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Survey Paper on Miniaturization of Branch Line Coupler

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Abstract

Microwave power divider or power combiner that is coupler are used for effective power transmission in antenna and different electromagnetic circuit design. in this paper we discuss different planner technology and approach for the reduction size of branch line coupler .in detail we describe fractal geometry reduced the are approximately 81.8%.that are used the inner and outer are effectively. for enhancing the bandwidth used the cascaded structure. used center frequency 2.4 GHz .

Keywords

branch line coupler,fractal

Introduction

Power divider, power coupler is the basic microwave components which are mostly used in RF engineering for the combing or division of two or more signal. Basic diagram of power flow is shown in fig 1. [1][8].The coupler or divider may have three port, or four port, or more and may be lossless .three port network forms the T-junction and other power divider while four port network take the form of direction coupler and hybrids .directional coupler are the basic can be designed for arbitrary power divison while hybrid junction for have either 90◦and 180◦ phase shift between the output port with equal power division .

In 1949 MIT radiation laboratory E and H plane waveguide magic-T and the Bethe hole coupler, multihole coupler the wave guide magic T and various type coupler using coaxial probe .In mid1950 through 1960 many coupler renewed use stripline or microstripline technology to develop new type of coupler and divider such as wiliksion divider the branch line hybrid coupled line directional coupler[2].

A) Key feature of branch line coupler:

There are four feature of branch line coupler are different for different application based on antenna and other microwave equipment. these parameter characterize a coupler:

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Coupling(C) = 10 log (p1/p2) (1)

Directivity (D) = 10log (p3/p4) (2)

Isolation (I) =10log (p1/p4) (3)

Insertion loss =10 log (p1/p2) (4)

[6]The coupling factor indicate the function of input power that is coupled to the output port .the directivity is measure of coupler ability to isolate forward and backward wave the isolation is measure of the power delivered to uncoupled port .these quantities are :

The insertion loss accounts for input power delivered to coupled and isolated ports the ideal infinite directivity and isolation the purpose of this paper is to provide both survey of recently proposed fractal geometry and give the detail information abouth types and different techniques to miniaturization the size of the branch line coupler .

In Section II provide the brief information about type of hybrids while focus on branch line coupler in rest of paper .SectionIII we introduce the concepts of different techniques to miniaturization of branch line coupler .finally ,conclusion and the potential research on fractal geometry present in Section IV.

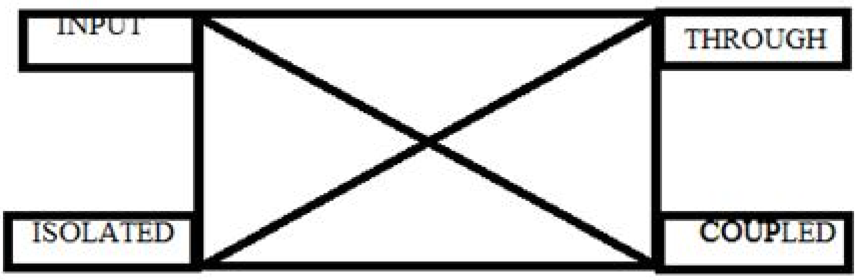


Figure1: Branch line coupler.

Types of branch line coupler

In this section we provided the different Types of microwave power divider or coupler such as:

A) T-shaped –the T-junction are used for power division or power combining is a simple network it can be implemented in virtually any type of transmission line medium that junction are in absence of transmission line loss ,lossless junction.in general ,there may be fringing field order modes associated with discontinuity such as junction ,leading to stored energy that can be account by lumped susceptence in oder to design characteristics impedance (z0).[5]

B) Resistive divider- the resistive power divider are easily design by lumped parameter that can be design by circuit theory to reduced the power dissipation.[11]

C) The Wilkinson power divider: The lossless T-junction divider suffers from the disadvantage not matched all port and no power isolation between output port .the resistive divider matched all port but not lossless, isolation is still not achieved .the Wilkinson power divider is such network with useful property of appearing lossless when the output port matched that is only reflected power from the output ports is dissipated .the Wilkinson power divider can be made with arbitrary power division but first consider the equal spilt (3dB).the design provide the even odd mode analysis and that circuit are derived by antisymmetric or symmetric source feeding.[14]

