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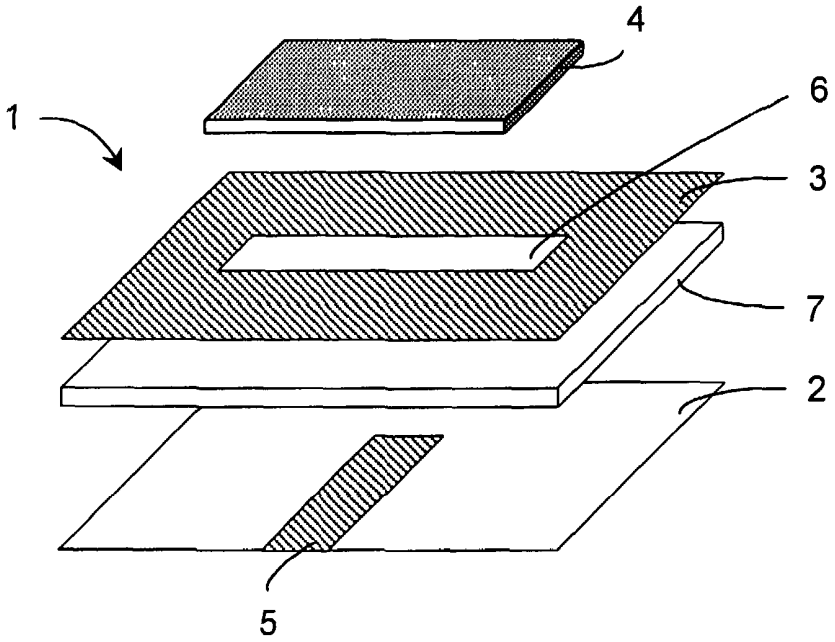
(54) **Title:** A LAYERED MICRO STRIP PATCH ANTENNA



(57) **Abstract:** The invention relates to a layered micro strip patch antenna (1), having first (2), second (3) and third (4) oppositely arranged layers. The second layer (3) being interposed between the first (2) and third layer (4). The first layer (2) comprises a feedline (5) for feeding an RF-signal to or from the antenna (1). The second layer (3) comprises a ground plane and the third layer (4) comprises a radiator patch. The ground plane and the third layer (4) comprises a radiator patch. The ground plane (3) at part thereof adjacent to the feedline (5) comprises an aperture (6) such that the feedline (5) and the aperture (6) form a feed structure for feeding an RF-signal to or from the radiator patch (4).

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Title

A Layered Micro Strip Patch Antenna

Field of the Invention

The present invention relates to telecommunication systems and, more specifically, to antennas and equipment for transmitting and receiving radio communication signals.

Background of the Invention

Radio equipment, such as radio transceiver devices for use in mobile and cordless telecommunication systems, often comprise micro strip patch antenna structures, connected to electronic circuitry using separate external wiring, such as coaxial cable, for example.

Those skilled in the art will appreciate that equipment having several separate interconnected parts provide a higher risk of malfunctioning of the product in use, whereas the product itself is relatively difficult to produce in an automated production process.

With the increase of the use of mobile and cordless telephone communication equipment, for example, there is a demand for less expensive, more easily to be manufactured radio equipment which is also less vulnerable to malfunctioning.

European patent 0 383 292 discloses an electronic circuit device having a micro strip patch antenna formed on a Printed Circuit Board (PCB). The PCB comprises a first surface on which a wiring track pattern is formed and on which components are mounted. A second surface of the PCB comprises a ground plane, part of which is formed as a coupling stub for feeding a radiator patch which is mounted opposite the ground plane at a distance thereof. A feed point of the coupling stub connects by a plated through hole to the wiring pattern on the first surface of the PCB.

For impedance matching of the coupling stub with a transceiver circuit, a separate impedance matching circuit is required. This impedance matching circuit occupies space on the PCB which, among others, is determined by the type of matching circuit and the wavelength

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for which the impedance should be matched. Those skilled in the art will appreciate that for relatively large wavelengths, the matching circuit may occupy a relatively large space on the PCB, thereby reducing the effective occupancy of the PCB. However, in view of the current trend for miniaturisation of mobile or cordless radio communication devices, an as high as possible occupancy of the PCB is to be demanded.

