

(19)



Europäisches
Patentamt
European
Patent Office
Office européen
des brevets



(11)

EP 2 869 395 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
06.05.2015 Bulletin 2015/19

(51) Int Cl.:
H01P 3/08 (2006.01)

(21) Application number: **13290270.1**

(22) Date of filing: **05.11.2013**

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**
Designated Extension States:
BA ME

(72) Inventor: **Pivit, Florian**
Dublin 15 (IE)

(74) Representative: **Lupton, Frederick**
51 Bullens Green Lane
Colney Heath
St. Albans, Herts. AL4 0QR (GB)

(71) Applicant: **ALCATEL LUCENT**
92100 Boulogne-Billancourt (FR)

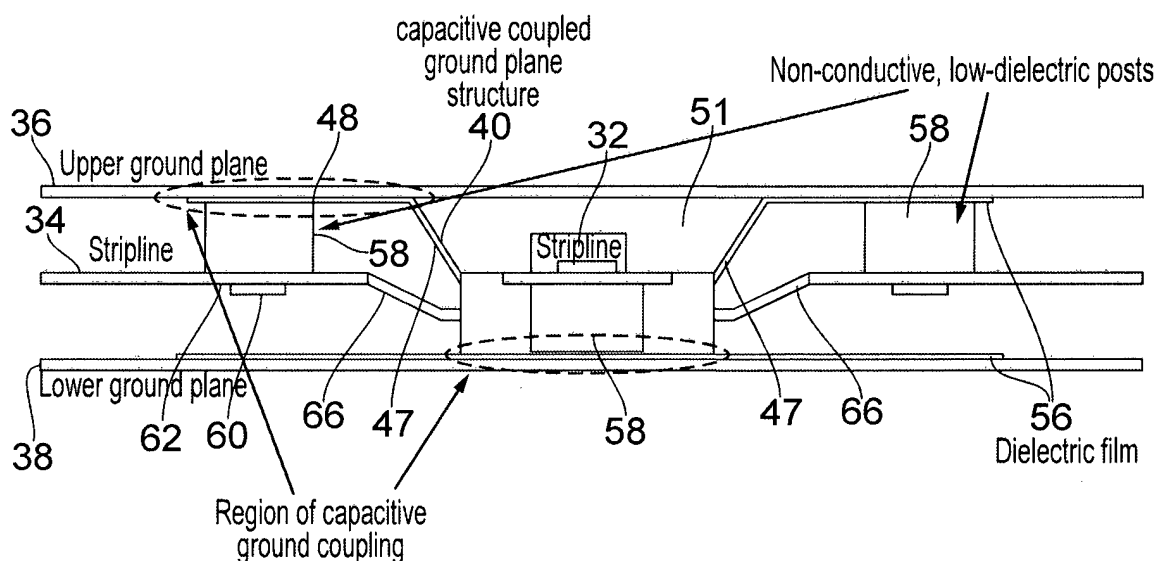
Remarks:

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

(54) Stripline crossover

(57) A suspended stripline crossover structure comprising first and second suspended striplines (32, 34) extending in different directions and disposed between first and second ground planes (36, 38), and a cross over region (30) in which the first and second suspended striplines cross over, but are spaced apart, the cross over region including a ground plane structure (40), which defines a third ground plane (42) disposed between the first and second suspended striplines, and which is electri-

cally coupled to the first and second ground planes by capacitive couplings, in the form of leg extension portions (43-46) of the ground plane structure having flat portions (48, 50) engaging dielectric films (56) located on the first and second ground planes, such that at a frequency of operation, the capacitive couplings provide low impedance connections between the third ground plane and the first and second ground planes.

**FIG. 4****EP 2 869 395 A1**

Description

Field of the Invention

[0001] The present invention relates to stripline cross-overs for use in RF feeds for telecommunications equipment, particularly though not exclusively suspended stripline crossovers for mobile telecommunications equipment.

Background Art

[0002] "Stripline" is commonly understood to mean a conductor sandwiched by dielectric between a pair of ground planes. Suspended stripline, for the purposes of this specification, is intended to mean a conductive strip suspended in air (or other gaseous medium) between first and second ground planes, which are commonly parallel to the plane of the strip.

[0003] Feeder networks in base station antennas are commonly built in suspended stripline technology (SST) in order to avoid losses in dielectric substrate materials occurring, were these feeder networks to be built in microstrip or dielectric substrate striplines. Traditional feeder networks for mobile communication antennas are built as tree- or star-distribution networks (or a combination thereof), which usually do not require crossovers of lines. A crossover between two striplines occurs when two lines cross each other's path, but separated by insulative dielectric. The feeder networks which are required for smart active antenna systems on the other hand require such crossovers. The four main performance requirements for such crossovers are good crosstalk-suppression, low insertion loss, low mechanical complexity to ease assembly and to reduce cost, and to reduce low passive intermodulation (PIM). PIM occurs on arise of RF currents flowing through mechanical structures, and encountering objects, such as screw couplings, solder connections or other contacts of similar or varying conductivity or semiconductive materials, where non-linear effects may occur.

[0004] Two known prior art structures of crossovers in SST are shown in Figure 1 and 2. Figure 1 is a schematic perspective view of a simple crossover, where first and second suspended striplines 2, 4 intersect in a cross over region 6. Region 6 includes first and second, upper and lower ground planes 8, 10. Lines 2, 4 are shown on different levels between the planes 8, 10 in the cross over region, but outside that region they may be bent to extend in the same plane, centrally between the two ground planes. This structure will show some significant cross-coupling, in region 6, of -20dB to -10dBm or more, depending on the precise spacing of the striplines and ground planes with respect to each other. With an optimised mechanical structure, the expected coupling is in the order of -15dB to -20dB, which is too low for the application of an RF antenna feeder network. This holds especially true if the signals on the two lines are not from

the same source.

