Design and Fabrication of Power Divider for High Power X-Band Applications

Semih Ünal

Supervisor

Prof. Dr. Birsen Saka Tanatar

Electrical and Electronics Engineering, Hacettepe University

Introduction

This project is done in collaboration with AB Mikro Nano A.Ş. & NANOTAM. The improvements in the RF/Microwave systems in the past decades have led to increasing demand for the compact, high performance power dividers. Power dividers are one of the essential components of the modern RF communication systems since dividing makes RF power amplification easier to handle. Therefore, the goal is to design a wideband power divider with high power handling capability for X-band (8-12 GHz).

Specifications and Design Requirements

- ❖ Specified footprint (maximum 3mm^2)
- ❖ Minimum 15dB isolation.
- ❖ Minimum 15 dB return loss.
- ❖ Low Insertion loss .

Solution Methodology

Wilkinson power divider is widely preferred topology since it is easy to fabricate in monolithic microwave integrated circuits (MMIC) processes. An ideal WPD is a symmetrical circuit that consists of two $\lambda/4$ transmission lines with the characteristic impedance of $\sqrt{2}Z0$ where Z0 is the characteristic impedance.However, because of the $\lambda/4$ arm lengths, they occupy a large area that increases the chip cost. So, miniaturization technique is applied.

Power dividers are fabricated at ABMN's Gallium Nitride (GaN) on Silicon Carbide (SiC) microfabrication process.

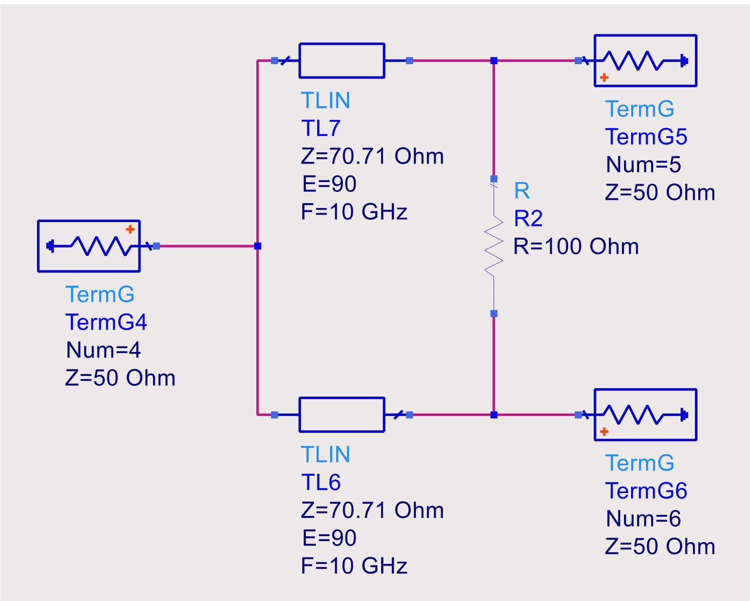

Figure 1. Ideal WPD model

First schematic model is designed, then the layout design is passed.

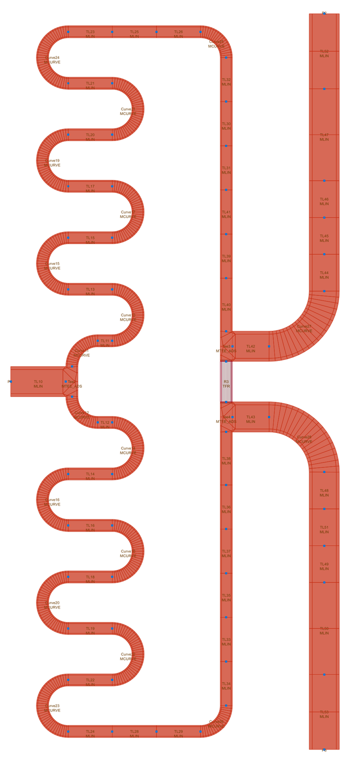

Figure 2. Layout model of WPD

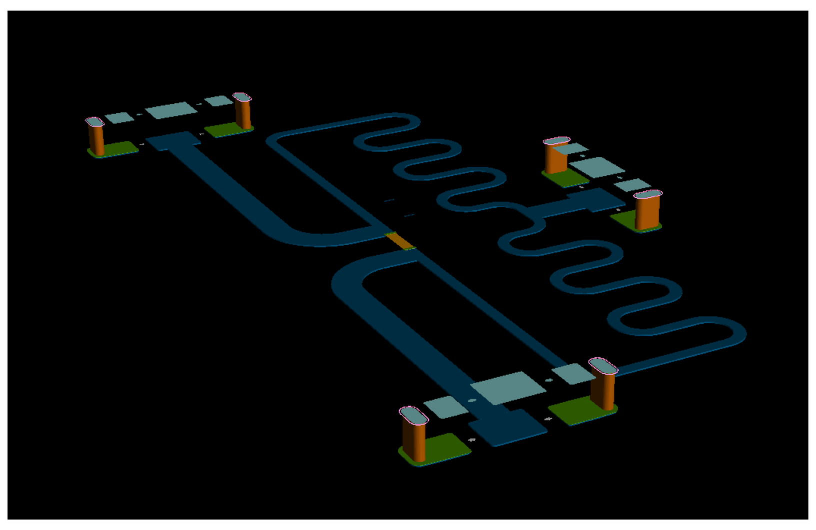

Figure 3. 3D view of WPD

Application Areas

Communication systems, radars, electronic warfare and space applications desire integrated circuits with higher operating frequencies. Working at the millimeter wave region increases data rates, provides a more efficient use of the spectrum and enables smaller products. Power dividers are used as building blocks for such applications to split and combine RF signals.

