AMERICAN INTERNATIONAL UNIVERSITY-BANGLADESH

Faculty of Engineering

Lab Report

Experiment # 02

Experiment Title: Familiarization with an STM32 microcontroller board, studying an LED blink test, and implementing a 2-push button LED activation circuit using an STM32 microcontroller board.

Date of Perform:	March 09, 2025	**Date of Submission:**	March 16, 2025
Course Title:	Microprocessor and Embedded Systems Lab		
Course Code:	EE4103	**Section:G**	
Semester:	Spring 2024-25	**Degree Program:**	BSc in CSE/EEE
Course Teacher:	**Prof. Dr. Engr. Muhibul Haque Bhuyan**		

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3	MD.SALMAN ISLAM	22-47393-2	BSc in CSE	
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5	MD TOYEB ALI	23-51819-2	BSc in CSE	

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FACULTY COMMENTS		
	Marks Obtained	
	Total Marks	

Table of Contents

Marking Rubrics (to be filled by Faculty):

Level Category	Excellent [5]	Proficient [4]	Good [3]	Acceptable [2]	Unacceptable [1]	No Response [0]
Title and Objectives	Able to clarify the understanding of the lab, no issues are missing and formatting is good.	Able to clarify the understanding of the lab experiment, no issues are missing but its formatting is not good.	Able to clarify the understanding of the lab experiment, but a few issues are wrong, and its formatting is bad.	Able to clarify the understanding of the lab experiment, but it lacks a few important issues of the experiment without maintaining the format.	Unable to clarify the understanding of the lab experiment.	No Response/ copied from others/ identical submissions with gross errors/image file printed
Codes and Methods	Able to explain the experimental codes and simulation methods using Proteus very well.	Able to explain the experimental codes and simulation methods using Proteus but is not formatted well.	Able to explain the experimental codes but simulation method using Proteus is not explained well.	Presents the experimental codes but didn't explain simulation methods using Proteus clearly.	Presents the experimental codes but didn't explain simulation methods using Proteus.	
Results	Key results and images are there. Figures/Tables have all identifications and refer to them properly in the texts.	Key results and images are there. Figures/Tables have all identifications, such as the axis labels, numbers, and captions with a few minor errors; the texts refer them.	Key results and images are there. Figures/Tables lack a few identifications, such as the axis labels, numbers, and captions; the texts refer them.	Misses several key results and images. Figures/Tables lack identification, such as the axis labels, numbers, and captions; the texts don't refer them.	Major results, such as experimental and simulation results' images are not included. Figures and tables are poorly constructed or not presented.	
Discussion and Conclusion	Proper interpretation of results and summarizes the results to draw a conclusion, discusses its applications in real-life situations to connect with the report's conclusion.	Proper interpretation of results and summarizes the results to draw a conclusion but didn't discuss its applications in real-life situations to connect with the conclusion of the report.	Interpretation of results is presented. However, there is a disconnect between the results and discussion.	Misses the interpretation of key results. There is little connection between the results and discussion.	Very poor interpretation of the results. No connection between results and discussions.	
Question and Answer	Able to produce all questions' answers correctly maintaining the lab report format.	Able to produce all questions' answers but didn't maintain the lab report format.	Able to produce all questions' answers but wrong answers to a few questions.	Able to produce all questions' answers but wrong/missing answers to multiple questions.	Unable to produce all questions' answers and completely wrong answers.	
Comments						**Total Marks (25)**

Experiment Title: Familiarization with an STM32 microcontroller board, studying an LED blink test, and implementing a push button LED activation circuit using an STM32 microcontroller board.

Objectives:

1. Studying the STM32 Microcontroller Board.
2. Understanding basic programming commands for the STM32 Microcontroller Board.
3. Implementing coding techniques for the STM32 Microcontroller Board.
4. Executing an LED blink test using the STM32 Board.
5. Designing a circuit with pushbutton and LED to control the LEDs separately, ensuring proper connections for efficient functionality.
6. Creating a simulation circuit model in Proteus that incorporates an LED blink test and controls two LEDs with two pushbuttons separately.

Circuit Diagram:

