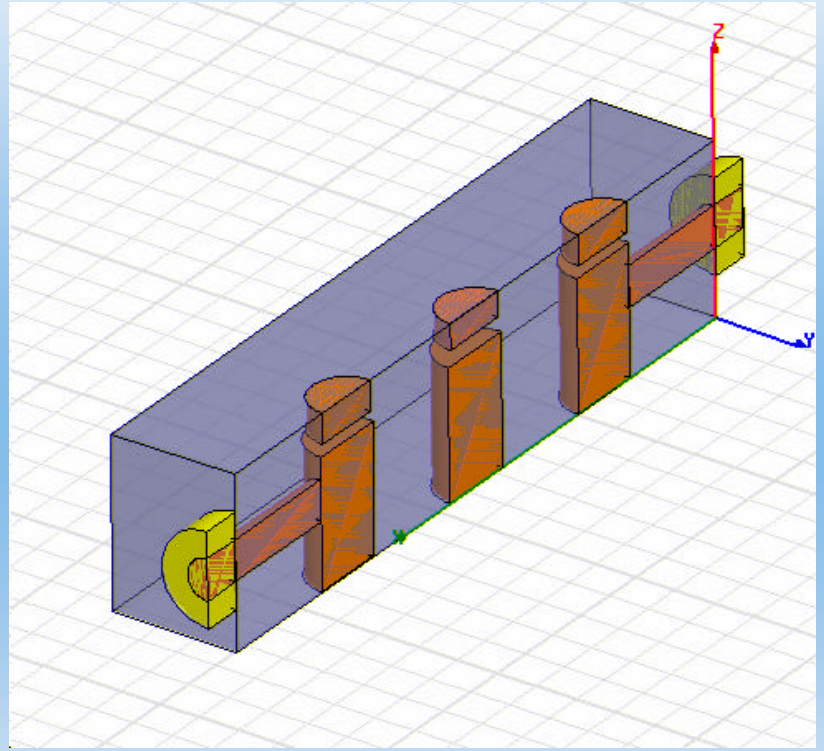
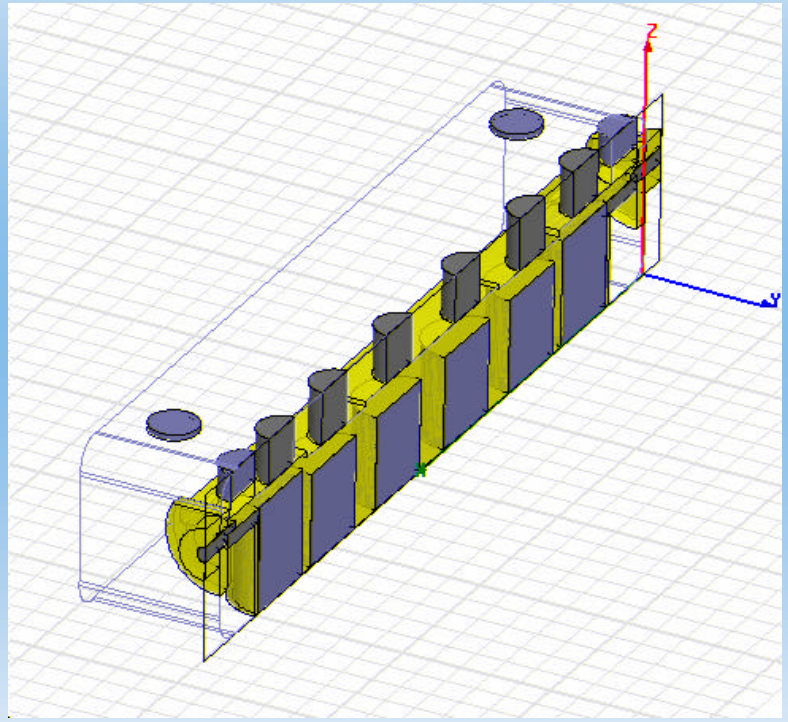
Combline Filter Tuning with Ansoft HFSS

Presented by Jim Reed of Optimal Designs



3 Pole Cavity Combline Filter to be used in Demonstration for Filter Tuning



Simulated / Measured Data for Real World Example, Compliments of Sierra Microwave Technologies

Combline Filter Tuning with Ansoft HFSS
Outline of Presentation

- Optimal Designs Inc. Company Overview
- 3 Pole Cavity Filter Design Approach
  - Initial Filter Design Using Filter Synthesis Software
  - Ansoft HFSS Parametric Analysis of Resonator Spacing and Tuning Screw Gaps
  - Ansoft Designer and Tuning Bar to Dynamically Adjust the Performance of the Filter
- Comparison of Ansoft HFSS Simulation to Measured Results of 6 Pole Partially Loaded Cavity Combline Filter
- Summary

Optimal Designs Inc
Company Overview

- Optimal Designs is solely owned and operated by Jim Reed, who has extensive experience in 3D EM simulation, both in time domain and frequency domain. Services provided by Optimal Design generally falls into two categories, often relating to the size of the engineering force of the customer.

- For customers with a large engineering force, services can be provided in the form of consultation at the beginning of a design cycle in separating the design into components, choosing appropriate design tool for these components, and modeling the components in a proficient and accurate manner. In addition, services can be provided at the end of a design cycle during critical review as an expert on modeling in EM simulation tools and accuracy verification.

