ELECENG 2CJ4

Lab 4 Report

Analyzing First-order Circuits

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1. Introduction

This lab analyzes first-order circuits to determine the oscillator's period and frequency. We compare theoretical calculations with measured values using the Analog Discovery 3 (AD3) and assess discrepancies due to experimental errors and component tolerances. Additionally, we explore generating a triangular output from a square wave signal.

2. Operational Principle of the experiment

We must determine the period and frequency voltage of the oscillator in Figure 9.

$$T = T_1 + T_2 = R_3 C \left[\ln\left(\frac{V_{sat}^{+} - V_{th2}}{V_{sat}^{+} - V_{th1}}\right) + \ln\left(\frac{V_{sat}^{-} - V_{th1}}{V_{sat}^{-} - V_{th2}}\right)\right] \rightarrow (17)$$

$$V_{th1} = \frac{R_2}{R_1 - R_2} V_{sat}^{+} = \frac{1k\Omega}{22k\Omega - 1k\Omega} \times 5V \approx 0.238V$$

$$V_{th1} = \frac{R_2}{R_1 - R_2} V_{sat}^{-} \approx -0.238V$$

Plugging in the required values into Eq.17:

$$T = 50k\Omega \times 100nF \left[\ln\left(\frac{5 + 0.238}{5 - 0.238}\right) + \ln\left(\frac{-5 - 0.238}{-5 + 0.238}\right)\right]$$

$$T_C \approx 0.9527ms$$

Thus, the frequency can be found by:

$$f = \frac{1}{T} = 1.049Hz$$

3. Measurement results

The AD3 measurement results and their resulting waveforms and circuits are included below.

