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Antenna and electronic device

Abstract

An antenna and an electronic device are provided. The antenna includes a first radiator, a matching circuit, a first adjustment circuit, a signal source, and a second radiator. The first adjustment circuit is electrically connected to the matching circuit. The signal source electrically connects the matching circuit to the feed point. A gap is defined between the second radiator and the first radiator, the second radiator is coupled to the first radiator via the gap. The antenna has at least two resonant modes. Transmission/reception of electromagnetic wave signals in a middle band (MB) and a high-band (HB), in an MB of long-term evolution (LTE) and an MB of new radio (NR), or in an HB of LTE and an HB of NR is supported by the at least two resonant modes cooperatively at the same moment.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION(S) (1) This application is a continuation of International Application No. PCT/CN2022/082912, filed Mar. 25, 2022, which claims priority to Chinese Patent Application No. 202110396848.0, filed Apr. 13, 2021, the entire disclosures of which are incorporated herein by reference.

TECHNICAL FIELD
(1) This disclosure relates to the field of communication technologies, and in particular, to an antenna and an electronic device.
BACKGROUND
(2) With the development of technologies, electronic devices like mobile phones that have communication functions become more and more popular, and the functions are increasingly powerful. An electronic device generally includes an antenna assembly to implement the communication function of the electronic device. However, in the related art, the communication performance of the antenna assembly in the electronic device is not good enough, and there is still room for improvement.
SUMMARY
(3) In the first aspect of the disclosure, an antenna is provided. The antenna includes a first radiator, a matching circuit, a first adjustment circuit, a signal source, and a second radiator. The first radiator has a first ground end, a first free end, and a feed point between the first ground end and the first free end. The matching circuit is connected to the first radiator via the feed point. The first adjustment circuit is electrically connected to the matching circuit, the first adjustment circuit includes a switch unit and multiple adjustment sub-circuits, and the switch unit electrically connects at least one adjustment sub-circuit to the matching circuit. The signal source is electrically connected to the matching circuit. A gap is defined between the second radiator and the first radiator, the second radiator is coupled to the first radiator via the gap, the second radiator has a second ground end and a second free end, the second free end is closer to the gap than the second ground end, and the antenna has at least two resonant modes. Transmission/reception of electromagnetic wave signals in a middle band (MB) and a high-band (HB) is supported by the at least two resonant modes cooperatively at the same moment, or transmission/reception of electromagnetic wave signals in an MB of long-term evolution (LTE) and an MB of new radio (NR) is supported by the at least two resonant modes cooperatively at the same moment, or transmission/reception of electromagnetic wave signals in an HB of LTE and an HB of NR is supported by the at least two resonant modes cooperatively at the same moment.
(4) In the second aspect of the disclosure, an electronic device is provided. The electronic device

includes the antenna mentioned in the first aspect.
(5) Other features and aspects of the disclosed features will become apparent from the following detailed description, taken in conjunction with the accompanying drawings, which illustrate, by way of example, the features in accordance with embodiments of the disclosure. The summary is not intended to limit the scope of any embodiments described herein.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) To describe technical solutions in embodiments of the disclosure more clearly, the following will give a brief introduction to accompanying drawings required for describing embodiments. Apparently, the accompanying drawings hereinafter described are merely some embodiments of the disclosure. Based on these drawings, those of ordinary skill in the art can also obtain other drawings without creative effort.
(2) FIG. **1** is a schematic diagram of an antenna provided in an embodiment of the disclosure.
(3) FIG. **2** is a schematic diagram of return loss of an antenna provided in an embodiment of the disclosure.
(4) FIG. **3** is a schematic diagram of current distribution in the first resonant mode.
(5) FIG. **4** is a schematic diagram of current distribution in the second resonant mode.
(6) FIG. **5** is a schematic diagram of current distribution in the third resonant mode.
(7) FIG. **6** is a schematic diagram of an antenna provided in another embodiment of the disclosure.
(8) FIG. **7** is a partial schematic circuit diagram of an antenna provided in an embodiment of the disclosure.
(9) FIG. **8** is a schematic diagram of an antenna provided in another embodiment of the disclosure.
(10) FIG. **9** is a partial schematic circuit diagram of an antenna provided in another embodiment of the disclosure.
(11) FIG. **10** is a schematic diagram of return loss of an antenna provided in an embodiment of the disclosure.
(12) FIG. **11** is a schematic diagram of return loss of an antenna provided in an embodiment of the disclosure.
(13) FIG. **12** is a schematic diagram illustrating antenna efficiency corresponding to each curve illustrated in FIG. **11**.
(14) FIG. **13** is a stereoscopic structure diagram of an electronic device provided in an embodiment of the disclosure.
(15) FIG. **14** is a schematic cross-sectional diagram of the electronic device illustrated in FIG. **13**, taken along line I-I.
(16) FIG. **15** is a schematic diagram of an electronic device provided in another embodiment of the disclosure.
DETAILED DESCRIPTION
(17) In the first aspect of the disclosure, an antenna is provided. The antenna includes a first radiator, a matching circuit, a first adjustment circuit, a signal source, and a second radiator. The first radiator has a first ground end, a first free end, and a feed point between the first ground end and the first free end. The matching circuit is connected to the first radiator via the feed point. The first adjustment circuit is electrically connected to the matching circuit and includes a switch unit and multiple adjustment sub-circuits, and the switch unit electrically connects at least one adjustment sub-circuit to the matching circuit. The signal source is electrically connected to the matching circuit. A gap is defined between the second radiator and the first radiator, the second radiator is coupled to the first radiator via the gap, the second radiator has a second ground end and a second free end, the second free end is closer to the gap than the second ground end, and the

antenna has at least two resonant modes. Transmission/reception of electromagnetic wave signals in a middle band (MB) and a high-band (HB) is supported by the at least two resonant modes cooperatively at the same moment, or transmission/reception of electromagnetic wave signals in an MB of long-term evolution (LTE) and an MB of new radio (NR) is supported by the at least two resonant modes cooperatively at the same moment, or transmission/reception of electromagnetic wave signals in an HB of LTE and an HB of NR is supported by the at least two resonant modes cooperatively at the same moment.

(18) In an embodiment, the at least two resonant modes include a first resonant mode and a second resonant mode. Current distribution in the first resonant mode is from the second ground end to the second free end and from the first free end to the first ground end. Current distribution in the second resonant mode is from the signal source to the first free end and from the second free end to the second ground end.

(19) In an embodiment, the antenna further has a third resonant mode used to support transmission/reception of electromagnetic wave signals in an ultra-high band (UHB).

(20) In an embodiment, current in the third resonant mode includes a first sub-current and a second sub-current, distribution of the first sub-current is from the first ground end to the first free end, and distribution of the second sub-current is from the second ground end to the second free end.

(21) In an embodiment, the antenna further includes a second adjustment circuit electrically connected to the second radiator, and the second adjustment circuit is configured to adjust a resonant frequency point of the second resonant mode and/or a resonant frequency point of the third resonant mode.

(22) In an embodiment, the second adjustment circuit includes a switch or a variable capacitor electrically connected to the ground.

(23) In an embodiment, the adjustment sub-circuit includes one or more selected from a group consisting of capacitors, inductors, and resistors.

(24) In an embodiment, the multiple adjustment sub-circuits include a first adjustment sub-circuit, a second adjustment sub-circuit, a third adjustment sub-circuit, and a fourth adjustment sub-circuit. The switch unit includes a public end, a first switch sub-unit, a second switch sub-unit, a third switch sub-unit, and a fourth switch sub-unit. The public end is electrically connected to the matching circuit, the first switch sub-unit electrically connects the first adjustment sub-circuit to the matching circuit, the second switch sub-unit electrically connects the second adjustment sub-circuit to the ground, the third switch sub-unit electrically connects the third adjustment sub-circuit to the ground, and the fourth switch sub-unit electrically connects the fourth adjustment sub-circuit to the ground.

