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A High Frequency Dualband Microstrip Bandpass Filter

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ABSTRACT: This paper is a representation of compact microstrip bandpass filter. In this design, two ports are located at the bottom. The basic geometry of this design consists of small thin metal lines that connect the main parts of the design. It operates at 6GHz with S11 of -11,9643dB, S12 of -1.05358. When frequency is 11GHz with S11 of -16,6695dB and S12 at -2,0354dB. Overall features of the design are given in the tables. All of the simulations are done in Sonnet. This design offers a reduction in the size of up to 57% compared to the conventional design. Overall this design offers unique reduction in size as well as good operational capacity.

Keywords:

Power divider; FR4; microstrip; simulation software

1. INTRODUCTION

Designers encounter difficulties when it comes to layout and routing with microwave integrated circuits [1]. Power dividers help them with that. Over a 20%, the power divider offers isolation between output terminals and nearly matched terminal impedances [2]. In multi-frequency power dividers, multi-frequency antenna arrays have gotten a lot of interest. When there are three or more antenna elements, N-way multi-frequency power dividers are used to supply antenna elements [3]. There are also 4-port power diwiders that split an input power to a four outputs [4]. Quarter wavelength long transmission lines are employed as the basic construction block in practically all of those designs, resulting in a substantial circuit size [5, 6]. Most used power dividers are Wilkinson power dividers. They are commonly utilized due to its simple construction, improved isolation, and design simplicity [7]. Due to their IN-PHASE responses, they are not suited for balanced circuits such as balanced mixers, multipliers, and push-pull amplifiers [8-11]. But they are still the most used because thes allows for both equal and uneven power division [12]. Power dividers are very useful element that couple a defined amount of the electromagnetic power in a transmission line to a port enabling the signal to be used in another circuit [13-15]. Using the FR4 substrate of dielectric constant εr = 4.4 and thickness of 1.55 mm allowed us to obtain the desired design of our compact microstrip power divider and further on, the simulation results. The thickness of air is 15.0 mm. All of our work was done in a box, dimensions of which are 23.0 mm and 10.0 mm by x and y axis respectively. The cell size is adjusted to 0.1 $mm * 0.1\ mm$ due to such compact size. The following figure shows the layout of the top view of the filter containing all the determined dimensions. Along with the design, analysis was done as well in Sonnet Suites which came in as a very handy and practical tool, thanks to its simplicity and variations of options.

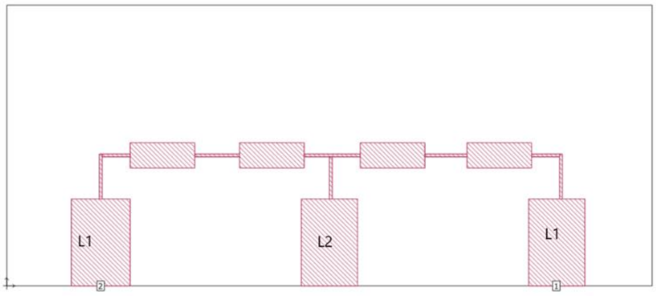


Figure 1: Top view of the filter

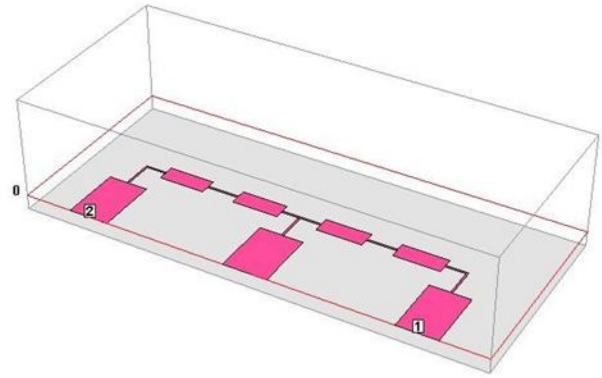


Figure 2: 3D view

It can be observed from the Figure 2 which shows how our graph appears, that this power divider passes frequencies between 6 and 11 GHz. The maximum of S11 is the value of -35 dB at 5.25 GHz and the value of S12 is near 0 dB 5.25 and 7 GHz. Creating alterations in the process of making allowed the obtaining of high value of S11 and low value of S12.

