CARLETON UNIVERSITY
Department of Systems and Computer Engineering

SYSC 3203
Project Title: EMG-Controlled Mouse
Milestone #3B: EMG rectifier and integrator

Since an EMG signal is not rhythmic in nature, typical signal processing involves rectification and integration of the EMG signal once it is adequately filtered as was done in the previous lab. The output of the integrator represents the intensity of the muscle contraction. Lab #3B therefore consists in designing a precision rectifier followed by an integrator circuit.

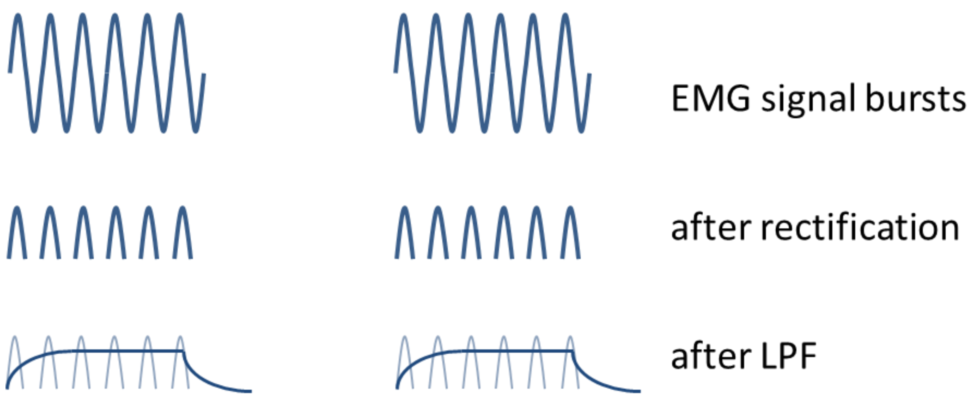

Figure 1: schematic representation of the half-wave rectifier / peak detector

NOTE: You are free to choose EITHER option 1A (half wave rectifier) or 1B (full wave rectifier). Either implementation will satisfy the overall requirements of the project, although the final performance (in terms of sensitivity to smaller muscle movements) may be slightly better with the full wave option.

1A. Half wave rectifier design

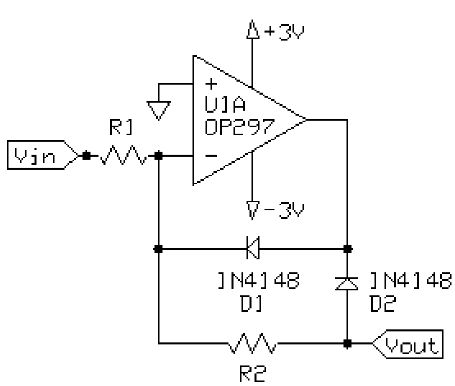

Figure 2: Half wave rectifier circuit

The circuit represented in Figure 3 realizes a half wave rectifier using one OP97 operational amplifier (or one half of an OP297 dual operational amplifier), two IN4148 diodes and 2 resistors. While supposing the diodes are ideal, analyze the circuit when Vin is positive and when Vin is negative.

1A.1. Write down in your lab book whether each diode is conducting or not when Vin is positive and when Vin is negative and have him/her sign your lab book.

Calculate the values for R1, R2 for the circuit to act as a half-wave rectifier with a unit gain.

1A.2. Show your calculated R1, R2 values to the instructor and have him/her sign your lab book.

1B. (OPTIONAL) Full wave rectifier design

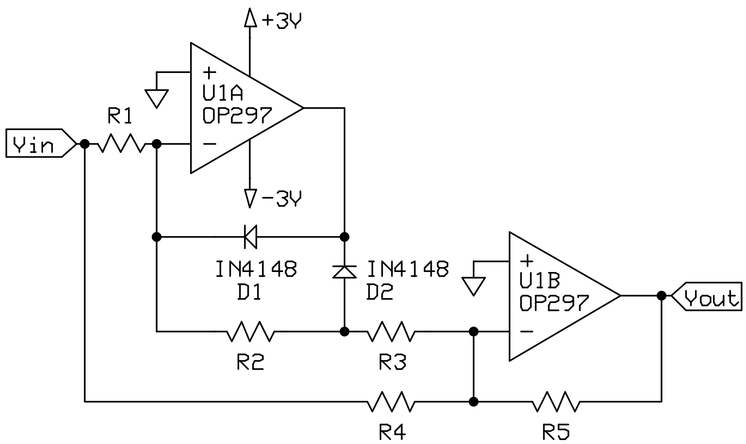

Figure 3. Full wave rectifier.

The circuit represented in Figure 3 realizes a full wave rectifier using one OP297 dual operational amplifier, two IN4148 diodes and 5 resistors. While supposing the diodes are ideal, analyze the circuit when Vin is positive and when Vin is negative.

1B.1. Write down in you lab book whether each diode is conducting or not when Vin is positive and when Vin is negative and have him/her sign your lab book.

Calculate the values for R1, R2, R3, R4 and R5 for the circuit to act as a full-wave rectifier with a unit gain.

1B.2. Show your calculated R1, R2, R3, R4 and R5 values to the instructor and have him/her sign your lab book.

1B.3. Write down two ways this circuit could be modified to act as a half-wave rectifier and have him/her sign your lab book.

1C. Rectifier assembly and test

Assemble and test your full wave rectifier using a function generator and an oscilloscope. Test that it works correctly with DC and then find the frequency where you start to see some distortion and the frequency where distortions are too high to be acceptable for a wave rectifier.

1C.1. Validate your observed frequencies with the instructor. Have him/her sign your lab book.

2. Integrator

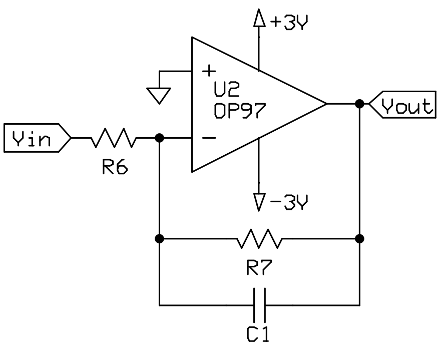

Figure 4: "Lossy" or practical integrator.

Figure 2 presents an integrator circuit that is called a "lossy" integrator or a practical integrator.

2.1. Analyze the circuit and explain why this circuit is called a "lossy" or practical integrator and how it compares to an ideal integrator. Have the instructor verify your explanation and sign you lab book.

2.2. How would an ideal integrator behave for the current project? Validate your answer with the instructor and have him/her sign your lab book.

Select an adequate cut-off frequency for this application and calculate adequate values for R6, R7 and C1 for a gain of 10.

2.3. Explain in your lab book why you selected this cut-off frequency and complete your calculations for R6, R7 and C1. Have him/her sign your lab book.

Test your circuit with a function generator and an oscilloscope and verify that the gain and cut-off frequency are as designed.

2.4. Show your experimental results to the instructor and have him/her sign your lab book.