A W BAND DIELECTRIC RESONATOR POWER COMBINER

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I - Abstract

This article presents the utilization of planar millimeter wavelength whispering gallery (W.G.) dielectric resonators modes for the realization of power combiners. A theoretical model of whispering Gallery dielectric resonator mode coupled with two transmissions lines and experimental results of power combination obtained in both X band (8-12.4 GHz) and W band (75-110 GHz) are given.

II - Introduction

Dielectric resonators are often used in integrated circuits at microwave frequencies. The utilization of these dielectric resonators acting on whispering gallery (W.G.) modes allow now the achievement of passive and active devices in the millimeter wavelength range [1].

In this paper we present theoretical and experimental investigations about dielectric resonators acting on their whispering gallery modes in X band (8-12.4 GHz) and in W band (75-110 GHz) for the achievement of power combiners. Measurement results of additional power are given.

III - Combination principle

Considering the travelling wave properties of W.G. modes, it has been shown that millimeter wave bandstop [2], bandpass and directional filters can be developped using planar W.G. modes dielectric resonators.

Using the properties of such filters, it's possible to realize some structures more sophisticated like power combiners [3]. First experimentations have been done with circuits using a dielectric resonator excited by two microstrip lines (X band) or two dielectric image guides (W band). The configuration of such a circuit is given in figure (1). Input ports are ports 1 and 3 and the output port depends on the resonator position with respect to the lines.

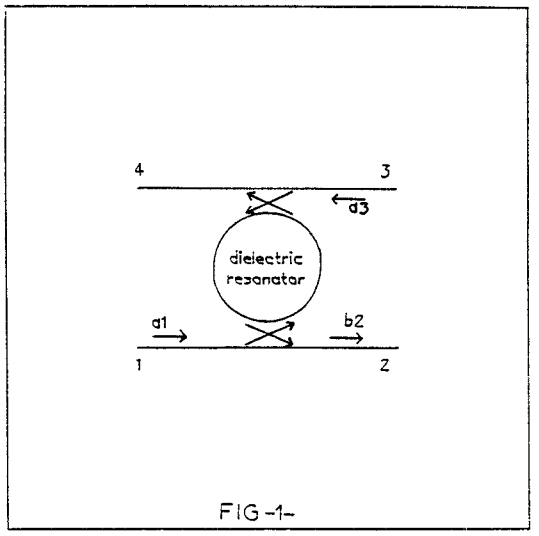

FIG -1-

Let be consider the case where output port is port 2 and in which the coupling coeffi-

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cient between the dielectric resonator and traveling waves a_1 and a_3 are respectively low and large.

To obtain a maximum power at the output (port 2) several conditions must be satisfied :

- the frequencies of the sources to be combined placed respectively at ports (1) and (3) must be the same that the dielectric resonator frequency excited on its W.G. modes.
- the phase of the two waves a_1 and a_3 must be equal in the dielectric resonator coupling plane. This condition is realized by using a phase shifter placed in one of the input access
- the level of a_1 and a_3 waves must also be equal in the dielectric resonator coupling plane.

IV - Electrical models

We have etablished an electrical model of the system dielectric resonator-transmission lines which takes into account the travelling wave properties of W.G. modes in azimuthal direction [4].

In this equivalent network given in figure 2, the directional properties are achieved by using two resonant circuits coupled magnetically (mutual inductance M) and electrically (capacitance C_c) with two lines supposed loss less.

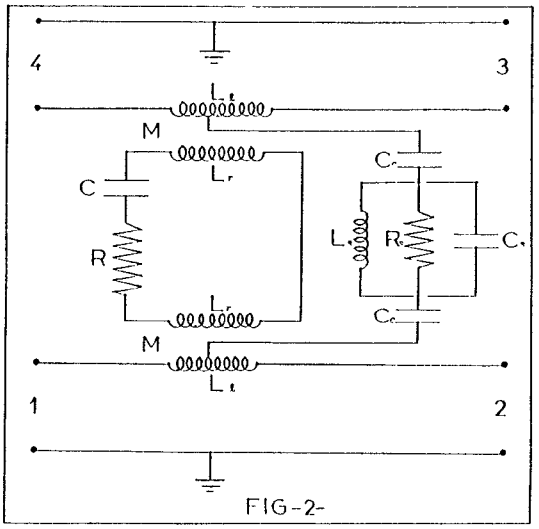

FIG-2-

The analysis of this type of circuits permits to obtain the additional power P_{sc} (figure 3) at the output. P_1 and P_3 being powers respectively on ports (1) and (3).

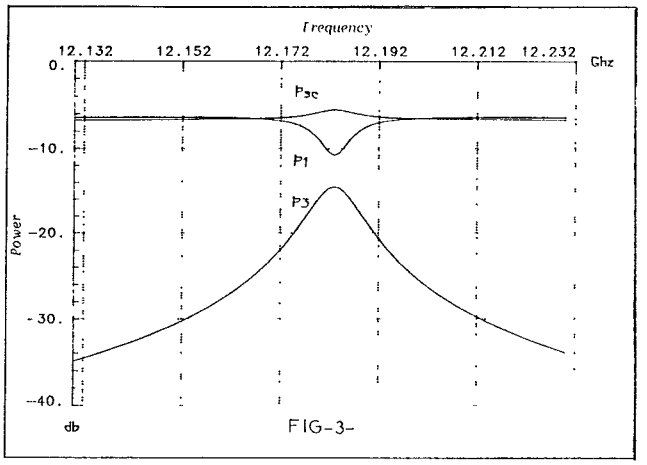

FIG-3-

V - Experimental results

Using this type of structure two power combiners have been realized one of them acts in the X band and the other on the W band.

