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(54) **A direct current energy supplying antenna structure**

(57) The invention relates to a direct current energy supplying antenna structure for converting radio frequency energy to direct current energy. The antenna structure comprises a micro strip patch antenna and a rectifier circuitry. The antenna structure further comprises a resistive element connecting a printed pattern on a first side of a dielectric layer with a ground plane on a second, opposite to the first side of the dielectric layer near an edge of the strip patch. In addition, the rectifier circuitry is arranged in series with the resistive element.

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Description

[0001] The invention relates to a direct current energy supplying antenna structure for converting radio frequency energy to direct current energy, comprising a micro strip patch antenna and a rectifier circuitry.

[0002] Such direct current energy supplying antenna structures are known for providing direct current energy to wireless mobile communication devices, thereby reducing the need for local energy suppliers, such as batteries.

[0003] In particular, a so-called rectenna is known wherein the micro strip patch antenna is connected to the rectifier circuitry.

[0004] However, an antenna that is connected to a rectifier cannot be used for communication purposes.

[0005] It is an object of the invention to provide a direct current energy supplying antenna structure according to the preamble, wherein the disadvantage identified above is reduced. In particular, the invention aims at obtaining a direct current energy supplying antenna structure according to the preamble wherein the antenna structure can be used for both providing direct current energy and wireless communicating. Thereto, according to the invention, the antenna structure further comprises a resistive element connecting a printed pattern on a first side of a dielectric layer with a ground plane on a second, opposite to the first side of the dielectric layer near an edge of the strip patch, and wherein the rectifier circuitry is arranged in series with the resistive element.

[0006] By applying the rectifier circuitry in an electrically conducting path between the printed pattern on a first side of a dielectric layer and a ground plane on the second side of the dielectric layer DC power can advantageously be retrieved from RF energy that is received by the antenna.

[0007] It is noted that antenna structure comprising a resistive element connecting a printed pattern on a first side of a dielectric layer with a ground plane on a second, opposite to the first side of the dielectric layer near an edge of the strip patch, is known *per se,* see e.g. 'Broadband circularly polarised square microstrip antenna using chip-resistor loading' by C.-Y. Huang a.o. in Antennas and Propagation, IEE Proceedings on Microwaves, 1999, page 94 sqq. Such lumped resistive connections of the printed pattern and a ground plane improve a bandwidth of the antenna and decrease a required antenna area, thus allowing miniaturization of micro strip patch antennas.

[0008] The direct current energy supplying antenna structure according to the invention can advantageously be used for mobile communication devices, especially in low power wireless communication applications with reduced power sources, or in applications wherein the use of local power sources is even undesired or impossible. Examples of low power wireless communication applications are devices for local area networks.

[0009] In a preferred embodiment the direct current energy supplying antenna structure further comprises an additional resistive element connecting a printed pattern on a first side of a dielectric layer with a ground plane on a second, opposite to the first side of the dielectric layer near an additional edge of the strip patch, wherein the edge and the additional edge are oriented substantially transverse with respect to each other and wherein the additional rectifier circuitry is arranged in series with the additional resistive element. In the preferred embodiment more DC energy can be obtained from RF waves as radio waves having different polarizations interact substantially with each or both rectifier circuitries.

[0010] Other advantageous embodiments according to the invention are described in the following claims.

[0011] By way of example only, an embodiments of the present invention will now be described with reference to the accompanying figures in which

[0012] Fig. 1 shows a direct current energy supplying antenna structure according to the invention.

[0013] The antenna structure 1 comprises a micro strip patch antenna 2 implemented in a planar structure. The antenna 2 is connected to an output port 9 via a transmission line segment that is realized in the same technology.

[0014] The transmission line and the patch 2 are realized using micro strip technology. In doing so, a ground plate of a printed circuit board serves as the earth, while on the opposite side of the board an electrically conducting pattern is printed. It is noted, however, that also other techniques could be used, such as etching techniques. The printed circuit board has dielectric properties to electromagnetically couple the printed pattern and the ground plate. In particular, the transmission line segment is formed as printed tracks. The patch is formed as a rectangular plane section that is designated for optimal receipt and transmission of e.g. 2.45 GHz.