- For customers with a smaller engineering force, services can be provided in the form of additional engineering support, analyzing and optimizing designs using advanced 3D simulation.

- An abridged list of recent and current clientele includes Malibu Research - Camarillo, Teledyne Medical Devices - LA, PCTel MaxRad - LA, Microfabrica - Burbank, General Dynamics - Phoenix, Raytheon Missile Systems- Tucson, Sierra Microwave Technologies - Georgetown, TX.

Combline Filter Tuning with Ansoft HFSS

3 Pole Cavity Combline Filter – Design Overview

- 3 Pole Cavity Filter Design Approach
  - Initial Filter Design Using Filter Synthesis Software
  - Ansoft HFSS Parametric Analysis of Resonator Spacing and Tuning Screw Gaps
  - Ansoft Designer and Tuning Bar to Dynamically Adjust the Performance of the Filter

Combline Filter Tuning with Ansoft HFSS

3 Pole Cavity Combline Filter – Initial Design I

Several programs are available for generating the initial design of a filter. For this cavity combline filter, the filter program by Wenzel / Erlinger Associates was utilized at the Sierra Microwave Technologies facility. A center frequency was defined at 10 GHz with a 10% bandwidth and VSWR 1.1. Other input parameters are listed below.

INPUT PARAMETERS

Read file = JRCL10	Loading capacity:		
Outfile = JRCL10	Lumped	X	
F Lower = 9.5000	Resonator		Screw dia. = .08600
F Upper = 10.500	Cover		Reson. Gap = .05000
VSWR = 1.1000	GPS = .31300		
Resonators = 3	Resonator dia. = .09400		
	Resonator len. = .16000		Connector K= .05000
	Tap line dia. = .05000		Reson. Qu = 1140.0 *
Surface = Silver	Tap line len. = .15500		Loss @ F0 = .24283

UNITS: Frequency = gHz Length = inch

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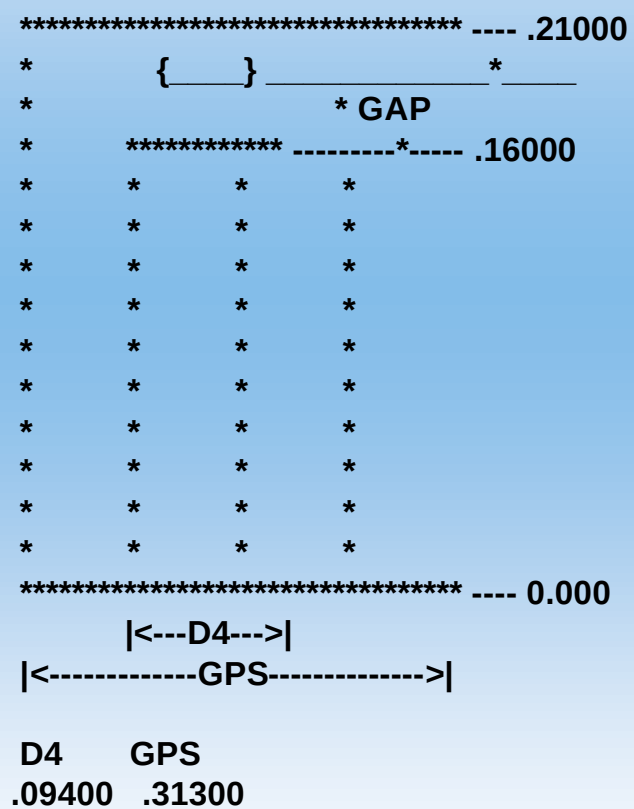
3 Pole Cavity Combline Filter – Initial Design II

The output parameters by Wenzel / Erlinger Associates filter program, listing the resonator spacing and the tuning screw gaps above the resonators.

RESONATOR DETAILS



D4 GPS
.09400 .31300

RESONATOR SPACINGS AND TUNING SCREW GAPS

Resonator physical length = .16000 inches.
Input tap line diameter = .05000 inches.
Input tap location above the 0.000 reference plane= .10823 inches.

RESONATOR AND COUPLING ADJUST LOCATIONS

ADJUST LOCATIONS	RESONATOR LOCATIONS	RESONATOR GAP SPACING	SCREW GAP
	|<- .31300->|		
0.0000	0.0000		
.07750	.20200	.15500	.01099
.31718	.43237	.13637	.01397
.54755	.66273	.13637	.01099
.78723	.86473	.15500	

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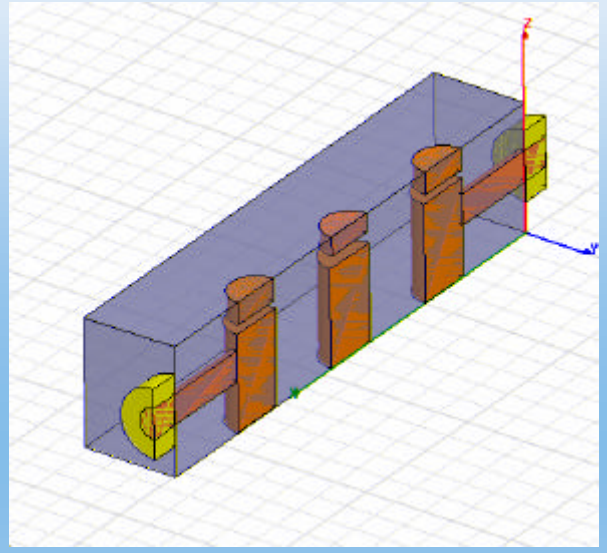
3 Pole Cavity Combline Filter – EM Simulation

Filter Tuning with EM Simulation



1) Taking the initial values from the Wenzel / Erlinger Associates filter program, the combline cavity filter was modeled in Ansoft HFSS 9.2 fully parameterized.

