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(71) Applicant: **Siemens Aktiengesellschaft**
80333 München (DE)

(72) Inventors:
• **Wu, Chang Ying**
710072 Xian (CN)
• **Yu, Dan**
100102 Beijing (CN)
• **Yuan, Yong**
102208 Beijing (CN)

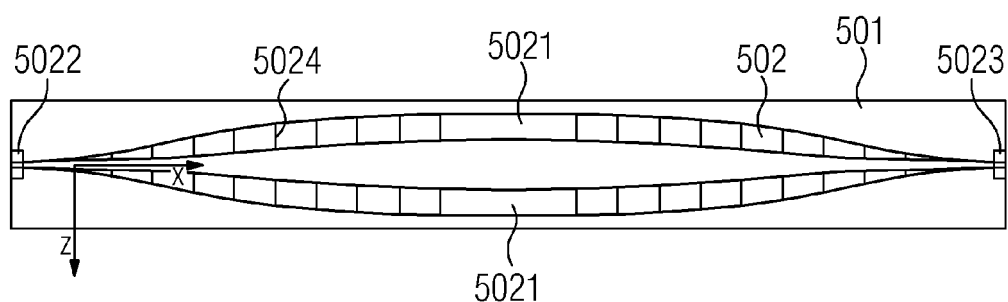
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(54) **Transmission line antenna for radio frequency identification**

(57) Disclosed in the present invention is a transmission line antenna for radio frequency identification, comprising a substrate and a conducting strip, wherein said conducting strip is arranged on said substrate; said substrate and said conducting strip form a transmission line;

and the width of said conducting strip gradually reduces from the middle area of said conducting strip to two sides, so as to reduce field nulls in an electric field radiated by the antenna, thereby improving the reading distance.

FIG 5



EP 2 713 441 A1

Description

Technical Field

[0001] The present invention relates to the technical field of radio frequency identification (RFID), and particularly, to a transmission line antenna for radio frequency identification.

Background Art

[0002] Radio frequency identification (RFID) technology is a noncontact automatic identification technology commonly known as an electronic tag, which automatically identifies a target object and obtains related data through radio-frequency signals and comprises the following basic constituent parts:

1. a tag composed of a tag antenna and a chip, attached to an object being controlled, detected or traced, wherein an RFID system usually includes a plurality of tags, each tag has a unique electronic code to uniquely identify the object being controlled, detected or traced; and a tag can also be referred to as a transponder here;
2. a reader for reading/writing information stored in the tag, which can be handheld or fixed, wherein an RFID system usually includes a reader which reads the information stored in each tag (sometimes it is also able to write tag information into the tag) so as to realize the control, detection or trace of the object attached to each tag; and a reader can also be referred to as an interrogator here;
3. an antenna connected to the reader for transmitting a radio-frequency signal between each tag and the reader, so as to transmit information between the reader and the tag.

[0003] Currently, one of the hotspots in the research of the RFID technology is the application of item-level tag identification, especially the application in retail industry and pharmaceutical industry, such as RFID-based smart shelves or conveying systems. A user uses an RFID reader connected to a shelf or a conveying system to obtain information about cargo placed on the shelf or the conveying system.

[0004] Near field (NF) ultrahigh frequency (UHF) RFID technology is mainly applied in item-level tag identification scenarios, such as smart shelves or conveying systems, and so on. In the technical field of NF UHF RFID, a variety of transmission line antenna structures have been proposed in order to obtain a larger reading area. A transmission line antenna mainly comprises three types: a microstrip transmission line antenna, a coplanar waveguide antenna and a grounded coplanar stripline antenna. In the application scenario of smart shelves,

the transmission line antenna is positioned on the shelves, with the length of the transmission line antenna being able to be over 1 m and an article with a tag being usually positioned on the transmission line antenna. However, the electric field of the transmission line antenna begins to have several very deep nulls at about 10 cm above the transmission line antenna, which has a strong impact on the reading performance. Two types of existing microstrip transmission line antenna structures are provided below.

[0005] Fig. 1 shows a microstrip transmission line antenna. As shown in Fig. 1, the antenna comprises a substrate 101, a ground plane 102, a conducting strip 103, a feeder 104 and a matched load 105. XYZ coordinate axes form a three dimensional coordinate system; the ground plane 102, located below the substrate 101, can be an electric conducting metal layer of the lower surface of the substrate 101; the conducting strip 103, arranged on the substrate 101 and running across the substrate 101 along the direction of the X axis, can be an electric conducting metal layer of the upper surface of the substrate 101; the substrate 101, the ground plane 102 and the conducting strip 103 constitute a microstrip transmission line; one end of the microstrip transmission line is connected to the feeder 104 in order to connect to the reader; and the other end of the microstrip transmission line is connected to the matched load 105, so that electromagnetic waves transmit in the form of travelling waves on the microstrip transmission line and have a very wide bandwidth and a very low far field gain. The specific connection manner of the microstrip transmission line and the feeder 104 and the matched load 105 belongs to the scope of the prior art, and no description is made here. When the antenna works, the tag is located above the antenna (i.e. above the XZ-axis plane). When the microstrip transmission line antenna is applied in smart shelves, the microstrip transmission line antenna is flatwise located on the smart shelves, the length of the substrate 101 along the X axis can be the same as or be close to the length of the shelves along the X axis, and an article with a tag is positioned on the microstrip transmission line antenna. When the article is within the reading distance, the electric field of the microstrip transmission line antenna can cover the tag of the article; thus, the reader is able to read the information about the tag.