[0005] Figure 2 is a cross-sectional view of a second prior art construction, where similar parts to those of Figure 1 are denoted by the same reference numeral. Striplines 2, 4, in a common plane outside the cross over region 6, are bent as at 20, 22 so as to be spaced apart in the cross over region. A third ground plane, formed as a conductive plate 24, is interposed between the striplines. Plate 24 is mechanically supported by posts 26 secured to the upper and lower ground planes 8, 10. Posts 26 are electrically conductive to provide DC conductive connections between the ground planes. This arrangement provides substantial improvement in cross-coupling of up to 90dB or higher, by ensuring good continuity and separation of ground-currents.

[0006] An example of a crossover structure unit for microstrips or non-suspended striplines is disclosed in US Patent No.5,600,285, where the crossover stripline region is removed, and is replaced with the unit. The crossover unit comprises a ground plane between two strips, formed by two metallic pyramidal structures joined end to end, which enclose the strips and which are connected to upper and lower ground planes. Crossover structures of this type and as shown in Figure 2 require techniques like soldering, plating, screws, bolts or rivets to implement the electrical contact, which require complex manual assembly, increased time and skills in order to guarantee minimum PIM-generation in these connections. Even if best practices are applied in the assembly process, still there is a risk of increased PIM-generation due to ageing, thermal stress, corrosion etc. Screw connections also often make it hard to implement suspended stripline structures with multiple layers (more than two ground planes, e.g. stacking two stripline-layers on top of each other).

[0007] A third prior art mechanism is to implement the crossover as a multilayer-stripline structure on a dielectric substrate, which is then connected to the suspended striplines. However this mechanism makes use of printed stripline structures, requiring dielectric substrates, which are expensive and cause increased dielectric losses.

Summary of the Invention

[0008] Embodiments of the invention provide suspended strip line crossover structures, which avoid any soldered or screw connections in the structure, and avoid the requirement for DC conductive connections to ground planes. A third ground plane is provided between the suspended strip lines in the crossover region. This third ground plane is provided by a ground plane structure, which is positioned between first and second, upper and lower ground planes. The third ground plane has a central region disposed between the strip lines and providing the third ground plane, and from which extend extension portions which are configured to extend toward the upper and lower ground planes, with free ends adjacent the upper and lower ground planes to define capacitive cou-

plings therewith. A dielectric film is disposed between the free ends and the first and second ground planes. Continuity of ground plane currents is enabled by means of the capacitive couplings between the ground planes without requiring conductive DC connections. In addition, non-conductive dielectric posts may be provided, positioned between the extension portions and the striplines, to provide a means of positioning the ground plane structure. Suitable means such as bonding or clamping, serve to fix the ground plane structure and associated parts in position and to form an integral crossover structure. This leads to a crossover structure which requires a minimum number of pre-assembled components to build a crossover with increased isolation, minimized insertion loss and minimized PIM-generation.

[0009] In general terms, embodiments provide a stripline structure comprising first and second striplines extending in different directions and disposed between first and second ground planes, and a cross over region in which said first and second striplines cross over, but are spaced apart, said cross over region including a ground plane structure, which defines a third ground plane disposed between said first and second striplines, and capacitive couplings electrically coupling said third ground plane to said first and second ground planes, such that at a frequency of operation, said capacitive couplings provide low impedance connections between the third ground plane and the first and second ground planes.

[0010] Various arrangements may be envisaged of the ground plane structure and capacitive coupling. For example, the ground plane structure might be a simple planar sheet, joined to the first and second ground plane by dielectric posts, which provide the capacitive coupling. However the material of the dielectric posts would require an extremely high dielectric constant to provide a high capacitance at frequency of operation. Commonly available dielectric materials such as Teflon or nylon have dielectric constants of the order of 5 or less, relative to air, which has a value of 1. The ground plane structure may therefore be formed so as to have extension portions, integral with and extending from a central planar portion (which provides the major part of the third ground plane), out of the plane of the planar portion towards the first and second ground planes, where they terminate in flat or foot portions of a relatively large area, disposed generally parallel to the first and second planes, and which define a capacitive coupling with the ground planes. It is possible to envisage arrangements with an air gap between the flat portions and the ground planes, which might function if the air gap were extremely narrow, but a more reliable arrangement is to insert a dielectric element between the flat portions and the ground planes, in the form of a sheet or a film. This provides a reliable spacing of the flat portions from the ground planes, and further, since the flat portions engage the dielectric element, provides a means of positioning the ground plane structure within the crossover region.

[0011] For a secure positioning of the ground plane

structure, the extension portions are provided as pairs of opposing portions, one pair extending upwardly to the first ground plane, and forming a first hollow region through which the first stripline extends, and another pair extending downwardly to the second ground plane, and forming a second hollow region through which the second stripline extends. In this way, the extension portions electrically confine the striplines in the crossover region, and contribute to the third ground plane area. Dielectric posts may be provided as an additional positioning and securing means, between the striplines and the flat portions.

[0012] In other embodiments, forms of stripline other than suspended stripline might be used, for example by printing the stripline on a foil substrate or on a PCB. This may avoid the use of dielectric posts for positioning the striplines, since the substrate may be formed of a suitable dielectric material, and be used for positioning the striplines against the upper and lower ground planes. An advantage arises in the increased accuracy of dimensioning of parts within the crossover region by using striplines printed on dielectric material, and such an arrangement may be employed in for example a power divider, where high accuracy is required. If used within a suspended stripline feeder network, appropriate transitional regions would be provided between the suspended stripline and substrate mounted stripline.