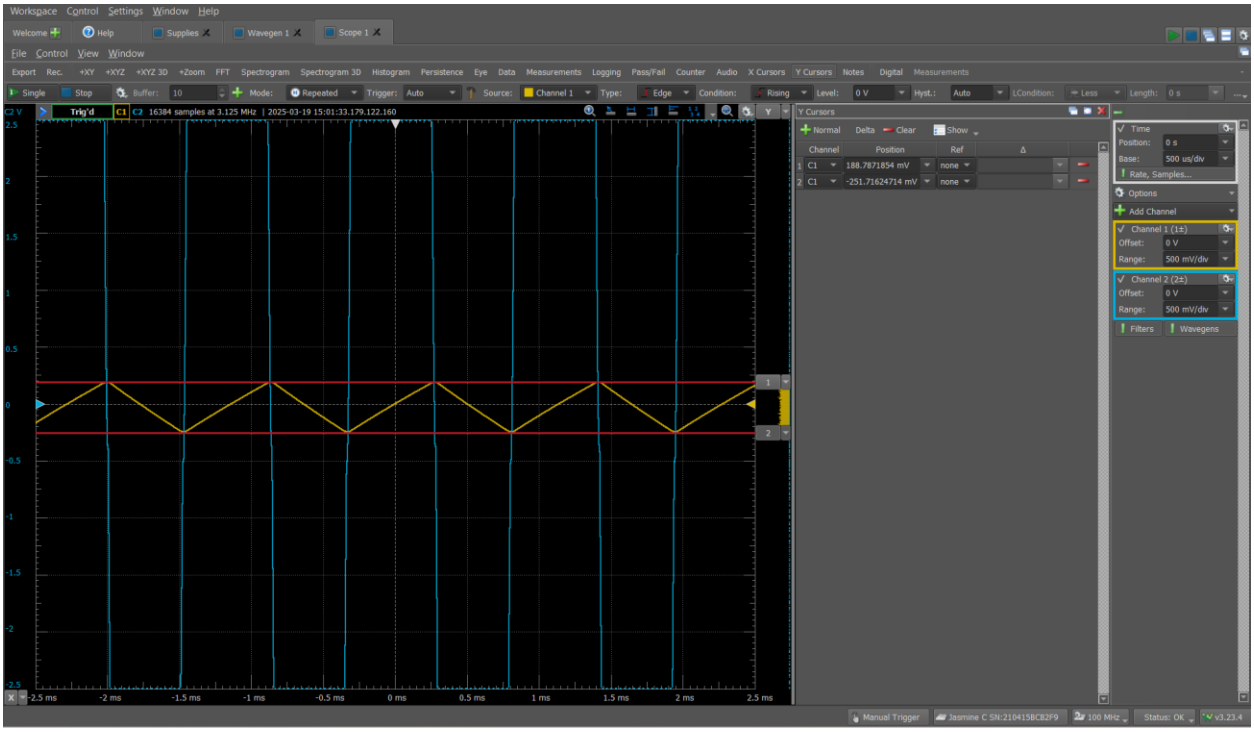

Figure 1. Simulation

4. Discussion

Measured results:

$$T_M = 50k\Omega \times 100nF \left[\ln\left(\frac{5 + 0.251}{5 - 0.188}\right) + \ln\left(\frac{-5 - 0.188}{-5 + 0.251}\right)\right]$$

$$T_M = 0.8786ms$$

Comparing Theoretical vs Measured Results:

$$T_C \approx 0.9527ms$$

$$percent\ difference = \frac{|C - M|}{\left(\frac{C + M}{2}\right)} \times 100$$

$$percent\ difference = \frac{|0.9527ms - 0.8786ms|}{\left(\frac{0.9527ms + 0.8786ms}{2}\right)} \times 100 = 8.0947\%$$

This difference is most likely due to experimental errors and component tolerances.

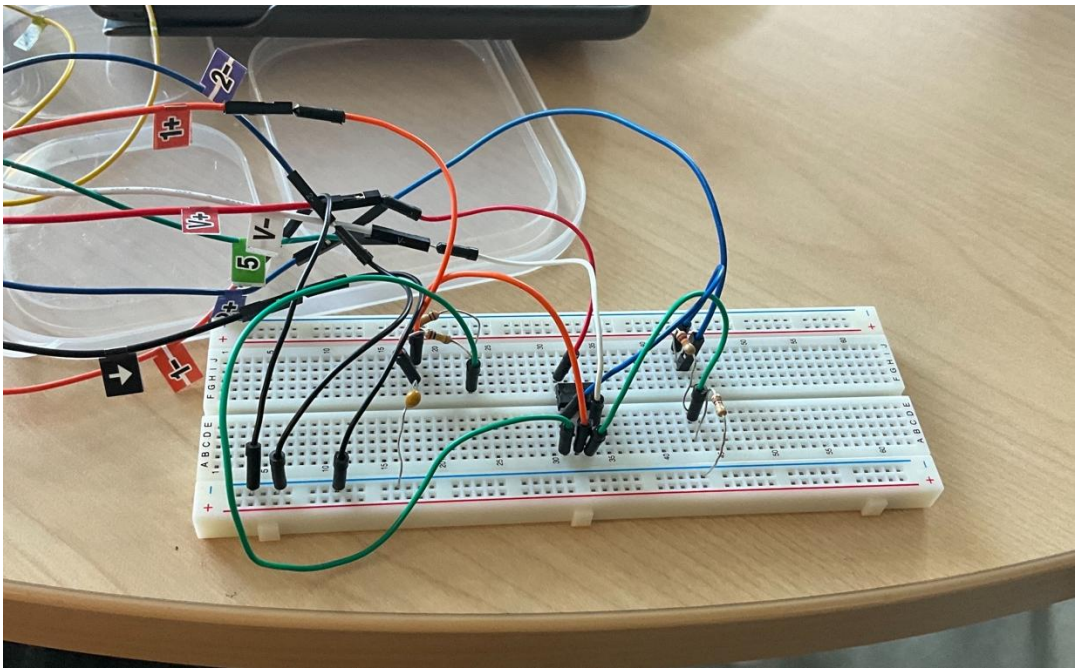

Figure 2. Physical Circuit

Generating a Triangular Output:

We can have a square wave output. Using this output as an input into an integrator will generate a triangular output.