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.

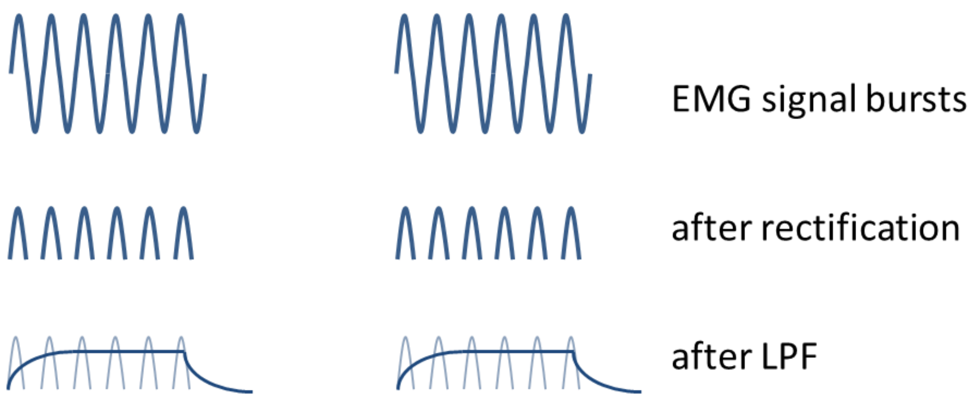

Figure 1: Schematic representation of the half-wave rectifier / peak detector.

1. Full Wave Rectifier Design

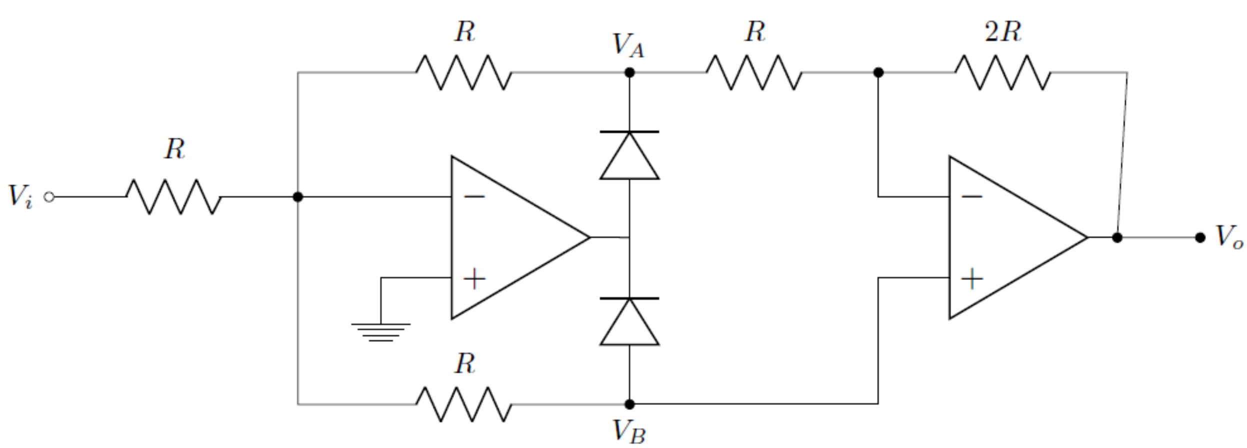

Figure 2: Full wave rectifier circuit.

The circuit represented in Figure 2 realizes a full wave rectifier using two OP97 operational amplifiers, two IN4148 diodes and 5 resistors. While supposing the diodes are ideal, analyze the circuit when V_i is positive and when V_i is negative.

1.1: Sketch the circuit diagram for the full wave rectifier. Indicate the resistor values you plan to use to build your circuit.

1.2: Indicate on your sketch whether each diode is conducting or not when: a) V_i is positive b) V_i is negative.

1.3: Sketch a schematic for the full wave rectifier showing the chip layouts for the OP97 op-amps and labeling the terminals. Please label the testing points for your circuit.

2. Full Wave Rectifier Assembly and Test

Assemble and test your full wave rectifier using a function generator and an oscilloscope.

2.1: Measure the outputs at V_A, V_B, and V_O given a sine wave input at V_i. What type of circuit does each point represent? Sketch the input and output for each of the three measurement points.

2.2. Demonstrate the proper operation of the full wave rectifier circuit to your TA.

3. Integrator Circuit

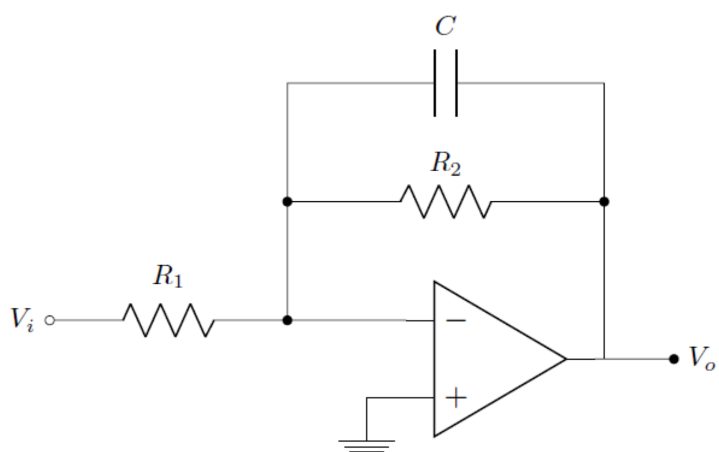

Figure 3: "Lossy" or practical integrator.

Figure 3 presents an integrator circuit that is called a "lossy" integrator or a practical integrator.

3.1: Analyze the circuit and explain why this circuit is called a "lossy" or practical integrator and how it compares to an ideal integrator.

3.2. How would an ideal integrator behave for the current project?

Select an adequate time constant for this application (hint: consider how fast the operator's forearm muscles will contract and relax). Calculate values for R1, R2 and C to achieve this time constant with a gain of 10.

3.3. Explain what time constant value you selected and show your calculations for R1, R2, and C.

3.4: Sketch the circuit diagram for the lossy integrator. Indicate the resistor and capacitor values you plan to use to build your circuit.

3.5: Sketch a schematic for the lossy integrator showing the chip layout for the OP97 op-amp and labeling its terminals. Please label the testing points for your circuit.

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

3.6. Demonstrate the proper operation of the integrator circuit to your TA.