**TITLE:**

Design and Implementation of a MOSFET-Based Voltage-Controlled Current Source (VCCS) System

**AIM:**

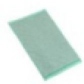
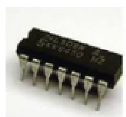
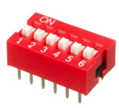
To design and implement a voltage-controlled current-source (VCCS) system using MOSFETs to control the brightness of RGB LEDs, enabling the generation of various colors. The system will include a memory/logic circuit to select and store specific colors from a color gamut and will incorporate an independent battery-powered supply module for complete system integration

**OBJECTIVE:**

1. To design a MOSFET-based voltage-controlled current-source (VCCS) circuit for precise control of LED current and brightness.
2. To interface RGB LEDs and achieve color mixing by varying individual LED currents.
3. To integrate a memory/logic circuit for storing and selecting specific color combinations.
4. To design a battery-powered supply module ensuring portable and independent operation.
5. To test and validate the system for stable color output, efficiency, and smooth brightness control.

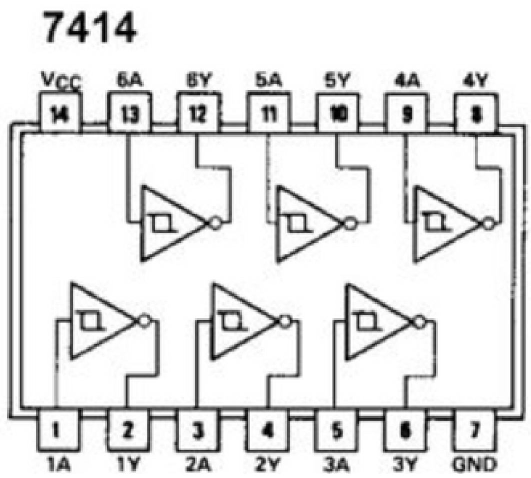
**COMPONENTS REQUIRED ALONG WITH THEIR SPECIFICATIONS:**

| SL NO | NAME OF THE COMPONENTS | SPECIFICATION | | QUANTITY |
|---|---|---|---|---|
| 1 | Lithium-ion 18650 3.7V 2600mAh Battery Cell | 3.7V 2600mAh Battery Cell |  | 1 |
| 2 | Battery Holder For 1x3.7V 18650 Lipo Battery | 3.7V |  | 1 |
| 3 | MT3608 2A Max DC-DC Step Up Power Module Booster Power Module | MT3608 2A Max DC |  | 1 |
| 4 | SN74HC74N-4 Dual D-Type Positive-Edge-Triggered Flip-Flops With Clear And Preset IC - DIP-14 Package | SN74HC74N-4 Dual D-TypeIC - DIP-14 Package |  | 3 |

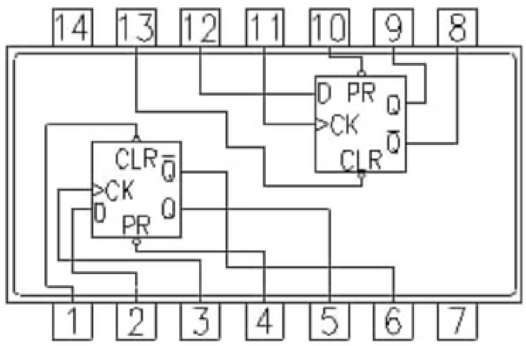
| SL NO | NAME OF THE COMPONENTS | SPECIFICATION | | QUANTITY |
|---|---|---|---|---|
| 5 | 74HC14 Hex Inverting Schmitt Trigger IC DIP-14 Package | SN74HC14N |  | 1 |
| 6 | 5mm RGB LED - Common Cathode - Diffuse | 5mm |  | 1 |
| 7 | Double Sided Universal PCB Prototype Board - 15x20 cm | 15 × 20 cm |  | 1 |
| 8 | 2N7000 - 60V 350mA N-Channel Mosfet - TO-92 Package | 2N7000 - 60V 350mA |  | 3 |
| 9 | 10K Ohm 1 Watt Metal Film Resistor 1% Tolerance | 10K Ohm 1 Watt |  | 9 |
| 10 | 74LS153 Dual 4 To 1 Line Data Selector/Multiplexer IC-DIP-16 Package | 74LS153 Dual 4 |  | 1 |
| 11 | AND gate | 7408AND gate IC(DIP-14 package) |  | 1 |
| 12 | Resistor | 680 Ohms |  | 1 |
| 13 | Capacitor | 10 microfarad |  | 1 |
| 14 | Switches | DIP Switches |  | 1 |

