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Size reduction of UWB power divider using double tapered transmission line

S.C. Sivaprakash*, A. Sivanantharaja, P. Senthil Babu* and K. Monika***

ABSTRACT

The ultra-wide band power divider using double tapered transmissionline is studied. The size of the structure is reduced using double tapered coupled transmission line, which operates in the same ultra-wide band frequency from 3.1 GHz -10.6 GHz. 50% of size reduction is obtained with all the S-parameters satisfies the requirements. Simulation is done by AnsoftHFSS 13.0.

Keywords: Wilkinson power divider, ultra-wide band, microstrip coupled line, tapered transmission line.

1. INTROUCTION

In recent years, there has been more interest to develop many passive microwave components using microstrip. One such thing is, power divider/power combiner circuit; it has been extensively used in communication systems. They couple a defined amount of electromagnetic power from the input port and couple the signal equally or unequally among the output ports.Good power divider performs better by giving good input return loss, insertion loss and better isolation between the output ports. Wilkinson introduced the first power divider that can split the power in any ratio [1]. It operates at only one frequency, which is decided by its line length. The isolation loss can beachieved by adding the resistor in between the output ports. The bandwidth of the power divider is improved by multi quarter-wave transformer sections [2-4]. But this increases the size of the power divider. The size of the power divider is reduced by using several methods [5-13]. But the performance of the S-parameters is decreased. The bandwidth and isolation characteristic of the divider is improved by different methods [14-20]. The ultra wide band power divider operates over a frequency of 3-18 GHz with high return loss is proposed [21]. But the output return loss and isolation were less than 15 dB. A UWB power divider was introduced with multilayer slot configuration to operate in the range of 3.6-10.2 GHz [22]. The isolation is improved to 10-15 dB by the introduction of resistors at the output ports. The quarter wave line is replaced by tapered transmission line [23-25]. This gives consistent impedance transformation over the desired band of frequency. The different electrical parameters are improved along with the isolation, by adding additional resistors. The structurewiththree section tapered line with three isolating resisters, also has the long input and output lines made it to a large structure [25]. The total structure is reduced and the resisters are added.

Fig. 1 shows the structure of ultra-wide band power divider. The power divider uses Rogers RT (5880) as the substrate with relative permittivity of ε_r of 2.2. The power divider which uses the tapered transmission line to provide the UWB bandwidth. The input output ports are matched by 50Ω load impedance.

Fig. 2 shows the tapered line. Tapered line used here is 30mm so that it produces the frequency range of 2GHz to 10GHz.

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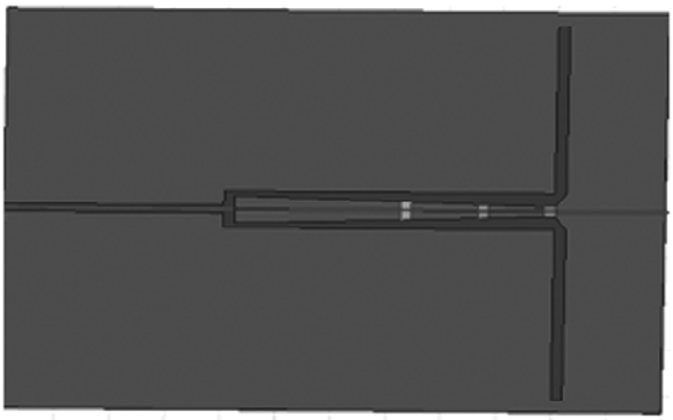

Figure 1: Structure of the UWB power divider

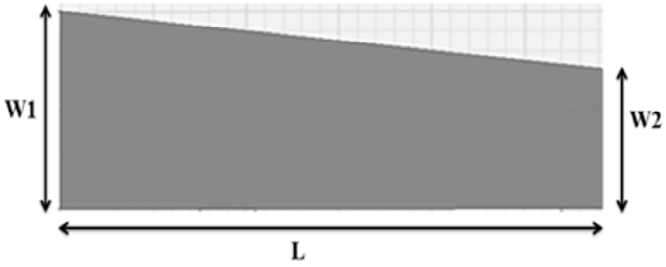

Figure 2: Existing tapered line

L-Length of the existing tapered line is 29.95 mm, W1-width of the existing tapered line is 1.5 mm and W2-width of the existing tapered line is 0.5 mm.

