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(54) **ULTRA-WIDEBAND ANTENNA AND TERMINAL**

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H01Q 5/378 (2015.01)
(Continued)

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CPC ***H01Q 5/0017*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 5/25*** (2015.01); ***H01Q 5/378*** (2015.01); ***H01Q 9/40*** (2013.01); ***H01Q 9/42*** (2013.01)

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CPC H01Q 5/0017; H01Q 5/25; H01Q 5/378; H01Q 5/385; H01Q 9/40; H01Q 1/38
USPC 343/850
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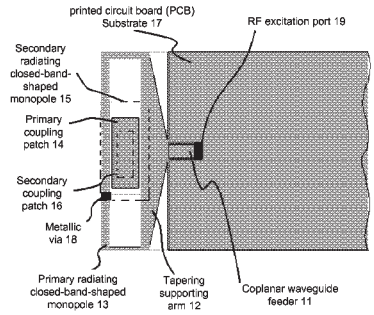
(57) **ABSTRACT**

The present disclosure discloses an ultra-wideband antenna, including: a coplanar waveguide feeder connected to a Radio Frequency (RF) excitation port on the PCB substrate at one end and to a tapering supporting arm at the other end; the tapering supporting arm connected to the coplanar waveguide feeder at one end and to a primary radiating closed-band-shaped monopole at the other end; the primary radiating closed-band-shaped monopole connected to the tapering supporting arm; a primary coupling patch located in the area closed by the closed band of the primary radiating closed-band-shaped monopole; a secondary radiating closed-band-shaped monopole connected to the primary radiating closed-band-shaped monopole through a metallic via; and a secondary coupling patch located in the area closed by the closed band of the secondary radiating closed-band-shaped monopole. The present disclosure also discloses an ultra-wideband terminal. With the antenna and the terminal of the present disclosure, space usage is reduced, facilitating development of an ultrathin terminal and widening bandwidth, and thus allowing the terminal to operate in the range of an ultra-wide band.

12 Claims, 3 Drawing Sheets



(51) **Int. Cl.**

H01Q 5/00	(2015.01)
H01Q 1/24	(2006.01)
H01Q 1/38	(2006.01)
H01Q 9/40	(2006.01)
H01Q 9/42	(2006.01)

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Fig. 1

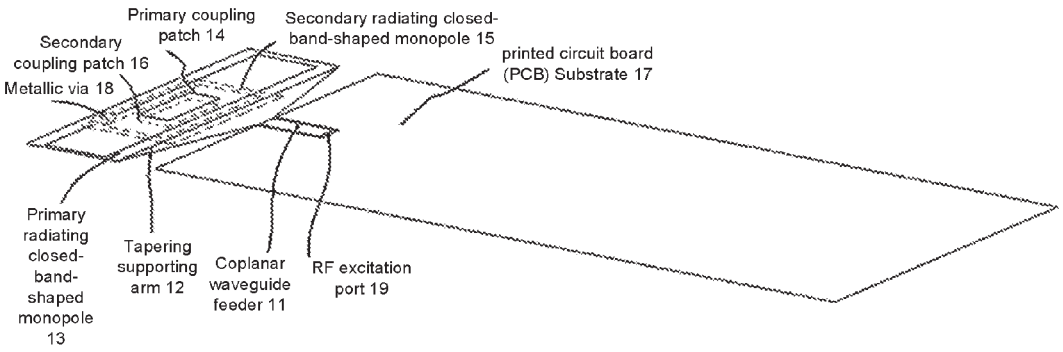

Primary coupling patch 14
Secondary radiating closed-band-shaped monopole 15
Secondary coupling patch 16
printed circuit board (PCB) Substrate 17
Metallic via 18
Primary radiating closed-band-shaped monopole 13
Tapering supporting arm 12
Coplanar waveguide feeder 11
RF excitation port 19