[0015] A first edge 3 of the patch 2 is connected via a rectifier circuitry 7 in series with a discrete resistive element 10 to an electrically conducting via 5 that is connected to the ground plane of the antenna structure 1. By using the resistive element 10 the bandwidth of the antenna is enlarged while sizes of the patch antenna 1 are kept small. The discrete resistive element 10 is assembled on the side of the printed circuit board on which the electrically conducting pattern is printed. Alternatively, the discrete resistive element 10 is arranged in the via 5 interconnecting both opposite surfaces of the printed circuit board. A second edge 4 being oriented substantially transverse with respect to the first edge 3, is similarly connected in series via a rectifier circuitry 8 and a discrete resistive element 11 to an additional via 6 interconnecting both opposite surfaces of the printed circuit board.

[0016] The rectifier circuitries 7, 8 are implemented e.g. a single diode component. However, also other rectifier circuitries 7, 8 are possible, such as a diode structure having two anti-parallel arranged diode components for improved gain of the direct current energy. The DC energy is retrieved by connecting to interconnection ports

of the rectifier circuitries 7, 8 and can be fed to local energy buffers, such as a capacitor or a rechargeable battery.

[0017] The circuitries 7, 8 and the discrete resistors 10, 11 might be connected to the other components of the patch 2 using several techniques, such as soldering, gluing or otherwise to obtain an electrical conducting connection.

[0018] Further, a more complex diode structure can be employed to further enhance a direct current energy retrieval from the received radio waves.

[0019] The invention is not restricted to the embodiments described herein. It will be understood that many variants are possible.

[0020] As an example, geometries of the antenna patches can also be designed for performing wireless communication using radio waves having other frequencies, e.g. more or less than 2.45 GHz.

[0021] In addition, in stead of using a discrete resistor in series with a rectifier circuitry, the resistor can be implemented integral with a via structure interconnecting the printed pattern with the ground plane.

[0022] Other such variants will be obvious for the person skilled in the art and are considered to lie within the scope of the invention as formulated in the following claims.

Claims

1. A direct current energy supplying antenna structure for converting radio frequency energy to direct current energy, comprising a micro strip patch antenna and a rectifier circuitry, wherein the antenna structure further comprises a resistive element connecting a printed pattern on a first side of a dielectric layer with a ground plane on a second, opposite to the first side of the dielectric layer near an edge of the strip patch, and wherein the rectifier circuitry is arranged in series with the resistive element.

2. A direct current energy supplying antenna structure according to claim 1, wherein the rectifier comprises a single diode component.

3. A direct current energy supplying antenna structure according to claim 1, wherein the rectifier comprises two anti-parallel placed diode components.

4. A direct current energy supplying antenna structure according to any of the previous claims, further comprising an additional resistive element connecting a printed pattern on a first side of a dielectric layer with a ground plane on a second, opposite to the first side of the dielectric layer near an additional edge of the strip patch, wherein the edge and the additional edge are oriented substantially transverse with respect to each other and wherein the additional rectifier circuitry is arranged in series with the additional resistive element.

