Broadband 3 leveled Wilkinson power divider for X band application - doi: 10.17932/ IAU.IJEMME.m.21460604.2015.5/1.875-879

***M. Fathalizadeh*[1]**
***Pejman Mohammadi*[2]**

Abstract
In this paper, a 3 leveled Broadband Wilkinson power divider is proposed. This power divider has superior performance in the X-band (8~12 GHz) and is smaller in size as compared to traditional power dividers. The simulation and experimental results show good insertion loss which is approximately-3 dB, good return loss that is less than -12 dB for the input port over the entire X-band and less than -16 dB for the other two ports. The power is divided equally between the output two ports and the isolation between the output ports is better than -11dB.

Keywords:

Introduction

Nowadays, Microwave circuits play an important role in wireless system and three- port power divider is one of the main components in microwave circuit. The three-port power divider is widely used in feeding the networks of antenna array, such a corporate or parallel feeding network. The corporate feed is a device that splits power between n outputs ports with certain distribution while maintaining the equal path lengths from input to output ports. The three-port power dividers are usually being used for the implementation with n-way power splitters. By using the high-isolation power divider, the bandwidth that is primarily limited by the match of the radiating elements can be reduced.

The Wilkinson Power Divider was first introduced in 1960 when Ernest J. Wilkinson [1] described that separated one signal into n signals of equal phase and amplitude. Wilkinson Power Divider has been introduced in purpose to split the power of the input equally between two output ports, ideally without loss. Wilkinson Power Divider can also be used as a power combiner. Other properties of the Wilkinson power divider is that all ports are matched, the two output terminals are isolated from one another, and that it is reciprocal.

The hybrid with arbitrary amplitude difference of the output signals was presented by Parad and Moynihan [2] in 1965. A perfect three-port hybrid property was again achieved

Department of Electrical Engineering, West Azarbaijan Science and Research Branch, Islamic Azad University, urmia, Iran. pmohamady@yahoo.com
Department of Electrical Engineering, West Azarbaijan Science and Research Branch, Islamic Azad University, urmia, Iran. fathalizadem@gmail.com

at one frequency. A class of equal-power dividers with isolation and matching at any number of frequencies has been presented by Cohn [3] in 1968. Further, in 1971 Ekinge [4] described three-port hybrids where each section is composed of two coupled lossless transmission lines of electrical length Φ and an intermediate isolation resistor. Usually, three-port networks cannot be matched without being lossy [10]. The solution to this, in the Wilkinson Power Divider, is to add a resistor between the two outputs with the function to absorb energy if there is a mismatch between the outputs.

Recently, most of the Wilkinson Power Divider designs have achieved better isolation with different type of material and different topology used that resulting in different performance. In [4] described the Wilkinson Power Divider is designed by using GaAS substrate with Ka-Band Planar topology give better performance of the isolation. Tones of studies have been reported such as in [4-11] to indicate the different Wilkinson Power Divider designs. The result dimension and discussion of proposed Wilkinson power divider will be presented in follow section

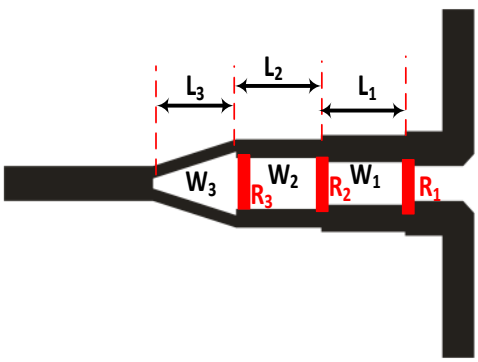

Fig. 1. *Structure of proposed power divider*

Design Method

The proposed Wilkinson Power Divider had been studied through the simulation by using Agilent (ADS) software. From the simulation result, the performance of the proposed 3 leveled Wilkinson Power Divider can be identified and analyzed. The first Wilkinson power divider was constructed by hand with copper tape and single-sided copper clad RT Duroid Rogers 4003 board.

Figure 1 shows the structure of the proposed Wilkinson power divider. This power divider is based on three leveled Wilkinson power divider. The amount of width for proposed power divider is illustrated in Table. I, and value of the line length of each level of power divider is presented in table. II. The length of the tapered transmission line is less than quarter wavelength of the center frequency of the 10GHz.

