ECE214: Electrical Circuits Laboratory Lab #3 — RC Filters Week of 3 February 2015

1 Introduction

In this lab you will design and build a filter to reduce the fundamental frequency from a 1 kHz square wave as illustrated below.



2 Pre-lab

- 1. Design a RC filter circuit, with the minimum number of components, to meet the following specification:
 - (a) Input: Square wave with a frequency of 1 kHz.
 - (b) Output: 3rd harmonic at least 6dB above fundamental frequency and 3rd harmonic larger than all other harmonics.
 - (c) Analyze the filter circuit in Micro-cap using both "ac" and "transient" analysis. In Micro-cap, use a 5 V peak square wave at a frequency of 1 kHz as the input to the filter. Use "ac" analysis to generate the frequency response of the filter. Use "transient" analysis for 100 ms to generate the time-domain response of the input and output signals. Use the FFT feature to generate the frequency-domain response of the input and output signals. (See page 3 for using the FFT feature to generate the frequency-domain response of a time-domain signal in Micro-cap.)
 - (d) In your notebook, have plots from the Micro-cap simulations showing the frequency response of the filter and the input and output of the filter in both the time-domain and the frequency-domain.

3 Lab Procedure

Build the filter you designed in the pre-lab.

- 1. Connect a 5 V peak square wave at a frequency of 1 kHz from the FG to the input of the filter. Measure the output of the filter on the scope in both the time-domain and the frequency-domain. Record the time- and frequency-domain signals in your notebook. Make sure all axes and peaks are properly labeled. Photographs of the scope screen are an efficient way to record this data.
- 2. Does the output of the filter meet the specifications? If "Yes," you are done with the Lab Procedure.
- 3. If the specification is not met, redesign the filter, then build and test the new filter. Repeat this step until the filter circuit meets the specification.

4 Post-Lab

Compare the measured results with the simulated results from Micro-cap. Make sure you understand the difference between the "ac" analysis in Micro-cap and the FFT of the transient response. Explain any differences between the simulations and measured results in your notebook.

FFT and Micro-cap

To generate the FFT of the time-domain signal in Micro-cap: Once you have the transient signal on the screen, click Transient -> FFT Windows -> Add FFT Window. In the Plot tab, select: db (Harm) and in the expression field enter the node of the circuit you want to examine. Set the FFT and Scales and Formats tabs as shown below. Use the cursor to determine the peak amplitudes.

Properties for FFT:dB(Harm(v(3)))		
Plot Scales and Formats Colors, Fonts, and Lines Scope FFT Numeric Output Tool Bar		
Upper Time Limit TMAX Lower Time Limit TSTART Frequency Step 10 Number of Points 131072		
Auto Scaling Include DC Harmonic AutoScale First 10 Harmonics		
OK Cancel Apply Help		

Plot Scales and Formats	Colors, Fonts, and Lines Scope FF X Range Low 500 Range High 10000 Grid Spacing 10 Bold Grid Spacing 0 Scale Factor None Scale Format 2 Digit Engineering Cursor Format 3 Digit Engineering Cursor Format 3 Digit Engineering Auto Scale Log Auto/Static Grids S Image Engineering Static Grids Cursor Scale	Numeric Output Tool Bar Y Range Low -60 Range Ligh 10 10 Grid Spacing 8 8 Bold Grid Spacing 0 • Scale Factor None • Scale Factor None • Scale Format 2 Digit Engineering Cursor Format 3 Digit Engineering Auto/Static Grids 5 I Enable Scaling Use Common Formats Common Y Scale Common Y Scale
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