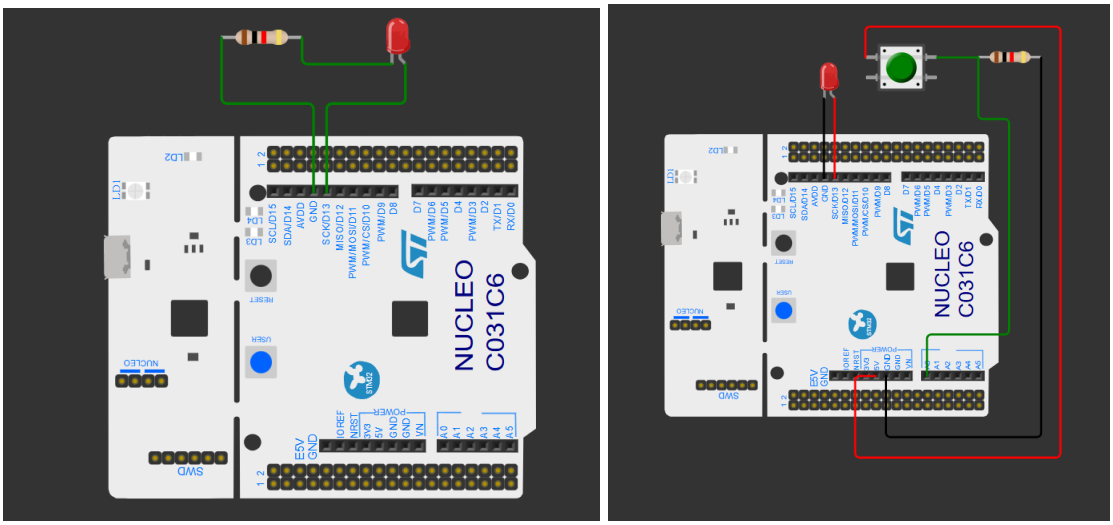

Fig. Circuit Diagram for LED Blink Test (Left) And push button LED activation circuit (Right)

Equipment List:

1. STM32 Cube IDE (1.0.1 or any recent version)
2. STM32 Microcontroller board
3. Two LED lights Experiment 2 Lab Manual
4. Two 100 Ω resistors and two 10kW resistors
5. Two push button switches
6. Jumper wires

Code:

Code For LED Blink Test (Main Function):

```
int main(void)
{
  HAL_Init();
  SystemClock_Config();
  MX_GPIO_Init();
  MX_USART2_UART_Init();
  while (1)
  {
      HAL_GPIO_TogglePin(GPIOA, GPIO_PIN_5);
      HAL_Delay(1000);
  }
}
```

Code For implementing a push button LED activation circuit (Main Function):

```
int main(void)
{
  HAL_Init();
  SystemClock_Config();
  MX_GPIO_Init();
  MX_USART2_UART_Init();

  while (1)
  {
    if (HAL_GPIO_ReadPin(GPIOA, GPIO_PIN_0) == 0) {
     HAL_GPIO_WritePin(GPIOA, GPIO_PIN_5, GPIO_PIN_SET);   // Green LED ON
   } else {
     HAL_GPIO_WritePin(GPIOA, GPIO_PIN_5, GPIO_PIN_RESET); // Green LED OFF
   }
}
```

Experimental Results:

Explanation for LED Blink Test:

In this implementation, a jumper wire was connected to pin 5 of GPIOA on the STM32 Nucleo-F401RE board. The wire was then linked to a breadboard. The anode of a green LED was connected to the wire from pin 5, while the cathode was attached to a 1 kΩ resistor. This resistor was subsequently connected to the Ground (GND) pin of the STM32 board. The STM32 Nucleo-

F401RE board was connected to a PC via USB to compile and upload the necessary code using STM32CubeIDE. This setup enabled the green LED to blink as controlled by the programmed instructions.

Here is the hardware implementation of the LED blink test attachments.

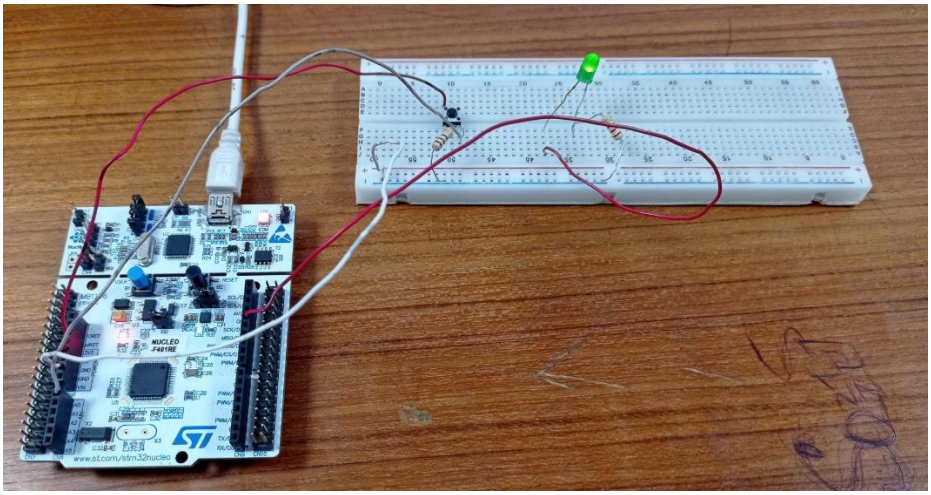

Fig. Hardware implementation for the blink test (Off state)

