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## Customer Background

Aptiv is a global technology company that produces software and hardware solutions for electrical systems in normal combustion vehicles, as well as new technologies for electric vehicles.

## Problem Statement

The problem with current filters in the automotive industry is the inadequate performance in higher, microwave, frequencies, and as cars are becoming more advanced the use of microwave frequencies will increase. This team has designed a circuit that aims to meet the operational frequency requirements of the automotive industry.

## Requirements

- Low Pass Filter
  - Cutoff (1GHz)
- Ranges of Focus
  - (150kHz - 18GHz)
  - (530kHz - 5.6GHz)
- Constraints
  - 6 PCB Layers
  - FR-4 Materials
  - 16V Bias Voltage
  - S:21 Insertion Loss
  - AEC-Q200 Component Compliance
- Cost & Space Efficient

Vendor	Part#	Description	Cost
JLPCB	N/A	FR-4 PCB	\$11.56
DigiKey	GCM1555C1H102GA 16D	Capacitor for 1 capacitor PCB	\$0.690
DigiKey	GCM155R71H681KA37J	Capacitor for 2 capacitor PCB	\$0.021
DigiKey	733910070	SMA Connector	\$16.24

Figure 1: Expenses for the PCB

## Experimentation and Concepts

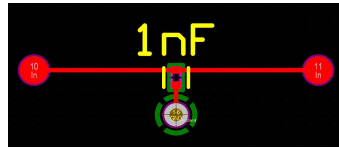


Figure 2: One Capacitor PCB

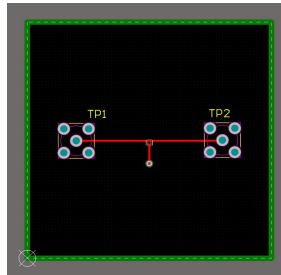


Figure 4: One Cap Testing Config.

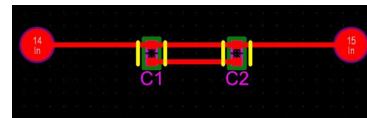


Figure 3: Two Capacitor PCB

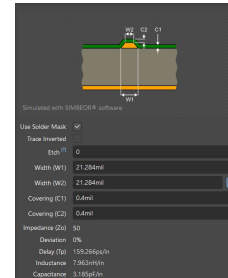


Figure 5: Parasitic Extraction

## Final Design



Figure 6: One Cap Mech. Design

#	Name	Material	Type	Weight	Thickness	DL	DF
1	Top Overlay	Solder Resist	Solder Mask		0.01016mm	35	
2	Top Solder	CF-004	Signal	0.0254mm			
3	Dielectric 1	FR-4	Dielectric	0.2112mm	41	0.02	
4	CF-004	Prepreg	Prepreg	0.0254mm			
5	Dielectric 2	PP-006	Cover	0.07112mm	41	0.02	
6	Prepreg	CF-004	Prepreg	0.0254mm			
7	Dielectric 3	PP-006	Cover	0.0254mm			
8	Dielectric 4	FR-4	Dielectric	0.3302mm	40		
9	CF-004	Prepreg	Prepreg	0.0254mm			
10	Dielectric 5	PP-006	Cover	0.07112mm	41	0.02	
11	CF-004	Prepreg	Prepreg	0.0254mm			
12	Dielectric 6	PP-006	Cover	0.0254mm			
13	Bottom Solder	Solder Resist	Solder Mask		0.01016mm	35	
14	Bottom Overlay	Overlay	Overlay				

Figure 7: PCB Layer Stackup

Board Material : FR-4  
Capacitance: 1nF  
Trace Width : 0.8mm  
Via Length : 1.27mm  
Dimension : 20.066mm X 10.033mm  
Stackup Thickness : 0.8364mm

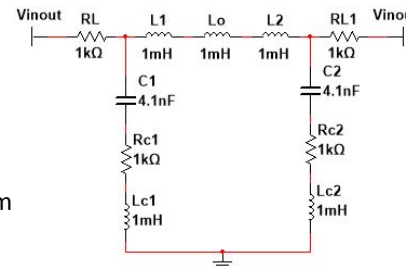


Figure 8: Shunt Filter Schematic

## Testing

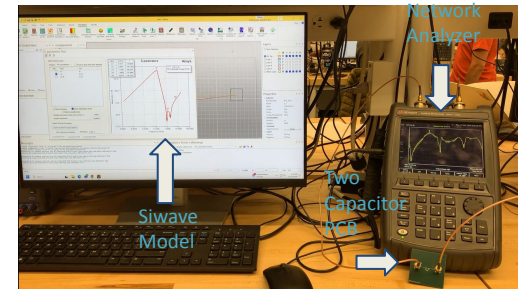


Figure 9: Simulation/NA Testing Setup

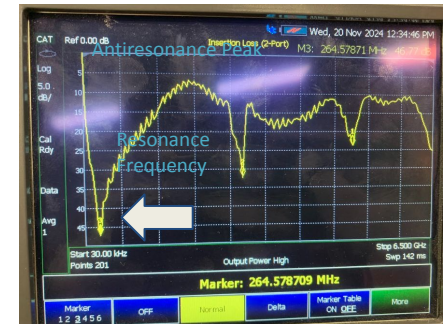


Figure 10: Two 680pF Capacitor Insertion Loss

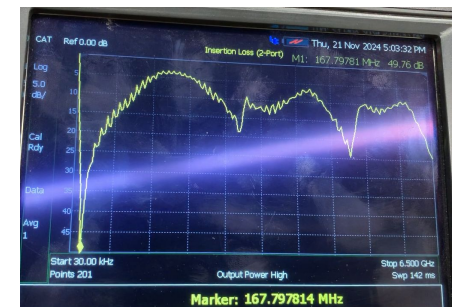


Figure 11: One 1nF Capacitor Insertion Loss