(25) In an embodiment, the first adjustment sub-circuit includes an adjustment capacitor. The second adjustment sub-circuit includes a first inductor. The third adjustment sub-circuit includes a second inductor. The fourth adjustment sub-circuit includes a third inductor.

(26) In an embodiment, the matching circuit includes a first matching sub-circuit and a second matching sub-circuit. The first matching sub-circuit has one end electrically connected to the signal source, and the other end electrically connected to the first adjustment sub-circuit, and the first matching sub-circuit and the first adjustment sub-circuit are configured to adjust a capacitance of the antenna. The second matching sub-circuit has one end electrically connected to the first matching sub-circuit, and the other end electrically connected to the feed point, the second matching sub-circuit and at least one of the second adjustment sub-circuit, the third adjustment sub-circuit, or the fourth adjustment sub-circuit are cooperatively configured to adjust an inductance of the antenna.

(27) In an embodiment, the first matching sub-circuit includes a first matching capacitor and a second matching capacitor, the first matching capacitor has one end electrically connected to the signal source, and the other end electrically connected to the second matching capacitor. A connection point between the first matching capacitor and the second matching capacitor is

electrically connected to the adjustment capacitor.
(28) In an embodiment, the second matching sub-circuit includes a first matching inductor and a second matching inductor, the first matching inductor has one end electrically connected to one end of the second matching capacitor away from the first matching capacitor, and electrically connected to the public end of the switch unit, and the first matching inductor has the other end electrically connected to the feed point. The second matching inductor has one end electrically connected to the feed point, and the other end connected to the ground.
(29) In an embodiment, the antenna further includes a third radiator electrically connected to the matching circuit. The fourth resonant mode is supported by the third radiator. Transmission/reception of electromagnetic wave signals in a preset frequency band is supported by the fourth resonant mode, and the preset frequency band is higher than a frequency band of electromagnetic wave signals supported by the first resonant mode and the second resonant mode.
(30) In an embodiment, the third radiator has a length ranging from ⅛ to ½ wavelength of the electromagnetic wave signals in the preset frequency band.
(31) In an embodiment, the antenna further includes an isolation circuit electrically connected to the third radiator and the matching circuit, and the isolation circuit is configured to isolate an interference of the electromagnetic wave signals transmitted/received by the first radiator and the second radiator on the electromagnetic wave signals in the preset frequency band transmitted/received by the third radiator.
(32) In an embodiment, the isolation circuit includes a first isolation capacitor and a second isolation capacitor. The first isolation capacitor has one end electrically connected to the matching circuit, and the other end electrically connected to the third radiator. The second isolation capacitor has one end electrically connected to the other end of the first isolation capacitor, and the other end connected to the ground.
(33) In an embodiment, LTE NR double connect (ENDC) and/or carrier aggregation (CA) in a frequency band ranging from 1.0 GHz to 6.0 GHz is implemented by the first radiator, the second radiator, and the third radiator cooperatively.
(34) In an embodiment, a width d of the gap satisfies: 0.5 mm≤d≤2.0 mm.
(35) In the second aspect of the disclosure, an electronic device is provided. The electronic device includes the antenna in the first aspect or any one of embodiments of the antenna in the first aspect.
(36) In an embodiment, the electronic device has a top and a bottom, the antenna is disposed on the top.
(37) In an embodiment, the electronic device includes a first side and a second side connected to the first side, the first side is at the top of the electronic device, the antenna is disposed adjacent to the first side and disposed adjacent to one end the first side connected to the second side.
(38) The following will illustrate technical solutions of embodiments of the disclosure with reference to the accompanying drawings of embodiments of the disclosure. Apparently, embodiments described herein are merely some embodiments, rather than all embodiments, of the disclosure. Based on the embodiments of the disclosure, all other embodiments obtained by those of ordinary skill in the art without creative effort shall fall within the protection scope of the disclosure.
(39) The reference term “an embodiment” or “embodiments” referred to herein means that a particular feature, structure, or characteristic described in conjunction with an embodiment or embodiments may be contained in at least one embodiment of the disclosure. The phrase appearing in various places in the specification does not necessarily refer to the same embodiment, and is not an independent or alternative embodiment mutually exclusive with other embodiments. It is expressly and implicitly understood by those skilled in the art that an embodiment described herein may be combined with other embodiments.
(40) Reference is made to FIG. **1**, which is a schematic diagram of an antenna provided in an embodiment of the disclosure. An antenna **10** is provided in the disclosure, which may be applied

to an electronic device **1**. The electronic device **1** includes but is not limited to electronic devices **1** with communication functions such as a cellphone, a mobile internet device (MID), an electronic book, a play station portable (PSP), or a personal digital assistant (PDA).
(41) The antenna **10** includes a first radiator **110**, a matching circuit **120**, a first adjustment circuit **130**, a signal source **140**, and a second radiator **150**. The first radiator **110** has a first ground end **111**, a first free end **112**, and a feed point P between the first ground end **111** and the first free end **112**. The matching circuit **120** is connected to the first radiator **110** via the feed point P. The first adjustment circuit **130** is electrically connected to the matching circuit **120**, the first adjustment circuit **130** includes a switch unit **131** and multiple adjustment sub-circuits **132**. The switch unit **131** electrically connects at least one adjustment sub-circuit to the matching circuit **120**. The signal source **140** is electrically connected to the matching circuit **120**. A gap **110***a* is defined between the second radiator **150** and the first radiator **110**, and the second radiator **150** is coupled to the first radiator **110** via the gap **110***a*. The second radiator **150** has a second ground end **151** and a second free end **152**. The second free end **152** is closer to the gap **110***a* than the second ground end **151**, such that the antenna has at least two resonant modes. Transmission/reception of electromagnetic wave signals in an MB and an HB is supported by the at least two resonant modes cooperatively at the same moment, or transmission/reception of electromagnetic wave signals in an MB of LTE and an MB of NR is supported by the at least two resonant modes cooperatively at the same moment, or transmission/reception of electromagnetic wave signals in an HB of LTE and an HB of NR is supported by the at least two resonant modes cooperatively at the same moment.
(42) It is to be noted that, transmission/reception of electromagnetic wave signals in the MB and the HB is supported by the at least two resonant modes cooperatively at the same moment, the MB may be an MB of LTE or an MB of NR, correspondingly, and the HB may be an HB of LTE or an HB of NR. Therefore, transmission/reception of electromagnetic wave signals in the MB and the HB supported by the at least two resonant modes cooperatively at the same moment includes the following. Transmission/reception of electromagnetic wave signals in the MB of LTE and the HB of LTE is supported by the at least two resonant modes cooperatively at the same moment; transmission/reception of electromagnetic wave signals in the MB of LTE and the HB of NR is supported by the at least two resonant modes cooperatively at the same moment; transmission/reception of electromagnetic wave signals in the MB of NR and the HB of LTE is supported by the at least two resonant modes cooperatively at the same moment; and transmission/reception of electromagnetic wave signals in the MB of NR and the HB of NR is supported by the at least two resonant modes cooperatively at the same moment.
(43) It is to be noted that, the terms “first”, “second”, and the like used in the specification, the claims, and the accompany drawings of the disclosure are used to distinguish different objects rather than describe a particular order. In addition, the terms “include” and “have” as well as variations thereof are intended to cover non-exclusive inclusion.
(44) The first radiator **110** may be a straight-bar-shaped radiator, or a bent radiator, or a radiator of other shapes, which is not limited in the disclosure. When the first radiator **110** is a straight-bar-shaped radiator, the first ground end **111** and the first free end **112** are two opposite ends of the first radiator **110**. When the first radiator **110** is a bent radiator, for example, when the first radiator **110** includes two radiation parts connected in a bending manner, the first ground end **111** and the first free end **112** are ends of the two radiation parts respectively, the first ground end **111** is one end of one radiation part facing away from the other radiation part, and the first free end **112** is one end of the other radiation part facing away from the one radiation part.
(45) Correspondingly, the second radiator **150** may be a straight-bar-shaped radiator, or a bent radiator, or a radiator of other shapes, which is not limited in the disclosure. When the second radiator **150** is a straight-bar-shaped radiator, the second ground end **151** and the second free end **152** are two opposite ends of the second radiator **150**. When the second radiator **150** is a bent radiator, for example, when the second radiator **150** includes two radiation parts connected in a