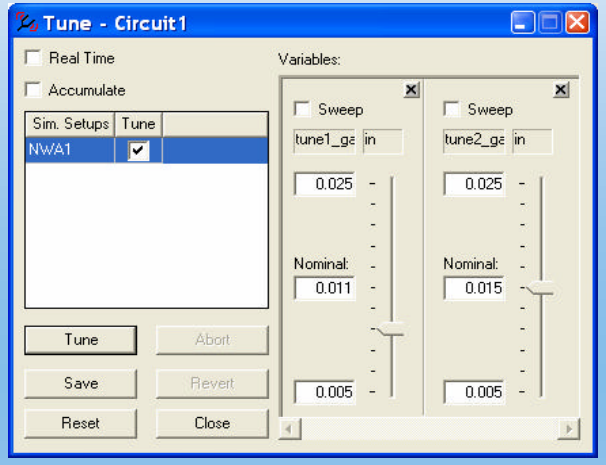
2) A large parametric analysis was conducted altering the spacing between the resonators and the tuning screw gaps above the resonators.

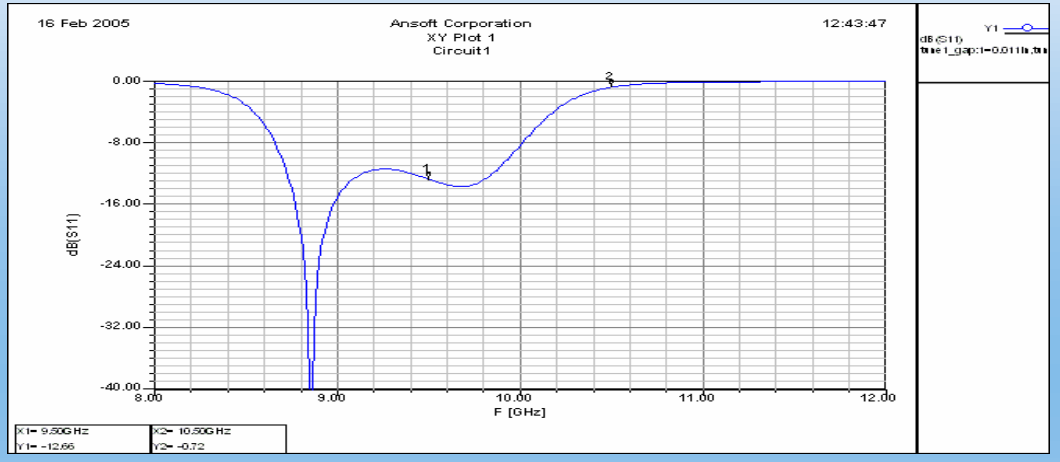
3) Ansoft Designer was used to dynamically view the parametric data viewing its tuning bar interface. This simulated a real world environment at a test bench by adjusting tuning screws to a desired performance.