Table I. *The amount of width for proposed power divider*

	Line impedance	Line width
W_1	57.485 Ω	1.3510[mm]
W_2	70.71 Ω	0.9168[mm]
W_3	86.98 Ω	0.5803[mm]

Table II. *The amount of length for proposed power divider*

	ε_{eff}	Line length
L_1	2.7785	4.4993[mm]
L_2	2.6817	4.5798[mm]
L_3	2.5877	4.6623[mm]

Table III. *The value of isolation resistance*

Resistance	Reference Resistance	Value of Resistance
R_1	8 Ω	400 Ω
R_2	4.2292 Ω	211.46 Ω
R_3	2.1436 Ω	107.18 Ω

Simulation and Measurement Results

The designed power divider has been simulated using full-wave electromagnetic simulator software. Rogers RT4003 with a thickness of 0.8 mm, and a relative permittivity of 3.55 is used in this design. The performance of the designed circuit is shown in Figure 3. The simulation results show good insertion loss which is approximately 3 dB, good return loss that is less than 11 dB for the input port over the entire X- band and less than 16 dB for the other two ports. The power is divided equally between the output two ports and the isolation between the output ports is better than 11 dB. The measured results are shown in Figure 4. A good agreement with the simulated results is assumed. The measured results show good insertion loss which is approximately 3:6 dB, good return loss that is less than 11 dB for the input port over the entire X band and less than 15 dB for the other two ports.

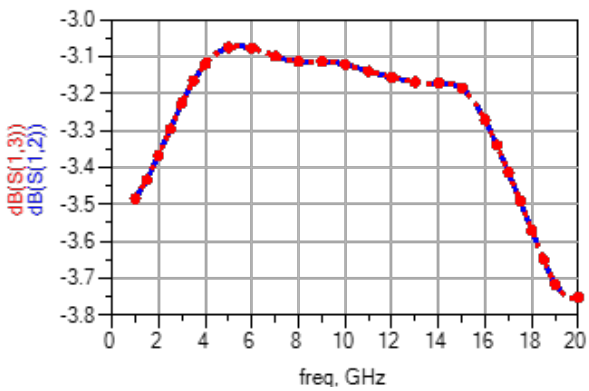

Fig. 2. *Simulated Transient parameter of proposed power divider*

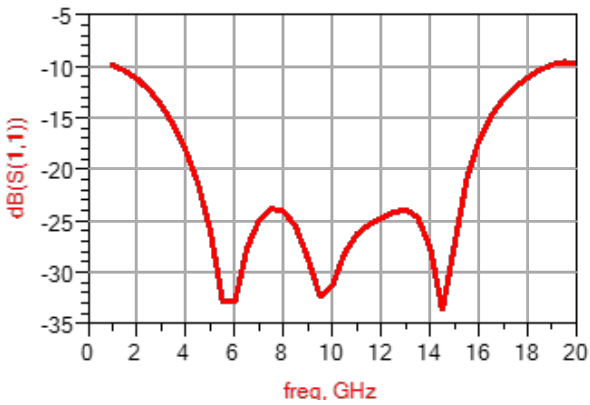

Fig. 3. *Simulated return loss parameter of proposed power divider*

Photograph of proposed 3 leveled Wilkinson power divider is shown in Fig. 6.