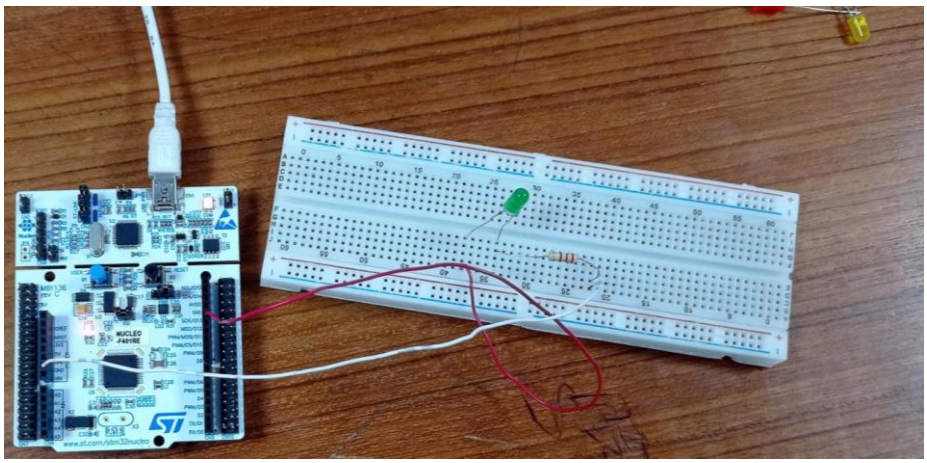

Fig. Hardware implementation for the blink test (On state)

Explanation for implementing a push button LED activation circuit:

In this setup, a jumper wire linked GPIOA pin 5 on the STM32 Nucleo-F401RE board to a breadboard, connecting the anode of a green LED. The cathode was tied to a 1 kΩ resistor, then to Ground (GND). GPIOA pin 0 was wired to a pushbutton with a pull-up resistor, going LOW when pressed. The board was connected to a PC via USB for coding in STM32CubeIDE. The

code uses HAL_GPIO_ReadPin(GPIOA, GPIO_PIN_0) == 0 to detect a button press, setting pin 5 HIGH with HAL_GPIO_WritePin(GPIOA, GPIO_PIN_5, GPIO_PIN_SET) to turn the green LED ON, and LOW with GPIO_PIN_RESET when released, turning it OFF.

Here is the hardware implementation of the push button LED activation attachments.

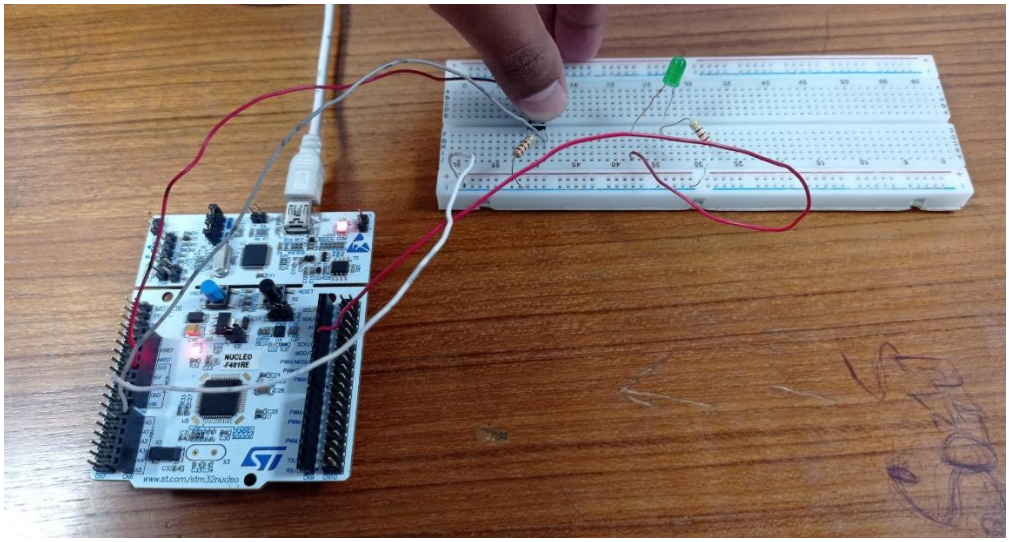

Fig. Hardware implementation for implementing a push button LED activation (Off state)

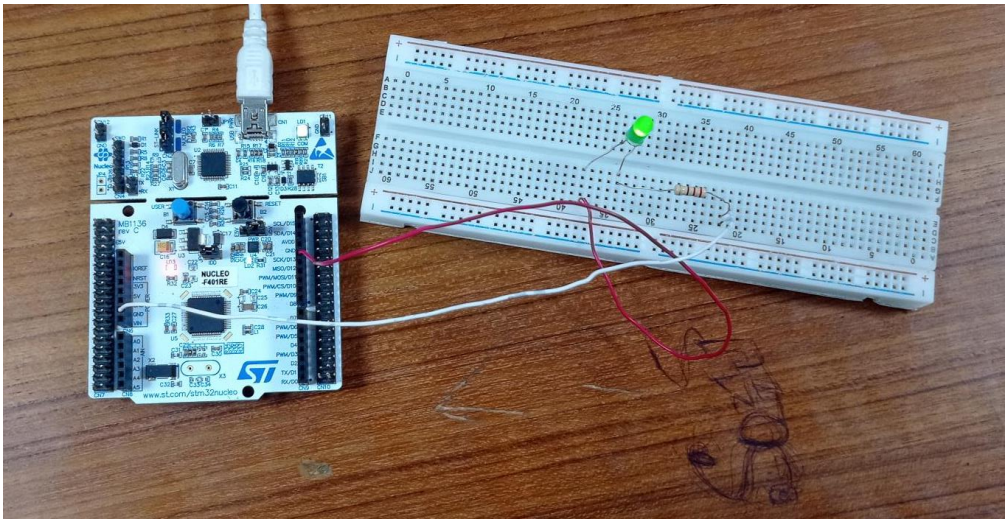

Fig. Hardware implementation for implementing a push button LED activation (On state)

