Chapter 13, part 1: Using PWM to Implement Dimmable LEDs

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1 Introduction

This article describes how *pulse width modulation* (**PWM**) can be used to implement dimmable LEDs on an STM32 dev-board. The first part of the article presents concepts related to how the hardware components work and are configured. The second part describes code that implements the dimmable LEDs.

This article is an introductory tutorial for those who are new to timers and PWM signals. A timer is used to generate the PWM signal. STM32 timers are complex, and their documentation is hard to use. As a beginner, the tutorials I found were hard to understand, had errors, or they did not have all of the info needed. This article presents my understanding of how dimmable LEDs are implemented, based on several documents and tutorials, which are cited.

This article is part of a study-guide for the book *Hands-On RTOS with Microcontrollers*. This article supplements Chapter 13, as the chapter doesn't describe its PWM implementation, nor the related example programs. For the book, the dev-board used is an STM32 Nucleo-144, NUCLEO-F767ZI. The article should be applicable to other STM32 MCUs.

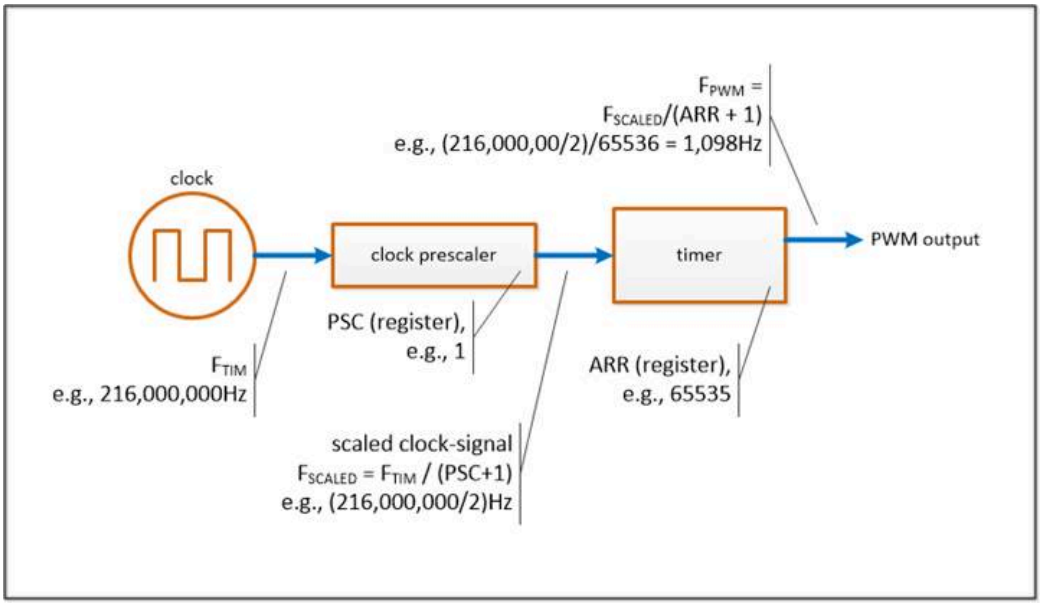
2 How the hardware components work and are configured

2.1 How PWM is used to dim LEDs

An LED is made dimmable by using PWM to power the LED's positive lead. This article assumes an elementary understanding of PWM and *duty cycles*. That info can be found in the articles listed below. (For the Wikipedia articles, the introductory sections are sufficient.)

- Frequency: https://blogs.arubanetworks.com/industries/frequency-cycle-wavelength-amplitude-and-phase/
- PWM: https://en.wikipedia.org/wiki/Pulse-width_modulation
- Duty cycle: https://en.wikipedia.org/wiki/Duty_cycle

On the dev-board, PWM is generated by these hardware components: a clock, clock prescaler, and timer. They are illustrated below, and descriptions follow.



The PWM signal is illustrated below.
F_{PWM} : the PWM frequency; the number of PWM cycles per second
P_{PWM} : the PWM period; (1/ F_{PWM})