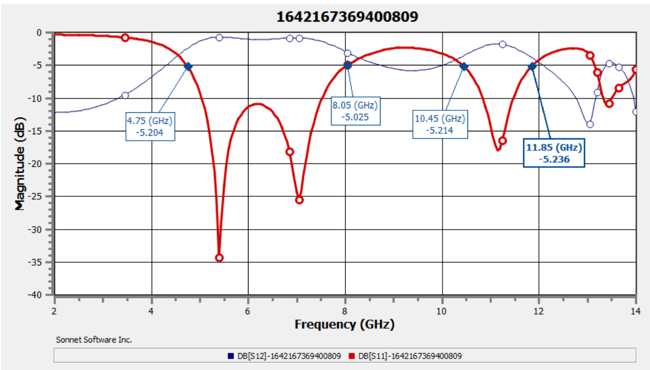


Figure 3: Filter response graph (S11 RED, S12 BLUE)

2. PARAMETRIC STUDY

In order to examine the output, physical parameters of the power divider were altered. Altering the size of the L1 and L2 parts of our design we where able to examine the changes in frequency in the S11 and S12 curves.In the tables below you can see our recorded data for the given changes. Both of the elements had the original width of 2.0 mm and we expanded that size by small increments and looked at the changes in the curve.

1) Changing the dielectric thickness

By increasing the dielectric thickness, S11 decreases at Frequency of 6GHz. Under the same conditions, S12 initially increases and then begins to decrease again. If we test the power divider again by increasing the dialectric thickness, but with a frequency of 11GHz, S11 will increase slightly, while S12 increase again until 1.57 mm. There it will decrease slightly, but after that it starts to increase again. You can see these variations in the following table.

TABLE 1 Changing the dielectric thickness

DIELECTRIC THICKNESS	MAGNITUDE (dB)		FREQUENCY (GHz)
	S11	S12	
1.50 mm	-11.655	-1.03447	6
1.53 mm	-11.6188	-1.0338	6
1.55 mm	-11.6094	-1.03195	6
1.57 mm	-11.5802	-1.04012	6
1,60 mm	-11.5308	-1.05358	6
DIELECTRIC THICKNESS	MAGNITUDE (dB)		FREQUENCY (GHz)
	S11	S12	
1.50 mm	-13.3344	-1.86399	11
1.53 mm	-13.3916	-1.85285	11
1.55 mm	-13.5338	-1.8388	11
1.57 mm	-13.571	-1.8561	11
1,60 mm	-13.5436	-1.8371	11

2) Changing the ε_r

With an increase in ε_r and a frequency of 6GHZ, S11 decreases, while S12 increases. With a frequency of 11GHz, S11 increases slightly, then decreases, then increases sharply. S12 is decreasing.

TABLE 2 Changing the ε_r

ε_r DIFFERENCE	MAGNITUDE (dB)		FREQUENCY (GHz)
	S11	S12	
4,5	-11,5533	-1,04826	6
4,45	-11,6064	-1,0413	6
4,40	-11,655	-1,03447	6
4,35	-11,7882	-1,03685	6
4,30	-11,8784	-1,01576	6
ε_r DIFFERENCE	MAGNITUDE (dB)		FREQUENCY (GHz)
	S11	S12	
4,5	-16,6695	-1,7773	11
4,45	-16,6175	-1,82473	11
4,40	-13,3344	-1,86399	11
4,35	-14,7665	-1,99787	11
4,30	-10,5882	-2,13898	11

3) Changing the length of L1

In the following table you can see how changing element L1 from 2 to 2.2 affects S11 and S12.

