed on a flexible circuit board, and the flexible circuit board is attached to a surface of the frame **51**. The first radiator **11**, the second radiator **21**, and the third radiator **23** may be integrated onto the flexible circuit board, and the flexible circuit board is attached to the inner surface of the middle frame by an adhesive or the like. In this implementation, the frame **51** may be made of a non-conductive material. The radiator may also be disposed on the inner surface of the back cover **52**.
(144) The specific position of the antenna assembly **100** on the frame **51** is not specifically limited in the disclosure, and the following implementations are exemplified.
(145) Please refer to FIG. **24**, two adjacent side edges in the multiple side edges of the frame **51** intersect, for example, the two adjacent side edges are perpendicular to each other. The first coupling gap **41** and the second coupling gap **42** are respectively disposed on two intersected side edges of the frame **51**, or the first coupling gap **41** and the second coupling gap **42** are both disposed on the same side edge of the frame **51**. The multiple side edges include a top edge **513** and a bottom edge **514** disposed opposite to each other, and a first side edge **515** and a second side edge **516** connected between the top edge **513** and the bottom edge **514**. The top edge **513** is a side away from the ground when the operator holds the electronic device **1000** to face the front surface of the electronic device **1000**, and the bottom edge **514** is a side facing the ground. The top edge **513** is parallel to and equal to the bottom edge **514**, and the first side edge **515** is parallel to and equal to the second side edge **516**. The length of the first side edge **515** is greater than the length of the top edge **513**. The first coupling gap **41** and the second coupling gap **42** may be disposed respectively at the top edge **513** and the first side edge **515**, the top edge **513** and the second side edge **516**, the first side edge **515** and the bottom edge **514**, or the bottom edge **514** and the second side edge **516**. Certainly, the first coupling gap **41** and the second coupling gap **42** may also be disposed on the same edge, for example, at any one of the top edge **513**, the bottom edge **514**, the first side edge **515**, and the second side edge **516**.
(146) In the foregoing description, the first coupling gap **41** and the second coupling gap **42** are respectively disposed on two adjacent edges of the frame **51**, so as to ensure that the antenna assembly **100** can have high T/R performance when the user holds the electronic device **1000** in different holding manners.
(147) Specifically, when the electronic device **1000** is held in a longitudinal direction by left hand, the first side edge **515** is blocked or shielded by the hand, and the first coupling gap **41** (or the second coupling gap **42**) disposed on the first side edge **515** may be blocked. Because the second coupling gap **42** (or the first coupling gap **41**) is disposed on the top edge **513** or the bottom edge **514**, the second coupling gap **42** (or the first coupling gap **41**) is not blocked at this time. In combination with the control method of the antenna assembly **100** when the first coupling gap **41** (or the second coupling gap **42**) is blocked, the low-frequency radiation of the antenna assembly **100** can be switched to the first resonant point C—the second coupling gap **42** (or the first coupling gap **41**). In this way, the left hand holding in the longitudinal direction does not affect the low-frequency T/R, and the second sub-resonant mode b in the high-frequency T/R can still work normally. This ensures that the antenna assembly **100** also has good performance in high-frequency T/R.
(148) When the electronic device **1000** is held in a vertical direction by the right hand, the second side edge **516** is blocked or shielded by the hand, and the first coupling gap **41** (or the second coupling gap **42**) disposed on the first side edge **515** may be blocked. Because the second coupling gap **42** (or the first coupling gap **41**) is disposed on the top edge **513** or the bottom edge **514**, the second coupling gap **42** (or the first coupling gap **41**) is not blocked at this time. In combination

with the control method of the antenna assembly **100** when the first coupling gap **41** (or the second coupling gap **42**) is blocked, the low-frequency radiation of the antenna assembly **100** can be switched to the first resonant point C—the second coupling gap **42** (or the first coupling gap **41**). In this way, the left hand holding in the longitudinal direction does not affect the low-frequency T/R, and the second sub-resonant mode b in the high-frequency T/R can still work normally. This ensures that the antenna assembly **100** also has good performance in high frequency T/R.

(149) When the electronic device **1000** is laterally held by both hands, both the top edge **513** and the bottom edge **514** are blocked by the hands. The first coupling gap **41** (or the second coupling gap **42**) disposed on the top edge **513** or the bottom edge **514** is blocked, while the second coupling gap **42** (or the first coupling gap **41**) disposed on the first side edge **515** or the second side edge **516** is not blocked. In combination with the control method of the antenna assembly **100** when the first coupling gap **41** (or the second coupling gap **42**) is blocked, the low-frequency radiation of the antenna assembly **100** can be switched to the first resonant point C—the second coupling gap **42** (or the first coupling gap **41**). In this way, both hands holding the electronic device **1000** laterally does not affect the low-frequency T/R, and the second sub-resonant mode b in the high-frequency T/R can still work normally. This ensures that the antenna assembly **100** also has good performance in high frequency T/R. It can be seen from the foregoing description that, the first coupling gap **41** and the second coupling gap **42** are respectively disposed on two adjacent edges of the frame **51**, so as to ensure that the antenna assembly **100** can have high T/R performance when the user holds the electronic device **1000** in different holding manners.

(150) In an implementation, the frame **51** is made of a metal material. The first coupling gap **41** is disposed on the bottom edge **514** and close to the first side edge **515**. The second coupling gap **42** is disposed on the second side edge **516**. The insulation medium is filled in both the first coupling gap **41** and the second coupling gap **42**. At least part of the first radiator **11** is disposed on the bottom edge **514**. One part of the second radiator **21** is disposed on the bottom edge **514**, and the other part of the second radiator **21** is disposed on the second side edge **516**. The third radiator **23** is disposed on the second side edge **516**.