Fig. 2

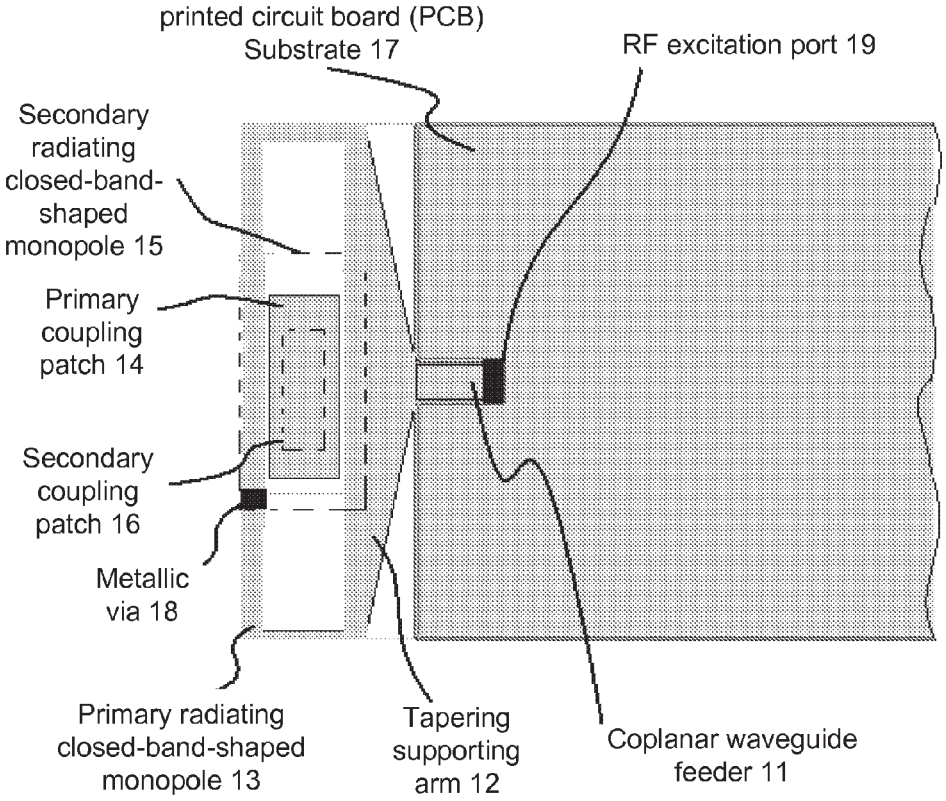

printed circuit board (PCB) Substrate 17
RF excitation port 19
Secondary radiating closed-band-shaped monopole 15
Primary coupling patch 14
Secondary coupling patch 16
Metallic via 18
Primary radiating closed-band-shaped monopole 13
Tapering supporting arm 12
Coplanar waveguide feeder 11

Fig. 3

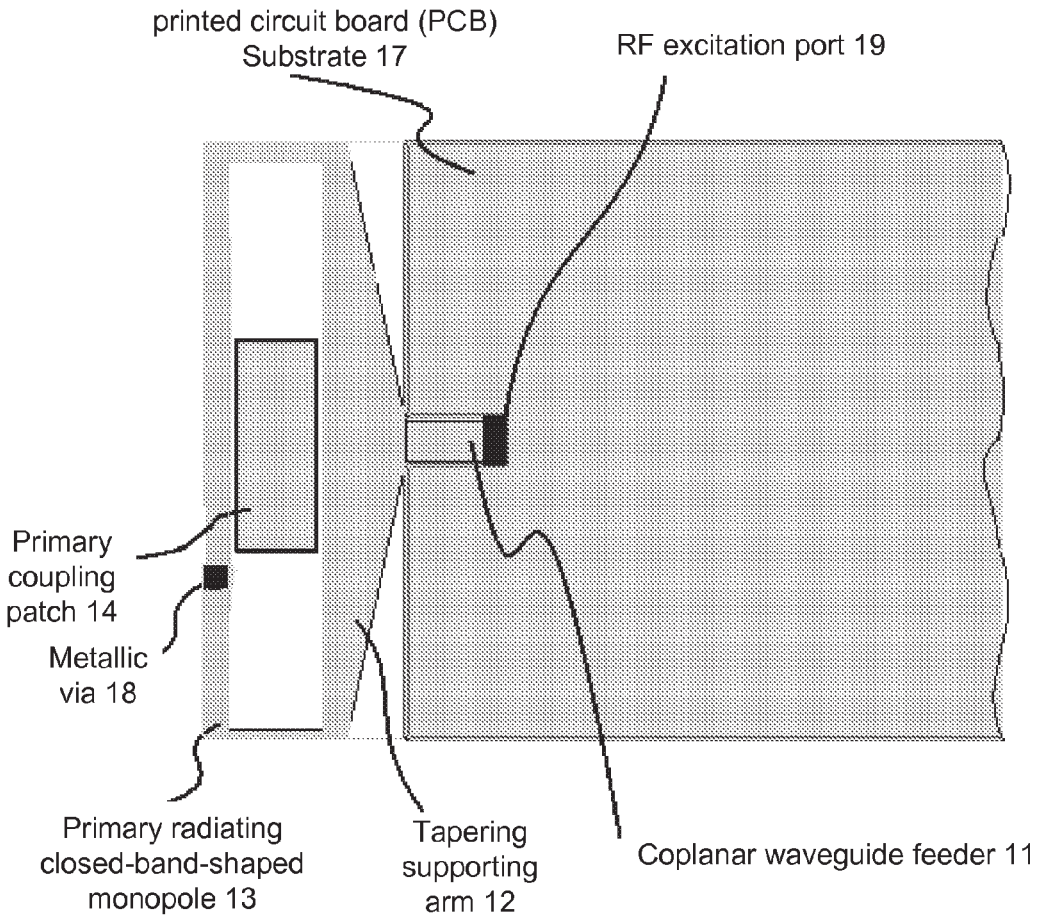

printed circuit board (PCB)
Substrate 17
RF excitation port 19
Primary
coupling
patch 14
Metallic
via 18
Primary radiating
closed-band-shaped
monopole 13
Tapering
supporting
arm 12
Coplanar waveguide feeder 11

