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Passive RF
Electromagnetic Analysis/Revisions Report

Substrate Configuration

For all microwave devices, we used the substrate design that can be seen in Figure 1. The substrate design was determined after much trial and error and many ADS tutorials.

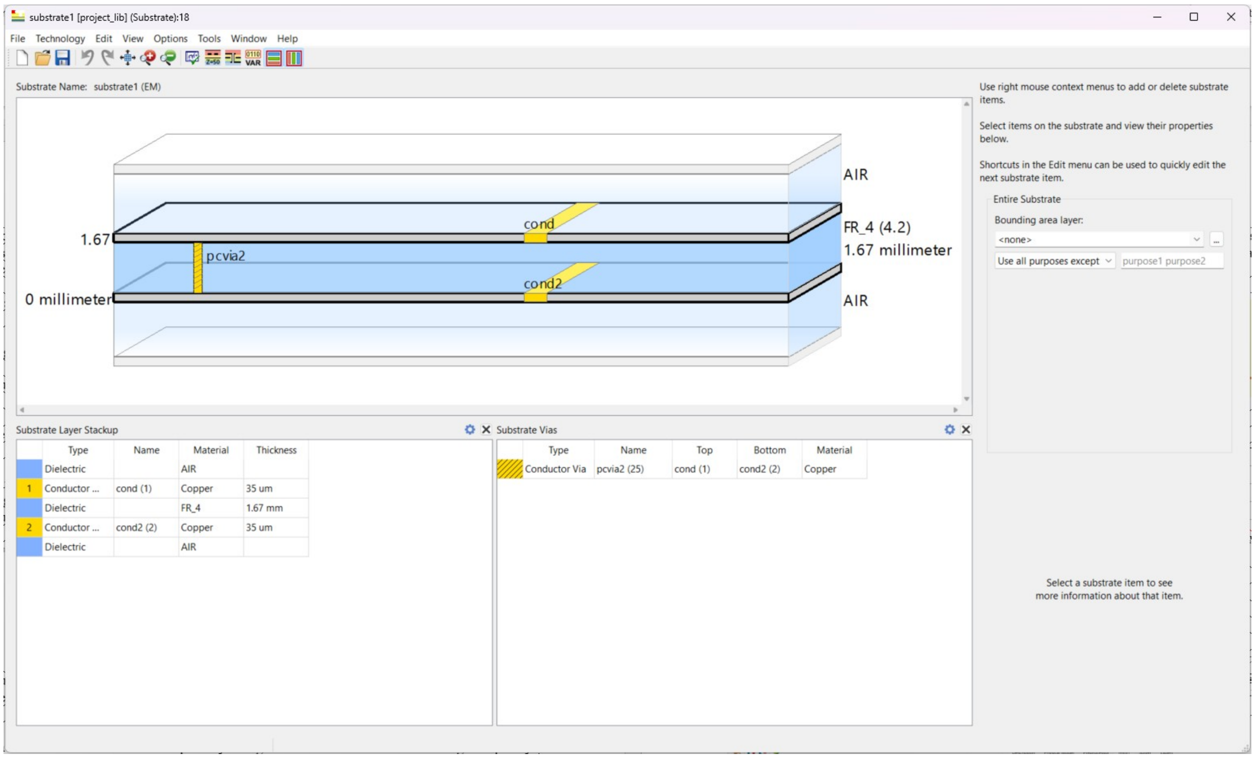

Figure 1. Substrate configuration for all microwave devices.

Chebyshev Bandpass Filter

After setting up the substrate properly in Momentum, we prepared the EM setup and simulated the response of the Chebyshev filter. The response of the initial Chebyshev filter design simulated in Momentum (red) compared to the schematic simulation (blue) can be seen in Figure 2. The black shapes denote the desired specifications.

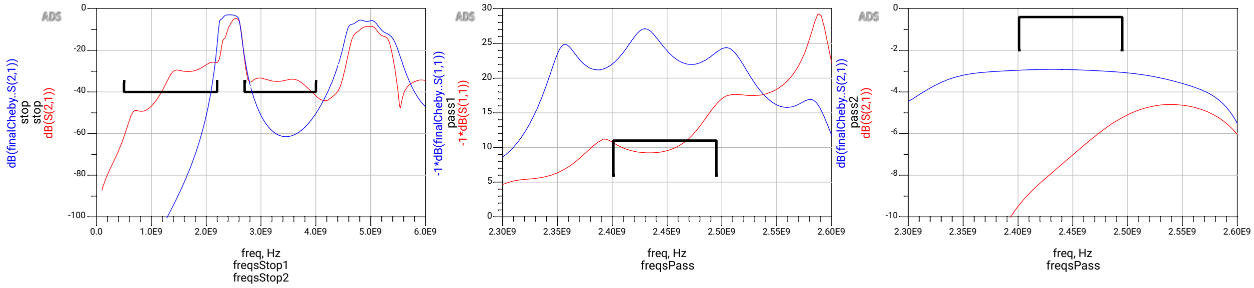

Figure 2. Initial Chebyshev Bandpass filter design Electromagnetic simulation compared to schematic output.