(151) The first side edge **515** is grounded at a position near the bottom edge **514**, so as to form a first ground end A of the first radiator **11**. The metal frame **51** between the first ground end A and the first coupling gap **41** forms the first radiator **11**, in other words, one part of the first radiator **11** is disposed on the first side edge **515**, and the other part is disposed on the bottom edge **514**. The metal frame **51** between the first coupling gap **41** and the second coupling gap **42** forms the second radiator **21**. The second side edge **516** is grounded at a position near the second coupling gap **42**, so as to form a second ground end G. The metal frame **51** between the second ground end G and the second coupling gap **42** forms the third radiator **23**.

(152) Please refer to FIG. **25**, the electronic device **1000** further includes a circuit board **600** and an electronic assembly **700** that are disposed inside the frame **51** and close to the bottom edge **514**. The circuit board **600** includes, but is not limited to, a rigid circuit board **600**, a flexible circuit board **600**, a flexible and rigid board, and the like. The circuit board **600** is arranged close to the bottom edge **514**, the bottom of the first side edge **515** (close to the bottom edge **514**), and the bottom of the second side edge **516** (close to the bottom edge **514**). The reference ground GND, the first to fifth matching circuits M**1**-M**5**, the first signal source **12**, and the second signal source **22** may all be disposed on the circuit board **600**.

(153) Please refer to FIG. **25**, the electronic assembly **700** includes at least one of a speaker **711**, a USB interface device **712**, an earphone base **713**, and a SIM card slot assembly **714**. The second antenna **20** further includes a feeding branch and multiple ground branches that are disposed on the circuit board **600** and electrically connected to the second radiator **21**. The feeding branch includes the fourth matching circuit M**4** and the second signal source **22**. The ground branch includes a grounded second matching circuit M**2**, a grounded fifth matching circuit M**5**, a grounded third matching circuit M**3**, and the like.

(154) Please refer to FIG. **25**, the electronic assembly **700** is located between the feeding branch and the ground branch or between two adjacent ground branches. For example, a first space **716** is defined between a branch connecting the first matching circuit M**1** and the first signal source **12** and the grounded second matching circuit M**2**, a second space **717** is defined between the grounded second matching circuit M**2** and the grounded fifth matching circuit M**5**, a third space **718** is defined between a branch connecting the second signal source **22** and the fourth matching circuit M**4** and the grounded fifth matching circuit M**5**, a fourth space **719** is defined between a branch connecting the second signal source **22** and the fourth matching circuit M**4** and the grounded third matching circuit M**3**. The multiple electronic assemblies **700** may be randomly disposed in the first to fourth spaces **716-719**. In other words, the feeding branch and the ground branch on the antenna assembly **100** may be disposed to avoid the electronic assembly **700**, so that the electronic assembly **700** and the antenna assembly **100** are disposed in a staggered manner, thereby further reducing an arrangement space of the electronic assembly **700** and the antenna assembly **100**, reducing interference of a device layout, improving structural compactness, and reducing a whole machine size.
(155) In one implementation, referring to FIG. **25**, the speaker **711** is located in the first space **716**, corresponding to the first coupling gap **41**. The first coupling gap **41** may be multiplexed with a hole(s) of the speaker **711** (for spreading out a sound coming from the speaker **711**). For example, at least one hole of the speaker **711** is opened on the insulation segment **512** filled in the first coupling gap **41**, so as to reduce holes of the speaker **711** opened on the second radiator **21**.
(156) In an implementation, referring to FIG. **25**, the second space **717** is in the middle of the bottom edge **514**, and the USB interface device **712** is disposed in the second space **717**. A USB hole is opened on the second radiator **21**, the metal bottom edge **514** is insulated from the USB interface device **712** by means of an isolation member, and a conductive joint of a charging cable is insulated from the metal bottom edge **514** by means of the isolation member, thereby improving performance compatibility of the USB interface device **712** and the antenna assembly **100**. Further, the isolation member may also be used as a sealing member for sealing the USB hole, so as to improve the waterproof and sealing performance of the USB hole.
(157) In an implementation, referring to FIG. **25**, the earphone base **713** and/or the SIM card slot assembly **714** are disposed in the third space **718**. When the earphone base **713** is arranged in the third gap **718**, the second radiator **21** is provided with an earphone hole corresponding to the earphone base **713**, and a conductive joint of the earphone is insulated from the metal bottom edge **514** by means of an isolation member, so as to improve performance compatibility between the earphone base **713** and the antenna assembly **100**. Further, the isolation member may also be used as a sealing member for sealing the earphone hole, so as to improve the waterproof and sealing performance of the earphone hole. When the SIM card slot assembly **714** is disposed in the third space **718**, the second radiator **21** defines a SIM hole corresponding to the SIM card slot assembly **714**, and a conductive joint of the SIM card slot assembly **714** is insulated from the metal bottom edge **514** by means of an isolation member, so that the performance compatibility of the SIM card slot assembly **714** and the antenna assembly **100** is improved. Further, the isolation member may also be used as a sealing element for sealing the SIM hole, so as to improve the waterproof and sealing performance of the SIM hole.
(158) The antenna assembly **100** provided in the implementations of the disclosure can also effectively and accurately detect the proximity of a human body. The detection function can be applied to reduce the T/R power of the antenna assembly **100** when the human body is in proximity, thereby reducing the specific absorption rate (SAR) of the human body to the electromagnetic wave, reducing the radiation influence of the electronic device **1000** on the human body, and further improving the application reliability of the electronic device **1000**.
(159) The second antenna **20** includes a first radio frequency front-end unit which is electrically connected to the second radiator **21**, where the first radio frequency front-end unit includes a

