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(54) **DEVICE WITH ANTENNA INTERCONNECTION TO MAIN BOARD**

(57) The invention relates to a device (1) comprising a main board (10) whereon electronic components are mounted, an antenna assembly comprising at least one antenna to be connected to said main board, and a casing for containing said main board and said antenna assembly, said casing comprising a top cover (11) and a bottom cover, wherein it further comprises at least one antenna holder (12) for holding said at least one antenna, said at least one antenna holder comprising at least one panel whereon one antenna is mounted, and wherein said at least one antenna holder is assembled to said top cover and is arranged to position the panel substantially perpendicularly to the main board and to connect said one antenna to the main board when the top cover of the casing is assembled to the bottom cover.

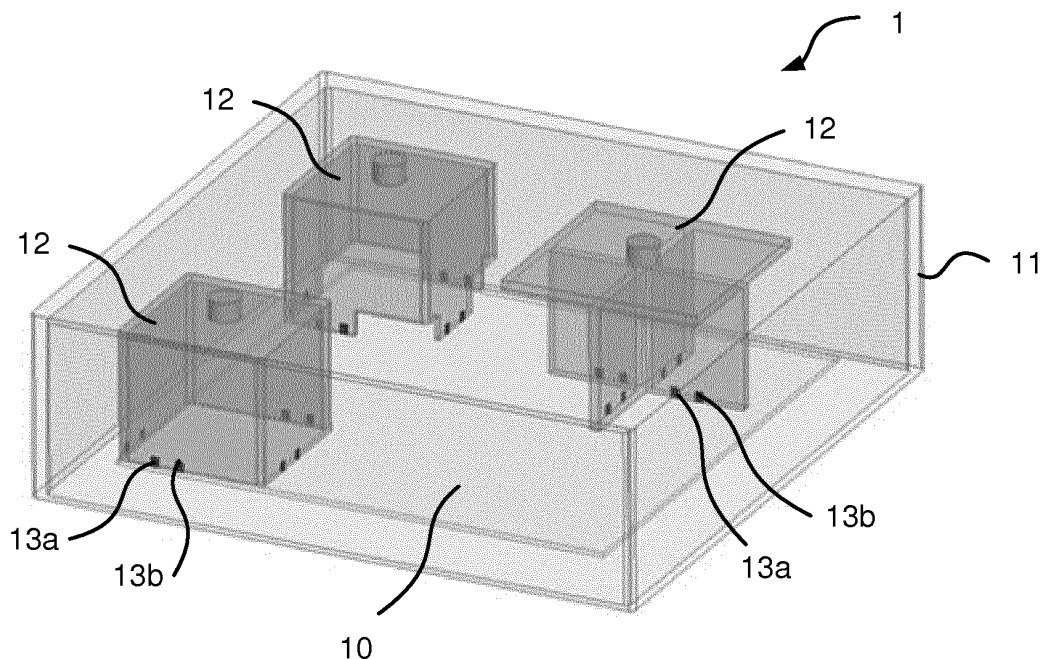


FIG.1

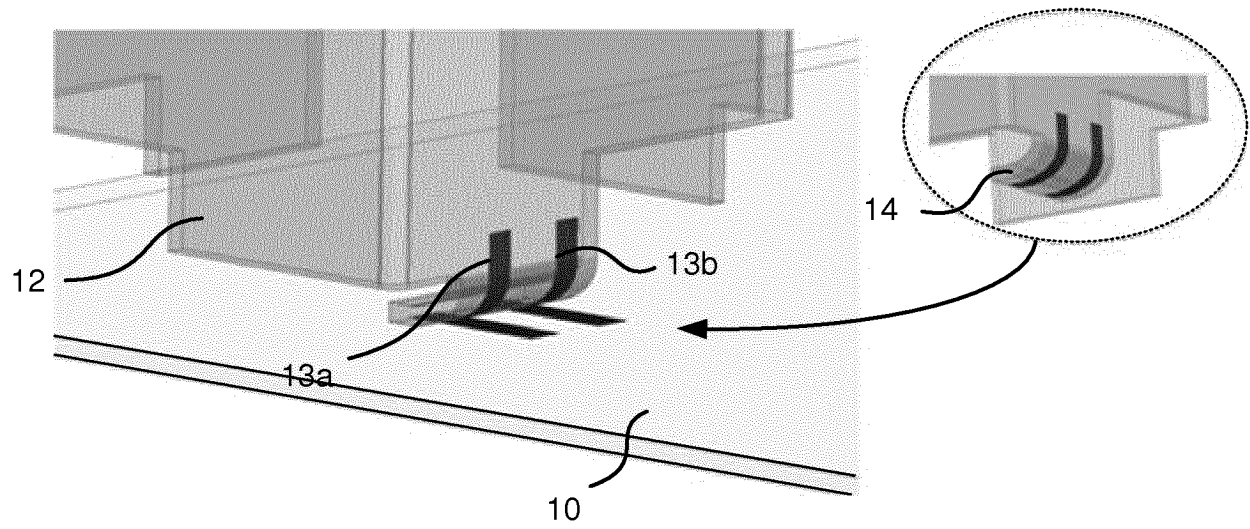


FIG.4

Description

1. Technical Field

[0001] The present invention relates generally to the field of electronic devices comprising at least one antenna. The invention can be integrated into, but not limited to, home-networking electronic devices, such as set-top-boxes, gateways and smart home devices.

2. Background Art

[0002] Nowadays home-networking devices such as internet gateways and set-top-boxes integrate numerous wireless systems in order to offer multiple services and applications. These include different systems complying with various communication standards such as, for example, RF4CE, ZigBee, Bluetooth, Zwave. Therefore, the electronic devices tend to integrate more and more antennas while at the same time, they become smaller. Consequently, integration and coexistence constraints, as well as manufacturing and assembly costs, are increased sensitively.

[0003] There exist different ways or solutions to integrate the antenna(s) to these electronic devices.

[0004] A first solution consists in directly printing the antenna(s) on the main board of the electronic device. Although this is the most cost-effective solution, it is applicable only if there is enough space on the board, which is not the case when there are a high number of antennas.

[0005] A second solution is to use off-board antenna(s), to attach it or them to the device casing and to interconnect it or them to the main board with a micro-coaxial cable. The antenna(s) can be printed on a common FR4-based substrate or a flexible polyimide (PI)-based substrate, or fabricated in a stamped metal technology. This solution enables to save space on the main board but is expensive (because of the use of coaxial connectors and cables).