Summary of the Invention

It is an object of the present invention to provide an improved micro strip patch antenna, which is of a simple, less expensive and less space consuming construction. In particular for use in radio transceiver means, such as a radio access unit and a radio communication unit for mobile or cordless radio communication systems.

It is a further object of the present invention to provide an improved micro strip patch antenna for use in radio transceiver means equipped with two or more antennas arranged for applying antenna diversity in order to improve radio link performance of the radio transceiver means.

It is a yet further object of the present invention to provide an improved micro strip patch antenna for use with radio transceiver means which can transmit and receive signals simultaneously in two separate frequency bands.

According to the present invention there is provided a layered micro strip patch antenna, having first, second and third oppositely arranged layers, the second layer being interposed between the first and third layer, the first layer comprises a feedline for feeding an RF-signal to or from the antenna, the second layer comprises a ground plane and the third layer comprises a radiator patch. The antenna is characterised in that the ground plane at part thereof adjacent to the feedline comprises an aperture such that the feedline and the aperture form a feed structure for feeding an RF-signal to or from the radiator patch.

The radiator patch forming the third layer of the micro strip patch antenna according to the invention is energized by a so-called aperture coupling, wherein the RF-signal on the feedline is coupled through the aperture in the ground plane to the radiator patch. Accordingly, the

feed structure of the micro strip patch antenna according to the invention does not require an electrically conductive connection between the feedline of the first layer and the coupling stub of the second layer or ground plane.

By altering the dimensions of the feed structures, i.e. the size of the aperture and/or the feedline dimensions and by a proper positioning of the feedline and the corresponding aperture, the antenna according to the present invention can be easily tuned to a desired frequency and matched to a desired impedance of the RF circuitry connected to the feedline of the antenna.

In an embodiment of the patch antenna according to the invention, the first layer comprising the feedline is arranged at a first surface of a PCB, the second layer comprising the ground plane is arranged at the second surface of the PCB, and the third layer comprising the radiator patch is arranged at a distance to the PCB.

Different from the prior art micro strip patch antenna no via's through the PCB are required for connecting the feedline. Those skilled in the art will appreciate that the antenna according to the present invention can be manufactured easier and cheaper compared to the prior art micro strip patch antennas formed on a PCB.

In a yet further embodiment of the antenna according to the invention, the first layer comprises a plurality of feedlines and the second layer comprises a plurality of apertures associated with the plurality of feedlines, forming a plurality of feed structures. Such an antenna can be used, among others, for dual band transceiver devices, which can transmit and receive signals simultaneously onto separate frequency bands, using one radiator patch for the frequency bands. It will be appreciated that this type of antenna is of advantage for reducing the dimensions of radio transceiver devices.

Preferably, each feed structure comprises a separate feedline and a separate associated aperture. A feedline may be formed by a conducting strip on the first layer. A slot-type opening in the second or ground layer may form the corresponding aperture. Preferably, a conducting strip feedline and a slot-type aperture are configured in an intersecting T-shape. By a proper positioning of the intersecting parts of the feedline and the aperture, and/or by proper sizing of the dimensions of the radiator patch, the antenna can be easily tuned and impedance matched.

In a preferred embodiment of the micro strip patch antenna according to the present invention for use as a diversity antenna, the plurality of slot-type apertures orthogonally intersect each other. In a configuration, two slot-type apertures are provided configured in a T-shape, wherein one of the apertures forms a first leg of the T-shape and the other aperture forms the second leg of the T-shape.

This embodiment of the patch antenna according to the present invention is characterised by a very high isolation between the two feed structures, thereby avoiding unwanted mixing effects between the different feed structures.

The radiator patch, i.e. the third layer of the patch antenna, has to be positioned at a certain distance to the feed structure. In a preferred embodiment of the invention, the third layer forming the radiator patch is arranged with a housing comprising the antenna. That is, the radiator patch can be connected to or even may form part of the (plastic) housing. In both cases, air may be used as dielectric material between the radiator patch and the feed structure.