As can be seen, the response of the Chebyshev filter simulation in Momentum is worse than its schematic simulation. The primary change that can be noted is that the design frequency and the Momentum simulation frequency are shifted by about $0.05\,GHz$. To correct this shift, we create a shift variable in the schematic and re-optimized after adding this shift to the goals in the optimizer. This creates a much better overall response.

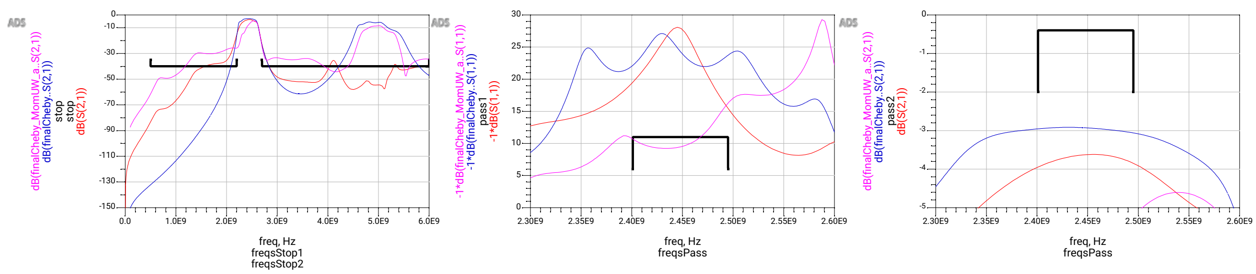

Figure 3. Initial Chebyshev Bandpass filter design Electromagnetic Simulation (magenta), compared to frequency shifted design (red), compared to Initial schematic simulation (blue).

You can see the updated layout of the Chebyshev bandpass filter in Figure 4. As this update created a decent response, and we do not know what changes could be made to get a better response, this design is the final design for the Chebyshev bandpass filter.

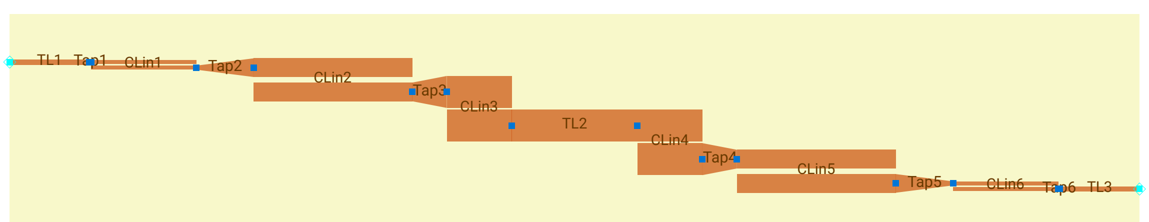

Figure 4. Final Bandpass filter layout.

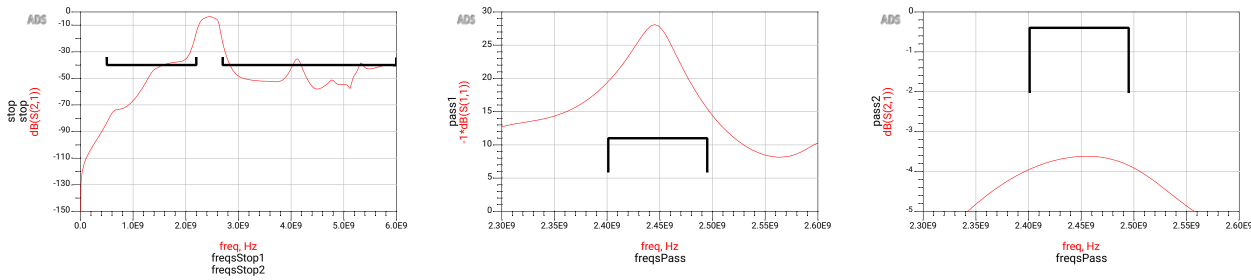

Figure 5. Final Bandpass filter S-parameters and constraints.