IC Diagrams:

- Hex Inverting Schmitt Trigger




- SN74HC74N-4 Dual D-Type Positive-Edge-Triggered Flip-Flops

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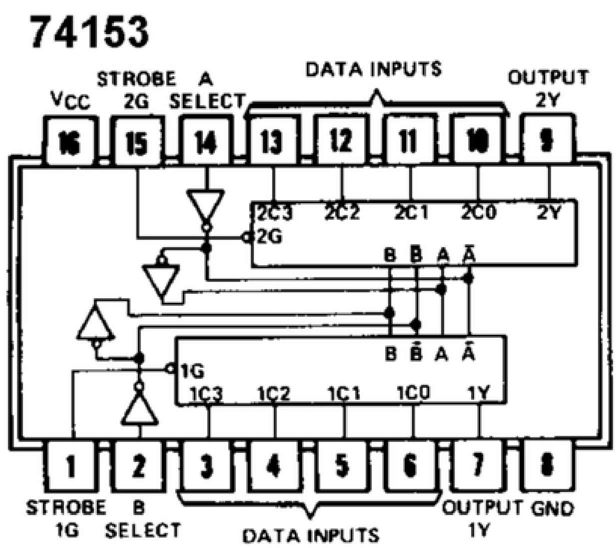
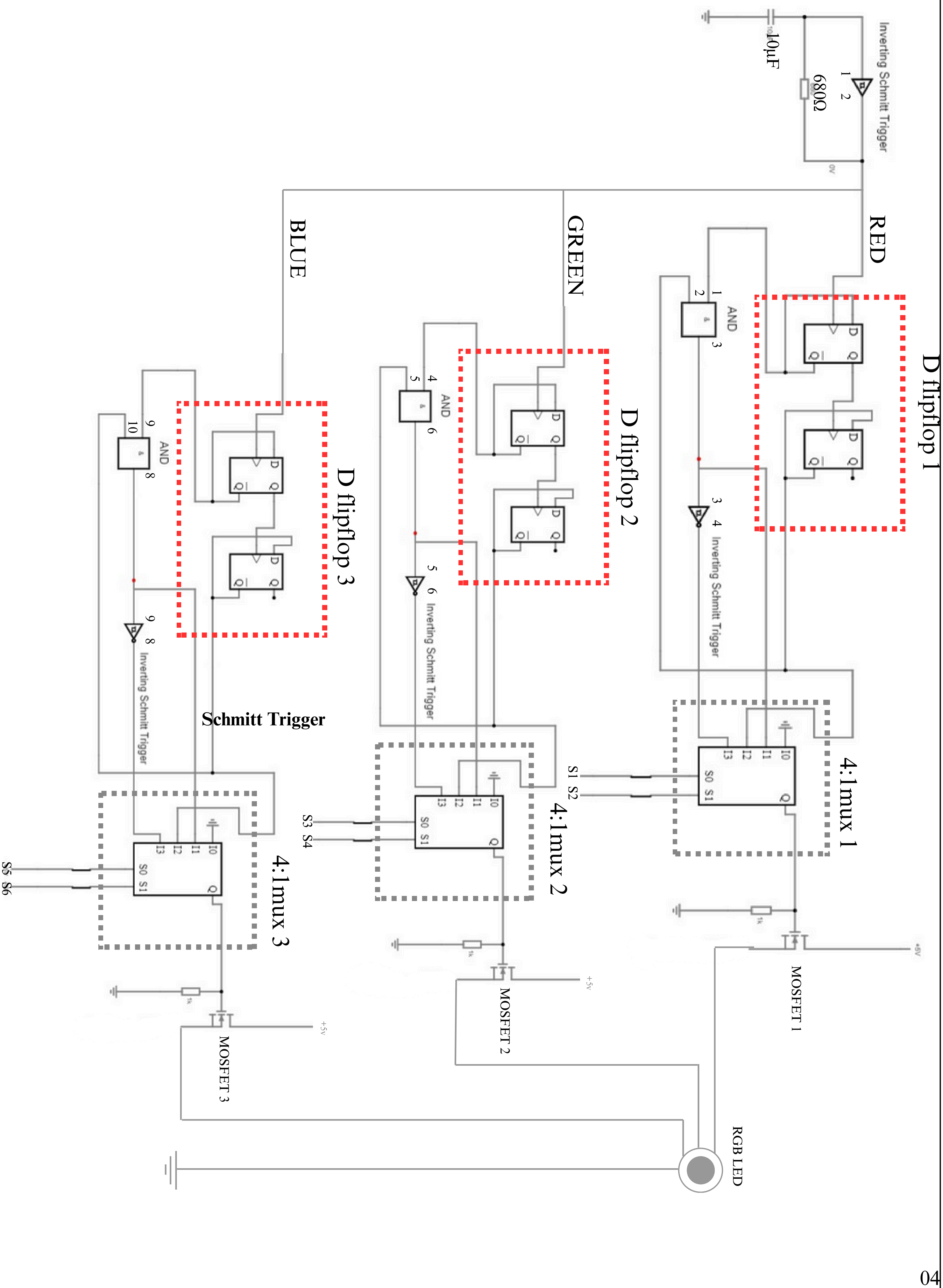
- 74LS153 Dual 4 To 1 Line Data Selector/Multiplexer IC