Fig. 4

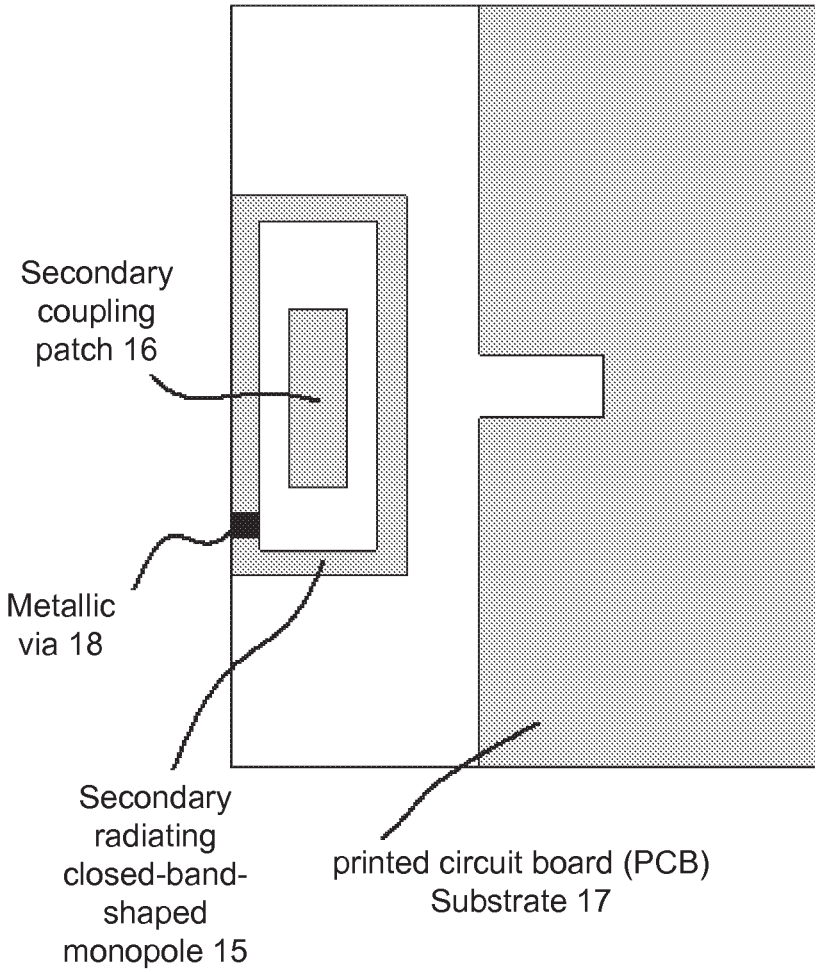
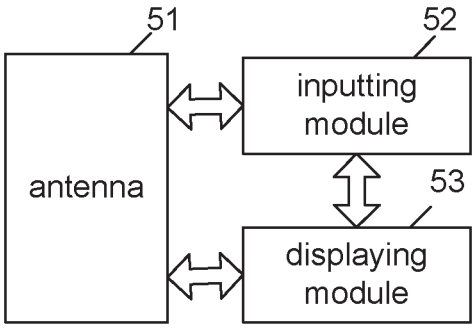

Secondary coupling patch 16
Metallic via 18
Secondary radiating closed-band-shaped monopole 15
printed circuit board (PCB) Substrate 17

Fig. 5


51
52
53
antenna
inputting module
displaying module

ULTRA-WIDEBAND ANTENNA AND TERMINAL

TECHNICAL FIELD

The disclosure relates to the field of antenna, and in particular to an ultra-wideband antenna and terminal.

BACKGROUND

With the development of world economy, mobile communication evolves continuously from a 3rd generation to a 4th generation, and there is an increasing demand for a multi-mode, multi-band, and multi-system mobile terminal such as a global-mode mobile phone or data card. It poses a great challenge to design of an antenna how to implement omnidirectional operation covering an ultrawide band of 0.8 GHz-5.5 GHz with a single antenna as a front portion of a mobile phone in a compact space, so as to save space and cost of the mobile terminal and facilitate development of a miniaturized and ultrathin mobile terminal.