Coupled Line 20dB Coupler

After setting up the substrate, ground plane and initial layout in the ADS, a momentum simulation was completed to determine the electromagnetic performance of the coupler. Figure 6. depicts the important momentum settings. Figure 7. depicts the initial layout, and Figure 8. depicts the S-Parameter performance.

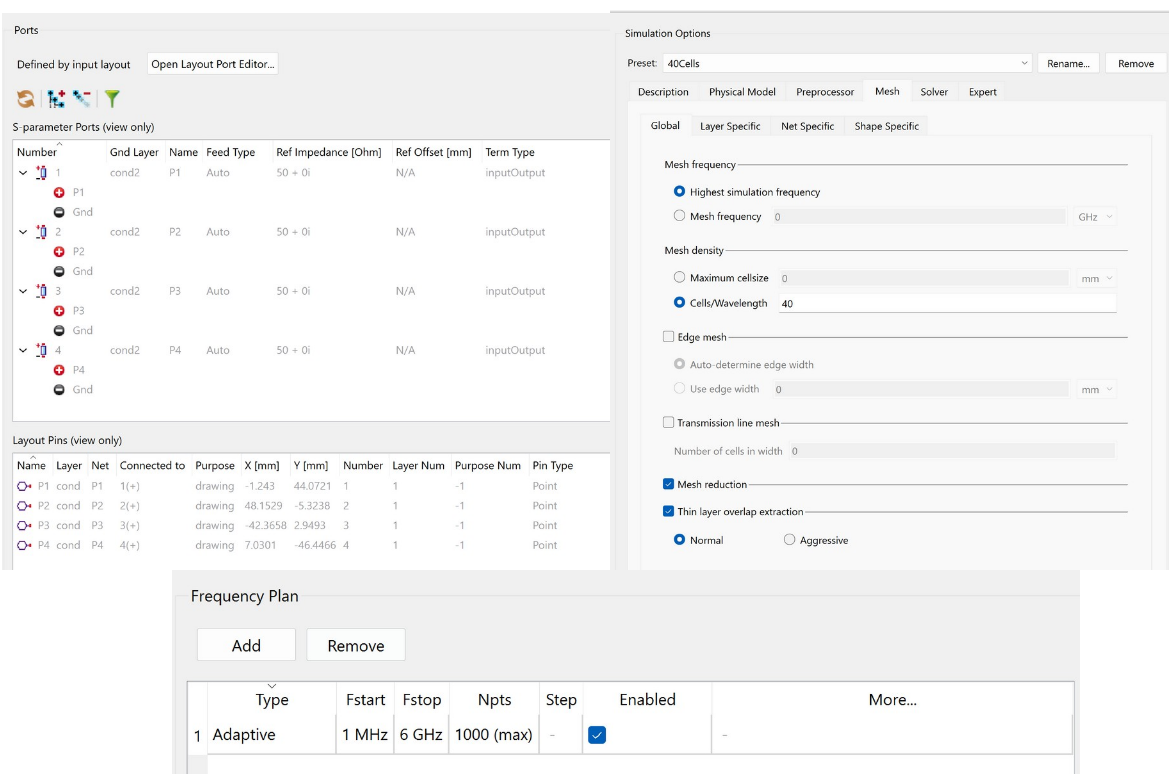

Figure 6. Important Momentum Configuration Settings.

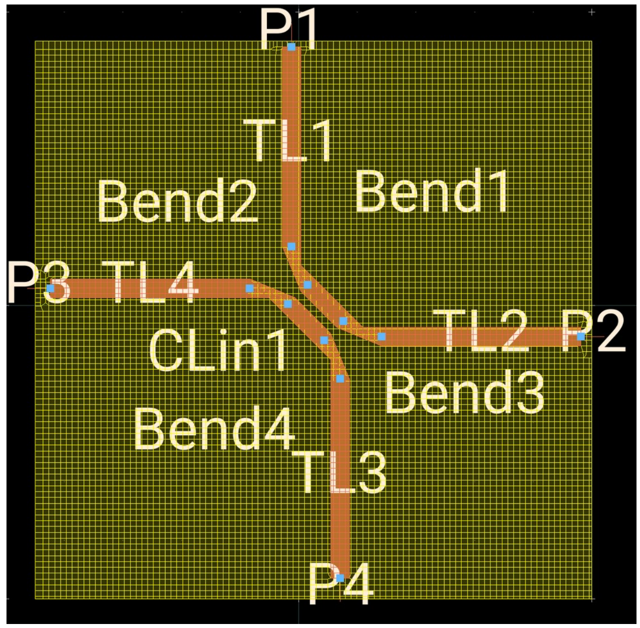

Figure 7. Substrate and Layout with Ground Plane.

