EE 508 Laboratory Experiment 1
Fall 2022

Filter Operation and Measurements

Purpose: The purpose of this experiment is to develop familiarity with measurements of filter characteristics and to start developing an understanding of some of the nonideal effects that must be considered when designing filters. Emphasis in this experiment will be placed on active filter structures because they can easily be investigated in the laboratory.

Part 1. Design a second-order bandpass filter with a dc gain of 10, and with 3dB band edges at 9.75KHz and 10.25KHz. The 3dB band edges should be accurate to within ± 0.5% and the gain accurate to within ±2%. In this design, assume that the operational amplifier is ideal.

You may use any active RC circuit architecture you choose to design this filter. After the circuit is designed, it should be built and tested. No potentiometers should be used in the design. Use 741 op amps. The circuit should be trimmed, if necessary, to meet the specified performance requirements. The trimming should be accomplished by changing the value of components (but not with a potentiometer). Accurately measure all of the component values you use in your filter after trimming and compare the measured response with that predicted using the measured component values. Demonstrate the frequency response of this circuit to the course instructor. In this demonstration, show a sweep of the frequency response from 5KHz to 15KHz and show a measurement procedure that verifies the accuracy of the band edges.

When discussing your design in the laboratory report, please identify the degrees of freedom you have in your design and the systematic procedure you followed to complete your design. Include a derivation of the transfer function of the filter you selected and describe how you can trim your circuit to meet the performance specifications given. Mark the op amps that you use in your design so that you can reconstruct exactly the same circuit later.

Increase the temperature of your circuit to approximately 70C. You can use the oven that is available in the laboratory. How much change in the band edges and the dc gain occur due to the temperature change? Identify which components contribute to this change and verify this by analytical derivation based upon measured temperature performance of the components.

Part 2 Develop a strategy for measuring the GB of an op amp.

a) Use this strategy to measure the GB of ten 741-type op amps to an accuracy of 1%. Validate the accuracy of your measurement in the context of the specifications of the instruments you are using to make the measurement. Mark these op amps so that you later know what the GB is of each of the op amps. What is the mean and standard deviation of the GB of the op amp?

b) Use this strategy to measure the GB of three 356 op amps. Mark these op amps as well.

c) Replace the op amp (or op amps) in the active filter you tested with the 356 op amps and repeat the measurement (at room temperature only). Do not change any of the passive component values from those that you used in Part 1. How does the performance with 356 op amp(or op amps) compare to that you saw with the 741 op amp (or op amps)?

Note: The op amps you have are yours to keep and since you have already measured the GB of these devices, be sure to not mix those up with the ones from your lab partner. If for any reason you burn out an op amp, you should get a replacement and record its GB.