[0006] A third solution is to use discrete stamped antenna(s) mounted on board. The metallic antennas are mounted substantially perpendicularly to the board and are soldered to feeding points of the antenna. This technology is considered as very low-cost but it does allow neither having complex antenna designs and shapes, nor building up a complete antenna system with multiple feedings.

[0007] A fourth solution consists in using 3D antenna hosted and carried by a 3D plastic member. The 3D plastic member is fixed by appropriate means to the main board of the device. This technology allows designing sophisticated antenna systems, taking the advantage of the 3-axis integration to deal with space constraints. Such an antenna structure can be realized according 3 main technologies:

a) using MID (for Molded Interconnect Device) technology: the process is adapted to metallize directly

the surface of the plastic member; antenna shapes and patterns can be metallized accurately but this technology is expensive;

b) using stamped metal technology: stamped metal strips and shapes are attached on the faces of the 3D plastic member by the use of plastic bumps and thermal staking technology, fitting their shape; thermal staking is an well-known assembly method that uses the controlled melting and reforming of a plastic bump (or stud or boss) to capture or lock another plastic or metal component of an assembly in place; the plastic bump protrudes through a hole of the metal strip to be locked in place; the top of the bump is melted by a thermal tip to produce a head, locking the metal strip in place.

c) using flexible substrate technology: antenna patterns are carried by a thin substrate, which can be for instance paper-based, PI (Polyimide) or PET (Polyethylene Terephthalate) based; the substrate containing the antennas is then wrapped onto the plastic part.

[0008] The three technologies used for implementing the fourth solution exhibit the following same disadvantages:

- since the 3D plastic member is attached onto the board, a surface area has to be freed on the board in order to place the 3D plastic member; this surface area is not negligible; therefore, there is a waste of space onto the board;
- in order to ensure good interconnection contacts between the antennas and the connection points of the main board, the plastic member is generally screwed to the board; this leads both to have a cost increase and to have holes on the board, meaning thus less space for on-board components; some clips, also called spring finger contacts, spring contacts or finger contacts, and/or pogo-pins can be used to ensure the interconnection contact in order to avoid attachment of the plastic member by screwing but this technique is known as to be expensive.