grounded second matching circuit M**2**, a grounded fifth matching circuit M**5**, a second signal source **22**, a fourth matching circuit M**4**, and a grounded third matching circuit M**3**.
(160) Please refer to FIG. **26**, the antenna assembly **100** further includes a first isolator **811**, a second isolator **812**, a first proximity sensor **813**, and a second controller **62**.
(161) Please refer to FIG. **26**, the first isolator **811** is disposed between the first radio frequency front-end unit and the second radiator **21**. The first isolator **811** is configured to isolate a first induction signal generated when a subject to-be-detected (for example, the head of the human body) is close to the second radiator **21** and conduct an electromagnetic wave signal transmitted/received by the second radiator **21**. Specifically, there are multiple first isolators **811**. The multiple first isolators **811** are respectively disposed between the second radiator **21** and the second matching circuit M**2**, between the second radiator **21** and the fifth matching circuit M**5**, between the second radiator **21** and the fourth matching circuit M**4**, and between the second radiator **21** and the third matching circuit M**3**. The first isolator **811** is configured to isolate the first induction signal generated when the subject to-be-detected is close to the second radiator **21** and conduct the electromagnetic wave signal transmitted/received by the second radiator **21**. Specifically, the first isolator **811** at least includes a blocking capacitor, and the subject to-be-detected includes, but is not limited to, the head of the human body. The multiple first isolators **811** are disposed so that the second radiator **21** is in a “flying” state relative to a direct current signal, so as to sense the electrical signal change caused by proximity of the head of the human body.
(162) It can be understood that, when the component connecting the second matching circuit M**2** and the second radiator **21** is a capacitor, the capacitor may be reused as the first isolator **811**, and no blocking capacitor needs to be additionally provided. Accordingly, this also applies to the third matching circuit M**3**, the fourth matching circuit M**4** and the fifth matching circuit M**5**, which will not be repeated here.
(163) Please refer to FIG. **26**, one end of the second isolator **812** is electrically connected between the second radiator **21** and the first isolator **811**. The second isolator **812** is configured to isolate an electromagnetic wave signal transmitted/received by the second radiator **21** and conduct the first induction signal. Specifically, the second isolator **812** at least includes an isolation inductor to isolate an electrical signal with a relatively high frequency, for example, an alternating current signal.
(164) It can be understood that, the first induction signal generated by the second radiator **21** is a direct current signal, and the electromagnetic wave signal transmitted/received by the second radiator **21** is an alternating current signal. By providing the first isolator **811** between the second radiator **21** and the first radio frequency front-end unit, the first induction signal does not flow to the first radio frequency front-end unit via the second radiator **21** and will not affect signal T/R of the second antenna **20**. By providing the second isolator **812** between the first proximity sensor **813** and the second radiator **21**, the electromagnetic wave signal does not flow to the first proximity sensor **813** via the second radiator **21**, thereby improving the sensing efficiency of the first proximity sensor **813** on the proximity induction signal.
(165) Please refer to FIG. **26**, the first proximity sensor **813** is electrically connected to the other end of the second isolator **812** and is configured to sense the magnitude of the first induction signal. The disclosure does not limit the specific structure of the first proximity sensor **813**. The first proximity sensor **813** includes, but is not limited to, a sensor configured to sense a capacitance change or an inductance change, and is configured to detect a capacitance change of the first isolator **811** connected to the first proximity sensor **813** or an inductance change of the second isolator **812** connected to the first proximity sensor **813**.
(166) The second controller is electrically connected to one end of the first proximity sensor **813** that is far away from the second isolator **812**, and is configured to determine, according to the magnitude of the first induction signal, whether a subject to-be-detected is close to the second radiator **21**, and reduce the power of the second antenna **20** when the subject to-be-detected is close

to the second radiator **21**. Specifically, when the second controller detects that the first induction signal is greater than or equal to the preset threshold, the second controller determines that the subject to-be-detected is close to the second radiator **21**, and controls to reduce the power of the second antenna **20**. When the power of the antenna is reduced, the radiation performance of the antenna is also correspondingly reduced, and the specific absorption rate of the human body to the electromagnetic wave radiated by the antenna is also correspondingly reduced, thereby further improving the reliability of the electronic device **1000**.

(167) One specific scenario is as follows. The body surface of the human body is charged, and when the human body is close to the second radiator **21**, an electric field is formed between the second radiator **21** and the body surface. The first isolator **811** senses a capacitance change caused by superposition of the electric field between the body surface and the second radiator **21**, as a result, the electrical signal flowing through the second isolator **812** changes, so that the first proximity sensor **813** can sense the first induction signal greater than the preset threshold. When the first proximity sensor **813** detects that the human body is close to the second antenna **20**, the transmission power of the second antenna **20** can be reduced, and thus the specific absorption rate of the human body to the electromagnetic wave signal transmitted by the second antenna **20** can be reduced. When the first proximity sensor **813** detects that the human body is far away from the second antenna **20**, the transmission power of the second antenna **20** can be increased so as to improve the antenna performance of the antenna assembly **100** without increasing the specific absorption rate of the human body to the electromagnetic wave signal transmitted by the second antenna **20**, thus realizing the intelligent adjustment of the radiation performance of the electronic device **1000**. Since the radiator of the antenna assembly **100** can not only serve as a carrier for electromagnetic wave T/R, but also serve as a carrier for sensing the proximity of an electric field of the human body, a dual function is achieved, and the function of the antenna assembly **100** is added without increasing the size of the radiator, thereby facilitating the implementation of the electronic device **1000** with multiple functions, a high integration level and a small size.

