United States Patent [19]

Gaudio

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[45] **Nov. 6, 1973**

[54] **STRIPLINE-TO-TWO-CONDUCTOR BALUN**

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[73] Assignee: **The United States of America as represented by the Secretary of the United States Air Force**, Washington, D.C.

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[52] **U.S. Cl.** ..... **333/26**, 333/84 M

[51] **Int. Cl.** **H03h 7/42**, H01p 3/08

[58] **Field of Search** ..... 333/26, 84 R, 84 M, 333/21 R; 343/814, 816, 859

[56] **References Cited**

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Assistant Examiner—Marvin Nussbaum
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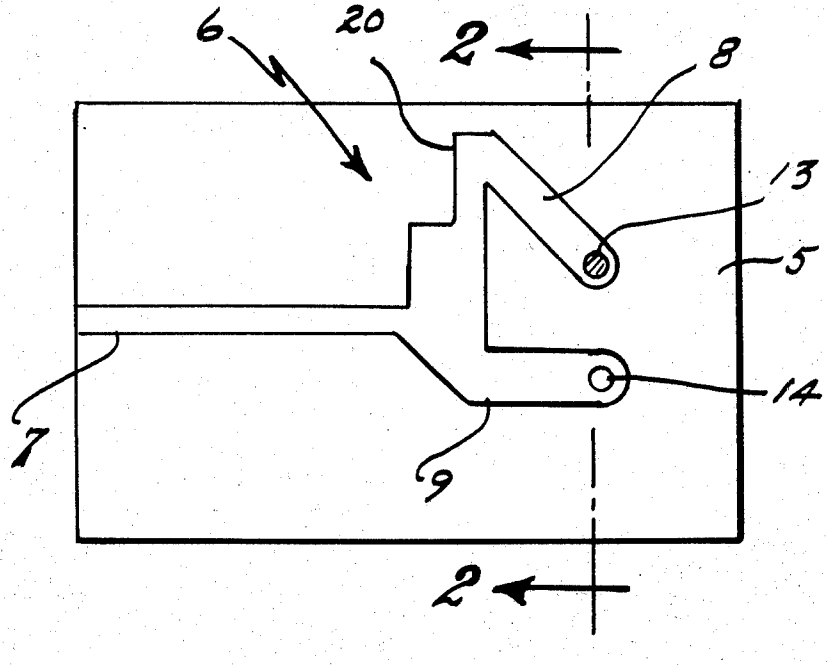
[57] **ABSTRACT**

A stripline-to-two conductor balun having a bifurcated stripline input that is disposed between and insulated from two parallel ground plane members. One output conductor is connected directly to a first bifurcated stripline leg and passes through and is insulated from one ground plane member. The other output conductor passes through and is electrically connected to both ground plane members and the second bifurcated stripline leg. The second stripline leg is lengthened to provide phase compensation for the resulting RF short circuit.

1 Claim, 5 Drawing Figures



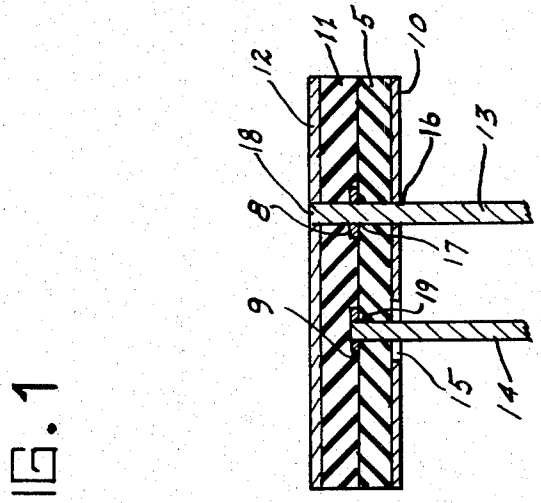
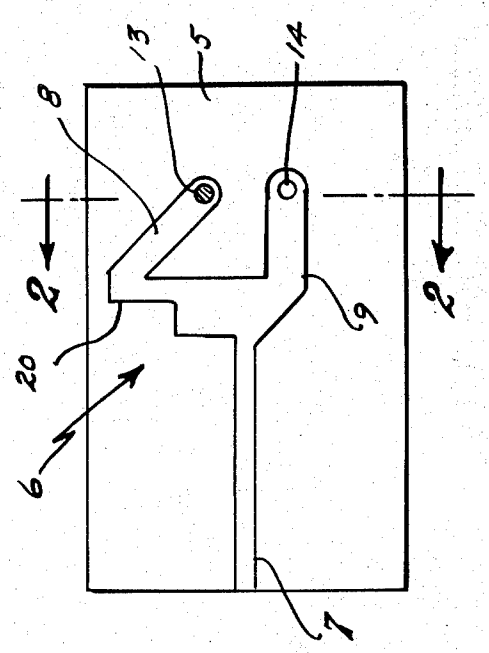