2. THEORY

Tapered transmission line is used to match input impedance to a low impedance load. There are many ways to choose the tapered line. One can obtain different pass band characteristics. Several taper profiles may consider such as: linear, exponential, triangular, and so on. The tapered line provides the constantimpedanceacross all frequencies. The amplitude ripple and the return loss are greatly improved by using doubletapered transmission line.

3. PROPOSED DESIGN

The proposed ultra-wide band power divider thatuses the tapered transmission line to provide smaller size and to provide UWB band. The proposed power divider which uses Taconic as the substrate with a relative permittivity ε_r of 3.5mm, With a thickness of 0.8mm. The input and output ports are chosen to be 50Ω load impedance. Fig.3 shows the geometry of the proposed power divider

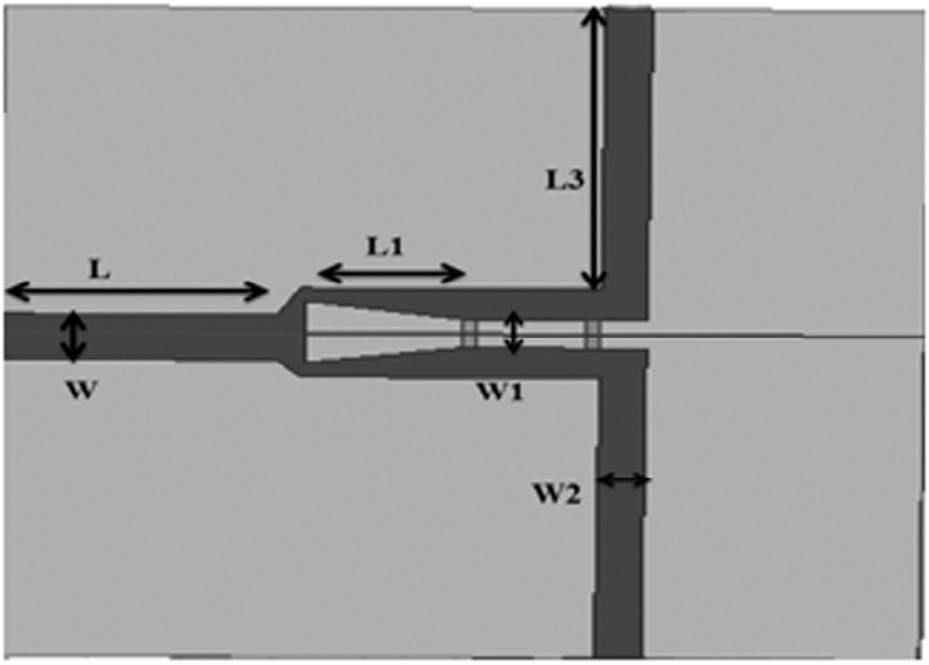

Figure 3: proposed UWB power divider

The tapered transmission line is used to provide the ultra-wide bandwidth. The advantage of using proposed power divider is that it reduces the sizeand cost, easy to design and fabricate.

The resistor Ro and R1 are placed between the output ports to achieve good isolation. The gap between the two resistors should be same. The resistance values are chosen to be 100Ω and 200Ω respectively.

Table 1
proposed power divider dimensions

parameter	L	W	L1	W1	L2	W2
value	6	1.54	3.5	1	10.5	1

Table 1 shows the dimensions of the proposed ultra wide band power divider using the double tapered transmission line.

4. PROPOSED TAPERED LINE

L-Length of the tapered line is 3 mm, W1-width of the tapered line is 1 mm and W2-width of the tapered line is 0.7 mm.

Fig. 5 and Fig. 6 show the measured return loss, insertion loss and isolation of the proposed UWB double tapered transmission line.