bending manner, the second ground end **151** and the second free end **152** are ends of the two radiation parts respectively, the second ground end **151** is one end of one radiation part facing away from the other radiation part, and the second free end **152** is one end of the other radiation part facing away from the one radiation part.
(46) The first radiator **110** may be a flexible printed circuit (FPC) antenna radiator a laser direct structuring (LDS) antenna radiator, a print direct structuring (PDS) antenna radiator, or a metal branch. The second radiator **150** may be an FPC antenna radiator, an LDS antenna radiator, a PDS antenna radiator, or a metal branch.
(47) In an embodiment, the type of the first radiator and the second radiator may be the same to facilitate preparation. In another embodiment, as long as electromagnetic wave signals can be transmitted/received, the type of the first radiator and the type of the second radiator may be different.
(48) The second free end **152** and the first free end **112** are spaced apart from each other to define the gap **110***a*, and the second radiator **150** is coupled to the first radiator **110**. That is, the antenna **10** may transmit/receive electromagnetic wave signals not only by the first radiator **110**, but also by the second radiator **150**. Specifically, an excitation signal generated by the signal source **140** is loaded to the first radiator **110** via the feed point P and coupled to the second radiator **150** via the gap **110***a*. Therefore, the antenna **10** may operate in a wide frequency band. In addition, since the second free end **152** and the first free end **112** are spaced apart from each other to define the gap **110***a*, and the second radiator **150** is coupled to the first radiator **110**, the size of the antenna **10** may be reduced. When the antenna **10** is applied to the electronic device **1**, a stacking space in which the antenna **10** is stacked in the electronic device **1** may be reduced.
(49) In the related art, an antenna **10** may only transmit/receive electromagnetic wave signals in one frequency band at the same moment. Another antenna **10** should be disposed additionally to support transmission/reception of electromagnetic wave signals in one of two frequency bands if electromagnetic wave signals in the two frequency bands are needed to be transmitted/received. Thus, in the related art, a larger number of antennas **10** are required to support transmission/reception of electromagnetic wave signals in multiple frequency bands, resulting in a larger volume of all antennas **10**, i.e., the sum of volumes of all antennas **10** is large. When all the antennas **10** are applied to the electronic device **1**, the difficulty increases for the antennas **10** to stack with other components since the sum of the volume of all the antennas **10** is large. Also, disposing an additional antenna **10** to support transmission/reception of electromagnetic wave signals in one of the frequency bands may result in an increase in radio frequency (RF) link insertion loss of the antennas **10**. The antenna **10** provided in the disclosure has at least two resonant modes, which are used to support transmission/reception of electromagnetic wave signals in an MB and an HB at the same moment, or support transmission/reception of electromagnetic wave signals in an MB of LTE and an MB of NR at the same moment, or support transmission/reception of electromagnetic wave signals in an HB of LTE and an HB of NR at the same moment. Thus, with the coupling of the first radiator **110** and the second radiator **150** and the at least two resonant modes excited by the coupling, the antenna **10** provided in the disclosure may transmit/receive electromagnetic wave signals in multiple frequency bands and has better communication effect. Therefore, the antenna **10** provided in the disclosure does not need another antenna **10** to support one of the frequency bands. Therefore, when transmitting/receiving electromagnetic wave signals in the same frequency band, the size of the antenna **10** of the disclosure is smaller than the sum of the volumes of all antennas **10** capable of supporting the same frequency band in the related art. When the antenna **10** is applied to the electronic device **1**, it is less difficult for the antenna **10** to stack with other components. Moreover, in the disclosure, there is no other antenna **10** provided to support transmission/reception of electromagnetic wave signals in one of the frequency bands. Compared to providing multiple antennas **10** to each support transmission/reception of electromagnetic wave signals in one of the frequency bands, the RF link

insertion loss of the antenna **10** provided in the disclosure is smaller.
(50) The signal source **140** is configured to generate an excitation signal, which is loaded to the feed point P via the matching circuit **120**. Since current distribution of the excitation signal on the first radiator **110** and the second radiator **150** is different, the antenna **10** may support transmission/reception of electromagnetic wave signals in different frequency bands. The matching circuit **120** is configured to adjust an output impedance of the signal source **140** and an input impedance of the first radiator **110**, resulting in higher radiation efficiency of the antenna **10**. A function of the first adjustment circuit **130** will be described in detail later with a specific structure of the first adjustment circuit **130**. The two resonant modes will be described and explained in detail later with reference to FIG. **2**. The MB and the HB may also be referred to as middle high band (MHB), and the range of the MHB is from 1.0 GHz to 3.0 GHz.
(51) In the embodiment, the gap **110***a* is defined between the first radiator **110** and the second radiator **150**, the second radiator **150** is coupled to the first radiator **110** via the gap **110***a*, then the two resonant modes of the antenna **10** are excited. Therefore, the antenna **10** may support transmission/reception of the electromagnetic wave signals in the MB and the HB at the same moment, or support transmission/reception of electromagnetic wave signals in the MB of LTE and the MB of NR at the same moment, or support transmission/reception of electromagnetic wave signals in the HB of LTE and the HB of NR at the same moment. That is, in an embodiment, the antenna **10** may support transmission/reception of electromagnetic wave signals in the MB and transmission/reception of electromagnetic wave signals in the HB at the same moment. Or in another embodiment, the antenna **10** may support transmission/reception of electromagnetic wave signals in the MB of LTE and transmission/reception of electromagnetic wave signals in the HB of NR at the same moment. Or in another embodiment, the antenna **10** may support transmission/reception of electromagnetic wave signals in the HB of LTE and transmission/reception of electromagnetic wave signals in the HB of NR at the same moment. Therefore, the antenna **10** provided in the disclosure may support a wide frequency band at the same moment, and the electronic device **1** with the antenna **10** has better communication performance.
(52) Reference is further made to FIG. **1**, a width d of the gap **110***a* satisfies: 0.5 mm≤d≤2.0 mm. The width d of the gap **110***a* between the first radiator **110** and the second radiator **150** is selected from the above range, ensuring a good coupling effect between the first radiator **110** and the second radiator **150**. The width d may further satisfy: 0.5 mm≤d≤1.5 mm, for better coupling effect between the first radiator **110** and the second radiator **150**.
(53) Reference is made to FIG. **2**, which is a schematic diagram of return loss of an antenna provided in an embodiment of the disclosure. Return loss, short for RL, is a kind of S-Parameters. In the embodiment, the abscissa represents the frequency in GHz and the ordinate represents the return loss in dB. Reference is made to FIG. **2**, the at least two resonant modes include a first resonant mode and a second resonant mode. The resonant mode is also called resonant model. Point **1** in the figure represents a resonant frequency point of the first resonant mode, and point **2** represents a resonant frequency point of the second resonant mode. As illustrated in the schematic diagram, the frequency band supported by the first resonant mode and the second resonant mode ranges from 1.45 GHz to 2.7 GHz.
(54) Reference is made to FIG. **3** and FIG. **4**, where FIG. **3** is a schematic diagram of current distribution in the first resonant mode and FIG. **4** is a schematic diagram of current distribution in the second resonant mode. As illustrated in FIG. **3**, current distribution in the first resonant mode is from the second ground end **151** to the first ground end **111**. As illustrated in FIG. **4**, current distribution in the second resonant mode is from the signal source **140** to the second ground end **151**.
(55) In other words, current distribution in the first resonant mode is from the second ground end **151** to the second free end **152**, and from the first free end **112** to the first ground end **111**.

Specifically, current distribution in the first resonant mode is from the second ground end **151** to the second free end **152**, from the second free end **152** to the first free end **112** through the coupling between the first free end **112** and the second free end **152**, and then from the first free end **112** to the first ground end **111**.

