Electronic Devices and Circuits I - EE2CJ4
Lab #4

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2023 - 02 - 09

i. Given the circuit in Fig. 9, calculate the period T and frequency f of the oscillator.

We first must calculate the values for V_{th1} & V_{th2} …

$$V_{th1} = \frac{R_1}{R_1 + R_2} \cdot V_{sat+} = \frac{1k\Omega}{1k\Omega + 22k\Omega} \cdot 5V = 0.217V$$

$$V_{th2} = \frac{R_1}{R_1 + R_2} \cdot V_{sat-} = \frac{1k\Omega}{1k\Omega + 22k\Omega} \cdot \text{-}5V = \text{-}0.217V$$

We can now calculate the time period of the circuit …

$$T_{total} = T_1 + T_2$$

$$T_1 = C \cdot R \cdot ln\left(\frac{V_{sat+} - Vth_2}{V_{sat+} - Vth_1}\right) = (100nF)(50k\Omega)ln\left(\frac{5V - (-0.217V)}{5V - 0.217V}\right) = 4.34 \cdot 10^{-4} Seconds$$

$$T_2 = C \cdot R \cdot ln\left(\frac{V_{sat-} - Vth_1}{V_{sat-} - Vth_2}\right) = (100nF)(50k\Omega)ln\left(\frac{-5V - 0.217V}{-5V - (-0.217V)}\right) = 4.34 \cdot 10^{-4} Seconds$$

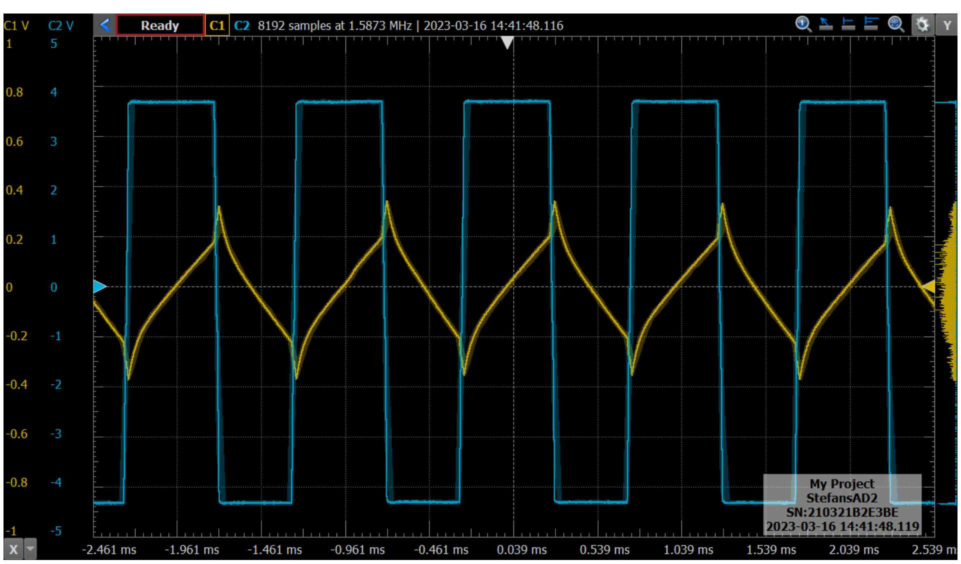
$$T_{total} = 4.34 \cdot 10^{-4} + 4.34 \cdot 10^{-4} = 8.68 \cdot 10^{-4} Seconds = 0.868\, mS$$

