2.RGB_LED

Introduction

In this lesson, we will use it to control an RGB LED to flash various kinds of colors.

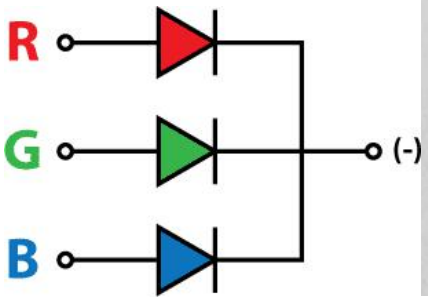
Hardware Required

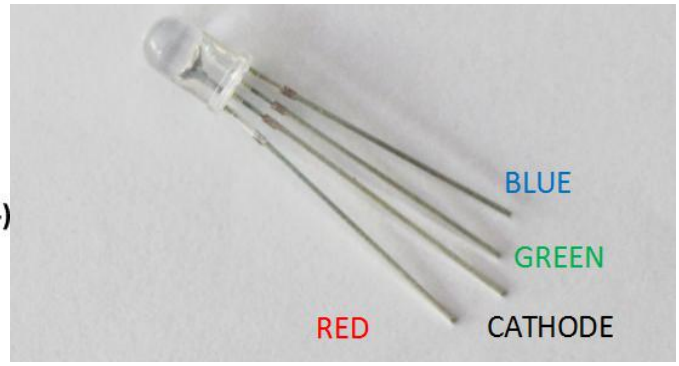
- ✓ 1 * Raspberry Pi
- ✓ 1 * T-Extension Board
- ✓ 1 * RGB LED
- ✓ 1 * 40-pin Cable
- ✓ Several Jumper Wires
- ✓ 1 * Breadboard
- ✓ 3 * Resistor(220Ω)

Principle

RGB

The RGB LED can emit different colors by mixing the 3 basic colors red, green and blue. So it actually consists of 3 separate LEDs red, green and blue packed in a single case. That's why it has 4 leads, one lead for each of the 3 colors and one common cathode or anode depending of the RGB LED type. In this tutorial I will be using a common cathode one.





We will use PWM for simulating analog output which will provide different voltage levels to the LEDs so we can get the desired colors.

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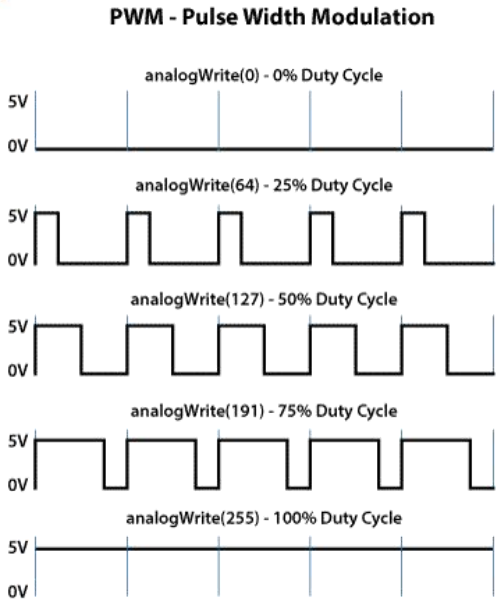
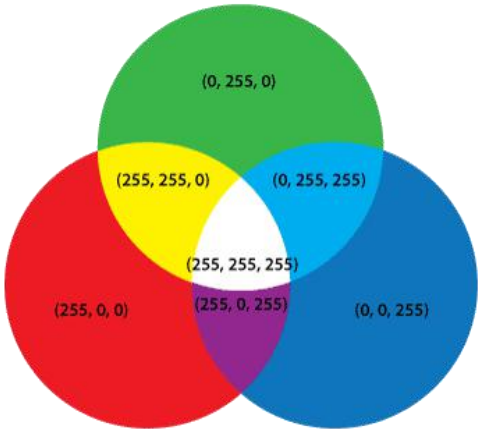
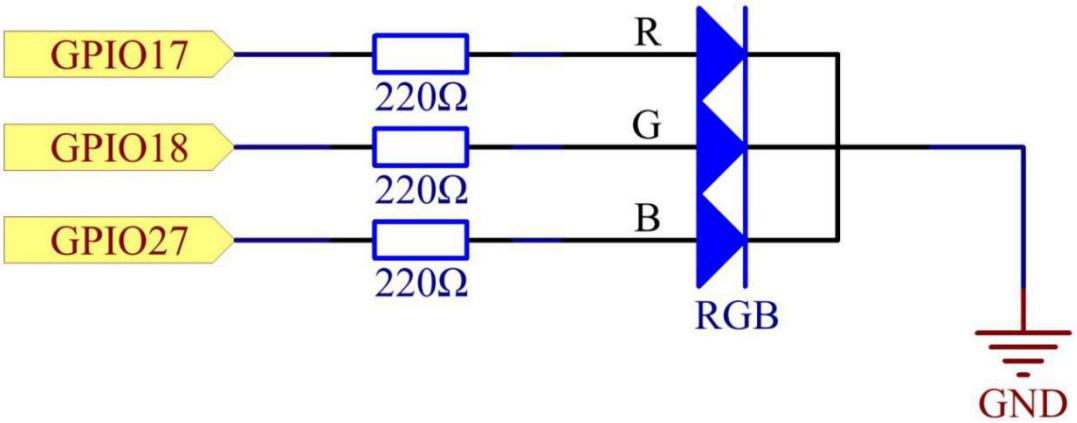




