Journal of Basic and Applied Engineering Research
Print ISSN: 2350-0077; Online ISSN: 2350-0255; Volume 2, Number 10; April-June, 2015 pp. 826-829

http://www.krishisanskriti.org/jbaer.html

Modeling and Analysis of Edge Coupled Coplanar Waveguide Discontinuities

Manoj Kumar[1] and R. Gowri[2]

[1]Electronics & Communication Engineering, Graphic Era University, Dehradun
[2]Electronics & Communication Egineering, Graphic Era University, Dehradun , India
E-mail: [1]manojkumar200925@yahoo.co.in, [2]rgowri07@gmail.com

Abstract—*This paper describes a new scalable technique for the design and analysis of several types of edge coupled coplanar waveguide (ECCPW) discontinuities such as ECCPW open end, ECCPW short circuit and ECCPW symmetric step discontinuity at 30 GHz with coupling coefficient 17dB .The topology assumes the fact that ECCPW coupled strip with small gap is equivalent to the center conductor strip of the CPW line. The model element values de embedded for the measured S-parameters. The results show that ECCPW discontinuities can be used successfully as reactive elements for related applications. ECCPW are widely using in realizing band pass filters in communication circuit. ECCPW Open end discontinuity shows the return loss (S_{11}) of -0.282 dB, ECCPW short circuit discontinuity gives the return loss (S_{11}) of -0.010 dB. The ECCPW symmetric step discontinuity return loss (S_{11}) of -12.9 dB and S_{12} of-17.667 dB with coupling coefficient of 17dB. All edge coupled coplanar waveguide (ECCPW) discontinuities structure realizing on substrate 450-μm thick GaAs with dielectric constant 12.9.*

Keywords: *Edge coupled coplanar waveguide, coplanar waveguide, and open end, short circuit, band pass filters.*

1. INTRODUCTION

As planar microwave circuits become more complex, the effect due to adopted topology, transmission line structure and high frequency complexity become increasingly important for more efficient and practical monolithic and monolithic microwave integrated circuits [1].An edge coupled coplanar waveguide (ECCPW) is the preferred choice for High frequency complex structure - design and MMIC applications. The edge coupled coplanar wave guide facilitates easy shunt as well as series mounting of active and passive device eliminates the need for wrap around and via-holes, and it has a low radiation loss. The propagation constant and the characteristic impedance of CPW can be adjusted by changing the slot width (distance between strips) to strip width ratio. This lack of sufficient discontinuities model for edge coupled coplanar waveguide has limits the extent of applications edge coupled coplanar waveguide models in various microwave circuit design [2][3]. A conventional coplanar wave guide (CPW) on a dielectric substrate consist of a center strip conductor

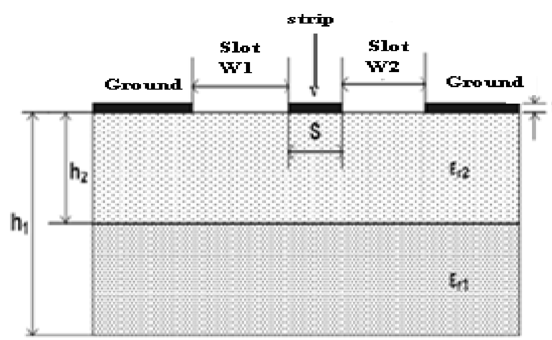

Fig. 1: Coplanar Wave Guide (CPW)

with the infinite ground planes on either side (Fig. 1) [4][5][6][8][9][10] .An edge coupled coplanar waveguide (ECCPW) with two parallel coupled strip conductors (S1 and S2) symmetrically located between two ground planes (Fig. 2) [7] [8].