While using a PCB on which the first and second layer of the antenna according to the invention have been provided, other electrical and/or electronic components, among others forming part of electrical circuitry for the processing of an RF-signal transmitted by a feedline, may be mounted on the PCB at the surface thereof comprising the first layer. The feedline or feedlines of the antenna according to the invention can be formed as a track of a pattern of tracks forming an interconnection wiring of the PCB.

In the case of a multi-layered PCB, comprising several layers of wiring, for example, the feedlines may form part of any of said wiring layers.

The invention further relates to a radio transceiver means comprising a layered micro strip patch antenna as disclosed above.

The invention relates in particular to a transceiver means comprising transmitter, receiver and control means arranged for providing wireless radio communication, such as wireless telephone and data communication. The transceiver means may comprise a radio access unit and/or a radio communication unit of a wireless communication system.

The above-mentioned and other features and advantages of the invention are illustrated in the following description with reference to the enclosed drawings.

Brief Description of the Drawings

Figure 1 shows schematically, in an exploded view representation, an illustrative embodiment of the patch antenna according to the present invention.

Figure 2 shows the patch antenna of Figure 1 mounted on a PCB.

Figures 3, 4, 5 and 6 show, in a schematic plane view, several embodiments of feed structures for use with the patch antenna according to the present invention.

Figure 7 shows, in a schematic and illustrative manner, a housing comprising a patch antenna according to the present invention, wherein the radiator patch forms part of the housing.

Detailed Description of the Embodiments

Figure 1 shows by way of an exploded view, a layered micro-patch antenna 1 in accordance with the present invention. The antenna 1 comprises oppositely arranged first, second and third layers, respectively designated with reference numerals 2, 3 and 4.

The first layer 2 comprises a feedline 5 for feeding an RF-signal to or from the antenna 1. The second layer 3 comprises a ground plane having a slot-type aperture 6. The third layer 4 forms a radiator patch for transmitting and/or receiving electromagnetic (EM) radiation.

The feedline 5, the ground plane 3 and the radiator patch 4 are formed from electrically conductive material, indicated by hatching, such as copper, for example.

In the embodiment shown, the first layer 2 and the second layer 3 are positioned at a distance of each other, separated by dielectric material 7. Instead of using dielectrical material, the first and second layers 2, 3 may be separated by air.

The third layer 4, forming the radiator patch, is arranged at a distance to the second layer 3.

Figure 2 schematically shows an embodiment of an antenna 9 according to the present invention, wherein the first layer 2, the second layer 3 and the dielectric material 7 are formed by a single-layered Printed Circuit Board (PCB) 8. For the purpose of the present invention, no particular requirements have to be set to the PCB material. Commercially available PCB's normally will be sufficient for frequencies up to the RF area.

The antennas 1 and 9 are fed by a so-called aperture coupling. An RF-signal on the feedline 5 is coupled through the slot or aperture 6 in the ground plane 3 to the radiator patch 4.

The antennas 1 and 9 are of a type having a single polarisation. However, with the present invention, it is also possible to provide dual polarisation using two apertures 11 and 12 and corresponding feedlines 13, 14 as shown for the antenna 10 in Figure 3.

The slot-type apertures 11 and 12 are arranged in a T-shape, such that aperture 11 forms a first leg of the T and the aperture 12 forms a second leg of the T. Both the apertures 11 and 12 are formed in the second layer or ground plane 3.

Figures 4 and 5 show further embodiments of dual polarised aperture coupled patch antennas 16, 17 in accordance with the present invention, for use as diversity antennas, for example.

In Figure 4, the apertures 11 and 12 are arranged near an edge of the ground plane 3, whereas in Figure 4 the apertures 12 and 13 are combined into a single cross-shaped aperture 18. In the antenna 17 of Figure 5, the feedlines 13 and 14 intersect a different leg of the aperture 18. In both the antennas 16 and 17 the structure of feedlines and apertures are symmetrical along a diagonal axis.

The patch antenna according to the present invention can be used for radio equipment at any frequency, by simply adjusting the shape and/or dimensions of the feed structure, that is the aperture and corresponding feedline, by changing the shape and/or dimensions of the radiator patch, and/or by changing the distance between the radiator patch and the feed structure, as well as between the feedline and the corresponding aperture. Impedance match can be provided by varying the position of intersection of a feedline and its corresponding aperture.