FIG. 2

FIG. 1



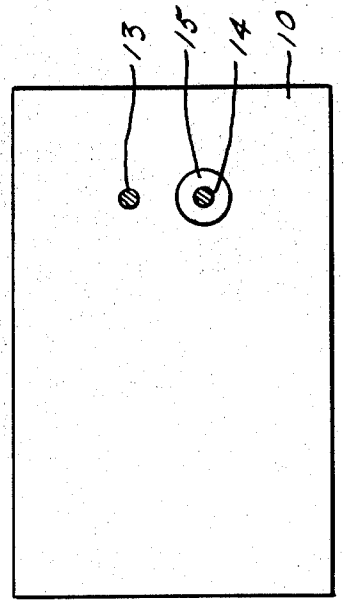


FIG. 3

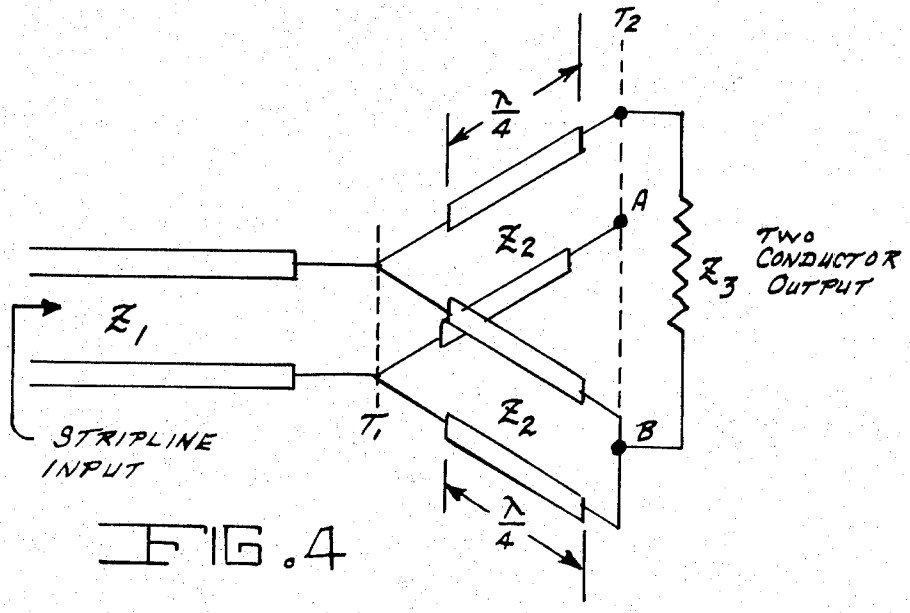

T_2
$\frac{\lambda}{4}$
A
Z_2
Z_3
TWO CONDUCTOR OUTPUT
Z_1
T_1
Z_2
B
STRIPLINE INPUT
$\frac{\lambda}{4}$

FIG. 4

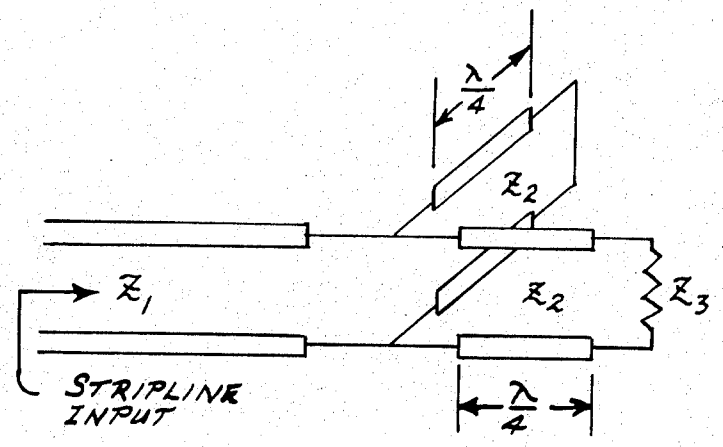

$\frac{\lambda}{4}$
Z_2
Z_1
Z_2
Z_3
STRIPLINE INPUT
$\frac{\lambda}{4}$

FIG. 5

STRIPLINE-TO-TWO-CONDUCTOR BALUN

BACKGROUND OF THE INVENTION

This invention relates to unbalanced-line to balanced-line converters, or baluns, and in particular to an improved stripline-to-two-conductor balun having improved bandwidth and VSWR characteristics.