The contribution of this paper are to provide a design methodology design curve for edge coupled coplanar waveguide discontinuities using the edge coupled coplanar waveguide structure given in Fig. 2 and discuss characteristics for accuracy and validity considerations. The adopted methodology consider that the two strip (S1 and S2) with the gap (d) of the edge coupled coplanar waveguide (ECCPW) is

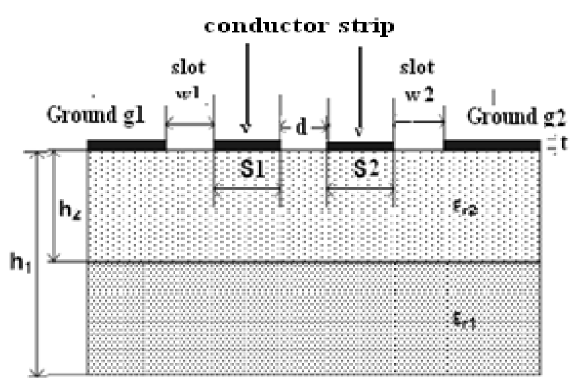

Fig. 2: Edge Coupled Coplanar Waveguide (ECCPW)

Equivalent to single strip (s) of coplanar waveguide (CPW) with following relationship

$$s = S1 + S2 + d \quad (1)$$

For symmetrical structure of edge coupled coplanar waveguide S1=S2=S and hence

$$s = 2S + d \quad (2)$$

2. ECCPW OPEN END DISCONTINUITY

An edge coupled coplanar waveguide open end discontinuity is realized by ending the conductor a short distance before the slots end , thereby creating a gap as shown in Fig. 3. Due to gap between conductor strips and ground and an electric field exists and give rise to open end capacitive reactance.

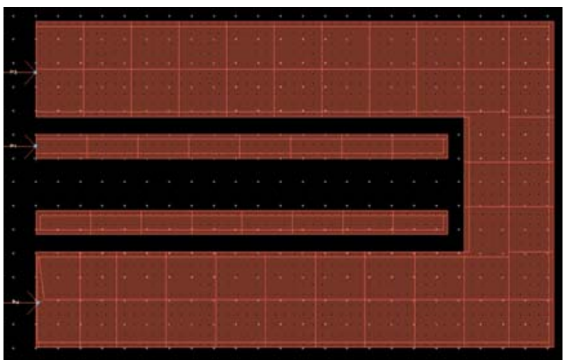

Fig. 3: ECCPW Open End Discontinuity

The open ended capacitance C_{OC} is parallel combination of the capacitance due to fringing field in gap and slot. It is the functional dependent on the gap (g) between conductor strips and ground [11]. Fig. 4 shows the magnitude of the return loss (S_{11}) for ECCPW open end discontinuity as the function of frequency. The return loss due to open end discontinuity is -0282dB at 30GHz.

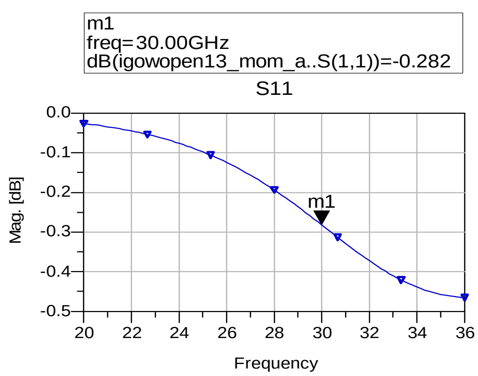

Fig. 4: S_{11} ECCPW Open End Discontinuity

3. ECCPW SHORT CIRCUIT DISCONTINUITY

An edge coupled coplanar waveguide short circuit discontinuity is realized by abruptly ending the slot as show in Fig. 5.

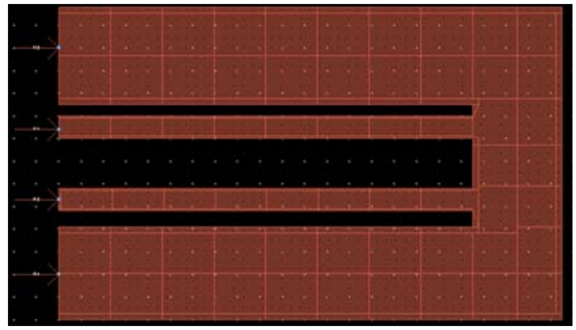

Fig. 5: ECCPW Short Circuit Discontinuity

Due to abruptly ending the RF current flows around the two slots region and therefore magnetic energy is stored behind the termination. This magnetic energy is give to rise of inductive reactance that is modeled as L_{sc}.