At present, technology for widening the bandwidth of an antenna is mainly limited to improvement on the form of an antenna such as a planar inverted-F antenna (PIFA), an inverted-F antenna (IFA), a monopole antenna and the like, such as short-circuit point addition in multiple branches, appending of a parasitic structure, addition of a slotted structure, extension of a current path, and the like; and it is also possible to implement multi-band characteristics through different combinations of slots with microstrip feeders. However, with increase in the number of modes of mobile communication, expansion of the bandwidth of a mobile terminal as well as development of data services, there exists a serious bottleneck of a narrow bandwidth coverage and an increased demand for space by the parasitic structure in an aforementioned way of improvement, which is thus difficult to be implemented on the miniaturized and ultrathin mobile terminal.

SUMMARY

In view of this, the main purpose of the disclosure is to provide an ultra-wideband antenna and terminal, so as to reduce space usage and facilitate development of an ultrathin terminal and bandwidth widening, thus allowing the terminal to operate in the range of the ultrawide band.

To achieve the above purpose, a technical solution of the present disclosure is implemented as follows.

The present disclosure provides an ultra-wideband antenna, including: a coplanar waveguide feeder, a tapering supporting arm, a primary radiating closed-band-shaped monopole, a primary coupling patch, a secondary radiating closed-band-shaped monopole, a secondary coupling patch and a Printed Circuit Board (PCB) substrate, wherein the coplanar waveguide feeder, the tapering supporting arm, the primary radiating closed-band-shaped monopole and the primary coupling patch are located on one side of the PCB substrate, and the secondary radiating closed-band-shaped monopole and the secondary coupling patch are located on the other side of the PCB substrate;

the coplanar waveguide feeder is connected to a Radio Frequency (RF) excitation port on the PCB substrate at one end, and connected to the tapering supporting arm at the other end, and is configured to transmit a current of the RF excitation port to the tapering supporting arm;

the tapering supporting arm is connected to the coplanar waveguide feeder at one end, and connected to the primary radiating closed-band-shaped monopole at the other end, and is configured to transmit the current to the primary radiating closed-band-shaped monopole;

the primary radiating closed-band-shaped monopole is connected to the tapering supporting arm, and forms electromagnetic coupling with the primary coupling patch;

the primary coupling patch is located in the area closed by the closed band of the primary radiating closed-band-shaped monopole, and is spaced apart from the primary radiating closed-band-shaped monopole by a distance that enables the primary radiating closed-band-shaped monopole to form electromagnetic coupling with the primary coupling patch;

the secondary radiating closed-band-shaped monopole is connected to the primary radiating closed-band-shaped monopole through a metallic via, and forms electromagnetic coupling with the secondary coupling patch; and

the secondary coupling patch is located in the area closed by the closed band of the secondary radiating closed-band-shaped monopole, and is spaced apart from the secondary radiating closed-band-shaped monopole by a distance that enables the secondary radiating closed-band-shaped monopole to form electromagnetic coupling with the secondary coupling patch.

In the solution, the widths of the closed bands of the primary radiating closed-band-shaped monopole and of the secondary radiating closed-band-shaped monopole may each be greater than 0.5 mm, and the relationship between a perimeter and a resonant frequency of each of the closed bands should be such that the perimeter equals to the speed of light divided by 2 and by the resonant frequency.

In the solution, the primary radiating closed-band-shaped monopole and the secondary radiating closed-band-shaped monopole may be rectangular-shaped closed bands each with a closed-band width of more than 0.5 mm and a closed-band perimeter between 100 mm and 200 mm; and accordingly, the primary coupling patch and the secondary coupling patch may be rectangles each with a perimeter between 50 mm to 100 mm.

In the solution, an impedance in the coplanar waveguide feeder and the tapering supporting arm may be 50 Ohm.

In the solution, there may not be interference between a projected area of the PCB substrate and the primary radiating closed-band-shaped monopole, the primary coupling patch, the secondary radiating closed-band-shaped monopole, the secondary coupling patch, or the tapering supporting arm.

In the solution, the metallic via connecting the primary radiating closed-band-shaped monopole and the secondary radiating closed-band-shaped monopole may be located at a predetermined position that maximizes a current of the primary radiating closed-band-shaped monopole.

