Comparison of Wilkinson Power Divider And Gysel Power Divider Using Ads® For The Frequency Range of 3 Ghz

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ABSTRACT

Wilkinson Power Divider (WPD) and Gysel Power Divider(GPD) are two competing power dividers and a simple comparison between them helps in choosing the technology for particular application. In this paper, the performance of Wilkinson Power Divider and Gysel Power Divider are analyzed based on the insertion loss, return loss, and also the isolation between the output ports. The insertion loss and return loss of GPD is found to be lower about -3.061dB and -13.754dB respectively when compared with WPD at a center frequency of 1.5GHz. These losses of power dividers realized by microstrip line are analyzed with the operating frequency of 3GHz using ADS® software.

KEYWORDS

Wilkinson Power Divider (WPD), Gysel Power Divider(GPD), Advanced Design System(ADS), Micro-strip line(MLIN).

1. INRODUCTION

Power dividers are also called as power splitters, when used in reverse acts as the power combiner. It plays a vital role in various RF and communication applications [1,2]. The areas of applications are TV analyzer, hand-held spectrum analyzer, antenna arrays, and microwave applications, WLAN such as 802.11b, 802.11g, and 802.11n over a frequency range of 2.4GHz band. It is a passive device which is used in the field of radio technology which requires power to be distributed among different paths. Power dividers are used especially for antenna array systems that utilize power-splitting network, such as a corporate or parallel feed system.

The two main categories of power dividers are reactive and resistive and each can be suited for specific applications. In the above categories, Wilkinson Power Divider (WPD) belongs to reactive power divider properties such as lossless network, high isolation between output ports, low insertion loss and low isolation loss [1,2,8]. It has a single input port and more than one output port with the advantage of matching all ports theoretically and output ports are isolated from one another [4]. Power dividers can be designed with different transmission line sections such as stripline, microstrip and lumped circuit elements.

The desirable properties of a power divider are low insertion loss, low isolation loss, high isolation between output ports and high return loss. The additional deseriable property of a power

Sundarapandian et al. (Eds): CoNeCo,WiMo, NLP, CRYPSIS, ICAIT, ICDIP, ITCSE, CS & IT 07,
pp. 01–08, 2012. © CS & IT-CSCP 2012 DOI : 10.5121/csit.2012.2401

divider is wider bandwidth leading to number of sections and is helpful for N-way power division [1,2].

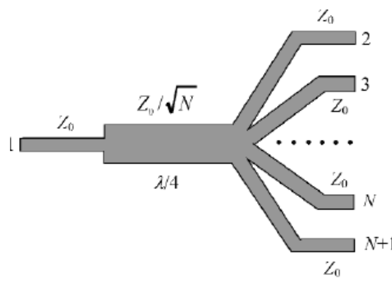

Figure 1: Basic N-way power divider [8,9]

As an illustration let us consider an RF and microwave transmitters which use power dividers/combiners to produce high output power to antenna in phased-array systems [8,9]. In such a case, it is also required to provide a high degree of isolation between output ports over some frequency range. Figure 1 shows a basic parallel beam *N*-way divider/combiner, which provides a combination of powers from the *N* signal sources. Here, the input impedance of the *N*-transmission lines (connected in parallel) with the characteristic impedance of Z_0 each is equal to Z_0/N. With Section I giving the introduction about power dividers the Section II deals with WPD and section III deals about GPD where as section IV describe the comparisons of GPD over WPD. Section V details about results and discussion where as section VI and section VII includes the conclusion and reference respectively.

2. WILKINSON POWER DIVIDER

Figure 2 shows the simulation design of WPD using ADS®. The WPD has been widely used, and numerous works have been done in order to minimize its size or to achieve unequal dual band power division or wideband power dividers [5, 6]. The shortcoming of WPD is the inability to dissipate the heat to the surrounding.