Simulation Output Results:

Simulation Result for LED Blink Test

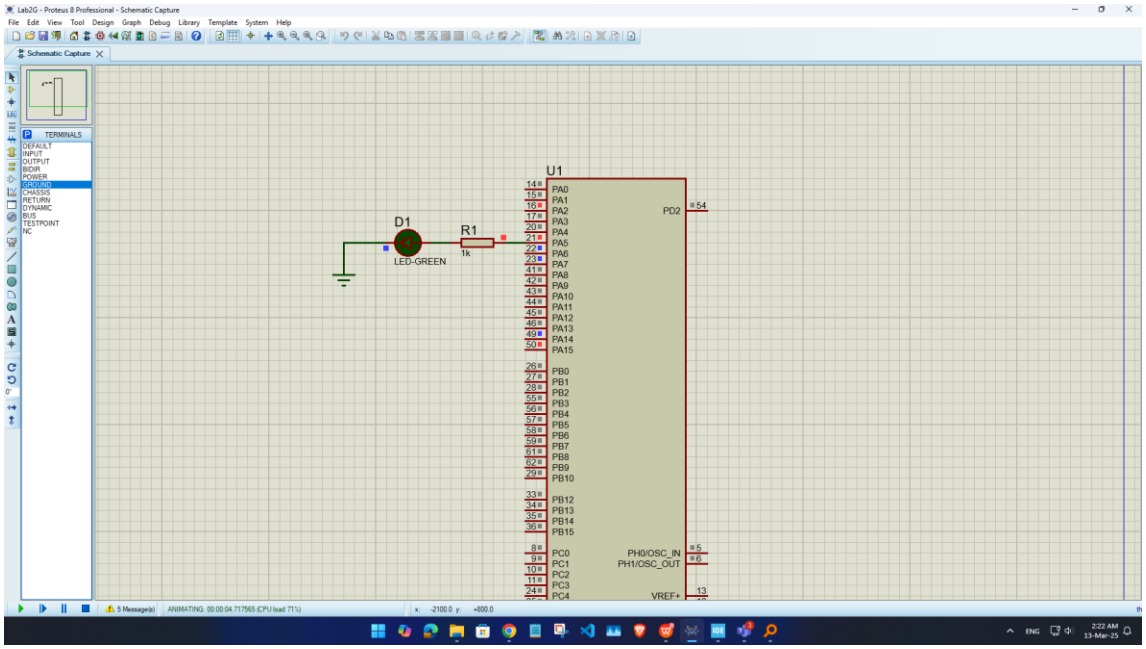

Fig. Proteus 8 Simulation for the blink test (On state)

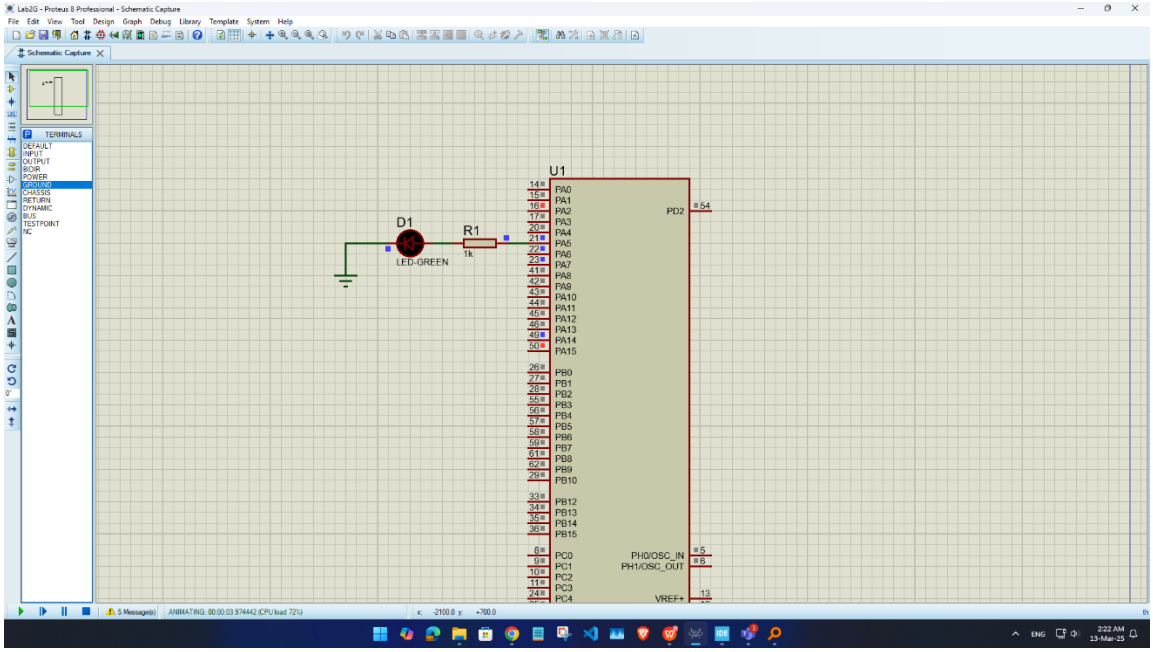

Fig. Proteus 8 Simulation for the blink test (Off state)