## CIRCUIT AND PIN DIAGRAM



## WORKING PRINCIPLE :

**1. Clock Pulse Generator:**

The 74HC14 is used with an RC network to generate a stable clock pulse.The capacitor charges and discharges through the resistor, producing a slowly varying voltage.Due to the Schmitt Trigger's hysteresis property, the output switches between HIGH and LOW once the input voltage crosses the threshold levels.This creates a clean square-wave clock signal, which is then used to drive the next stage.Thus, the 74HC14 converts the analog RC signal into a digital clock waveform.
Here we have use 680ohm resistor and 10uF capacitor.

Thus frequency of the square wave produced is :

$$\frac{1.2}{RC} = \frac{1.2}{(680)\,(10\mu)} \approx 176$$

**2. Frequency Divider and PWM Generator:**
The 74HC74 receives the clock pulse from the 74HC14 and divides the frequency by two on each output. By using the Q and Q′ outputs from the flip-flops, different logic levels are obtained that represent timing signals. Now we will play with the 2 signals produced from D-flip Flop so that we can

- **25% Duty Cycle:** Obtained by using an AND gate — the output is HIGH only when both Q1 and Q2 are HIGH. →
  - Logic: OUT 25% = Q1 AND Q2
- **50% Duty Cycle:** Directly taken from one flip-flop output (Q1).
  - Logic: OUT 50% = Q1
- **75% Duty Cycle:** Obtained by taking the NOT of the AND gate output, so the signal is HIGH except when both Q1 and Q2 are HIGH.
  - Logic: OUT 75% = NOT(Q1 AND Q2)

Here, the 74HC14 can also function as the NOT gate to invert the AND output and obtain the 75% duty-cycle signal

**3. Signal Selection:**
The 74LS153 is used to select one of the three duty-cycle signals generated by the flip-flops.Based on the selection inputs or switches, it passes the chosen PWM signal to the next stage.This allows the user to select between 25%, 50%, or 75% duty cycles — effectively choosing the LED brightness level

**5. MOSFET as VCCS (Current Control Stage):**
The selected PWM (duty-cycle) signal is applied to the gate of the MOSFET, which acts as a Voltage-Controlled Current Source (VCCS).The MOSFET regulates the current through the LED according to the duty cycle of the control signal higher duty cycle means more average current.

