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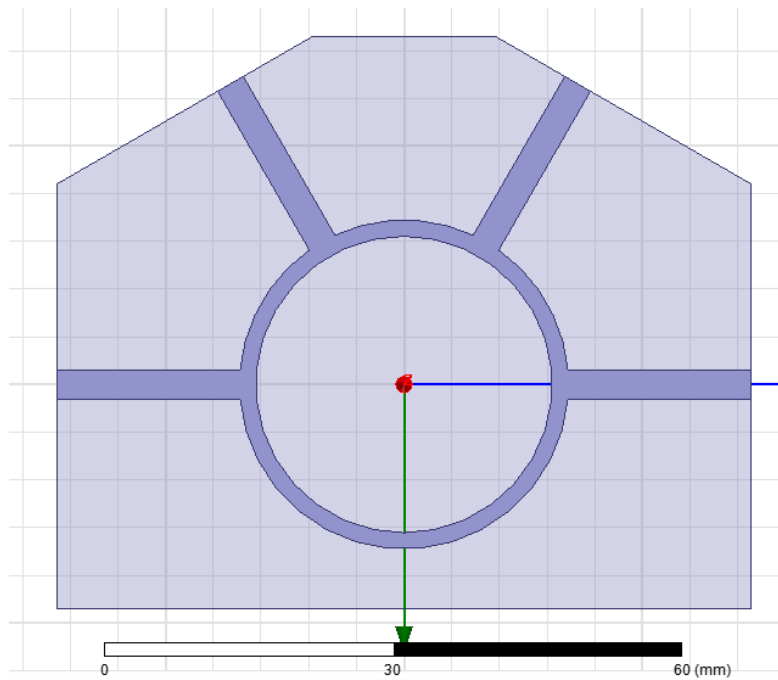
## Lab 8

### Introduction/Background

This lab introduced us to how different kinds of couplers operate. In lab we focused on the Rat-Race coupler and the Hybrid coupler. The rat race coupler has four ports, each a quarter wavelength from each other, on the top half of the circle (the circles total circumference is  $3/2$  wavelengths), with the circle having an intrinsic impedance of  $Z_0\sqrt{2}$ . The Hybrid coupler is a directional coupler that divides the power evenly between the output ports.

### Design

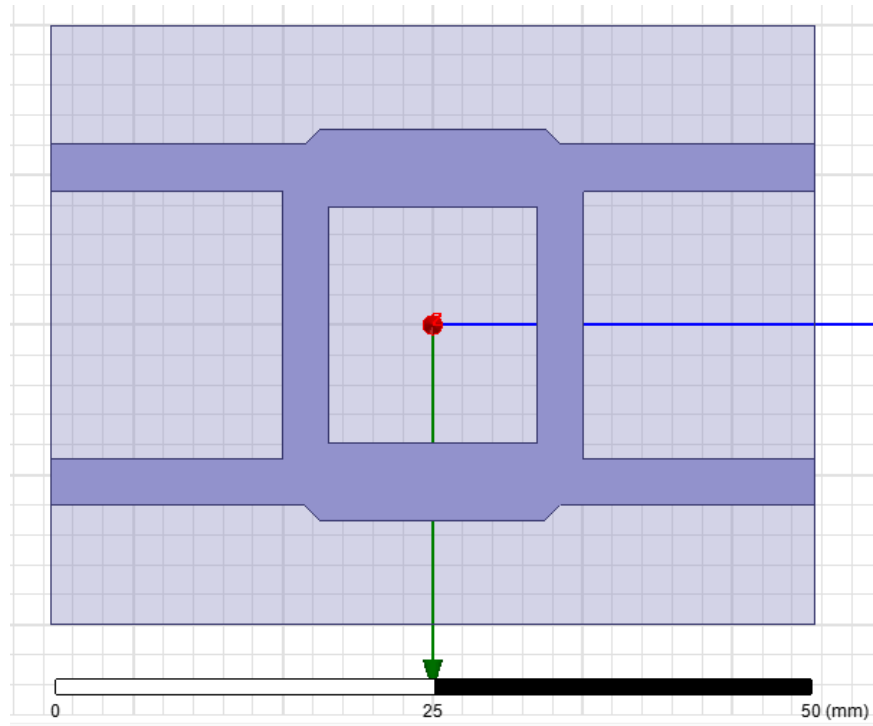
We designed the two couplers in HFSS.



