# NEW TYPES OF 3-dB DIRECTIONAL COUPLERS OF MICROSTRIP TRANSMISSION LINES

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ABSTRACT:In this paper the author has brought forward three new types of 3-dB directional couplers suitable to microstrip circuit. The originality of these couplers is that by using these couplers extraordinary close coupling which is less than1-db can easily be achieved.An analysis is given to the electric field distribution and the characteristic impedance of the coupling circuit.The designing curves and the design of the 3-dB coupler with experimental data are provided in the paper.

## I. PLANE SOLID MICROWAVE STRUCTURE

Fig. 1 gives the layout of three couplers in different structures.

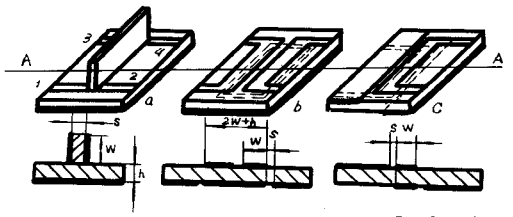


Fig. 1a is a perpendicular coupled microstrip-transmission line 3-db directional coupler,coupler afor short.The coupling is achieved by a slice of dielectric which has metal foils on both sides and which stands perpendicularly on the subtrate of the microstrip line.The coupling dielectric slice which stands perpendicularly solders the microstrip transmission lines by the ends and thus forms four ports.

Fig. 1b is a floating conductor coupled microstrip transmisson line 3-dB directional coupler b,for short.On the back of two coupled strip condutors,namely on the ground plate, a slot is open along the coupling reginn.By this on the ground plate plate in the coupling region a floating conductor of electic potential is created. Thus the reciprocal coupling between the two strip conductors is made through the floating conductor of the electric potential.

In coupler c,there are two symmetriac coupling strip conductors on both the up and down sides of the substrate and in the coupling region separate coplaner microstrip lines are formed. The ground plate which on the coplaner of the coupling strip conductor is also the ground plate of another coupling strip conductor's imput circuit. The coupling is created between the two symmetric coupling strip conductor and the ground plate on the coplaner. The wave transmission in the line can be regarded as a linear superposition of



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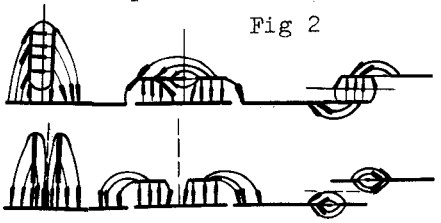
the odd-mode and even-mode fields. According to the boundary conditions shown in Fig. 2,a satisfactory anser can be achived by both analytical and numerical methods. Fig 3 give the design charts for the three couplers when $\varepsilon_r=2.6$

Fig 2



## II.THE DESIGN AND EXPERIMENTAL RESULT

The following steps are to be taken in designing the 3-dB couplers.

From the coefficient of coupling k,we have

$$z_{oo}=z_o\sqrt{\frac{1-k}{1+k}}$$

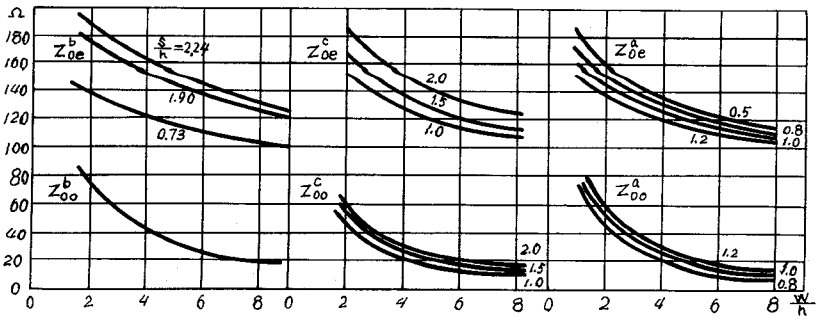
$$z_{oe}=z_o\sqrt{\frac{1+k}{1-k}}$$

where zo is the characteristic impedance of microstrip.The substrate is made of copper clad poly-tetraflouro efhyhene glass fiber board. Its dielectric constant $\varepsilon_r=2.6$.The curves shown in Fig.3 can determine the couplers in Fig.1.

coupler a: w=4.8mm s=1.0mm
h=1.0mm
coupler b: w=9.0mm s=1.8mm
h=1.0mm

coupler c: w=5.5mm s=1.5mm
h=1.0mm

Fig 3



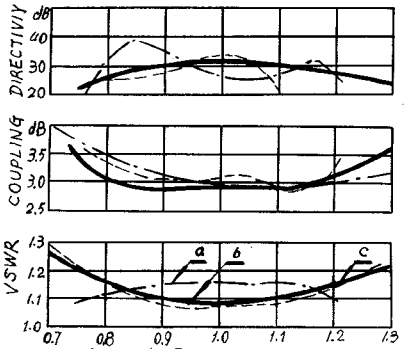




Fig4 the experimental response of the couplers.

## III. CONCLUSION

In coupler b and coupler c, the function of the slot lines is to reduce the characteristic impedance of the odd-mode and increase the characteristic impedance of the even-mode,so as to realize the close coupling. That is completely different from the conventional couplers.

As the slot can not form independent transmission, there will not be radiation loss.Radiation loss is especially effectively controlled in coupler a.

The designing curves in Fig.3 agree with the experimental results.