

Prototyping capability test case #1 7/7/2007

After finally taking the plunge into buying a PCB milling machine for RFdude.com, I thought a microstrip filter would be a great initial test case for experimenting with the capabilities. This example turned out quite well. This brief write-up is simply intended to summarize our results with the first example as we learn the machine.

I used M/FILTER in Agilent/Eagleware Genesys to synthesize a filter quickly. The assumptions were that the PCB thickness was 20 mils (some stock I had around) and the FR4 dielectric constant was 4.2 with a dielectric loss tangent of 0.022. With all of the variables of FR4 this is perhaps a poor test case....

In any case, the pictures tell most of the story. I would not get too worried about the fact that the filter basically didn't really meet the desired specification – without EM analysis and optimization I've found in the past that it can be very tough to hit it in one try.

M/FILTER™ Properties	
Topology Settings Options G Values Summary	
Input Resistance	50 🔺
Passband Ripple (dB)	.1
Attenuation at Cutoff (dB)	3
Order	3
Low Freq Cutoff (MHz)	3300
High Freq Cutoff (MHz)	3800
Desired resonator Z	60
Slide factor	
Tapped	▼ ▼
Auto Adjust Frequency Range Estimate Order	
Output Resistance = 50 3dB Frequencies are 3299.87MHz to 3800.15MHz	
Reposition Windows Optimize	
Ceposidon windows Opunize Ondo	

Enough words....



Figure 1: basic 3.5 GHz filter synthesized in Genesys on 20 mil thick FR4



Figure 2: Layout & EM analysis setup. I used a 6.6666 mil x and y grid for the EMPOWER analysis which gave 150 cells in X and Y



Figure 3: Protoype Milled at RFdude.com using new <u>AccurateCNC</u> machine (one of two prototypes). Note, the software that runs the machine doesn't support the "rub-out" so after the isolation was done, I used a heat gun, an exacto knife, and tweezers to peel the excess copper off.



Figure 4: EMPOWER (EM) simulation vs. linear analysis vs. 2 milled prototypes



Figure 5: Two prototypes tested against eachother. Excellent repeatability (luck or skill and quality of mill?)