

INDOOR OMNI-DIRECTIONAL MONOPOLE DISC ANTENNA FOR QUAD-BAND SYSTEM OPERATION (GSM 900, GSM 1800, 3G AND WIMAX)

Field of the Invention

5 The present invention relates to antennas. In particular, the invention relates to an omnidirectional monopole indoor antenna for quad-band system.

Background of the Invention

10 With the increasing popularity of wireless communications, there is also increase demand on antennas that are adapted for various ranges of communication bands. It can thus be seen that there exists a need for a simple and robust way for an antenna system adapted to provide multiband transmission with a broadband characteristic.

15 Summary of the Invention

In accordance with one aspect of the present invention, there is provided an indoor antenna for receiving and transmitting signals of multi-band. The indoor antenna comprises a disc; an antenna block for mounted on the disc, the antenna block having a top cylinder defining a top
20 portion of the antenna block, a bottom cylinder projected beneath the top cylinder, and an inner cylinder extended from the top cylinder within the bottom cylinder; and a connector for mounted on the disc with a terminal connected to the bottom cylinder.

In accordance with one embodiment, the antenna block may be mounted on the disc via the inner cylinder. Further, the antenna block may be mounted on the disc with a gap defined between the disc and the bottom cylinder. The height of the gap may determine a Voltage Standing Wave Ratio (VSWR) of the indoor antenna.

5

In accordance with another embodiment, the antenna may further comprise an L-bracket mounting on the bottom cylinder with a horizontal leg in close proximity above the disc, the L-bracket provides a matching stub operationally.

10 In accordance with yet another embodiment, a height and diameter of the top cylinder may determine a first frequency band that resonant with the antenna block. In addition, a height and diameter of the bottom cylinder may determine a second frequency band that resonant with the antenna block. The inner cylinder may ground the antenna for providing multi-resonance response for the antenna block.

15

In a further embodiment, the indoor antenna may further comprise a radome for housing the antenna block on the disc.

In yet a further embodiment, the connector may be a N type connector. In particularly, it may
20 be a N-female type connector.

In accordance with yet a further embodiment, the indoor antenna is an omnidirectional monopole antenna. The multi-band may include any of GSM900, GSM1800, 3G and WiMAX.

In accordance with another aspect, the present invention provides an omnidirectional monopole indoor antenna. The indoor antenna includes an antenna block mounting on a disc, the antenna block is adapted for receiving and transmitting multi-band frequencies signals. The antenna block has a top cylinder defines at top, a bottom cylinder projected beneath the top cylinder, and an inner cylinder extended from the top cylinder within the bottom cylinder. The indoor antenna further comprises a connector for mounting on the disc with a terminal connected to the bottom cylinder. The indoor antenna further comprises an L-bracket mounted on the bottom cylinder. The L-bracket is operable to provide a matching stub. The indoor antenna has a broadband characteristic.

Brief Description of the Drawings

The accompanying drawings are included to provide a further understanding of the invention, and are incorporated in and constitute a part of this specification. The drawings illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention, in which:

FIG. 1 illustrates a perspective view of an indoor antenna in accordance with one embodiment of the present invention;

FIG. 2 illustrates a cross sectional view of the indoor antenna of **FIG. 1** in accordance with one embodiment of the present invention;

FIG. 3 illustrates a top view of the indoor antenna of **FIG. 2**;

FIG. 4 illustrates a bottom view of the indoor antenna of **FIG. 2**;

FIG. 5 illustrates a top perspective view of a radome in accordance with one embodiment of the present invention; and

5

FIG. 6 is a graph showing VSWR performance of the antenna of **FIG. 1**.

Detailed Description of the Preferred Embodiments

10 In line with the above summary, the following description of a number of specific and alternative embodiments is provided to understand the inventive features of the present invention. It shall be apparent to one skilled in the art, however that this invention may be practiced without such specific details. Some of the details may not be described at length so as not to obscure the invention. For ease of reference, common reference numerals will be
15 used throughout the figures when referring to the same or similar features common to the figures.

FIG. 1 illustrates a perspective view of an indoor antenna **100** in accordance with one embodiment of the present invention. The indoor antenna **100** is made suitably for mounting
20 on any indoor wall and ceiling. The indoor antenna **100** comprises a disc **110**, an antenna block **120**, and an L-bracket **130**. The disc **110** is a circular shape base disc. The disc is made of any suitable material including aluminum or any suitable material. The antenna block **120** is generally a cylindrical block mounted on the center of the disc **110**. The L-bracket **130** is fastened to a lower part of the antenna block **120** with its horizontal leg floating above the

disc's surface with close proximity. The vertical leg (the attached portion) of the L-bracket 130 further defines an elongated slot 132. The L-bracket 130 is fastened to the antenna block 120 through the elongated slot 132 and the elongated slot 132 allows the L-bracket 130 to slidably move up and down on the surface of the antenna block 120. The L-bracket 130 performs as a matching stub to improve the indoor antenna 100 performance.