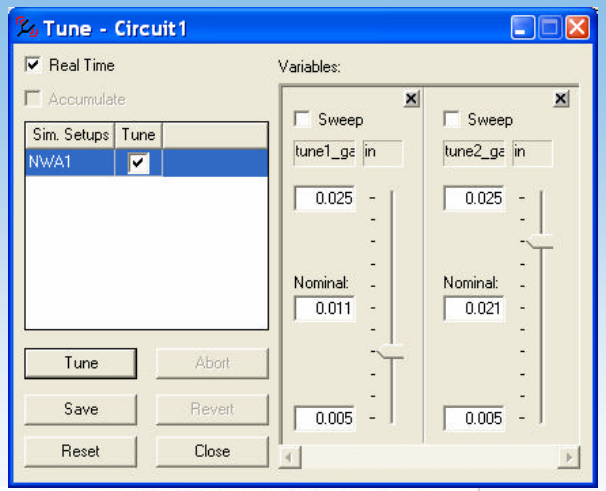
Combline Filter Tuning with Ansoft HFSS

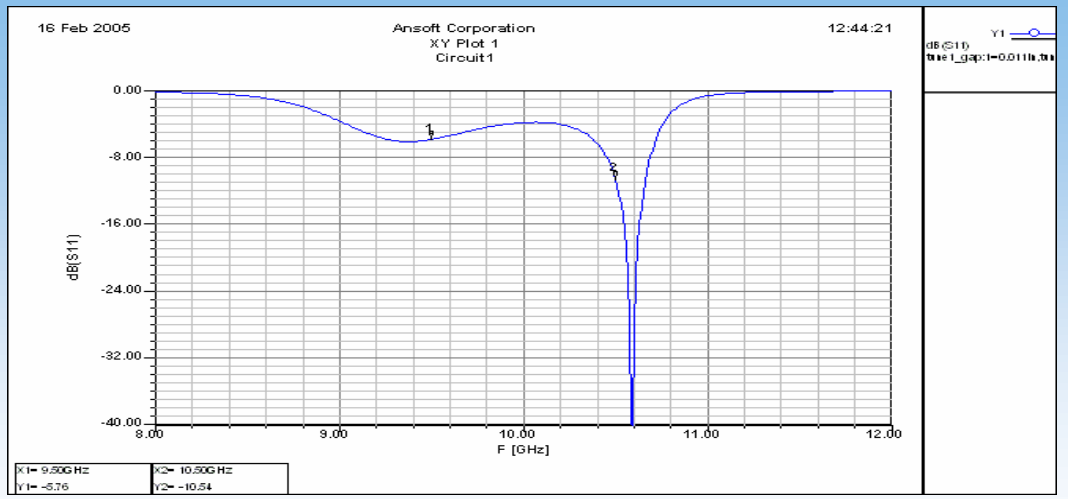
3 Pole Cavity Combline Filter – Initial Design

Using the original filter parameters in the 3D EM simulation does not yield the desired filter response. Adjusting tuning screw 2 moves the resonance toward 10GHz.