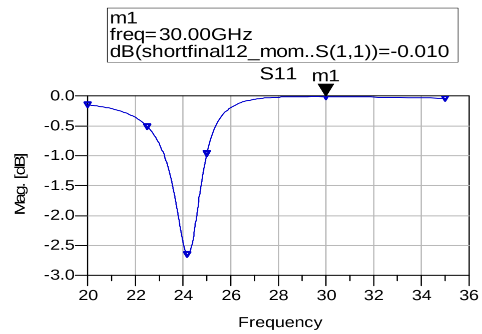

Fig. 6: $S_{11}$of ECCPW Short Circuit Discontinuity

Fig. 6 shows the magnitude of the return loss (S_{11}) for ECCPW short circuit discontinuity as the function of frequency. The return loss is -0.01dB at 30GHz .

4. ECCPW SYMMETRIC STEP DISCONTINUITY

Change in the steps width (W1) and (W2) of two conductor strips of different characteristic impedance in edge coupled coplanar waveguide shown in Fig. 7. In open end a discontinuity capacitance in terms of an equivalent extra length of the ECCPW.

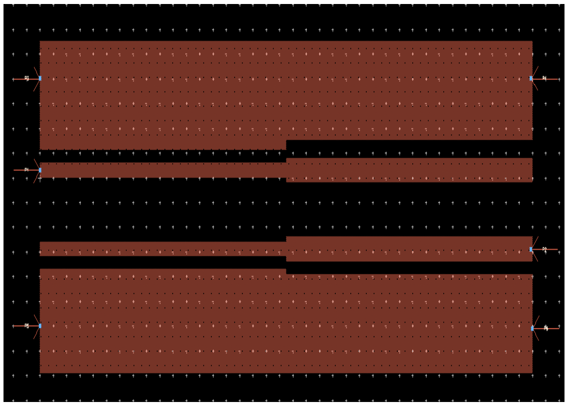

Fig. 7: ECCPW Symmetric Step Discontinuity

This approach can be used for step, where influence of the capacitance due to increase in the effective length of the wider line W2. As there is the step change in two conductor strips the inductive reactance induced due change in magnetic energy [12].Fig. 7 shows the schematic of step discontinuity.

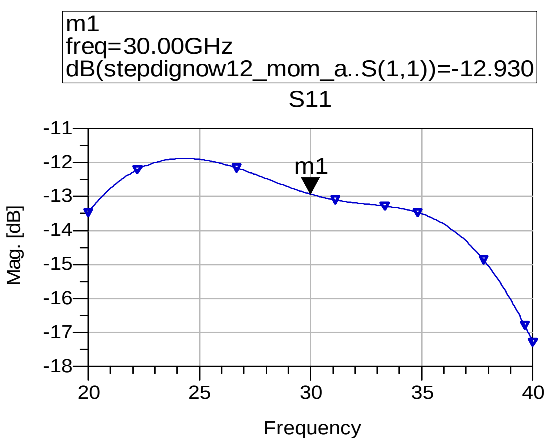

Fig. 8. S_{11} of ECCPW Step Circuit Discontinuity

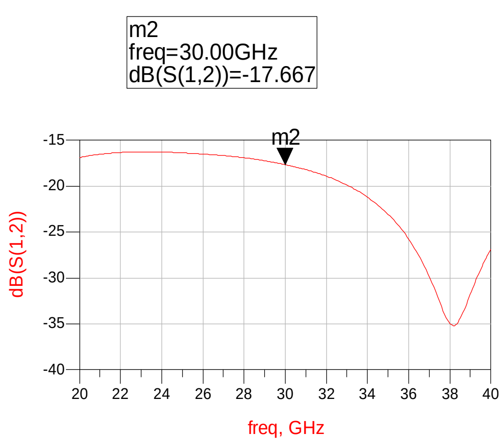

Fig. 9: S_{12} of ECCPW Step Circuit Discontinuity

Fig. 8 shows the return loss of -12.93dB and Fig. 9 shows S_{12} of -17.667 dB with coupling coefficient of edge coupled CPW of 17 dB.

5. DISCUSSION AND CONCLUSION

ECCPW discontinuities (open end, short circuit and step) are analyzed as these are very important in realizing the filters that are used in communication systems at 30GHz. Return loss of open end discontinuity is formed to be -0.282dB . Return loss of short circuit discontinuity is found to be -0.010 dB and exhibits inductive reactance. S_{12} of step discontinuity is found to be -17.667 dB. These results are found to be very well matching with that specified [4] from the input impedance equivalent electrical component vale can be determine & filter can be realized.

