Design of a Power Divider for Dual Band at 1.5GHz and 2.4GHz

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Abstract— In recent years, there are increasing demands for dual-band equipment due to the development of multiband technologies. Therefore, the conventional power divider is not suitable for dual-band applications. In recent time power divider is used for many applications which inspired me for doing a work on that topic .Within the RF and microwave community, power dividers have served a prominent role for years. The main function of a power divider is to split a given input signal into two or more signals as needed by the circuit/system .Another power divider application and the inspiration for this thesis work is for GPS and BLUETOOTH application. In this system a signal is either fed through an equal split power divider featuring a specific number of output ports, or a series of equal split power dividers. In recent time due to scope of multiband frequency dual band power divider play a nominant role .This research presents design and implementation of power dividers at frequency 1.5 GHz and 2.4GHz using FR4 substrate. Design parameters used in the design of power divider are input and output matching, insertion loss and isolation between the both output ports. The design parameters presented in graph on the simulation result from ADS2011.10 software simulation .The simulation and measurement results taken where the return loss is >-30db insertion loss is about -3.5dB and isolation between the output ports is -15db is achieved.

Key words: Power Divider, Return Loss, Isolation, Insertion Loss

I. INTRODUCTION

In this paper, first, a dual-band Wilkinson divider is designed, which uses two-section TLT along with two isolation resistors. Using even–odd mode analysis, closed-form expressions are derived for the isolation resistors. It is shown that such a simple configuration achieves perfect match at all the ports and perfect isolation between the two output ports at the two design frequencies.

II. DESIGN PROCEDURE

A schematic diagram of the proposed symmetric Wilkinson power divider, which realizes equal power split at N arbitrary frequencies is shown in Figure 1.

Each quarter-wave branch in the conventional Wilkinson divider is replaced by N sections of transmission lines, with the characteristic impedances of Zi and physical lengths li, i = 1, 2, . . . , N. The isolation between the output ports is achieved by using N resistors, as shown in Figure 1. The purpose of the present analysis is to determine the divider parameters : Zi, li, and Ri, for i = 1, 2, . . . , N, such that a perfect match, if possible, at all ports and a perfect isolation between the output ports is achieved at N frequencies. Since this divider is symmetric, the even- and odd-mode analysis will be used to determine the divider parameters for the multi-frequency operation.

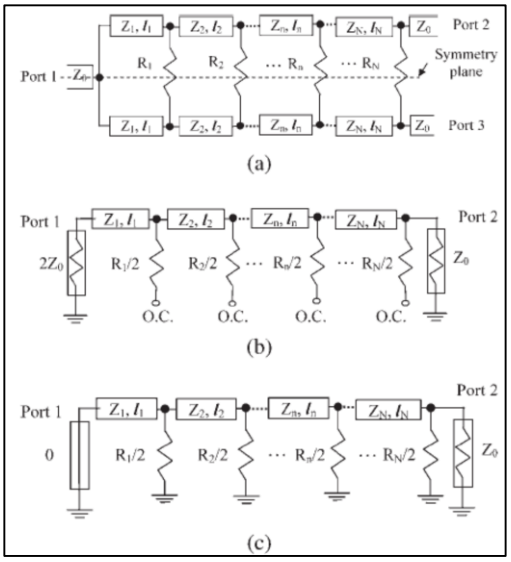

Fig. 1: (a) Multi-band WWilkinson Power Divider (b) Even-mode Analysis (c) Odd-mode Analysis

III. CALCULATION EQUATIONS

To design a power divider there mainly three components should known L,Z and R. By getting these values by below equations we will achieve the power divider configuration.

Length of micro strip line is calculated using following equations

$$L_1=L_2=\frac{\pi}{\beta 1+\beta 2}, \text{ where } \beta=\frac{2\pi}{\lambda}$$

Impedance values is calculated by,

$$Z_2=Z_0\sqrt{\frac{1}{2\alpha}+\sqrt{\frac{1}{4\alpha^2}+2}}$$

$$Z_1=\frac{2\times {Z_0}^2}{Z_2}$$

Resister values found using following equations

$$R_1=\sqrt{\frac{BF}{AE}} \text{ and } R_2=\frac{F}{D-ER1}$$

Where, $A= 2Z_2 (\frac{1+Z_2T_2}{Z_1T_1})$

$$B=2Z_2$$

$$E= T_2-\frac{Z_2}{Z_1T_1}$$

$$C=\frac{Z_2}{Z_0(1+Z_2\frac{T_2}{Z_1T_1})}$$

$$D=\frac{2T_2{Z_2}^2}{Z_0}$$

Where, $T_1= \tan\beta L_1$

$$T_2=\tan \beta L_2$$

Using these equations we will get the values of the required parameters as

Parameters	(1.5ghz)	(2.4ghz)
L	38.46mm	38.46mm
Z	60.86ohm	82.155ohm
R	168ohm	486ohm

Table 1: Calculations

IV. ADS DESIGN

After finding the values of required parameters design od power divider in ADS software as shown as below figure 2.