Brief Description of the Drawings

[0013] A preferred embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings, wherein:

Figure 1 is a schematic perspective view of a known arrangement of two suspended striplines crossing at right angles in a crossover region without measures to prevent coupling between the two lines;

Figure 2 is a schematic side view of a known arrangement of a crossover region with ground plane separation of the crossing suspended striplines, where a separating third ground plane is electrically DC connected to upper and lower ground planes;

Figure 3 is a 3D perspective drawing of an embodiment of the invention, showing component parts in a cross over region, including a third ground plane positioned between suspended striplines;

Figure 4 is a side-view of the embodiment of Figure 3, showing component parts thereof;

Figure 5 is a 3D perspective exploded view of the components of this embodiment;

Figure 6 is an exploded side view of the components of this embodiment; and

Figure 7 comprises perspective and top views of the ground plane structure and fixing posts of this embodiment.

Description of an Embodiment

[0014] For the purposes of the present specification, "upper" and "lower", "up", down", "concave" and "convex" are relative terms only, within the bounds of the crossover region, and do not refer to an absolute orientation relative to earth.

[0015] Referring to the embodiment shown in Figures 3 to 7 of the drawings, a crossover region 30 for first suspended stripline 32 and second suspended stripline 34, whose paths cross at right angles, includes upper and lower, first and second, ground planes 36, 38, and a ground plane structure 40 which provides a third ground plane between the striplines.

[0016] Ground plane structure 40 is shown specifically in Figure 7 and comprises a piece of metal formed as a single integral piece, stamped from metal sheet, and including a rectangular central portion 42 with legs 43 - 46 extending from the sides thereof. Opposing legs 43, 45 are bent or canted upwardly to form oblique portions 47, and flat end portions 48. Opposing legs 44, 46 are bent or canted downwardly to form oblique portions 49 and flat end portions 50. Oblique portions 47 define a first hollow region 51 for placement of stripline 32, and oblique portions 49 define a second hollow region 52 for placement of stripline 34. Flat end portions 48, 50 are apertured as at 54.

[0017] Dielectric films 56 are placed on the inner surfaces of upper and lower ground planes 36, 38. This film can be made from a relatively thin film (order of 0.1mm or less, depending on structural strength of the film) of non-conductive dielectric material, e.g. Capton or Teflon (Trade Marks). The film can be held in place by a single or double sided adhesive film, or the separation-film itself could be adhesive.

[0018] Non-conductive, low-dielectric (e.g. Teflon or Nylon, dielectric constant about 2 to 4) cylindrical posts 58 are positioned between flat end portions 48, 50 and strip lines 32, 34. One end of each post 58 has a raised cylindrical projection 60 for engaging in a registering aperture 62 in striplines 32, 34.

[0019] Striplines 32, 34, extending at right angles to one another, are disposed in the same plane outside crossover region 30, but inside the crossover region are bent out of the common plane. Stripline 32 is bent upwardly with oblique portions 64 to form a convex shape, and stripline 34 is bent downwardly with oblique portions 66 to form a concave shape, so that the striplines are spaced apart in the cross over region, are disposed in respective first and second hollow regions 51, 52, and generally follow the profile of the ground plane structure, as can be best seen in Figure 4. Within the crossover region, striplines 32, 34 are reduced in width from shoulders 68, at the base ends of oblique portions 64, 66. The purpose of this narrowing is to maintain the characteristic impedance of the striplines within the confinements of the crossover region to be the same as that of the strip lines in free space outside the cross over region. Thus,

the lines outside the structure have an assumed impedance of Z_0 ; the striplines within the crossover region are adjusted in width, such that the impedance Z_0 is maintained along the line and mismatch is minimized.

[0020] In the assembled condition, as shown in Figures 3 and 4, flat end portions 48, 50 of the ground plane structure engage dielectric films 56 on the upper and lower ground planes, and cylindrical posts 58 are positioned between the end portions 48, 50 and striplines 32, 34, with projections 60 engaging in apertures 62. Various means (not shown) may be employed to secure and fix together the crossover structure, comprising ground plane structure 40, first and second ground planes 36, 38, and dielectric posts 58 and films 56. The films 56 may be secured in place by bonding to either the upper or lower ground plane or to the third ground plane structure, but a double-sided bond for bonding the film both to the flats 48, 50 and to the upper or lower ground plane, can help with mechanical integrity. Dielectric posts 60 may be fixed by an easy-to-assemble method, e.g. by using snap-in clips, threads, glue, molding or any other suitable method. The posts 60 not only keep the isolation ground plane structure in place, but they also ensure a controlled position of the striplines between the three ground planes. Apertures 54 allow the mounting of a spacing element to adjust the distance between the stripline and the third ground plane.

[0021] The end portions 48, 50 of the structure 40 are dimensioned in such a way that the resulting capacitive structure is large enough to form a low enough impedance at the operating frequency to result in a near-short between the three ground planes. This low-resistivity connection now does not require and actually avoids a galvanic contact between the three ground planes, resulting in a structure which will not generate any PIM due to mechanically weak or corroded or otherwise impaired electrical connections:

E.G. a 20mmx20mm large capacitive coupling area, separated by a 0.1mm thick Teflon foil would result in a capacity of $C=A/d \cdot \epsilon_0 \cdot \epsilon_r = 78\text{pF}$ (A is coupling area, d is separation of ground planes) which results in a reactance of $Z_c = 1/(j \cdot 2 \cdot \pi \cdot f \cdot C)$ (f is frequency of operation) leading to reactances between $-j0.4\text{Ohm}$ and $-j40\text{Ohm}$ Ohm for frequencies between 0.5GHz and 5GHz resulting in an effectively RF-short connection between the upper and lower ground planes and the third isolation ground plane. Thus, this embodiment is useful at frequencies within the range 0.5 to 5 GHz, which encompasses most frequencies for mobile telecommunications.

