University of Cyprus
Photovoltaic Technology

Report produced by the UCY for the Cyprus Research Promotion Foundation.

Prepared in fulfilment of deliverables D15 of Work Package 4, “Design and Implementation of a Novel Wireless Receiver Chain using Metamaterial Quad Band Devices”, ΤΠΕ/ΕΠΙΚΟΙ/0609(ΒΕ)

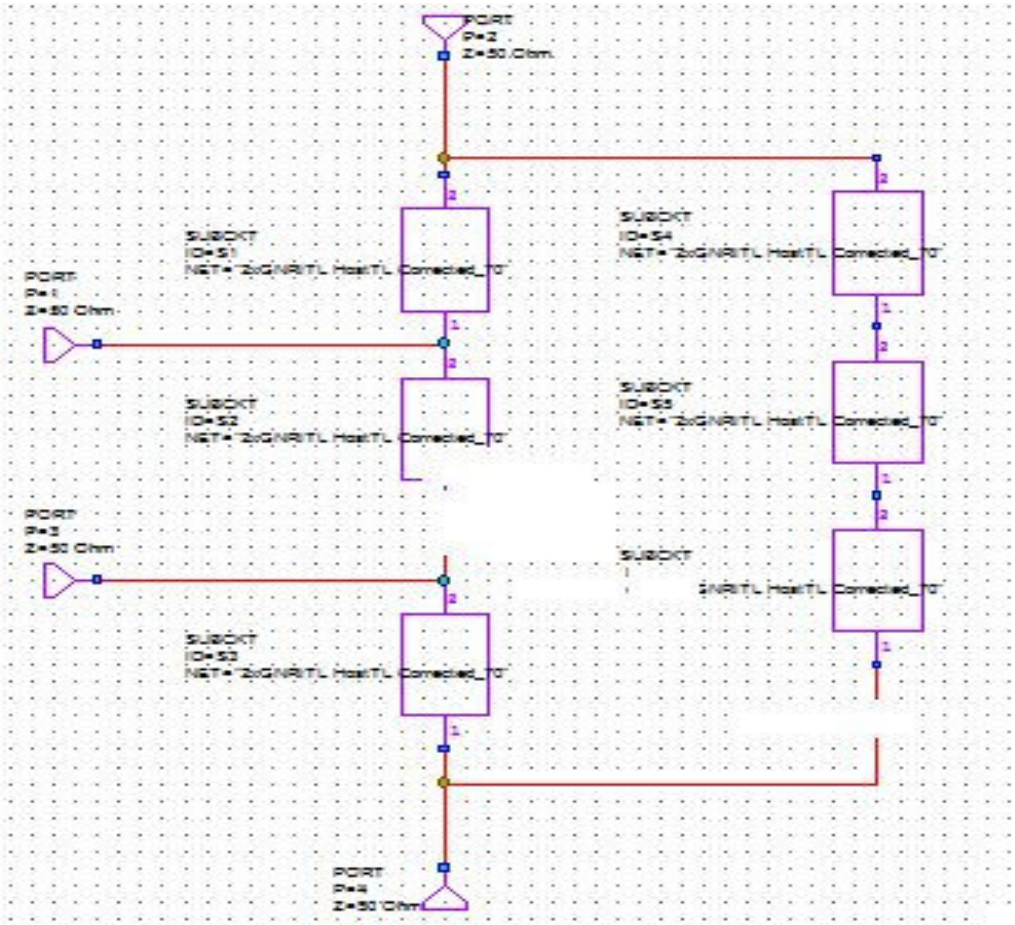
Table of Contents

Summary

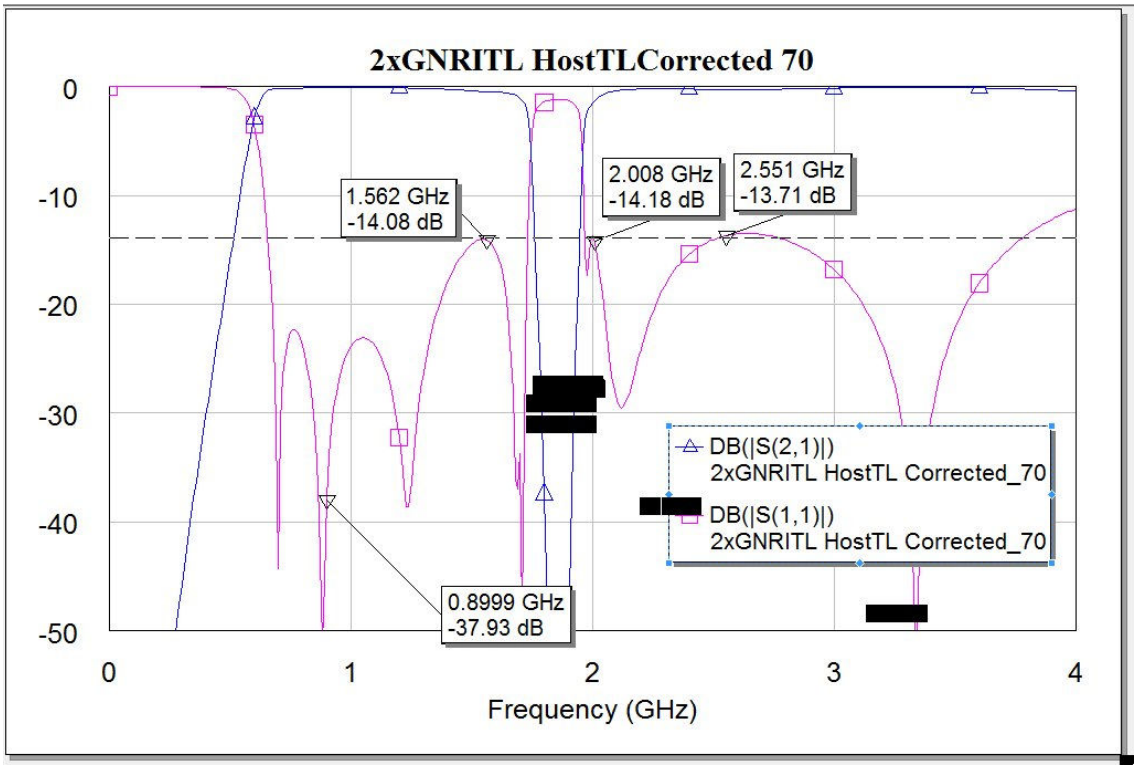
The objective of this work package was to develop a simulation for the quad band branch-line coupler, then design the branch-line coupler layout and assembly and finally fabricate, test and tune the metamaterial coupler. Deliverable 15 (D15) deals with the fabrication of the branch-line coupler. However, as stated in D12, after some preliminary circuit simulations, it was decided that the rat-race coupler shall be fabricated instead, to give better performance on the magnitude and phase tolerance to circuit variations. The goal was thus