Waveguide_Filter

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Understanding AWR .emz Files

Design Notes

Analyst Waveguide Filter

This example demonstrates the implementation of a Ku-band WR62 waveguide filter and a straight Thru waveguide for comparison. WR62 covers a frequency range of 12.4 - 18 GHz. The waveguides are complete, including flanges, and conform to industry standards. The waveguides were built in the Arbitrary 3D Analyst EM Structures and parameterized to allow for adjustment, optimization and Monte Carlo sensitivity analysis in AWRDE.

Overview

The waveguide filter is a posted filter, which performs pass-band filtering. Waveguide filters have low loss and a high Q, as the signal is transmitted through the waveguide. The parameters of the posts, including the diameter of the center and outer posts, and the spacing between the posts, are swept in with an EM Simulation and optimized in the circuit simulator in order to achieve the desired filtering center frequency and bandwidth.

Graphs

Thru Waveguide Loss Graph:

This graph shows the loss of a regular waveguide with no filtering effects for comparison with the waveguide filter.

Nominal Waveguide Filter Performance Graph:

This graph demonstrates the performance of the waveguide filter with optimized post filter parameters.

Nominal Waveguide Filter Performance vs Measured Graph:

The simulated versus measured results for a 3D printed waveguide filter is presented in this graph.

WG Filter Parameter Sweep Graph:

This graph shows the performance of the filter for each value in the filter parameter sweeps showing the spread of the filter performance.

Yield Analysis Graphs:

Yield Analysis was performed on the filter parameters (the post diameters and spacing) to analyze the effects of varying these parameters on the measurement results. There are two sets of Monte Carlo (or yield) measurement graphs. The first set is the component sensitivity graphs. The second set is the Pareto measurement, which determines which components in the yield analysis most influence a chosen measurement, e.g. in this case, the insertion loss.

Wave Port Impedances Graph:

This graph shows the Analyst wave port impedances over frequency which is important for the designer to know if they use the EMDocs directly in a circuit simulation because the impedances of the waveguide input and outputs are not 50Ohms.

Note about Yield Analysis:

These types of graphs are different from the normal graphs, in that to show their results, one must navigate on the toolbar to Simulate>Yield Analysis; this will display the Yield Analysis dialog. From here, one can adjust the Yield Analysis settings, or leave the settings as-is and click "Start". This will run the Yield Analysis for the measurements displayed on these graphs.

Modifications

It was found during the development of this example that the "Curvature Refinement Level" setting in Analyst Mesh Tab was critical to better simulations of this type of filter. The refinement level had to be lowered so that the Analyst mesh represented the curvature of the posts more accurately than the default value. By adjusting this setting the simulation time was significantly reduced due to the convergence sensitivity of those posts.