[0006] Fig. 1 shows a rectangular conducting strip 103 running across the substrate 101 in a straight line. Fig. 2 shows another microstrip transmission line antenna, which comprises a substrate 201, a ground plane 202, a conducting strip 203, a feeder 204 and a matched load 205, is similar to the microstrip transmission line antenna shown in Fig. 1, and the difference therebetween lies in the shape of the conducting strip 203. As shown in Fig. 2, the width of the conducting strip 203 is unchanged and is in the shape of twists and turns, running across the substrate 201 by the way of twists and turns along the X axis.

[0007] However, the electric field distributions of both

these two types of microstrip transmission line antennas shown in Figs 1 and 2 have problems. In the electric fields of both these two types of microstrip transmission line antennas, there are lots of field nulls that cause the reading distance to be not large enough (i.e. the maximum height of the area without null that can be radiated by the antennas along the Y axis direction).

[0008] In conclusion, the RFID system currently requires a transmission line antenna that has a long enough effective reading distance (i.e. no null exists within the reading distance) to ensure the reading performance of the antenna.

Contents of the Invention

[0009] In order to resolve the abovementioned problems, a transmission line antenna in a radio frequency identification system is proposed in the present invention that can reduce field nulls to obtain a long enough reading distance.

[0010] The transmission line antenna in a radio frequency identification system proposed in the present invention comprises a substrate and a conducting strip, wherein said conducting strip is arranged on said substrate; said substrate and said conducting strip form a transmission line; and the width of said conducting strip gradually reduces from the middle area of the conducting strip to two sides, so as to reduce field nulls in an electric field radiated by the antenna, thereby improving the reading distance.

[0011] Preferably, said antenna is symmetrical with respect to the middle area so that the field nulls can be further reduced and the size design of the antenna is also easier at the same time.

[0012] The transmission line antenna according to one embodiment of the present invention further comprises a feeder and a matched load; and one end of said transmission line is connected to said feeder and the other end thereof is connected to said matched load. This antenna is suitable for independent use and can reduce field nulls and improve the reading distance.

[0013] In the transmission line antenna according to one embodiment of the present invention, the two ends of the abovementioned antenna comprise two ports for cascading connection to other antennas. Such an antenna is suitable for the application scenario where a plurality of antennas are connected in a cascading manner and can reduce field nulls and improve the reading distance.

[0014] The transmission line antenna according to one embodiment of the present invention further comprises a ground plane; and said ground plane is located below said substrate and covers the entire substrate. Adopting the ground plane can completely prevent the downward radiation of electromagnetic waves of the antenna, thus making the upward radiation signals stronger.

[0015] In the transmission line antenna according to one embodiment of the present invention, said conducting strip is formed by splicing a plurality of conducting

strip segments. Adopting such a solution, the field nulls can be reduced by designing the size of each conducting strip segment, thus making the reading distance large enough and the processing technology simple, and the size design of the conducting strip much easier.

[0016] In the transmission line antenna according to one embodiment of the present invention, said conducting strip is formed by splicing a plurality of conducting strip segments and the length and the width of the conducting strip segments in the middle position are the largest. Adopting such a solution, the processing technology is simple and the size design of the conducting strip much easier.

[0017] In the transmission line antenna according to one embodiment of the present invention, the adjacent borders of every two adjacent conducting strip segments are parallel. Adopting such a solution, the size design of the conducting strip segments would be easier and the placement manner would also be easier; therefore, it is easier to realize. Preferably, said conducting strip segment is a parallelogram. The size design of such conducting strip segments is relatively easy.

[0018] In the transmission line antenna according to one embodiment of the present invention, said conducting strip is an integral strip. Adopting such a solution, the transition of the width of the conducting strip is more smooth and therefore there is less reflection.

[0019] The transmission line antenna according to the embodiments of the present invention can be a microstrip transmission line antenna comprising any one of the abovementioned conducting strips or is a grounded coplanar stripline antenna comprising any two of the abovementioned conducting strips.

[0020] Preferably, the characteristic impedances of the abovementioned conducting strip segments are the same. Adopting such a solution, a reflection current would not be produced among various conducting strip segments with the same characteristic impedance, thus a wider bandwidth can be obtained.

[0021] Adopting the transmission line antenna provided in the present invention, in an application scenario of a radio frequency identification system, such as smart shelves or conveying systems, the field nulls of the electric field radiated by the transmission line antenna can be reduced so as to ensure a long enough reading distance.