(56) In other words, current distribution in the second resonant mode is from the signal source **140** to the first free end **112**, and from the second free end **152** to the second ground end **151**. Specifically, current distribution in the second resonant mode is from the signal source **140** to the feed point P, from the feed point P to the first free end **112**, from the first free end **112** to the second free end **152** through the coupling between the first free end **112** and the second free end **152**, and then from the second free end **152** to the second ground end **151**.

(57) Reference is further made to FIG. **2**, the antenna **10** further includes the third resonant mode. As illustrated in FIG. **2**, point **3** represents a resonant frequency point of the third resonant mode. The third resonant mode is used to support transmission/reception of electromagnetic wave signals in an ultra high band (UHB). The range of UHB is from 3.0 GHz to 6.0 GHz. As illustrated in FIG. **2**, point **3** represents the resonant frequency point of the third resonant mode, and the frequency band of electromagnetic wave signals supported by the third resonant mode is greater than 3.0 GHz, which means the third resonant mode supports transmission/reception of electromagnetic wave signals in the UHB.

(58) Reference is made to FIG. **5**, which is a schematic diagram of current distribution in the third resonant mode. Current in the third resonant mode includes a first sub-current Ia and a second sub-current Ib. Distribution of the first sub-current Ia is from the first ground end **111** to the first free end **112**, and distribution of the second sub-current Ib is from the second ground end **151** to the second free end **152**.

(59) Reference is made to FIG. **6**, which is a schematic diagram of an antenna provided in another embodiment of the disclosure. The antenna **10** also includes a second adjustment circuit **160**. The second adjustment circuit **160** is electrically connected to the second radiator **150** and configured to adjust a resonant frequency point of the second resonant mode and/or a resonant frequency point of the third resonant mode. The second adjustment circuit **160** further included in the antenna **10** may be incorporated into the antenna described in any of the previous embodiments.

(60) In an embodiment, the second adjustment circuit **160** includes a switch or a variable capacitor electrically connected to the ground.

(61) In an embodiment, the adjustment sub-circuit **132** includes one or more selected from a group consisting of capacitors, inductors, and resistors.

(62) Reference is made to FIG. **7**, which is a partial schematic circuit diagram of an antenna provided in an embodiment of the disclosure. The second radiator **150** is left out in the schematic diagram. The multiple adjustment sub-circuits **132** include a first adjustment sub-circuit **1321**, a second adjustment sub-circuit **1322**, a third adjustment sub-circuit **1323**, and a fourth adjustment sub-circuit **1324**. The switch unit **131** includes a public end A, a first switch sub-unit **1311**, a second switch sub-unit **1312**, a third switch sub-unit **1313**, and a fourth switch sub-unit **1314**. The public end A is electrically connected to the matching circuit **120**. The first switch sub-unit **1311** electrically connects the first adjustment sub-circuit **1321** to the matching circuit **120**. The second switch sub-unit **1312** electrically connects the second adjustment sub-circuit **1322** to the ground. The third switch sub-unit **1313** electrically connects the third adjustment sub-circuit to the ground. The fourth switch sub-unit **1314** electrically connects the fourth adjustment sub-circuit to the ground.

(63) When the first switch sub-unit **1311** is turned on, the first adjustment sub-circuit **1321** is electrically connected to the matching circuit **120**; and when the first switch sub-unit **1311** is turned off, the first adjustment sub-circuit **1321** disconnects from the matching circuit **120**. When the second switch sub-unit **1312** is turned on, the second adjustment sub-circuit **1322** is electrically connected to the matching circuit **120**; and when the second switch sub-unit **1312** is turned off, the

second adjustment sub-circuit **1322** disconnects from the matching circuit **120**. When third switch sub-unit **1313** is turned on, the third adjustment sub-circuit **1323** is electrically connected to the matching circuit **120**; and when the third switch sub-unit **1313** is turned off, the third adjustment circuit **1323** disconnects from the matching circuit **120**. When the fourth switch sub-unit **1314** is turned on, the fourth adjustment sub-circuit **1324** is electrically connected to the matching circuit **120**; and when the fourth switch sub-unit **1314** is turned off, the fourth adjustment sub-circuit **1324** disconnects from the matching circuit **120**.

(64) In an embodiment, the first adjustment sub-circuit **1321** includes an adjustment capacitor C**11**. The second adjustment sub-circuit **1322** includes a first inductor L**11**. The third adjustment sub-circuit **1323** includes a second inductor L**12**. The fourth adjustment sub-circuit **1324** includes a third inductor L**13**.

(65) In an embodiment, the inductance of the first inductor L**11**, the inductance of the second inductor L**12**, and the inductance of the third inductor L**13** are all different. Therefore, when the inductance of the first inductor L**11**, the inductance of the second inductor L**12**, and the inductance of the third inductor L**13** are all different, the inductance is different when one of the following is electrically connected to the matching circuit **120**: the first inductor L**11**, the second inductor L**12**, the third inductor L**13**, a combination of the first inductor L**11** and the second inductor L**12**, a combination of the first inductor L**11** and the third inductor L**13**, a combination of the second inductor L**12** and the third inductor L**13**, or a combination of the first inductor L**11**, the second inductor L**12**, and the third inductor L**13**. Therefore, different combinations of inductance may be achieved, thereby achieving different LC resonances.

(66) Reference is further made to FIG. **7**, the matching circuit **120** includes a first matching sub-circuit **121** and a second matching sub-circuit **122**. The first matching sub-circuit **121** has one end electrically connected to the signal source **140** and the other end electrically connected to the first adjustment sub-circuit **1321**. The first matching sub-circuit **121** and the first adjustment sub-circuit **1321** are configured to adjust the capacitance of the antenna **10**. The second matching sub-circuit **122** has one end electrically connected to the first matching sub-circuit **121** and the other end electrically connected to the feed point P. The second matching sub-circuit **122** and at least one of the second adjustment sub-circuit **1322**, the third adjustment sub-circuit **1323**, or the fourth adjustment sub-circuit **1324** are cooperatively configured to adjust the inductance of the antenna **10**. In other words, the second matching sub-circuit **122** and at least one of the adjustment sub-circuits are cooperatively configured to adjust the inductance of the antenna **10**, where the adjustment sub-circuits include the second adjustment sub-circuit **1322**, the third adjustment sub-circuit **1323**, and the fourth adjustment sub-circuit **1324**.

(67) The first matching sub-circuit **121** and the first adjustment sub-circuit **1321** are configured to adjust the capacitance of the antenna **10**. The second matching sub-circuit **122** and at least one adjustment sub-circuits **132** of the second adjustment sub-circuit **1322**, the third adjustment sub-circuit **1323**, or the fourth adjustment sub-circuit **1324** are cooperatively configured to adjust the inductance of the antenna **10**. Therefore, the antenna **10** may have different LC resonances with different inductance and capacitance, and the antenna **10** may resonate at different frequency points.

(68) In the embodiment, the first matching sub-circuit **121** includes a first matching capacitor C**21** and a second matching capacitor C**22**. The first matching capacitor C**21** has one end electrically connected to the signal source **140** and the other end electrically connected to the second matching capacitor C**22**. The first matching capacitor C**21** and the second matching capacitor C**22** have a connection point electrically connected to the adjustment capacitor C**11**.