(168) In addition to electromagnetic wave signal T/R, the radiator of the antenna assembly **100** can also be used as a sensing electrode detecting the proximity of the subject to-be-detected such as the human body, and can isolate the induction signal and the electromagnetic wave signal through the first isolator **811** and the second isolator **812** respectively. As such, in this disclosure, it is possible to achieve the communication performance and the function of sensing the subject to-be-detected of the antenna assembly **100**, achieve intelligent adjustment of the radiation performance of the electronic device **1000** and improve the security performance of the electronic device **1000**, and improve the utilization rate of the components of the electronic device **1000**, thereby reducing the overall size of the electronic device **1000**.

(169) Further, in terms of reducing the specific absorption rate of the human body to the electromagnetic wave radiated by the electronic device **1000**, the specific absorption rate of the human body to the electromagnetic wave radiated by the electronic device **1000** can be reduced in a more necessary scenario in combination with other detectors or functions in the electronic device **1000**. For example, when the head of the human body is close to the electronic device **1000**, the power of the electronic device **1000** is reduced, and then the specific absorption rate of the head of the human body to the electromagnetic wave radiated by the electronic device **1000** is reduced. In a scenario where the head of the human body is close to the electronic device **1000**, whether the electronic device **1000** is in a call state can be detected. Specifically, when it is detected that the electronic device **1000** is in the call state and the human body is close to the radiator of the electronic device **1000**, it is highly likely that the head of the human body is close to the electronic device **1000** to prepare for answering a call. In this case, the power of the antenna assembly **100** can be reduced to reduce the radiation of the electromagnetic wave radiated by the electronic device **1000** to the head of the human body, and the specific absorption rate of the head of the human body to the electromagnetic wave radiated by the electronic device **1000** can be reduced.

For the detection that the electronic device **1000** is in the call state, it may be achieved by detecting whether a receiver and an earpiece are in a working state.

(170) Further, multiple antenna assemblies **100** may be disposed on several sides of the electronic device **1000** respectively, and the radiators of the antenna assemblies **100** are all used as carriers for detecting proximity of the electric field of the human body to the electronic device **1000**. When the electric field of the human body is detected on sides of the electronic device **1000** and the display screen **300** is in a screen-off state, it indicates that the electronic device **1000** may be in a portable state. In this case, the electronic device **1000** may control to reduce the power of all antenna assemblies **100**, so as to reduce the specific absorption rate of the human body to the electromagnetic wave radiated by the antenna assemblies **100**, and further save electric quantity.

(171) Please refer to FIG. **26**, the second radiator **21** at least covers or is disposed at one corner of the frame **51** (the corner refers to an intersection of two adjacent sides). For example, the second radiator **21** covers the bottom edge **514**, the second side edge **516**, and a corner between the bottom edge **514** and the second side edge **516**. In this way, the second radiator **21** can detect proximity of the human body facing the front surface, the rear surface, the bottom surface, and the second side edge **516**.

(172) The above is an implementation in which the second radiator **21** is used as a carrier for sensing an electric field of the human body. Since the second antenna **20** is an antenna for T/R of a low-frequency signal, the length of the second radiator **21** is relatively long, and by setting the second radiator **21** as a carrier for sensing the proximity of the electric field of the human body, the proximity of the human body can be detected within a relatively large range on the electronic device **1000**, thereby improving the accuracy of the proximity detection of the human body. Certainly, the first radiator **11** and the third radiator **23** can also be separately used as carriers for sensing the electric field of the human body, or used together with the second radiator **21** as carriers for sensing the electric field of the human body. For details, refer to the following implementations.

(173) Please refer to FIG. **27**, the second antenna **20** further includes a third isolator **814**. One end of the third isolator **814** is electrically connected to the second ground end G, and the other end is grounded. The third isolator **814** is a blocking capacitor, so that the third radiator **23** is in a “flying” state with respect to the direct current signal. The principle for the third radiator **23** to detect the proximity of the electric field of the human body is the same as the principle for the second radiator **21** to detect the proximity of the electric field of the human body, and details are not described herein again.

(174) In a first possible implementation, when an electric field of the human body is close to the third radiator **23**, the third radiator **23** generates a second induction signal, and transmits the second induction signal to the second radiator **21** through the second coupling gap **42**, so that the second radiator **21** generates a sub-induction signal. The first proximity sensor **813** detects the sub-induction signal and reduces the power of the second antenna **20**.

(175) In this implementation, both the second radiator **21** and the third radiator **23** serve as sensing electrodes for sensing proximity of the subject to-be-detected, and a proximity sensing path of the third radiator **23** is from the third radiator **23** to the second radiator **21** and then to the first proximity sensor **813**. In other words, when the subject to-be-detected is close to the third radiator **23**, the third radiator **23** generates the second induction signal, and the second induction signal makes, through the first coupling gap **41**, the second radiator **21** generate the sub-induction signal, so that the first proximity sensor **813** can also sense the subject to-be-detected at the third radiator **23**. There is no need to use two proximity sensors, and the coupling effect between the second radiator **21** and the third radiator **23** and the first proximity sensor **813** are also fully utilized, so that the second radiator **21** and the third radiator **23** can also be used in proximity detection, thereby increasing the utilization rate of the devices, reducing the number of devices, and further facilitating the integration and miniaturization of the electronic device **1000**.