[0022] The third ground plane introduced by means of crossover structure 40, which is bent as described above to form end portions 48, 50, which are electrically coupled by virtue of a capacitive coupling to the upper and lower ground planes 36, 38, ensures that the three ground planes form a path for the continuation of the ground

currents and at the same time shield the electric fields between the two striplines from each other, therefore increasing the isolation. The isolation achievable by such a coupled structure reaches in the order of 60dB, which is an improvement of over 40dB over a non-isolated line crossing. If the cross over structure were to be galvanically connected to the upper and lower ground plane, the achievable isolation levels might be greater, but with the concomitant drawback of the necessity for a very thorough electrical connection between the three ground planes to avoid PIM generation, leading to increased cost due to increased assembly complexity and sensitivity.

[0023] Advantages of the invention are as follows:

Cheap to manufacture (stamped sheet metal parts, low-cost dielectric post, and adhesive dielectric film).
Easy to assemble (no screws, solder joints).

[0024] The achievable coupling-capacities are especially suited in the 0.5GHz-5GHz frequency region, since the mechanical dimensions and manufacturing technologies are especially suited to implement this application.

[0025] Provides great level of improved isolation of two crossing suspended striplines without the necessity to create any conductive connection between the isolation layer and other conducting parts of the structure, therefore avoiding any possible PIM generation.

[0026] The description and drawings merely illustrate the principles of the invention. It will thus be appreciated that those skilled in the art will be able to devise various arrangements that, although not explicitly described or shown herein, embody the principles of the invention and are included within its spirit and scope. Furthermore, all examples recited herein are principally intended expressly to be only for pedagogical purposes to aid the reader in understanding the principles of the invention and the concepts contributed by the inventor(s) to furthering the art, and are to be construed as being without limitation to such specifically recited examples and conditions. Moreover, all statements herein reciting principles, aspects, and embodiments of the invention, as well as specific examples thereof, are intended to encompass equivalents thereof.

Claims

1. A stripline structure comprising first and second striplines extending in different directions and disposed between first and second ground planes, and a cross over region in which said first and second striplines cross over, but are spaced apart, said cross over region including a ground plane structure, which defines a third ground plane disposed between said first and second striplines, and capacitive couplings electrically coupling said third ground plane to said first and second ground planes, such that at a frequency of operation, said capacitive couplings provide

low impedance connections between the third ground plane and the first and second ground planes.

2. A structure according to claim 1, wherein said ground plane structure comprises a single piece of metal sheet.
3. A structure according to claim 1 or 2, wherein said ground plane structure comprises a central region providing said third ground plane, from which extend extension portions, integral with said central region, which are configured to extend toward the first and second ground planes with the free ends thereof terminating close to said first and second ground planes, such as to provide said capacitive couplings.
4. A structure according to claim 3, wherein said extension portions comprise, extending from said central portion, a first pair of opposing extension portions, and a second pair of opposing extension portions, said first pair extending upwardly for engaging with said first ground plane and defining a first hollow region for receiving said first stripline, and said second pair extending downwardly for coupling with said second ground plane and defining a second hollow region for receiving said second stripline.
5. A structure according to claim 3 or 4, wherein the free ends of said extension portions have flat portions of predetermined area for defining the extent of said capacitive couplings with said first and second ground planes.
6. A structure according to claim 5, wherein said flat portions physically engage with dielectric elements disposed between said flat portions and said first and second ground planes.
7. A structure according to any of claims 3 to 6, wherein said extension portions are formed as legs, each leg having parallel longitudinal edges.
8. A structure according to any preceding claim, wherein said capacitive couplings include dielectric elements disposed between said ground plane structure and said first and second ground planes.
9. A structure according to claim 8, wherein said dielectric elements comprise first and second dielectric films are attached to inner surfaces of respective said first and second ground planes, and said ground plane structure is arranged to physically engage the dielectric films.
10. A structure according to any preceding claim, including a plurality of dielectric posts, which are connected between portions of said ground plane structure and

said striplines for positioning the ground plane structure and said striplines.

11. A structure according to claim 10, wherein one end of each post has an upstanding projection for engaging in a registering aperture in one of said first and second strip lines. 5
12. A structure according to the combination of claims 10 or 11, as dependent on claim 6, wherein said conductive posts are positioned on said flat portions. 10
13. A structure according to claim 4, wherein said first stripline is bent upwardly to define a convex part for positioning in said first hollow region, and said second stripline is bent downwardly to define a concave part, for positioning in said second hollow region. 15
14. A structure according to any preceding claim, wherein said first and second striplines are each reduced in width in the region of said crossover structure to maintain their characteristic impedance equal to that outside the crossover region. 20
15. A structure according to claim 1, wherein said first and second striplines are suspended striplines. 25

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

1. A stripline structure comprising first and second striplines (32, 34) extending in different directions and disposed between first and second ground planes (36, 38), and a cross over region (30) in which said first and second striplines cross over, but are spaced apart, said cross over region including a ground plane structure (40), which defines a third ground plane disposed between said first and second striplines, **characterized by** capacitive couplings (56, 58) electrically coupling said third ground plane to said first and second ground planes, such that at a frequency of operation, said capacitive couplings provide low impedance connections between the third ground plane and the first and second ground planes. 30 35 40 45 50
2. A structure according to claim 1, wherein said ground plane structure comprises a single piece of metal sheet. 50
3. A structure according to claim 1 or 2, wherein said ground plane structure comprises a central region (42) providing said third ground plane, from which extend extension portions (43-46), integral with said central region, which are configured to extend toward the first and second ground planes with the free ends thereof (48, 50) terminating close to said first and 55

second ground planes, such as to provide said capacitive couplings.