Simulation Result for implementing a push button LED activation

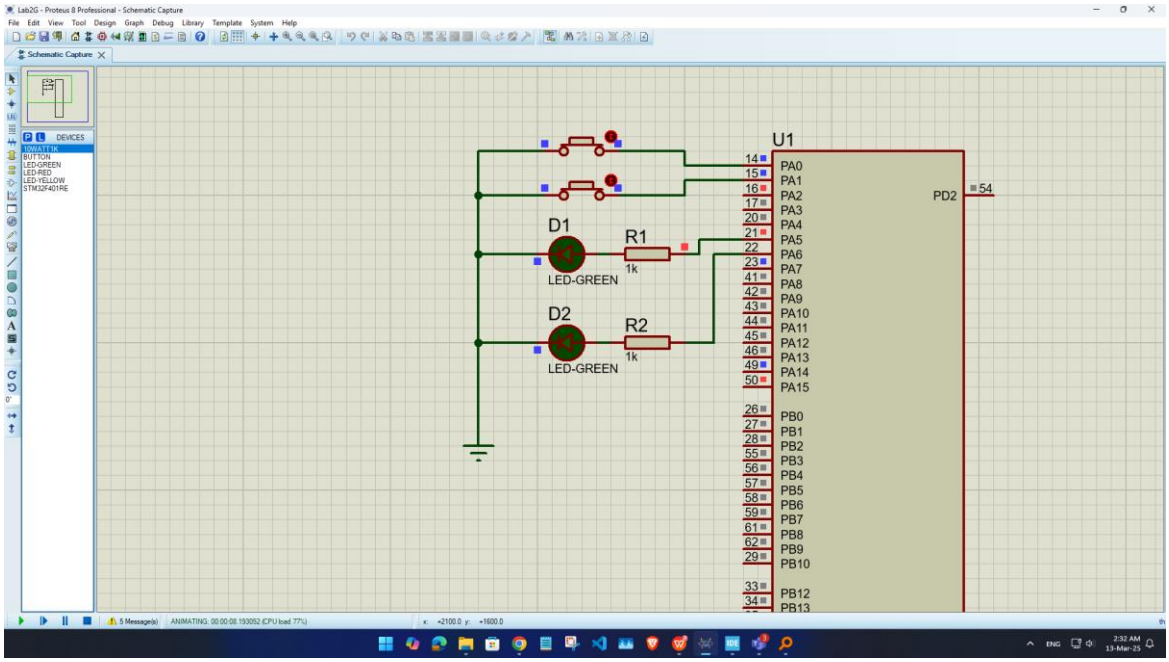

Fig. Simulation for implementing a push button LED activation (On state)

