Department of

Electrical & Electronics Engineering

Abdullah Gul University

Electronics 1

Uneven Seven-Sided Dice Roller Project

Task 1

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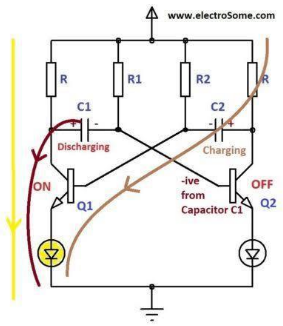
Pulse Generator for Data (D0)

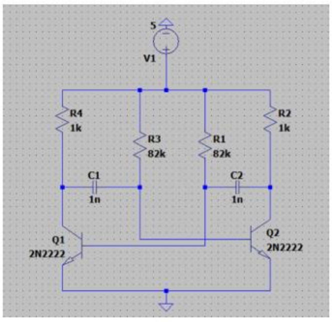
This task involves the design and construction of a multivibrator specifically adapted for Data (D0) output.



Multivibrators, which form the basis of flip-flop circuits, are circuits that produce the square wave signal, that is, the trigger signal, required for the circuits. Its working principle is based on a positive feedback mechanism; That is, the output signal is fed back to the input and with the phase shift, oscillation occurs.

One bit of data (D0) is a pulse signal used to ensure randomness in the system. This signal is designed to introduce unexpectedness and randomness into the system. For example, a 1-bit data (D0) signal represents the unexpected outcome of rolling a dice. This signal is used in conjunction with other components to ensure that the results stored in the output register are random.

A. Circuit Diagram

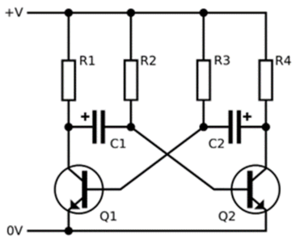


(Figure 1.0 – D0 Pulse Generator)

A multivibrator circuit has been designed to provide pulse signals for Data (D0). The circuit is designed to produce a proper square wave with a low voltage level of ground and a high voltage level of 5 volts. The circuit in Figure 1.0 was designed with the help of 2 1k resistors, 2 82k resistors, 2 1 nanometer capacitors and 2 2N2222 model transistors. In the produced circuit, care was taken to ensure that the frequency complies with the limits of 10fck1 < fdata<100fck1.

A multivibrator circuit was used as the pulse generator circuit. A multivibrator circuit was designed as a pulse generator in the circuit because its basic components can be easily created and applied, it has a wide frequency range to adapt the desired frequency range in task 1, its operating parameters can be easily adjusted and its low power consumption.

a. Calculation of Data Frequency



(Figure 1.1 – A Multivibrator Diagram)

$$V_{cap}(t) = \left[\left(V_{capinit} - V_{charging}\right) * e^{-\frac{t}{RC}}\right] + V_{CC} \ (1.0)$$

$$t = -RC * \ln\left(\frac{V_{BE_{Q1}} - V_{CC}}{V_{BE_{Q1}} - 2V_{CC}}\right) \ (1.1)$$

For this circuit to work, VCC>>VBE_Q1 (for example: VCC=5 V, VBE_Q1=0.6 V), therefore the equation can be simplified to:

$$t = -RC * \ln\left(\frac{-V_{CC}}{-2V_{CC}}\right) \ (1.2)$$

$$t = -RC * \ln(2) \ (1.3)$$

The period of each half of the multivibrator is therefore given by t = ln(2)RC.

The total period of oscillation is given by:

$$T = t1 + t2 = \ln(2)R2\,C1 + \ln(2)R3\,C2$$

$$f = \frac{1}{T} = \frac{1}{\ln(2) * (R2\,C1 + R3\,C2)} = \frac{1}{0.693 * (R2\,C1 + R3\,C2)} \ (1.4)$$

