AMERICAN INTERNATIONAL UNIVERSITY-BANGLADESH

Faculty of Engineering

Lab Report

Experiment # 03

Title: Timers: Implementation of a traffic control system

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Course Code	COE3104	**Section**	C
Semester	Spring 2022-23	**Degree Program**	BSc in CSE & EEE
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FACULTY COMMENTS	**Marks Obtained**	
	Total Marks	

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Experiment Title

Timers: Implementation of a traffic control system.

Abstract

The purpose of this report is to explore the concept of timers in electronics and demonstrate their application in the implementation of a traffic control system using an Arduino controller. The report begins by explaining the importance of timers in sequential logic circuits and the concept of a time base. The focus then shifts to the Arduino controller, where the functionality of timers and counters is described. The report also highlights the difference between 8-bit and 16-bit timers and the number of steps each is capable of counting. Overall, this report provides a comprehensive overview of the theory and methodology behind the use of timers in electronics and their practical application in the development of a traffic control system.

Introduction

This experiment aims to introduce you to the world of Microcontrollers using Arduino. In this this experiment, we have gained hands-on experience in controlling an LED using the delay function and implementing a traffic control system. The main objectives of the experiment are to learn making the LED blink using Arduino and the delay functions and implementing a traffic control system using Arduino.

Theory and Methodology

Timer: Every electronic component of a sequential logic circuit works on a time base. This time base helps to keep all the work synchronized. Without a time base, devices would have no idea as to when to perform particular actions. Thus, the timer is an important concept in the field of electronics.

A timer/counter is a piece of hardware built into the Arduino controller. It is like a clock and can be used to measure time events. A timer is a register whose value increases/decreases automatically.

In AVR, timers are of two types: 8-bit and 16-bit timers. In an 8-bit timer, the register used is 8-bit wide whereas, in a 16-bit timer, the register width is 16 bits. This means that the 8-bit timer is capable of counting 28=256 steps from 0 to 255. Similarly, a 16-bit timer is capable of counting 216=65536 steps from 0 to 65535.

Experimental Procedure

1. The LEDs were connected to the breadboard, with one end of each LED connected to a different digital output pin on the Arduino board.
2. A resistor was connected to each LED, with the other end of the resistor connected to the ground pin on the Arduino board.
3. The positive end of the LED was connected to the corresponding digital output pin on the Arduino board using a wire.
4. The ground pin on the Arduino board was connected to the negative rail of the breadboard.
5. The USB cable was connected to the Arduino board and the computer, and the codes were uploaded.