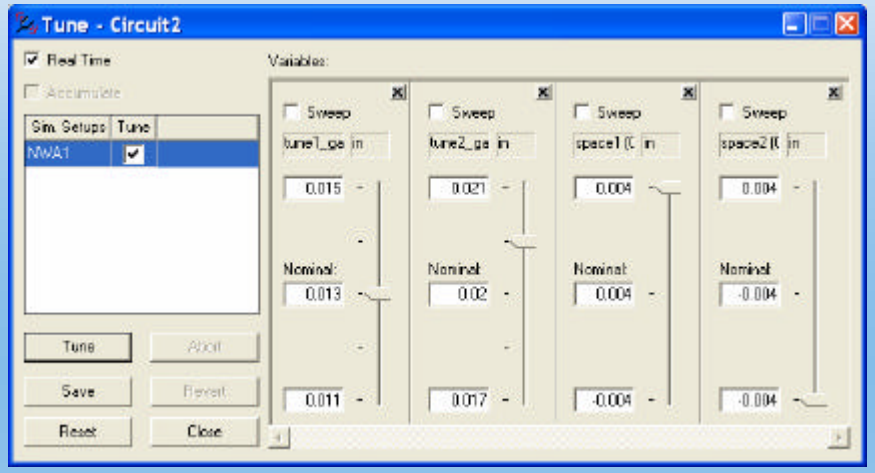


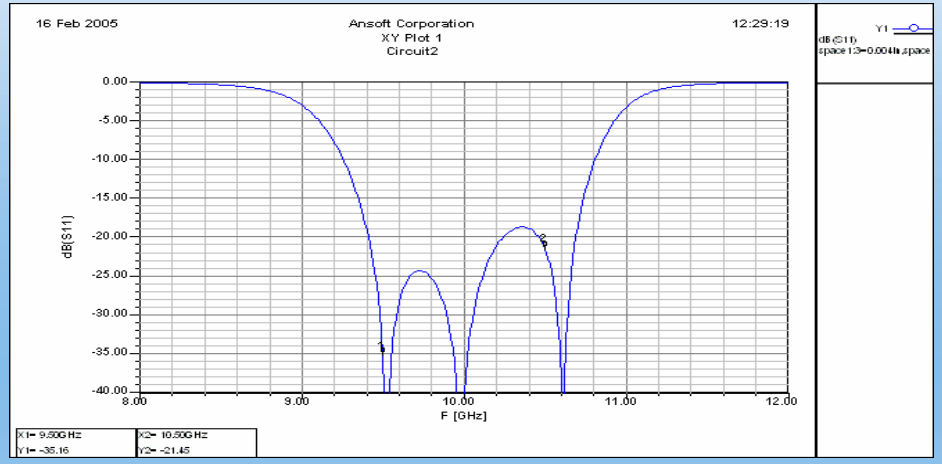


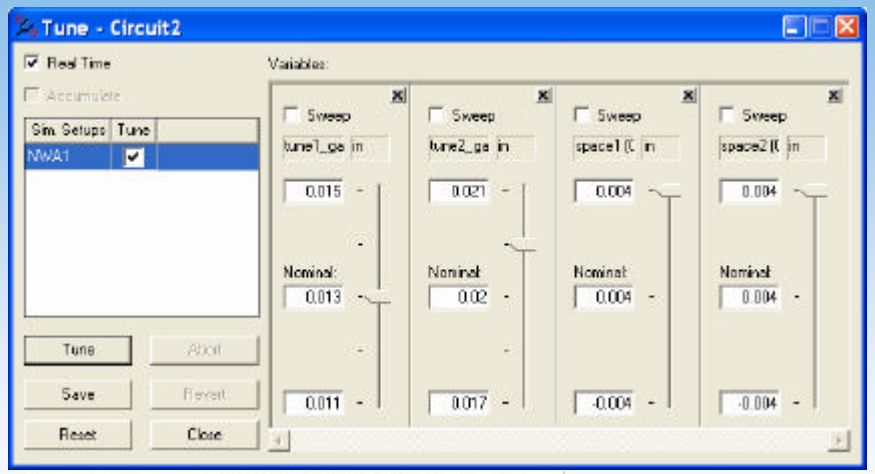
Combline Filter Tuning with Ansoft HFSS

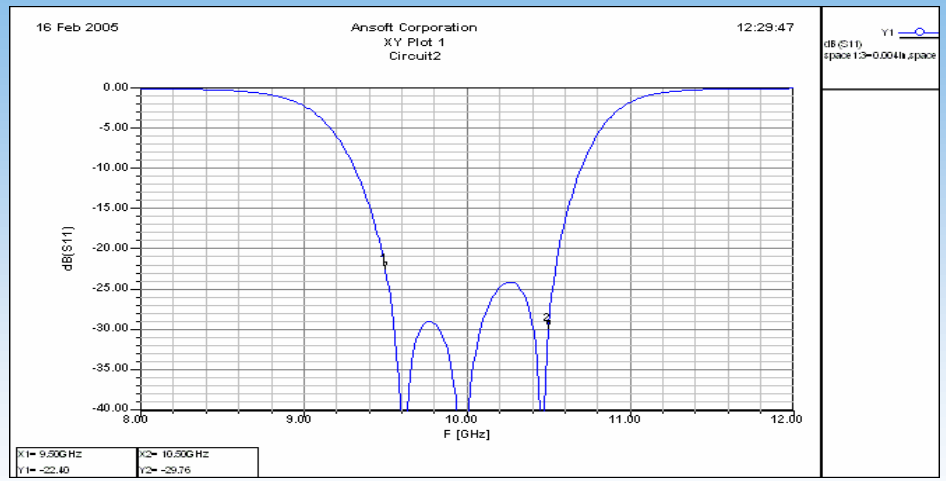
3 Pole Cavity Combline Filter – Trends I

Looking for other trends, the bandwidth is greatly affected by the spacing between end and center resonators. The smaller the gap, the broader the band.





