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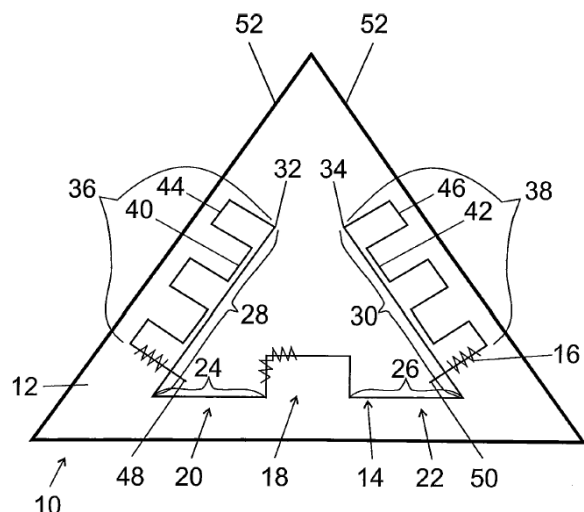
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(54) Title: **Antenna module**

(57) Main claim: Antenna module (10), comprising: a carrier (12); and an antenna conductor (14) disposed thereon and comprising a coupling coil (18) and two emitter elements (20, 22) branching from the coupling coil (18) and respectively made of a plurality of sections; wherein, starting from the coupling coil (18), first sections (24, 26) initially move away from the coupling coil (18), characterized in that subsequently at the first sections (24, 26), second sections (28, 30) of the emitter elements (20, 22) bend at least once at an angle to the adjacent first sections (24, 26), and at least parts of these second sections (28, 30) extend toward each other and end at locations (32, 34) that have the smallest opposing distance from each other.



Description

[0001] The invention relates to an antenna module according to the preamble of claim 1.

[0002] From DE 10 2007 016 584 A1, a textile information carrier is known that comprises an antenna module and a chip module. The antenna module comprises a carrier made of a textile with an antenna conductor. The chip module comprises a chip with a coupling loop. The chip module is disposed on the antenna module, and the coupling loop of the chip module is inductively coupled to a coupling winding of the antenna module. The antenna conductor comprises two emitter elements which, starting from the coupling loop, initially move away from the coupling loop. Then the further sections of the antenna conductor meander.

[0003] The object underlying the invention is to provide an antenna module that has a compact design and whose electrical properties make possible a long transmission- and reception-range with, at the same time, low influence on the resonance frequency by conductive objects located nearby.

[0004] In an antenna module according to the preamble of claim 1, this object is achieved by the features of this claim.

[0005] Further developments and advantageous designs of the invention arise from the dependent claims.

[0006] In the inventive antenna module, the antenna conductor represents a mechanically shortened dipole, but which is lengthened electrically by the type of the conductor routing so far that it is again in resonance with the operating wavelength. A dipole is in principle an electrical antenna, in which in comparison to a magnetic antenna, the electric component of the electromagnetic field in the near field is larger than the magnetic component of the electromagnetic field. The higher proportion of the electric component of the electromagnetic field has the consequence that conductive objects located in the vicinity of the antenna, which predominantly influence an electric field but influence a magnetic field less, can mistune the antenna. These also include antenna modules of adjacent detector plates, which impede the separating of the detector plates. Here "separating" is understood to mean that a plurality of mutually adjacent detector plates can be read by applying an anti-collision method.

[0007] With a stretched dipole, the ratio of the electric component to the magnetic component of the

electromagnetic field is highest. With the type of conductor routing according to the invention, the ratio of the electric component to the magnetic component of the magnetic field is shifted more in favor of the magnetic component. The influences of conductive objects located in the near field thereby decrease. Accordingly, a plurality of adjacent detector plates can be separated more easily.

[0008] At the same time, due to the routing of the antenna conductor, a pronounced directivity of the antennas otherwise occurring with stretched dipoles is also reduced; that is, in the inventive design the antennas obtain an omnidirectional characteristic. Otherwise, however, the increased transmission- and reception-range of the antenna remain largely preserved compared to a purely magnetic antenna, for example, a coil.

[0009] Because, according to the invention, the ends of the second sections abut more closely against each other in comparison to the other regions of the second sections, the shape of the antenna approximates the shape of a closed resonant circuit. The hot ends of the antenna, i.e., the locations at which the voltage antinodes and current nodes occur, thereby internally form a higher capacitance than in the case of a stretched dipole, whereby the influence of external mistuning capacitances is reduced.

[0010] According to a further development, to the second sections, third sections can connect that bend at an angle to the adjacent second sections and extend in the opposite direction to the second sections, wherein parts of the third sections directly approach the second sections at least once.

[0011] This embodiment makes possible an improved reproducibility of the resonance frequency of the electric antenna in the case of textile fixing of the antenna conductor onto the carrier using embroidery technology. Here the antenna conductor is specifically fixed only pointwise; nevertheless, tolerances of 1/10 mm can be met in areas in and between the embroidery points. Conversely, the mechanical end of the antenna conductor is not fixed, in particular when carriers are manufactured as continuous tape and cut in a repeating pattern. By parts of the third sections at least once directly approaching the second sections, in terms of capacitance a short circuit is generated between the antenna conductor in the third section and in the second section. The end relevant for the calculating the resonance frequency is then the end of the second section, at which the antenna conductor bends into the third section. Conversely, the position of the mechanical end of the antenna conductor behind the capacitive short circuit is

largely irrelevant. Thus even when the mechanical end protrudes, unattached, beyond the last embroidery point and assumes an undefined position there, the resonance frequency does not change.

