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Remarks:

Amended claims in accordance with Rule 137(2) EPC.

(54) **DEVICE FOR THE CONNECTION BETWEEN A STRIP LINE AND A COAXIAL CABLE**

(57) Device for the connection between a strip line and a coaxial cable. Antenna comprising the device for the connection between a strip line and a coaxial cable. The strip line is realized on a first part of a printed circuit board (102), and the coaxial cable includes an inner conductor and an outer conductor. The device comprises a cover top and a cover bottom respectively located over

and under the printed circuit board. Within this device a second part of the printed circuit board is inductively coupled with the cover top and the cover bottom and the inner conductor is electrically connected to the strip line and the outer conductor is inductively or electrically connected to the second part of the printed circuit board.

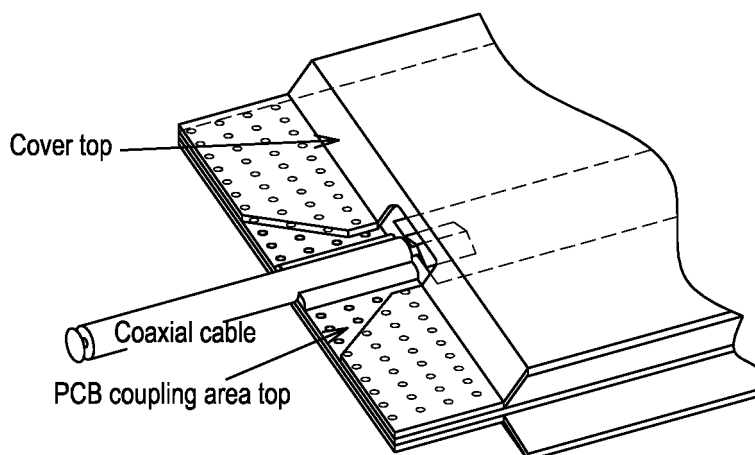


Fig. 2c

Description

FIELD OF INVENTION

[0001] The present subject matter relates to a device for the connection between a strip line and a coaxial cable. The strip line is realized on a printed circuit board. This device allows the transition between a coaxial cable and a suspended stripline and is also known as junction.

BACKGROUND

[0002] Base station antennas are built with arrays of several radiating elements, connected to distribution networks (power dividers, phase shifters) with transmission lines.

[0003] The market trends to require more and more complex antennas for example dual polarization antenna, multiband band antenna, MIMO arrays. In these very complex antennas the radiating elements are almost always connected to the distribution network using coaxial cables because it is impossible to interleave several network lines with technologies like strip lines, or PCB micro strip lines with acceptable performances.

[0004] However the most efficient distribution network technology is strip line, which is a fully shielded transmission line and preferably air strip line, as air is the minimum loss and cheapest dielectric available.

[0005] The problem, solved by the preset subject matter, is to design an efficient junction between the strip line distribution network sub-assemblies and the coaxial cables driving the signals to the radiating elements of the antenna array.

[0006] The device proposed in this divulgation will have the following advantages:

- to ensure low Passive Inter Modulation performances (PIM) for the junction
- to propose a very low cost junction, because in such complex antennas there is a lot of these connections (for example, in a penta band antenna there is hundreds of these connections) .

SUMMARY

[0007] Various embodiments propose device for the connection between a strip line and a coaxial cable that can solve the previously described problems.

[0008] In one implementation, a device for the connection between a strip line and a coaxial cable is described. The strip line is realized on a first part of a printed circuit board, and the coaxial cable includes an inner conductor and an outer conductor. The device comprises a cover top and a cover bottom respectively located over and under the printed circuit board. Within this device a second part of the printed circuit board is inductively coupled with the cover top and the cover bottom and the inner conductor is electrically connected to the strip line and

the outer conductor is inductively or electrically connected to the second part of the printed circuit board.

[0009] In one implementation, an antenna comprising a device for the connection between a strip line and a coaxial cable is described.