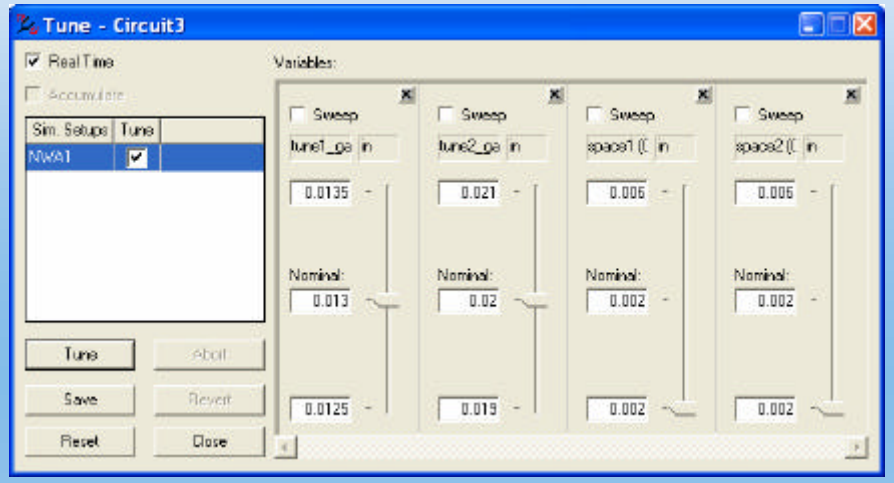


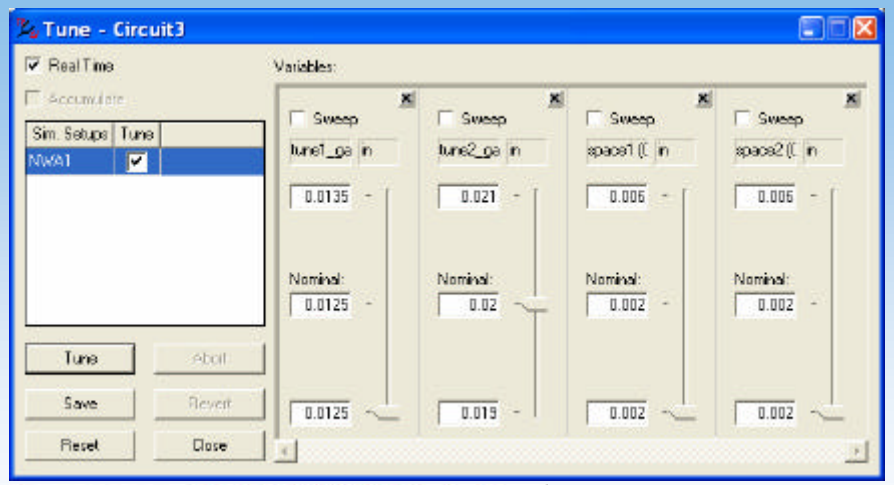


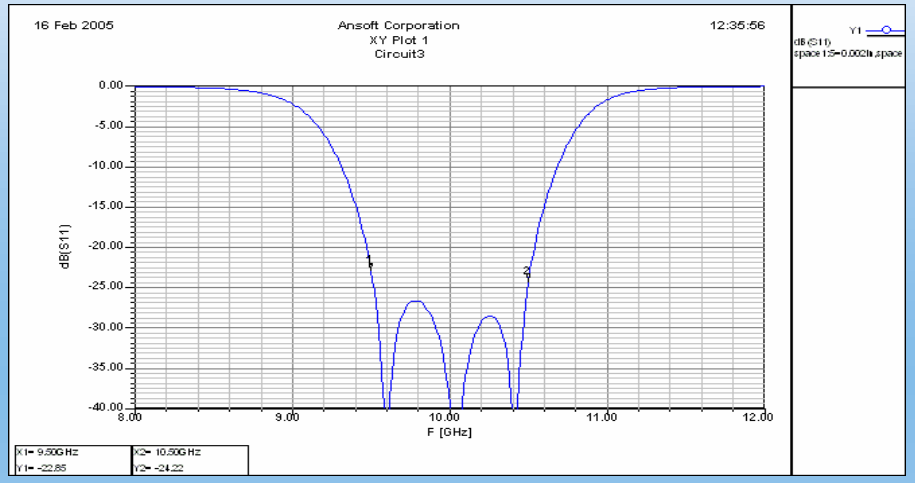
Combline Filter Tuning with Ansoft HFSS

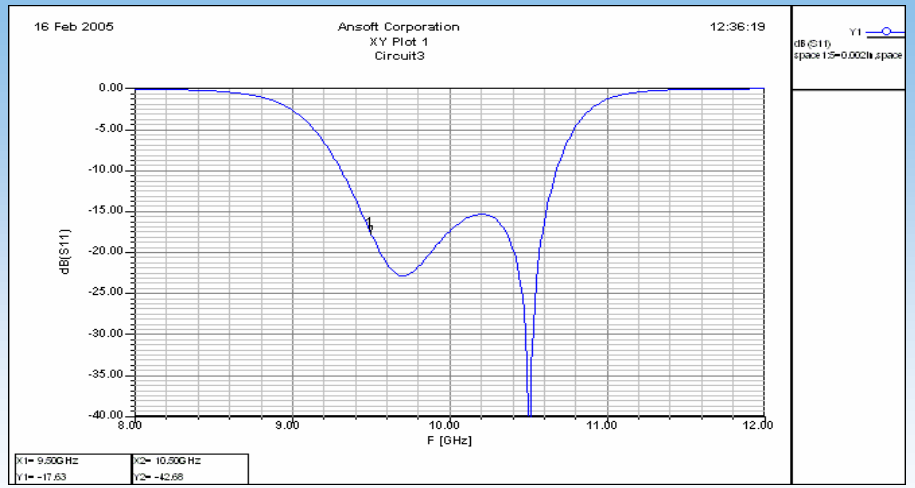
3 Pole Cavity Combline Filter – Trends II

Once the bandwidth is fixed, adjusting the tuning screw above the first resonator refines the match of the filter. The below case is a half mil difference.







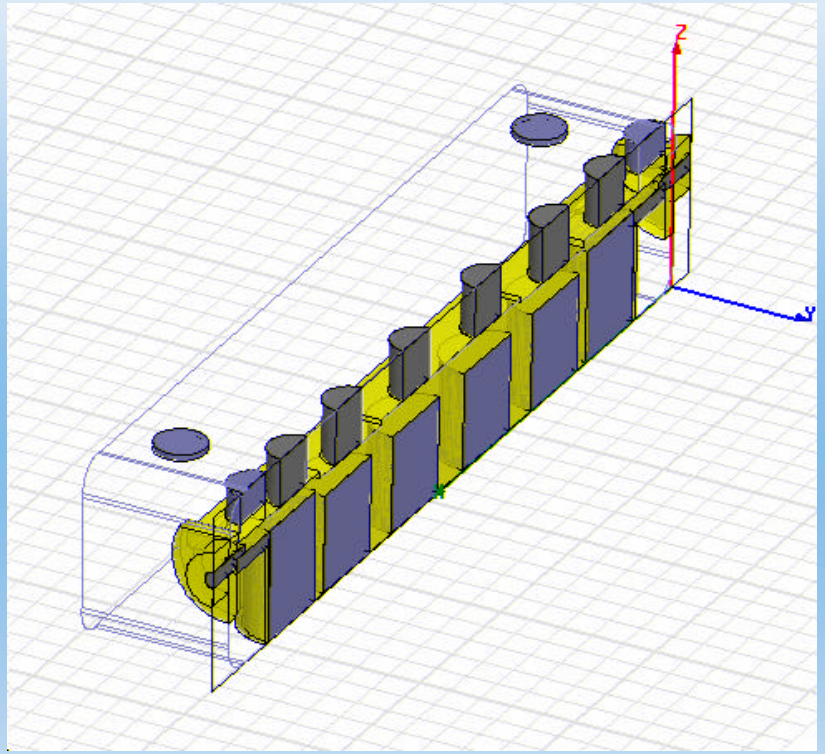


Combline Filter Tuning with Ansoft HFSS

Ansoft HFSS Simulation to Measured Results

The before exercise was to demonstrate the filter tuning of a simple 3 pole cavity combline filter. For this exercise, a large parametric analysis was conducted in Ansoft HFSS. The data was reviewed and tuned with the Tuning Bar interface of Ansoft Designer.

The following model is a real world example with much higher complexity, compliments of Sierra Microwave Technologies. This combline is partially dielectrically loaded to avoid corona effect in a high power environment.

