ECE271: Microcomputer Architecture and Applications — University of Maine

Prelab for Lab #8: Pulse Width Modulation and Servo Motor Control

Week of 28 March 2022

Part A – Textbook Readings / Videos

1. Read Textbook `Chapter 15.3` to review pulse-width modulation.
2. For background on how the timer works, the textbook recommends the following videos (note, I haven't extensively reviewed these).
   (a) PWM: `http://www.youtube.com/watch?v=zkrVHIcLGww`

Part B – Prelab assignment

In this lab we will set up the TIM1 timer and use it to generate Pulse-width modulated (PWM) signals. We will first use it to pulse the green LED on the STM board, and then we will use it to control a servo motor.

1. Settings needed to PWM the Green LED

We want to PWM the Green LED on the board. Remember it is connected to GPIOE8.
You will need to set the following fields. Write the values to mask/set. If no mask is needed you can let that blank. You can use pre-defined names for the bits rather than raw hex values.

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- Set `GPIOE->MODER` for pin 8 to be "alternate" mode.
  MASK MODER=~(GPIO_MODER_MODER8)
  VALUE MODER=GPIO_MODER_MODER8_1

- Set `GPIOE->AFR[0]` and `GPIOE->AFR[1]` for alternate function of Pin 8 to be `TIM1_CH1N`. You can look in Appendix I of the book to see which one this is. (Note: in theory these values should be in one of the datasheets but I've been unable to find it documented anywhere besides the textbook).
  MASK AFR[0]=0xffff ffff
  VALUE AFR[0]=0x0000 0000
  MASK AFR[1]=0xffff fff0
  VALUE AFR[1]=0x0000 0001

Pg 703 in textbook

- Set `GPIOE->OTYPER` for Pin 8 to be push-pull
  MASK OTYPER=~(GPIO_OTYPER_OT_8)
  VALUE OTYPER=____________

- Set `GPIOE->PUPDR` for Pin 8 for no pull-up/pull-down
  MASK PUPDR=~(GPIO_PUPDR_PUPDR8)
  VALUE PUPDR=NA

2. Settings needed to use TIM1 for PWM mode

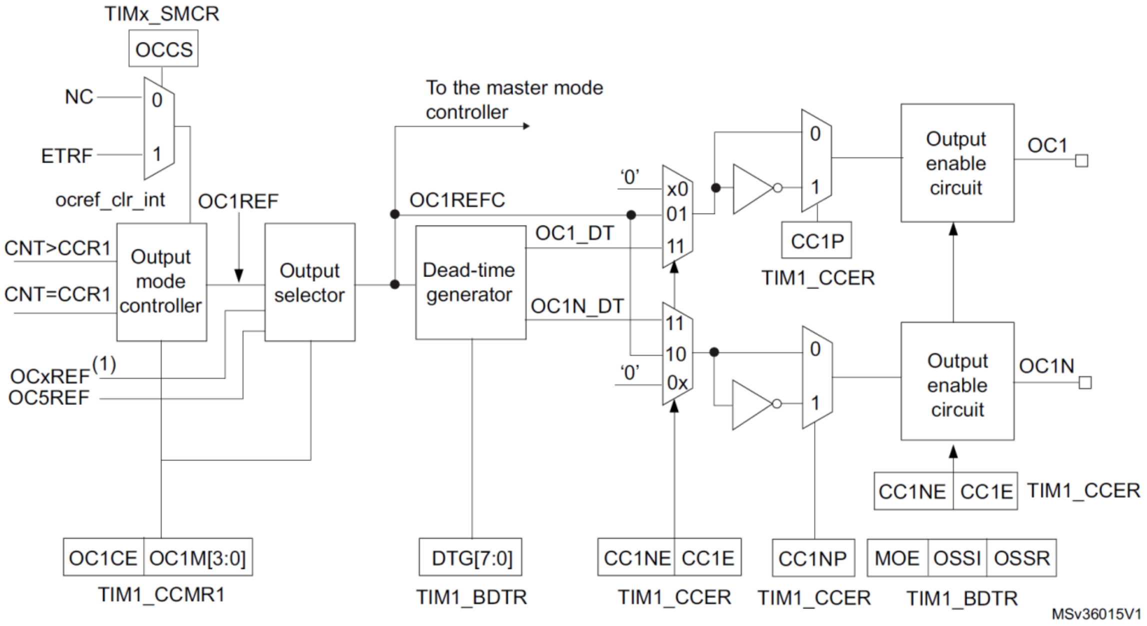

Figure 1: The TIM1 timer has many more configuration settings than the SysTick timer did.

Setting up the TIM1 timer has a lot more options than the SysTick timer, as you can see in Figure 1. You can find the settings in Chapter 30 of the STM manual, and also in Chapter 15.3 of the textbook (specifically example 15-4). Pg. 394

You will need to set the following fields. Write the values to mask/set. If no mask is needed you can let that blank. You can use pre-defined names for the bits rather than raw hex values.

- Set `TIM1->CR1` for the counting direction to be up.
  MASK CR1=~(TIM_CR1_DIR)
  VALUE CR1=____________

- We will use a 4MHz MSI clock for this lab. Set the prescaler `TIM1->PSC` to count at 100kHz.
  MASK PSC=____________
  VALUE PSC=____________ `TIM1->PSC` = 39

- Set the `TIM1->ARR` register to a value that will give a period of 0.01s
  MASK ARR=____________
  VALUE ARR=____________ `TIM1->ARR` = 999

- Clear the `OC1M` field in the `TIM1->CCMR1` register and select PWM Mode 1 (`OC1M` = 110):
  MASK CCMR1=~(TIM_CCMR1_OC1M)
  VALUE CCMR1=____________
  TIM_CCMR1_OC1M_1 | TIM_CCMR1_OC1M_2

- Enable the Output 1 preload enable in `TIM1->CCMR1`:
  MASK CCMR1= NA
  VALUE CCMR1= TIM_CCMR1_OC1PE

- Select the output polarity by clearing the `CC1NP` field in the `TIM1->CCER` register:
  MASK CCMR1= ~(TIM_CCER_CC1NP)
  VALUE CCMR1= NA

- Enable complementary output of Channel 1 (CH1N) by setting the CC1NE bit in `TIM1->CCER`:
  MASK CCER= NA
  VALUE CCER= TIM_CCER_CC1NE

- Set the main output enable (MOE) in `TIM1->BDTR`:
  MASK BDTR= NA
  VALUE BDTR= TIM_BDTR_MOE

- Set the output compare register for channel 1 `TIM1->CCR1` to have a duty cycle of 50%:
  MASK CCR1=____________
  VALUE CCR1=____________

`TIM1->CCR1` = 500

Enable Counter

TIM1 → CR1 |= TIM_CR1_CEN