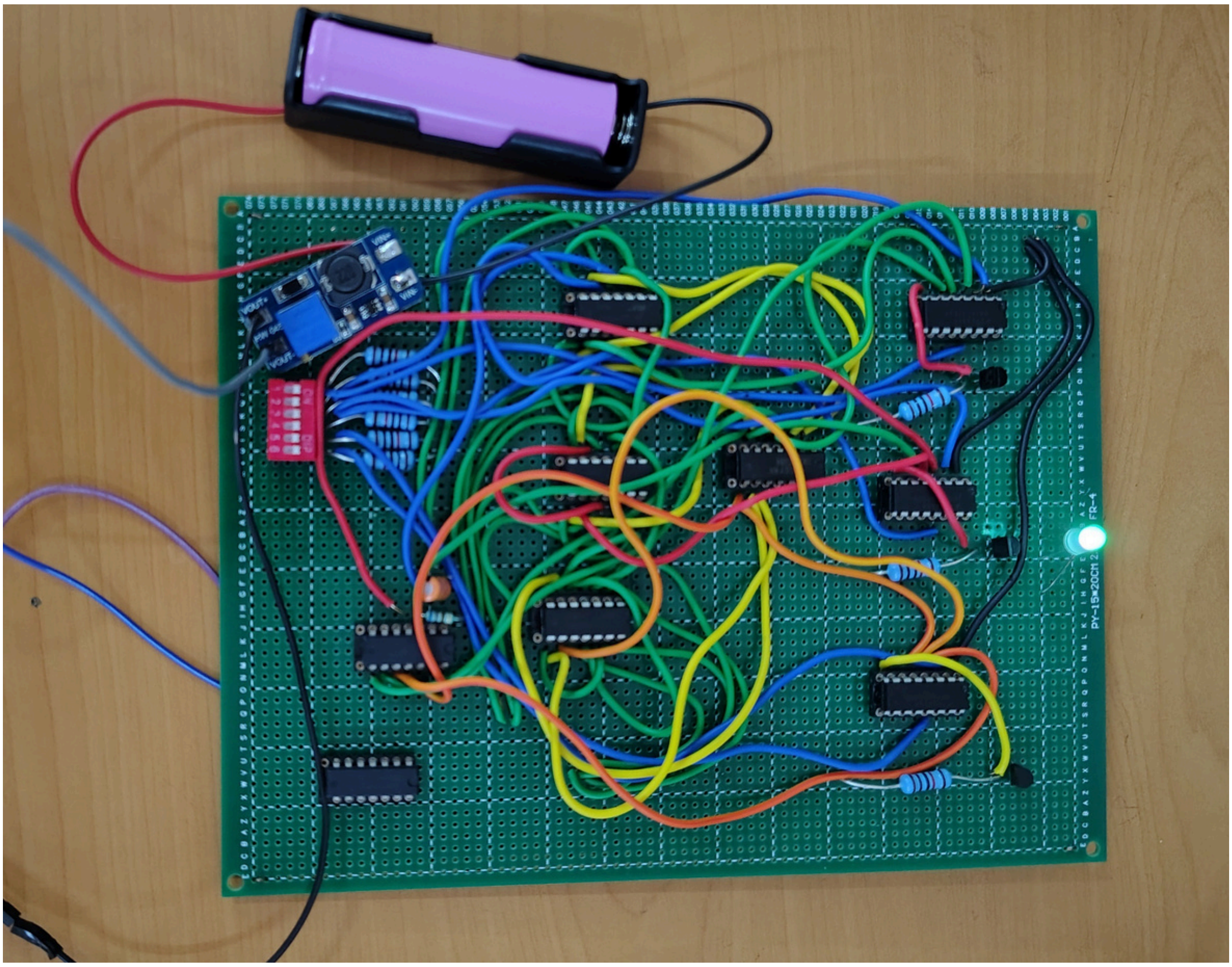
6. Power Supply Module:
The system is powered by a 3.7V 18650 Li-ion battery, and a DC-DC boost converter (MT3608) steps up the voltage to the required level for the LED and control circuit.

**7. Final Output:**

The LED glows according to the selected logic input — the 25%, 50%, or 75% duty cycle signal determines the amount of current and hence the brightness level.