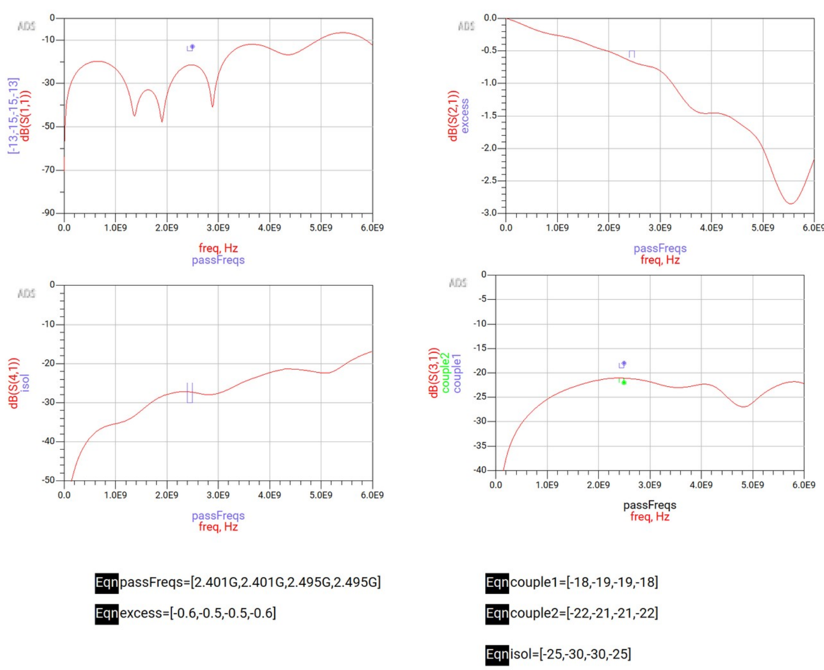

Figure 8. S-Parameter Performance using Momentum EM Simulation

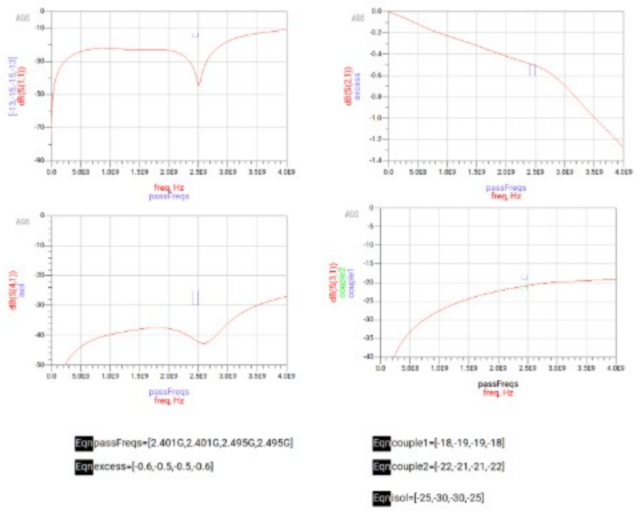

Figure 9. Microstrip Design S-Parameters

The response is slightly worse than the simulated microstrip design, especially in isolation and excess loss. Because the values are incredibly close, and excess loss can only be fixed by changing geometries/lengths of the output transmission line, we are comfortable with the current design performance. Similarly, we are not particularly concerned about isolation, as this port will be connected to a 50-ohm load.

90 Degree Hybrid Coupler

The same simulation setting and substrate were used for the 90-degree hybrid coupler. Results are as follows.