Ratrace coupler simulated in HFSS

Name	Value	Unit	Evaluated Value	Type
feed_line_width	3.1	mm	3.1mm	Design
rat_race_line_width	1.7	mm	1.7mm	Design
rat_race_circumf...	103	mm	103mm	Design

Ratrace HFSS parameters



**Hybrid coupler simulated in HFSS**

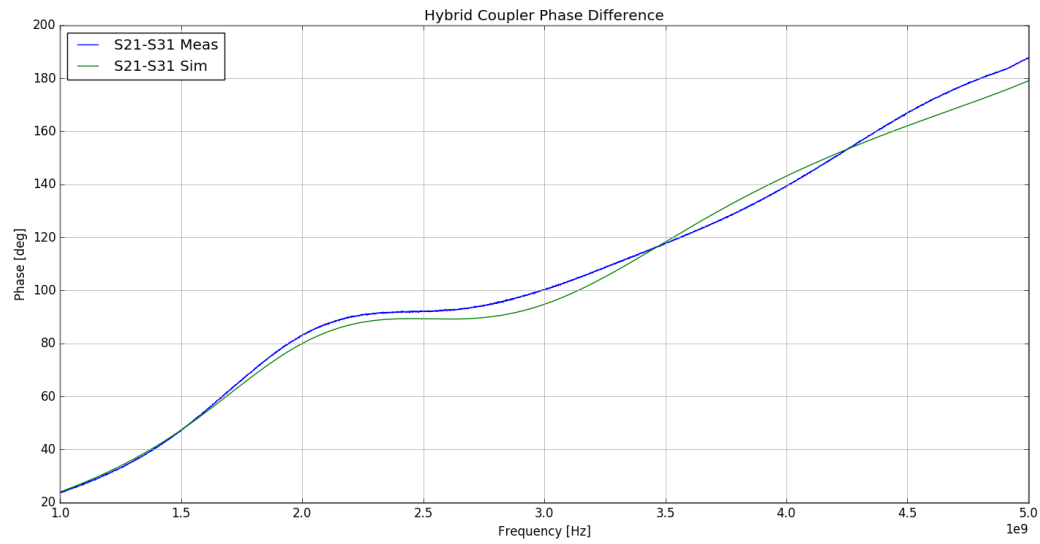
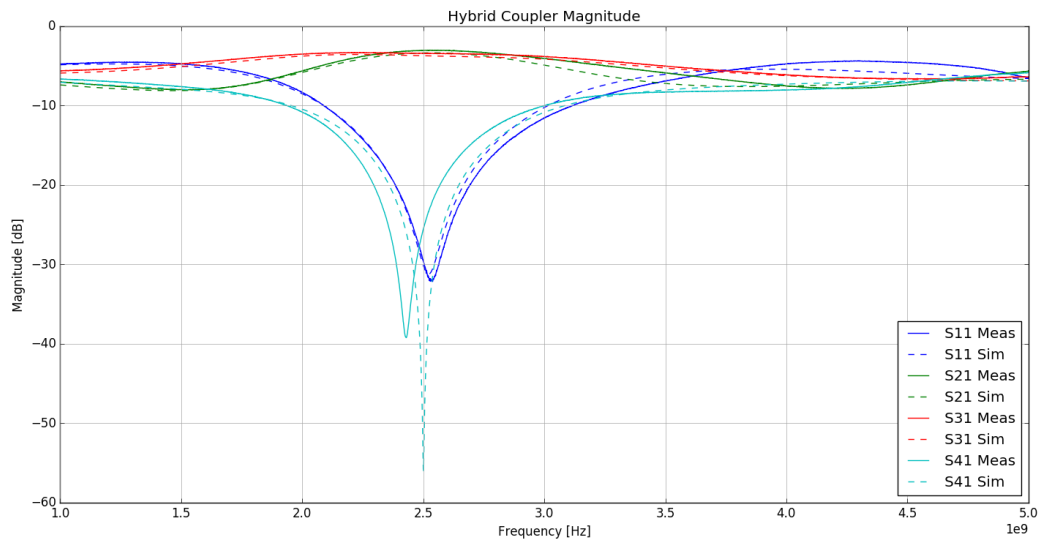
Name	Value	Unit	Evaluated Value	Type
feed_line_width	3.1	mm	3.1mm	Design
coupler_x_width	3.1	mm	3.1mm	Design
coupler_y_width	5.2	mm	5.2mm	Design
coupler_x_length	21	mm	21mm	Design
coupler_y_length	17	mm	17mm	Design