(69) Since the first switch sub-unit **1311** is electrically connected to the first adjustment sub-circuit **1321**, when the first switch sub-unit **1311** is turned on, the adjustment capacitor C**11** has one end electrically connected to the connection point between the first matching capacitor C**21** and the second matching capacitor C**22**, and has the other end electrically connected to an end point of the

second matching capacitor C**22** far away from the first matching capacitor C**21** (i.e., the end point marked as point B in the schematic diagram). When the first switch sub-unit **1311** is turned off, the other end of the adjustment capacitor C**11** is electrically disconnected from the end of the second matching capacitor C**22** far from the first matching capacitor C**21**. In other words, the adjustment capacitor C**11** is electrically disconnected from point B. Therefore, the turning on and off of the first switch unit **131** will lead to the change of capacitance in the antenna **10**.
(70) The second matching sub-circuit **122** includes a first matching inductor L**21** and a second matching inductor L**22**. The first matching inductor L**21** has one end electrically connected to the end of the second matching capacitor C**22** far away from the first matching capacitor C**21** (i.e., point B), and electrically connected to the public end A of the switch unit **131**. The first matching inductor L**21** has the other end electrically connected to the feed point P. The second matching inductor L**22** has one end electrically connected to the feed point P, and the other end connected to the ground.
(71) Since the second adjustment sub-circuit **1322** includes the first inductor L**11**, the third adjustment sub-circuit **1323** includes the second inductor L**12**, the fourth adjustment sub-circuit **1324** includes the third inductor L**13**, and the second matching sub-circuit **122** includes the first matching inductor L**21** and the second matching inductor L**22**, when any one or any combination of the second adjustment sub-circuit **1322**, the third adjustment sub-circuit **1323**, or the fourth adjustment sub-circuit **1324** is electrically connected to the public end A, the adjustment sub-circuit and the second matching sub-circuit **122** will cooperatively generate different inductance.
(72) Optionally, in the embodiment, the antenna **10** further includes a fourth inductor L**14**. The fourth inductor L**14** has one end electrically connected to the signal source **140**, and the other end electrically connected to the first matching sub-circuit **121**. The fourth inductor L**14** is configured to adjust the inductance of the antenna **10** cooperatively with the second matching sub-circuit **122**, the second adjustment sub-circuit **1322**, the third adjustment sub-circuit **1323**, and the fourth adjustment sub-circuit **1324**.
(73) In another embodiment, the inductance of the fourth inductor L**14** may be zero, which means the fourth inductor L**14** is not included in the antenna **10**.
(74) Reference is made to FIG. **2** and FIG. **8**, where FIG. **8** is a schematic diagram of an antenna provided in another embodiment of the disclosure. In the embodiment, the antenna **10** includes the first radiator **110**, the matching circuit **120**, the first adjustment circuit **130**, the signal source **140**, and the second radiator **150**. In the embodiment, the antenna **10** further includes a third radiator **170**. The third radiator **170** is electrically connected to the matching circuit **120** and configured to support a fourth resonant mode (referring to FIG. **2**, point **4** represents the resonant frequency point of the fourth resonant mode). The fourth resonant mode is used to support transmission/reception of electromagnetic wave signals in a preset frequency band. The preset frequency band is higher than the frequency band of electromagnetic wave signals supported by the first resonant mode and the second resonant mode. In the embodiment, the preset frequency band is also higher than the frequency band of electromagnetic wave signals supported by the third resonant mode.
(75) The third radiator **170** may be a FPC antenna radiator, an LDS antenna radiator, a PDS antenna radiator, or a metal branch.
(76) In an embodiment, the types of the first radiator **110**, the second radiator **150**, and the third radiator **170** may be the same to facilitate preparation. In another embodiment, as long as electromagnetic wave signals can be transmitted/received, the types of the first radiator **110**, the second radiator **150**, and the third radiator **170** may be different.
(77) In the embodiment, the third radiator **170** has a length ranging from ⅛ to ½ wavelength of electromagnetic wave signals in the preset frequency band. The length of the third radiator **170** ranges from ⅛ to ½ wavelength of electromagnetic wave signals in the preset frequency band, so that the length of the third radiator **170** matches electromagnetic wave signals in the preset frequency band, and the third radiator will have a good radiation efficiency when

transmitting/receiving electromagnetic wave signals in the preset frequency band.

(78) In an embodiment, the preset frequency band is in the UHB. For example, the preset frequency band is an N79 frequency band (4.4 GHz˜5.0 GHz).

(79) Reference is made to FIG. **9**, which is a partial schematic circuit diagram of an antenna provided in another embodiment of the disclosure. The antenna **10** also includes an isolation circuit **180**. The isolation circuit **180** is electrically connected to the third radiator **170** and the matching circuit **120**, and the isolation circuit **180** is configured to isolate an interference of electromagnetic wave signals transmitted/received by the first radiator **110** and the second radiator **150** on electromagnetic wave signals in the preset frequency band transmitted/received by the third radiator **170**. In the embodiment, for illustrative purpose, the isolation circuit **180** of the antenna **10** is combined to FIG. **7**, and it is to be understood that it should not constitute a limitation to the antenna provided in the embodiment.

(80) The third radiator **170** is configured to support the fourth resonant mode, the fourth resonant mode is used to support transmission/reception of electromagnetic wave signals in the preset frequency band, and the preset frequency band is higher than the frequency band of electromagnetic wave signals supported by the first resonant mode, the second resonant mode, and the third resonant read, which means the preset frequency band is a high frequency band. Therefore, the isolation circuit **180** is electrically connected to the third radiator **170** and the matching circuit **120**, and the isolation circuit **180**, for other frequency bands, is equivalent to a smaller capacitor connected in parallel. Therefore, on one hand, the isolation circuit **180** may isolate an interference of electromagnetic wave signals transmitted/received by the first radiator **110** and the second radiator **150** on electromagnetic wave signals in the frequency band transmitted and received by the third radiator **170**, on the other hand, reduce the impact on electromagnetic wave signals transmitted/received by the first radiator **110** and the second radiator **150**.

(81) In the embodiment, the isolation circuit **180** includes a first isolation capacitor C**31** and a second isolation capacitor C**32**. The first isolation capacitor C**31** has one end electrically connected to the matching circuit **120** and the other end electrically connected to the third radiator **170**. The second isolation capacitor C**32** has one end electrically connected to the other end of the first isolation capacitor C**31**, and the second isolation capacitor C**32** has the other end connected to the ground.

(82) It is to be noted that, the matching capacitor described earlier is also known as a capacitor, the isolation capacitor is also known as a capacitor, and the matching inductor is also known as an inductor. Due to the limitations of the actual specifications of capacitors, one or more capacitors may be required to achieve a preset capacitance. In the embodiment, the isolation circuit **180** includes the first isolation capacitor C**31** and the second isolation capacitor C**32**, which is beneficial for selecting suitable capacitors to achieve the above capacitance.

(83) The electromagnetic wave signals transmitted/received by the antenna **10** provided in an embodiment of the disclosure will be described in the following with reference to the simulation diagrams. Reference is made to FIG. **2** and FIG. **10**, where FIG. **10** is a schematic diagram of return loss of an antenna provided in an embodiment of the disclosure. The schematic diagram of FIG. **10** is simulated on the basis of the structure of the antenna **10** in FIG. **8** and the circuit of the antenna **10** in FIG. **11**. In the embodiment, the abscissa represents the frequency in GHz and the ordinate represents the return loss in dB. There are four curves in the schematic diagram, which are labeled as Curve{circle around (**1**)}, Curve{circle around (**2**)}, Curve{circle around (**3**)} and Curve{circle around (**4**)}. Curve{circle around (**1**)}, Curve{circle around (**2**)}, Curve{circle around (**3**)} and Curve{circle around (**4**)} respectively represent return loss when the switch unit **131** is in different states, that is, four curves correspond to four states of the switch unit **131**. It is to be noted that since the switch unit **131** includes the first switch sub-unit **1311**, the second switch sub-unit **1312**, the third switch sub-unit **1313**, and the fourth switch sub-unit **1314**, the states of the first switch sub-unit **1311**, the second switch sub-unit **1312**, the third switch sub-unit **1313**, and the fourth