[0012] In addition, it can be provided that regions of the second and third sections have a large spacing and form a loop before the direct approaching toward each other.

[0013] This loop represents a mechanical broadening of the electrically effective end of the antenna and causes an increase of the bandwidth. A bandwidth increase can be necessary when the antenna module is to be used in different environments with more or less conductive objects that can cause a resonance frequency shift of the antenna.

[0014] According to one alternative embodiment, at the second sections, third sections can connect that overlap the third, or third and second, sections of the respective other emitter element, and at least sectionally extend parallel directly adjacent to each other.

[0015] In this embodiment, the closely abutting regions of the third, or third and second, sections mutually form a capacitance, whereby the shape of the antenna further approximates the shape of a closed resonant circuit. The influence of external mistuning capacitances is thereby reduced even further than is already the case in the embodiment with the merely adjacent ends of the antenna.

[0016] According to one further development, at least one of the third sections can have a meander-shaped course.

[0017] The emitter elements thereby become asymmetric and obtain different resonance frequencies. However, because only a part of the emitter elements is changed by the meander-shaped course while the other parts remain unchanged, no separated discrete maxima arise in the resonance curve, but rather a wide tableau arises. The consequence is thus an increase in the bandwidth.

[0018] The coupling coil of the antenna module preferably encloses a coupling coil of a chip module at least one half time.

[0019] With the enclosing of the coupling loop of the chip module beyond one half time, a particularly strong coupling results with a higher energy transfer between

the antenna and the chip and also a widening of the resonance curve of the antenna.

[0020] In a carrier manufactured as continuous tape and cut up at repeating-pattern points, the last end of the antenna conductor fixed on the carrier can respectively be aligned parallel to a cut edge of the carrier, or directed from the cut edge of the carrier into the interior of the carrier.

[0021] Owing to the type of manufacturing of the antenna module, a free end of the antenna conductor arises that is no longer attached to the carrier but rather protrudes unattached. If the still-fixed end of the antenna conductor extends toward the cut edge, then this also applies for the remaining, non-fixed end. This end can provoke mechanical damage when installing a detector plate equipped with the antenna module in an application product. By aligning the last end, fixed on the carrier, of the antenna conductor parallel to a cut edge of the carrier, or directed from the cut edge of the carrier into the interior of the carrier, the remaining, non-fixed end is also urged in the same direction. The free end is thereby “deactivated.”

[0022] The invention is explained below based on an exemplary embodiment that is depicted in the drawings.

[0023] Fig. 1 shows an antenna module with spaced regions, and

[0024] Fig. 2 shows an antenna module with overlapping regions.

[0025] Fig. 1 shows an antenna module 10 comprising a carrier 12 and an antenna conductor 14. The carrier 12 can be a textile material. The antenna conductor 14 is an insulated wire or an insulated braid. In the carrier 12 made of textile material, the antenna conductor 14 can also comprise one or more electrically conductive textile threads or a combination of electrically non-conductive and electrically conductive textile threads. Here the antenna conductor 14 is fixed completely and continuously on the carrier 12 by embroidery technology using embroidery yarn 16. However, for reasons of clarity, the representation of the embroidery-type attaching is limited only to small regions. To form a complete detector plate, a chip module, which comprises a chip and a coupling loop, must then be arranged on the carrier 12 in such a manner that the coupling loop is inductively coupled to a coupling coil 18 of the antenna conductor 14. However, for reasons of clarity, no chip module has been depicted here.

[0026] The antenna conductor 14 comprises two emitter elements 20, 22 that are connected to the coupling coil 18. The antenna represents a dipole. Each of the emitter elements 20, 22 of the dipole is subdivided below into three sections in order to describe the different positions of the course of the emitter elements 20, 22.

[0027] First sections 24, 26 emanate from the coupling coil 18, and continuously move away from the coupling coil 18. At the end of the first sections 24, 26, second sections 28, 30 of the emitter elements 20, 22 connect and bend once at an angle to the adjacent first sections 24, 26. These second sections 28, 30 extend toward each other and end at locations 32, 34, which have the smallest opposing distance from each other.

[0028] At the second sections 28, 30, third sections 36, 38 connect and bend at an angle to the adjacent second sections 28, 30 and extend in the opposite direction to the second sections 28, 30. Here parts 40, 42 of the third sections 36, 38 at least once directly approach the second sections 28, 30. Before the direct approaching toward one another, regions 44, 46 of the second sections 28, 30 and third sections 36, 38 have a greater spacing and form a loop. At the same time, the ends 32, 34 of the second sections 28, 30 form the electrical ends of the emitter elements 20, 22 and determine the resonance frequency. Conversely, the mechanical ends 48, 50 have almost no influence on the resonance frequency because a capacitive short circuit is formed beforehand between regions 40, 42 of the second section 28, 30 and parts of the third section 36, 38. The loop corresponds to a widening of the ends of the emitter elements 20, 22 and leads to an increase of the bandwidth of the antenna.