(176) In a second possible implementation, referring to FIG. **28**, the third radiator **23** is disposed on

the second side edge **516**. An insulation segment **512** is disposed between the second ground end G and the metal second side edge **516** of the non-third radiator **23**, so that the third radiator **23** is disconnected from other metal second side edges **516**. The second antenna **20** further includes a fourth isolator **815**, where one end of the fourth isolator **815** is electrically connected between the third radiator **23** and the third isolator **814** or electrically connected to the third radiator **23**, and is configured to isolate electromagnetic wave signals transmitted/received by the third radiator **23** and conduct second induction signals. Specifically, the fourth isolator **815** includes an isolation inductor.
(177) Further, referring to FIG. **28**, the antenna assembly **100** further includes a second proximity sensor **816**. The second proximity sensor **816** is electrically connected to the other end of the fourth isolator **815** and is configured to sense the magnitude of the second induction signal. Specifically, the second radiator **21** and the third radiator **23** are both sensing electrodes that sense the proximity of the subject to-be-detected, and the proximity sensing path of the second radiator **21** is independent from the proximity sensing path of the third radiator **23**, so that it can be accurately detected that the subject to-be-detected is close to the second radiator **21** or the third radiator **23**, thereby timely responding to the foregoing proximity behavior. Specifically, when the subject to-be-detected is close to the third radiator **23**, the second induction signal generated by the third radiator **23** is a direct current signal. The electromagnetic wave signal is an alternating current signal. The fourth isolator **815** is disposed between the third radiator **23** and the reference ground GND, so that the second induction signal does not flow to the reference ground GND through the third radiator **23** and will not affect signal T/R of the second antenna **20**. By providing the fourth isolator **815** between the second proximity sensor **816** and the third radiator **23**, the electromagnetic wave signal does not flow to the second proximity sensor **816** through the third radiator **23**, thus improving the sensing efficiency of the second proximity sensor **816** for the second induction signal. The specific structure of the second proximity sensor **816** is not limited in the disclosure. The second proximity sensor **816** includes, but is not limited to, a sensor configured to sense a capacitance change or an inductance change.
(178) In other implementations, only the second proximity sensor **816** is provided, and the first proximity sensor **813** is not provided, and the inductive signal of the second radiator **21** is transferred to the second proximity sensor **816** through the third radiator **23** with aid of the coupling between the second radiator **21** and the third radiator **23**.
(179) In a third possible implementation, referring to FIG. **29**, this implementation is different from the second implementation in that the second proximity sensor **816** is not provided. The other end of the fourth isolator **815** is electrically connected to the first proximity sensor **813**. When the second radiator **21** and the third radiator **23** are in capacitive coupling, a coupling induction signal is generated. The first proximity sensor **813** is further configured to sense a change of the coupling induction signal when the subject to-be-detected is close to the second radiator **21** and/or the third radiator **23**.
(180) Specifically, when the second radiator **21** is coupled with the third radiator **23**, a constant electric field is generated, which is featured by generating a stable coupling induction signal. When the human body is close to the constant electric field, the constant electric field changes, which is manifested as a change in the coupling induction signal, and the proximity of the human body is detected according to the change of the coupling induction signal.
(181) In this implementation, both the second radiator **21** and the third radiator **23** serve as sensing electrodes, and may perform accurate detection when the human body is close to an area corresponding to the second radiator **21**, an area corresponding to the third radiator **23**, and an area corresponding to the second coupling gap **42**. There is no need to use two proximity sensors, and the coupling effect between the second radiator **21** and the third radiator **23** and the first proximity sensor **813** are also fully utilized, so that the second radiator **21** and the third radiator **23** can also be used in proximity detection, thereby increasing the utilization rate of the devices, reducing the

number of devices, and further facilitating the integration and miniaturization of the electronic device **1000**.
(182) Please refer to FIG. **30**, the first antenna **10** further includes a fifth isolator **817**. There are multiple fifth isolators **817**. The fifth isolators **817** are electrically connected between the first ground end A of the first radiator **11** and the reference ground GND, and between the first feeding point B and the first matching circuit M**1**. Alternatively, the first ground end A may be insulated from a metal frame other than the first radiator **11**, and the fifth isolator **817** is a blocking capacitor, so that the first radiator **11** is in a “flying” state relative to the direct current signal. The principle for the first radiator **11** to detect the proximity of the electric field of the human body is the same as the principle for the second radiator **21** to detect the proximity of the electric field of the human body, and details are not described herein again.
(183) In a possible implementation, when the electric field of the human body is close to the first radiator **11**, the first radiator **11** generates a third induction signal, and transfers the third induction signal to the second radiator **21** through the first coupling gap **41**, so that the second radiator **21** generates a sub-induction signal. The first proximity sensor **813** detects the sub-induction signal and reduces the power of the first antenna **10**. In this implementation, the sensing path is the first radiator **11**, the second radiator **21**, and the first proximity sensor **813**.
(184) In a second possible implementation, referring to FIG. **31**, the first radiator **11** is disposed on the first side edge **515**. An insulation segment **512** is disposed between the first ground end A and the first metal side edge **515** other than the first side edge **515** of the first radiator **11**, so as to disconnect the first radiator **11** from other first metal side edges **515**. The first antenna **10** further includes a sixth isolator **818**, where one end of the sixth isolator **818** is electrically connected between the first radiator **11** and the fifth isolator **817** or electrically connected to the first radiator **11**, and is configured to isolate an electromagnetic wave signal transmitted/received by the first radiator **11** and conduct the third induction signal. In particular, the sixth isolator **818** includes an isolation inductor.
(185) The other end of the sixth isolator **818** is electrically connected to the first proximity sensor **813**. When the second radiator **21** is in capacitive coupling to the first radiator **11**, a coupling induction signal is generated. The first proximity sensor **813** is further configured to sense the change of the coupling induction signal when the subject to-be-detected is close to the second radiator **21** and/or the first radiator **11**.
(186) Specifically, when the second radiator **21** is coupled with the first radiator **11**, a constant electric field is generated, which is featured by generating a stable coupling induction signal. When the human body is close to the constant electric field, the constant electric field changes, which is manifested as a change in the coupling induction signal, and the proximity of the human body is detected according to the change of the coupling induction signal.
(187) In a third possible implementation, referring to FIG. **32**, this implementation differs from the foregoing second implementation in that the sixth isolator **818** is not electrically connected to the first proximity sensor **813**. The antenna assembly **100** further includes a third proximity sensor **819** electrically connected to the other end of the sixth isolator **818** for sensing the magnitude of the third induction signal. Specifically, the second radiator **21** and the first radiator **11** are both sensing electrodes that sense the proximity of the subject to-be-detected, and the proximity sensing path of the second radiator **21** is independent from the proximity sensing path of the first radiator **11**, so that it can be accurately detected that the subject to-be-detected is close to the second radiator **21** or the first radiator **11**, thereby timely responding to the described proximity behavior. Specifically, when the subject to-be-detected is close to the first radiator **11**, the third induction signal generated by the first radiator **11** is a direct current signal. The electromagnetic wave signal is an alternating current signal. By providing the sixth isolator **818** between the first radiator **11** and the reference ground GND, the third induction signal does not flow to the reference ground GND through the first radiator **11** and will not affect signal T/R of the second antenna **20**. By providing the sixth