FIG. 2 illustrates a cross sectional view of the indoor antenna 100 of FIG. 1 in accordance with one embodiment of the present invention. The antenna block 120 comprises a top cylinder 122, a bottom cylinder 124 and an inner cylinder 126. The top cylinder 122 is a solid cylinder block defining the top portion of the antenna block 120. The bottom cylinder 124 is formed hollow and has a slightly bigger diameter than the top cylinder 122. It is disposed beneath the top cylinder 122 with the edge of the bottom cylinder 124 flanged to the verge along the bottom perimeter of the top cylinder 122 with an opened circular end. The inner cylinder 126 is located inside the bottom cylinder 124 and at the centre of the disc 110. The inner cylinder 126 has a smaller diameter than the top cylinder 122 and the bottom cylinder 124, but with a slightly longer length (height) than the bottom cylinder 124. The inner cylinder 126 extended from the top cylinder 122 with an opposing end of the inner cylinder 126 slightly extended beyond the bottom cylinder 126. All the three cylinders 122, 124, 126 are arranged concentrically about a same axis.

20

When assembled, the antenna block 120 is mounted on the disc 110 through fastening the protruded end of the inner cylinder 126 to the center of the disc 110 with fasteners. As the inner cylinder 126 is longer than the bottom cylinder 124, the opened circular end of the bottom cylinder 124 is in close proximity apart from the surface of the disc 110.

As shown in FIG. 2, the indoor antenna 100 further comprises a connector 140 having a connector end 142 and a terminal end 144. The connector 140 is adapted to attach, off center, on a reversed surface of the disc 110 opposing to the antenna block 120. When the connector 140 is attached on the disc 110, the connector end 142 extends from the reverse surface of the disc 110, and the terminal end 144, through the disc 110, extends towards the antenna block 120 until the terminal end 144 is electrically connected to the bottom cylinder 124. Preferably, the connector 140 is attached beneath the L-bracket 130.

In accordance with one embodiment, the antenna 100 is an in-building or indoor antenna for wall or ceiling mounting. The disc 110 and the antenna block 120 are configured as a monopole radiating element that provides an omnidirectional pattern in azimuth plane.

In yet another embodiment, a height and diameter of the top cylinder 122 are adapted to determine the frequencies that resonant with frequency band for GSM900, whilst the height of the bottom cylinder 124 is adapted to determine the frequencies that resonant with the frequency band for GSM 1800 and 3G. The inner cylinder 126 shorts the antenna block 120 to the disc 110 as ground and provides "multi-resonance response" for the antenna 100 suitably for working at least with GSM900/1800, and 3G bands. In addition, the L-bracket 130 provides a matching stub and its dimension can be adapted to provide an improved antenna performance at WiMAX band.

Further, thickness of the bottom cylinder 124 and the inner cylinder 126, as well as the circular space between the bottom cylinder 124 and the inner cylinder 126, are factors that determine a broadband characteristic of the antenna 100. The height of the gap between the

disc 110 and the bottom cylinder 124 is one of the factors that determine the Voltage Standing Wave Ratio (VSWR) of the antenna 100. The VSWR is also affected by the diameter of an inner pin (not shown) of the connector 140. Accordingly, these parameters can be configured accordingly to provide an optimized performance multi-band monopole omnidirectional antenna.

The disc 110 and the antenna block 120 of the antenna 100 can be made of any suitable materials, which include aluminum. In accordance with an embodiment, a light weight aluminum A1000 can be used to construct the main components of the antenna 100. The aluminum A1000 provides good antenna properties.

In yet another embodiment, the connector 140 is a N-female type connector suitably for connecting the antenna 100 to an RF coaxial cable with N-male type connector.

In accordance with another embodiment, it is possible that the antenna 100 can be adapted to provide operating frequencies of approximately 890-960MHz and 1710-2600MHz with bandwidths of approximately 140MHz and 550MHz. The indoor antenna 100 can also provides a low VSWR of less than or equal to 1.6, a maximum gain of 2dBi and omnidirectional radiation pattern with a linear polarization characteristic.

20

FIGs. 3 and 4 illustrate respectively a top view and a bottom view of the indoor antenna 100 of FIG. 2. Besides the orientations and arrangements of the disc 110, the antenna block 120, the L-bracket 130 and the connector 140, two sets of three mounting holes 152 and 155 are provided on the disc 110. Each set of the mounting hole are arranged circularly about the

center of the disc 110. One set of the mounting holes 152 is provided for fastening the indoor antenna 100 on the wall or ceiling. One set of the mounting holes 155 are adapted for receiving mounting means of an antenna cap.

5 **FIG. 5** illustrates a top perspective view of a radome 500 in accordance with one embodiment of the present invention. The radome 500 is adapted to fit over the indoor antenna 100 of **FIG. 1** as a protecting cap. The radome 500 is generally pith-helmet liked with a sloping rim projecting around a spherical cap or dome. Two concentric ring grooves 501 are defined on the spherical cap surface of the radome 500, with the upper ring groove wider than the lower
10 ring groove. The radome 500 is fitted over the indoor antenna 100 through three snap fittings (not shown) provided on the bottom side of the radome 500. The radome 500 is provided for protecting the indoor antenna 100 from environment impact.

