

Embedded Systems

Exercise 5

Introduction

This task aims to write a precise time counter program using the 7-segment display and basic timer (TIM6) built into the STM32L4 microcontroller. The program should configure the timer and use it to implement precise delays between changes in the displayed value. The program must be written in C using STM documentation for the microcontroller registers.

Tasks

- Create a C structure describing registers of the basic timer
- Create an initialisation function for the timer
- Create delay function(s) measuring the time using the basic timer
- Modify the program counting and displaying values from 0 to 9999 to use the basic timer for precise time measurements

Initial Questions

As a preparation for writing the program, read chapter 33 of the STM32L4 reference manual and answer the following questions:

1. What is the main reference clock for TIM6 and which microcontroller unit is responsible for generating it?
[TIM6 uses APB1 clock which is generated from MSI RC oscillator.](#)
2. What is the default frequency of the main reference clock for TIM6 configured by the 'Clock Configuration' Tool and HAL library?
[With the use of HAL_RCC_GetSysClockFreq\(\) it's 4MHz](#)
3. What is the name and address of the main control register of TIM6?
[TIM6_CR1 at 0x40001000](#)
4. What is the name and address of the status register of TIM6?
[TIM6_SR at 0x40001010](#)
5. Which register should be used to configure the overflow value (expected value to which the timer should count)?
[TIM6_ARR](#)
6. Which register should be used to set the prescaler value of TIM6?
[TIM6_PSC](#)
7. Which register can be used to read the current value of the TIM6 counter?
[TIM6_CNT](#)
8. Which flag can be used to check if the counter reached the configured value? How to read and clear it?
[The Update Interrupt Flag \(UIF\) of Status Register \(SR\)](#)
9. How to enable the TIM6 timer? Please specify both the register and bit name.
[To enable the TIM6, we need to set TIM6_CR1 register, specifically bit CEN \(Counter Enable\)](#)
10. Which bit specifies whether the timer works in continuous or one-pulse mode? Please specify both names of the register and bit.
[Register TIM6_CR1, bit: OPM \(one-pulse mode\)](#)
11. Assuming the default frequency of the TIM6 timer specified in point 2, please calculate the minimum and maximum time that can be counted when the prescaler is set to:

Prescaler	Minimum time	Maximum time
1	0.00025 ms	16.38 ms
512	0.128 ms	8.39 s
1024	0.256 ms	16.78 s

$$\text{MinT} = (\text{Prescaler} + 1) * (1/\text{fclk})$$

$$\text{MaxT} = (65536 - 1) * (\text{Prescaler} + 1) * (1/\text{fclk})$$

32767	8.19 ms	536.85 s
65535	16.38 ms	1073.70 s
131071	prescaler exceeded max value	prescaler exceeded max value

12. What is the absolute maximum time that can be counted using the TIM6 timer?

...if prescaler = 65535 then it's 1073.70 s.....

Requirements for the application

The final goal of the exercise is to implement a precise timer for counting up and down in the range of 0-9999 seconds.

The functionality of the application stays the same as in exercise 4. However, the counting rate should be precisely configured to 1 second. For this purpose, dedicated functions using the basic timer TIM6 should be implemented to replace the previous delay functions. The counting rate should also be easily modifiable to any other value requested by the teacher.