The disclosure further provides an ultra-wideband terminal, including an antenna, an inputting module, and a displaying module, wherein

the inputting module is configured to convert input information into an RF signal, and send the RF signal to the antenna;

the displaying module is configured to demodulate and display an RF signal received by the antenna;

the antenna is configured to transmit the RF signal sent by the inputting module and send the received RF signal to the displaying module; the antenna includes: a coplanar waveguide feeder, a tapering supporting arm, a primary radiating closed-band-shaped monopole, a primary coupling patch, a secondary radiating closed-band-shaped monopole, a secondary coupling patch and a Printed Circuit Board (PCB) substrate, wherein the coplanar waveguide feeder, the tapering supporting arm, the primary radiating closed-band-

shaped monopole and the primary coupling patch are located on one side of the PCB substrate, and the secondary radiating closed-band-shaped monopole and the secondary coupling patch are located on the other side of the PCB substrate;

the coplanar waveguide feeder is connected to a Radio Frequency (RF) excitation port on the PCB substrate at one end, and connected to the tapering supporting arm at the other end, and is configured to transmit a current of the RF excitation port to the tapering supporting arm;

the tapering supporting arm is connected to the coplanar waveguide feeder at one end, and connected to the primary radiating closed-band-shaped monopole at the other end, and is configured to transmit the current to the primary radiating closed-band-shaped monopole;

the primary radiating closed-band-shaped monopole is connected to the tapering supporting arm, and forms electromagnetic coupling with the primary coupling patch;

the primary coupling patch is located in the area closed by the closed band of the primary radiating closed-band-shaped monopole, and is spaced apart from the primary radiating closed-band-shaped monopole by a distance that enables the primary radiating closed-band-shaped monopole to form electromagnetic coupling with the primary coupling patch;

the secondary radiating closed-band-shaped monopole is connected to the primary radiating closed-band-shaped monopole through a metallic via, and forms electromagnetic coupling with the secondary coupling patch; and

the secondary coupling patch is located in the area closed by the closed band of the secondary radiating closed-band-shaped monopole, and is spaced apart from the secondary radiating closed-band-shaped monopole by a distance that enables the secondary radiating closed-band-shaped monopole to form electromagnetic coupling with the secondary coupling patch.

In the solution, the widths of the closed bands of the primary radiating closed-band-shaped monopole and of the secondary radiating closed-band-shaped monopole may each be greater than 0.5 mm, and the relationship between a perimeter and a resonant frequency of each of the closed bands should be such that the perimeter equals to the speed of light divided by 2 and by the resonant frequency.

In the solution, the primary radiating closed-band-shaped monopole and the secondary radiating closed-band-shaped monopole may be rectangular-shaped closed bands each with a closed-band width of more than 0.5 mm and a closed-band perimeter between 100 mm and 200 mm; and accordingly, the primary coupling patch and the secondary coupling patch may be rectangles each with a perimeter between 50 mm and 100 mm.

In the solution, an impedance in the coplanar waveguide feeder and the tapering supporting arm may be 50 Ohm.

In the solution, there may not be interference between a projected area of the PCB substrate and the primary radiating closed-band-shaped monopole, the primary coupling patch, the secondary radiating closed-band-shaped monopole, the secondary coupling patch, or the tapering supporting arm.

In the solution, the metallic via connecting the primary radiating closed-band-shaped monopole and the secondary radiating closed-band-shaped monopole may be located at a predetermined position that maximizes a current of the primary radiating closed-band-shaped monopole.

Therefore, with the antenna and the terminal described in the present disclosure, the primary radiating closed-band-shaped monopole and the secondary radiating closed-band-shaped monopole may be laid out utilizing the space near the edge of the Printed Circuit Board (PCB) substrate, which reduces the space usage, and the primary radiating closed-band-shaped monopole and the secondary radiating closed-band-shaped monopole are connected with each other through the metallic via and are located on opposite sides of the PCB substrate, facilitating design of an ultrathin terminal; electromagnetic coupling among the primary radiating closed-band-shaped monopole, the secondary radiating closed-band-shaped monopole, the primary coupling patch and the secondary coupling patch widens the bandwidth, which may allow the terminal to operate in the range of the ultrawide band; the impedance of the tapering supporting arm and the coplanar waveguide feeder allows the antenna to have good impedance matching within the frequency band, thus further optimizing characteristics of ultra-wideband operation of the antenna.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic diagram of the structure of an ultra-wideband antenna according to the present disclosure;

FIG. **2** is a top view of the ultra-wideband antenna according to the present disclosure;

FIG. **3** is a front view of a primary radiating closed-band-shaped monopole, a tapering supporting arm, a coplanar waveguide feeder and a primary coupling patch in the present disclosure;

FIG. **4** is a front view of a secondary radiating closed-band-shaped monopole and a secondary coupling patch in the present disclosure; and

FIG. **5** is a schematic diagram of the structure of an ultra-wideband terminal in the present disclosure.

DETAILED DESCRIPTION

According to various embodiments of the present disclosure, a tapering supporting arm and a coplanar waveguide feeder transmit a current of an RF excitation port to a primary radiating closed-band-shaped monopole, which is coupled with a primary coupling patch; meanwhile, the primary radiating closed-band-shaped monopole transmits the current to a secondary radiating closed-band-shaped monopole through a metallic via, and the secondary radiating closed-band-shaped monopole is coupled with a secondary coupling patch.