Schematic Diagram

After connecting the pins of R, G, and B to a current limiting resistor, connect them to the GPIO17, GPIO18, and GPIO27 respectively. The longest pin (GND) of the LED connects to the GND of the Raspberry Pi. When the three pins are given different PWM values, the RGB LED will display different colors.

T-Board Name	physical	wiringPi	BCM
GPIO17	Pin 11	0	17
GPIO18	Pin 12	1	18
GPIO27	Pin 13	2	27



Experimental Procedures

Step 1: Build the circuit.

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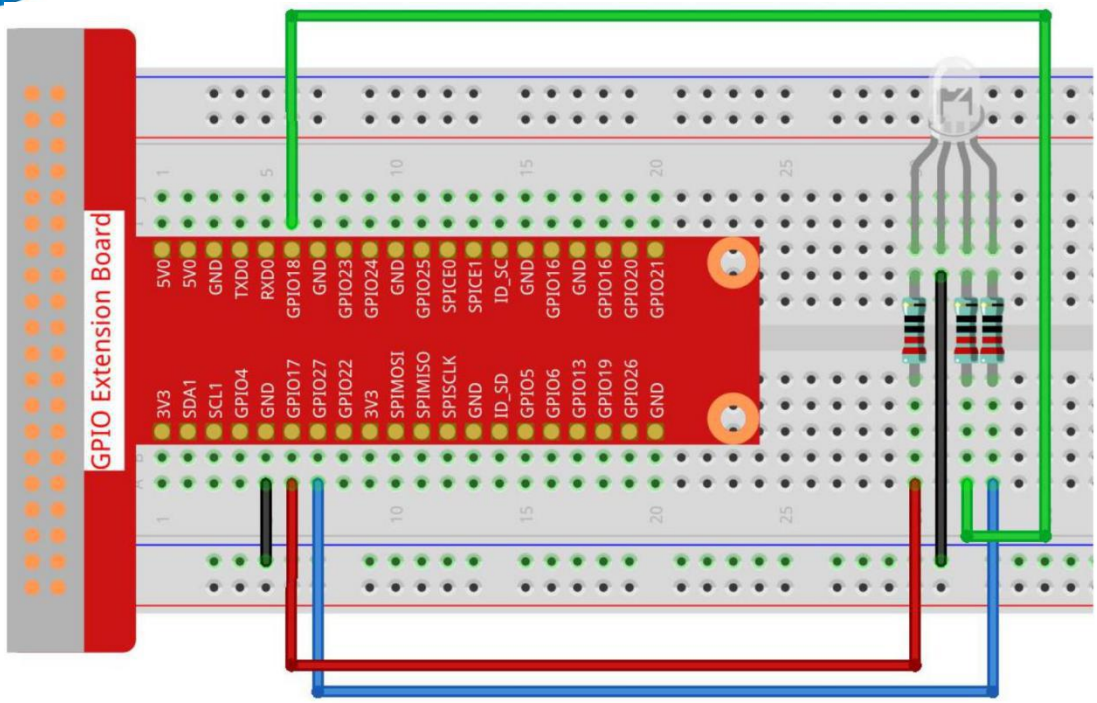

For C Language Users

Step 2: Go to the folder of the code.

```
cd /home/pi/REXQualis_Raspberry_Pi_Complete_Starter_Kit/C/2.RGB_LED
```

Step 3: Compile the code.

```
gcc 2.RGB_LED.c -o RGB_LED.out -lwiringPi
```

Note: When the instruction "gcc" is executed, and outputting an executable fileis named "RGB_LED.out".

Step 4: Run the executable file.

```
sudo ./RGB_LED.out
```

After the code runs, you will see that RGB displays red, green, blue, yellow, pink, and cyan.