BRIEF DESCRIPTION OF THE FIGURES

[0010] The detailed description is given with reference to the accompanying figures. In the figures, the left-most digit(s) of a reference number identifies the figure in which the reference number first appears. The same numbers are used throughout the figures to reference like features and components. Some embodiments of system and/or methods in accordance with embodiments of the present subject matter are now described, by way of example only, and with reference to the accompanying figures, in which:

Figure 1 presents a device for the connection between a strip line and a coaxial cable

Figures 2-a to 2-d present in another way the device for the connection between a strip line and a coaxial cable

[0011] In the present document, the word "exemplary" is used herein to mean "serving as an example, instance, or illustration." Any embodiment or implementation of the present subject matter described herein as "exemplary" is not necessarily to be construed as preferred or advantageous over other embodiments.

DESCRIPTION OF EMBODIMENTS

[0012] In an embodiment the junction of coaxial cables to strip lines is realized by using metal plates on which the cable braid can be soldered directly for example be brass, copper. Provided that a good soldering process is used then the PIM performances are good, but the main problem regarding this solution is material cost. Huge brass or copper plates are necessary, and these materials are expensive (three times aluminum cost, and the trend is regular increase of these copper alloys cost).

[0013] In another embodiment the junction of coaxial cables to strip lines is realized by using metal plates on which the cable cannot be soldered, for example aluminum. In this case, the two ways of doing the junction are:

- The cable braid has a direct contact with the 2 ground plates of the strip line via a metal grounding interface soldered on the coaxial cable, and this interface is tightened between the 2 ground plates of the strip line with screws or studs.
- The cable braid is soldered on a grounding interface, and this grounding interface is virtually in contact with the two ground plates of the strip line by capacitive coupling.

[0014] The main problem with these 2 solutions is the cost, because the quality of the parts and of the assembly must be very high to avoid PIM generation. Indeed from these conventional methods of connection, either expensive material strip line ground plates associated with critical soldering process, either interfaces with several parts with significant assembly time are used.

[0015] Moreover, for both solutions, the assembly process is not optimal: either soldering operation on brass plates is rather long, either assembling several interface parts together takes also some time. The consequence is that the production line capacity is lowered.

[0016] Figure 1 presents an embodiment of a device for the connection between a strip line 101, realized on a first part of a printed circuit board 102, and a coaxial cable 103. The coaxial cable 103 includes an inner conductor 104 and an outer conductor 105. The device comprises a cover top 106 and a cover bottom 107 respectively located over and under the printed circuit board. Within this device a second part of the printed circuit board 102 is inductively coupled with the cover top 106 and the cover bottom 107. The inner conductor 104 is electrically connected to the strip line 101 and the outer conductor 105 is inductively or electrically connected to the second part of the printed circuit board. Regarding the connection of the outer conductor 105 to the second part of the printed circuit board the best results are achieved by using an inductive connection.

[0017] The device of this embodiment allows cheap material for the strip line ground plates with no solder on these plates. This embodiment also avoids adding extra parts to reduce cost and PIM performances. This embodiment reduces assembly time to improve production line capacity.

[0018] In an embodiment of the device the second part of the printed circuit board is covered by a metal layer on both side of the printed circuit board and

- the two metal layer are connected via a plurality of via and
- the two metal layer are covered by an insulating layer and
- the cover top comprises a flat part in contact with the insulating layer in one side of the printed circuit board and
- the cover bottom comprises a flat part in contact with the insulating layer in the other side of the printed circuit board.

[0019] In an embodiment of the device at least one of the insulating layers is constituted of an insulating varnish.

[0020] In an embodiment the second part is located around the strip line.