switch sub-unit **1314** of the switch unit **131** are different in turning on or off, resulting in different states of the switch unit **131**. As illustrated in the schematic diagram, the antenna **10** may transmit/receive electromagnetic wave signals ranging from 1.0 GHz to 6.0 GHz. Therefore, the antenna **10** may cover frequency bands B3, B39, B1, B7, N41, N77, N78, N79, and other frequency bands of the same frequency. Therefore, the antenna **10** of the disclosure may support the coverage of electromagnetic wave signals in a wider frequency band.
(84) Referring to the left first resonant mode (first resonant mode) of curve{circle around (**3**)} and the left first resonant mode (first resonant mode) of curve{circle around (**4**)}, compared with the first resonant mode of curve{circle around (**3**)}, the first resonant mode of curve{circle around (**4**)} shifts to the right, and the resonant frequency point of the first resonant mode of curve{circle around (**4**)} (the lowest point of the first resonant mode) is closer to the resonant frequency point of the B39 (from 1.88 GHz to 1.92 GHz) than that of the first resonant mode of curve{circle around (**3**)}. Therefore, the B39 may be better covered by changing the state of the switching unit **131**. For electromagnetic wave signals in other frequency bands, the antenna **10** may better cover each frequency band by switching the state of the switch unit **131**.
(85) In addition, as illustrated in point **3** and point **4** of the schematic diagram, the antenna **10** has two resonant modes in a frequency band ranging from 1.45 GHz to 2.7 GHz. Therefore, a wider frequency band can be covered in the frequency band ranging from 1.45 GHz to 2.7 GHz, which means the antenna **10** is a wideband antenna in the frequency band ranging from 1.45 GHz to 2.7 GHz. The frequency band of electromagnetic wave signals transmitted/received by the antenna **10** may be adjusted by adjusting a matching value of the matching circuit **120**.
(86) Reference is made to FIG. **11**, which is a schematic diagram of return loss of an antenna provided in an embodiment of the disclosure. In the embodiment, the abscissa represents the frequency in GHz and the ordinate represents the return loss in dB. According to different matching values, there are four curves in the schematic diagram, which are labeled as Curve{circle around (**5**)}, Curve{circle around (**6**)}, Curve{circle around (**7**)}, and Curve{circle around (**8**)}. Curve{circle around (**5**)}, Curve{circle around (**6**)}, Curve{circle around (**7**)}, and Curve{circle around (**8**)} respectively correspond to different matching values of the matching circuit **120**. In the schematic diagram, the frequency corresponding to point **1** is 1.4805 GHz, and the frequency corresponding to point **2** is 1.6611 GHz. As illustrated from point **1** and point **2** in the schematic diagram, the frequency range covered by point **1** and point **2** ranges from 1.45 GHz to 1.70 GHz. Therefore, the antenna **10** may cover the 1.5 GHz frequency band corresponding to B32 (from 1.452 GHz to 1.496 GHz) and N75 (from 1.432 GHz to 1.517 GHz).
(87) As can be seen from the above analysis, by adjusting the state of the switch unit **131** and the matching value of the matching circuit **120**, the first radiator **110**, the second radiator **150**, and the third radiator **170** may cooperatively implement LTE NR double connect (ENDC) of the fourth generation mobile communication technology (4G) signals and the fifth generation mobile communication technology (5G) signals in the frequency ranging from 1.0 GHz to 6.0 GHz, and/or the carrier aggregation (CA) of 4G signals or 5G signals.
(88) Reference is made to FIG. **12**, which is a schematic diagram illustrating antenna efficiency corresponding to each curve illustrated in FIG. **11**. In the embodiment, the abscissa represents the frequency in GHz and the ordinate represents the efficiency in dB. Curve{circle around (**1**)}′ is an efficiency curve corresponding to Curve{circle around (**1**)} in FIG. **11**, Curve{circle around (**2**)}′ is an efficiency curve corresponding to Curve{circle around (**2**)} in FIG. **11**, Curve{circle around (**3**)}′ is an efficiency curve corresponding to Curve{circle around (**3**)} in FIG. **11**, and Curve{circle around (**4**)}′ is an efficiency curve corresponding to Curve{circle around (**4**)} in FIG. **11**.
(89) In the related art, the efficiency higher than −3.5 dB may be regarded as high efficiency of an antenna **10**. As can be seen from the efficiency diagram of the antenna **10**, the efficiency of the antenna **10** of the disclosure is higher than −3.5 dB at multiple frequencies. Therefore, the antenna **10** provided in the disclosure has significantly high single-band efficiency and significantly wide

ENDC and/or CA state efficiency.
(90) An electronic device **1** is also provided in the disclosure. Reference is made to FIG. **13** and FIG. **14**, where FIG. **13** is a stereoscopic structure diagram of an electronic device provided in an embodiment of the disclosure, and FIG. **14** is a schematic cross-sectional diagram of the electronic device illustrated in FIG. **13**, taken along line I-I. The electronic device **1** includes any one of antennas **10** provided in the above embodiments. The antennas **10** may be referred to the above description, which will not be repeated here.
(91) In the embodiment, the electronic device **1** includes a middle frame **30**, a screen **40**, a circuit board **50**, and a battery cover **60**. The middle frame **30**, the screen **40**, the circuit board **50**, and the battery cover **60** will be described in details in the following.
(92) The middle frame **30** is made of metal, such as aluminum-magnesium alloy and copper plate. At least part of the middle frame **30** (e.g. a main body portion **310** of the middle frame **30**) generally constitutes the ground of the electronic device **1**. When an electronic component of the electronic device **1** needs to be grounded, the electronic component may be electrically connected to the at least part of the middle frame **30** so as to be grounded. The middle frame **30** includes a main body portion **310** and an edge frame **320** connected to a periphery of the main body portion **310** in a bending manner. At least one of the first radiator **110**, the second radiator **150**, or the third radiator **170** may be arranged on the edge frame **320**, and the main body **310** constitutes the ground of the electronic device **1**. When at least one of the first radiator **110**, the second radiator **150**, and the third radiator **170** is arranged on the edge frame **320**, the at least one radiator arranged on the edge frame **320** is electrically connected to the main body **310** so as to be grounded. It is to be understood that when the at least one radiator arranged on the edge frame **320** is electrically connected to the main body portion **310**, the at least one radiator may be connected to the main body portion **310** via a conductive elastic piece or a conductive connecting rubber.
(93) It is to be noted that, at least one of the first radiator **110**, the second radiator **150**, and the third radiator **170** is arranged on the edge frame **320**, and the radiator not arranged on the edge frame **320** among the first radiator **110**, the second radiator **150**, and the third radiator **170** is an FPC antenna radiator, an LDS antenna radiator, or a PDS antenna radiator. For example, if the first radiator **110** and the second radiator **150** are arranged on the edge frame **320**, the third radiator **170** is not arranged on the edge frame **320** (e.g., the third radiator **170** is arranged on the circuit board **50**), then the third radiator **170** is an FPC antenna radiator, an LDS antenna radiator, or a PDS antenna radiator.
(94) The screen **40** may be a display screen with a display function or a screen **40** integrated with display and touch functions. The screen **40** is configured to display texts, images, videos, and other information. The screen **40** is carried by the middle frame **30** and is at one side of the middle frame **30**. The circuit board **50** is also generally carried by the middle frame **30**, and the circuit board **50** and the screen **40** are carried on opposite sides of the middle frame **30**. At least one of the signal source **140**, the matching circuit **120**, the first adjustment circuit **130**, the fourth adjustment circuit **160**, or the isolation circuit **180** in the antenna **10** described above may be arranged on the circuit board **50**. The battery cover **60** is arranged on one side of the circuit board **50** facing away from the middle frame **30**. The battery cover **60**, the middle frame **30**, the circuit board **50**, and the screen **40** are assembled into a complete electronic device **1** cooperatively. It is to be understood that the description of the structure of the electronic device **1** is only a description of a form of the structure of the electronic device **1**, and should not be understood as a limitation to the electronic device **1** or the antenna **10**.
(95) Reference is made to FIG. **15**, which is a schematic diagram of an electronic device provided in another embodiment of the disclosure. The electronic device **1** includes a top **1***a* and a bottom **1***b*, and the antenna **10** is disposed on the top **1***a*.
(96) The top **1***a* refers to an upper part of the electronic device **1** when the electronic device **1** is placed or used in a stereoscopic manner, while the bottom **1***b* refers to a lower part of the electronic

device **1** opposite to the top **1***a*. For example, when the electronic device **1** is used in a vertical direction, the top **1***a* is the upper part of the electronic device **1**, which means the top **1***a* is usually located away from the ground, and the bottom **1***b* is a part of the electronic device **1** close to the ground, which means the bottom **1***b* is usually located close to the ground.