D) Waveguide directional coupler : It is a four port device . Basic operation, direction coupler is poor incident at port 1 will couple tom port 2 (through port)and porrt3 (coupled port)but not port4 (isolated port).[15]

E) Quadrature hybrids : Quadrature hybrid are 3 dB directional couplers with 90 phase difference in the output port of the through and coupled arms .this type of hybrid is made in microstrip line or strip line is also known branch line hybrid .other 3 dB coupler such as coupled line couplers or Lange couplers can be can be used as quadrature coupler these coupler analysis using even-odd mode decomposition techniques the operation of with all ports are matched ,power entering port 1 is evenly divided between ports 2and port 3 with 90phase shift . no power is coupled to port 4(isolated port)observe that branch line hybrids has a high degree of symmetry ,as any port can be used as the input port .the output port will always be on the opposite side of the junction from the input port . the output ports will always always opposite side of the junction from input port and isolated port will be reaming port on the same side as the input port .[5]

F) Lange coupler to enhance the bandwidth between edge –coupled lines s to use several line parallel to each other ,so that the fringing field at both edge of line contribute to the coupling most practical implementation idea is Lange coupler where four parallel line used with interconnection to provides tight coupling this coupler achieve 3db coupling ratio with octave or more bandwidth the design tends to compensate for unequal even –and –odd mode phase velocity which also improves the bandwidth . The difference between the output lines (port2and port 3)so the Lange coupler is type quadrature type coupler. Output lines (ports 2 and 3), so the Lange coupler is a type of quadrature hybrid. The main disadvantage very narrow and close together and required bonding wires across the lines increase complexity.[4]

Techniques of branch line couple

In this section we explain the different techniques for miniuarisation of the branch line coupler baluns and coupler are the basic components in the planner microwave integrated circuits .The 180 hybrid is implemented using either a rat race coupler or coupled line baluns while 90◦ hybrid is implemented using branch line coupler or langecoupletr. lange coupler is compact and wide bandwidth but require very narrow and closely spaced intredigitedmicrostripline well as crossovers .

All design are used λ/4segments of transmission or coupled line having different electrical charaterstics to provide the required performance .More easily realized using a standard printed circuit board (PCB)fabrication process which have main limitation it require large surface area at lower frequency .because of the large electrical length the of transmission –line elements ..the conventional branch –line coupler occupies a significant amount of circuit area and leave the interior area unoccupied.[4]

The photonic –band gap structure are another way to minimize the circuit the existence of many defect cells on ground plane limit the use of this techniques .Compact coupler achieved by artificial transmission line which consisted of microstripline periodically loaded with open shunt stub or simply T-shaped stubs the maximize the reduction of these techniques is only 63% as compared with a conventional design.[15].