4. A structure according to claim 3, wherein said extension portions comprise, extending from said central portion, a first pair of opposing extension portions (43, 45), and a second pair of opposing extension portions (44, 46), said first pair extending upwardly for engaging with said first ground plane and defining a first hollow region (51) for receiving said first stripline, and said second pair extending downwardly for coupling with said second ground plane and defining a second hollow region (52) for receiving said second stripline.
5. A structure according to claim 3 or 4, wherein the free ends of said extension portions have flat portions (48, 50) of predetermined area for defining the extent of said capacitive couplings with said first and second ground planes.
6. A structure according to claim 5, wherein said flat portions physically engage with dielectric elements (56) disposed between said flat portions and said first and second ground planes.
7. A structure according to any of claims 3 to 6, wherein said extension portions are formed as legs, each leg having parallel longitudinal edges.
8. A structure according to any preceding claim, wherein said capacitive couplings include dielectric elements (56) disposed between said ground plane structure and said first and second ground planes.
9. A structure according to claim 8, wherein said dielectric elements comprise first and second dielectric films (56) attached to inner surfaces of respective said first and second ground planes, and said ground plane structure is arranged to physically engage the dielectric films.
10. A structure according to any preceding claim, including a plurality of dielectric posts (58), which are connected between portions of said ground plane structure and said striplines for positioning the ground plane structure and said striplines.
11. A structure according to claim 10, wherein one end of each post has an upstanding projection (60) for engaging in a registering aperture (62) in one of said first and second strip lines.
12. A structure according to the combination of claims 10 or 11, as dependent on claim 6, wherein said conductive posts are positioned on said flat portions.
13. A structure according to claim 4, wherein said first

stripline is bent upwardly (64) to define a convex part for positioning in said first hollow region, and said second stripline is bent downwardly (66) to define a concave part, for positioning in said second hollow region.

5

- 14.** A structure according to any preceding claim, wherein said first and second striplines are each reduced in width (68) in the region of said crossover structure to maintain their characteristic impedance equal to that outside the crossover region.

10

- 15.** A structure according to claim 1, wherein said first and second striplines are suspended striplines.