Code/Program

```
//define name of pins used
#define RED_PIN 8
#define YELLOW_PIN 10
#define GREEN_PIN 12

//define the delays for each traffic light color
```

```
//Student ID: 20-42459-1
int red_on = 4000; //4s delay
int red_yellow_on = 1000; //1s delay
int green_on = 9000; //9s delay
int green_blink = 500; //.5s delay
int yellow_on = 5000; //5s delay
```

```
//Student ID: 20-41973-1
int red_on = 9000; //9s delay
int red_yellow_on = 1000; //1s delay
int green_on = 7000; //7s delay
int green_blink = 500; //.5s delay
int yellow_on = 3000; //3s delay
```

```
//Student ID: 19-41702-3
int red_on = 7000;
int red_yellow_on = 1000;
int green_on = 2000;
int green_blink = 500;
int yellow_on = 0000;
```

```
//Student ID: 18-38950-3
int red_on = 9000;
int red_yellow_on = 1000;
int green_on = 0000;
int green_blink = 500;
int yellow_on = 5000;
```

```
//Student ID: 17-33371-1
int red_on = 3000;
int red_yellow_on = 1000;
int green_on = 1000;
int green_blink = 500;
int yellow_on = 7000;
```

```
int delay_timer(int milliseconds) {
  int count = 0;
  while (1) {
    //Checking if 1 millisec has passed
    if (TCNT0 >= 4)
    {
      TCNT0 = 0;
      count++;

      //checking if required
      milliseconds delay has passed
      if (count == milliseconds)
      {
        count = 0;
        break; // exits the loop
      }
    }
  }
  return 0;
}

void setup() {
  //define pins connected to LEDs as
  outputs
  pinMode(RED_PIN, OUTPUT);
  pinMode(YELLOW_PIN, OUTPUT);
  pinMode(GREEN_PIN, OUTPUT);

  //set up timer
  TCCR0A = 0b00000000;
  TCCR0B = 0b00000100; //setting pre-
               scaler for timer clock
  TCNT0 = 0;
}
```

```
void loop() {
  //to make red LED on
  digitalWrite(RED_PIN, HIGH);
  delay_timer(red_on);

  //to turn yellow LED on
  digitalWrite(YELLOW_PIN, HIGH);
  delay_timer(red_yellow_on);

  //turning off RED_PIN and YELLOW_PIN,
  and turning on greenLED
  digitalWrite(RED_PIN, LOW);
  digitalWrite(YELLOW_PIN, LOW);
  digitalWrite(GREEN_PIN, HIGH);
  delay_timer(green_on);
  digitalWrite(GREEN_PIN, LOW);

  //for turning green Led on & off for
  3 times
  for (int i = 0; i < 3; i = i + 1) {
    delay_timer(green_blink);
    digitalWrite(GREEN_PIN, HIGH);
    delay_timer(green_blink);
    digitalWrite(GREEN_PIN, LOW);
  }

  //for turning on yellow LED
  digitalWrite(YELLOW_PIN, HIGH);
  delay_timer(yellow_on);
  digitalWrite(YELLOW_PIN, LOW);
}
```

Code Explanation

```
#define RED_PIN 8
#define YELLOW_PIN 10
#define GREEN_PIN 12
```

Defining the output pin configuration. In this case, the Red LED is in pin 8, Yellow and Green LED is in pin 10 and 12 respectively.

```
int red_on = 9000; //9s delay
int red_yellow_on = 1000; //1s delay
int green_on = 7000; //7s delay
int green_blink = 500; //.5s delay
int yellow_on = 3000; //3s delay
```

This code sets the duration of different states for a traffic light. The red light will stay on for 9000 milliseconds (9 seconds), the red and yellow lights will be on for 1000 milliseconds (1 second), the green light will stay on for 7000 milliseconds (7 seconds), the green light will blink with a delay of 500 milliseconds (.5 seconds), and the yellow light will be on for 3000 milliseconds (3 seconds).

*** Here, the lighting delays have been set based on the ID of one of our group members (20-41973-1). This has been demonstrated 5 times in the main code, each with a different value, as we have 5 members in our group.**

```
void loop()
```

Pin connection to LED's are defined as output.

```
pinMode(RED_PIN, OUTPUT);
pinMode(YELLOW_PIN, OUTPUT);
pinMode(GREEN_PIN, OUTPUT);

//set up timer
TCCR0A = 0b00000000;
TCCR0B = 0b00000100; //setting pre-scaler for timer clock
TCNT0 = 0;
```

Timer/Counter Control Register A for Timer0 – **TCCR0A**: The bits WGM02 (from TCCR0B), WGM01 and WGM00 decide which mode the timer will run on. For normal mode they are turned to zero.

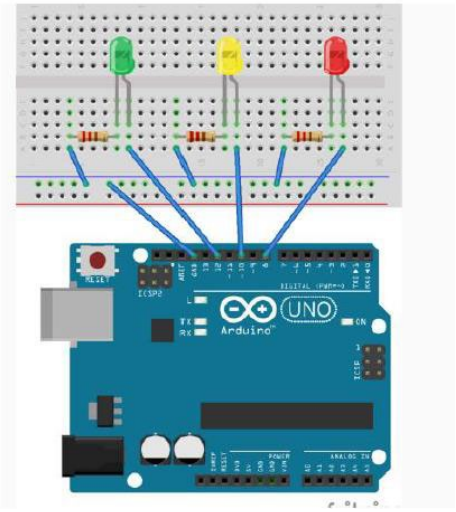
Timer/Counter Control Register B for Timer0 – **TCCR0B**: The three Clock Select bits- CS02, CS01, CS00 select the clock source and pre-scalar value to be used by the Timer/Counter. As the prescalar is 1024, CS02, CS01, CS00 set to 1,0,0.