For the special case where

- $t_1 = t_2$ (50% duty cycle)
- $R_2 = R_3$

- $C_1 = C_2$

$$f = \frac{1}{T} = \frac{1}{\ln(2) * 2 * RC} = \frac{0.72}{RC} \quad (1.5)$$

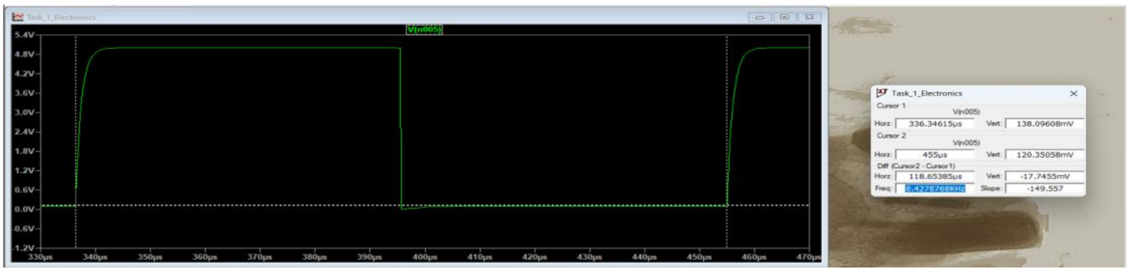
Data frequency, then

$$f_{data} = \frac{0.72}{82 * 10^3 * 1 * 10^{-9}} =$$

$$f_{data} = 8.798{,}78\ Hz = 8.7kHz$$

B. Simulation Results

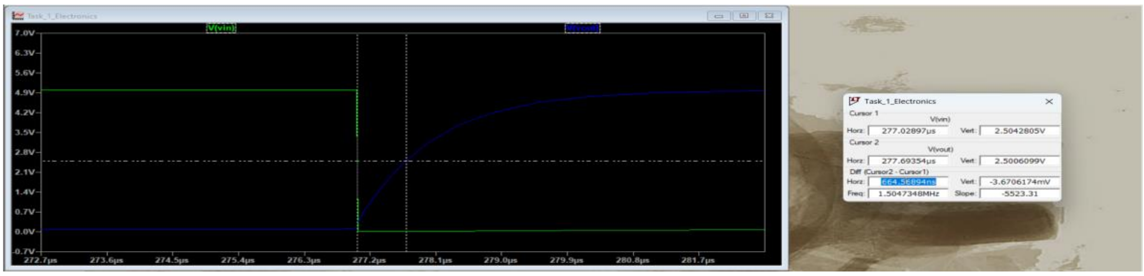
a. f_{data} :



(Figure 2.0 – Value of f_{data})

According to the simulation results, the data was found to be 8.4278768KHz.

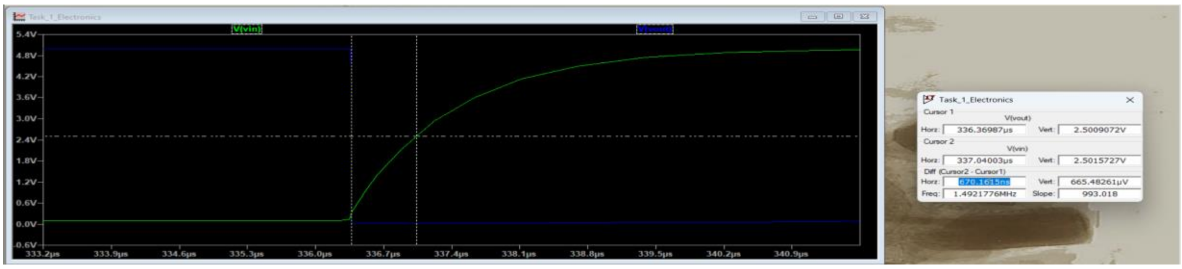
b. t_{PHL}



(Figure 2.1 – Value of t_{PHL})

According to the simulation results, the t_{PHL} was found to be 664.56894ns.

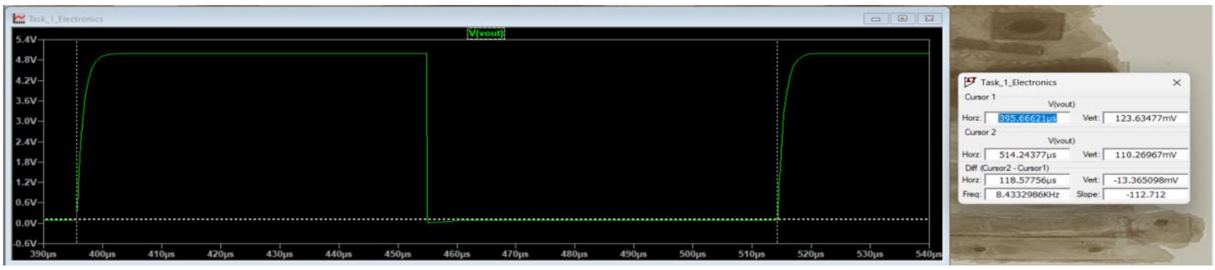
c. t_{PLH}



(Figure 2.1 – Value of t_{PLH})

According to the simulation results, the t_{PLH} was found to be 670.1615ns.