15

20

25

30

35

40

45

50

55

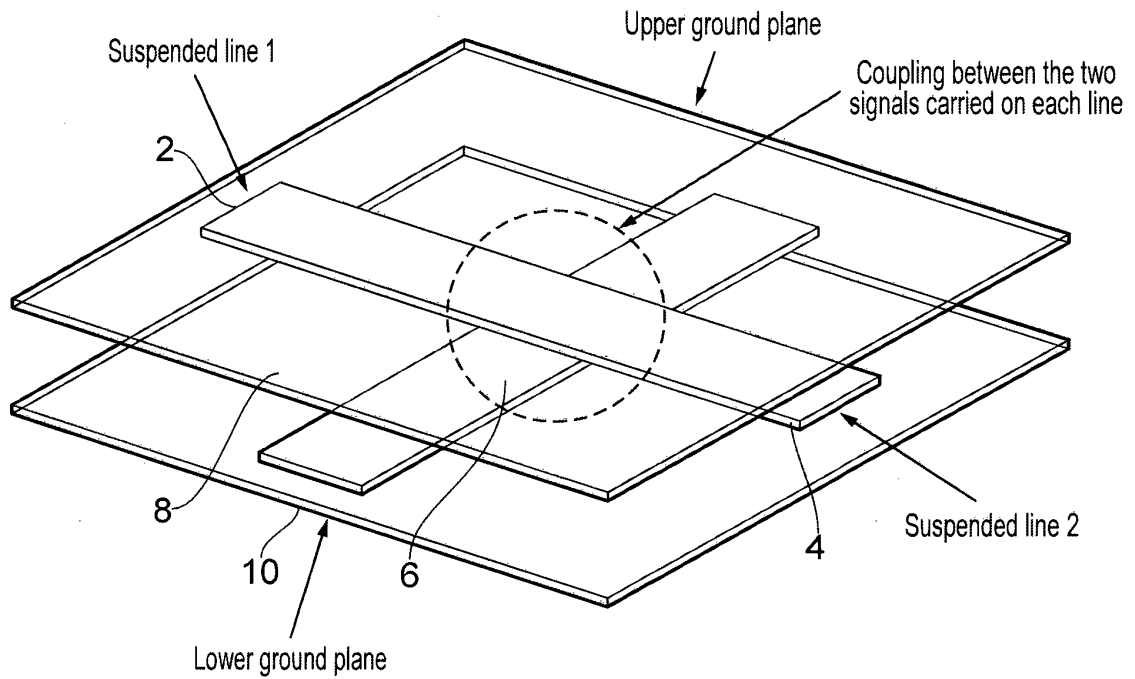


FIG. 1

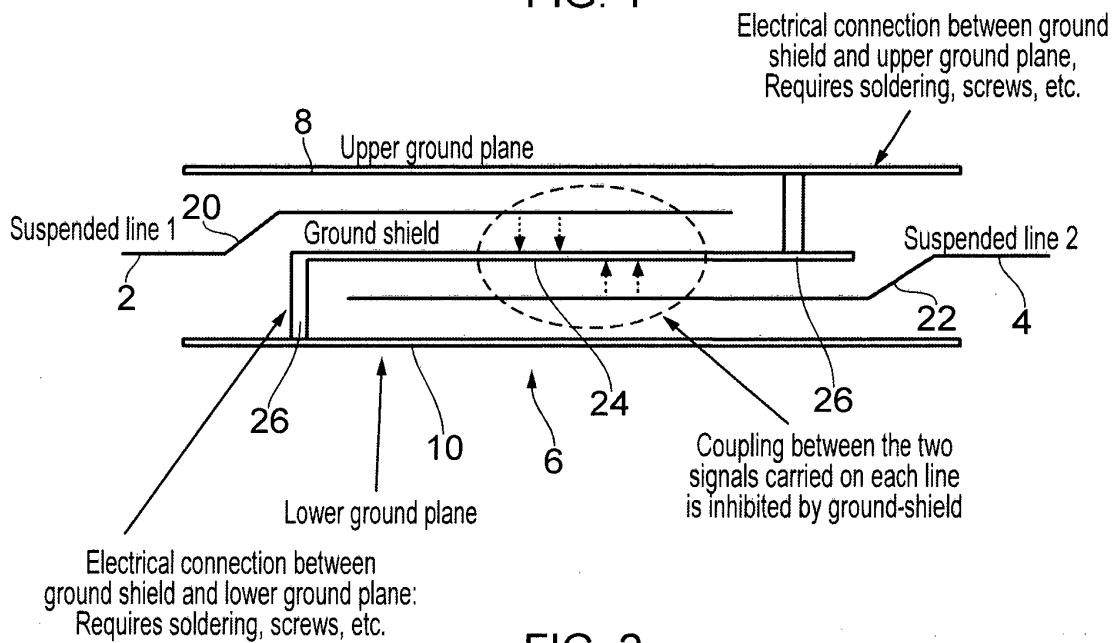


FIG. 2

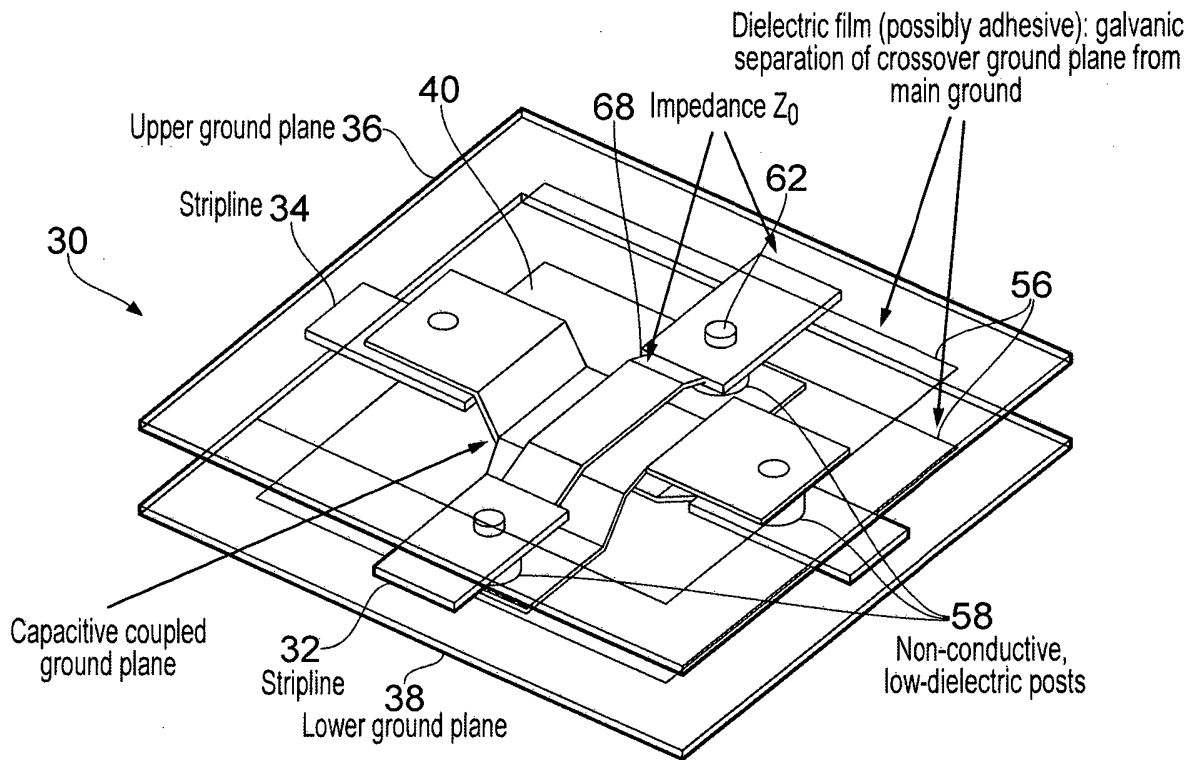


FIG. 3

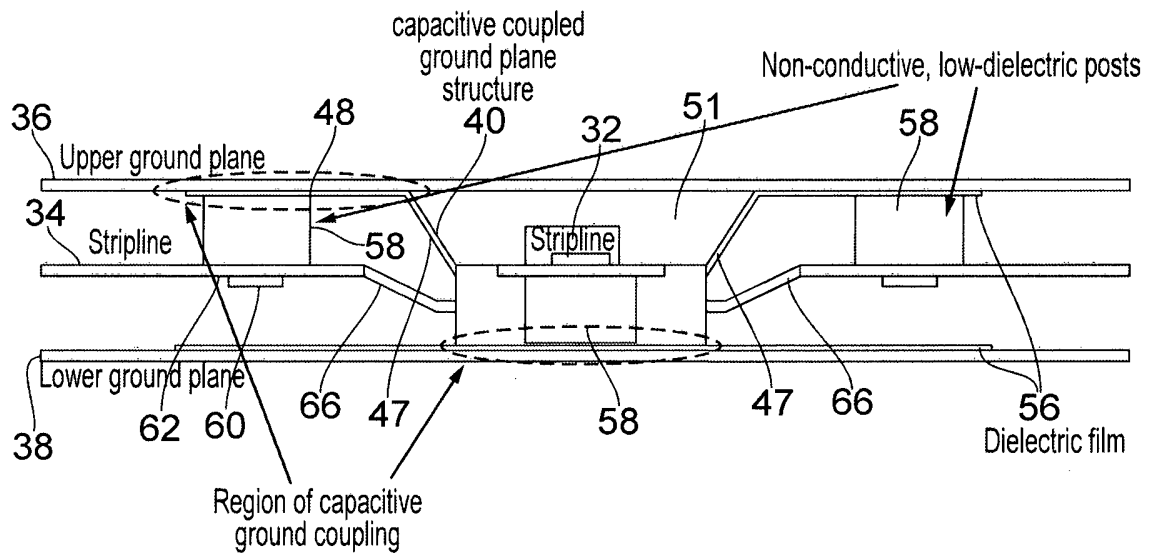


FIG. 4

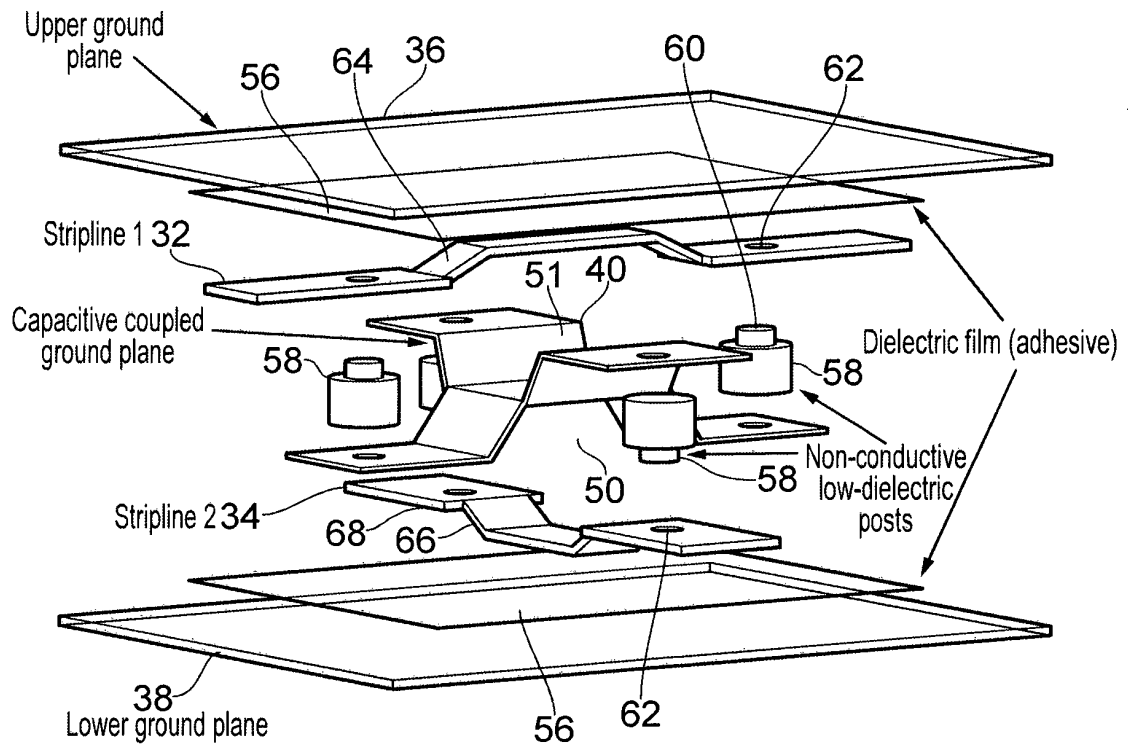


FIG. 5

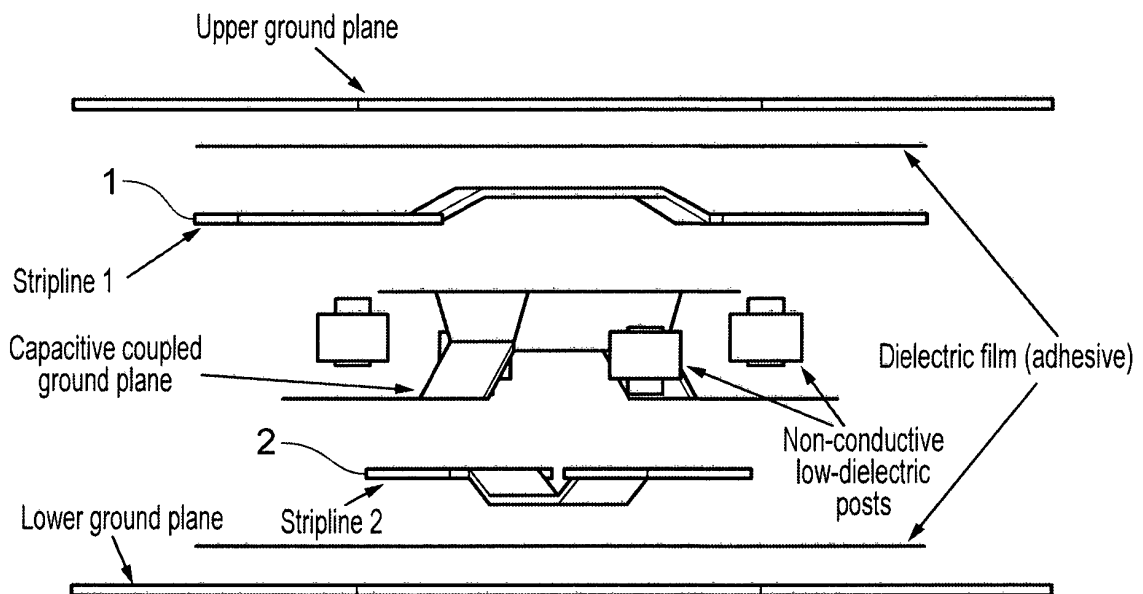


FIG. 6

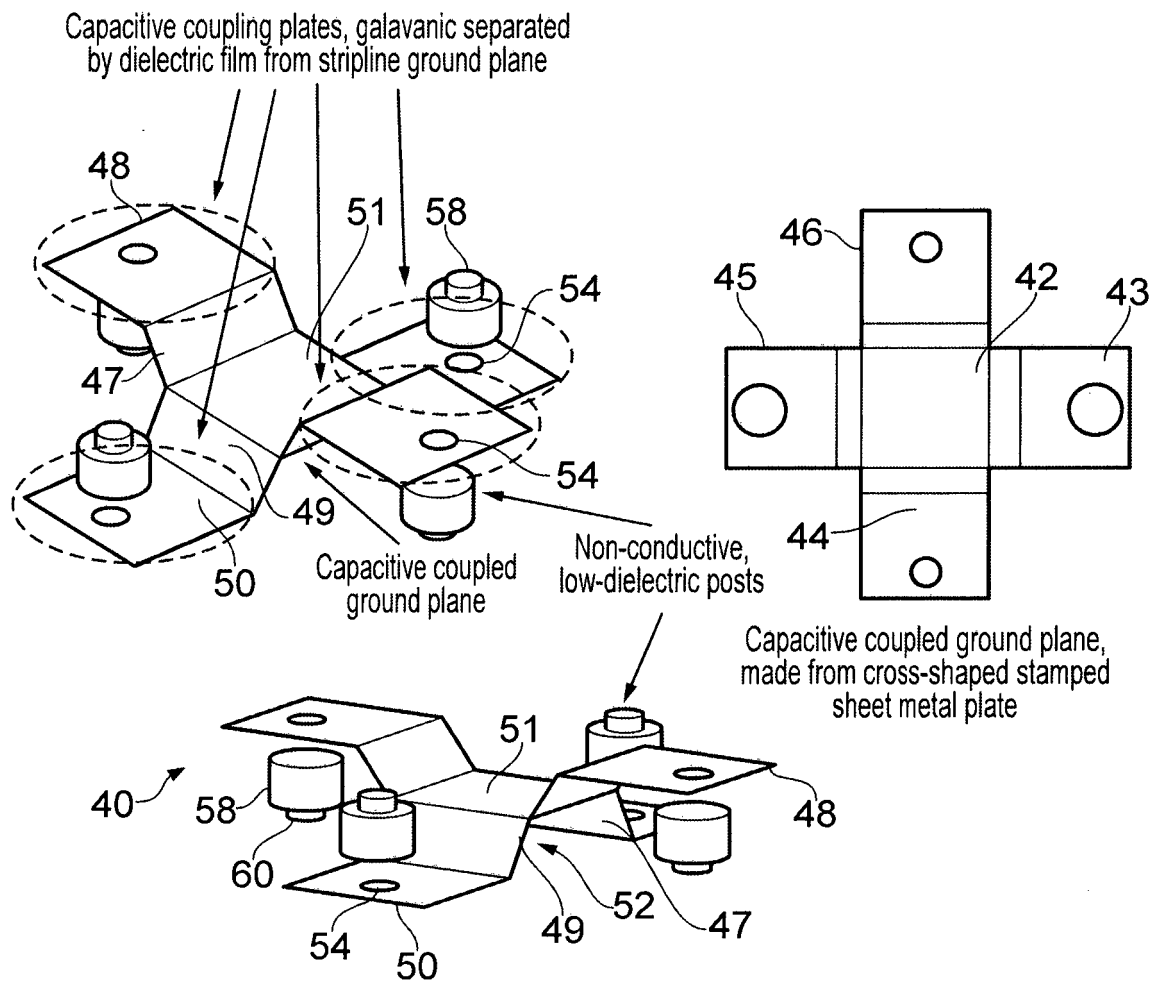


FIG. 7



EUROPEAN SEARCH REPORT

Application Number
EP 13 29 0270

5

10

15

20

25

30

35

40

45

50

55

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 5 600 285 A (SACHS RICHARD A [US] ET AL) 4 February 1997 (1997-02-04) * column 5, line 2 - column 6, line 37; figure 4 *	1-15	INV. H01P3/08