(97) The electronic device **1** of the embodiment includes a first side **11**, a second side **12**, a third side **13**, and a fourth side **14** connected in sequence. The first side **11** is opposite and spaced apart from the third side **13**, and the second side **12** is opposite and spaced apart from the fourth side **14**. The second side **12** is connected to the first side **11** and the third side **13**, and the fourth side **14** is connected to the first side **11** and the third side **13**. The first side **11** is at the top **1***a*, and the third side **13** is at the bottom **1***b*. A connection between the first side **11** and the second side **12**, a connection between the second side **12** and the third side **13**, a connection between the third side **13** and the fourth side **14**, and a connection between the fourth side **14** and the first side **11**, each constitute a corner of the electronic device **1**. The first side **11** serves as a top side, the second side **12** serves as a right side, the third side **13** serves as a bottom side, and the fourth side **14** serves as a left side. The corner constituted by the first side **11** and the second side **12** serves as a first corner K**1**, which is an upper right corner; and the corner constituted by the first side **11** and the fourth side **14** serves as a second corner K**2**, which is an upper left corner.

(98) It is to be noted that, in an embodiment, the first side **11** and the second side **12** are both straight-line segments, the first side **11** is directly connected to the second side **12**, which means no curve segment between the first side **11** and the second side **12**. In another embodiment, the first side **11** is connected to the second side **12** through a curve segment. In both embodiments, the connections between the first side **11** and the second side **12** each are called as the first corner K**1**.

(99) Correspondingly, in an embodiment, the first side **11** and the fourth side **14** are both straight-line segments, the first side **11** is directly connected to the fourth side **14**, which means no curve segment between the first side **11** and the fourth side **14**. In another embodiment, the first side **11** is connected to the fourth side **14** through a curve segment. In both embodiments, the connections between the first side **11** and the fourth side **14** each are called as the second corner K**2**.

(100) In the embodiment, the top **1***a* includes the first side **11**, the first corner K**1**, and the second corner K**2**. When the antenna **10** includes the first radiator **110** and the second radiator **150**, the antenna **10** is disposed on the top **1***a* as follows. The first radiator **110** and the second radiator **150** are arranged at the upper left corner of the electronic device **1**; or the first radiator **110** and the second radiator **150** are arranged corresponding to the top side of the electronic device **1**; or the first radiator **110** and the second radiator **150** are arranged at the upper right corner of the electronic device **1**. When the first radiator **110** and the second radiator **150** are both disposed on the top **1***a*, the first radiator **110** and the second radiator **150** may be arranged corresponding to the same side or arranged corresponding to different sides.

(101) When the first radiator **110** and the second radiator **150** are arranged at the upper left corner of the electronic device **1**, the situations include but are not limited to the following. Part of the first radiator **110** is arranged corresponding to the fourth side **14**, the other part of the first radiator **110** is arranged corresponding to the first side **11**, and the second radiator **150** is arranged corresponding to the first side **11**; or part of the second radiator **150** is arranged at the first side **11**, the other part of the second radiator **150** is arranged corresponding to the fourth side **14**, and the first radiator **110** is arranged corresponding to the fourth side **14**; or the first radiator **110** is arranged corresponding to the first side **11**, and the second radiator **150** is arranged corresponding to the fourth side **14**; or the first radiator **110** is arranged corresponding to the fourth side **14**, and the second radiator **150** is arranged corresponding to the first side **11**.

(102) When the first radiator **110** and the second radiator **150** are arranged at the upper right corner of the electronic device **1**, the situations include but are not limited to the following. The first radiator **110** is arranged corresponding to the first side **11**, the second radiator **150** is arranged corresponding to the second side **12**; or the first radiator **110** is arranged corresponding to the first

side **11**, part of the second radiator **150** is arranged corresponding to the second side **11**, and the other part of the second radiator **150** is arranged corresponding to the first side **12**; or part of the first radiator **110** is arranged corresponding to the first side **11**, the other part of the first radiator **110** is arranged corresponding to the second side **12**, and the second radiator **150** is arranged corresponding to the second side **12**; or the first radiator **110** is arranged corresponding to the second side **12**, and the second radiator **150** is arranged corresponding to the first side **11**.

(103) It is to be noted that, in the embodiment, for illustrative purpose, the electronic device **1** includes the first side **11**, the second side **12**, the third side **13**, and the fourth side **14** connected in sequence, which should not be understood as a limitation to the electronic device **1** provided in the embodiment. In other embodiments, the electronic device **1** may include sides in other number, for example, three sides, six sides, etc., as long as the electronic device **1** includes the first side **11** and the second side **12** connected to the first side **11**, where the first side **11** is on the top **1***a* of the electronic device **1**, the antenna **10** is disposed adjacent to the first side **11** and adjacent to one end of the first side **11** connected to the second side **12**.

(104) In the schematic diagram of the embodiment, for illustrative purpose, the antenna **10** is disposed on the first side **11** and disposed adjacent to the end of the first side **11** connected to the second side **12**. Specifically, for illustrative purpose, in the embodiment, the first radiator **110** and the second radiator **150** are both arranged corresponding to the first side **11**. In the schematic diagram of the embodiment, for illustrative purpose, the first side **11** and the third side **13** are short sides of the electronic device **1**, and the second side **12** and the fourth side **14** are long sides of the electronic device **1**. In other embodiments, the length of the first side **11**, the second side **12**, the third side **13**, and the fourth side **14** may be the same, or may be in other situations. The length of the first side **11**, the second side **12**, the third side **13**, and the fourth side **14** should not be understood as a limitation to the electronic device **1** provided in the embodiment. When the antenna **10** is disposed corresponding to the first side **11** and disposed adjacent to the end of the first side **11** connected to the second side **12**, the antenna **10** will not be blocked when a user is holding the electronic device **1**, thus the communication of the electronic device **1** will not be effected.

(105) When the electronic device **1** is placed or used in a stereoscopic manner, the top **1***a* of the electronic device **1** is usually arranged away from the ground, and the bottom **1***b* of the electronic device **1** is usually arranged close to the ground. Therefore, when the first radiator **110** and the second radiator **150** are arranged on the top **1***a*, the antenna **10** has greater upper hemisphere radiation efficiency, rendering greater communication efficiency of the antenna **10**. In other embodiments, however, the first radiator **110** and the second radiator **150** may be arranged on the bottom **1***b* of the electronic device **1**. Although the antenna **10** has lower upper hemisphere radiation efficiency when the first radiator **110** and the second radiator **150** are arranged on the bottom **1***b* of the electronic device **1**, the antenna **10** may still have good communication effect as long as the upper hemisphere radiation efficiency is greater than a preset efficiency.

(106) When the antenna **10** includes the first radiator **110**, the second radiator **150**, and the third radiator **170** and when the antenna **10** is disposed on the top **1***a*, the first radiator **110**, the second radiator **150**, and the third radiator **170** may be arranged corresponding to the same side or different sides.

(107) When the first radiator **110**, the second radiator **150**, and the third radiator **170** are arranged on the top **1***a*, the antenna **10** has greater upper hemisphere radiation efficiency, rendering greater communication efficiency of the antenna **10**. In other embodiments, however, the first radiator **110**, the second radiator **150**, and the third radiator **170** may be arranged on the bottom **1***b* of the electronic device **1**. Although the antenna **10** has lower upper hemisphere radiation efficiency when the first radiator **110**, the second radiator **150**, and the third radiator **170** are arranged on the bottom **1***b* of the electronic device **1**, the antenna **10** may still have good communication effect as long as the radiation efficiency of the upper hemisphere is greater than the preset efficiency.

(108) The above are only some embodiments of the disclosure and are not intended to limit the

disclosure. For those skilled in the art, the disclosure may have various modifications and variations. Any modification, equivalent arrangement and improvement made within the spirit and principles of the disclosure shall be included in the scope of protection of the disclosure.