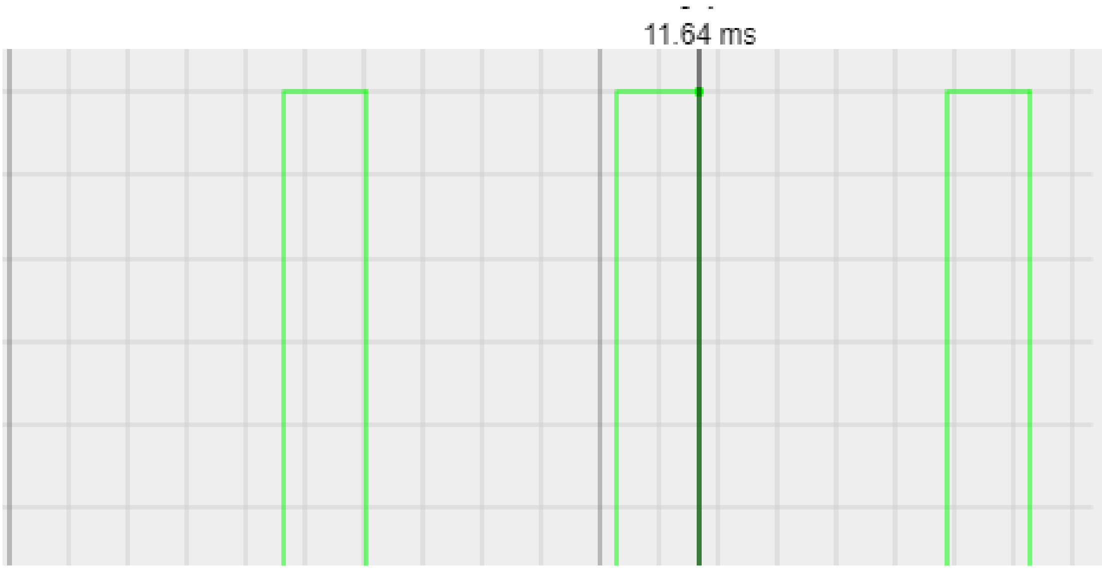
The overall circuit thus provides stable, stepwise brightness control using digital logic instead of analog variation.