Description of the accompanying drawings

[0022] The above described and other features and advantages of the present invention will become clearer below to those skilled in the art by describing the exemplary embodiments of the present invention in conjunction with the accompanying drawings in detail, in which:

Fig. 1 is a structural schematic diagram of a microstrip transmission line antenna in the prior art;

Fig. 2 is a structural schematic diagram of another microstrip transmission line antenna in the prior art;

Fig. 3 is a structural schematic diagram of a coplanar stripline antenna proposed in the present invention;

Fig. 4 is a schematic diagram of the electric field distribution of the coplanar stripline antenna shown in Fig. 3;

Fig. 5 is a structural schematic diagram of a coplanar stripline antenna according to one embodiment of the present invention;

Fig. 6 is a schematic diagram of the electric field distribution of the coplanar stripline antenna shown in Fig. 5;

Fig. 7 is a schematic diagram of the simulation result of S11 performance of the coplanar stripline antenna shown in Fig. 5;

Fig. 8 is a structural schematic diagram of a coplanar stripline antenna according to another embodiment of the present invention; and

Fig. 9 is a structural schematic diagram of a microstrip transmission line antenna according to another embodiment of the present invention.

Particular Embodiments

[0023] The abovementioned characteristics, technical features, advantages of the present invention and implementations thereof will be further described below in a clear and easily understood way by describing the preferable embodiments in conjunction with the accompanying drawings.

[0024] Aiming at the aforementioned problems existing in the prior art, the inventor conducted further experimental research and proposed a grounded coplanar stripline antenna as shown in Fig. 3. Fig. 3 shows a grounded coplanar stripline antenna with a length of 80 cm, which comprises: a substrate 301, a ground plane 302 and two conducting strips 303, wherein the XYZ coordinate axes form a three dimensional coordinate system, the substrate 301, the ground plane 302 and two conducting strips 303 form a grounded coplanar stripline; one end of the grounded coplanar stripline is connected to the feeder so as to connect to the reader; the other end of the grounded coplanar stripline is connected to the matched load; and other constituent parts such as a feeder and a matched load that are not shown in Fig. 3 belong to the scope of the prior art and will not be described here. It can be seen from Fig. 3 that the widths of the main bodies of the two conducting strips 303 remain unchanged.

[0025] Adopting the antenna structure as shown in Fig.

3 can significantly enhance the reading distance; however, the electric field of the antenna still has several field nulls. Fig. 4 shows a schematic diagram of the electric field distribution on the XY-axis plane of the coplanar stripline antenna shown in Fig. 3 that is obtained through a simulation experiment. As shown in Fig. 4, the radiation scope of the coplanar stripline antenna shown in Fig. 3 along the Y axis direction can reach 1.3 m; however, the electric field distribution of the coplanar stripline antenna is not uniform enough, several very deep field nulls emerge at 0.1 m above the substrate 301, and the reading distance can merely reach 0.1 m.

[0026] On the basis of the above experimental research, the present invention designs a transmission line antenna which can radiate a uniform electric field so as to reduce the field nulls shown in Fig. 4 and ensure a long enough reading distance. The width of the conducting strip gradually reduces from the middle area to two sides so that the field nulls in an electric field radiated by the antenna are reduced, thereby improving the reading distance.

[0027] In the transmission line antenna proposed in the present invention, the width of the conducting strip gradually reduces from the middle area to two sides, the conducting strip can be taken as several segments and the width of the conducting strip segment in the middle area is the largest. It can be understood by a person skilled in the art that, under the circumstance of maintaining a certain characteristic impedance, with the width and length of the conducting strip increasing, more electric energy would be leaked out, enhancing the electric field radiated by the conducting strip. Thus, the conducting strip segment with the largest width has the strongest electric field intensity radiated out (i.e. the amplitude of the radiated electromagnetic waves is the largest), while the electric field intensity radiated by each conducting strip segment distributed on two sides of the conducting strip segment with the largest width reduces with the decrease of the width of the conducting strip segment (i.e. the amplitude of the radiated electromagnetic waves reduces). That is to say, in the transmission line antenna structure proposed in the present invention, the electric field radiated by the conducting strip segment with the largest width is the strongest, while the electric field radiated by the conducting strip segments on two sides of this conducting strip segment is reduced gradually. Since in the transmission line antenna provided in the present invention, the amplitudes of electromagnetic waves produced by conducting strip segments with different widths differentiate a lot, when the electromagnetic waves are superimposed, the electromagnetic waves would not be totally offset, thereby reducing the field nulls in the electric field.

[0028] The transmission line antenna proposed in the present invention can further comprise a feeder and a matched load; and one end of the transmission line is connected to the feeder and the other end thereof is connected to the matched load. Such an antenna is suitable

for independent use and can reduce field nulls and improve the reading distance.

[0029] The transmission line antenna proposed in the present invention can further comprise two ports for cascading connection to the other antennas. Such an antenna is suitable for the application scenario where a plurality of antennas are connected in a cascading manner and can reduce field nulls and improve the reading distance.