became to design and fabricate a rat-race coupler using the 70.7 ohm quad-band metamaterial unit cells instead of the 90 degree Transmission Line segments that make up the classical rat-race coupler. Test data will be taken using the labs' Vector Network Analyzer.

Design and fabrication process

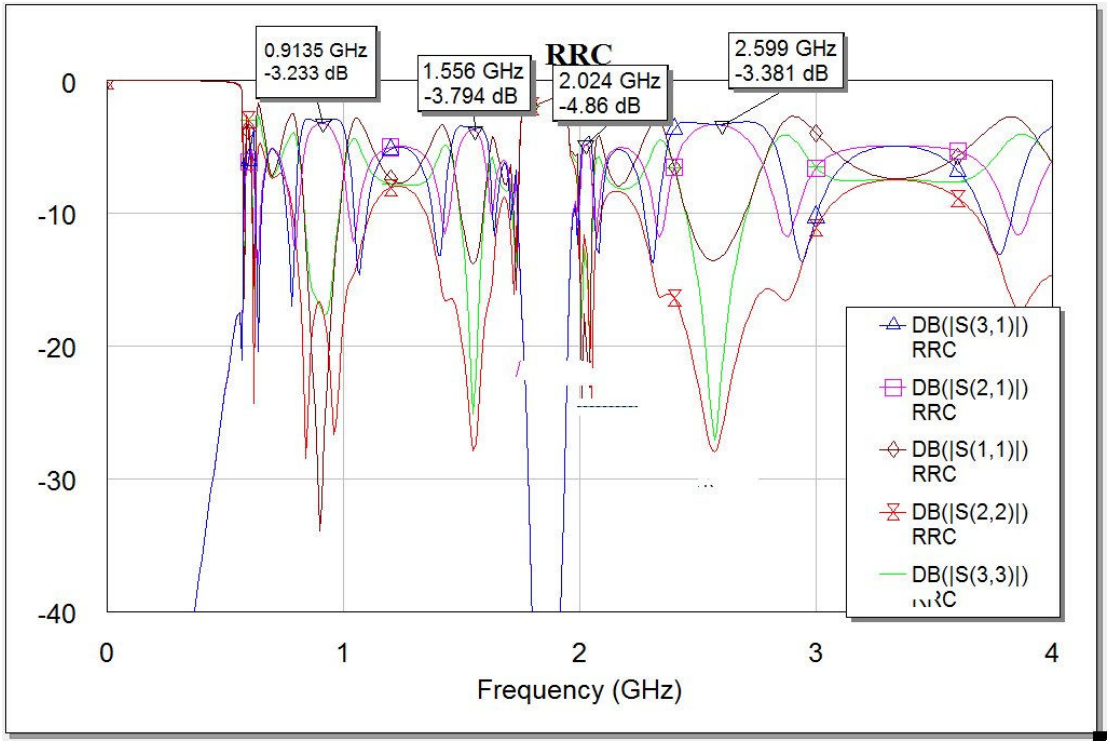
The four frequencies of operation that were chosen were f1=900MHz, f2=1.55GHz, f3=2.017GHz and f4=2.592GHz. The desired phase shift that we wish to be incurred by each unit cell at these four frequencies is 45 degrees. The schematic of the rat-race coupler using two unit cells for each 90 degree line section is shown below:



The performance of each double unit-cell section is shown in the graph below and it can be seen that the return loss at each frequency is below 13dB which is acceptable. At the same time, we note that the effects of the host transmission line is already accounted for in the performance.