Figure 6 shows an embodiment of a feed structure of a dual band patch antenna 20 in accordance with the present invention. The feedline 21 and aperture 22 are tuned to a first frequency and the feedline 23 and corresponding aperture 24 are tuned to a second frequency, which is higher than the first frequency. The two feed structure are orthogonally polarised, i.e. 90°.

It will be appreciated that in Figures 3, 4, 5 and 6 the layers are viewed from the first layer 2 and that no dielectric material 7 and no radiator patch 4 are shown, in order to facilitate the understanding of the present invention.

Those skilled in the art will appreciate that other polarisation angles can be supported by the antenna in accordance with the present invention, by arranging the feed structures, i.e. the apertures, under any mutual angle as required for the demanded polarisation type.

Figure 7 shows, in a schematic and illustrative manner, part of a radio transceiver device 25 having a plastic housing 29 comprising an integrated micro strip patch antenna 26 in accordance with the present invention, mounted on a PCB 30. In this embodiment, the conductive radiator patch 28 is attached to or may form part of a wall of the housing 29. In this embodiment, there is no need for additional distance holders or other additional fasting means to keep the radiator patch 28 at a specified distance above the feed structure 27 of the antenna 26. It will be appreciated that this type of housing is advantageous in view of reduced mounting effort.

The PCB 30 may comprise electrical and/or electronic components 31, 32, 33 forming part of electrical circuitry for the processing of an RF-signal transmitted or received via a feedline. Of course other electrical and/or electronic components may be mounted on the PCB 30, for example, control circuitry and the like.

The feedlines can be advantageously formed as current conductive tracks on a PCB. Care has to be taken that, at the position of the apertures, all the layers, accept of course the feedline, are empty.

For the purpose of the present invention multi-layered PCB's may be used, wherein the feedlines are formed in a layer separate from the electrical wiring for connecting the electrical and/or electronic components mounted on the PCB.

As illustrated above, the layered micro strip patch antenna according to the present invention is easy to manufacture on a PCB, without the need for plated through holes or via's, and can be mounted in a housing or enclosure with a minimal amount of assembly operations to make a complete radio transceiver means, comprising transmitter, receiver and control means for example arranged for providing wireless radio communication, such as wireless telephone and data communication. The transceiver device 25 may be arranged as a radio communication unit or a radio access unit for use in mobile radio networks, such as operating under the GSM (Global Systems for Mobile Communications) standard or the DECT (Digitally Enhanced Cordless Telecommunications) standard or any other radio communication standard such as Bluetooth and Hyperlan radio operating in multiple frequency bands, for example.

Claims

1. A layered micro strip patch antenna, having first, second and third oppositely arranged layers, said second layer being interposed between said first and third layer, said first layer comprises a feedline for feeding an RF-signal to or from said antenna, said second layer comprises a ground plane and said third layer comprises a radiator patch, characterised in that said ground plane at part thereof adjacent to said feedline comprises an aperture such that said feedline and said aperture form a feed structure for feeding an RF-signal to or from said radiator patch.

2. A layered micro strip patch antenna according to claim 1, wherein said first layer comprising said feedline is arranged at a first surface of a Printed Circuit Board (PCB), said second layer comprising said ground plane is arranged at a second surface of said PCB, and said third layer comprising said radiator patch is arranged at a distance to said PCB.

3. A layered micro strip patch antenna according to claim 1 or 2, wherein said first layer comprises a plurality of feedlines, and said second layer comprises a plurality of apertures associated with said plurality of feedlines, forming a plurality of feed structures.

4. A layered micro strip patch antenna according to claim 3, wherein each feed structure comprises a separate feedline and a separate associated aperture.

5. A layered micro strip patch antenna according to any of the previous claims, wherein a feedline is formed by a conducting strip on said first layer and an aperture is formed by a slot-type opening in said second layer.

6. A layered micro strip patch antenna according to claim 5, wherein a conducting strip feedline and a slot-type aperture are configured in an intersecting T-shape.

7. A layered micro strip patch antenna according to claim 5 or 6, wherein a plurality of slot-type apertures intersect each other.