[0030] The transmission line antenna proposed in the present invention can further comprise a ground plane which is located below the substrate and covers the entire substrate. Adopting the ground plane can completely prevent the downward radiation of electromagnetic waves of the antenna, thus making the upward radiation signals stronger.

[0031] In the transmission line antenna provided in the embodiments of the present invention, said conducting strip comprises a plurality of conducting strip segments, wherein the width of the conducting strip segment located in the middle area is the largest, and the width of each conducting strip segment from the middle area of said conducting strip segment to the two ends of said conducting strip is reduced gradually. Adopting such a solution, the field nulls in the electric field can be reduced or even eliminated, so as to obtain a large enough reading distance and make the processing technology simple and the size design of the conducting strip easier. The characteristic impedances of these conducting strip segments can be the same and can also be different. Preferably, by designing the size of each conducting strip segment (including the width and separation distance), each conducting strip segment can have the same characteristic impedance; thus, the border parts (such as 5024) between every two adjacent conducting strip segments would not produce a reflection current.

[0032] The transmission line antenna proposed in the present invention comprises two types: a grounded coplanar stripline antenna and a microstrip transmission line antenna. Fig. 5 shows a schematic diagram of a grounded coplanar stripline antenna according to one embodiment of the present invention. Fig. 5 shows the XZ-axis plane of the grounded coplanar stripline antenna which comprises a substrate 501 and two conducting strips 502. In this embodiment, the size of the entire transmission line antenna is 932 mm x 120 mm x 21.5 mm. Each conducting strip is divided into 20 segments. The width of the middle conducting strip segment is 24.5 mm, and the separation distance between two middle conducting strip segments on two conducting strips is 45 mm. The characteristic impedance of the transmission line is 200 ohm (i.e. the characteristic impedance of each conducting strip segment is 200 ohm), and the impedance of the matched load is 50 ohm. The impedance ratio of Balun is 1 : 4. Fig. 5 does not show other constituent parts, such as a ground plane, a feeder and a matched load. These components and the connection relationship thereof can both be easily learned by a person skilled in the art according to the prior art, and will not be described

here. The embodiments of the present invention improve the structures of the two conducting strips 502. As shown in Fig. 5, each conducting strip 502 is composed of twenty quadrangular conducting strip segments that are placed sequentially and have the same characteristic impedance, i.e. the characteristic impedance of each conducting strip segment is 200 ohm, wherein the width and length of the middle conducting strip segment 5021 are both the largest and the width from the middle conducting strip segment 5021 to each conducting strip segment 5022 or 5023 at either end reduces gradually. By designing the size of each conducting strip segment, each conducting strip segment can have the same characteristic impedance; thus, the border parts (such as 5024) between every two adjacent conducting strip segments will not produce a reflection current. The quadrangular conducting strip segments here can be of various shapes like a parallelogram (e.g. rectangle and trapezoid), etc. Said width refers to the distance along the Z axis direction and said length refers to the distance along the X axis direction.

[0033] Fig. 6 shows a schematic diagram of the electric field distribution of coplanar stripline antennas shown in Fig. 5 that is obtained through a simulation experiment on the XY-axis plane. As shown in Fig. 6, the reading distance of the coplanar stripline antenna shown in Fig. 5 along the Y axis direction can reach above 70 cm, and the electric field distribution is uniform, and the field nulls do not emerge at 70 cm above the substrate 501. Here, designing the size of the middle conducting strip segment to make the width and length thereof large enough can enable the antenna to have a long enough reading distance, and even to reduce and even eliminate the field nulls in the electric field. A certain size can be designed for each conducting strip segment in the transmission line antenna, and whether the antenna of the conducting strip segment having such size can reduce the field nulls can be judged through simulation experiments (such as through a simulation diagram similar to Fig. 6).

[0034] Fig. 7 is a schematic diagram of the simulation result of S11 performance of the coplanar stripline antenna shown in Fig. 5. A person skilled in the art will know that S11 is one of the S parameters indicating the return loss characteristic, and the lost dB value and the impedance characteristic thereof are usually seen through a network analyzer. This S11 parameter is used to evaluate the emission efficiency of the antenna, the larger its value, the larger the energy reflected back by the antenna itself and therefore the worse the efficiency of the antenna. It can be seen from Fig. 7 that even when the S11 parameter is at the maximum value of -20 dB (i.e. when the efficiency of the antenna is the worst), the bandwidth of the antenna can also reach 800 MHz-1000 MHz (exceeding the basic requirement of 200 MHz). This indicates that the bandwidth of the coplanar stripline antenna shown in Fig. 5 can totally meet the requirements.

[0035] In addition, the far field gain of the grounded coplanar stripline antenna shown in Fig. 5 is obtained

through simulation, the largest far field gain thereof is just -5 dB. Apparently, such a grounded coplanar stripline antenna is particularly suitable for the application scenario of near field, such as RFID-based smart shelves and conveying systems.