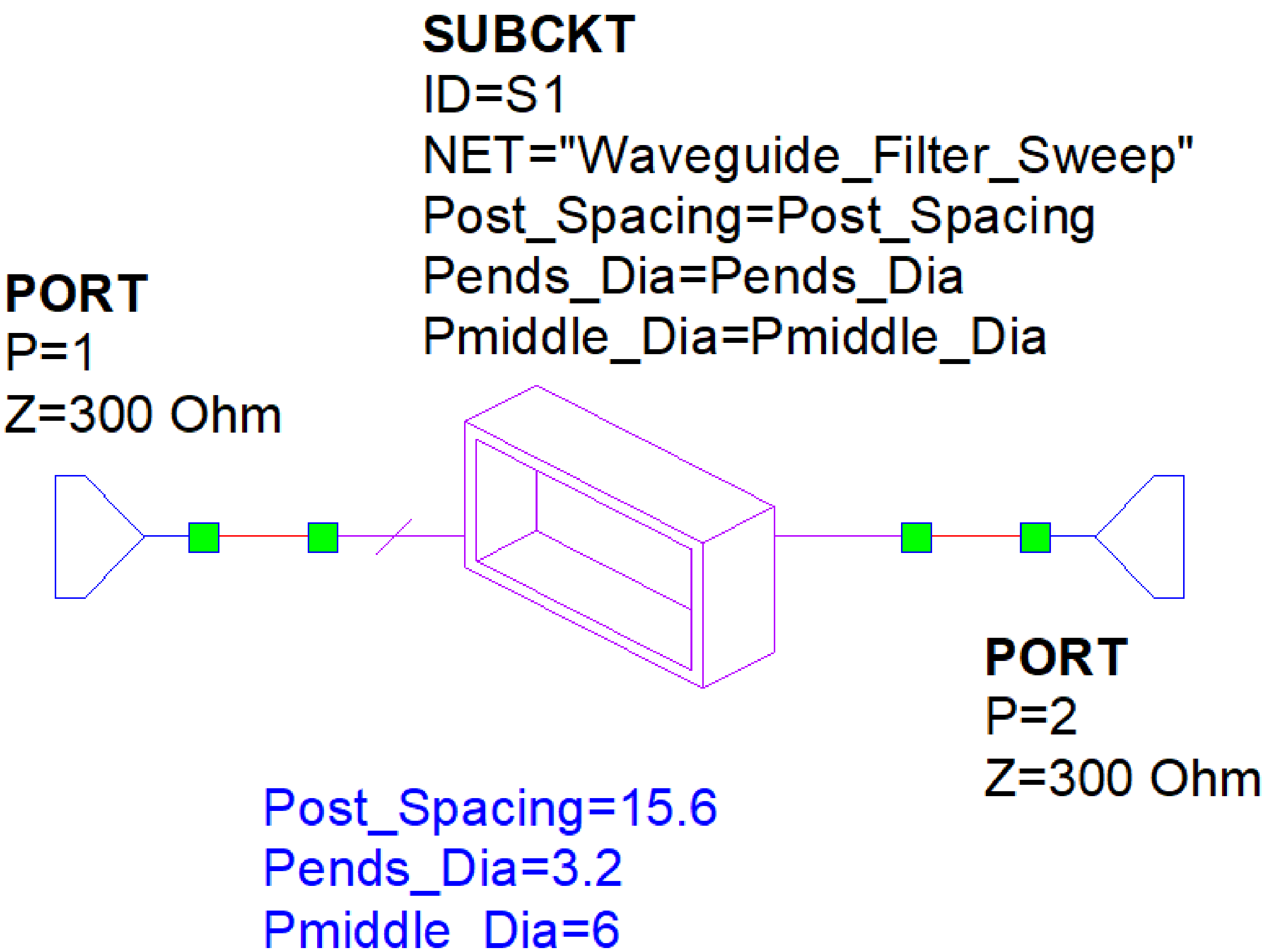
3D Printing

The waveguide filter in this example is excellent for demonstrating the capability of 3D printing Arbitrary 3D EM Structures. 3D printing can be a huge advantage over other prototyping methods, in cost, time, and accuracy. It's also beneficial that adding complexity does not add to the cost, so a filter waveguide is a similar cost to a thru waveguide. To initiate the 3D printing process, an STL file is needed, which can be exported from the Analyst 3D Editor. However, before the STL file is exported, any blocks that are made of Air material need to be excluded from the simulation, as the STL file doesn't differentiate between materials, and air will come out as a solid block. The units must also be noted, as the STL file does not record units. Then any 3D printing service can receive the STL file and the units, and a variety of materials can be chosen, including aluminum or steel for a complete, 3D printing working waveguide filter (or any other arbitrary EM doc).