5. RESULTS AND DISCUSSION

The proposed double tapered transmission lineultra-wide band power divider is designed to operate at 3-11 GHz have been simulated by using the simulator Ansoft HFSS 13 (High Frequency Structure Simulator) and the scattering parameters are analyzed. The power divider is simulated with TaconicRF35 substrate

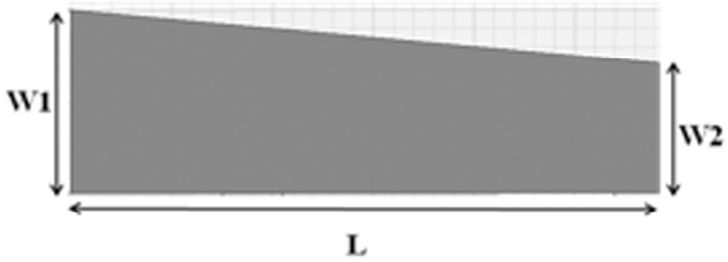

Figure 4: proposed tapered line

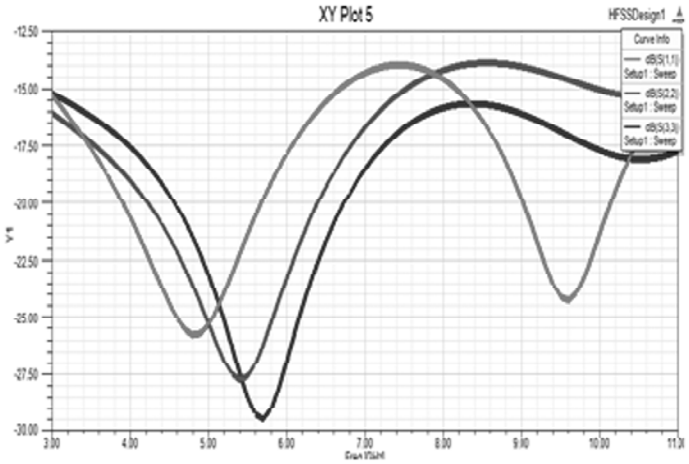

Figure 5: Measured S-parameters S11, S22, S33

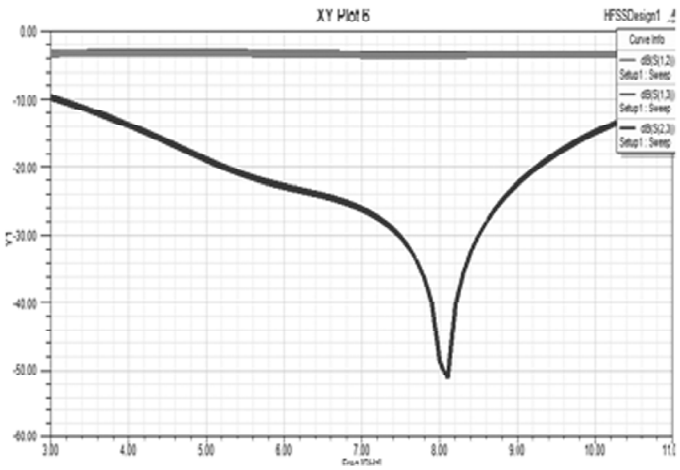

Figure 6: Measured S-parameters S12, S13, S23

which has 0.8 mm thick and a relative permittivity of 3.5 mm. The input and output port impedances are chosen to be 50 Ω. The simulated results shows that, by using double tapered transmission line the size gets reduced and it provides better insertion, return and isolation losses between the ports.

6. CONCLUSION

The proposed power divider works under the ultra-wide band in the frequency range of 3.0-10.6GHz. In this paper tapered transmission line is used to reduce the size of the power divider. The size of the total structure is 21 × 20mm. The return loss is also reduced up to -30dB. Isolation between the ports is obtained -50dB.The Insertion loss is to be maintained at -3.1dB. So the proposed power is well suited for UWB Band applications.

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