[0036] On the basis of the implementation principle of the grounded coplanar stripline antenna shown in Fig. 5, another embodiment of the grounded coplanar stripline antenna is also proposed in the present invention, as shown in Fig. 8. The grounded coplanar stripline antenna shown in Fig. 8 comprises a substrate 801 and two conducting strips 802. Other constituent parts not shown in Fig. 8, such as a ground plane, a feeder and a matched load, belong to the prior art and will not be described here. The antenna structure shown in Fig. 8 differs from the antenna structure shown in Fig. 5 in that these two conducting strips 802 are not formed by a plurality of quadrangular conducting strip segments, but by two integral conducting strips with gradually changing widths and smooth edges, wherein the width of the middle part of each conducting strip 802 is the largest, and the width from the middle part to the part at either end 8021 or 8022 reduces gradually. By designing the size of each part in each conducting strip 802, each conducting strip 802 can be divided into several parts with the same characteristic impedances, and the electric field intensity radiated from the middle part to the part at either end 8021 or 8022 is reduced gradually; thus, the field nulls in the electric field can be reduced so as to obtain a relatively uniform electric field distribution. Here, said width refers to the width along the Z axis direction and said length refers to the length along the X axis direction.

[0037] In the transmission line antenna provided in the embodiments of the present invention, the conducting strip segments can be of various shapes, preferably, quadrangle, such as parallelogram like rectangle and trapezoid, etc. Thus, the size design of the conducting strip segment is relatively easy.

[0038] Preferably, the adjacent borders of every two adjacent conducting strip segments are parallel. Adopting such a solution, the size design of the conducting strip segment would be easier and the placement manner would also be easier; therefore, it is easy to realize.

[0039] In the transmission line antenna provided in the embodiments of the present invention, the abovementioned conducting strip can be formed by splicing a plurality of conducting strip segments (such as by splicing a plurality of electric conducting metal sheets), and can also be an integral conducting strip without segments (such as an integral conducting strip metal sheet). The edge of this integral conducting strip can be a smooth curve and can also be a non-smooth fold line. Adopting such a solution, the transition of the conducting strip width is more smooth and therefore there is less reflection.

[0040] In various transmission line antennas provided in the embodiments of the present invention, the conducting strip can be of a symmetrical shape and can also be of a non-symmetrical shape, and that the conducting

strip is of a symmetrical shape means that the conducting strip is of an axisymmetric shape. For example, making a straight line along the Z axis direction at the midpoint along the length of the X axis direction of the conducting strip, the conducting strip is of a symmetrical shape using the straight line as the symmetry axis; or making a straight line along the X axis direction at the midpoint along the length of the Z axis direction of the conducting strip, the conducting strip is of a symmetrical shape using the straight line as the symmetry axis.

[0041] On the basis of the abovementioned embodiments, an embodiment of a microstrip transmission line antenna is also proposed in the present invention. As shown in Fig. 9, the microstrip transmission line antenna comprises a substrate 901 and a conducting strip 902. Fig. 9 does not show other constituent parts, such as a ground plane, a feeder and a matched load, and these components and the connection relationship thereof can both be easily learned by a person skilled in the art according to the prior art, and will not be described here. The microstrip transmission line antenna shown in Fig. 9 differs from the microstrip transmission line antenna shown in Fig. 1 in the structure of the conducting strip. As shown in Fig. 9, the conducting strip 902 is composed of several rectangular conducting strip segments, wherein the width and length of the middle conducting strip segment 9021 are both the largest and the width from the middle conducting strip segment 9021 to each conducting strip segment at either end 9022 or 9023 reduces gradually. A uniformly distributed radiation electric field can be obtained by designing the size of each conducting strip segment. Here, designing the size of the middle conducting strip segment 9021 to make the width and length thereof large enough can enable the antenna to have a long enough effective reading distance. The shape of the conducting strip segment is not limited to a rectangle, and can also be various quadrangles such as trapezoid and parallelogram, and so on. Said width refers to the width along the Z axis direction and said length refers to the length along the X axis direction.

[0042] On the basis of the implementation principle of the microstrip transmission line antenna shown in Fig. 9, an embodiment of another microstrip transmission line antenna is also proposed in the present invention. The antenna structure of this embodiment differs from the antenna structure shown in Fig. 9 in that the conducting strip is not formed by a plurality of conducting strip segments, but by an integral conducting strip with gradually changing widths and smooth edges, wherein the middle part width of the conducting strip is the largest (i.e. the wide part), and the width from the middle part to the part at either end of the conducting strip reduces gradually. By designing the size of each part of the conducting strip, the conducting strip can be divided into several parts with the same characteristic impedance, and the electric field intensity radiated from the middle part to the part at either end reduces gradually; thus, the field nulls can be reduced.

[0043] The present invention has been illustrated and described above in detail by way of the accompanying drawings and preferable embodiments; however, the present invention is not limited to these disclosed embodiments, and other solutions derived therefrom by those skilled in the art are within the scope of protection of the present invention.