The WPD is a three-port network and lossless when the output ports are matched; where only reflected power is dissipated. Input power can be split into two or more in-phase signals with same amplitude [9]. The design of equal-split (3dB) WPD consists of two parallel microstrip lines. The input is given to both the microstrip lines and the outputs are terminated with twice the system impedance bridged between them. The desirable characteristic of WPD is that it solves the matching problem of the simple T-junction, low VSWR at all ports and isolation between output ports [8-10]. When it acts as an *N*-way combiner it cannot provide sufficient isolation between input ports. The output impedances are perfectly matched only when all input signals have the same amplitudes and phases at any combiner input. Isolation between any two input ports can be expressed by *S*-parameter as

$$S_{ij} = -10log_{10}\left(\frac{1}{N^2}\frac{N^2-1}{2N-1}\right) \quad (1)$$

Where *N* is a number of the input ports and *i*,

$j = 2\ldots N + 1$.

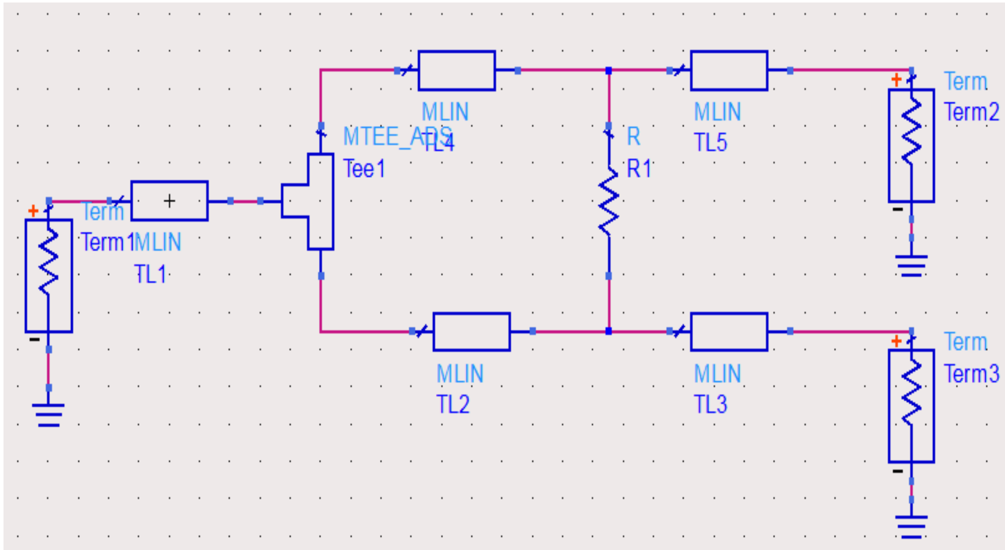

Figure 2: Realization of WPD using ADS®.

3. GYSEL POWER DIVIDER

As opposed to WPD, GPD is used to successfully combine and divide RF power above 10 kilowatt level for each input. This design has characteristics such as low insertion loss, high isolation between output ports, matched conditions at all ports, external high power load resistors and monitoring capabilities for imbalances at the input ports.

GPD has not only the advantage of high power-handling capability [12] but also monitoring capability for imbalance at the output ports. In the above aspects it outperforms the WPD. Figure 3 shows the simulated design of GPD using ADS.