The present disclosure will be elaborated below with reference to specific embodiments and the accompanying drawings.

An ultra-wideband antenna, as shown in FIG. **1** and FIG. **2**, includes: a primary radiating closed-band-shaped monopole **13**, a primary coupling patch **14**, a tapering supporting arm **12**, a coplanar waveguide feeder **11**, a secondary radiating closed-band-shaped monopole **15**, a secondary coupling patch **16** and a Printed Circuit Board (PCB) substrate **17**; FIG. **2** is a top view.

Wherein, the primary radiating closed-band-shaped monopole **13**, the tapering supporting arm **12**, the coplanar waveguide feeder **11** and the primary coupling patch **14** are photoetched on one side of the PCB substrate **17** through a microstrip fabricating process.

Shown in FIG. **3** is a front view of the primary radiating closed-band-shaped monopole **13**, the tapering supporting arm **12**, the coplanar waveguide feeder **11** and the primary coupling patch **14**;

The coplanar waveguide feeder **11** is connected to RF excitation port **19** on the PCB substrate **17** at one end and to the tapering supporting arm **12** at the other end, and is configured to transmit a current of the RF excitation port **19** to the tapering supporting arm **12**;

The tapering supporting arm **12** is connected to the coplanar waveguide feeder **11** at one end and to the primary radiating closed-band-shaped monopole **13** at the other end, and is configured to transmit the current transmitted from the coplanar waveguide feeder **11** to the primary radiating closed-band-shaped monopole **13**;

The primary radiating closed-band-shaped monopole **13** is connected to the tapering supporting arm **12**, and is shaped as a closed band with a width of more than 0.5 mm, and a perimeter of the closed band is closely related to a resonant frequency of the closed band, satisfying formula (1): $L=C/2f$, wherein C is the speed of light, L is the perimeter and f is the resonant frequency;

The primary coupling patch **14** is located in the area closed by the closed band of the primary radiating closed-band-shaped monopole **13**, and is spaced apart from the primary radiating closed-band-shaped monopole **13** by a distance ensuring that the primary radiating closed-band-shaped monopole **13** is coupled with the primary coupling patch;

The secondary radiating closed-band-shaped monopole **15** and the secondary coupling patch **16** are photoetched on the other side of the PCB substrate **17** through a microstrip fabricating process. Shown in FIG. **4** is a front view of the secondary radiating closed-band-shaped monopole **15** and the secondary coupling patch **16**, wherein

the secondary radiating closed-band-shaped monopole **15** is shaped as a closed band with a width of more than 0.5 mm, and the relationship between the width and perimeter of the closed band and the resonant frequency of the closed band satisfies the formula (1), the secondary radiating closed-band-shaped monopole **15** is connected to the primary radiating closed-band-shaped monopole **14** through a metallic via **18** on the PCB substrate **17**;

The secondary coupling patch **16** is located in the area closed by the closed band of the secondary radiating closed-band-shaped monopole **15**, and is spaced apart from the secondary radiating closed-band-shaped monopole **15** by a distance ensuring that the secondary radiating closed-band-shaped monopole **15** is coupled with the secondary coupling patch. For example, the distance is between 0.4 mm and 3 mm.

In the aforementioned ultra-wideband antenna, the coplanar waveguide feeder **11** and the tapering supporting arm **12** transmit the current of the RF excitation port to the primary radiating closed-band-shaped monopole **13** to excite the primary radiating closed-band-shaped monopole **13**. There exists a difference in electric field between the primary radiating closed-band-shaped monopole **13** and the primary coupling patch **14**, which form electromagnetic coupling, thus widening the frequency bandwidth. Since the secondary radiating closed-band-shaped monopole **15** is connected to the primary radiating closed-band-shaped monopole **13** through the metallic via **18**, the secondary radiating closed-band-shaped monopole **15** is excited as well. The primary radiating closed-band-shaped monopole **13**, the secondary radiating closed-band-shaped monopole **15**, the primary coupling patch **14**, and the secondary coupling patch **16** are coupled with each other, such that the antenna supports a frequency band of 700 MHz-5.5 GHz, with a return loss S11 less than −7.5 dB in a primary communication frequency band of 700 MHz-2.5 GHz, and a return loss S11 less than −4.8 dB over a frequency band of 2.5 GHz-5.5 GHz included in a global wireless local area network.

Further, the primary radiating closed-band-shaped monopole **13** and the secondary radiating closed-band-shaped monopole **15** may be a circular closed band, a rectangular closed band, or a closed band of another shape; the primary coupling patch **14** and the secondary coupling patch **16** may be circular, rectangular, or of another shape.