3. Summary of Invention

[0009] It is an object of the invention to alleviate at least partially the above-mentioned drawbacks.

[0010] More specifically, it is an object of the invention to propose a novel and inexpensive way for integrating an antenna assembly in an electronic device.

[0011] It is an object of the invention to propose a device with an antenna assembly taking up little space on the main board of the device while decreasing the time required for the assembly.

[0012] A subject of the invention is therefore a device comprising at least a main board whereon electronic components are mounted, an antenna assembly comprising at least one antenna to be connected to said main

board, and a casing for containing said main board and said antenna assembly, said casing comprising a top cover and a bottom cover, wherein it further comprises at least one antenna holder for holding said at least one antenna, said at least one antenna holder comprising at least one panel whereon one antenna is mounted, and wherein said at least one antenna holder is assembled to said top cover and is arranged to position the panel substantially perpendicularly to the main board and to connect said one antenna to the main board when the top cover of the casing is assembled to the bottom cover.

[0013] With this device structure, the antenna holder takes up little space onto the main board. The antenna holder is not attached to the main board but to the top cover of the casing such that the antenna is connected to the main board only when the top cover of the casing is assembled to the bottom cover.

[0014] In one embodiment, the antenna comprises conductive traces on a substrate, said substrate being mounted on a face of the panel of the antenna holder. In one embodiment, said substrate is flexible.

[0015] In a variant, the antenna comprises conductive strips, said conductive strips being directly mounted on a face of the panel.

[0016] In some embodiments, the antenna holder is made from plastic material.

[0017] In some embodiments, the antenna comprises at least one connection pad, called antenna pad, placed on an edge of the panel of the antenna holder and the main board comprises at least one connection pad, called board pad, said antenna pad and said board pad being arranged to be into electrical contact when the top cover is assembled to the bottom cover.

[0018] This device structure is not expensive since it does not comprise connectors (like for example coaxial connectors) for connecting the antenna to the main board.

[0019] In one particular embodiment, the panel comprises at least one flexible leg comprising said antenna pad, said flexible leg being applied against the board pad when the top cover of the casing is assembled to the bottom cover. It enables having a reliable contact between the antenna and the main board.

[0020] In one particular embodiment, the flexible leg is a bent portion of the panel.

[0021] The present invention also relates to a method for assembling a device comprising at least a main board whereon electronic components are mounted, at least one antenna to be connected to said main board, at least one antenna holder and a casing for containing said main board, said antenna holder and said antenna assembly, said casing comprising a top cover and a bottom cover, said antenna comprising at least one connection pad, called antenna pad and said main board comprises at least one connection pad, called board pad, the method comprising:

- assembling at least one antenna holder to said top

cover, said at least one antenna holder comprising at least one panel whereon one antenna is mounted; and

- assembling the top cover of the casing to the bottom cover,

wherein the at least one antenna holder is assembled to the top cover so that the panel of said antenna holder is substantially perpendicular to the main board when the top cover is assembled to the bottom cover and wherein the antenna pad is electrically connected to the board pad when the top cover is assembled to the bottom cover.

[0022] Additional aspects of embodiments will be set forth, in part, in the detailed description, figures and any claims which follow, and in part will be derived from the detailed description. It is to be understood that both the foregoing general description and the following detailed description are only exemplary and do not limit the claimed inventions.

4. Brief description of the drawings

[0023] The invention can be better understood with reference to the following description and drawings, given by way of example and not limiting the scope of protection, and in which:

- Fig.1 is a schematic top view of a device according to an embodiment of the invention, said device comprising a main board, antenna holders and a top cover;
- Fig.2 is a bottom view of the top cover and the antenna holders of the device of Fig.1;
- Fig.3 is the view of Fig.2 wherein the contact areas between the antenna holders and the main board are identified in a different level of grey; and
- Fig.4 is a view showing an example of means for electrically connecting an antenna of an antenna holder to a main board.