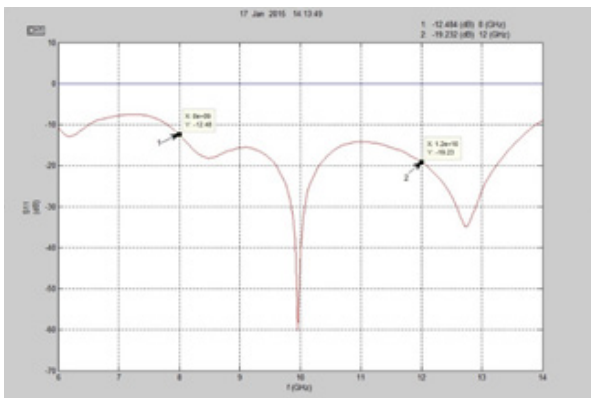

Fig. 4. *Measured return loss parameter of proposed power divider*

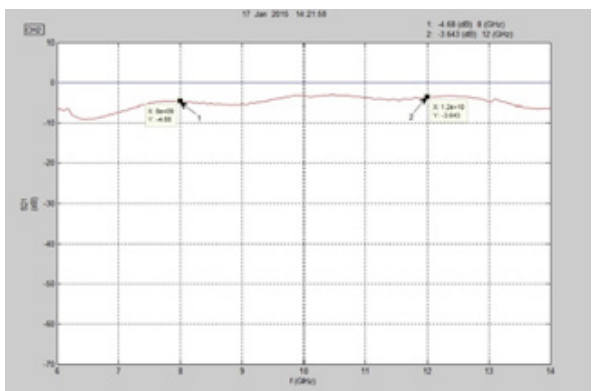

Fig. 5. *Measured transient parameter of proposed power divider*

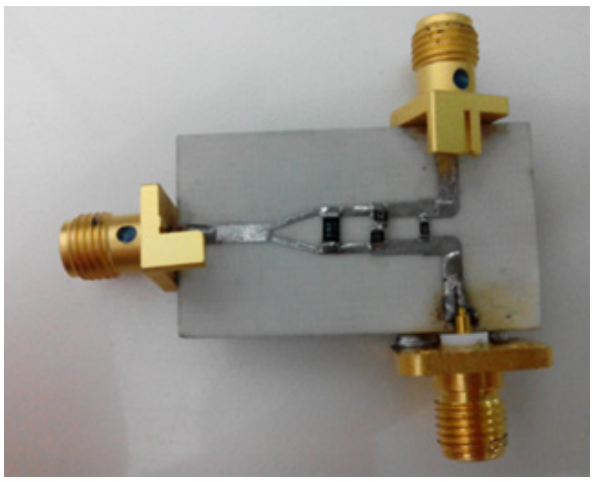

Fig. 6. *Photograph of fabricated Wilkinson power divider*

Conclusion

A three leveled Wilkinson power divider has been proposed for X-band applications. The designed power divider is compact and easy to fabricate. Quality better performance is obtained without using stubs and with only one isolation resistor. Good power dividing, matching, and isolations over the entire X-band spectrum range are obtained as demonstrated by simulation and experimental results.

REFERENCES

[1] Hsin-Hau Chen, Yi-Hsin Pang, A Tri-band Wilkinson Power Divider Utilizing Coupled Lines. IEEE Antenna and Propagation Society International Symposium, 2011.

[2] M.-J. Park and B.Lee, A Dual –band Wilkinson Power Divider. IEEE Transaction on Microwave Wireless Component Letters, vol.18, no.2, February 2008.

[3] H.Zhang and H.Xin, Designs of dual-band Wilkinson Power Divider with flexible frequency ratios. IEEE MTT-S International Microwave Symposium, 2008.

[4] Yu-Ann Lai, Chi-Ming Lin, Jui-Chieh Chiu, Che-Hung Lin, and Yeong-Her Wang, A Compact Ka-Band Planar Three-Way Power Divider. IEEE Transaction on Microwave and Wireless Components Letters, Vol. 17, No. 12, DECEMBER 2007.

[5] Pozar, D. M., Microwave Engineering, 3rd edition, John Wiley & Sons, 2005.

[6] H.Oraizi and A.-R.Sharifi, Design and optimization of broadband asymemetrical multisection Wilkinson power divider. IEEE Transaction on Microwave Theory Technology, vol.54, no.5, May 2006.

[7] M.-J. Park, Two-section cascaded coupled line Wilkinson power divider for dual-band applications. IEEE Transactions on Microwave Wireless Component Letter, vol. 19, no. 4, April 2009.

[8] Yongle Wu, Yuanan Liu and Quan Xue, An Analytical Approach for a Novel Coupled-Line Dual-Band Wilkinson Power Divider. IEEE Transactions on Microwave Theory and Techniques, Vol. 59, No. 2, FEBRUARY 2011.

[9] Yongle Wu, Yuanan Liu, Quan Xue, Shulan Li and Cuiping Yu, Analytical Design Method of Multiway Dual-Band Planar Power Dividers With Arbitrary Power Division. IEEE Transactions on Microwave Theory and Techniques, Vol. 58, No. 12,

DECEMBER 2010.

[10] Xing-Ping Ou and Qing-Xin Chu, A modified Two-Section UWB Wilkinson Power Divider. School of Electronic and Information Engineering South China University of Technology Guangzhou, 2008.

[11] Shangbin Fang, Huiping Guo, Xueguan Liu and Lingfeng Mao, A miniaturized dual-frequency Wilkinson power divider using planar artificial transmission line. IEEE Conference Publication, May 2010.