A balun finds its most widespread use as a transition between a coaxial transmission line and a balanced type antenna (such as a diple or spiral radiator). Over a specified frequency bandwidth the transition must be accomplished with a minimum input VSWR. The balun can be fabricated using waveguide, coaxial line or stripline. However, the stripline method generally results in a more compact mechanical design. There currently exists, therefore, the need for a compact stripline balun having a wide frequency bandwidth and a low input VSWR. The present invention is directed toward satisfying such a need.

SUMMARY OF THE INVENTION

The stripline-to-two conductor balun of the present invention comprises a stripline Y junction with suitably terminated output arms. The stripline circuit is etched on one surface of a printed circuit board the other side of which is copper plated to form a ground plane. A cover board having its outer surface copper plated to form a second ground plane is affixed to the stripline circuit board. One output conductor is connected directly to the end of one stripeline output arm. The other output conductor is connected to both ground planes and the end of the other stripline output arm. The short circuit stripline output arm is configured to compensate for phase unbalance due to the RF short circuit.

It is a principal object of the invention to provide a new and improved stripline balun.

It is another object of the invention to provide a stripline-to-two-conductor balun having improved frequency bandwidth and VSWR characteristics.

These, together with other objects, features and advantages of the invention will become more readily apparent from the following detailed description when taken in conjunction with the illustrative embodiment in the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top view (cover board removed) of one presently preferred embodiment of the stripline balun comprehended by the invention;

FIG. 2 is a sectional view of the stripline balun of FIG. 1 taken at 2—2;

FIG. 3 is a bottom view of the stripline balun of FIG. 1;

FIG. 4 is an actual equivalent circuit of the stripline balun of FIG. 1; and

FIG. 5 is an approximate equivalent circuit of the stripline balun of FIG. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A stripline balun constructed in accordance with the principle of the invention is illustrated in detail by FIGS. 1, 2 and 3 of the drawings. In essence, the balun comprises stripline input circuity 6, ground plane members 10 and 12, dielectric insulating materials 5 and 11 and output conductors 13 and 14. Stripline input member 7 of input circuit 6 is bifurcated into a Y junction having output arms 8 and 9. Output conductor 14 is electrically connected to output arm 9 at point 19. It passes through ground plane 10 and is insulated therefrom by insulating material 5 and the cutaway portion 15. Output conductor 13 is electrically connected to ground plane member 10 at point 16, output arm 8 at point 17, and ground plane member 12 at point 18. The RF short circuit at the plane through points 16 and 18 would normally effectively shorten the electrical length of output arm 8. Output arm 9 would thus be longer by an amount equal to the stripline board thickness. The resulting phase unbalance would, of course, significantly degreade the balun operation. Accordingly output arm 8 is lengthened to provide a phase compensating bend 20 that effectively equalizes the electrical lengths of the two Y junction arms. The above described tripline balun can be readily fabricated using commercially available stripline boards and standard printed circuit techniques.

The equivalent circuit of the balun illustrated by FIGS. 1, 2 and 3 is presented in FIG. 4. Since one output conductor is short-circuit across both ground planes and the center conductor of the stripline, points A and B have the same potential. The approximate equivalent circuit of FIG. 5 is therefore valid.

For a matched condition at plane T, three conditions must be satisfied:

$$Z_2 = 2Z_1 \quad 1.$$

$$Z_3 = Z_2^2/Z_1 \quad 2.$$

3. The length of the short circuited stub must equal a quarter wavelength.

The first of these conditions assumes a simple parallel combination of the Y junction impedances. The second assumes a single stage quarter-wavelength transformer between Z_3 and Z_1. the last provides that the susceptance of the short-circuited stub is zero at the plane T_1. From conditions 1 and 2 it is found that $Z_3 = 4Z_1$. The balun therefore behaves as a 4:1 impedance transformer.

The equivalent circuit of FIG. 5 can be shown to be double tuned with a potentially large useful bandwidth. The theoretical VSWR of the circuit as shown is less than 1.33 over a 40 percent band. By properly choosing Z_1 and Z_3 the theoretical VSWR can be considerably lowered. For example, if $Z_3 = 3Z_1$, the balun is capable of producing a VSWR less than 1.15 over a 40 percent bandwidth.

While the invention has been described in one presently preferred embodiment, it is understood that the words which have been used are words of description rather than words of limitation and that changes within the purview of the appended claims may be made without departing from the scope and spirit of the invention in its broader aspects.

What is claimed is:

1. A stripline-to-two conductor balun comprising

first and second ground plane members in spaced parallel relationship,

a dielectric substrate between and in contiguous relationship with said first and second ground plane members,

a stripline input circuit disposed within said dielectric substrate, said input circuit terminating in a Y junction and having a long and a short terminal arm,

a first output conductor electrically connected to said short terminal arm through said first ground plane member, and

a second output conductor electrically connected to said first ground plane member, said long terminal arm and said second ground plane member.

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