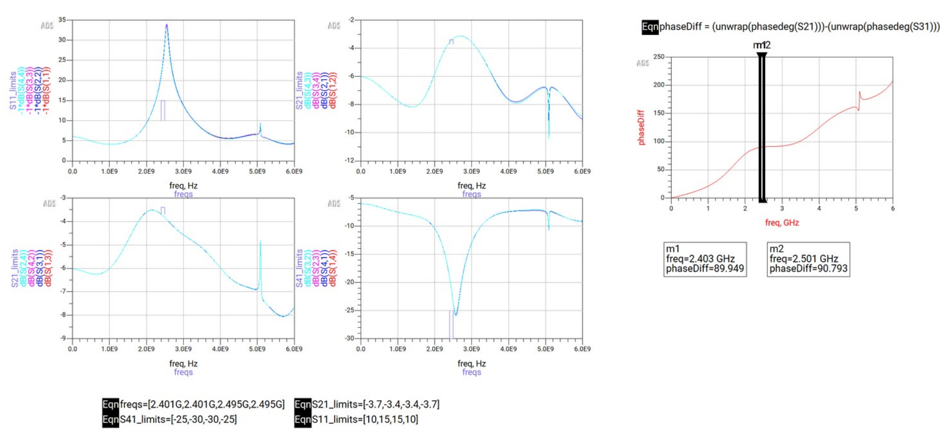

Figure 10. Original Momentum Sim

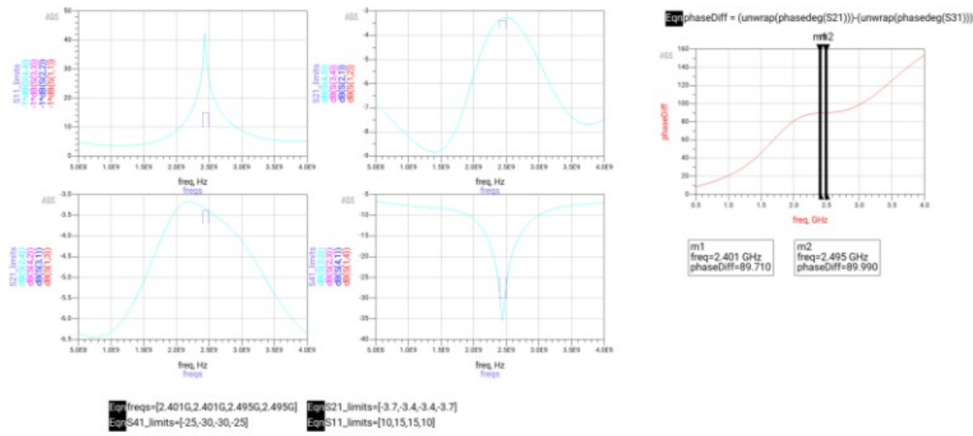

Figure 11. Microstrip Design

The primary issue identified in the momentum simulation is a shifted design band. Because the new band in the S-Parameter plots was approximately 100 *MHz* above the design band, we re-ran the optimizer to design the new band to be approximately 100 *MHz* below specifications.

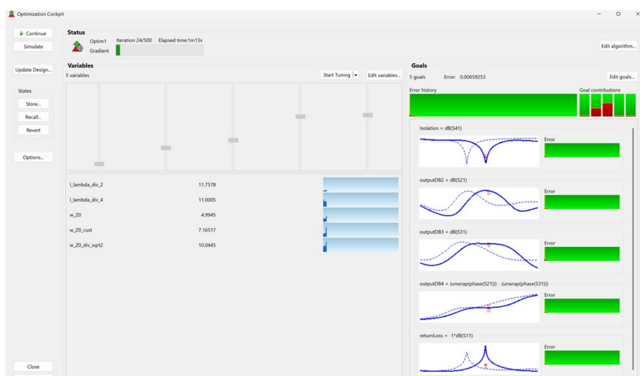

Figure 12. Optimization Run Example

Unfortunately, this did not work out. We ultimately made the return loss so bad that the original design was better suited for functioning. The outputs still only have around 3.5dB excess loss. Isolation unfortunately suffers, and outputs around 20dB.

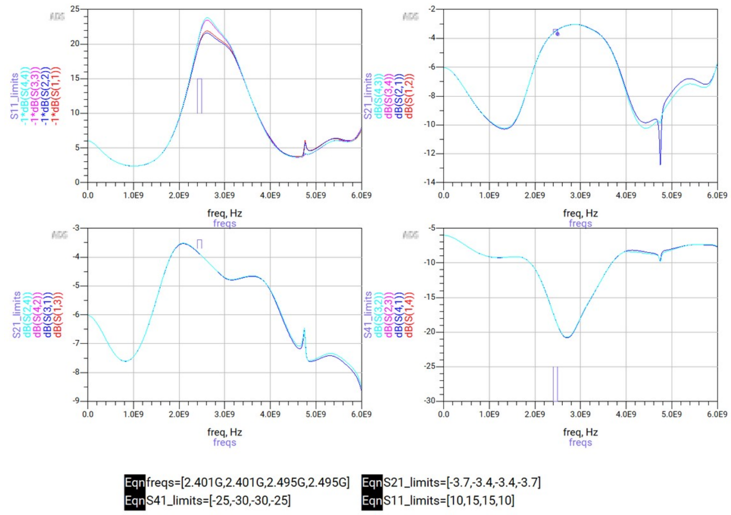

Figure 13. Post-Optimization Results

Figure 10. depicts our best results. The general layout is shown in Figure 14.

Figure 14. General Layout for Hybrid Coupler.