In accordance with another embodiment, the radome 500 is made by thermo plastic material
15 which includes Polycarbonate-ABS Blend (PC-ABS). It is understood that the material is only a possible material that can be used, not limitations within the scope of the present invention.

In accordance with the present invention, aforesaid indoor antenna can be made light weight and easy to manufacture. Preferably, the indoor antenna is made by cost effective commercial
20 material that is reliable and provides a superior performance. Further, the indoor antenna is easy to assemble and can easily be mounted on the wall or ceiling indoor.

FIG. 6 is a graph showing VSWR performance of the indoor antenna of **FIG. 1**. As shown, the monopole indoor antenna is resonant at the frequencies of 890-960MHz and 1710-

2600MHz. The indoor antenna operates over the following bands with a VSWR less or equal to 1.6. These bands cover typical commercial bands such as GSM900/1800, 3G, WiMAX.

In one example, the indoor antenna 100 is adapted to provide a disc 110 with 170mm
5 diameter; the top cylinder 122 with a height of 24mm and a diameter of 30mm; the bottom
cylinder 124 with a height of 25mm and a wall thickness of 2mm; a gap between the disc 110
and the bottom cylinder 124 with a height of 3mm; and a length of the horizontal leg of the L-
bracket 130 extending across the surface of the disc 110 of 20.9mm. With this configuration,
a 50 ohm input impedance antenna with a power rating of 50 watts may provide the operating
10 frequencies of about 890-960MHz and about 1710-2600MHz, with a bandwidth of about
70MHz and 890MHz. The indoor antenna 100 further provide a 2dBi (max) of gain and a
VSWR less than 1.6. The indoor antenna 100 provides a linear polarization with a horizontal
beam width of $306^{\circ} \pm 5^{\circ}$ and a vertical beam width of $100^{\circ} \pm 5^{\circ}$. The front-to-back ratio for the
indoor antenna is 18dB at 900MHz, 34dB at 1800MHz and 41dB at 2GHz.

15

It is understood that the above example is provided by way of example only and it is not
intended to limit the scope of the invention. A skilled person will recognize that other
alterations and modifications can be desired to achieve wider band reception for the indoor
antenna.

20

It will be apparent to those skilled in the art that various modifications and variations may be
made to the structure of the present invention without departing from the scope or spirit of the
invention. In view of the foregoing, it is intended that the present invention cover

modifications and variations of this invention provided they fall within the scope of the following claims and their equivalents.

CLAIMS:

1. An indoor antenna (100) for receiving and transmitting multi-band signals, said indoor antenna (100) comprising:
 - a disc (110);
 - an antenna block (120) mounted on said disc (110), said antenna block (120) having:
 - a top cylinder (122) defining a top portion of said antenna block (120);
 - a hollow bottom cylinder (124) with a larger diameter than said top cylinder (122), the hollow bottom cylinder (124) electrically connected to and extending from the bottom of said top cylinder (122) towards said disc (110), and wherein a gap is defined between said disc (110) and said bottom cylinder (124);
 - and a hollow inner cylinder (126) electrically connected to said top cylinder (122) and extending towards said disc (110) through said hollow bottom cylinder (124), wherein a height and diameter of said top cylinder (122) determine a first resonant frequency band of said antenna block (120) and a height and diameter of said bottom cylinder (124) determine a second resonant frequency band of said antenna block (120), and wherein said inner cylinder (126) grounds the antenna (100) for providing multi-resonance response for said antenna block (120);
 - a connector (140) mounted on said disc (110) with a terminal (144) connected to said bottom cylinder (124), wherein a diameter of an inner pin of the connector (140) and a height of the gap between the disc (110) and the bottom cylinder (124) determine a Voltage Standing Wave Ratio (VSWR) of the antenna (100); and
 - an L-bracket (130) slidably connected to said bottom cylinder (124) with a horizontal leg in close proximity above said disc (110), said L-bracket (130) being operable to slide up and down the bottom cylinder (124) to provide a matching stub for improving the antenna (100) performance.
2. The indoor antenna (100) according to claim 1, wherein said antenna block (120) is mounted on said disc (110) via said inner cylinder (126).
3. The indoor antenna (100) according to either claim 1 or 2, wherein said antenna block (120) is mounted on the center of said disc (110).
4. The indoor antenna (100) according to any one of claims 1 to 3, said indoor antenna further comprising a radome (500) for housing said antenna block (120) on said disc (110).
5. The indoor antenna (100) according to any one of claims 1 to 4, wherein said connector (140) is a N-female type connector.
6. The indoor antenna (100) according to any one of claims 1 to 5, wherein said indoor antenna (100) is an omnidirectional monopole antenna.
7. The indoor antenna (100) according to any one of claims 1 to 6, wherein said multi-band includes but not limited to the wireless communication of GSM900, GSM 800, 3G and WiMAX.