6. ACKNOWLEDGMENT

The authors express their sincere gratitude and thanks to Dr. B.S. Jassal, Dean of Projects, and Graphic Era University, Dehradun for his valuable suggestions and discussions.

REFERENCES

[1] Rainee N. Simons "coplanar Waveguide Circuits, Components and Systems" John Wiley & Sons 2001.

[2] Wolff, *Microwave Integrated Circuits*, Wiley-Interscience, New York, NY, USA, 2006.

[3] Michal R.Lyons and Constantine A. Balanis "Transient coupling reduction and Design consideration in Edge coupled coplanar waveguide couples" *IEEE Transactions on Microwave Theory and Techniques* Vol.44, No.5, May 1996.

[4] Rainee N. Simons and George E. Ponchak "Modeling of some coplanar waveguide discontinuities " *IEEE Microwave Theory and Techniques* -S International Microwave Symposium New York, New York, May 25-27, 1988.

[5] N. I. Dib, L. P. B. Katehi, G. E. Ponchak, and R. N. Simons," Theoretical and experimental characterization of coplanar waveguide discontinuities for filter applications," *IEEE* Transactions on Microwave Theory and Techniques, Vol. 39, No. 5, pp. 873–882, 1991.

[6] R. Masood and S. A. Mohsin, "Optimization of the S-parameter response of a coplanar waveguide series short stub for broadband applications," *Proceedings of the 3rd International Conference on Communications and Electronics (ICCE'10)*, pp. 384–388, Nha Trang, Vietnam, August 2010.

[7] Chun-Li- liao and Chun Hsiung Chen "Quasistatic and Full wave Analysis of Conductor Back Edge Coupled Coplanar Waveguide Structure" Proceeding of APMC 2001,Taipei, Taiwan, R.O.C

[8] Thomas M. Weller "Edge coupled Coplanar Waveguide Bandpass Filter Design" *IEEE Transactions on Microwave Theory and Techniques*, Vol. 48, No.12, Dec 2000

[9] C. P. Wen, "Coplanar waveguide: a surface strip transmission line suitable for nonreciprocal gyro magnetic device applications," *IEEE Transactions on Microwave Theory and Techniques*, Vol. 17, No. 12, pp. 1087–1090, 1969.

[10] R. E. Collin, *Foundations for Microwave Engineering*, McGraw- Hill, New York, NY, USA, 2nd edition, 1992.

[11] M. Naghed and I. Wolff, “Equivalent capacitances of coplanar waveguide discontinuities and interdigitated capacitors using a three-dimensional finite difference method,” *IEEE Transactions on Microwave Theory and Techniques*, Vol. 38, No. 12, pp. 1808–1815, 1990.
[12] K. Beilenhoff, H. Klingbeil,W. Heinrich, and H. L. Hartnagel, “Open and short circuits in coplanar MMIC’s,” *IEEE Transactions on Microwave Theory and Techniques*, Vol. 41, No. 9, pp. 1534–1537, 1993.
[13] R. W. Jackson, "Considerations in the use of coplanar waveguide for millimeter-wave integrated circuits," *IEEE Transactions on Microwave Theory and Techniques* Vol.-34. pp. 1451-1456. Dec. 1986.
[14] T. Hirota. Y**.** Tarusawa. and H. Ogawa, "Uniplaniu MMIC hybrids-a proposed new MMIC structure," *IEEE Transactions on Microwave Theory and Techniques*, Vol.-35. pp. 576-581. June 1987.
[15] T. K. Sarkar, Z. A**.** Maricevic, and M. Kahrizi, **“**An accurate deembedding procedure for characterizing discontinuities,” Int. J. Microwave and MM-wave Computer Aided Eng., Vol. 2, No. 3, pp. 135-143, 1992.
[16] 10. T.C. Edwards, Foundations for Micro strip Circuit Design, New York: John Wiley &, Sons, 1981.
[17] C. W. Kuo and T. Itoh, “Characterization of shielded coplanar type transmission line junction discontinuities incorporating the finite metallization thickness effect,” *IEEE Trans. Microwave Theory Tech.*, vol.40, pp. 73–80, Jan. 1992.