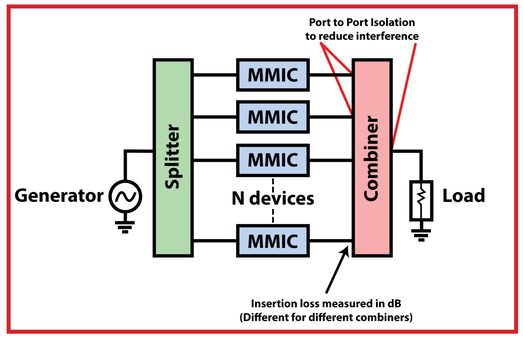
# Raytheon

# Power Combiners for RF Transmitters

Olin College of Engineering

For applications like radar, the efficient generation of high output powers is desirable since detection range is limited to a large extent by the system's RF output power. To increase power levels and improve system reliability, it is desirable to achieve required power levels by combining the outputs of multiple amplifiers. We researched state of the art combiner technologies, evaluated their performance metrics, and designed a prototype of a down selected approach.

## Power Combiner Basics




A power combiner is a device that combines multiple RF signals into one, with minimal loss in the system. A typical system consists of a splitter, N power amplifiers, and the power combiner. The purpose of this system is to realize efficient, cost effective RF power amplification in a small form factor with solid state power amplifier ICs.

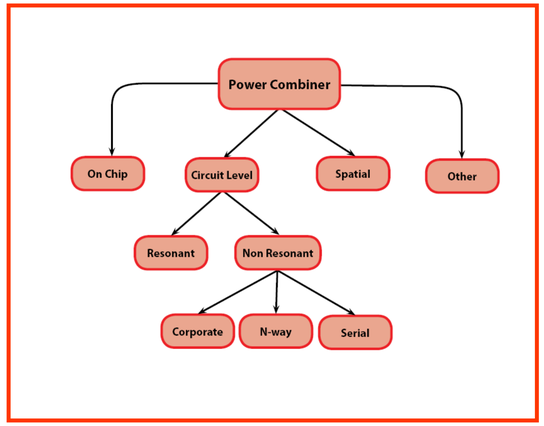
Power combiners are desirable alternatives to vacuum tube technology. By splitting the amplification over multiple chips, the system becomes much more robust. Instead of catastrophic failure and an intensely difficult replacement process, power combiners allow for the failure of individual amplifiers to result in graceful degredation.

## Literature Review

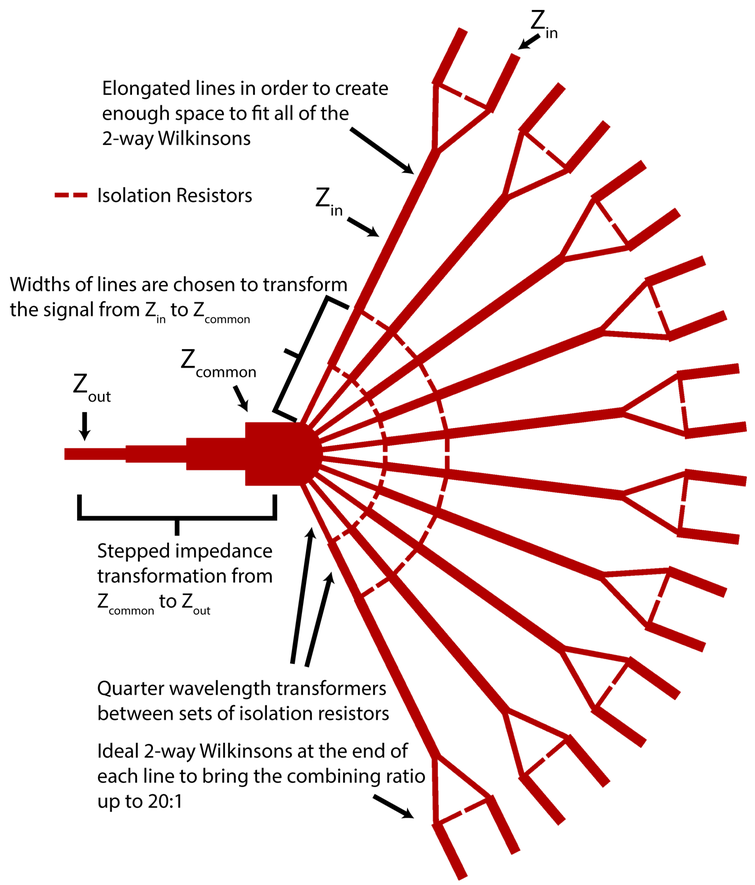
Our first semester was devoted to the investigation of power combiner technologies for the purposes of determining which designs were best suited to our specifications.

There are a variety of different types of power combiners ranging from combiners built on chip with the amplifiers themeselves to combiners that utilize spatial geometry for RF signal combination.

Due to the constraints of the team and its resources, our investigation into power combiners was limited to technologies on a circuit level and spatial designs.

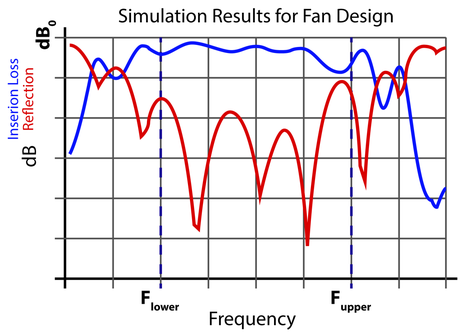



## Design




Our final design consists of a fan shaped combiner that combines 10 signals into one. Each of these 10 signals is the output of a 2-port Wilkinson combiner, allowing us to embrace the postive aspects of both the N-way and Wilkinson combiners in one design.

## Simulation




We have seen simulation results that are comparable to those achieved by other designs for smaller numbers of ports and much narrower bandwidths.

## Test Approach

Due to time constraints, our involvment in this project concluded after the completion of the design phase. Our final report to Raytheon included plans for the testing of our power combiner design.

Our main goal with testing is to verify the results we were able to achieve during the design process. Our simulations primarily focused on s-parameters. Typically these are tested using a specturm analyzer on two port networks. Alterations to the test process will have to be made to accomodate the increased number of ports in our system, including the use of 50 Ω terminations to allow for testing of smaller sections of the combiner.


## The Team 2015-2016

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