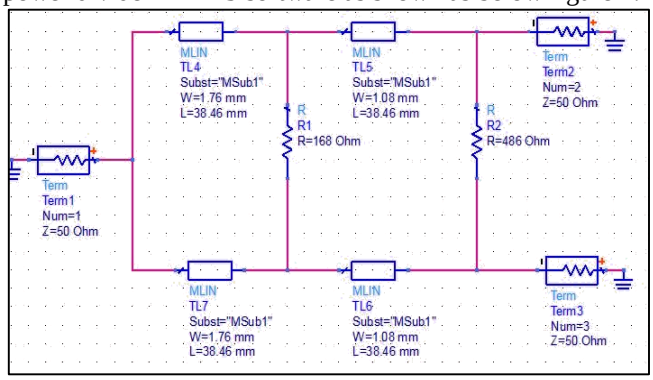

Fig. 2: Schematic of power divider [ADS screenshot]

V. SIMULATION RESULTS

The simulation results of power divider parameters like return loss, isolation, VSWR is graphed as below

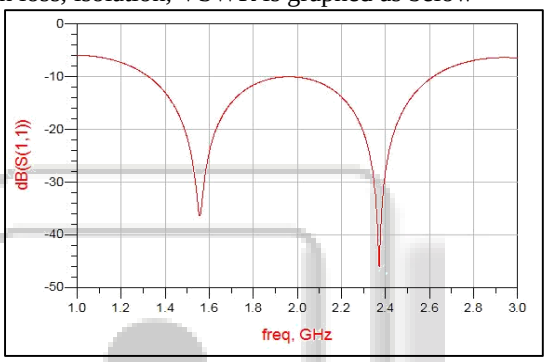

Fig. 3: Input return loss)[ADS screenshot]

Frequency	Return loss
1.575 GHz	-36 db
2.4 GHz	-30 db

Table 2: Input Return Loss

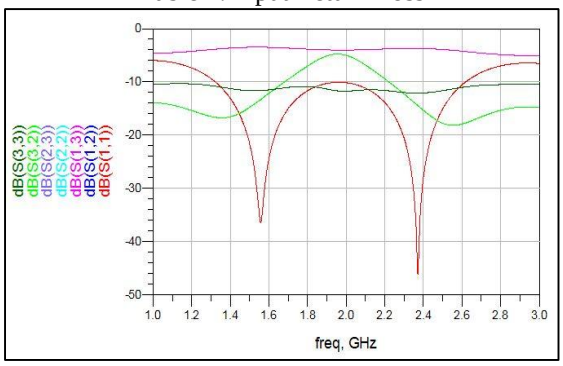

Fig. 4: Simulated Parameters Result

Parameters	1.575 GHz	2.4 GHz
S11 (Return loss)	-36db	-30db
S13 (insertion loss)	-3.5db	-3.5db
S12 (insertion loss)	-3.5db	-3.5db
S23 Isolation	-15db	-15db

Table 3: Parameters Value

The standing wave ratio is simulated as below

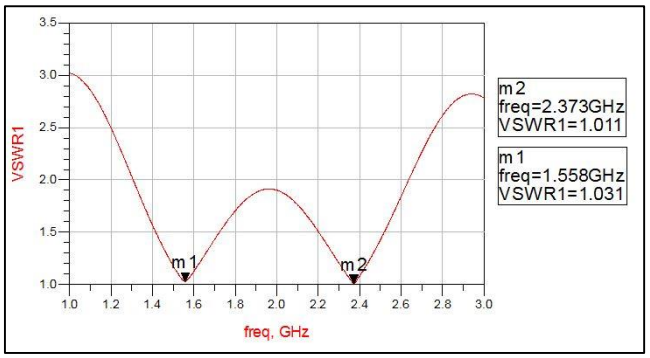

Fig. 5: VSWR [ADS screenshot]

VI. CONCLUSION

After the simulation in ADS and referring papers we can see that wilkinsion power divider provide very good VSWR and is also compatible for lower frequency applications. After the simulations results we can see that power divider provides very good return loss for both 1.5GHz and 2.4GHz with -15db isolation at both band with efficient VSWR.

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