[0029] Fig. 2 shows an antenna module 10 with overlapping regions. Analogously to Fig. 1, the antenna conductor 14 also comprises the two emitter elements 20, 22 that are connected to the coupling coil 18. The coupling coil 18 itself has a plurality of windings.

[0030] First sections 24, 26 emanate from the coupling coil 18, and continuously move away from the coupling coil 18. At the end of the first sections 24, 26, second sections 28, 30 of the emitter elements 20, 22 connect and bend once at an angle to the adjacent first sections 24, 26. Just as in Fig. 1, the second sections 28, 30 extend toward each other and end at locations 32, 34, which have the smallest distance from each other. However, concordance with Fig. 1 ends here.

[0031] At the second sections 28, 30, third sections 36, 38 connect, which here initially extend toward the adjacent second sections 28, 30, and subsequently overlap third sections 38, 36, or third 38, 36 and second sections 30, 28, of the respective other emitter element 22, 20, and at least sectionally extend parallel, directly adjacent to each other. Here the third sections 36, 38 partially have a meander-shaped course.

[0032] The size of the carrier 12 of the antenna module 10 for the antenna conductor 14 is dimensioned such that the antenna conductor 14 can be securely attached there. If this is effected by embroidery technology, a distance to the outer edge 52 of the carrier 12 must be maintained so that the embroidery yarn 16 finds secure support. The fixing of the antenna conductor 14 by embroidery yarn 16 is limited to the contour of the antenna conductor 14 that ensures the electrical properties. If, during the manufacturing, the antenna module 10 is cut as a continuous band at repeating-pattern locations, the ends 48, 50 of the antenna conductor 14 that was processed as continuous conductor are free. In order to achieve a position, safe from damage, of the non-fixed ends 48, 50 of the antenna conductor 14, the last end, fixed on the carrier 12, of the antenna conductor 14 is aligned parallel to a cut edge 52 of the carrier 12, or is directed from the cut edge 52 of the carrier into the interior of the carrier 12. The outer, no-longer fixed end 48, 50 is thereby also urged in the same direction as the fixed ends, and thus cannot cause any outwardly directed damage.

Reference Number List

10	Antenna module
12	Carrier
14	Antenna conductor
16	Embroidery yarn
18	Coupling coil
20	Emitter element
22	Emitter element
24	First section
26	First section
28	Second section
30	Second section
32	Location
34	Location
36	Third section
38	Third section
40	Region
42	Region
44	Region
46	Region
48	Mechanical end
50	Mechanical end
52	Edge/cut edge

CITATIONS INCLUDED IN THE DESCRIPTION

This list of documents referred to by the applicant has been generated automatically and is included solely to better inform the reader. The list is not a component of the German patent- or utility-model-application. The DPMA assumes no responsibility for any errors or omissions.

Cited patent literature

- DE 102007016584 A1 [0002]

Claims

1. Antenna module (10), comprising: a carrier (12); and an antenna conductor (14) disposed thereon and comprises a coupling coil (18) and two emitter elements (20, 22) branching from the coupling coil (18) and respectively made of a plurality of sections; wherein, starting from the coupling coil (18), first sections (24, 26) initially move away from the coupling coil (18), characterized in that subsequently at the first sections (24, 26), second sections (28, 30) of the emitter elements (20, 22) bend at least once at an angle to the adjacent first sections (24, 26), and at least parts of these second sections (28, 30) extend toward each other and end at locations (32, 34) that have the smallest opposing distance from each other.

2. Antenna module according to claim 1, characterized in that, at the second sections (28, 30), third sections (36, 38) connect that bend at an angle to the adjacent second sections (28, 30) and extend in the opposite direction to the second sections (28, 30), wherein regions (40, 42) of the third sections (36, 38) directly approach the second sections (28, 30) at least once.

3. Antenna module according to claim 2, characterized in that regions (44, 46) of the second (28, 30) and third sections (36, 38) have a greater distance before the direct approaching to each other, and form a loop.

4. Antenna module according to claim 1, characterized in that, at the second sections (28, 30), third sections (36, 38) connect that overlap third (38, 36), or third (38, 36) and second sections (30, 28), of the respective other emitter element (22, 20), and at least sectionally extend parallel, directly adjacent to each other.

5. Antenna module according to claim 4, characterized in that at least one of the third sections (36, 38) partially has a meander-shaped course.

6. Antenna module according to one of claims 1 to 5, characterized in that the coupling coil (18) of the antenna module (10) encloses a coupling loop of a chip module at least one half time.

7. Antenna module according to one of claims 1 to 6, characterized in that the last end, fixed on the carrier, of the antenna conductor (14) is aligned

parallel to a cut edge (52) of the carrier (12) or directed from the cut edge (52) of the carrier (12) into the interior of the carrier (12).

One page of drawings follows

Appended Drawings