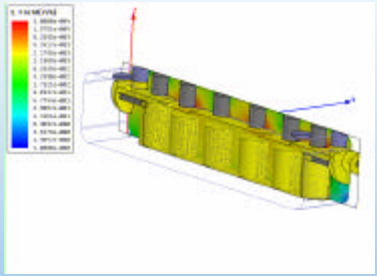


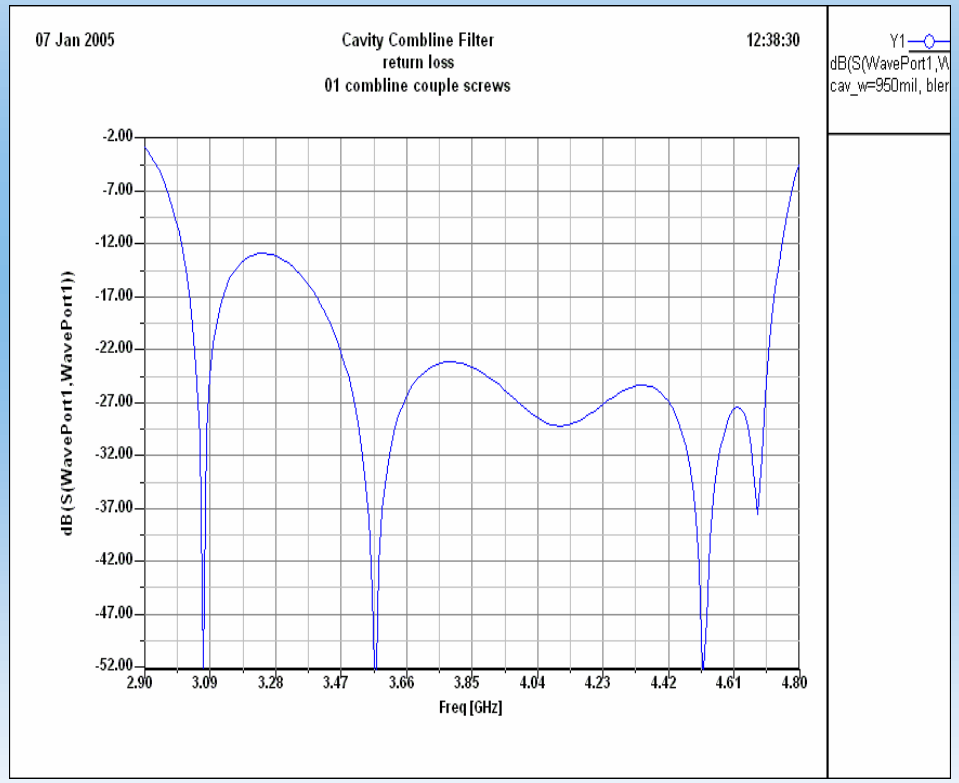
Model and Measured Results Compliments of Sierra Microwave Technologies

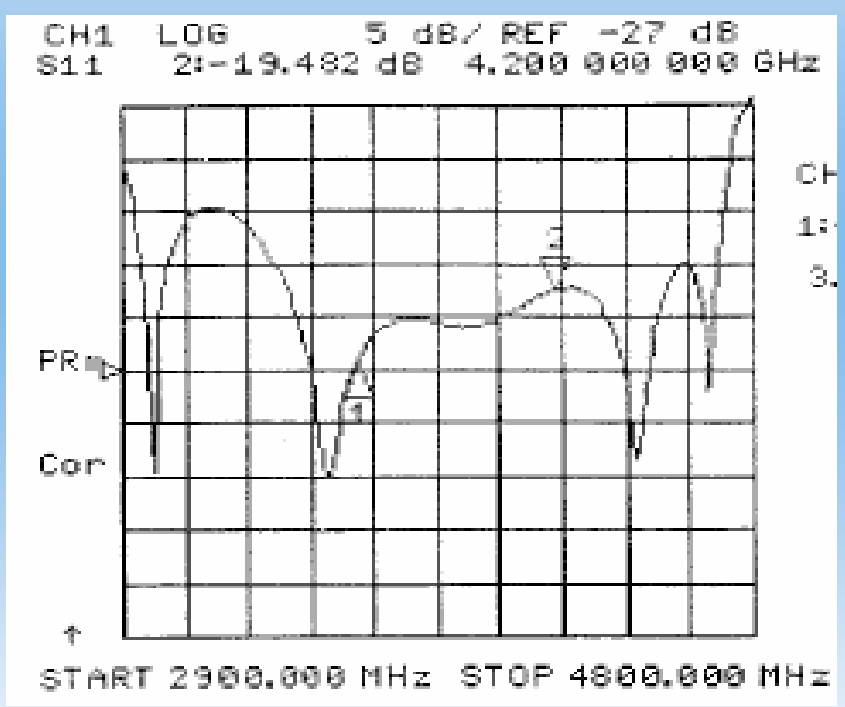
Combline Filter Tuning with Ansoft HFSS

Partially Loaded Cavity Combline Filter

Ansoft HFSS simulation to measured results for S11.
Simulation results match well to measured results.





