Team #5

Shunt Filter Exploration for High Frequency Applications

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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

Vedor	Part #	Description	Cost
JLCPCB	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

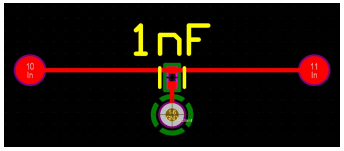

Figure 2: One Capacitor PCB

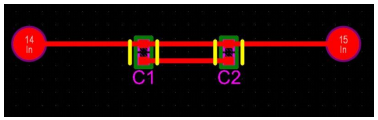

Figure 3: Two Capacitor PCB

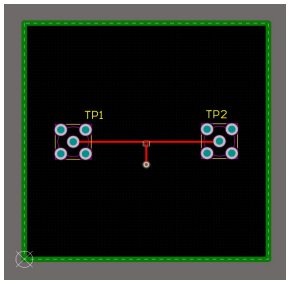

Figure 4: One Cap Testing Config.

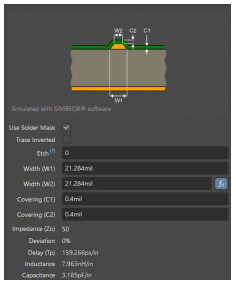

Figure 5: Parasitic Extraction

Final Design

Figure 6: One Cap Mech. Design

Figure 7: PCB Layer Stackup

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

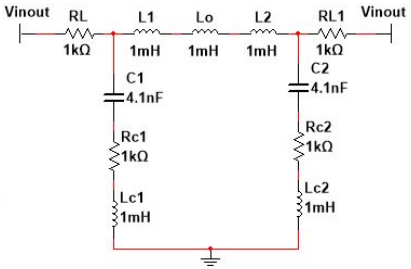

Figure 8: Shunt Filter Schematic

Testing

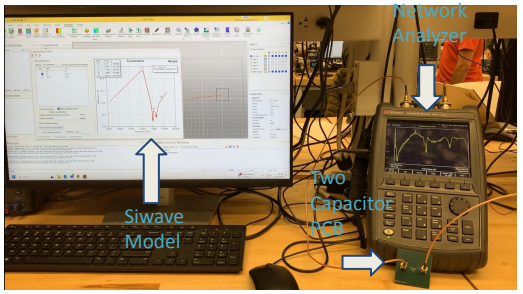

Figure 9: Simulation/NA Testing Setup

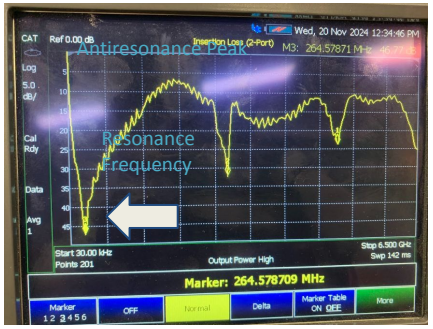

Figure 10: Two 680pF Capacitor Insertion Loss

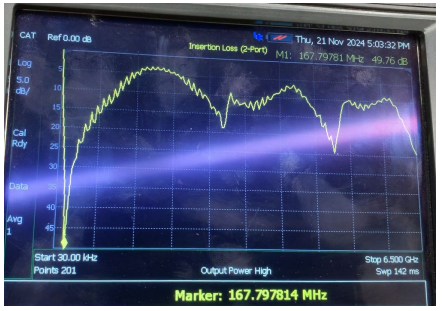

Figure 11: One 1nF Capacitor Insertion Loss