Code

```
#include <wiringPi.h>
#include <softPwm.h>
#include <stdio.h>
```

2.RGB_LED

```
#define uchar unsigned char
#define LedPinRed       0
#define LedPinGreen     1
#define LedPinBlue      2

void ledInit(void){
        softPwmCreate(LedPinRed,    0, 100);
        softPwmCreate(LedPinGreen,0, 100);
        softPwmCreate(LedPinBlue, 0, 100);
}

void ledColorSet(uchar r_val, uchar g_val, uchar b_val){
        softPwmWrite(LedPinRed,      r_val);
        softPwmWrite(LedPinGreen, g_val);
        softPwmWrite(LedPinBlue,    b_val);
}

int main(void){
        if(wiringPiSetup() == -1){ //when initialize wiring failed, printf messageto screen
                printf("setup wiringPi failed !");
                return 1;
        }

        ledInit();
        while(1){
                printf("Red\n");
                ledColorSet(0xff,0x00,0x00);      //red
                delay(1000);
                printf("Green\n");
```

```
            ledColorSet(0x00,0xff,0x00);      //green
            delay(1000);
            printf("Blue\n");
            ledColorSet(0x00,0x00,0xff);      //blue
            delay(1000);
            printf("Yellow\n");
            ledColorSet(0xff,0xff,0x00);      //yellow
            delay(1000);
            printf("Purple\n");
            ledColorSet(0xff,0x00,0xff);      //purple
            delay(1000);
            printf("Cyan\n");
            ledColorSet(0xc0,0xff,0x3e);      //cyan
            delay(1000);
        }
        return 0;
}
```

Code Explanation

```
#include <wiringPi.h>
```

Library used for realizing the pwm function of the software.

```
void ledInit(void){
        softPwmCreate(LedPinRed,    0, 100);
        softPwmCreate(LedPinGreen,0, 100);
        softPwmCreate(LedPinBlue, 0, 100);
}
```

The function is to use software to create a PWM pin, set its period between 0x100us- 100x100us.

The prototype of the function softPwmCreate(LedPinRed, 0, 100) is as follows:

```
int softPwmCreate(int pin,int initialValue,int pwmRange);
```

Parameter pin: Any GPIO pin of Raspberry Pi can be set as a PWM pin.

Parameter initialValue: The initial pulse width is that initialValue times100us.

Parameter pwmRange: the period of PWM is that pwmRange times100us.

```
void ledColorSet(uchar r_val, uchar g_val, uchar b_val){
    softPwmWrite(LedPinRed,    r_val);
    softPwmWrite(LedPinGreen, g_val);
    softPwmWrite(LedPinBlue,   b_val);
}
```

This function is to set the colors of the LED. Using RGB, the formal parameter r_val represents the luminance of the red one, g_val of the green one, b_val of the blue one.

The prototype of the function softPwmWrite(LedPinBlue, b_val) is as follows：

```
void softPwmWrite (int pin, int value) ;
```

Parameter pin: Any GPIO pin of Raspberry Pi can be set as a PWM pin.

Parameter Value: The pulse width of PWM is value times 100us. Note that value can only be less than pwmRange defined previously, if it is larger than pwmRange, the value will be given a fixed value, pwmRange.

```
ledColorSet(0xff,0x00,0x00);
```

Call the function defined before. Write 0xff into LedPinRed and 0x00 into LedPinGreen and LedPinBlue. Only the Red LED lights up after running this code. If you want to light up LEDs in other colors, just modify the parameters.

For Python Language Users

Step 2: Open the code file.

```
cd /home/pi/REXQualis_Raspberry_Pi_Complete_Starter_Kit/Python
```

Step 3: Run.

```
sudo python3 2.RGB_LED.py
```

After the code runs, you will see that RGB displays red, green, blue, yellow, pink, and

cyan.