* Power combination in the X band

The dielectric resonator is excited by two microstrip lines on a WGE mode (mode which has a large longitudinal magnetic field). Accesses 1 and 3 are excited by the same source by means of a 3 db coupler. The position of the resonator with respect to the lines has been calculated theoretically to have a large coupling between wave a_3 and the resonator, and a low coupling coefficient between dielectric resonator and wave a_1 [2].

On figure (4) graph (P_1) represents power at access 2 when port 1 is excited. Graph (P_3) is the power at access 2 when only access 3 is excited. (P_{sc}) is the added power at access 2 when both accesses 1 and 3 are excited.

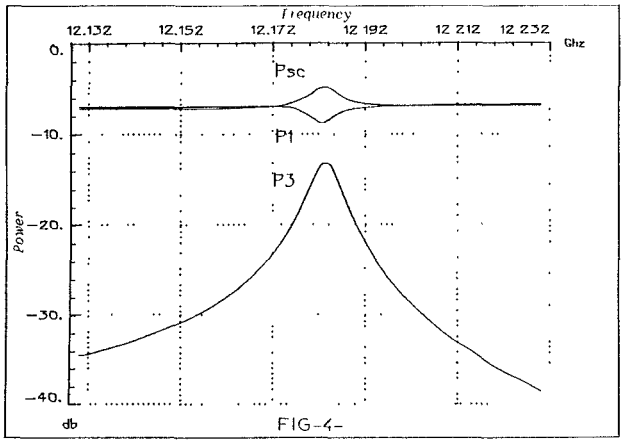

FIG-4-

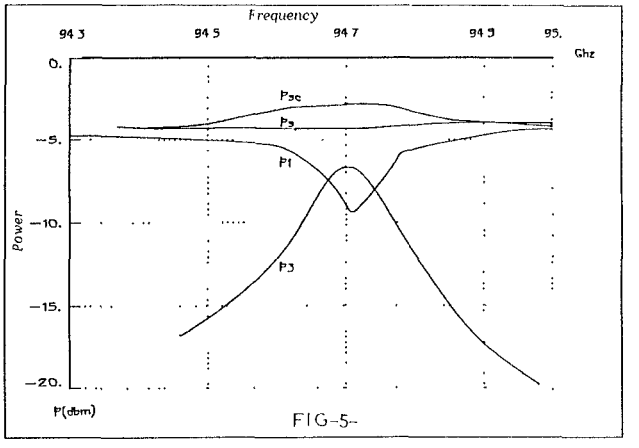

FIG-5-

If we take into account experimental losses in transmission lines, we can evaluate the efficient combination. In this experimentation it is 71 per cent in the coupling plane and only 59 per cent in the input planes (1) and (3) of the system.

** Power combination in the W band*

The second experimentation has been made in the W band. In this case the planar dielectric resonator made from alumina (ϕ=6 mm, h=0,635 mm) is excited by two dielectric images guides. Input accesses (1 and 3) are excited by two Gunn diodes.

The results obtained are given on figure (5) for a dielectric resonator, the resonant frequency of which being near 95 GHz , (P_s) represents power at access 2 without resonator and (P_{sc}) the added power at access 2 when accesses 1 and 3 are excited. Graphs (P_1) and (P_3) represent the variations of powers at access 2 when respectively accesses 1 and 3 are excited.

In this experimentation the efficient combination in the coupling plane is about 67 per cent.

VI - Conclusion

Experimental results show that it's possible to use the travelling-waves properties dielectric resonator for power combination in the millimeter wave frequencies band. These results permit to intend the realisation of millimeter wavelength planar power combiners using more than two sources. For that, it will be necessary to choose new type of configuration, one of which can be that shown in figure (6).

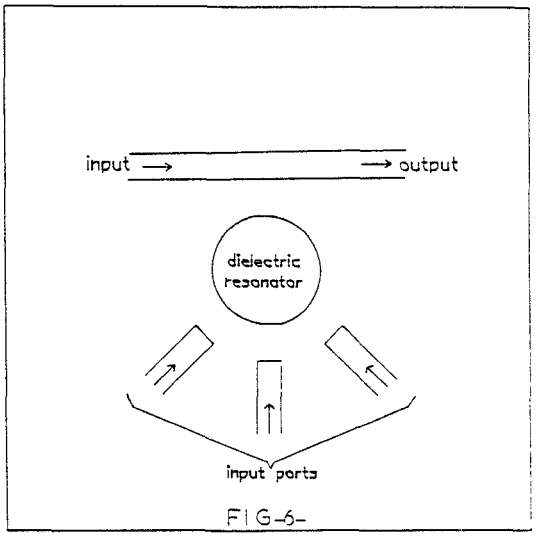

FIG-6-

VII - Références

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