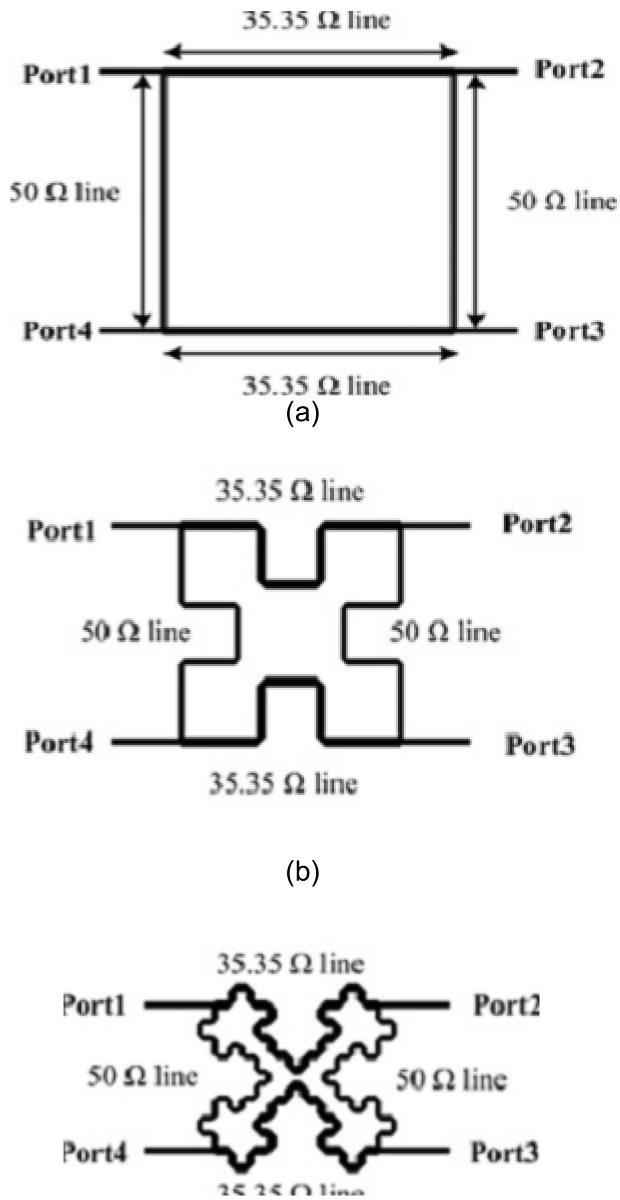
There are several method to reduce the size of these topology. The mender-line techniques has been used for miniaturization of coupled line structure this techniques provides considerable size reduction but limitation are use of such configuration at high frequency. By meandering microstripline using to used outwards space –filling curve to utilize vacant space outside the conventional coupler.

By employing inwards meandering line to utilize vacant space inside the coupler the fractal shaped branch line coupler achieved maximum 75.3%and 70%size reduction respectively.

It is based on the use of Novell techniques the use of space filling curve has been proposed for miniaturization of rat race coupler using a second –iteration Moore space filling curve with constant width a rat race coupler reduce approximately 10% relative to the conventional structure area has been proposed.

Space filling curve to reduce the hybrid structure both type that is closed and open space-filling curve has been implemented. siezpinski closed space filling curve with a constant width used for miniaturization of rat race couplers in the closed space –filling curve having different segment length and width is also proposed for miniaturization of branch line coupler. Minkowsaki fractal geometry (open space – filling curve) to reduce the size of the coupled – line balun. These depend mainly on the ability to fit the same segment length isreduced area. On other hand, the coupled line balun design make use of the compactness properties of space filling curve to replace straight coupled line section by compact coupled space –filling curve by proper choice of fractal geometry and iteration number determine crossponding area reduction .
in this paper we detail discuss abouth fractal geometry is applied to microwave engineering which are used in eltromagneticbandgap structure design in microwave circuit design and in the antenna design it is givean by iteration oder and iteration factor 50 ohamcharatersticsimpdence are used for matching and electrical length$\frac{\lambda}{4}$.iteration

oder incease to reduced the size of branch line coupler



(c)

Figure 2: Fractal shaped branch line coupler - A) K0 B) K1 C) K2 [12]

First, as the chamfered bends effectively lengthen the line,themicrostrip length must be reduced by Δb per bend,[13]

where , Δb is given by :

$$\frac{\Delta b}{D} = 0.16\{2 - \left(\frac{f}{fp}\right)^2\} \qquad (5)$$

where, D and fp are given by

$D = \frac{120\pi h}{\sqrt{\varepsilon Z_0}}$ (6)

$f_{p=\frac{0.4Z_0}{h}}$ (7)[17]

Where,

h the height in millimetres , Z0 the characteristic impedance in ohm of the microstripline and fp is in gigahertz. From the formulae given above, we can determine the initial length l of K1 and K2 with 90◦transmission phase as 21.87 and 17.41mm, respectively. Secondly, simulating the K1 and K2 structures using Ansoft Designer by changing the values of length l around their initial values, and when the phase of S21 at 2.4 GHz equal to 90, the length (l) of each fractal-shaped microstripline can be obtained. Thus, the lengths of Koch-fractal-shaped microstripline of thezeroth, first and second iteration order at 2.4 GHz are arrived at 22.76, 21.85 and 17.25 mm, respectively.