Claims

1. An antenna comprising: a first radiator having a first ground end, a first free end, and a feed point between the first ground end and the first free end; a matching circuit connected to the first radiator via the feed point; a first adjustment circuit electrically connected to the matching circuit and comprising a switch unit and a plurality of adjustment sub-circuits, the switch unit electrically connecting at least one adjustment sub-circuit to the matching circuit; a signal source electrically connected to the matching circuit; a second radiator, wherein a gap is defined between the second radiator and the first radiator, the second radiator is coupled to the first radiator via the gap, the second radiator has a second ground end and a second free end, the second free end is closer to the gap than the second ground end, the antenna has at least two resonant modes, and transmission/reception of electromagnetic wave signals in a middle band (MB) and a high-band (HB) is supported by the at least two resonant modes cooperatively at the same moment, or transmission/reception of electromagnetic wave signals in an MB of long-term evolution (LTE) and an MB of new radio (NR) is supported by the at least two resonant modes cooperatively at the same moment, or transmission/reception of electromagnetic wave signals in an HB of LTE and an HB of NR is supported by the at least two resonant modes cooperatively at the same moment, the at least two resonant modes comprise a first resonant mode and a second resonant mode; and a third radiator, wherein the third radiator is electrically connected to the matching circuit, another resonant mode is supported by the third radiator, wherein transmission/reception of electromagnetic wave signals in a preset frequency band is supported by the another resonant mode, and the preset frequency band is higher than a frequency band of electromagnetic wave signals supported by the first resonant mode and the second resonant mode.
2. The antenna of claim 1, wherein current distribution in the first resonant mode is from the second ground end to the second free end and from the first free end to the first ground end; and current distribution in the second resonant mode is from the signal source to the first free end and from the second free end to the second ground end.
3. The antenna of claim 2, wherein the at least two resonant modes further comprise: a third resonant mode used to support transmission/reception of electromagnetic wave signals in an ultra-high band (UHB).
4. The antenna of claim 3, wherein current in the third resonant mode comprises a first sub-current and a second sub-current, distribution of the first sub-current is from the first ground end to the first free end, and distribution of the second sub-current is from the second ground end to the second free end.
5. The antenna of claim 3, further comprising: a second adjustment circuit electrically connected to the second radiator configured to adjust a resonant frequency point of the second resonant mode and/or a resonant frequency point of the third resonant mode.
6. The antenna of claim 5, wherein the second adjustment circuit comprises a switch or a variable capacitor electrically connected to the ground.
7. The antenna of claim 1, wherein an adjustment sub-circuit comprises one or more selected from a group consisting of capacitors, inductors, and resistors.
8. The antenna of claim 7, wherein the plurality of adjustment sub-circuits comprises a first adjustment sub-circuit, a second adjustment sub-circuit, a third adjustment sub-circuit, and a fourth adjustment sub-circuit, and the switch unit comprises: a public end electrically connected to the matching circuit; a first switch sub-unit electrically connecting the first adjustment sub-circuit to the matching circuit; a second switch sub-unit electrically connecting the second adjustment sub-

circuit to the ground; a third switch sub-unit electrically connecting the third adjustment sub-circuit to the ground; and a fourth switch sub-unit electrically connecting the fourth adjustment sub-circuit to the ground.
9. The antenna of claim 8, wherein: the first adjustment sub-circuit comprises an adjustment capacitor; the second adjustment sub-circuit comprises a first inductor; the third adjustment sub-circuit comprises a second inductor; and the fourth adjustment sub-circuit comprises a third inductor.
10. The antenna of claim 9, wherein the matching circuit comprises: a first matching sub-circuit, wherein first matching sub-circuit has one end electrically connected to the signal source, and another end electrically connected to the first adjustment sub-circuit, and the first matching sub-circuit and the first adjustment sub-circuit are configured to adjust a capacitance of the antenna; and a second matching sub-circuit, wherein the second matching sub-circuit has one end electrically connected to the first matching sub-circuit, and another end electrically connected to the feed point, the second matching sub-circuit and at least one of the second adjustment sub-circuit, the third adjustment sub-circuit, or the fourth adjustment sub-circuit are cooperatively configured to adjust an inductance of the antenna.
11. The antenna of claim 10, wherein: the first matching sub-circuit comprises a first matching capacitor and a second matching capacitor, the first matching capacitor has one end electrically connected to the signal source, and another end electrically connected to the second matching capacitor, and a connection point between the first matching capacitor and the second matching capacitor is electrically connected to the adjustment capacitor; and the second matching sub-circuit comprises a first matching inductor and a second matching inductor, the first matching inductor has one end electrically connected to one end of the second matching capacitor away from the first matching capacitor, and electrically connected to the public end of the switch unit, and the first matching inductor has another end electrically connected to the feed point; and the second matching inductor has one end electrically connected to the feed point, and another end connected to the ground.
12. The antenna of claim 1, wherein the third radiator has a length ranging from ⅛ to ½ wavelength of the electromagnetic wave signals in the preset frequency band.
13. The antenna of claim 1, further comprising: an isolation circuit, wherein the isolation circuit is electrically connected to the third radiator and the matching circuit, and the isolation circuit is configured to isolate an interference of the electromagnetic wave signals transmitted/received by the first radiator and the second radiator on the electromagnetic wave signals in the preset frequency band transmitted/received by the third radiator.
14. The antenna of claim 13, wherein the isolation circuit comprises: a first isolation capacitor, wherein the first isolation capacitor has one end electrically connected to the matching circuit, and another end electrically connected to the third radiator; and a second isolation capacitor, wherein the second isolation capacitor has one end electrically connected to the other end of the first isolation capacitor, and the other end connected to the ground.
15. The antenna of claim 1, wherein LTE NR double connect (ENDC) and/or carrier aggregation (CA) in a frequency band ranging from 1.0 GHz to 6.0 GHz is implemented by the first radiator, the second radiator, and the third radiator cooperatively.
16. The antenna of claim 1, wherein a width d of the gap satisfies: $0.5\ mm \leq d \leq 2.0\ mm$.
17. An electronic device, comprising: an antenna, wherein the antenna comprises: a first radiator having a first ground end, a first free end, and a feed point between the first ground end and the first free end; a matching circuit connected to the first radiator via the feed point; a first adjustment circuit electrically connected to the matching circuit and comprising a switch unit and a plurality of adjustment sub-circuits, the switch unit electrically connecting at least one adjustment sub-circuit to the matching circuit; a signal source electrically connected to the matching circuit; and a second radiator, wherein a gap is defined between the second radiator and the first radiator, the second

radiator is coupled to the first radiator via the gap, the second radiator has a second ground end and a second free end, the second free end is closer to the gap than the second ground end, the antenna has at least two resonant modes, and transmission/reception of electromagnetic wave signals in a middle band (MB) and a high-band (HB) is supported by the at least two resonant modes cooperatively at a same moment, or transmission/reception of electromagnetic wave signals in an MB of long-term evolution (LTE) and an MB of new radio (NR) is supported by the at least two resonant modes cooperatively at a same moment, or transmission/reception of electromagnetic wave signals in an HB of LTE and an HB of NR is supported by the at least two resonant modes cooperatively at the same moment, the at least two resonant modes comprise a first resonant mode and a second resonant mode; and a third radiator, wherein the third radiator is electrically connected to the matching circuit, another resonant mode is supported by the third radiator, wherein transmission/reception of electromagnetic wave signals in a preset frequency band is supported by the another resonant mode, and the preset frequency band is higher than a frequency band of electromagnetic wave signals supported by the first resonant mode and the second resonant mode.

18. The electronic device of claim 17, having a top and a bottom, wherein the antenna is disposed on the top.

19. The electronic device of claim 18, comprising a first side and a second side connected to the first side, wherein the first side is at the top of the electronic device, the antenna is disposed adjacent to the first side, and the antenna is disposed adjacent to one end of the first side connected to the second side.