TCNT0 is the Timer0 register which will store and increase/decrease the value after the clock pulse is provided. Initially which is set to Zero meaning that no clock pulse is generated.

```
void loop()
```

The loop method first turns the red LED on using the digitalWrite function and the red_on duration set in the previous code block. Then, it turns the yellow LED on for the duration specified by red_yellow_on. After that, both the red and yellow LEDs are turned off and the green LED is turned on for the duration specified by green_on. After that, the green LED blinks on and off for three cycles with a delay set by green_blink. Finally, the yellow LED is turned on for the duration specified by yellow_on before being turned off. This loop is repeated continuously to simulate the behavior of a traffic light.

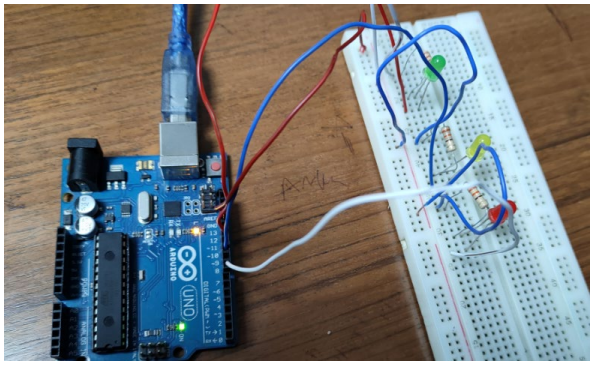
Circuit Diagram



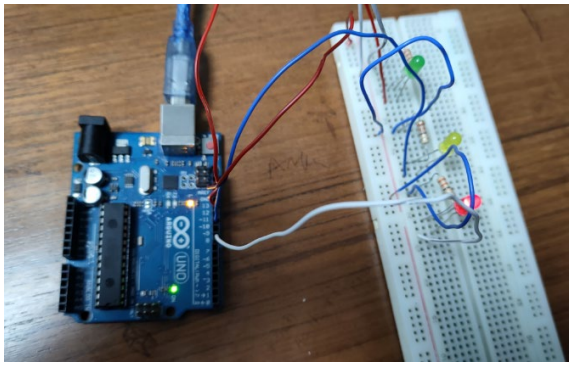
Equipment List

- Arduino Uno/ Arduino Mega
- LED lights (YELLOW, RED, and GREEN)
- Resistors (220 ohms)