Code

The code here is for Python3, if you need for Python2, please open the code with the suffix py2 in the attachment.

```
#!/usr/bin/env python3

import RPi.GPIO as GPIO
import time

# Set up a color table in Hexadecimal
COLOR = [0xFF0000, 0x00FF00, 0x0000FF, 0xFFFF00, 0xFF00FF, 0x00FFFF]
# Set pins' channels with dictionary
pins = {'Red':17, 'Green':18, 'Blue':27}

def setup():
    global p_R, p_G, p_B
    # Set the GPIO modes to BCM Numbering
    GPIO.setmode(GPIO.BCM)
    # Set all LedPin's mode to output and initial level to High(3.3v)
    for i in pins:
        GPIO.setup(pins[i], GPIO.OUT, initial=GPIO.HIGH)

    # Set all led as pwm channel and frequece to 2KHz
    p_R = GPIO.PWM(pins['Red'], 2000)
    p_G = GPIO.PWM(pins['Green'], 2000)
    p_B = GPIO.PWM(pins['Blue'], 2000)

    # Set all begin with value 0
    p_R.start(0)
```

```
    p_G.start(0)
    p_B.start(0)

# Define a MAP function for mapping values.    Like from 0~255 to 0~100
def MAP(x, in_min, in_max, out_min, out_max):
    return (x - in_min) * (out_max - out_min) / (in_max - in_min) + out_min

# Define a function to set up colors
# input color should be Hexadecimal with
# red value, blue value, green value.
def setColor(color):
  # configures the three LEDs' luminance with the inputted color value .
    # Devide colors from 'color' veriable
    R_val = (color & 0xFF0000) >> 16
    G_val = (color & 0x00FF00) >> 8
    B_val = (color & 0x0000FF) >> 0
  # these three lines are used for analyzing the col variables
  # assign the first two values of the hexadecimal to R, the middle two assigned to G
  # assign the last two values to B, please refer to the shift operation of the
hexadecimal for details.

    # Map color value from 0~255 to 0~100
    R_val = MAP(R_val, 0, 255, 0, 100)
    G_val = MAP(G_val, 0, 255, 0, 100)
    B_val = MAP(B_val, 0, 255, 0, 100)

    # Change the colors
    p_R.ChangeDutyCycle(R_val)
    # Assign the mapped duty cycle value to the corresponding PWM channel to
```

```
change the luminance.
    p_G.ChangeDutyCycle(G_val)
    p_B.ChangeDutyCycle(B_val)

    print ("color_msg: R_val = %s,    G_val = %s, B_val = %s"%(R_val, G_val,
B_val))
def main():
    while True:
        for color in COLOR:# Assign every item in the COLOR list to the color
respectively and change the color of the RGB LED via the setColor() function.
            setColor(color)# change the color of the RGB LED
            time.sleep(0.5)# set delay for 0.5s after each color changing. Modify this
parameter will changed the LED's color changing rate.

# the function of exception
def destroy():
    # Stop all pwm channel
    p_R.stop()
    p_G.stop()
    p_B.stop()
    # Release resource
    GPIO.cleanup()

# If run this script directly, do:
if __name__ == '__main__':
    setup()
    try:
        main()
    # When 'Ctrl+C' is pressed, the program
    # destroy() will be    executed.
```

```
except KeyboardInterrupt:
    destroy()
```

Code Explanation

```
p_R = GPIO.PWM(pins['Red'], 2000)
p_G = GPIO.PWM(pins['Green'], 2000)
p_B = GPIO.PWM(pins['Blue'], 2000)
p_R.start(0)
p_G.start(0)
p_B.start(0)
```

Call the GPIO.PWM( )function to define Red, Green and Blue as PWM pins and set the frequency of PWM pins to 2000Hz, then Use the Start() function to set the initial duty cycle to zero.

```
def MAP(x, in_min, in_max, out_min, out_max):
    return (x - in_min) * (out_max - out_min) / (in_max - in_min) + out_min
```

Define a MAP function for mapping values. For instance, x=50, in_min=0, in_max=255,out_min=0, out_max=100. After the map function mapping, it returns (50-0) * (100-0)/(255-0) +0=19.6, meaning that 50 in 0-255 equals 19.6 in 0-100.

```
def setColor(color):
    R_val = (color & 0xFF0000) >> 16
    G_val = (color & 0x00FF00) >> 8
    B_val = (color & 0x0000FF) >> 0
```

Configures the three LEDs' luminance with the inputted color value, assign the first two values of the hexadecimal to R_val, the middle two assigned to G_val, the last two values to B_val. For instance, if color=0xFF00FF, R_val=（0xFF00FF & 0xFF0000）>> 16 = 0xFF，G_val = 0x00, B_val=0xFF.

```
    R_val = MAP(R_val, 0, 255, 0, 100)
    G_val = MAP(G_val, 0, 255, 0, 100)
    B_val = MAP(B_val, 0, 255, 0, 100)
```

2.RGB_LED

Use map function to map the R,G,B value among 0~255 into PWM duty cycle range 0-100.

```
p_R.ChangeDutyCycle(R_val)
p_G.ChangeDutyCycle(G_val)
p_B.ChangeDutyCycle(B_val)
```

Assign the mapped duty cycle value to the corresponding PWM channel to change the luminance.

```
for color in COLOR:
    setColor(color)
    time.sleep(0.5)
```

Assign every item in the COLOR list to the color respectively and change the color of the RGB LED via the setColor() function.

Phenomenon Picture