## ECEN405 Lab 1 Report Pulse Width Modulation

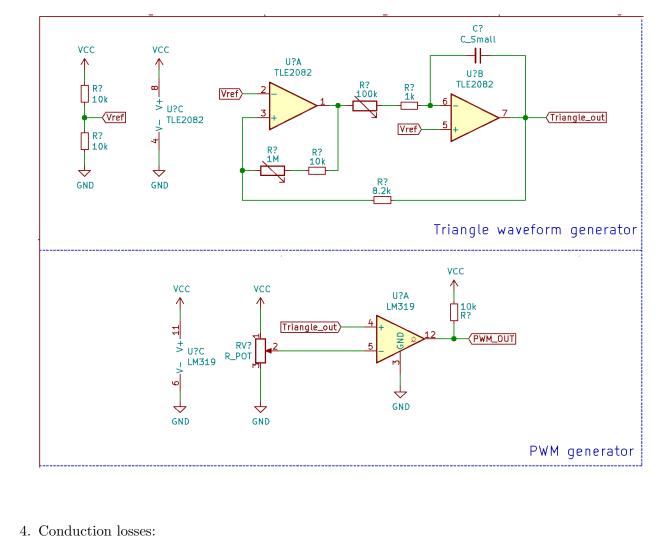
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1.  $C_1 = 10 \ nF$ 

 $f_{max} = 3.03 \text{ MHz}$ 

2.  $f_{min} = 297 \text{ Hz}$ 

3. Schematic of the PWM generator



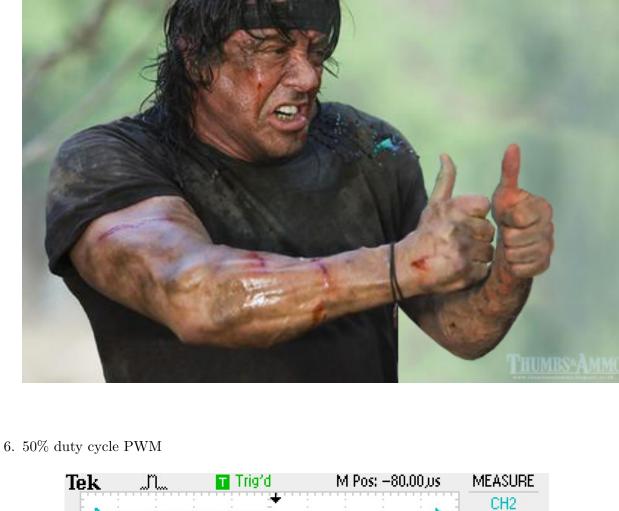
$$P_{sw} = 78.4 \; \mu W$$
 Maximum frequency switching losses

 $P_{cond} = 0.6 W$ 

and proudly show him.

Minimum frequency switching losses

 $P_{sw} = 0.799 W$ 



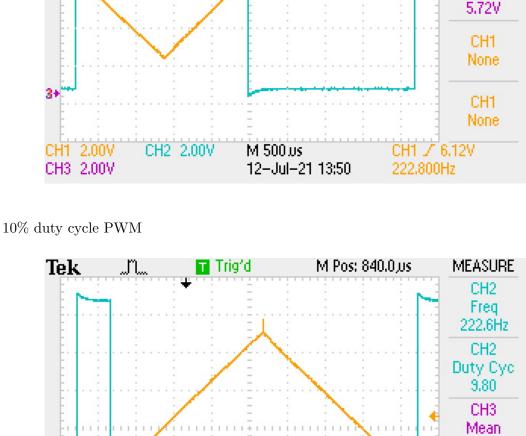
Freq 222.8Hz CH2 Duty Cyc 50.8 CH3 Mean

2,427

CH1 None

CH1 None

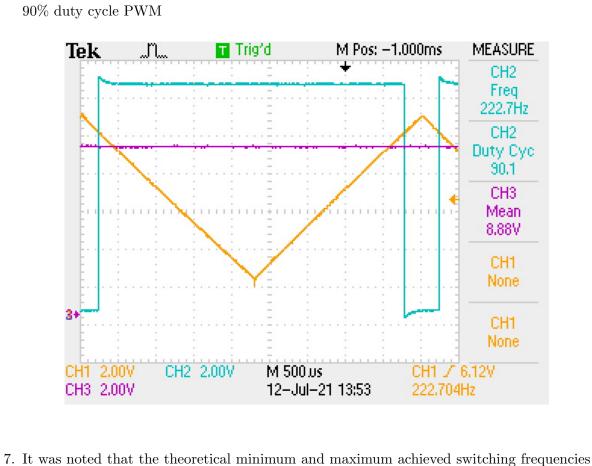
CH1 / 6.12V 222,600Hz



CH1 2,00V

CH3 2,00V

CH2 2,00V



M 500 us

12-Jul-21 13:52

affect these frequencies. By creating the circuit on a breadboard, we introduce parasitic capacitances, and inductances to the circuit, which will affect the operation of the op-amps. It is also possible that op-amp characteristics such as slew rate are affecting the frequency of the output. 8. To get both an inverted and non-inverted signal, you can switch the input terminals of the comparator. Since the LM319 is a dual comparator, it is possible to have both the inverted and non-inverted signals out from the same IC. 9. Below is a block diagram of the two sub-circuits that can be found with the triangle wave generator, and their respective outputs. The first circuit is a square wave generator or oscillator, and the second is an integrator. This circuit is made using a gain amplifying opamp that has positive feedback and hysteresis. This positive feedback causes it to become unstable, and the hysteresis causes it to oscillate from rail to rail. The frequency of this oscillation can be set using R4.

The second sub-circuit is an opamp integrator. This sub-circuit will integrate the square wave generated by the first to produce a triangle wave. The scaling of this circuits output

(both frequency and gain) is controlled using R3.

of the circuit were not achieved by the designed circuit. Although it is hard to exactly pinpoint where this issue comes from, there are a range of possible factors that would

Oscillator Signal Integrator Appendix Q1: Equation to calculate the capacitor size

Q2: Equations to calculate the minimum and maximum frequencies  $f_{min} = \frac{R_2}{4R_1 (R_4 + R_5) C_1} = 297 \ Hz$ 

 $C_1 = \frac{R_2 + R_3}{4R_1 \left( R_4 + R_5 \right) F_T}$ 

$$4R_1(R_4+R_5)C_1$$

 $f_{max} = \frac{R_2 + R_3}{4R_1 \cdot R_5 \cdot C_1} = 3.03 \ MHz$ 

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**Q4**: Conduction switching losses:

Minimum frequency switching losses:

 $P_{cond} = R_{DS(on)} \cdot d \cdot I^2 = 0.6 W$ 

$$P_{sw} = \frac{1}{2}V_{in} \cdot I_o(t_{c(on)} + t_{c(off)})f_{min} = 78.4 \ \mu W$$

Maximum frequency switching losses:  $P_{sw} = \frac{1}{2}V_{in} \cdot I_o(t_{c(on)} + t_{c(off)})f_{max} = 0.799 W$