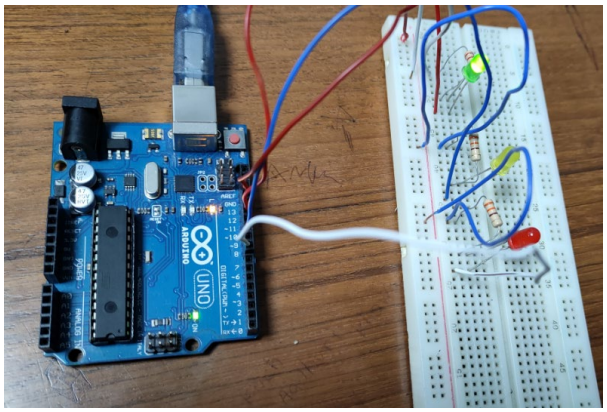
Hardware Output Results



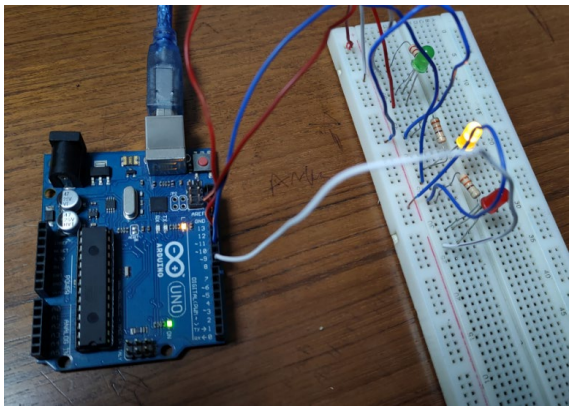
Hardware Setup



Red LED Turned On

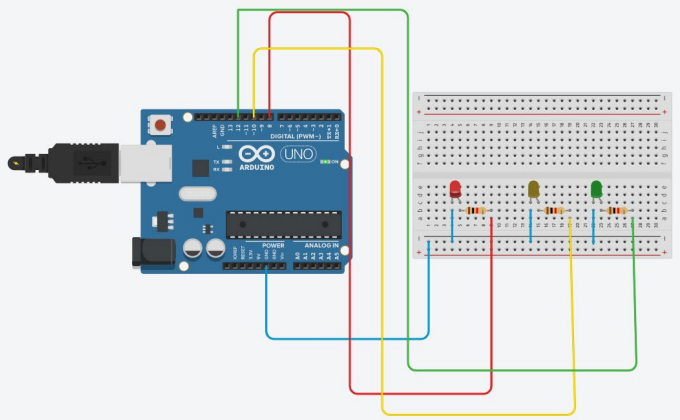


Green LED Turned On

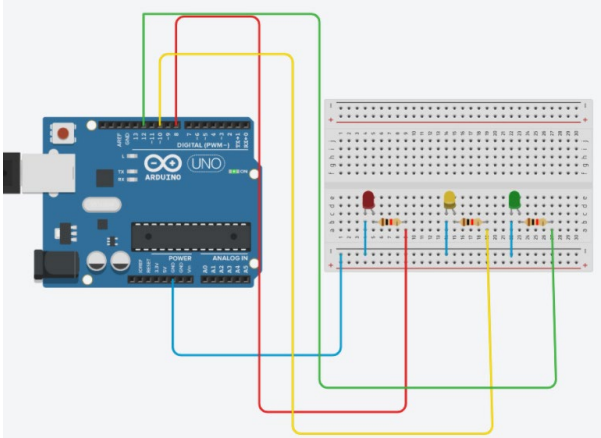


Yellow LED Turned On

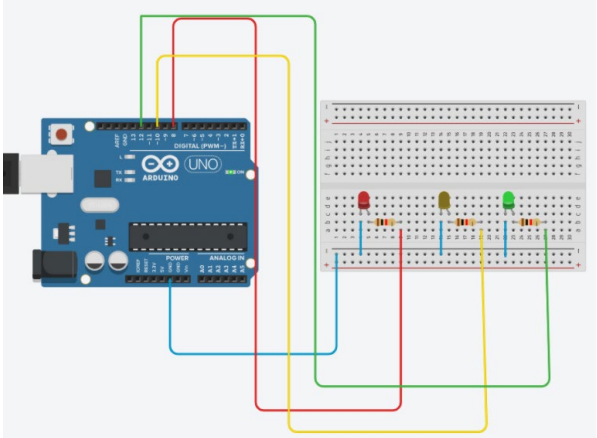
Simulation Output Results



Red LED Turn On



Yellow LED Turned On



Green LED Turned On

Discussion & Conclusion

The objective of the experiment was achieved by using the timer register of the Arduino microcontroller. The implementation of the traffic light system allowed for a hands-on demonstration of how the timer operates and how the delay function is defined. The experiment provided a comprehensive understanding of the functioning of the timer register and how it can be utilized in practical applications.

Overall, the experiment was a success in achieving its goal of providing a deeper understanding of the timer register and its operation. The implementation of the traffic light system served as an effective demonstration of the use of the timer and how it can be applied in real-world situations. The experiment proved to be a valuable learning experience and will contribute to a better understanding of microcontroller operations in the future.

References

- AIUB Lab Manual
- https://www.arduino.cc/
- ATMega328 manual
- https://www.avrfreaks.net/forum/tut-c-newbies-guide-avr-timers