Design And Analysis Of Four-Way Power Divider For High Frequency Applications

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***Abstract*--Power dividers are important passive components in the implementation of various microwave circuits for wireless communication. This paper proposes the design of the four way power divider at 4GHz center frequency .The power divider is intended to divide or split a microwave power signal into other devices equally or unequally .The proposed divider network is designed by applying T junction power divider design (16.7mm×18mm) in which each one of the port will receive one quarter power of the input signal that is 6dB of the input signal. Power dividers are analyzed and solved mathematically and numerically. These analysis are validated by fabrication process and finally compared with measurements experimentally. The layout is simulated on Fr-4 substrate with thickness 1.6mm and ε_r 4.6 which is commercially used for high speed RF circuit design. The proposed power divider simulation results show that the return loss is approximately -15dB and insertion loss is -5dB.The results obtained are compared with the other designs of different dimensioned power dividers like (14mm×17mm) and (21mm×18mm).It find its wider applications in telecommunication, radar technologies ,coherent power splitting of local oscillator power and antenna feedback network of phased array radars, external leveling and radio measurements.**

***Keywords*-Four-way Power divider, Return loss, Insertion loss.**

I. INTRODUCTION

Wireless standards and applications continue to evolve, there is an increasing demand for further miniaturization of passive microwave components. A power divider is a passive component which is used to split the electromagnetic microwave power into other devices equally or unequally. In an ideal three port power divider network, the power given in port 1 is equally split between the two output ports and vice versa operation is carried out for power combiner. In this paper T-junction four-way power divider is designed and compared with powerdivider of different length and width. Five port power divider consists one input port and four output ports,hence the power given in port 1 will split equally to the four ports (i.e.) each port will receive 6dB of gain.

II. DESIGN ANALYSIS:

Three structures are proposed for this paper. The layout of the proposed power divider has been numerically analysed with ADS. The overall size of the design is presented in millimeter (mm).

A. STRUCTURE 1:

The structure 1 is a five port device of length 14mm and width 17mm.It is operated at the range of frequency 3.5-4.5GHz with a center frequency of 4GHz.It is designed on layout window of ADS & the substrate used is FR4 with thickness 1.6mm.The structure 1 layout is shown in figure1:

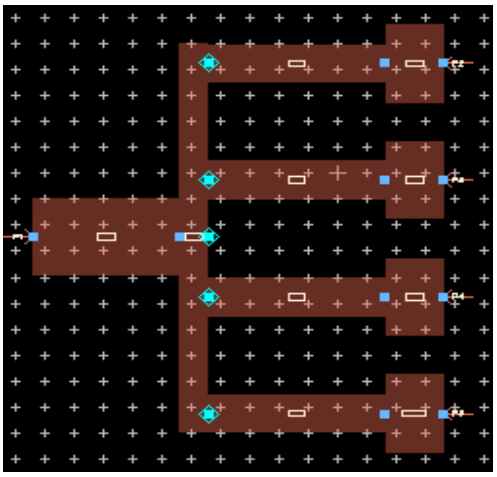

Fig.1 Layout design of structure 1

B. *STRUCTURE 2:*

The 2nd structure is of dimension 21mm×18mm.it is also designed with the same operating range 3.5-4.5 GHz and centre frequency of 4GHz.The structure 2 layout is shown in figure2:

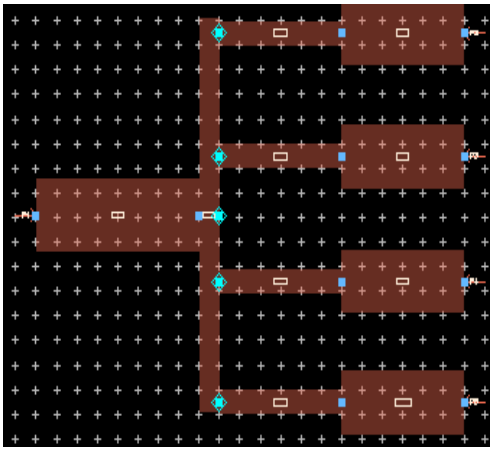

Fig.2 Layout design of structure 2

C. *STRUCTURE 3:*

The design of structure 3 four way power divider is of length 16.7mm and width 18mm.It is done using ads (advanced design system) software. The design is plotted in layout and ports are fixed at the input and outputs.In this FR4 substrate with thickness 1.6mm.The structure 3 layout is shown in figure33:

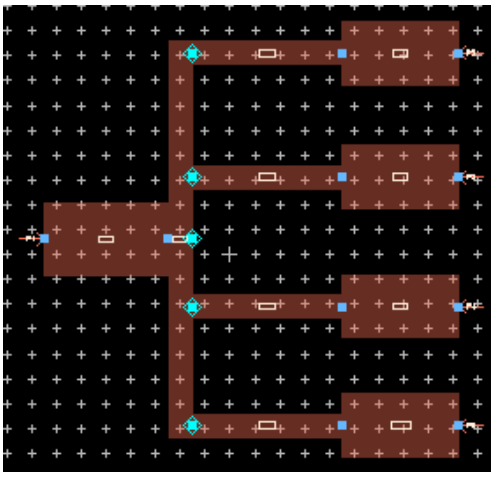

Fig. 3: Layout design of structure 3

III. SIMULATION AND RESULTS

The layout of the design has been simulated on Method of Moment (MoM)analysis in ADS software.

A. *STRUCTURE 1:*

The first structure was simulated and the results are observed.The marker m1 of this graph depicts the power reflected in ports1,2,3,4,5.

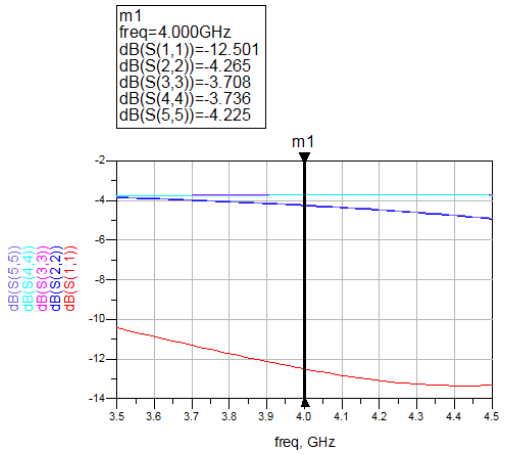

Fig .4Simulated results of input ports S11 and output ports (S22, S33, S44, S55).

In the simulated results S11 is -12.5dB and S22, S33, S44, S55 are less than -4.5dB at a centre frequency of 4GHz.

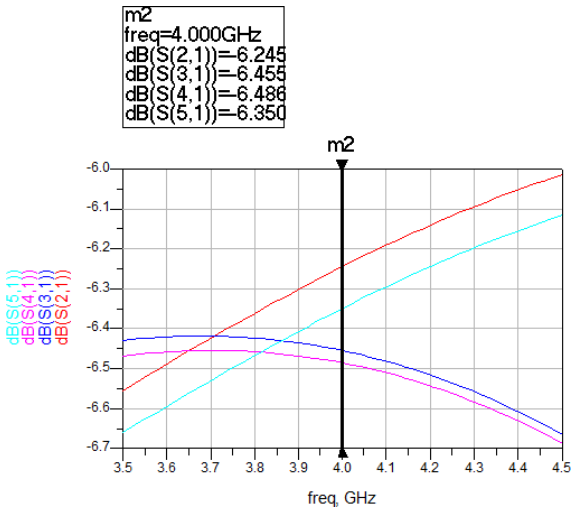

Fig.5 Simulated results of insertion loss (S21, S31, S41, S51).

The marker m2 shows that S21, S31, S41, S51 is around -6dB at 4GHz of operating range 3.5-4.5GHz.

B. STRUCTURE 2:

The structure 2 was simulated and the results are obtained

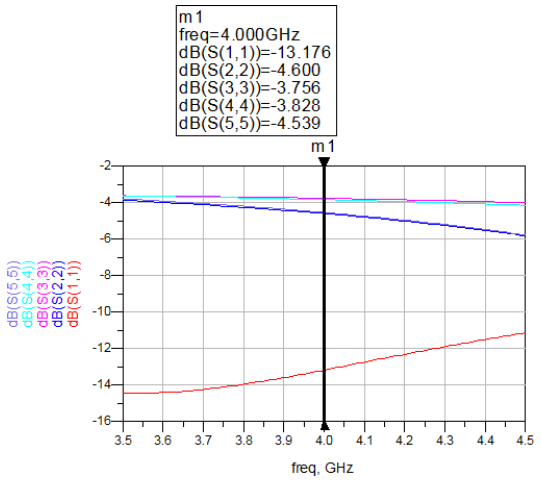

Fig.6Simulated results of input ports S11 and output ports (S22, S33, S44, S55).

In the simulated results the input return loss (S11) is approximately -13dB and output return loss (S22, S33, S44, S55) are less than -5dB at a frequency of 4GHz.