isolator **818** between the second proximity sensor **816** and the first radiator **11**, the electromagnetic wave signal does not flow to the third proximity sensor **819** through the first radiator **11**, thereby improving the sensing efficiency of the third proximity sensor **819** for the third induction signal. The disclosure does not limit the specific structure of the third proximity sensor **819**. The third proximity sensor **819** includes, but is not limited to, a sensor for sensing a capacitance change or an inductance change. In this implementation, the sensing path of the first radiator **11** may be independent from the sensing path of the second radiator **21**.

(188) The first radiator **11**, the second radiator **21** and the third radiator **23** each form a detecting electrode, so that the area of the detecting electrode can be increased, and the proximity of the subject to-be-detected can be detected in a larger range, thereby improving the accuracy of adjusting radiation performance of the electronic device **1000**.

(189) In the antenna assembly and the electronic device provided herein, by designing the radiator of the first antenna and the radiator of the second antenna to be in capacitive coupling via the first coupling gap, the signal source of the first antenna can excite, by means of coupling of the first radiator, the radiator of the second antenna to transmit and receive an electromagnetic wave signal of a corresponding band. In this way, the radiator of the second antenna can also be used as the radiator of the first antenna, the space for stacking the radiator of the first antenna and the radiator of the second antenna is saved, and the overall size of the antenna assembly is reduced, which is beneficial to the overall miniaturization of the electronic device. By having the second coupling gap in the radiator of the second antenna, the second radiator can generate at least one resonant mode at a position close to the second coupling gap under excitation of the signal source of the first antenna, so as to increase the number of positions where the resonant mode is generated, thereby increasing the number of resonant modes generated, and further increasing the bandwidth of a signal transmitted or received by the antenna assembly.

(190) The above are only some implementations of the disclosure. It should be noted that, a person skilled in the art may make further improvements and modifications without departing from the principle of the disclosure, and these improvements and modifications shall also belong to the scope of protection of the disclosure.

Claims

1. An antenna assembly comprising: a first antenna comprising a first radiator and a first signal source electrically connected to the first radiator; and a second antenna comprising a second radiator and a third radiator, wherein one end of the second radiator is spaced apart from one end of the first radiator with a first coupling gap, and another end of the second radiator is spaced apart from one end of the third radiator with a second coupling gap; wherein the first radiator is configured to generate at least one resonant mode under excitation of the first signal source, and a part of the second radiator that is close to the second coupling gap is configured to generate at least one resonant mode under excitation of the first signal source through coupling of the first radiator; wherein the first signal source is configured to excite through the first coupling gap, a part of the second radiator that is close to the first coupling gap and the part of the second radiator that is close to the second coupling gap to generate at least one resonant mode, wherein the at least one resonant mode comprises a first sub-resonant mode and a second sub-resonant mode, wherein a resonant frequency of the first sub-resonant mode is less than a resonant frequency of the second sub-resonant mode.
2. The antenna assembly of claim 1, wherein a resonant frequency of the at least one resonant mode generated by the first radiator under the excitation by the first signal source is different than a resonant frequency of the at least one resonant mode generated by the second radiator under the excitation through coupling of the first radiator.
3. The antenna assembly of claim 2, wherein a bandwidth of a band formed by a combination of a