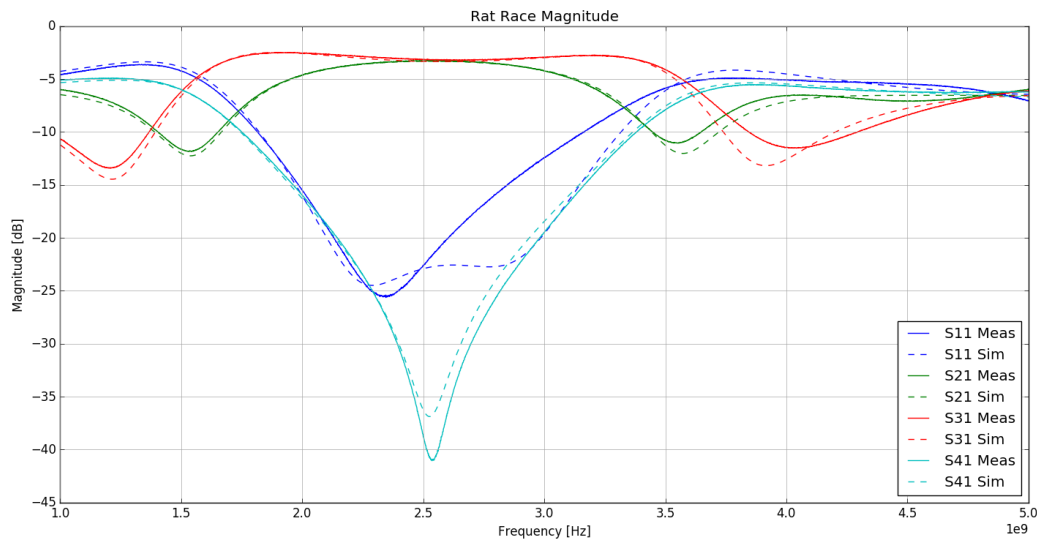
**Hybrid coupler HFSS parameters**

## In Lab Procedure

We only had to do the simulations for this lab so there was no in-lab portion.

## Results and Discussion





Our hybrid coupler simulation performed very similarly to the measured values. Other than S41, all of our s parameters were nearly identical, and S41 was fairly similar as well. The phase of the hybrid coupler also was very close to the measured values.

Our rat race coupler also performed very similarly to the measured results.

## Conclusion

In this lab we learned how to design rat race and hybrid couplers. The design of the hybrid coupler ended up coming in handy later for understanding the final project (which utilized a hybrid coupler).

## Hindsight

I should have researched more which ports should be showing what characteristics in the plots.

## Reflection

The most challenging aspect was dealing with HFSS, since none of us have much experience with the program. The most rewarding was getting our coupler simulations' plots so close to the measured values.