TABLE 3 Changing the length of L1

CHANGE IN LENGTH OF L1	MAGNITUDE (dB)		FREQUENCY (GHz)
	S11	S12	
2,0	-11,8742	-1,01554	6
2,05	-11,8289	-1,02637	6
2,1	-11,78	-1,03441	6
2,15	-11,7263	-1,03814	6
2,2	-11,667	-1,04679	6
CHANGE IN LENGTH OF L1	MAGNITUDE (dB)		FREQUENCY (GHz)
	S11	S12	
2,0	-10,3081	-3,4928	11
2,05	-10,1289	-3,5332	11
2,1	-9,65088	-3,6500	11
2,15	-10,067	-3,62851	11
2,2	-9,56303	-4,0354	11

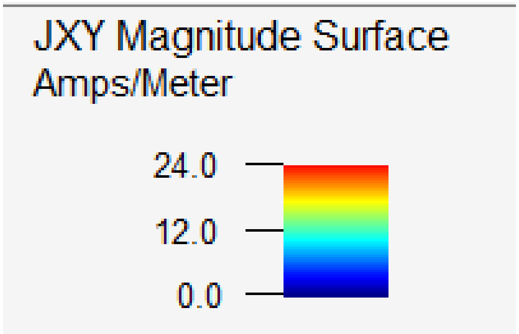
4) Changing the length of L2

In the following table you can see how changing element L2 from 2 to 2.2 affects S11 and S12.

TABLE 4 Changing the length of L2

CHANGE IN LENGTH OF L2	MAGNITUDE (dB)		FREQUENCY (GHz)
	S11	S12	
2,0	-11,8742	-1,01554	6
2,05	-11,9643	-1,01004	6
2,1	-12,053	-1,00454	6
2,15	-12,1422	-0,999142	6
2,2	-12,2307	-0,9939	6
CHANGE IN LENGTH OF L2	S11	S12	FREQUENCY (GHz)
2,2	-14,1431	-1,89305	11
2,15	-14,1431	-1,89305	11
2,1	-14,2499	-1,83331	11
2,05	-14,0862	-1,82801	11
2,0	-14,0862	-1,82801	11

Figures 4 and 5 show the current distribution on two resonant frequencies. As seen in figures, currents are crowded at the outer sections of the metals, as expected and at discontinuities.



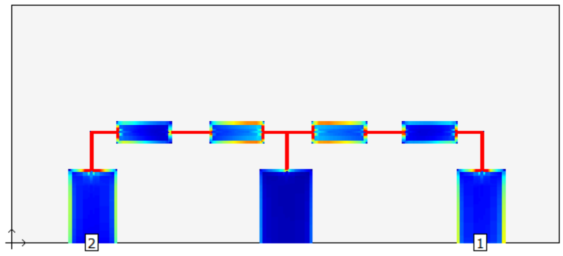


Figure 4: Current distribution at 7 GHz

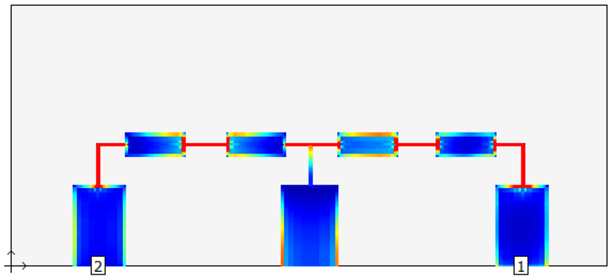


Figure 5: Current distribution at 11 GHz

3. CONCLUSION

The starting point to observing this work's characteristics is Figure 1, where we have laid out the top view of our power divider along with all its dimensions. Our aim was to present the best response of such power divider and by using the proposed dimensions, the response recorded is shown in Figure 2. With frequency of 6GHz, S11 is -11,9643dB, S12 is -1.05358. When frequency is 11GHz, S11 -16,6695dB and S12 is -2,0354dB. The Parametric Study part of this paper shows all the deviations created by varying four features of our work. This power divider was designed in pursuit of demonstrating the compactness and good performance.

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