A	US 6 097 260 A (WHYBREW WALTER M [US] ET AL) 1 August 2000 (2000-08-01) * column 3, line 26 - column 4, line 30; figures 4-6 *	1-15	
A	UWANO T ET AL: "Characterization of Stripline Crossing by Transverse Resonance Analysis", MICROWAVE SYMPOSIUM DIGEST, 1987 IEEE MTT-S INTERNATIONAL, MTT005, PISCATAWAY, NJ, USA, 9 May 1975 (1975-05-09), pages 777-780, XP031668497, * abstract * * paragraph [introduction]; figure 1 *	1-15	
A	JP 2007 053440 A (MURATA MANUFACTURING CO) 1 March 2007 (2007-03-01) * figures 1,2 *	1-15	TECHNICAL FIELDS SEARCHED (IPC) H01P
A	JP S63 221701 A (MITSUBISHI ELECTRIC CORP) 14 September 1988 (1988-09-14) * abstract *	1-15	
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 13 March 2014	Examiner van Norel, Jan
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	

EPO FORM 1503 03.02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 13 29 0270

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

13-03-2014

10

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5600285	A	04-02-1997	NONE	

US 6097260	A	01-08-2000	NONE	

JP 2007053440	A	01-03-2007	NONE	

JP S63221701	A	14-09-1988	NONE	

15

20

25

30

35

40

45

50

55

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

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 5600285 A [0006]