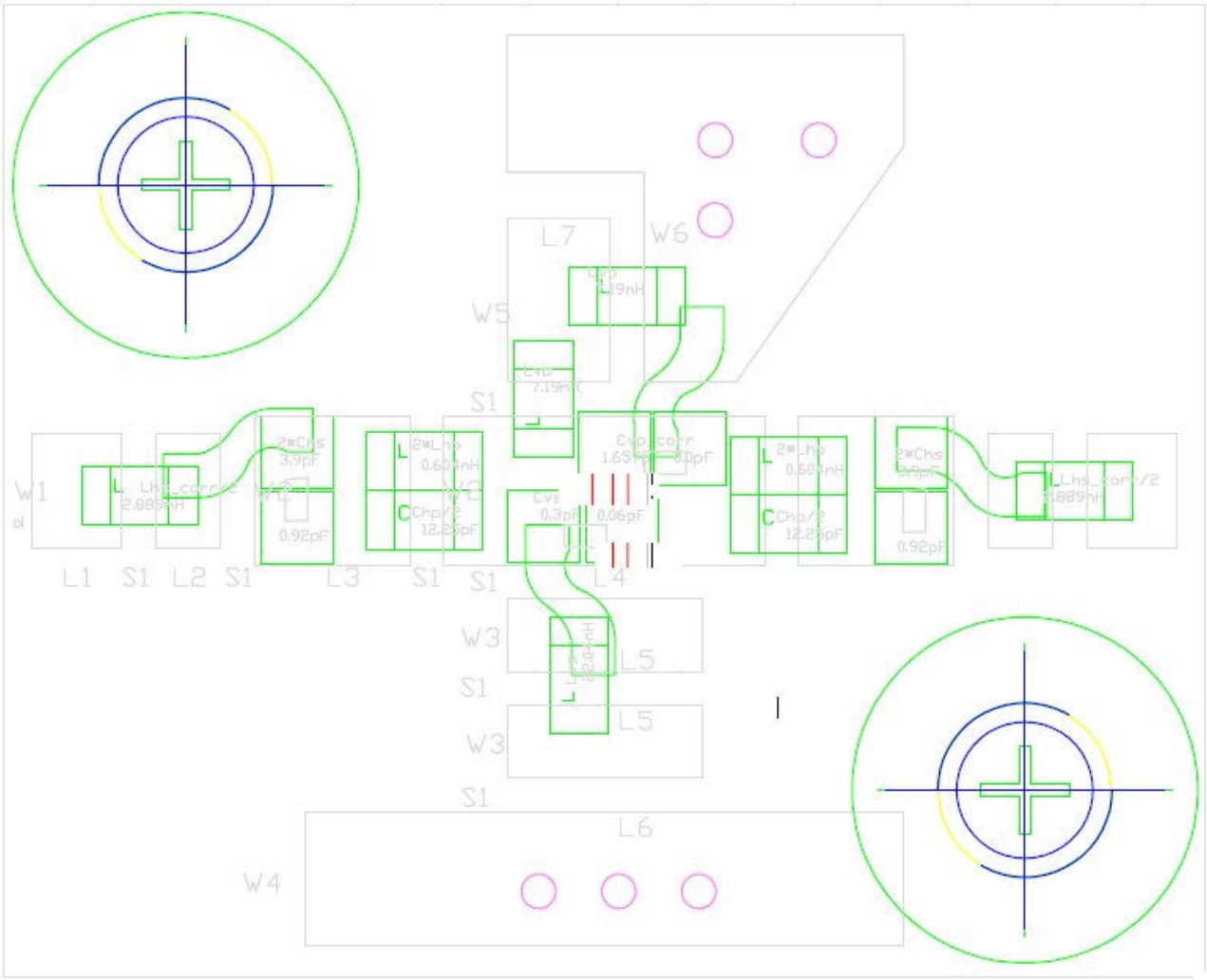


The final performance of the rat-race coupler is shown in the graph below:



From the above graph, it can be seen that the insertion loss at the four design frequencies is acceptable and thus validation of the rat-race coupler concept using NRT-TL unit cells is complete.

The next step in the design process was to design the unit cells in a CAD software in order to set the topology and the structure of the rat-race couplerl and its components. Below, an image from AutoCAD shows this design using the 70.7 ohm unit cell.



In the next few weeks, the fabrication will be completed, since the capacitors ordered for the unit cells have not yet arrived. Once the capacitors are in the lab and the unit cell fabricated, the measured data will also be presented.

References

[1]. G.V Eleftheriades, “Design of Generalized Negative-Refractive-Index Transmission Lines for Quad-Band Applications”, IET Microwaves, Antennas and Propagation, 2009

[2] M. Pozar, “Microwave Engineering, 3rd Ed.”