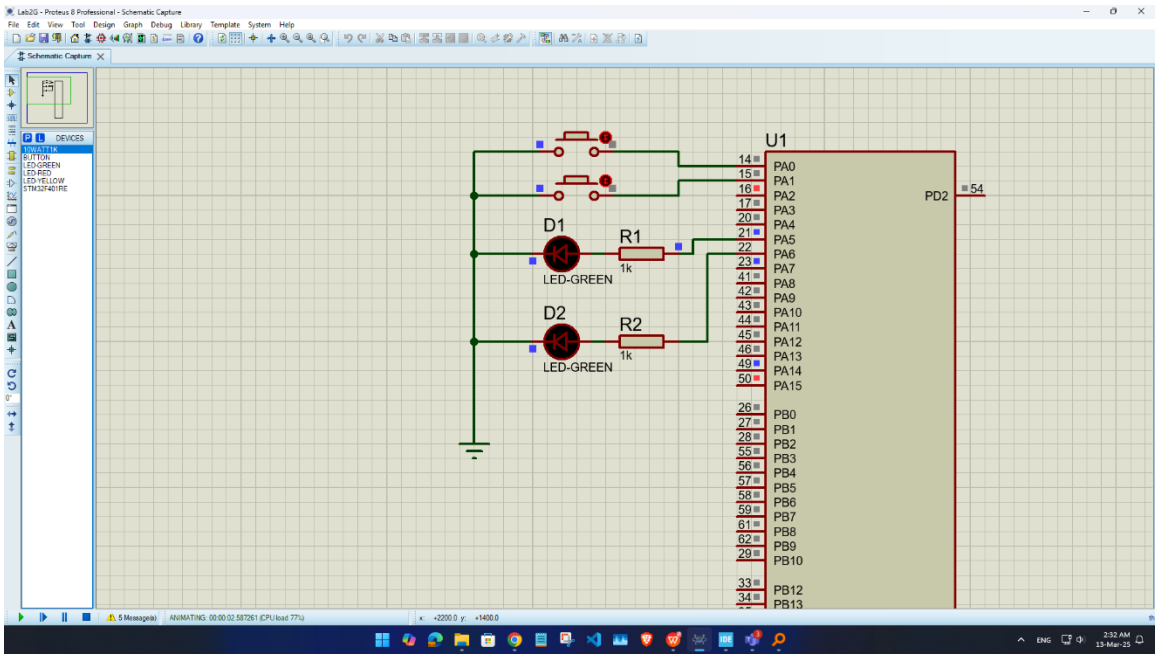

Fig. Simulation for implementing a push button LED activation (Off state)