[0021] The figures 2-a to 2-d present in another way the embodiments previously described. As presented by these figures a coaxial cable is connected to a strip line as. The whole assembly comprises the coaxial cable, the strip line conductor, the top and bottom covers. The strip

line conductor is printed on a thin PCB board. The top and bottom covers are made with bended plates of low cost material, for example aluminum. The top cover is capacitively coupled through the PCB top varnish layer to the PCB metal coupling area (top side). This PCB metal coupling area is connected to the PCB bottom coupling area by PCB metalized via. This PCB bottom coupling area is also capacitively coupled through a PCB varnish layer to the bottom cover. The link to the coaxial cable is made by soldering the braid on the PCB top metal coupling area. The inner conductor of the cable is soldered on the strip line conductor. A window is shaped in the top cover in front of the cable to avoid random contact.

[0022] In an embodiment the top and bottom covers and the printed circuit board are maintained together by very low cost plastic rivets (not represented on the figures). As the plates use capacitive coupling, the contact pressure required is much less critical than direct contact for good PIM performances.

[0023] Another embodiment of the present subject matter is an antenna comprising one of the connection devices previously described.

[0024] In an embodiment of the antenna at least one connection device is used to connect radiating elements and/or feeding networks and/or splitters and/or phase shifters and/or filters and/or active boards and/or any other RF devices implemented within the antenna.

[0025] The connection device of the present subject matter can also be used for any kind of device requiring a coaxial cable to stripline connection, for example filters, amplifiers, etc..

Claims

1. Device for the connection between:

- a strip line (101), realized on a first part of a printed circuit board (102), and
- a coaxial cable (103), including an inner conductor (104) and an outer conductor (105), the device comprising :
- a cover top (106) and a cover bottom (107) respectively located over and under the printed circuit board;

wherein:

- a second part of the printed circuit board being inductively coupled with the cover top (106) and the cover bottom (107) and
- the inner conductor (104) being electrically connected to the strip line (101) and
- the outer conductor (105) being inductively or electrically connected to the second part of the printed circuit board.

2. Device according to the claim 1 wherein:

- the second part of the printed circuit board is cover by a metal layer on both side of the printed circuit board (102) and
 - the two metal layer are connected via a plurality of via and
 - the two metal layer are covered by a insulating layer and
 - the cover top comprises a flat part in contact with the insulating layer in one side of the printed circuit board and
 - the cover bottom comprises a flat part in contact with the insulating layer in the other side of the printed circuit board.
3. Device according to the claim 2 wherein:
- at least one of the insulating layers is constituted of a insulating varnish.
4. Device according to any of the previous claims wherein:
- the second part is located around the strip line (101).
5. An antenna comprising the device of any of the preceding claims.
6. Antenna according to the claim 5 wherein the device is used to connect radiating elements and/or feeding networks and/or splitters and/or phase shifters and/or filters and/or active boards and/or any other RF devices implemented within the antenna.
- Amended claims in accordance with Rule 137(2) EPC.**
1. Device for the connection between:
- a center conductor (101) of a tri-plate transmission line structure, realized on a first part of a printed circuit board (102), and
 - a coaxial cable (103), including an inner conductor (104) and an outer conductor (105),
- the device comprising:
- a cover top (106) and a cover bottom (107) made of a conductive metal material and respectively located over and under the printed circuit board;
- wherein:
- a second part of the printed circuit board being capacitively coupled with the cover top (106) and the cover bottom (107) and
- the inner conductor (104) being electrically connected to the center conductor (101) and
 - the outer conductor (105) being inductively or electrically connected to the second part of the printed circuit board.
2. Device according to the claim 1 wherein:
- the second part of the printed circuit board is cover by a metal layer on both side of the printed circuit board (102) and
 - the two metal layer are connected via a plurality of via and
 - the two metal layer are covered by a insulating layer and
 - the cover top comprises a flat part in contact with the insulating layer in one side of the printed circuit board and
 - the cover bottom comprises a flat part in contact with the insulating layer in the other side of the printed circuit board.
3. Device according to the claim 2 wherein:
- at least one of the insulating layers is constituted of a insulating varnish.
4. Device according to any of the previous claims wherein:
- the second part is located around (101).
5. An antenna comprising the device of any of the preceding claims.
6. Antenna according to the claim 5 wherein the device is used to connect radiating elements and/or feeding networks and/or splitters and/or phase shifters and/or filters and/or active boards and/or any other RF devices implemented within the antenna.

