Design and Realization of Wide Band Power Divider

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***Abstract*— This paper presents wide band power divider on tapered microstrip line which is designed analyzed and fabricated for 500 to 700 MHz frequency rang. The Tapered microstrip line is used to decrease the overall size and enhance the bandwidth of the power divider. Similar approach was used to design a WB three-way tapered microstrip line power divider (TMPD) that operates over a frequency range of 500-700 MHz WB applications using tapered microstrip line. All simulations are carried out by AWR simulator. The measured results show low insertion loss, higher return loss, and high isolation among the output ports across the whole frequency band.**

***Index Terms*—Advancing the wireless revolution (AWR), Tapered microstrip line power divider (TMPD).**

I. INTRODUCTION

Power dividers are devices those not only divides the power but shows reciprocity, as it can also combine the powers from input ports to a single output. The power divider is one of the most common components in RF and microwave systems. The PD can be matched at all ports, which is lossless if the output ports are matched, reciprocal, and the output ports are highly isolated. However, its narrow bandwidth is considered a serious barrier for wideband applications. Various designs and modifications have been introduced in order to increase the bandwidth of the power divider while keeping its other advantages such as high isolation and low power dissipation intact. A method for bandwidth enhancement of the power divider is proposed. To achieve this purpose, tapered microstrip line is used.

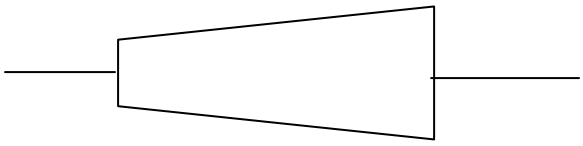

FIGURE:1 Tepered Microstrip Transmission Line

II. RELATED WORK

Author in [1] investigated different type of microwave transmission line like tapered, coupled microstrip transmission lines. These lines, used as interconnects between integrated circuit devices. This paper presents a miniaturized broadband three-way power divider. Most three way power dividers use in-phase power topology such as Wilkinson power dividers, and the output ports are close to each other. To overcome these problems, [2] author adopt a cascade connection of 90° Lange couplers, and is implemented on an FR4 substrate for the frequency range of 460–710 MHz. The quarter-wave transformer in the conventional Wilkinson power divider is replaced by an exponentially tapered microstrip line. In [3] Two additional resistors are added along the tapered line to improve the output return loss and isolation. Another scheme was presented in [4] a 3-way Ultra-Wideband (UWB) unequal split. This paper also focus, an UWB Wilkinson power divider using tapered transmission lines. Using tapered transmission lines in microwave components consequences in reduction of the element length and consequently the overall component size at the same time as presenting wider operational band widths. This power divider [5] author has advanced overall performance in the UWB band (3.1 GHz {10.6 GHz) and is smaller in size as compared to conventional power dividers. In this paper, a wide band power divider based on tapered microstrip lines is designed and realized. Tapered line is used to enhance the bandwidth and decrease the overall size of the power divider. This power divider is designed without any isolation resistor for output ports. The simulation and measured results show good performance over the WB range. Arlon Tc 360 substrate with relative permittivity of 3.5 and thickness of 0.786 mm has been used in the realization of this power divider. This power divider was designed for operating frequencies on 500 to 700 MHz.

III. SIMULATION AND MEASUREMENT RESULTS

A wide band tapered microstrip line power divider was designed for 500- 700 MHz with Source Impedance = 50 ohms, and Load Impedance = 50 ohms. This power divider was designed and fabricated on a Arlon TC 350 with a relative permittivity εr=3.5, a thickness of substrate 0.786mm, and conductor thickness of .035 mm. By using the LPKF ProtoMat C60 tools on AWR software.

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a) EM LAYOUT

Figure 2 shows the layout diagram of the 3-way tapered microstrip line power divider (TMPD). Layout diagram of the proposed design that has been simulated and optimized with MWO simulation in AWR software. Noting that this divider is symmetric around its centre line, an equivalent circuit (looking from port 1 to the right or left side) can be drawn as shown in Figure. Resulting in a perfect match at port 1 (the input port) and equal split power division to the three output ports. In the layout diagram, the proposed design has only use tapered line for wide band range.