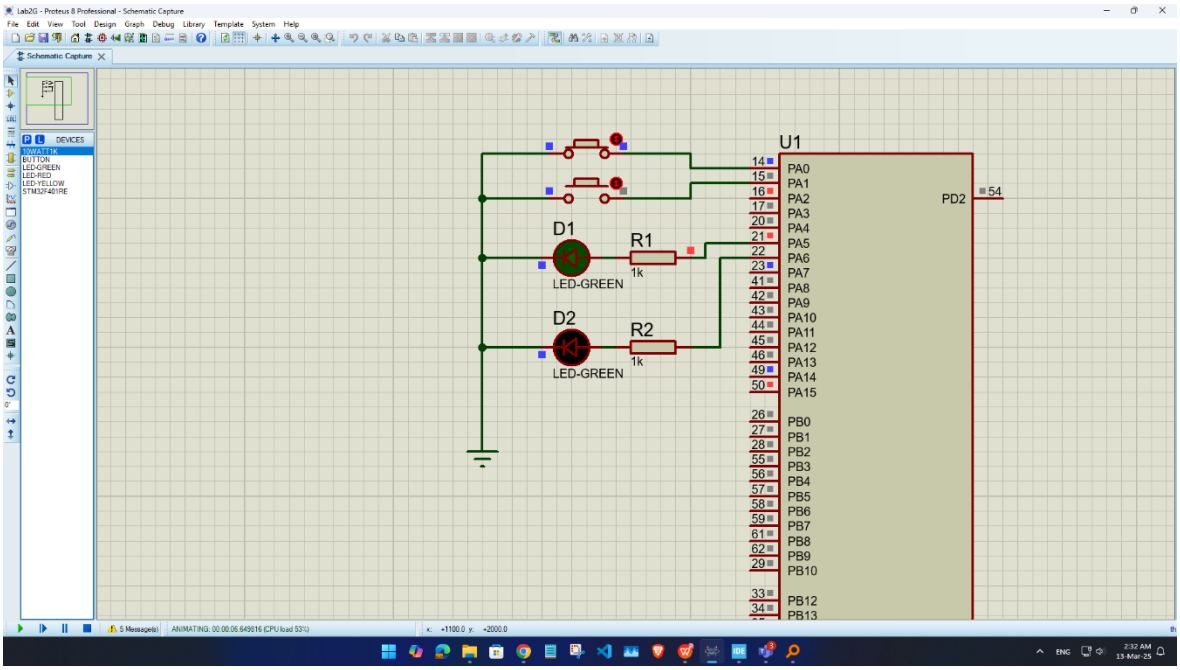

Fig. Simulation for implementing a push button LED 1 activation

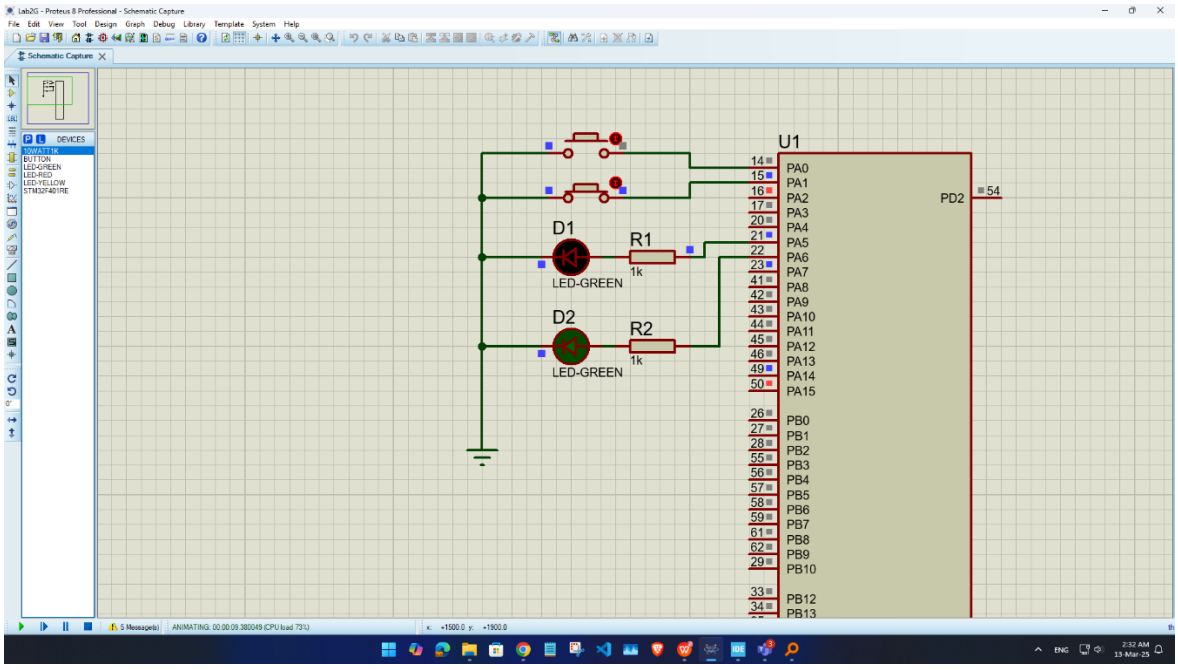

Fig. Simulation for implementing a push button LED 2 activation

Answering Questions:

blink program and traffic light control system:

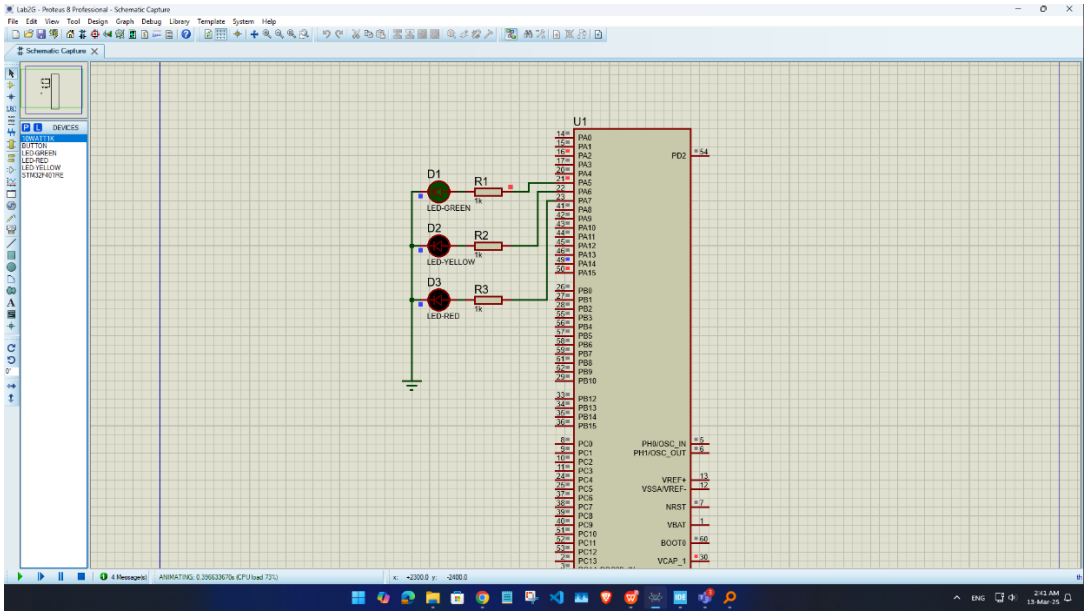

Fig. Simulation of Traffic Light Control System (Green Light is on)

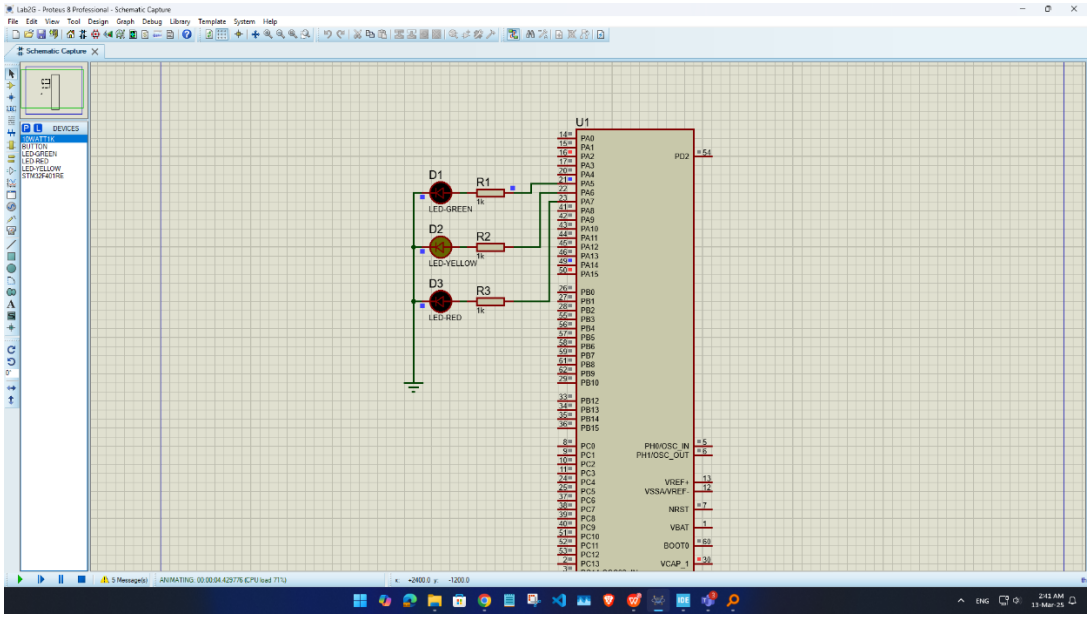

Fig. Simulation of Traffic Light Control System (Yellow Light is on)