**PHOTO OF CIRCUIT:**

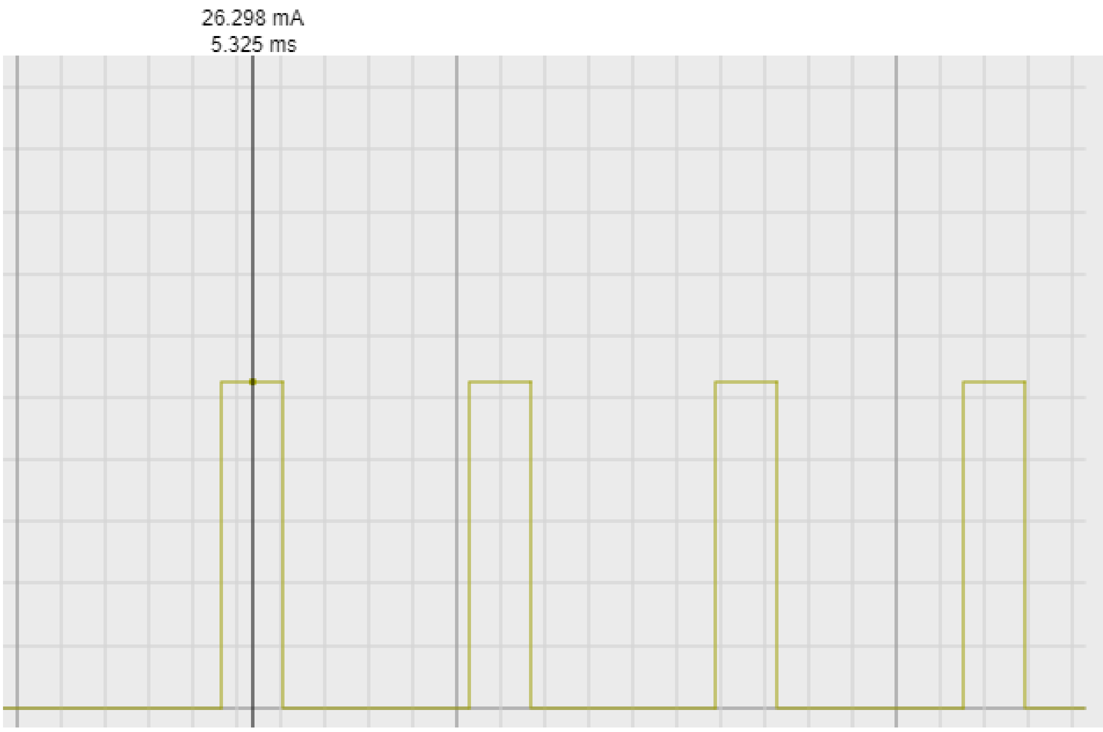


## SIMULATION GRAPHS

### 25% DUTY CYCLE

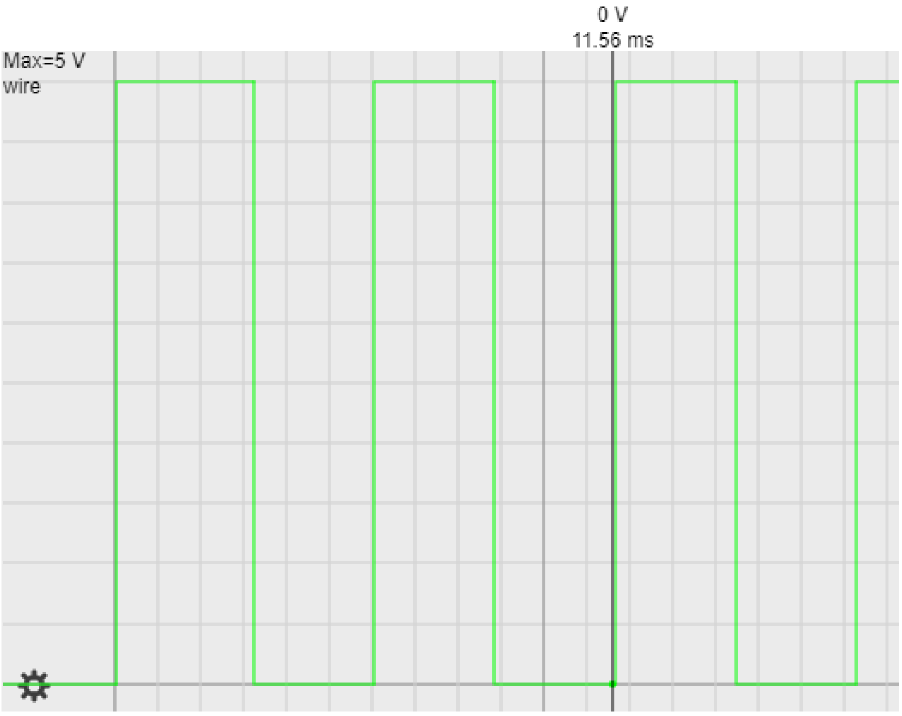



**Gate to Drain Voltage**

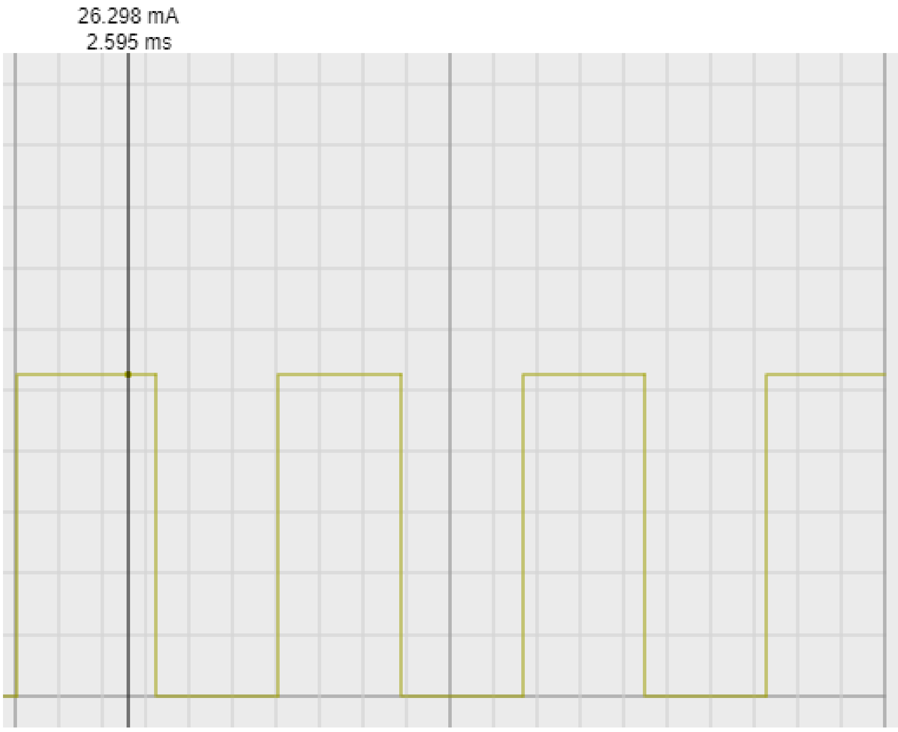