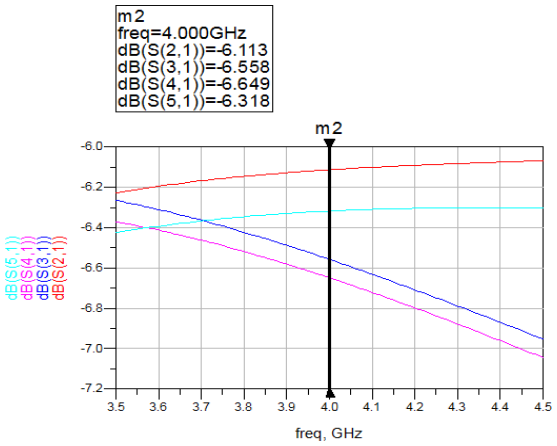

Fig.7 Simulated results of insertion loss (S21, S31, S41, S51).

The marker m2 shows S21, S31, S41, S51 is around -6dB at 4GHz of operating range 3.5-4.5GHz.

C. STRUCTURE 3:

The structure 3 was simulated and the results are obtained.

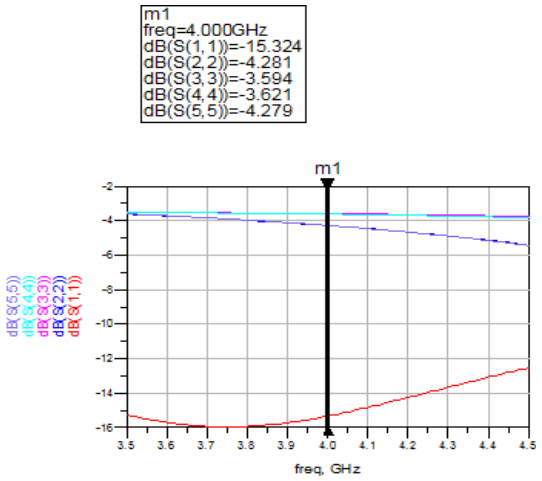

Fig.8 Simulated results of input ports S11 and output ports (S22, S33, S44, S55).

In the simulated results the input return loss (S11) is approximately -15dB and output return loss (S22, S33, S44, S55) are less than -4.3dB at a frequency of 4GHz.

IV. CONCLUSION

The four way power divider of the proposed design has been simulated on FR4 substrate which operates at centre frequency of 4GHz.Then the proposed power divider was compared with design of different structures was analyzed.

From these three structures we conclude that the 3rd structure had better results and with a minimum insertion loss of -15.317dB and return loss of -6dB. It's good agreement for the input-output ports of simulation

Hence from these results we can conclude that power consumption could be minimized for high frequency applications.

REFERENCES

[1] SriramMuralidharan and *KefeiWu,"A Compact Low Loss Single-Ended to Two-Way Differential Power Divider/Combiner"*, IEEE microwave and wireless components letters, Vol: 25 , Issue: 2 , Feb. 2015

[2] ElnazAbaei ; Hugo Moreno Aviles, "*Optimum design of a miniaturized onchip wide band power divider-combiner combined with impedance transformer"*, 9th European Conference on Antennas and Propagation (EuCAP), 31 August 2015

[3] Robin Kalyan ; Karun Rawat, "*Design of reconfigurable concurrent dual-band quarter-wave transformer with application of power combiner/divider*"2015 IEEE MTT-S International Microwave and RF Conference (IMaRC), 12 Dec. 2015

[4] M. Pasian ; L. Silvestri , "*E-plane 3-dB power divider/combiner in substrate integrated waveguide technology*". 2015 European Microwave Conference (EuMC), 03 December 2015

[5] UsmanAhmed ; Asim Ali Khan" *Design and analysis of left-handed transmission lines based miniaturized power divider/combiner for microwave applications.*": 2015 12th International Bhurban Conference on Applied Sciences and Technology (IBCAST), 12 March 2015

[6] Osama Hussein ; Khair Al Shamaileh, "Wideband impedance-varying n-way wilkinson power divider/combiner for rf power amplifiers". 2016 88th ARFTG Microwave Measurement Conference (ARFTG) 06 February 2017

[7]Valerij. I. Govorukhin ; Nikolai. E. Unru "*A ring power divider/combiner integrated with circle-shaped ballast resistor"*.2016 13th International Scientific-Technical Conference on Actual Problems of Electronics Instrument Engineering (APEIE) 05 January 2017.

[8] Bin Xia ; Lin-Sheng Wu , *"An approach to 1-to-3 way microstrip balanced-to-balanced power divider/combiner*". IEEE Electrical Design of Advanced Packaging and Systems Symposium (EDAPS),2018

[9] José Antonio GarcíaPérez ; SavvasKosmopoulos "*A Compact 12-Way Slotted Waveguide Power Combiner for Ka-Band Applications*". IEEE Microwave and Wireless Components Letters (Volume: 27 , Issue: 2 , Feb. 2017)