Conclusion

In this paper we extensive survey of recent fractal geometry proposed for the coupler section I introduce the concept of the coupler design and in section we discuss type of different coupler in which present the advantage of quadrature hybrids and section III presents the techniques for reduced structure for coupler design using fractal geometry.to effective use the concepts for inner and the outer area of the coupler.

References

[1] Riblet, G. P., “A directional coupler with very flat coupling, ”IEEE Trans. Microw. Theory Tech., Vol. 26, No. 2, 70–74,Feb.1978.

[2] Banba, S., T. Hasegawa, and H. Ogawa, “Multilayer MMIC branch-line hybrid using thin dielectric layers,” IEEE Microw.Guided Wave Lett., Vol. 1, No. 11, 346–347, Nov. 1991.

[3] Muraguchi, M., T. Yukitake, and Y. Naito, “Optimum design of 3-dB branch-line couplers using microstrip lines,” IEEE Trans. Microw. Theory Tech., Vol. 31, No. 8, 674–678, Aug.1983.

[4] Weng, L. H., Y. C. Guo, X. W. Shi, and X. Q. Chen, “An overview on defected ground structures,” Progress In Electromagnetics Research B, Vol. 7, 173–189, 2008.

[5] Chiang, Y. C. and C. Y. Chen, “Design of a wide-band lumped element 3-dB quadrature coupler,” IEEE Trans. Microw. Theory Tech., Vol. 49, No. 3, 476–479, Mar. 2001.

[6] Wang, C. W., T. G. Ma, and C. F. Yang, “A new planar artificial transmission line and its applications to a miniaturized butler matrix,” IEEE Trans. Microw. Theory Tech.,Vol.55,No.12,2792–2801,2007.

[7] Chen, W. L. and G. M. Wang, “Design of novel miniaturized fractal-shaped branch-line couplers,” Asia-Pasic Microwave Conf., APMC 2007, 13, Dec. 11–14, 2007.

[8] Sun, K. O., S. J. Ho, C. C. Yen, and D. Weide, "A compact branch-line coupler using discontinuous microstrip lines," IEEE Microw. and Wirel. Compon. Lett., Vol. 15, No. 8, 519–520, 2005.

[9] POZAR D.M.: 'Microwave engineering' (Wiley, New York, 1998, 2nd edn.), Ch.7, pp. 379–383.

[10] LIAO S.-S., PENG J.-T.: 'Compact planar microstrip branch-line couplers using the quasi-lumped elements approach with nonsymmetrical and symmetrical T-shaped structure', IEEE Trans. Microw. Theory Tech., 2006, 54, (9), pp.3508–3514.

[11] ECCLESTON K.W., ONG S.M., ET AL.: 'Compact planar microstriplinebranchline and rat-race couplers',IEEE Trans. Microw. Theory Tech., 2003, 5 1, (10), pp. 2119–2125

[12] LIAO S.-S., SUN P.-T., CHIN N.-C., PENG J.-T.: 'A novel compact size branch-line coupler', IEEE Microw. Wireless Compon. Lett., 2005, 15, (9), pp. 588–590

[13] GHALI H., MOSELHY T.A.: 'Miniaturized fractal rat-race,branch-line and coupled-line hybrids', IEEE Trans. Microw. Theory Tech., 2004, 52, (11), pp. 2513–2520

[14] AWIDA M.H., SAFWATA.M.E., EL-HENNAWY H.: 'Compact rat-race hybrid coupler using meander spacefilling curves', Microw. Opt. Technol. Lett., 2006, 48, (3), pp. 606–609.

[15] CHEN W.-L., WANG G.-M.: 'Design of novel fractal-shaped branch-line couplers'. 2007 Asia-Pacific Microwave Conf., Bangkok, Thailand, 11–14 December 2007

[16] BALIARDA C.P., ROMEU J., CARDAMA A.: 'The Koch monopole: a small fractal antenna', IEEE Trans. Antennas Propagat.,2000, 48, (11), pp. 1773–1781

[17] BALIARDA C.P., ROMEU J., POUS R., CARDAMA A.:'On the behavior of the Sierpinski multiband antenna', IEEE Trans. Antennas Propagat. , 1998, 4 6, (4), pp. 517–524