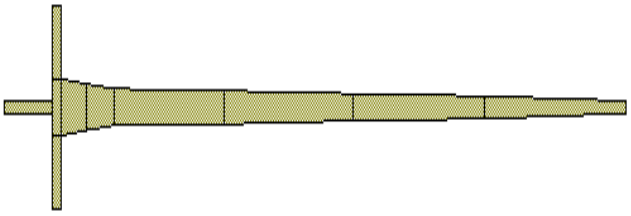


FIGURE 2 Layout Of WB 3-Way Tapered Microstrip Line Power Divider

b) *SIMULATION RESULTS*

Figure 3 shows the return loss (S_{11}) and transmission loss parameter (coupling S_{21}, S_{31},S_{41}). Simulate the circuit of WB 3-Way tapered microstrip line power divider (TMPD) and plot the graphs of various S parameters.

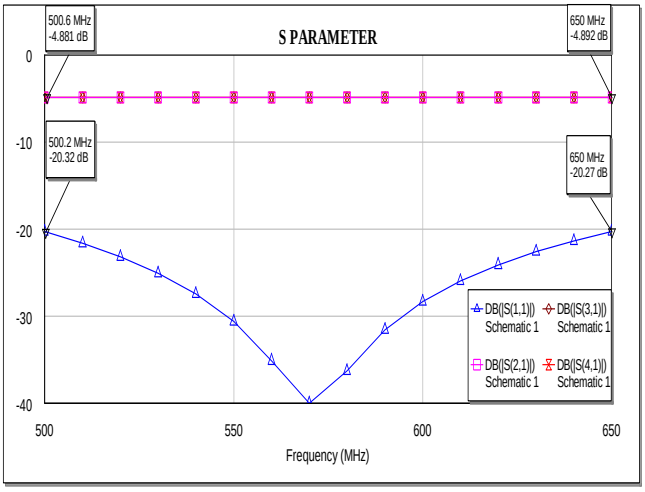


FIGURE 3 Graph Of Wb 3-Way Tapered Microstrip Line Power Divider

This Figure shows that an input return loss better than -20 dB is achieved over the frequency range of 500-700 MHz. Moreover, the resulting transmission parameter S_{21} (which is equals to S_{31}, S41 because of the symmetry of the structure) is close to its theoretical value of −4.7 dB. Over the same frequency range except for the increase in the losses at higher frequencies. Such losses can be decreased through the use of low-loss tangent substrates.

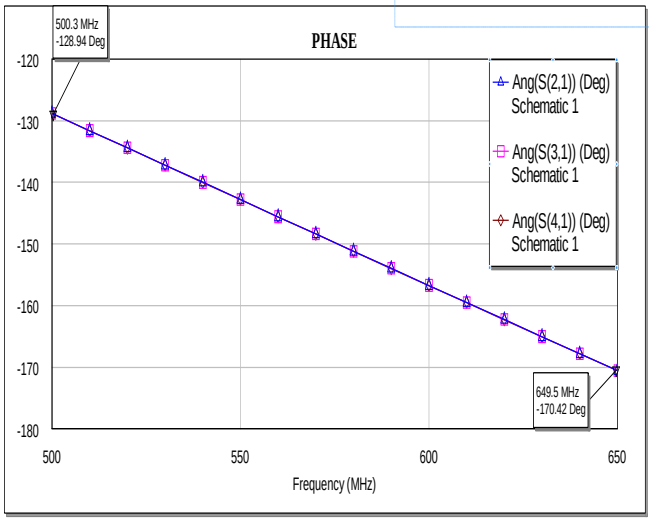
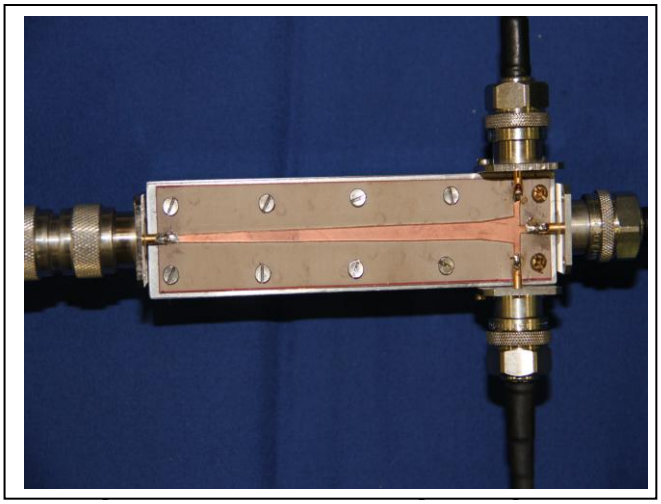


FIGURE 4 Phase of WB 3-Way Tapered Microstrip Line Power Divider

Figure 4 shows that the phase of the output port. The input and output port are perfectly match so resulting in all ports are same phase.