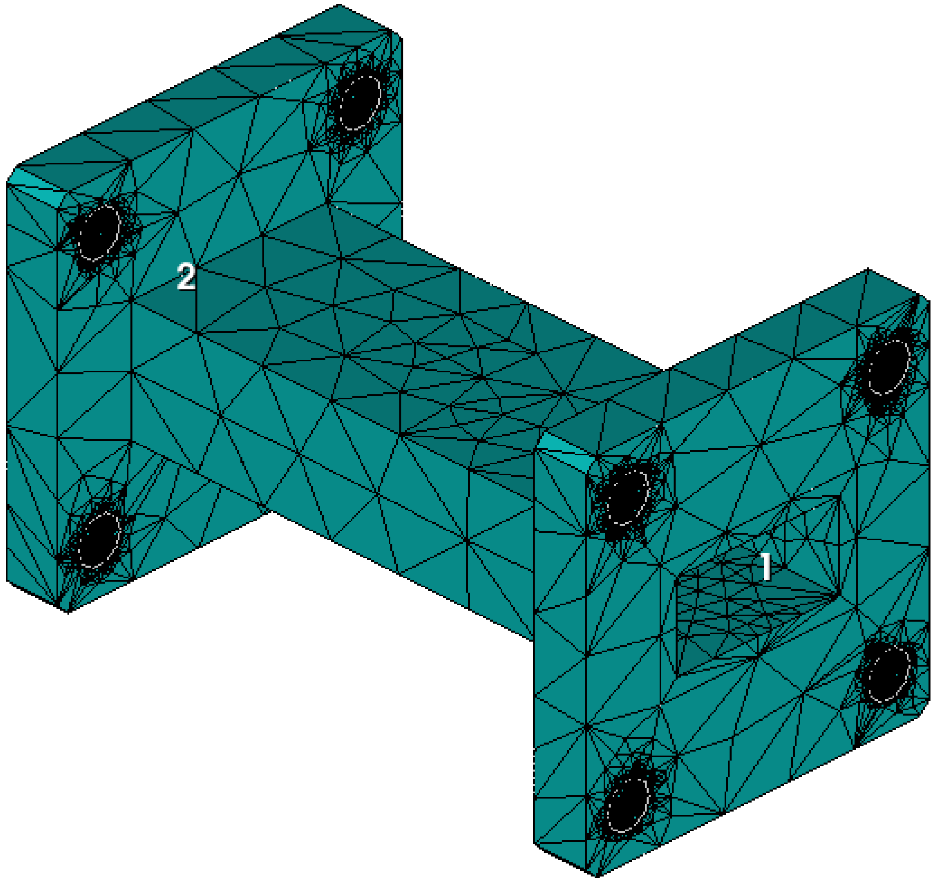
Measured Data

Using the 3D Printing process described, the waveguide filter was printed and its performance measured. This was done using waveguide adapters on a VNA calibrated to the flanges. The results are shown in the graph "Nominal Waveguide Filter Performance vs Measured". It can be seen that the measured results are quite close to the simulation results, showing the effectiveness of this design process.

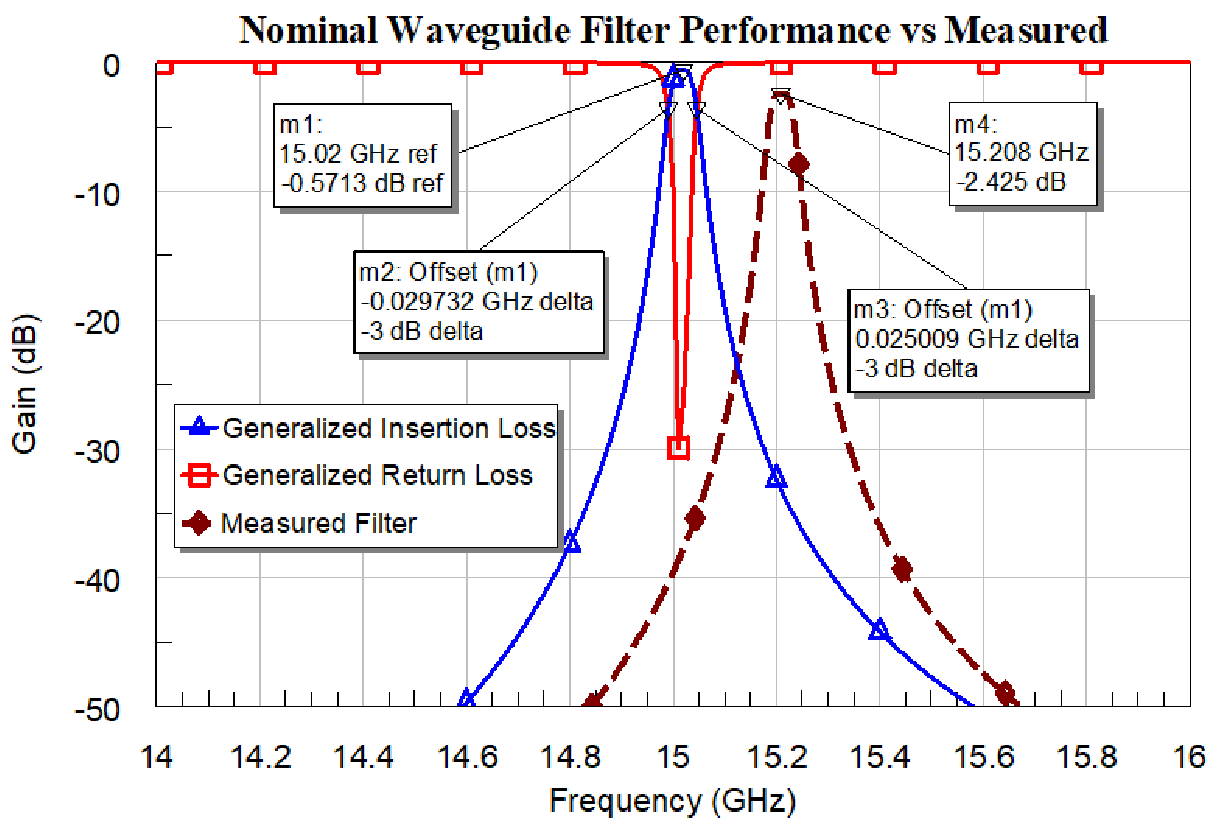
Schematic - TestBench_Optimize_Filter [AWR_RFBoard_2layer]