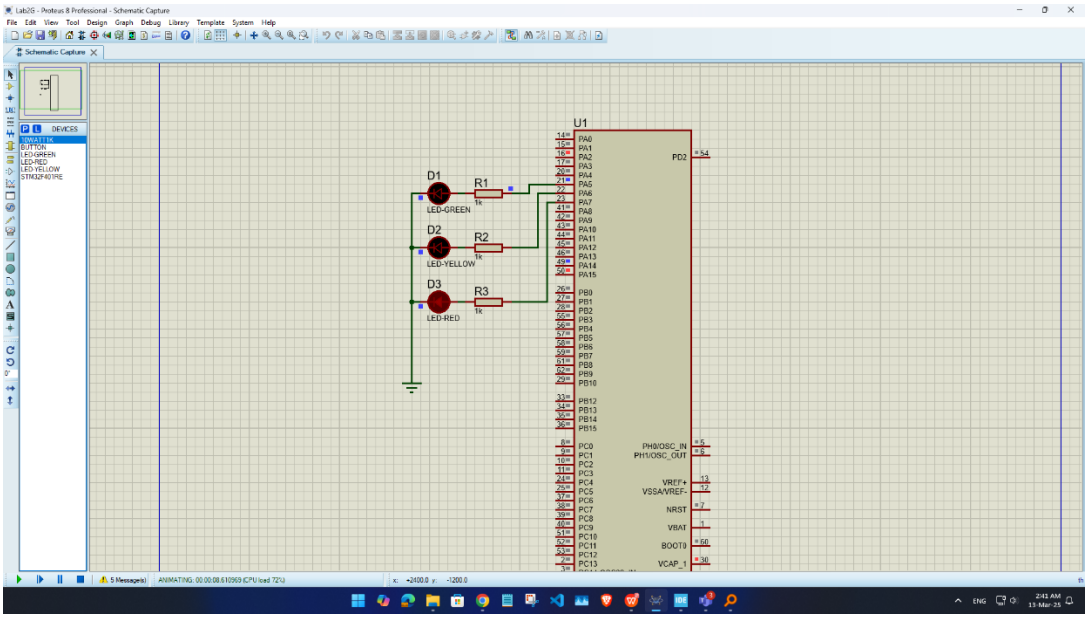

Fig. Simulation of Traffic Light Control System (Red Light is on)

Code:

Code For Traffic Light (Main Function):

```
int main(void)
{
  HAL_Init();
  SystemClock_Config();
  MX_GPIO_Init();
  MX_USART2_UART_Init();

  while (1)
  {
    HAL_GPIO_WritePin(GPIOA, GPIO_PIN_7, GPIO_PIN_RESET);
    HAL_GPIO_WritePin(GPIOA, GPIO_PIN_5, GPIO_PIN_SET);
    HAL_Delay(4000);
    HAL_GPIO_WritePin(GPIOA, GPIO_PIN_5, GPIO_PIN_RESET);
    HAL_GPIO_WritePin(GPIOA, GPIO_PIN_6, GPIO_PIN_SET);
    HAL_Delay(4000);
    HAL_GPIO_WritePin(GPIOA, GPIO_PIN_6, GPIO_PIN_RESET);
    HAL_GPIO_WritePin(GPIOA, GPIO_PIN_7, GPIO_PIN_SET);
    HAL_Delay(4000);
  }
}
```

Discussion:

Both experiments successfully showcased STM32 microcontroller functionality. The LED blink test, toggling GPIOA pin 5 with a 1-second delay, confirmed basic output control and timing using HAL_GPIO_TogglePin and HAL_Delay, producing a steady blink with the green LED and 1 kΩ resistor. The button-controlled setup effectively turned the LED ON/OFF via GPIOA pin 0 input, proving reliable input-output interaction with HAL_GPIO_ReadPin and HAL_GPIO_WritePin. The 1 kΩ resistor worked well, though brightness could improve with a smaller value. Minor button bounce affected consistency, suggesting a delay fix. These tests highlighted GPIO handling and HAL library basics, offering a solid start for embedded programming.

Reference(s):

[1] https://www.st.com/en/evaluation-tools/nucleo-f401re.html for STM32F401RE datasheet.

[2] www.st.com.

[3] https://www.st.com/resource/en/user_manual/dm00105879-description-of-stm32f4-hal-and-ll-drivers-stmicroelectronics.pdf.

[4] www.st.com/en/development-tools/stm32cubeide.html.