IV. FABRICATION OF WB 3-WAY TAPERED MICROSTRIP LINE POWER DIVIDER

In this paper, a WB 3-way TMPD that operates over the frequency range of 500-700 MHz is presented. Moreover, the divider is fabricated and measured, and the simulation and measurement results are in a good agreement.



worth mentioning here that the substrate used in order to obtain the tapered microstrip line width for all cases is Arlon TC350 with a relative permittivity εr=3.5, a thickness of substrate =0.786 mm, and a loss tangent of 0.002. The length of the designed tapered microstrip line is set to 136.63 mm. Slight increase in the circuitry size leads to obtaining the desired electrical performance, especially the input port matching and transmission parameters performances, not only at a single frequency, but also over a considerable wide range of 500-700 MHz.

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V. RF POWER MEASUREMENTS WITH VNA

The circuit layout shown in Figure 2 is implemented on the same substrate mentioned in above (Arlon TC 350 with a thickness of substrate 0.786 mm and a relative permittivity εr=3.5). A photograph of the fabricated circuit is shown in Figure 5. The measurements have been performed using **R&S ZVB Vector Network Analyzer**. The measured results are shown in Figure 6 the measured return loss is better than -15 dB from 500 to 700 MHz.

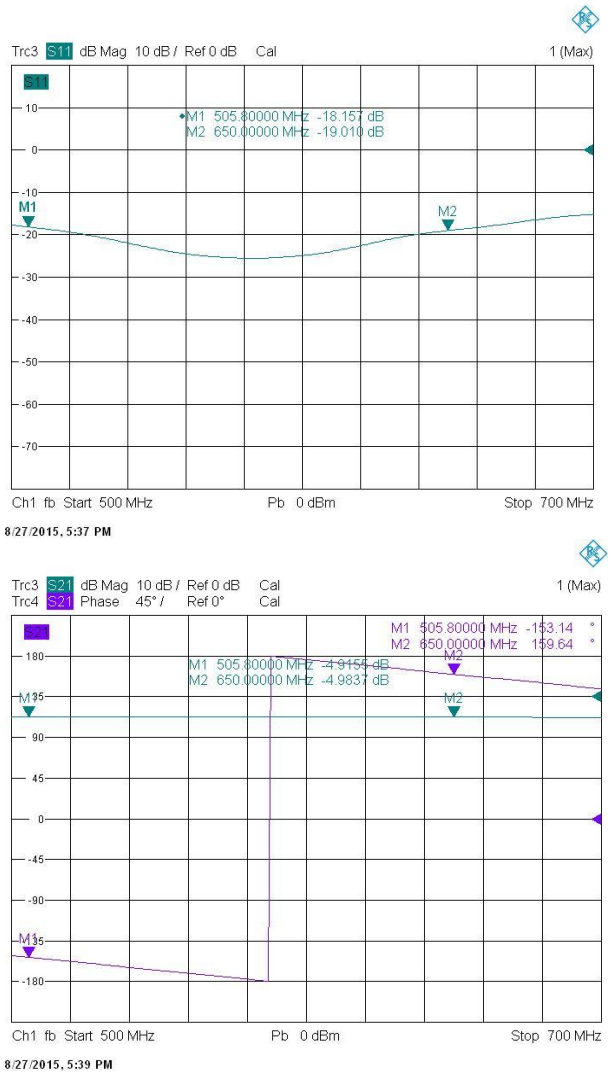

FIGURE 6 VNA Measurements of WB 2-Way Tapered Microstrip Line Power Divider

S PARAMETER	MAGNITUDE (dB)		PHASE	
	MEASUREMENT RESULT		MEASUREMENT RESULT	
	505.8 MHz	650 MHz	505.8 MHz	650 MHz
S_{11}	18.15	19.01		
S_{21}	-4.91	-4.98	153.14^0	159.64^0
S_{31}	-4.91	-4.98	153.14^0	159.64^0
S_{41}	-4.91	-4.98	153.14^0	159.64^0

VI. CONCLUSION

A modified power divider using tapered microstrip lines has been fabricated for wide band applications. This 3-way power divider is lighter and also Compact, cost effective and efficient in comparison to the other power divider with return loss better than 18 dB and excellent amplitude and phase symmetry over frequency band of 500-700 MHz. The measurement results generally match the simulation results.

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