Matthew Spencer – Fall 2023

E157 Design Project 1: Filter

Design a ladder filter that will be implemented on the stock filter PCBs, layouts for which can be found on the RF lab website. The ladder filter should be a lowpass which meets the following specifications:

- Designed for a source impedance and load impedance of 50Ω
- Pass band edge of 100MHz
- Stop band start of 200MHz
- 20dB of rejection in the stop band
- Insertion loss of less than 3dB
- In-band ripple of less than 1dB

Start your design with hand analysis, then simulate your filter using ltSpice to help you to verify your filter design. Finally, build and test your design.

Your deliverable is a filled in "Design Project 1 Template" document, which can be found on the course website. Theory, simulation and measurement need to match in your final design. Be sure to comment on the comparison between the predicted, simulated and measured values in the appropriate places as you fill in your template report.

Important hints:

- Documents containing a variety of filter tables have been posted in the Resources folder on Canvas.
- You can use the Siglent SVA100X VNA to measure transmission through your filter by connecting one side of the filter to the TG port and the other to the RF port, then finding appropriate display options.
- Insertion loss is defined as $IL = P_L/P_{avS}$, and that PavS is 6dB below your input power. That factor of 6dB comes from the source and load being matched to the line impedance. Even if you had a perfect filter, you'd expect a factor of two divider in voltage between your source and load impedance, and you shouldn't count that factor against your filter's insertion loss.
- Be careful to account for component variation and parasitics. The parasitic extraction process in lab 3 may be beneficial, because board parasitics can affect this design. If you still can't dial your design in after accounting for board parasitics, then consider the parasitics of the components themselves: you may need to add a little series inductance to your models, and you can extract the value of that inductor with a 0 ohm resistor on an open board.
- You'll find that your soldering job affects the quality of your impedance match, so you may achieve the design specifications faster by paying close attention to the Smith chart as you construct your filter rather than rigidly adhering to your initial design. Be sure to document this design/implementation process and import any quirks from your physical measurements into your simulations and calculations.