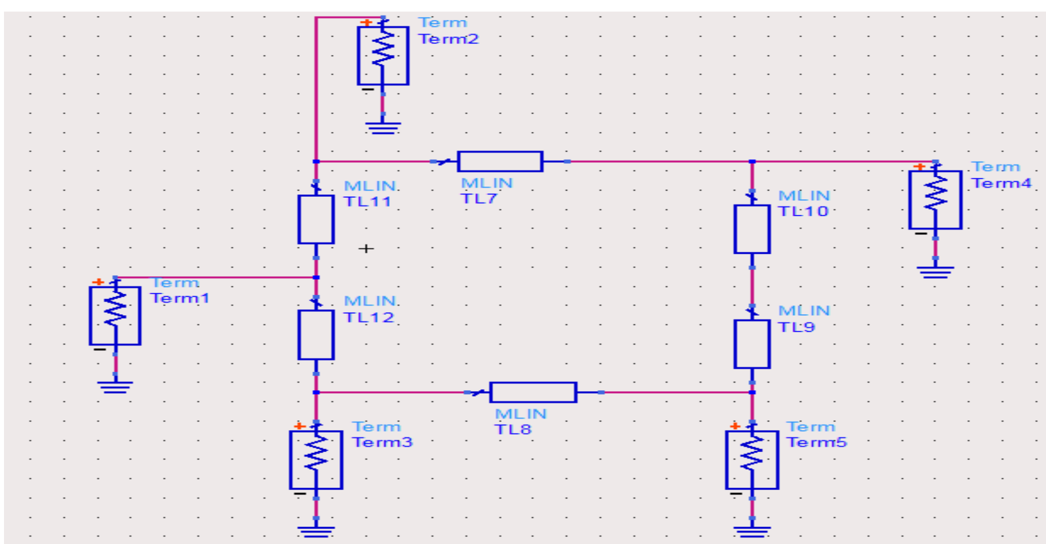

Figure 3: Realization of GPD using ADS®.

4. GPD VERSUS WPD

The GPD provides high power-handling capability and monitoring capability for imbalance at the output ports [12]. The presence of the resistor is transferred the generated heat to the surrounding media. Thus we can say from this GPD overcomes the problem of WPD. GPD has high isolation between output ports when compared to WPD and so it has high power handling capability. It also closely relates to RRC[11]. The above properties are already reported in many literatures for example see [11 - 12].

5. RESULTS AND DISCUSSION

The following figures show the simulation result of insertion loss and return loss of WPD and GPD using ADS®. From the figures, it is shown that GPD's return loss is highly desirable and the insertion loss is low when compared with WPD. Figure 4 and Figure 7 shows the return loss of about -5.823dB and -19.577dB respectively. Comparing these two return loss is highly desirable of about -13.754dB.

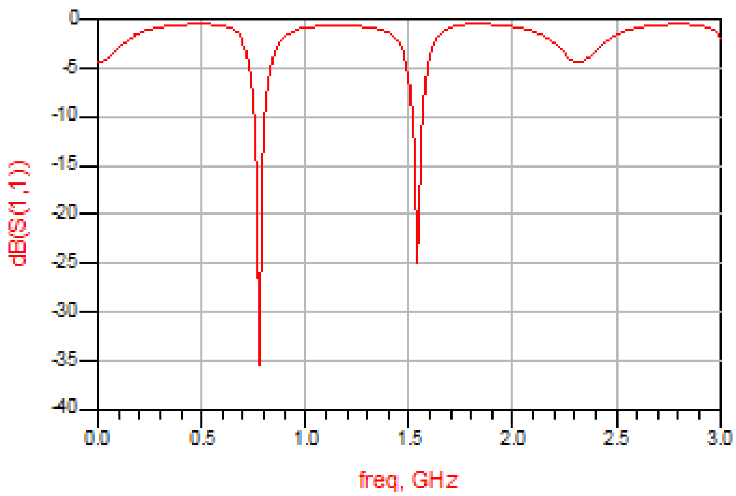

Figure 4: Return loss of GPD

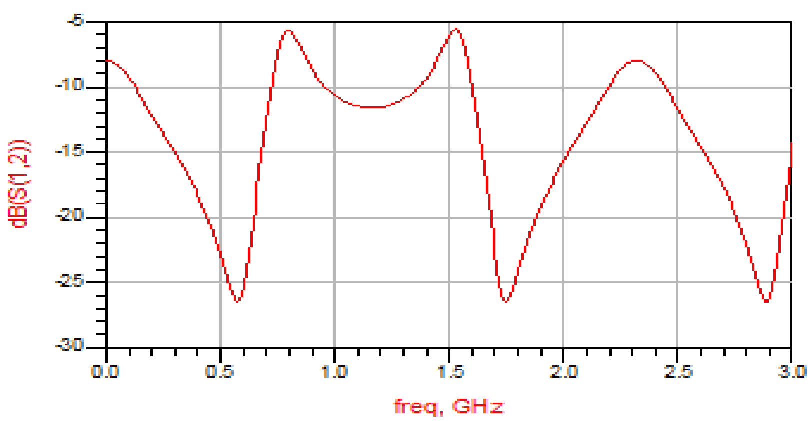

Figure 5: Insertion loss of GPD

It is also seen in Figure 5 and Figure 8 the insertion loss of about -6.128dB and -3.067dB respectively. Comparing these two figures the insertion loss is minimized to about -3.061dB. So GPD is advantageous over WPD. Figure 6 and Figure 9 shows the general s-parameter[S(1,1),S(2,1),S(2,3)] simulation of GPD and WPD respectively.