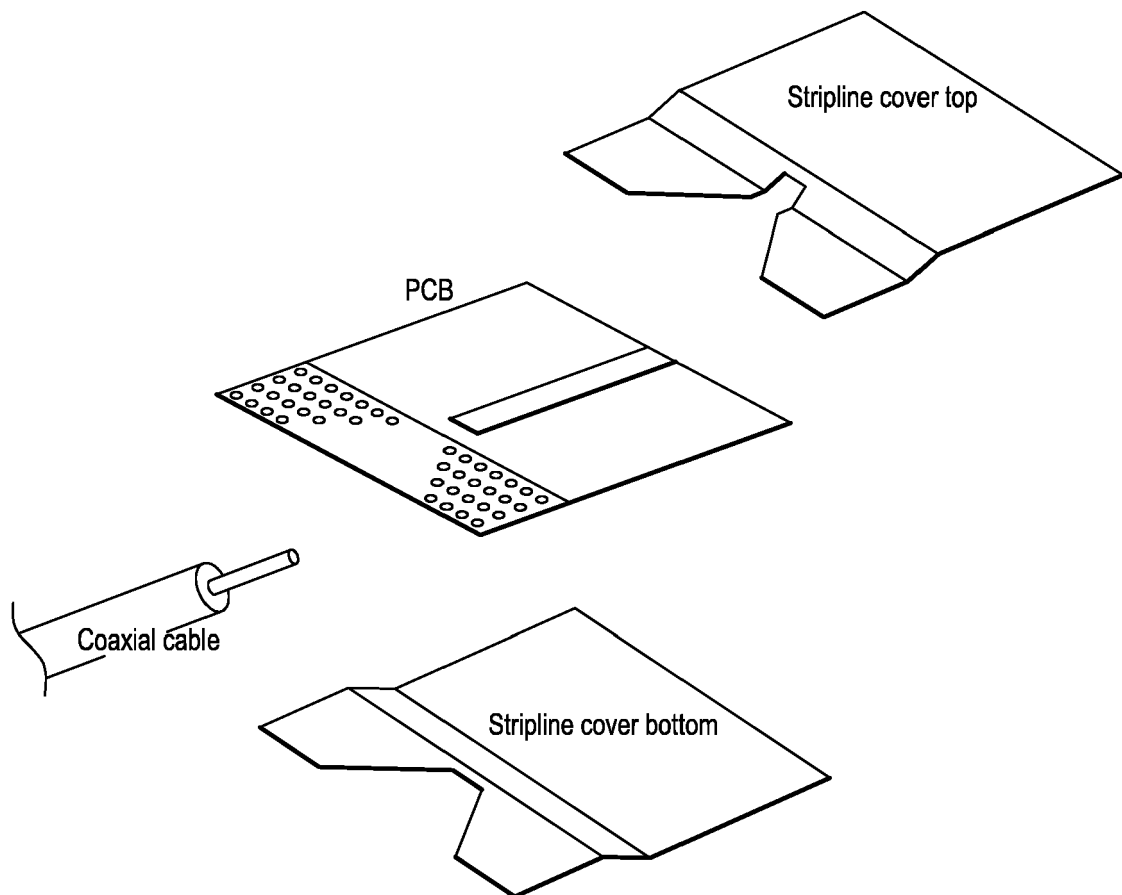
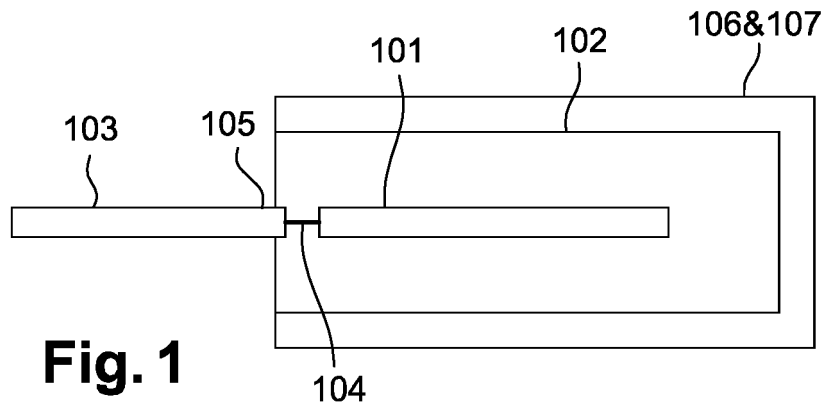


