EEE3096S

Tutorial 3

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Question 1:

1.1. From the figure 1 we can estimate that the maximum output data value is 244 and the minimum output data value is 14. So, we know that there are 244-14=230 step representations required.

$$Number\ of\ bits\ required = \log_2(230) = 7.845$$

But since you can't get a bit resolution of 7.845 we can say that the bit resolution that was used is 8-bit resolution.

1.2. Frequency = 500Hz. (Given)

$$T = \frac{1}{F} = \frac{1}{500} = 0.002\ sec$$

$$Calculated\ slope: \frac{2.5 - 0}{0.002 - 0}\frac{V}{sec} = 1250\ V/s$$

$$two\ points\ on\ slope: \frac{182 - 57}{0.007 - 0.006}\frac{ADC\ value\ (steps)}{sec} = 125000\ steps/s$$

$$Quantizing\ resolution = Q = \frac{1250}{125000} = 0.01\frac{V}{step}$$

Question 2:

2.1. To get the DC offset error of the ADC we need to multiply the average of the data by the quantizing resolution.

The average value from Figure 2 is obviously 15. The quantizing resolution (Q) from the previous question is 0.01 V/step.

$$DC\ offset\ error = average\ \times Q$$

$$DC\ offset\ error = 15 \times 0.01$$

$$DC\ offset\ error = 0.15$$

2.2. SFDR = Fundamental amplitude in dB – Largest spur amplitude in dB

$$SFDR = 26dB - 5dB = 21dB$$

$$Power = 10^{\frac{SFDR}{10}} = 10^{\frac{21}{10}}$$

$$\therefore Power = 125.89\ Watts$$

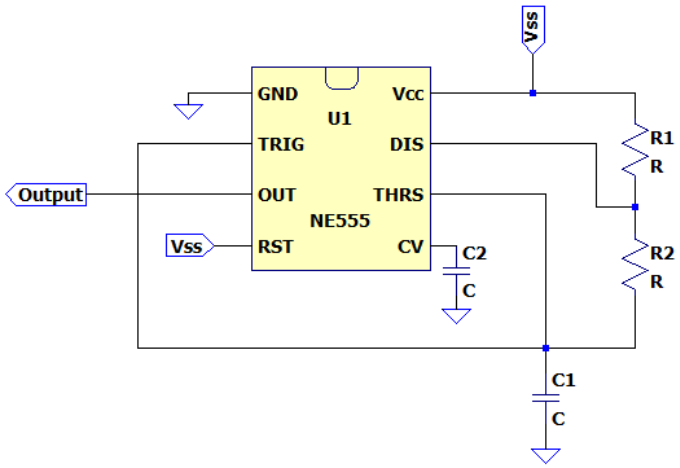
Question 3:

3.1. PWM Frequency is how quickly the PWM signal switches between on and off. While Duty Cycle is the percentage of time that the signal stays on.

3.2. By increasing the duty cycle of the PWM signal you can increase the brightness of the LED.

3.3. Persistence of vision is when an image persists when there are repeated interrupts to a light stream, so the light stream does not enter our eyes during those periods. A PWM circuit can vary the time and brightness of LEDs so it can utilise persistence of vision. Therefore, a PWM circuit can be used for persistence of vision instead of needing a whole lot of other components and circuitry therefore simplifying circuit design.

3.4.



This 555-timer circuit will generate a PWM signal with the ability to vary the duty cycle. You can vary the duty cycle by changing the value of R2.

Using the following equation:

$$t_{off} = -\ln\left(\frac{1}{2}\right) R_2 C$$

By decreasing the R2 value the time off will decrease therefore increasing the percentage of time on which is the Duty Cycle.

References:

Amayo, Paul.” EEE1006F: Module 6 555”, Class notes, EEE1006F, University of Cape Town, 16 June 2021

DIY led POV display, STEMpedia Education. Available at: https://ai.thestempedia.com/project/diy-led-pov-display/#:~:text=What%20is%20POV%3F,our%20eyes%20during%20those%20durations. (Accessed: 17 September 2023).