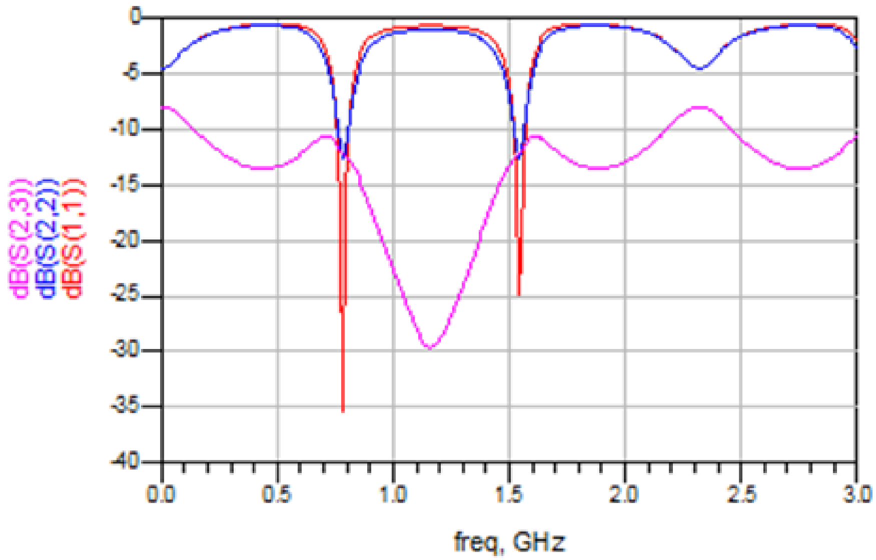

Figure 6: S-parameter simulation of GPD

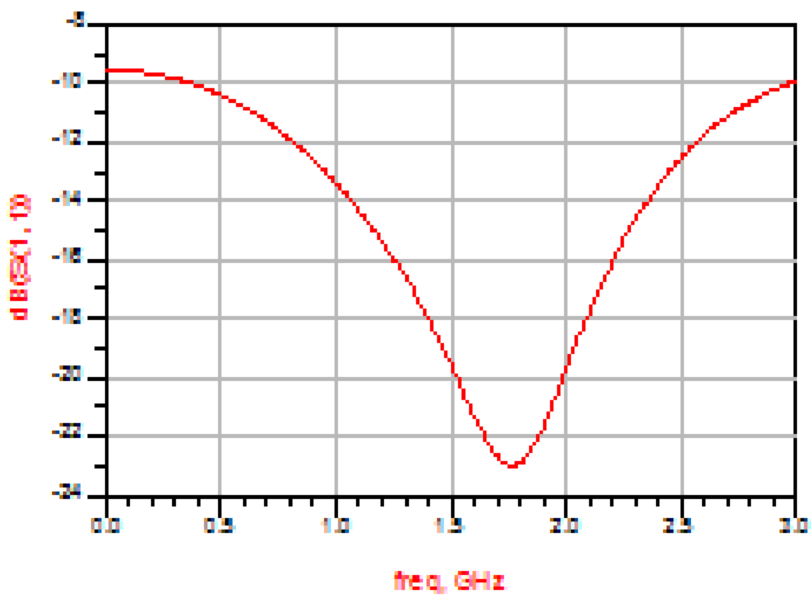

Figure 7: Return loss of WPD

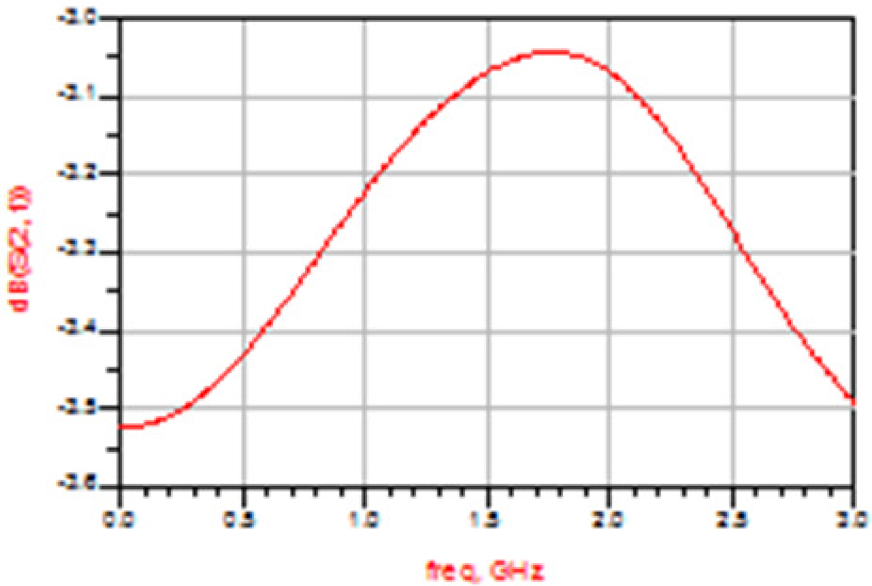

Figure 8: Insertion loss of WPD

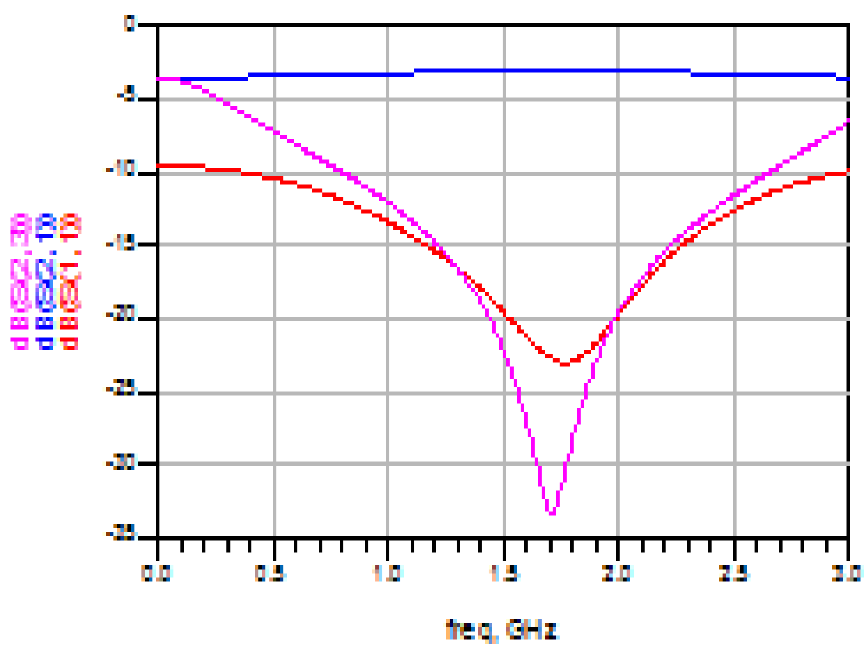

Figure 9: S-parameter simulation of WPD

The important results are tabulated in Table 1.

Table 1: Performance analysis of GPD and WPD

Power dividers	**Return loss (S11 in dB)**	**Insertion loss (S12 in dB)**
WPD	-19.577	-3.067
GPD	-5.823	-6.128

Table1 gives the performance analysis of GPD over WPD on the basis of return loss and insertion loss at the center frequency of 1.5GHz. GPD's return loss and insertion loss is measured of about -5.823dB and -6.128dB where as WPD's return loss and insertion loss is measured about -19.577dB and -3.067dB respectively. Hence the insertion loss and return loss of GPD is found to be lower about -3.061dB and -13.754dB respectively when compared with WPD.

6. CONCLUSION

In this paper, the performance comparison of WPD and GPD are analyzed in terms of return loss and isolation loss with the operating frequency of 3GHz. Due to the transfer of heat through the resistors, GPD possesses high power-handling capabilities and also due to high isolation between the output ports, the insertion loss, return loss gets minimized to about -3.061dB and -13.754dB respectively. The simulation result shows the reduction of losses between the two dividers using ADS software. Thus, we conclude that GPD overcomes the limitations and has better performance when compared to WPD.

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