8. A layered micro strip patch antenna according to claim 5, 6 or 7, having a first feed structure comprising first conducting strip and a first slot-type aperture and a second feed structure comprising

a second conducting strip and a second slot-type aperture, wherein said first and second feed structures are arranged such that said first and second conducting strips and said first and second slot-type apertures are mutually orthogonally positioned.

9. A layered micro strip patch antenna according to claim 5, 6, 7 or 8, comprising slot-type apertures of different size.

10. A layered micro strip patch antenna according to any of the previous claims, wherein said third layer forming said radiator patch is arranged with a housing comprising said antenna.

11. A layered micro strip patch antenna according to claim 10, wherein said third layer forms part of said housing.

12. A layered micro strip patch antenna according to any of the previous claims dependent on claim 2, wherein said PCB comprises electrical and/or electronic components forming part of electrical circuitry for the processing of an RF-signal transmitted by a feedline.

13. A layered micro strip patch antenna according to claim 12, wherein a feedline forms a track of a pattern of tracks forming an interconnection wiring of said PCB.

14. A radio transceiver means comprising a layered micro strip patch antenna according to any of the claims 1-13.

15. A transceiver means according to claim 14, comprising transmitter, receiver and control means arranged for providing wireless radio communication, such as wireless telephone and data communication.