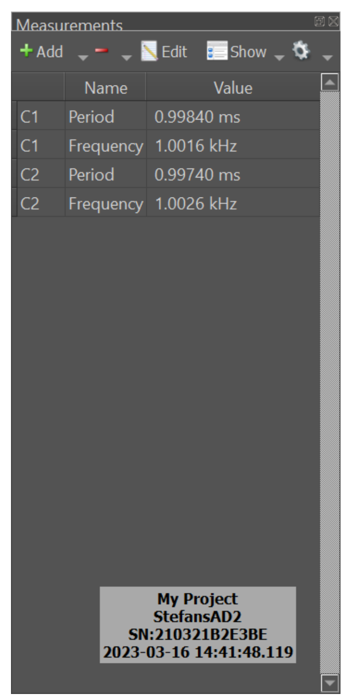
We can now use T_{total} to determine the frequency of the circuit …

$$f = \frac{1}{T_{total}} = \frac{1}{8.68 \cdot 10^{-4} S} = 1152Hz = 1.152KHz$$

ii. Build the circuit in Fig. 9 and plot the voltage of the capacitor and the output voltage with respect to time (assuming $V_{sat} = \pm 5V$). Measure the time period T using the Analog Discovery 2 and

In this figure, the voltage of the capacitor is the yellow waveform, and the output voltage of the op amp is the blue waveform. The figure to the left shows the values for frequency and period.





The below figure shows the built circuit in real life

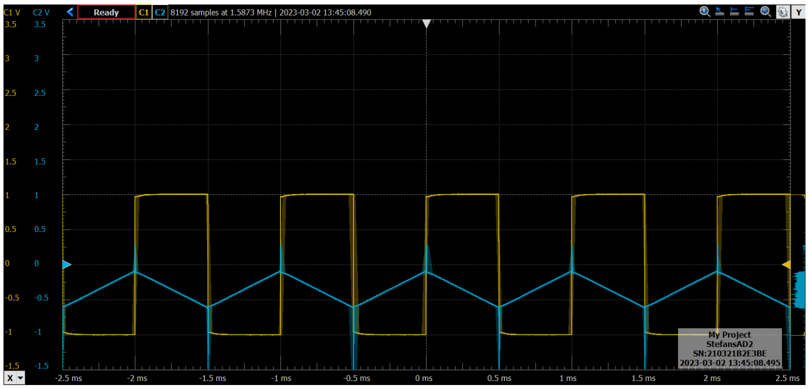
As can be seen from the above data, the measurements that we got from the testing of the circuit on the AD2 were very similar to the theoretical values that were calculated. We calculated a frequency of 1.1KHz, and the actual measurements showed a frequency of about 1.06KHz. We can calculate the percent error in these measurements… $\% \, Error = \frac{1.152 - 1.0016}{1.1} \times 100\% = 13.6\%$

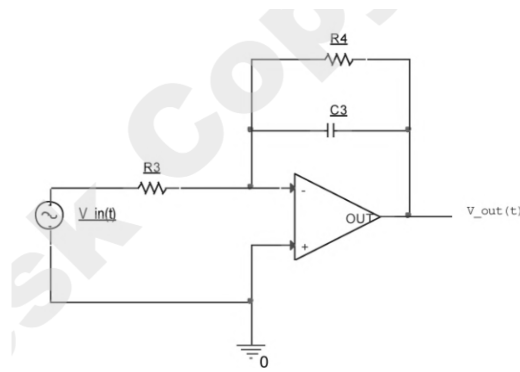
Additionally, we had calculated a time period of about 0.86mS, and the actual measurements are showing a time period of 0.94mS. We can calculate the percent error in our values using the same formula as we used above… $\% \, Error = \frac{0.869 - 0.99840}{0.86} \times 100\% = 15.05\%$

As we can see, our theoretical calculations are a very good estimate for our actual data, with both measurements falling within 10% error of the actual values.

iii. Can you build a circuit by using another Op-Amp LM358P to generate a triangular output? Explain.

This would definitely be possible to achieve. As we explored in the previous lab, we saw that the integrator circuit is a circuit that takes a square wave input, and produces a triangular wave output. In this circuit, the output voltage waveform is a square wave. Thus, we can feed the output of this circuit into the input of an integrator, and achieve a triangular wave output from the output of the integrator.





In this case, the yellow waveform is the input square wave (output of the relaxation oscillator, and input to the integrator), and the blue waveform is the output triangular wave (output of the integrator)