Further, the primary radiating closed-band-shaped monopole **13** is rectangular, with a perimeter between 100 mm and 200 mm;

Accordingly, the primary coupling patch **14** is rectangular, with a perimeter of 50 mm-100 mm.

The secondary radiating closed-band-shaped monopole **15** is rectangular, with a perimeter of 100 mm-200 mm;

Accordingly, the secondary coupling patch **16** is rectangular, with a perimeter of 50 mm-100 mm.

Further, metallic via **18** is preset at different positions, and currents of primary radiating closed-band-shaped monopoles **13** corresponding to the metallic via **18** at different positions are measured, the metallic via **18** connecting the primary radiating closed-band-shaped monopole **13** and the secondary radiating closed-band-shaped monopole **15** is set at a predetermined position that maximizes the current of the primary radiating closed-band-shaped monopole **13**, so as to ensure a low-frequency resonance.

Further, the impedance of the coplanar waveguide feeder **11** and the tapering supporting arm **12** is 50 Ohm.

Further, there is no interference between a projected area of the PCB substrate **17** and the primary radiating closed-band-shaped monopole **13**, the primary coupling patch **14**, the secondary radiating closed-band-shaped monopole **15**, the secondary coupling patch **16**, or the tapering supporting arm **12**.

The present disclosure also provides an ultra-wideband terminal, as shown in FIG. **5**, includes an antenna **51**, an inputting module **52**, and a displaying module **53**, wherein

the inputting module **52** is connected to the antenna **51** and the displaying module **53**, and is configured to send input information to the displaying module **53**, convert the input information into an RF signal, and send the RF signal to the antenna **51**;

the displaying module **53** is connected to the inputting module **52** and the antenna **51**, and is configured to display information input by the inputting module **52**, and demodulate and display an RF signal received by the antenna **51**;

the antenna **51** is connected to the inputting module **52** and the displaying module **53**, and is configured to transmit the RF signal sent by the inputting module **53** and send the received RF signal to the displaying module **53**.

The inputting module **52** is specifically configured to convert the input information into an RF signal by performing modulation such as encoding and up-conversion on the input information, wherein the method for the modulation is an existing technique and will not be repeated here.

The displaying module **53** is specifically configured to perform demodulation such as down-conversion and decoding on the received RF signal to acquire and display a baseband signal, wherein the demodulation is an existing technique and will not be repeated here.

Wherein, the structure of the antenna **51** is the same as that of the antenna shown in FIG. **1** and will not be repeated here.

What described are merely preferred embodiments of the present disclosure, and are not intended to limit the protection scope of the present disclosure.

The invention claimed is:

1. An ultra-wideband antenna, comprising: a coplanar waveguide feeder, a tapering supporting arm, a primary radiating closed-band-shaped monopole, a primary coupling patch, a secondary radiating closed-band-shaped monopole, a secondary coupling patch and a Printed Circuit Board (PCB) substrate, wherein the coplanar waveguide feeder, the tapering supporting arm, the primary radiating closed-band-

shaped monopole and the primary coupling patch are located on one side of the PCB substrate, and the secondary radiating closed-band-shaped monopole and the secondary coupling patch are located on the other side of the PCB substrate;

the coplanar waveguide feeder is connected to a Radio Frequency (RF) excitation port on the PCB substrate at one end, and connected to the tapering supporting arm at the other end, and is configured to transmit a current of the RF excitation port to the tapering supporting arm;

the tapering supporting arm is connected to the coplanar waveguide feeder at one end, and connected to the primary radiating closed-band-shaped monopole at the other end, and is configured to transmit the current to the primary radiating closed-band-shaped monopole;

the primary radiating closed-band-shaped monopole is connected to the tapering supporting arm, and forms electromagnetic coupling with the primary coupling patch;

the primary coupling patch is located in the area closed by the closed band of the primary radiating closed-band-shaped monopole, and is spaced apart from the primary radiating closed-band-shaped monopole by a distance that enables the primary radiating closed-band-shaped monopole to form electromagnetic coupling with the primary coupling patch;

the secondary radiating closed-band-shaped monopole is connected to the primary radiating closed-band-shaped monopole through a metallic via, and forms electromagnetic coupling with the secondary coupling patch; and

the secondary coupling patch is located in the area closed by the closed band of the secondary radiating closed-band-shaped monopole, and is spaced apart from the secondary radiating closed-band-shaped monopole by a distance that enables the secondary radiating closed-band-shaped monopole to form electromagnetic coupling with the secondary coupling patch.

2. The antenna according to claim **1**, wherein

the widths of the closed bands of the primary radiating closed-band-shaped monopole and of the secondary radiating closed-band-shaped monopole are each greater than 0.5 mm, and the relationship between a perimeter and a resonant frequency of each of the closed bands satisfies that the perimeter equals to the speed of light divided by 2 and by the resonant frequency.