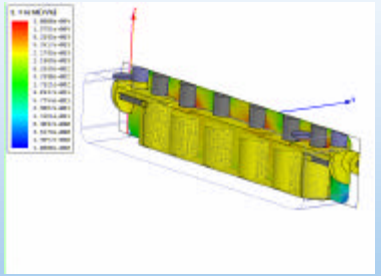


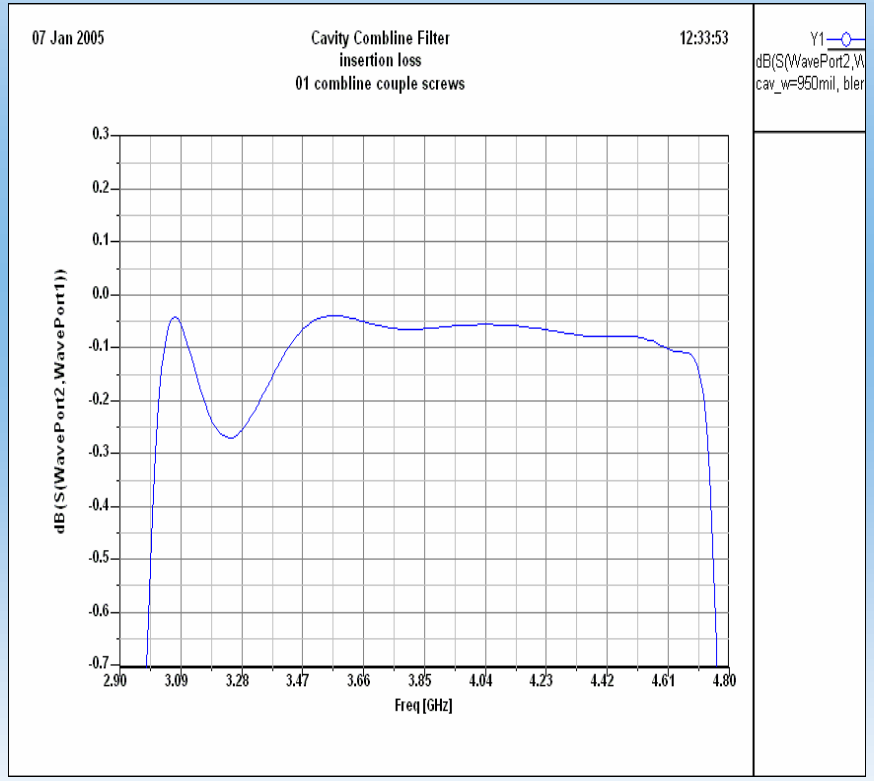
Model and Measured Results Compliments of Sierra Microwave Technologies

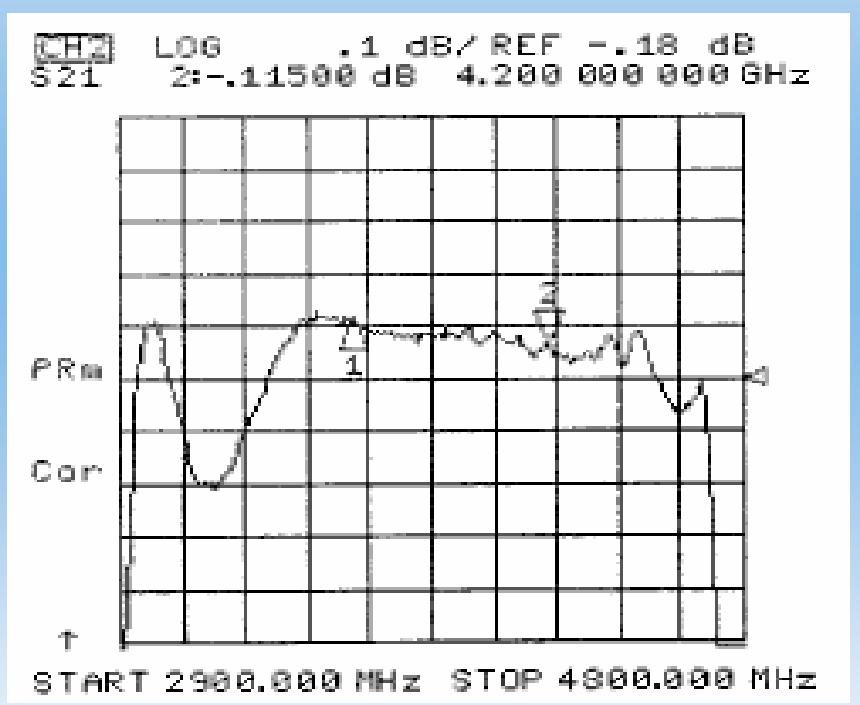
Combline Filter Tuning with Ansoft HFSS

Partially Loaded Cavity Combline Filter

Ansoft HFSS simulation to measured results for S21.
Simulation results match well to measured results.







Model and Measured Results Compliments of Sierra Microwave Technologies

Combline Filter Tuning with Ansoft HFSS
Summary and Comments

Summary

A design approach for cavity combline filters was presented where the initial design was generated with a filter synthesis tool, followed by parametric analysis in Ansoft HFSS. Ansoft Designer was used to dynamically review the data and tune the filter with its Tuning Bar interface.

After demonstrating this approach, a proprietary model of Sierra Microwave Technologies was presented with a comparison of Ansoft HFSS simulation to measured results.

Comments

With the increase complexity of filter design, such as partially filled dielectric volumes and unique launch configurations, the more 3D EM simulation is needed to design a filter that is "tunable" on the bench.