Claims

1. A transmission line antenna for radio frequency identification, comprising a substrate (101, 201, 301, 501, 801, 901) and a conducting strip (502, 802, 902), wherein said conducting strip (502, 802, 902) is arranged on said substrate (101, 201, 301, 501, 801, 901), and said substrate (101, 201, 301, 501, 801, 901) and said conducting strip (502, 802, 902) form a transmission line; and
the width of said conducting strip (502, 802, 902) gradually reduces from the middle area of the conducting strip (502, 802, 902) to two sides, so as to reduce field nulls in an electric field radiated by the antenna.
2. The antenna according to claim 1, further comprising a feeder (104, 204) and a matched load (105, 205), wherein one end of said transmission line is connected to said feeder (104, 204), and the other end thereof is connected to said matched load (105, 205).
3. The antenna according to claim 1, two ends of the antenna comprising ports for cascading connection to other antennas.
4. The antenna according to claim 1, further comprising a ground plane (102, 202, 302), wherein said ground plane (102, 202, 302) is located below said substrate (101, 201, 301, 501, 801, 901), and covers the entire substrate (101, 201, 301, 501, 801, 901).
5. The transmission line antenna according to any one of claims 1-4, **characterized in that** said transmission line is a microstrip transmission line comprising one said conducting strip (902), or a grounded coplanar stripline comprising two said conducting strips (502, 802).
6. The transmission line antenna according to any one of claims 1-4, **characterized in that** said conducting strip (802) is an integral strip.
7. The transmission line antenna according to any one of claims 1-4, **characterized in that** said conducting strip (502, 902) is formed by splicing a plurality of conducting strip segments.
8. The transmission line antenna according to claim 7,

characterized in that both the length and the width of the conducting strip segments in the middle position are the largest.

9. The transmission line antenna according to claim 7, **characterized in that** the adjacent borders (5024) of every two adjacent conducting strip segments are parallel.
10. The transmission line antenna according to claim 9, **characterized in that** said conducting strip segment is a parallelogram.
11. The transmission line antenna according to claim 7, **characterized in that** characteristic impedances of said plurality of conducting strip segments are the same.