Results and Discussion

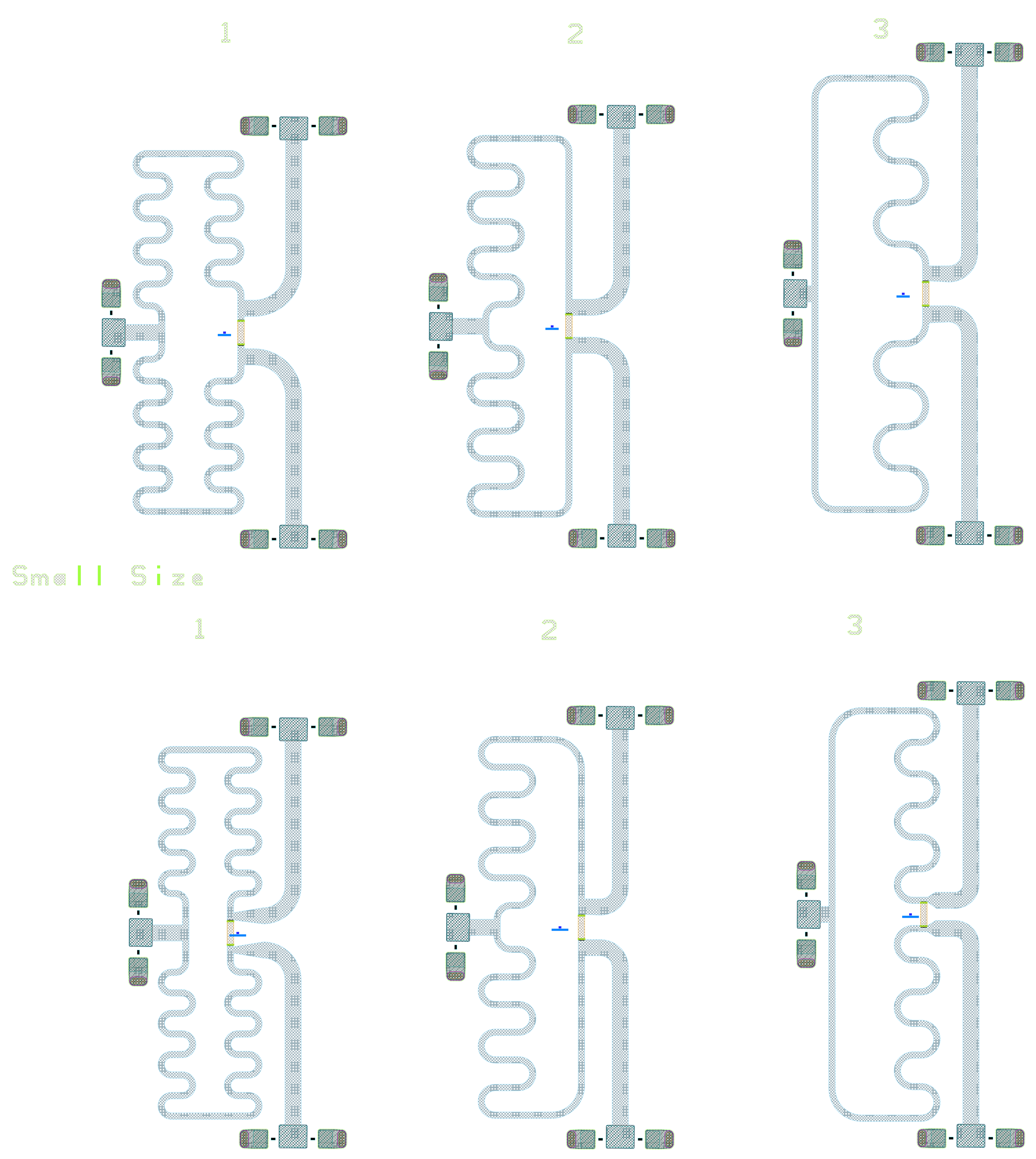

Figure 4. Tape out models of all designs

Upper side represents the main 3 designs and bottom side represents their enhanced versions.

Model	Input Return Loss (dB)	Output Return Loss(dB)	Isolation (dB)	Extra Insertion Loss (dB)	Size (mm^2)
Design 1	18dB	25dB	17dB	0.60dB	2.75
Design 2	15dB	24dB	17dB	0.59dB	2.81
Design 3	17dB	25dB	18dB	0.55dB	3
E. Design 1	17.5dB	25dB	17.5dB	0.62dB	2.42
E. Design 2	17.5dB	24dB	16dB	0.58dB	2.58
E. Design 3	18dB	25dB	17dB	0.58dB	2.76

Table 1. Comparision of all designs

All designs occupy a small area, and this means that cost effective. For all designs, the extra insertion loss is between 0.5dB to 0.8dB. The isolation between the output ports is better than 17dB throughout the bandwidth. Input return loss is also better than 17dB and and output return loss is better than 24dB.

References

[1] D. Pozar, Microwave Engineering, 3rd ed. Hoboken, New Jersey: John Wiley & Sons Inc. pp. 308-361, 2005.

Acknowledgements

- ❖ This project was completed within the context of ELE401-402 Graduation Project courses in Hacettepe University, Faculty of Engineering, Department of Electrical and Electronics Engineering.
- ❖ Special thanks to Prof. Dr. Birsen Saka, Erdem Aras and ABMN Team for this project and for their invaluable contributions.