**Drain Current**

**50% DUTY CYCLE**

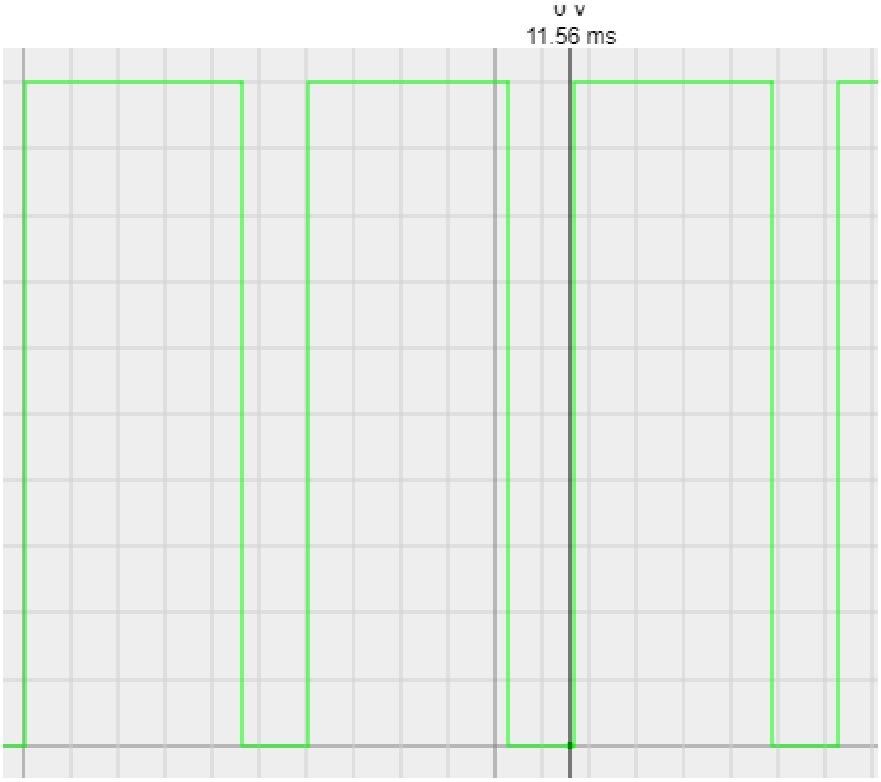



**Gate to Drain Voltage**

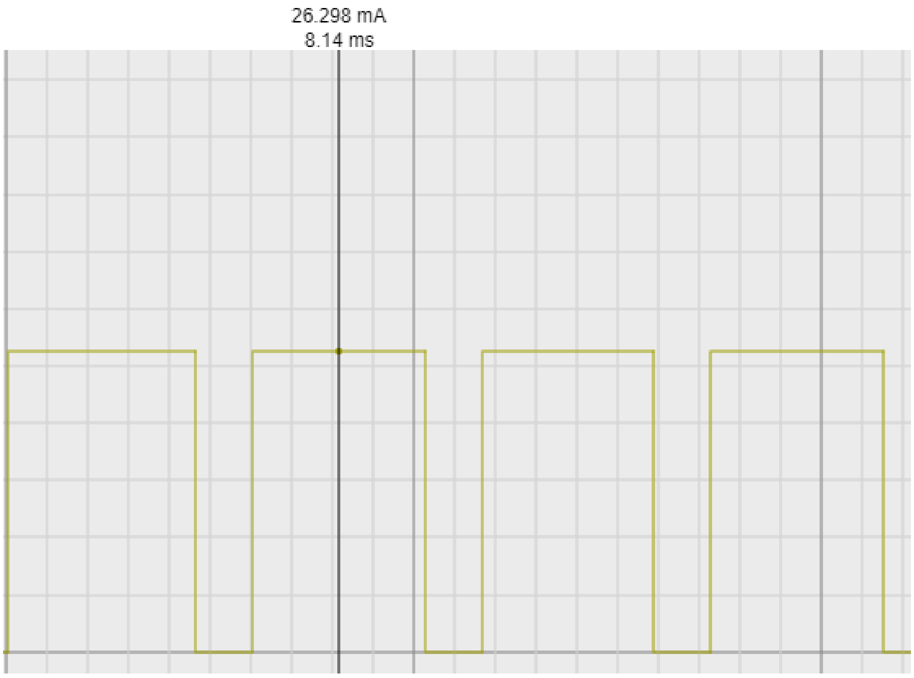



**Drain Current**

**75% DUTY CYCLE**




**Gate to Drain Voltage**




**Drain Current**