FIG 1

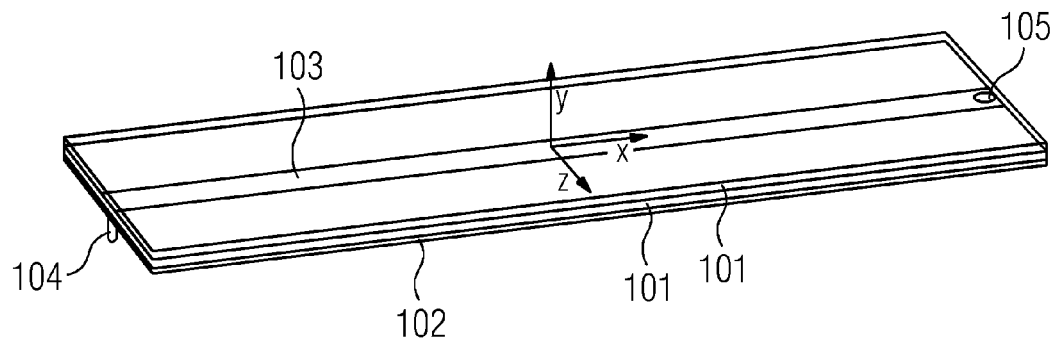


FIG 2

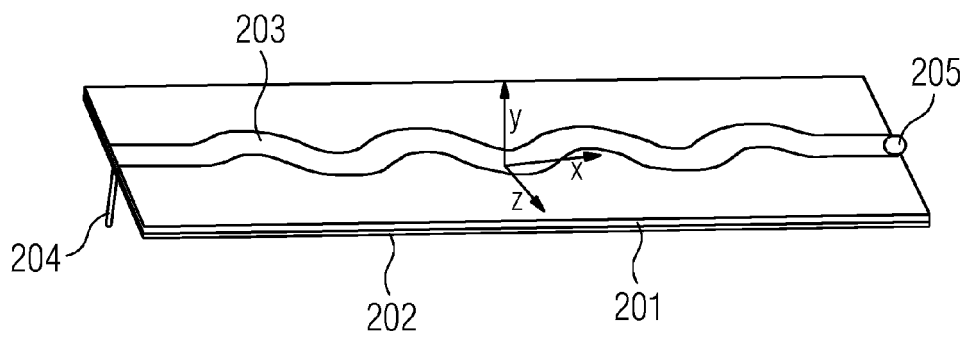


FIG 3

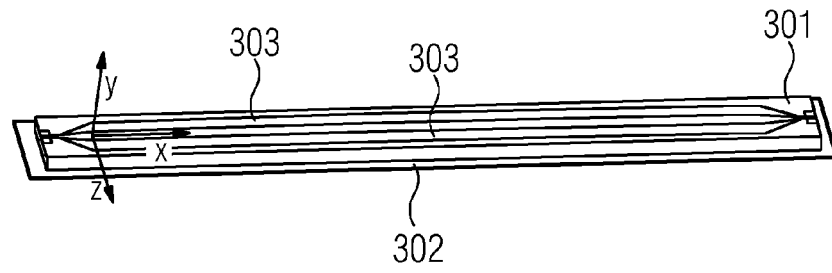


FIG 4

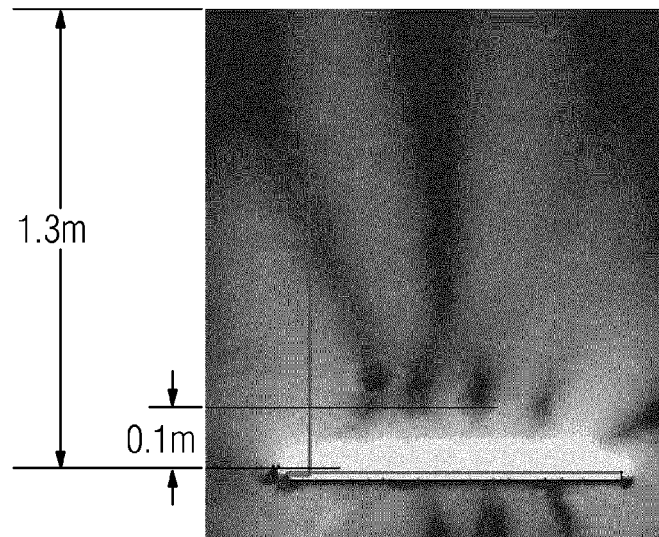


FIG 5

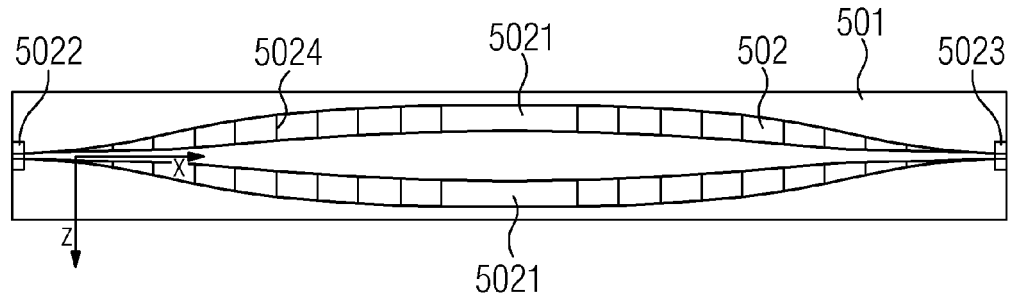


FIG 6

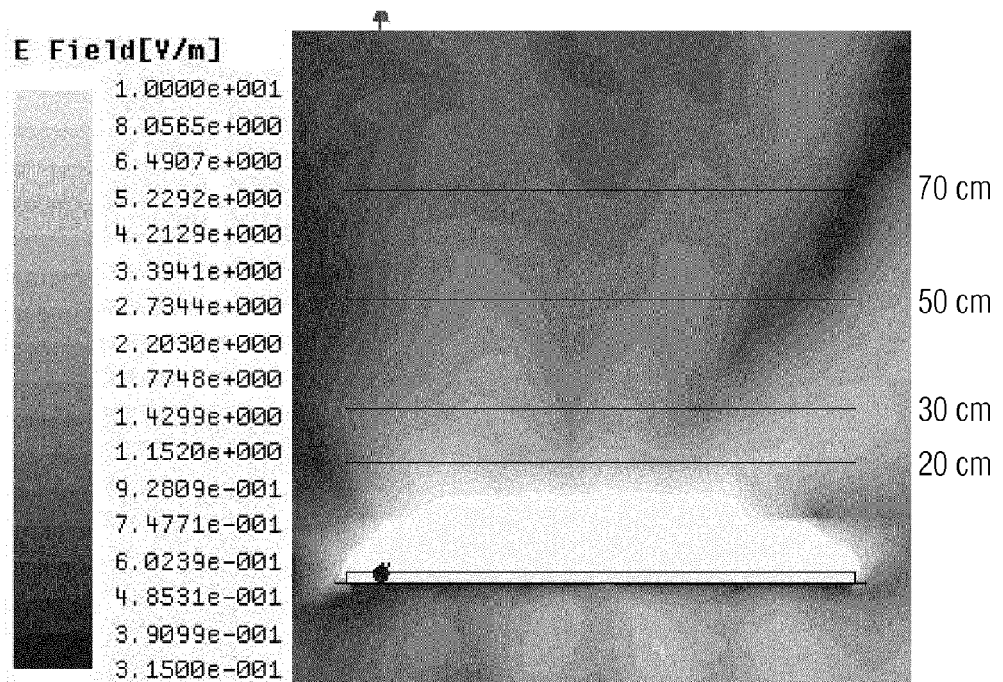


FIG 7

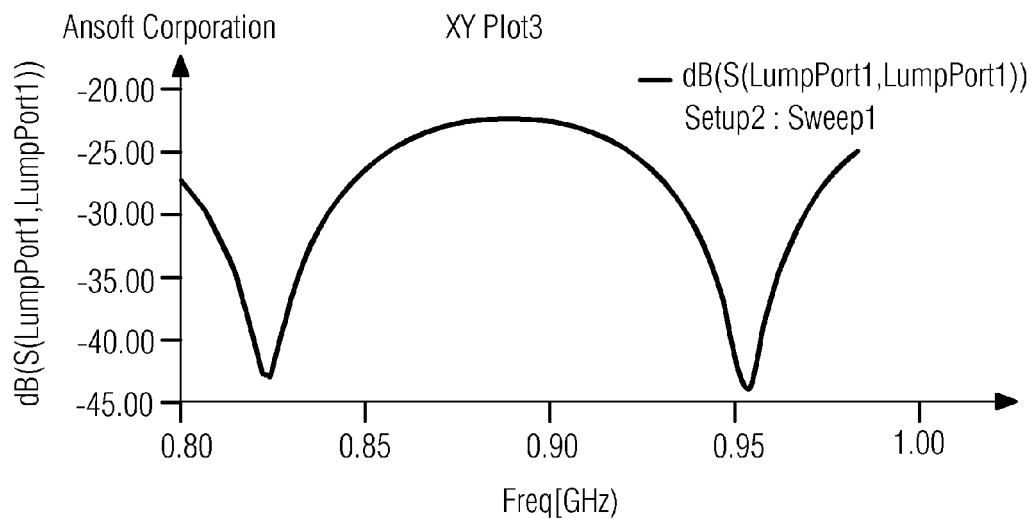


FIG 8

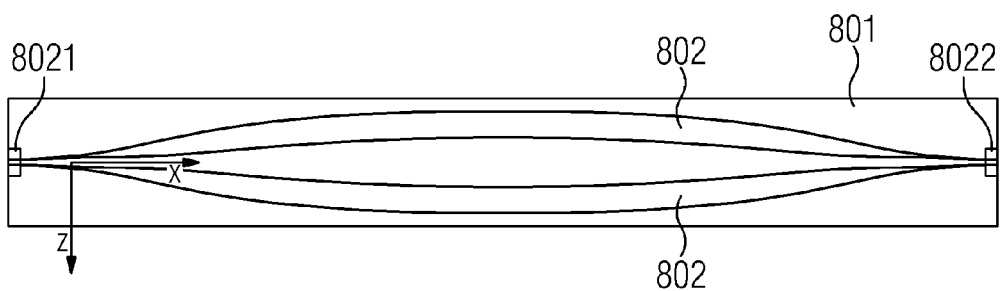
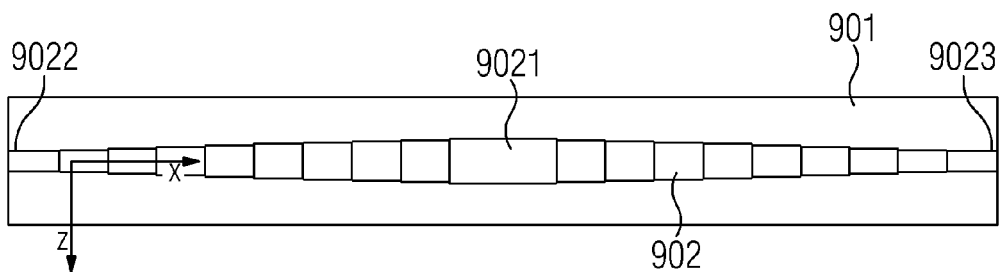


FIG 9





EUROPEAN SEARCH REPORT

Application Number
EP 13 18 5656

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2009/085746 A1 (ERICKSON DAVID P [US] ET AL) 2 April 2009 (2009-04-02) * abstract; figures 1-4 * * paragraphs [0004] - [0048] * -----	1-6	INV. H01Q13/20 ADD. H01Q1/38 H01Q1/22
X	NL 7 708 089 A (LICENTIA GMBH) 24 January 1978 (1978-01-24) * pages 1-5; figures 1-4 * -----	1,4,5, 7-11	
X	LOUIS SAAD: "Eine Streifenleitungs-Richtantenne für den Frequenzbereich 2 bis 40 GHz", WISSENSCH. BER. AEG-TELEFUNKEN,, vol. 51, no. 2/3, October 1978 (1978-10), pages 167-176, XP001383588, * the whole document * -----	1,4,5, 7-11	
A	US 2010/060457 A1 (BURNSIDE WALTER D [US] ET AL) 11 March 2010 (2010-03-11) * abstract; figures 7-11 * * paragraphs [0006] - [0012], [0036] - [0040] * -----	1-11	
			TECHNICAL FIELDS SEARCHED (IPC)
			H01P H01Q
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 23 January 2014	Examiner Hüschelrath, Jens
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document			

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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