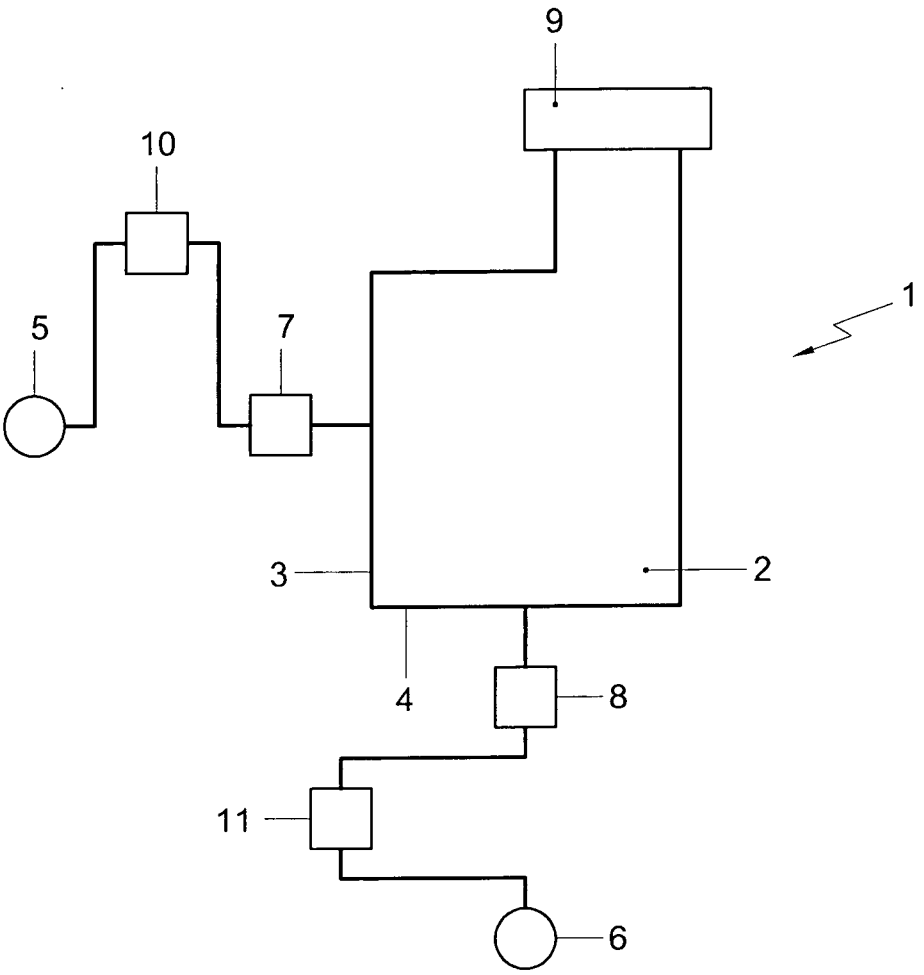

Fig. 1

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EUROPEAN SEARCH REPORT

Application Number
EP 07 10 3007

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 5 671 133 A (FUJITA SUGURU [JP] ET AL) 23 September 1997 (1997-09-23) * column 3, line 10 - column 4, line 4; figures 2,3 *	1-4	INV. H01Q1/24 H01Q9/04
X	EP 0 257 544 A2 (BBC BROWN BOVERI & CIE [DE]) 2 March 1988 (1988-03-02) * the whole document *	1-4	
A	J. THEEUWES ET AL: "Compact, efficient, low-cost rectenna analysis and design" URSI BENELUX MEETING, 12 May 2006 (2006-05-12), XP002429220 * the whole document *	3	
A	DE 40 10 658 A1 (YAMATAKE HONEYWELL CO LTD [JP]; YOKOWO SEISAKUSHO KK [JP]) 4 October 1990 (1990-10-04) * abstract *	1	
A	JP 61 001102 A (JAPAN RADIO CO LTD) 7 January 1986 (1986-01-07) * figure 3 *	1	TECHNICAL FIELDS SEARCHED (IPC) H01Q

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	13 April 2007	Van Dooren, Gerry

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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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

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 07 10 3007

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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13-04-2007

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5671133 A	23-09-1997	JP 3063513 B2	12-07-2000
		JP 7231585 A	29-08-1995
EP 0257544 A2	02-03-1988	DE 3628583 A1	10-03-1988
		JP 2812680 B2	22-10-1998
		JP 63054023 A	08-03-1988
		US 4918749 A	17-04-1990
DE 4010658 A1	04-10-1990	CA 2013424 A1	03-10-1990
		FR 2646739 A1	09-11-1990
		GB 2232027 A	28-11-1990
		JP 1904840 C	08-02-1995
		JP 2262723 A	25-10-1990
		JP 6036492 B	11-05-1994
		US 5122809 A	16-06-1992
JP 61001102 A	07-01-1986	JP 1605570 C	31-05-1991
		JP 2026402 B	11-06-1990

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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Non-patent literature cited in the description

- **C.-Y. HUANG A.O.** Antennas and Propagation. *IEE Proceedings on Microwaves,* 1999, 94 **[0007]**