[0024] The components in the figures are not necessarily to scale, emphasis instead being placed upon illustrating the principles of the invention.

5. Description of embodiments

[0025] While example embodiments are capable of various modifications and alternative forms, embodiments thereof are shown by way of example in the drawings and will herein be described in details. It should be understood, however, that there is no intent to limit example embodiments to the particular forms disclosed, but on the contrary, example embodiments are to cover all modifications, equivalents, and alternatives falling within the scope of the claims.

[0026] Figs.1 to 3 illustrate schematically an embodiment of a device according to the invention. In this embodiment, the device 1 comprises a main board 10 whereon electronic components are mounted, an antenna assembly comprising a plurality of antennas (not shown) and a casing for enclosing the main board and the antenna assembly. The casing comprises a top cover 11 and a bottom cover (not shown). The antennas are mounted on three antenna holders 12.

[0027] The antenna holders 12 comprise one or more panels whereon the antennas are mounted. These panels may be arranged together to form antenna holders of different shapes. In the example of Figures 1-3, the three antenna holders 12 comprise four vertical side panels assembled to a horizontal top panel. These panels are arranged together differently to form different shapes of antenna holders.

[0028] The panels and the top cover are for example made of plastic material. The plastic material of the panels can be different from the plastic material of the top cover.

[0029] The antenna holders 12 are attached to the top cover 11 by appropriate means represented by cylinders in the figures. The antenna holders can be attached to the top cover by a rigid link, for example a plastic cylinder, or by any kind of clipping systems. In the first case, the antenna holder is part of the top cover and can be molded together with the top cover. In the second, the top cover and the antenna holder are separate elements and therefore can be made of different plastic materials.

[0030] The antennas are mounted on faces of the panels of antenna holders. These antennas are not visible on the figures 1-3. They are for instance designed using Flexible printed circuit technology based on a Pi, PET or paper substrate. In that case, conductive traces are mounted on a flexible substrate. The substrates of the antennas are assembled on the vertical side panels of the antenna holders, for example by adhesive bonding or sticking.

[0031] The antennas are disposed relative to each other on the antenna holders in order to meet the requested isolation or radiation diversity requirements.

[0032] The antenna holders 12 are arranged such that the vertical side panels are substantially perpendicular to the main board 10 when the top cover 11 is assembled to the bottom cover, for example by screwing. Thus the contact areas between the antenna holders 12 and the main board are reduced as shown in Fig.3. The contact areas are shown by a different level of grey in this figure. This allows to release space on the main board 10 for the integration of other on-board components.

[0033] The antenna holders 12 and the main board 10 comprise pads in order to electrically connect the antennas to components of the main board. In the present embodiment, each antenna comprises a ground pad 13a and a feeding pad 13b. These pads are visible on the figures. They are arranged to be in contact with a ground pad (or ground plane) and a feeding pad of the main

board when the top cover is assembled to the bottom cover.

[0034] In a preferred embodiment, the connection between the antenna holders and the main board is flexible as illustrated by Fig.4. In this embodiment, the antenna holder comprises a flexible leg 14 for electrically connecting the pads of the antenna to dedicated pads of the main board. In this example, the flexible leg is a bent portion of the antenna holder. This flexible leg 15 is arranged to be in contact with the main board 10 when the top cover is assembled to the bottom cover. Since no solder is used, the bended portion should feature a degree of flexibility to guarantee a reliable contact. The contact is achieved when the main board is totally enclosed in the casing, with the top and bottom covers assembled together for example by screwing the top cover onto the bottom cover. This enclosing should exert the required pressure of the bended portions on the main board while considering the assembling tolerances.

[0035] Although some embodiments of the present invention have been illustrated in the accompanying Drawings and described in the foregoing Detailed Description, it should be understood that the present invention is not limited to the disclosed embodiments, but is capable of numerous rearrangements, modifications and substitutions without departing from the invention as set forth and defined by the following claims.

[0036] For example, the antennas mounted on the antenna holders have been described as being designed using a flexible printed circuit technology. The antennas can also be signed by using Molded Interconnect Device (MID) technology wherein the antennas are directly metallized on a plastic antenna holder. The antennas may also be made of conductive strips directly mounted on the panels of the antenna holder.