Fig. 2a

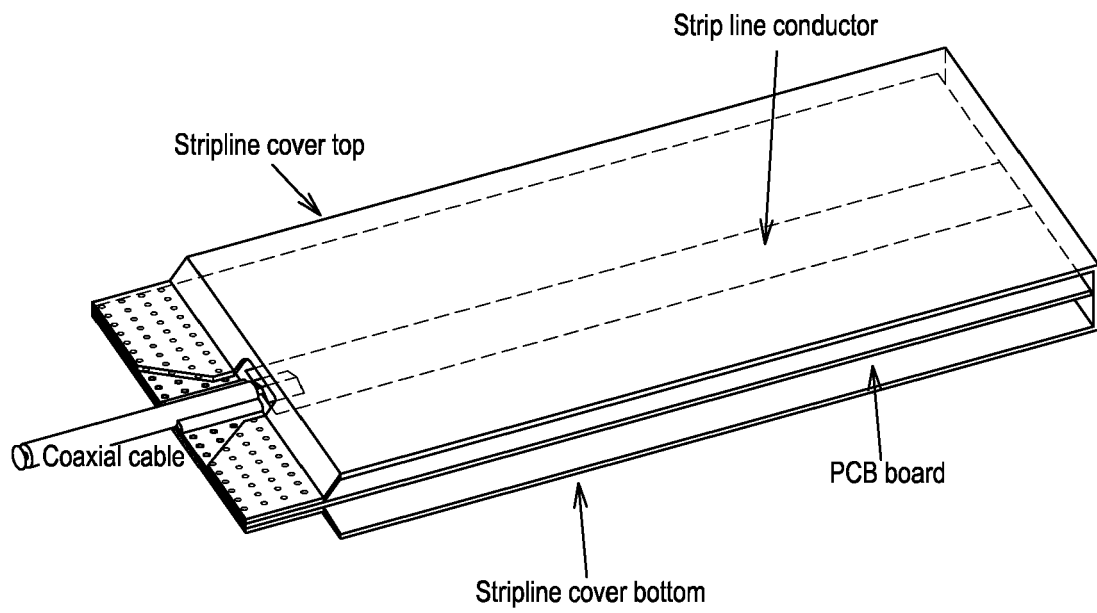


Fig. 2b

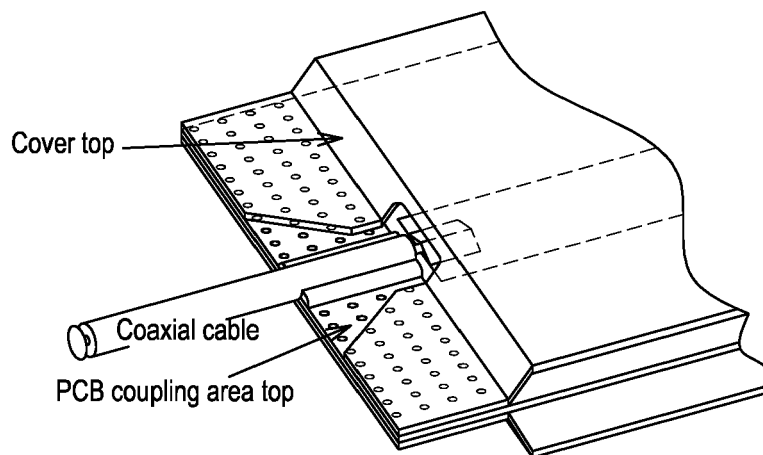


Fig. 2c

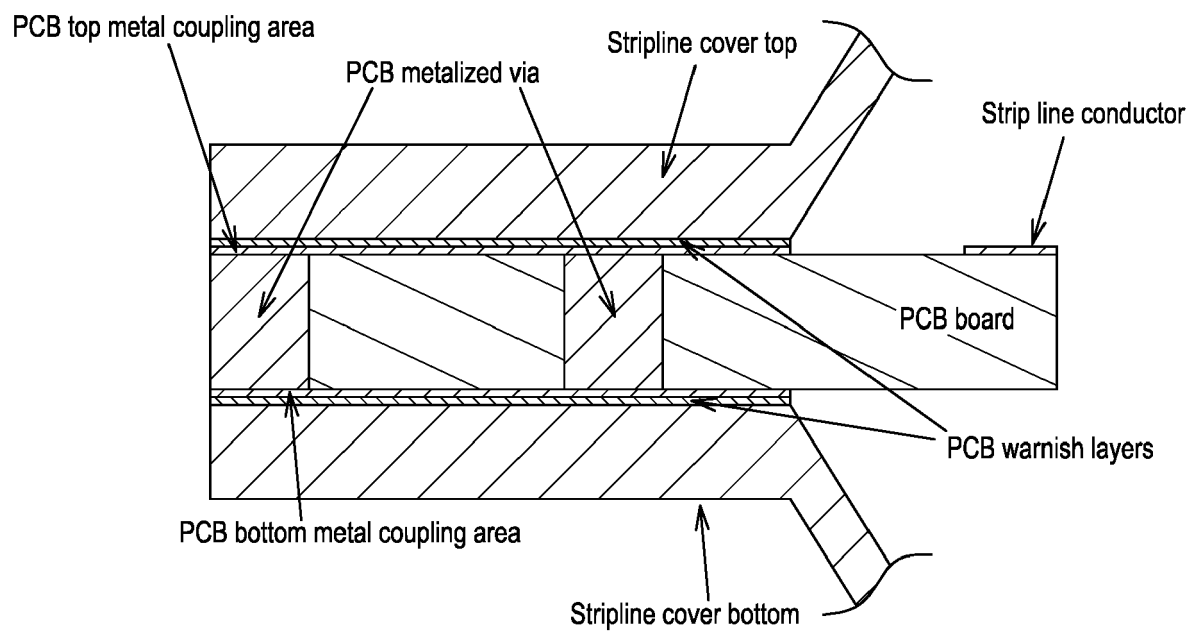


Fig. 2d



EUROPEAN SEARCH REPORT

Application Number
EP 16 30 5603

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X A	US 2003/218515 A1 (TAMAKI NAOYA [JP] ET AL) 27 November 2003 (2003-11-27) * page 1, paragraph 5 - page 1, paragraph 6; figures 16A, B * * page 2, paragraph 37 - page 3, paragraph 48; figures 1A, B * * page 4, paragraph 58 - page 4, paragraph 60; figures 4A-D * * page 4, paragraph 68 - page 5, paragraph 77; figures 7A-C *	1,4-6 2,3	INV. H01P5/08
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A	US 3 587 004 A (PARAD LEONARD I) 22 June 1971 (1971-06-22) * column 4, line 5 - column 6, line 21; figures 1-5 *	5,6	TECHNICAL FIELDS SEARCHED (IPC) H01P H01Q H01R
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 11 November 2016	Examiner Blech, Marcel
<p>CATEGORY OF CITED DOCUMENTS</p> <p>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</p> <p>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</p>			

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 16 30 5603

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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