VILNIUS UNIVERSITY
SIAULIAI ACADEMY

PROGRAMŲ SISTEMOS BACHELOR STUDY PROGRAMME

Software engineering

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Programming of Embedded Systems

Laboratory work No.3

Pulse Width Modulation (PWM)

Šiauliai, 2025

Laboratory Work Report

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1. The Aim of the Laboratory Work

The goal of this laboratory work is to study Pulse Width Modulation (PWM) and its application in controlling LED brightness using an STM32 microcontroller. The experiment focuses on generating a PWM signal with a specified frequency and using a timer interrupt to create a fading effect on an LED.

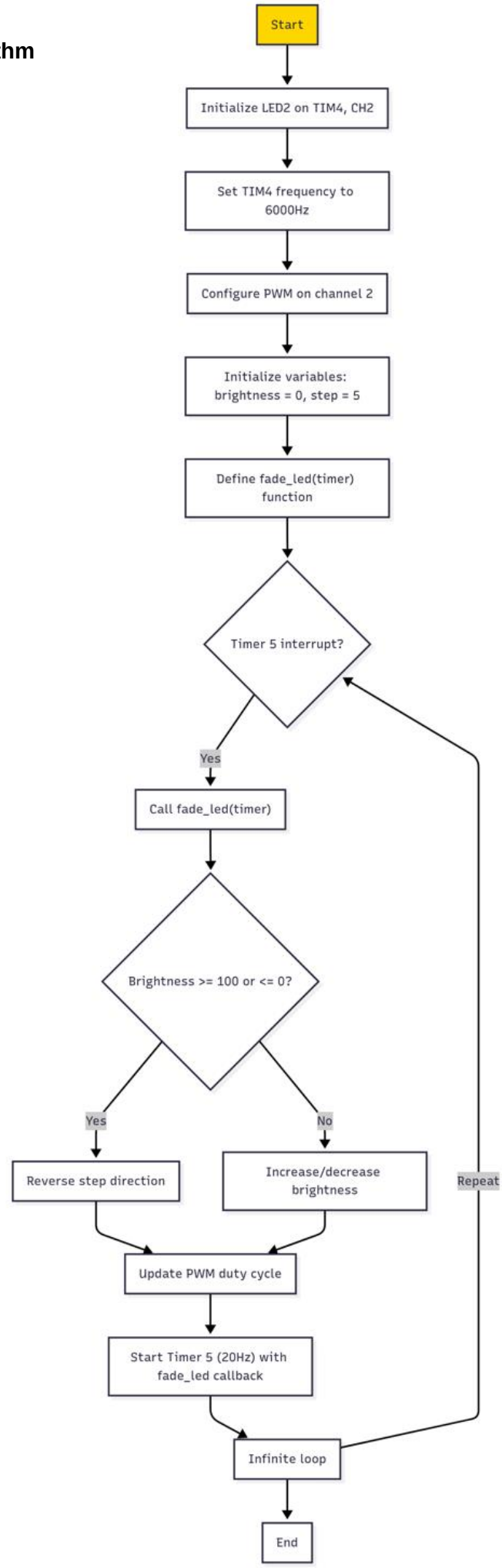
2. Variant No and Data

Variant No: 9

No.	Pin	TIMx, CHx	PWM frequency, Hz
9	LED2	TIM4, CH2	6000

Date: 04/03/2025

3. Program Algorithm



4. Program body

```
from pyb import Pin, Timer

# LED2 is on TIM4, CH2
p = Pin("LED2")

# Set TIM4 frequency to 6000Hz
tim = Timer(4, freq=6000)

# Configure timer in PWM mode on channel 2
ch = tim.channel(2, Timer.PWM, pin=p)

# Initial duty cycle
brightness = 0
step = 5  # Brightness change step

def fade_led(timer):
    global brightness, step
    brightness += step
    if brightness >= 100 or brightness <= 0:
        step = -step  # Reverse direction
    ch.pulse_width_percent(brightness)

# Use timer interrupt to change brightness
fade_timer = Timer(5)  # Create Timer 5
fade_timer.init(freq=20, callback=fade_led)  # 20Hz → period 50ms

while True:
    pass
```

5. Conclusions

- PWM is a simple and effective way to control LED brightness. By changing the duty cycle, the LED appears brighter or dimmer without extra hardware.
- Timers and interrupts automate brightness control. Instead of manually updating values, the timer interrupt adjusts brightness at regular intervals.
- The fading effect happens by smoothly increasing and decreasing the duty cycle over time, creating a gradual transition.
- MicroPython makes embedded programming easier by providing built-in functions for PWM and timers, reducing code complexity.

This laboratory work demonstrates the practical application of PWM in embedded systems, particularly for LED control.