[0037] Likewise, the interconnect between the antenna holders and the main board can be realized by using intermediary components, such as metal springs or clips soldered on the main board.

Claims

1. Device (1) comprising:

- at least a main board (10) whereon electronic components are mounted,
- an antenna assembly comprising at least one antenna to be connected to said main board, and
- a casing for containing said main board and said antenna assembly, said casing comprising a top cover (11) and a bottom cover,

characterized in that it further comprises at least one antenna holder (12) for holding said at least one antenna, said at least one antenna holder comprising at least one panel whereon at least one antenna is mounted, and **in that** said at least one antenna hold-

er is assembled to said top cover (11) and is arranged to position the panel substantially perpendicularly to the main board (10) and to electrically connect said one antenna to the main board (10) when the top cover (11) of the casing is assembled to the bottom cover.

2. Device according to Claim 1, wherein the antenna comprises conductive traces on a substrate, said substrate being mounted on a face of the panel. 5
3. Device according to Claim 2, wherein said substrate is flexible. 10
4. Device according to Claim 1, wherein the antenna comprises conductive strips, said conductive strips being directly mounted on a face of the panel. 15
5. Device according to any one of Claims 1 to 4, wherein the antenna holder is made from plastic material. 20
6. Device according to any one of Claims 1 to 5, wherein the antenna comprises at least one connection pad, called antenna pad (13a, 13b), placed on an edge of the panel of the antenna holder and the main board comprises at least one connection pad, called board pad, said antenna pad (13a, 13b) and said board pad being arranged to be into electrical contact when the top cover of the casing is assembled to the bottom cover. 25
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7. Device according to Claim 6, wherein the panel of the antenna holder comprises at least one flexible leg (14) comprising said antenna pad, said flexible leg (14) being applied against the board pad when the top cover of the casing is assembled to the bottom cover. 35
8. Device according to Claim 7, wherein the flexible leg (14) is a bent portion of the panel of the antenna holder. 40
9. Method for assembling a device comprising at least a main board whereon electronic components are mounted, at least one antenna to be connected to said main board, at least one antenna holder and a casing for containing said main board, said antenna holder and said antenna assembly, said casing comprising a top cover and a bottom cover, said antenna comprising at least one connection pad, called antenna pad and said main board comprises at least one connection pad, called board pad, the method comprising: 45
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 - assembling at least one antenna holder to said top cover, said at least one antenna holder comprising at least one panel whereon one antenna is mounted; and 55

- assembling the top cover of the casing to the bottom cover,

wherein the at least one antenna holder is assembled to the top cover so that the panel of said antenna holder is substantially perpendicular to the main board when the top cover is assembled to the bottom cover and wherein the antenna pad is electrically connected to the board pad when the top cover is assembled to the bottom cover.