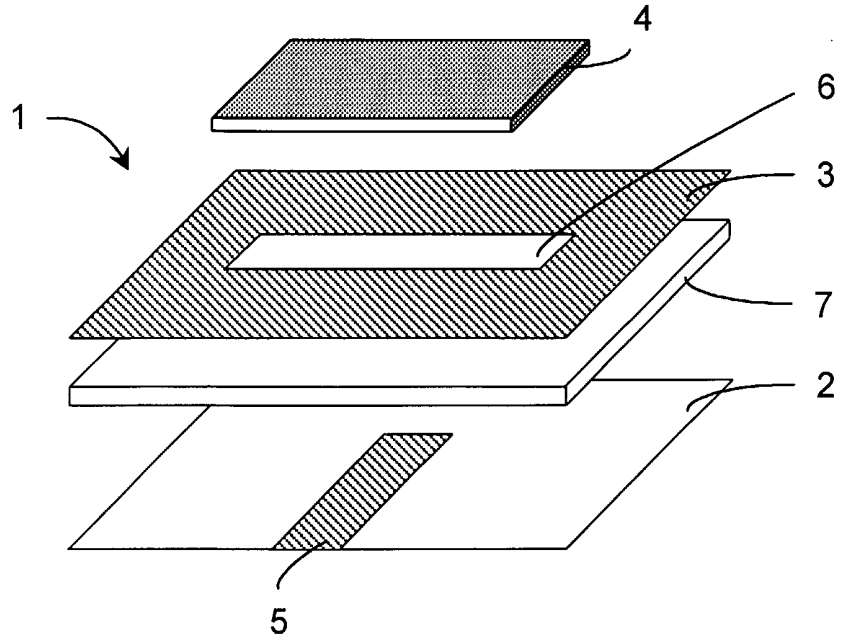

Fig. 1

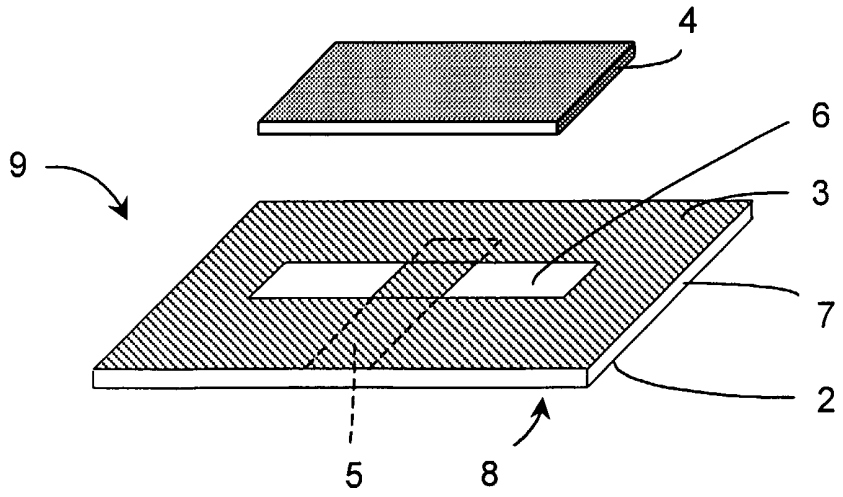

Fig. 2

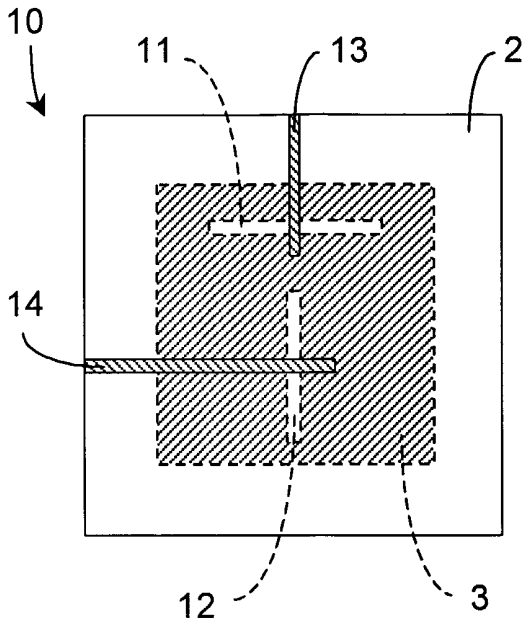

Fig. 3

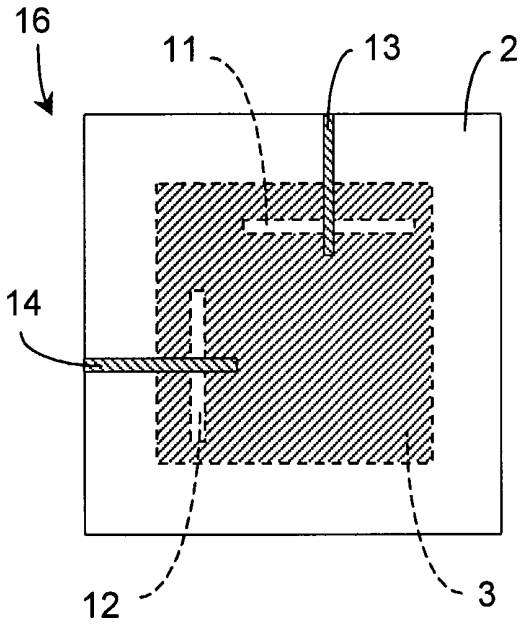

Fig. 4

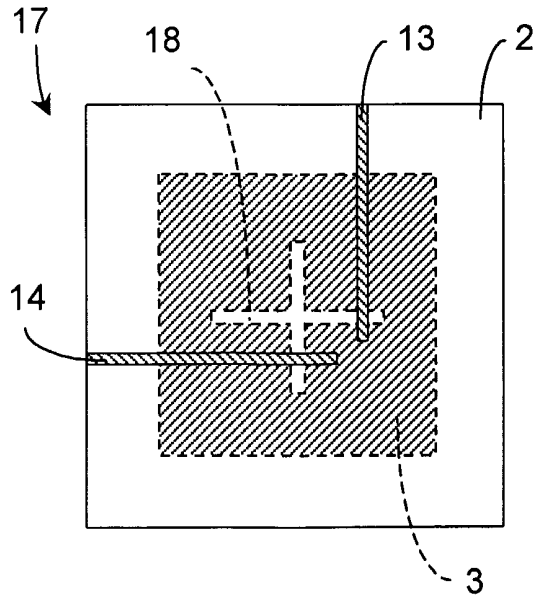

Fig. 5

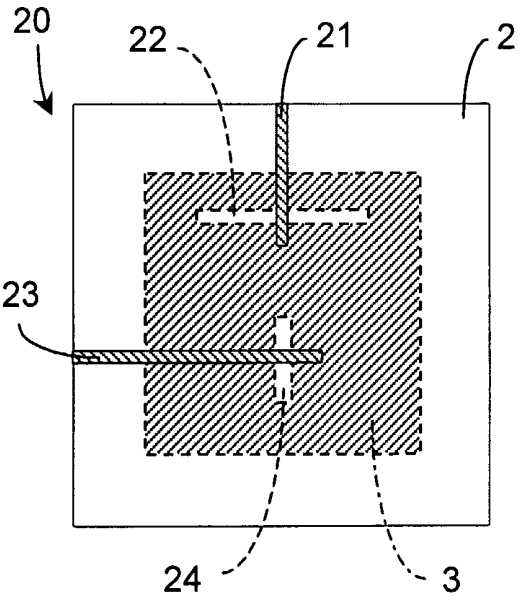

Fig. 6

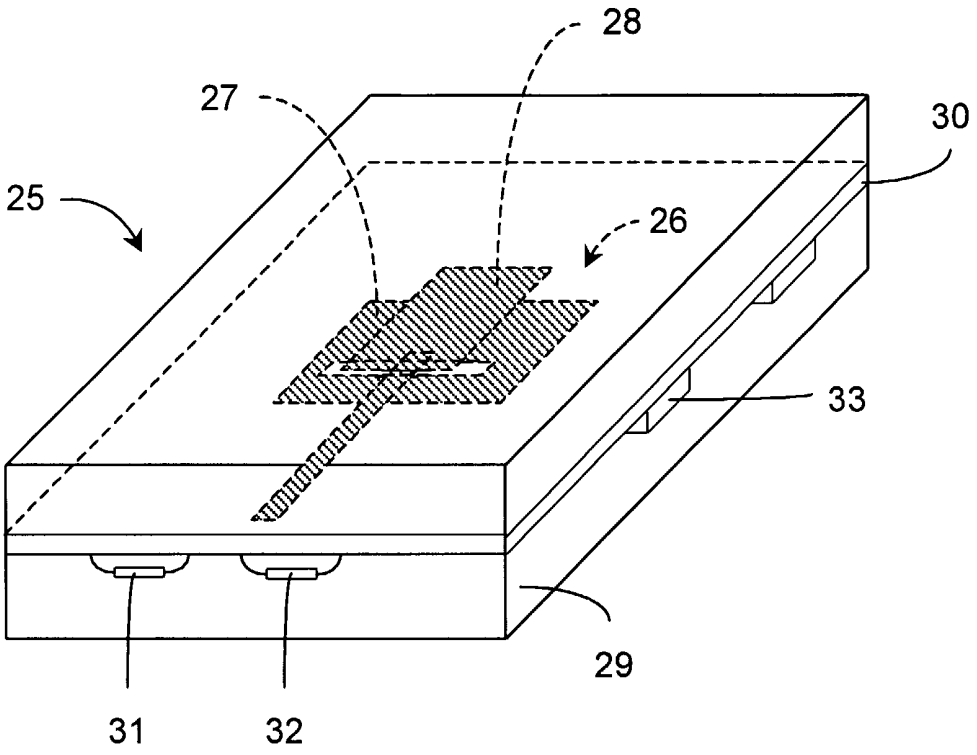

Fig. 7

INTERNATIONAL SEARCH REPORT

Inte nal Application No
PC., LP 01/01737

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01Q9/04 H01Q1/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H01Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 6 107 965 A (CHRIST JOCHEN) 22 August 2000 (2000-08-22) column 2, line 41 - line 56; figures 1-3	1-6,8,9, 12-15 10,11
Y	GB 2 345 196 A (NOKIA MOBILE PHONES LTD) 28 June 2000 (2000-06-28) page 6, line 14 - line 23; claims 1,2; figure 3	10,11
X	US 6 018 319 A (LINDMARK BJORN) 25 January 2000 (2000-01-25) column 2, line 12 - line 23; figures 1,2	1,3-8
A	EP 0 383 292 A (FUJITSU LTD) 22 August 1990 (1990-08-22) cited in the application column 3, line 45 - line 58; claim 1; figure 3	12,13

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search	Date of mailing of the international search report
16 October 2001	23/10/2001

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

mation on patent family members

Inte[illegible]al Application No
PC[illegible] 01/01737

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