3. The antenna according to claim **2**, wherein

the primary radiating closed-band-shaped monopole and the secondary radiating closed-band-shaped monopole are rectangular-shaped closed bands each with a closed-band width of more than 0.5 mm and a closed-band perimeter between 100 mm and 200 mm; and

the primary coupling patch and the secondary coupling patch are rectangles each with a perimeter between 50 mm to 100 mm.

4. The antenna according to claim **1**, wherein

an impedance in the coplanar waveguide feeder and the tapering supporting arm is 50 Ohm.

5. The antenna according to claim **4**, wherein

there is no interference between a projected area of the PCB substrate and the primary radiating closed-band-shaped monopole, the primary coupling patch, the secondary radiating closed-band-shaped monopole, the secondary coupling patch, or the tapering supporting arm.

6. The antenna according to claim **5**, wherein

the metallic via connecting the primary radiating closed-band-shaped monopole and the secondary radiating closed-band-shaped monopole is located at a predetermined position that maximizes a current of the primary radiating closed-band-shaped monopole.

7. An ultra-wideband terminal, comprising an antenna, an inputting module, and a displaying module, wherein

the inputting module is configured to convert input information into an RF signal, and send the RF signal to the antenna;

the displaying module is configured to demodulate and display an RF signal received by the antenna;

the antenna is configured to transmit the RF signal sent by the inputting module and send the received RF signal to the displaying module; the antenna comprises: a coplanar waveguide feeder, a tapering supporting arm, a primary radiating closed-band-shaped monopole, a primary coupling patch, a secondary radiating closed-band-shaped monopole, a secondary coupling patch and a Printed Circuit Board (PCB) substrate, wherein the coplanar waveguide feeder, the tapering supporting arm, the primary radiating closed-band-shaped monopole and the primary coupling patch are located on one side of the PCB substrate, and the secondary radiating closed-band-shaped monopole and the secondary coupling patch are located on the other side of the PCB substrate;

the coplanar waveguide feeder is connected to a Radio Frequency (RF) excitation port on the PCB substrate at one end, and connected to the tapering supporting arm at the other end, and is configured to transmit a current of the RF excitation port to the tapering supporting arm;

the tapering supporting arm is connected to the coplanar waveguide feeder at one end, and connected to the primary radiating closed-band-shaped monopole at the other end, and is configured to transmit the current to the primary radiating closed-band-shaped monopole;

the primary radiating closed-band-shaped monopole is connected to the tapering supporting arm, and forms electromagnetic coupling with the primary coupling patch;

the primary coupling patch is located in the area closed by the closed band of the primary radiating closed-band-shaped monopole, and is spaced apart from the primary radiating closed-band-shaped monopole by a distance that enables the primary radiating closed-band-shaped monopole to form electromagnetic coupling with the primary coupling patch;

the secondary radiating closed-band-shaped monopole is connected to the primary radiating closed-band-shaped monopole through a metallic via, and forms electromagnetic coupling with the secondary coupling patch; and

the secondary coupling patch is located in the area closed by the closed band of the secondary radiating closed-band-shaped monopole, and is spaced apart from the secondary radiating closed-band-shaped monopole by a distance that enables the secondary radiating closed-band-shaped monopole to form electromagnetic coupling with the secondary coupling patch.

8. The terminal according to claim **7**, wherein

the widths of the closed bands of the primary radiating closed-band-shaped monopole and of the secondary radiating closed-band-shaped monopole are each greater than 0.5 mm, and the relationship between a perimeter and a resonant frequency of each of the closed bands satisfies that the perimeter equals to the speed of light divided by 2 and by the resonant frequency.

9. The terminal according to claim **8**, wherein

the primary radiating closed-band-shaped monopole and the secondary radiating closed-band-shaped monopole are rectangular-shaped closed bands each with a closed-

band width of more than 0.5 mm and a closed-band perimeter between 100 mm and 200 mm; and

the primary coupling patch and the secondary coupling patch are rectangles each with a perimeter between 50 mm to 100 mm.

10. The terminal according to claim **7**, wherein

an impedance in the coplanar waveguide feeder and the tapering supporting arm is 50 Ohm.

11. The terminal according to claim **10**, wherein

there is no interference between a projected area of the PCB substrate and the primary radiating closed-band-shaped monopole, the primary coupling patch, the secondary radiating closed-band-shaped monopole, the secondary coupling patch, or the tapering supporting arm.

12. The terminal according to claim **11**, wherein

the metallic via connecting the primary radiating closed-band-shaped monopole and the secondary radiating closed-band-shaped monopole is located at a predetermined position that maximizes a current of the primary radiating closed-band-shaped monopole.

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