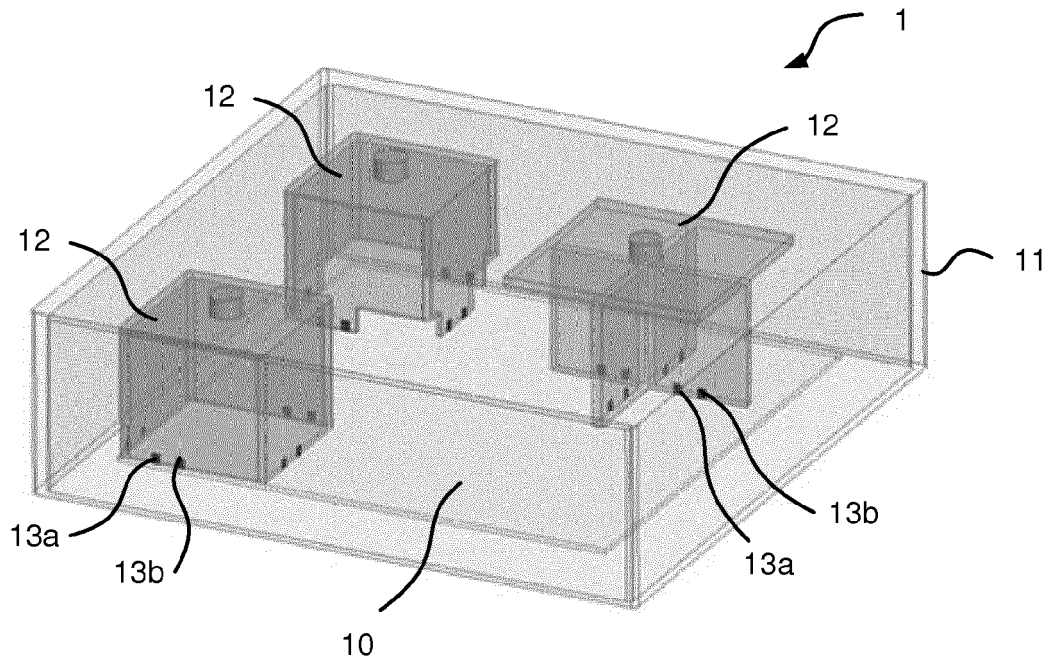


FIG.1

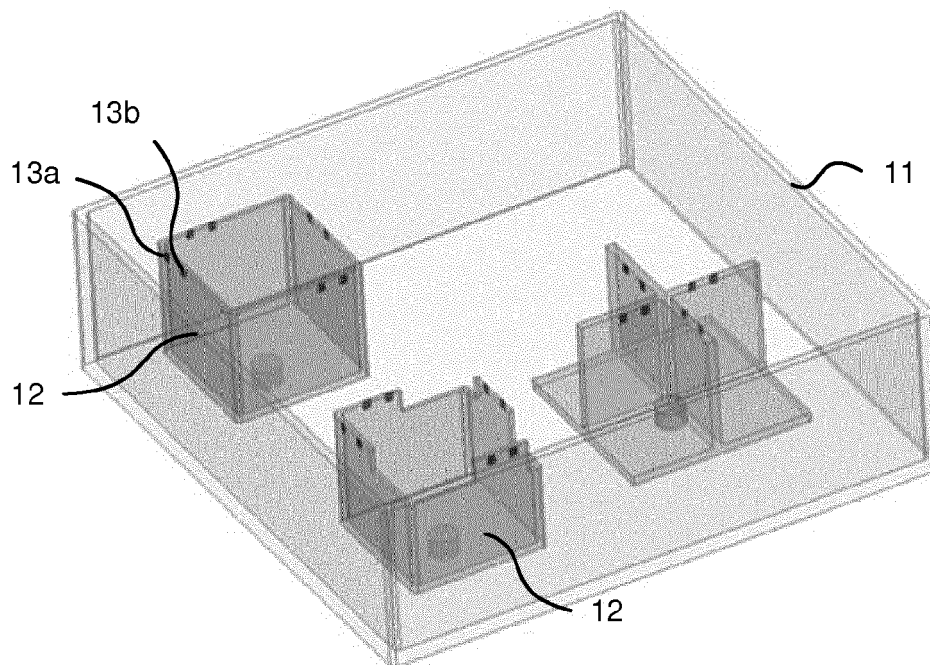


FIG.2

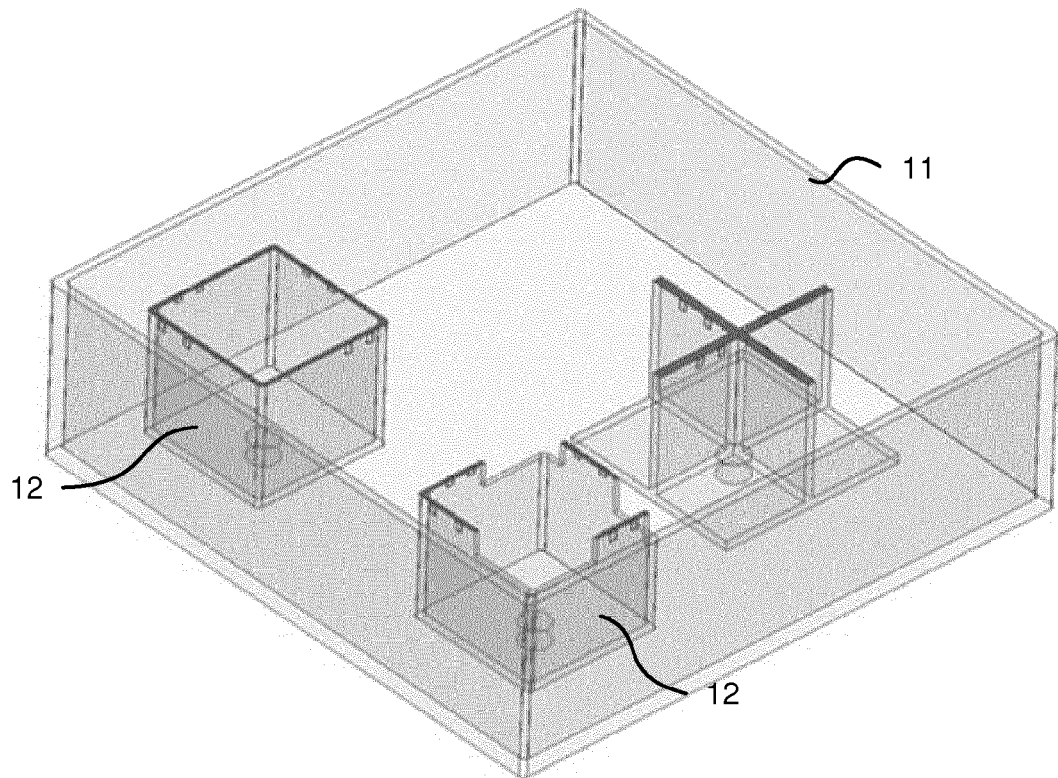


FIG. 3

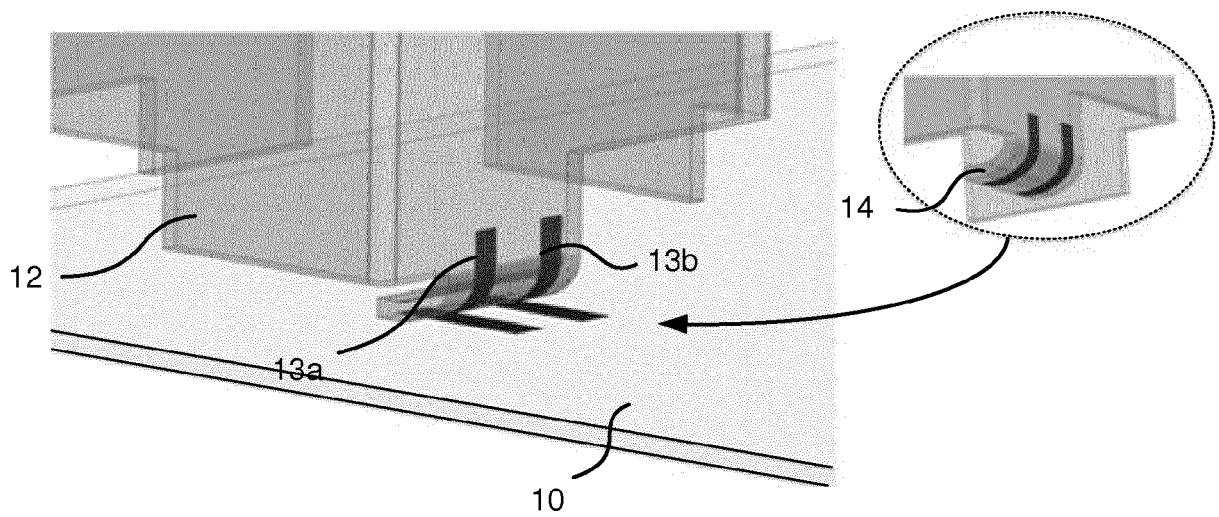


FIG. 4



EUROPEAN SEARCH REPORT

 Application Number
 EP 16 30 5694

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Y	* column 11, line 40 - column 13, line 24; figures 17, 18 *	6-9	
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A	* column 5, paragraph 21 - column 7, paragraph 29; figure 4 *	2,3,7,8	
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A	* column 3, line 60 - column 6, line 19; figures 2-4, 6 *	1-5	
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			H01Q H01R H01K H05K
Place of search		Date of completion of the search	Examiner
The Hague		8 December 2016	Blech, Marcel
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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**ANNEX TO THE EUROPEAN SEARCH REPORT
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5 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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