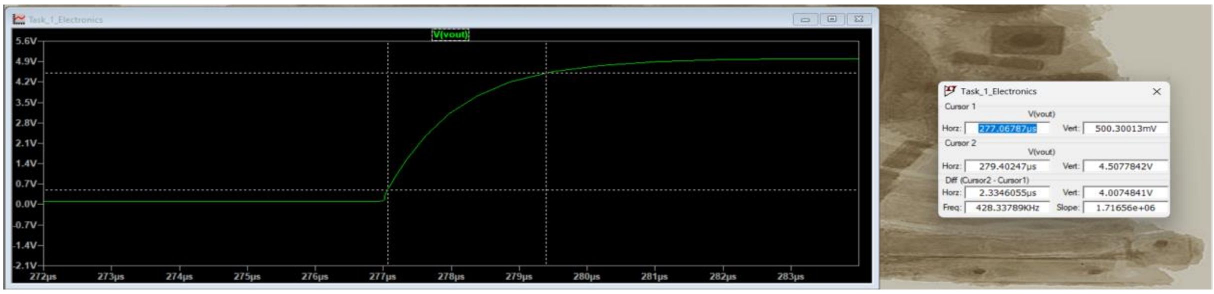
d. t_{cycle}



(Figure 2.2 – Value of t_{cycle})

According to the simulation results, the t_{cycle} was found to be 118.57756µs.

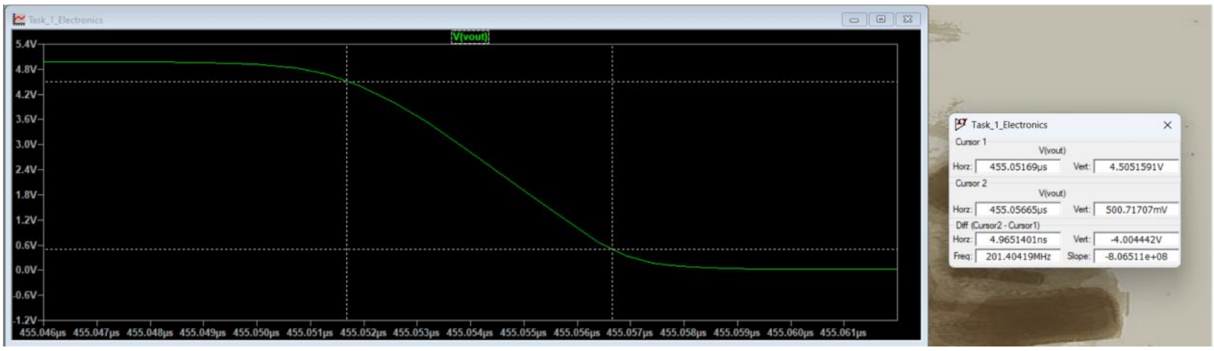
e. t_{rising}



(Figure 2.3 – Value of t_{rising})

According to the simulation results, the t_{rising} was found to be 2.3346055µs.

f. $t_{falling}$



(Figure 2.4 – Value of $t_{falling}$)

According to the simulation results, the t_{rising} was found to be 4.9651401ns.

C. Results and Discussion

	Time
t_{PHL}	664.56894ns
t_{PHL}	670.1615 ns
t_{cycle}	118.57756µs
t_{rising}	2.3346055µs
$t_{falling}$	4.9651401ns

While the manual calculation of fdata is 8,798.78 Hz, the fdata value obtained as a result of the simulation is 8,427.8768 Hz. As a result of the calculations, it was determined that there was an error of 4.215 percent.Also transition time is 1.97 percent of the cycle time. Transition time has been found to be less than 5 percent of the cycle time.

The results obtained in Task 1 show that errors may exist. The accuracy of the method or simulation parameters used in the manual calculation may need to be reconsidered. The fact that the transition time corresponds to a very small percentage of the cycle time shows that the transitions in the system are fast and efficient.