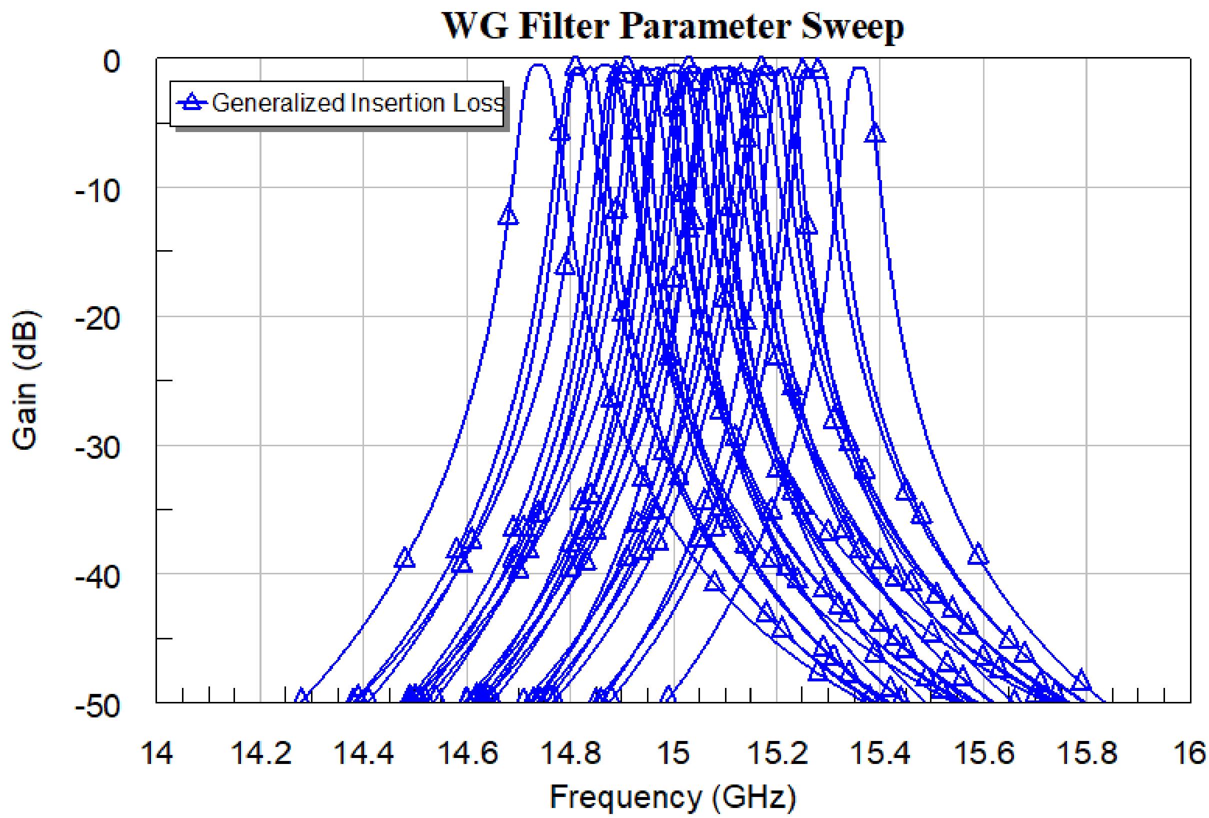
EM Structure 3D - Waveguide_Filter_Nominal



Graph - Nominal Waveguide Filter Performance vs Measured



Graph - WG Filter Parameter Sweep


WG Filter Parameter Sweep
Generalized Insertion Loss
Gain (dB)
0
-10
-20
-30
-40
-50
14
14.2
14.4
14.6
14.8
15
15.2
15.4
15.6
15.8
16
Frequency (GHz)