band covered by the resonant mode generated by the first radiator under excitation of the first signal source and a band covered by the resonant mode generated by the second radiator under excitation of the first signal source is 500 MHz˜1000 MHz, and/or the band covered by the resonant mode generated by the first radiator under excitation of the first signal source and the band covered by the resonant mode generated by the second radiator under excitation of the first signal source are both greater than 1000 MHz.
4. The antenna assembly of claim 2, wherein a band formed by a combination of a band covered by the resonant mode generated by the first radiator under excitation of the first signal source and a band covered by the resonant mode generated by the second radiator under excitation of the first signal source covers 1000 MHz-6000 MHz.
5. The antenna assembly of claim 1, wherein: one of the first sub-resonant mode and the second sub-resonant mode is generated by the part of the second radiator close to the first coupling gap, and the other one of the first sub-resonant mode and the second sub-resonant mode is generated by the part of the second radiator close to the second coupling gap; or the first sub-resonant mode and the second sub-resonant mode are both generated by the part of the second radiator close to the second coupling gap.
6. The antenna assembly of claim 1, wherein the at least one resonant mode generated by the first radiator under excitation of the first signal source comprises a third sub-resonant mode and a fourth sub-resonant mode, wherein a resonant frequency of the third sub-resonant mode is less than a resonant frequency of the fourth sub-resonant mode.
7. The antenna assembly of claim 6, wherein: the resonant frequency of the second sub-resonant mode is less than the resonant frequency of the third sub-resonant mode; or the resonant frequency of the second sub-resonant mode is greater than the resonant frequency of the third sub-resonant mode and less than the resonant frequency of the fourth sub-resonant mode, and the resonant frequency of the first sub-resonant mode is less than or greater than the resonant frequency of the third sub-resonant mode; or the resonant frequency of the second sub-resonant mode is greater than the resonant frequency of the fourth sub-resonant mode, and the resonant frequency of the first sub-resonant mode is less than the resonant frequency of the third sub-resonant mode, or the resonant frequency of the first sub-resonant mode is greater than the resonant frequency of the third sub-resonant mode and less than the resonant frequency of the fourth sub-resonant mode, or the resonant frequency of the first sub-resonant mode is greater than the resonant frequency of the fourth sub-resonant mode.
8. The antenna assembly of claim 6, wherein the resonant mode generated by the first radiator under excitation of the first signal source further comprises a fifth sub-resonant mode, a resonant frequency of the fifth sub-resonant mode, the resonant frequency of the first sub-resonant mode, the resonant frequency of the second sub-resonant mode, the resonant frequency of the third sub-resonant mode, and the resonant frequency of the fourth sub-resonant mode increase sequentially; the fifth sub-resonant mode is a resonant mode where the first radiator operates in high-order resonance, and the third sub-resonant mode is a resonant mode where the first radiator operates in a ground state.
9. The antenna assembly of claim 8, wherein the first radiator comprises a first ground end, a first coupling end, and a first feeding point disposed between the first ground end and the first coupling end; the first ground end is grounded, and the first coupling end is an end where the first coupling gap is formed; the first antenna further comprises a first matching circuit; one end of the first matching circuit is electrically connected to the first signal source, and another end of the first matching circuit is electrically connected to the first feeding point; wherein the first radiator between the first ground end and the first coupling end is configured to generate the third sub-resonant mode under action of the first signal source; part of first radiator between the first feeding point and the first coupling terminal is configured to generate the fourth sub-resonant mode under action of the first signal source; and the first radiator between the first ground end and the first

coupling end is configured to generate the fifth sub-resonant mode under effect of capacitive coupling feed of the first signal source.

10. The antenna assembly of claim 8, wherein the second radiator comprises a second coupling end, a third coupling end, and a first resonant point and a second resonant point that are disposed between the second coupling end and the third coupling end, wherein the second coupling end is an end of the second radiator where the first coupling gap is formed, and the third coupling end is an end of the second radiator where the second coupling gap is formed; and wherein the second antenna further comprises a second matching circuit and a third matching circuit, wherein one end of the second matching circuit is grounded, another end of the second matching circuit is electrically connected to the first resonant point, one end of the third matching circuit is grounded, and another end of the third matching circuit is electrically connected to the second resonant point; wherein the second radiator between the first resonant point and the second coupling end is configured to generate the first sub-resonant mode under excitation through coupling of the first radiator, and the second radiator between the second resonant point and the third coupling end is configured to generate the second sub-resonant mode under excitation through coupling of the first radiator.

11. The antenna assembly of claim 1, wherein the second antenna further comprises a second signal source electrically connected to the second radiator, the second radiator is configured to generate at least one resonant mode under excitation of the second signal source, and a band covered by the resonant mode generated by the second radiator under excitation of the second signal source is less than 1000 MHz.

12. The antenna assembly of claim 11, wherein the second antenna further comprises a fourth matching circuit, a second matching circuit, and a third matching circuit; wherein the second radiator comprises a second coupling end, a third coupling end, and a first resonant point, a second feeding point, and a second resonant point that are disposed in sequence between the second coupling end and the third coupling end; wherein the third radiator comprises a fourth coupling end and a second ground end, wherein the second ground end is grounded; wherein the second coupling end is an end of the second radiator where the first coupling gap is formed, the second coupling gap is formed between the third coupling end and the fourth coupling end, one end of the fourth matching circuit is electrically connected to the second signal source, and another end of the fourth matching circuit is electrically connected to the second feeding point; one end of the second matching circuit is grounded, another end of the second matching circuit is electrically connected to the first resonant point, one end of the third matching circuit is grounded, another end of the third matching circuit is electrically connected to the second resonant point, and the second radiator between the first resonant point and the third coupling end is configured to generate at least one resonant mode under excitation of the second signal source; or the second radiator between the second resonant point and the second coupling end is configured to generate at least one resonant mode under excitation of the second signal source.

13. The antenna assembly of claim 12, wherein the second radiator further comprises a frequency tuning point, and the frequency tuning point is located between the first resonant point and the second feeding point; the second antenna further comprises a fifth matching circuit, one end of the fifth matching circuit is grounded, and another end of the fifth matching circuit is electrically connected to the frequency tuning point; wherein at least one of the second matching circuit, the third matching circuit, the fifth matching circuit, and the fourth matching circuit is configured to regulate a resonant frequency of the at least one resonant mode generated by the second radiator under excitation of the second signal source.

14. The antenna assembly according to claim 13, wherein the antenna assembly comprises a first controller, and the first controller is configured to determine, according to that the first coupling gap is in a free radiation scenario and the second coupling gap is in a blocked radiation scenario, that the second radiator is in a first radiation mode; further configured to determine, according to

that the first coupling gap is in the blocked radiation scenario and the second coupling gap is in the free radiation scenario, that the second radiator is in a second radiation mode; and further configured to determine that the second radiator is in the first radiation mode or the second radiation mode when both the first coupling gap and the second coupling gap are in the free radiation scenario; wherein the first resonant mode is at least one resonant mode generated by the second radiator between the second resonant point and the second coupling end under excitation of the first signal source; the second resonant mode is at least one resonant mode generated by the second radiator between the first resonant point and the third coupling end under excitation of the second signal source.

15. The antenna assembly according to claim 14, wherein: the second matching circuit comprises at least one first selection switch, a first high-impedance branch, and a first low-impedance branch, wherein the first selection switch is configured to select one of the first high-impedance branch and the first low-impedance branch to be electrically connected to the first resonant point; the third matching circuit comprises at least one second selection switch, a second high-impedance branch, and a second low-impedance branch, and the second selection switch is configured to select one of the second high-impedance branch and the second low-impedance branch to be electrically connected to the second resonant point; the first controller is electrically connected to the first selection switch and the second selection switch, and the first controller is configured to control the first selection switch to connect the first high-impedance branch to the first resonant point and control the second selection switch to connect the second low-impedance branch to the second resonant point according to that the first coupling gap is in the free radiation scenario and the second coupling gap is in the blocked radiation scenario; the first controller is configured to control the first selection switch to connect the first low-impedance branch to the first resonant point and control the second selection switch to connect the second high-impedance branch to the second resonant point according to that the first coupling gap is in the blocked radiation scenario and the second coupling gap is in the free radiation scenario.

16. The antenna assembly of claim 12, wherein the second antenna further comprises a middle-high frequency band-pass branch, one end of the middle-high frequency band-pass branch is grounded, and another end of the middle-high frequency band-pass branch is electrically connected to the fourth matching circuit.

17. The antenna assembly of claim 1, wherein the second antenna further comprises a radio frequency front-end unit electrically connected to the second radiator; and wherein the antenna assembly further comprises a first isolator, a second isolator, a proximity sensor, and a second controller, wherein the first isolator is disposed between the radio frequency front end unit and the second radiator, and the first isolator is configured to isolate an induction signal generated when a subject to-be-detected is close to the second radiator and conduct electromagnetic wave signals transmitted and received by the second radiator; one end of the second isolator is electrically connected between the second radiator and the first isolator or electrically connected to the second radiator, and the second isolator is configured to isolate the electromagnetic wave signals transmitted and received by the second radiator and conduct the induction signal; the proximity sensor is electrically connected to another end of the second isolator and is configured to sense a magnitude of the induction signal; and the second controller is configured to determine, according to the magnitude of the induction signal, whether the subject to-be-detected is close to the second radiator, and reduce power of the second antenna when the subject to-be-detected is close to the second radiator.

18. An electronic device, comprising: a frame and an antenna assembly, wherein the antenna assembly comprises: a first antenna comprising a first radiator and a first signal source electrically connected to the first radiator; and a second antenna comprising a second radiator and a third radiator, wherein one end of the second radiator is spaced apart from one end of the first radiator with a first coupling gap, and another end of the second radiator is spaced apart from one end of the

third radiator with a second coupling gap; wherein one or more of the following: the first radiator is configured to generate at least one resonant mode under excitation of the first signal source, and a part of the second radiator that is close to the second coupling gap is configured to generate at least one resonant mode under excitation of the first signal source through coupling of the first radiator; wherein the first signal source is configured to excite through the first coupling gap, a part of the second radiator that is close to the first coupling gap and the part of the second radiator that is close to the second coupling gap to generate at least one resonant mode, wherein the at least one resonant mode comprises a first sub-resonant mode and a second sub-resonant mode, wherein a resonant frequency of the first sub-resonant mode is less than a resonant frequency of the second sub-resonant mode; the first radiator, the second radiator, the third radiator and the frame are integrated into a whole; or the first radiator, the second radiator, and the third radiator are formed on a surface of the frame; or the first radiator, the second radiator, and the third radiator are disposed on a flexible circuit board, and the flexible circuit board is attached to a surface of the frame; and the frame comprises a plurality of side edges connected end to end in sequence, and two adjacent side edges are intersected; the first coupling gap and the second coupling gap are respectively disposed on two intersected side edges of the frame; or, the first coupling gap and the second coupling gap are both disposed on a same side edge of the frame.

19. The electronic device of claim 18, wherein the plurality of side edges comprises a top edge and a bottom edge opposite to the top edge, and a first side edge and a second side edge connected between the top edge and the bottom edge, wherein at least a part of the first radiator is disposed on the bottom edge, the first coupling gap is disposed on the bottom edge, and a part of the second radiator is disposed on the bottom edge, a remaining part of the second radiator is disposed on the second side edge, the third radiator is disposed on the second side edge, and the second coupling gap is disposed on the second side edge; wherein the electronic device further comprises a circuit board and an electronic assembly which are disposed inside the frame and are close to the bottom edge, wherein the electronic assembly comprises at least one of a speaker, a universal serial bus (USB) interface device, an earphone base, and a subscriber identification module (SIM) card slot component; the second antenna further comprises a feeding branch and multiple ground branches that are disposed on the circuit board and electrically connected to the second radiator; and the electronic assembly is located between the feeding branch and the ground branch or between two adjacent ground branches.

20. The electronic device of claim 18, wherein: one of the first sub-resonant mode and the second sub-resonant mode is generated by the part of the second radiator close to the first coupling gap, and the other one of the first sub-resonant mode and the second sub-resonant mode is generated by the part of the second radiator close to the second coupling gap; or the first sub-resonant mode and the second sub-resonant mode are both generated by the part of the second radiator close to the second coupling gap.