Embedded Systems Laboratory

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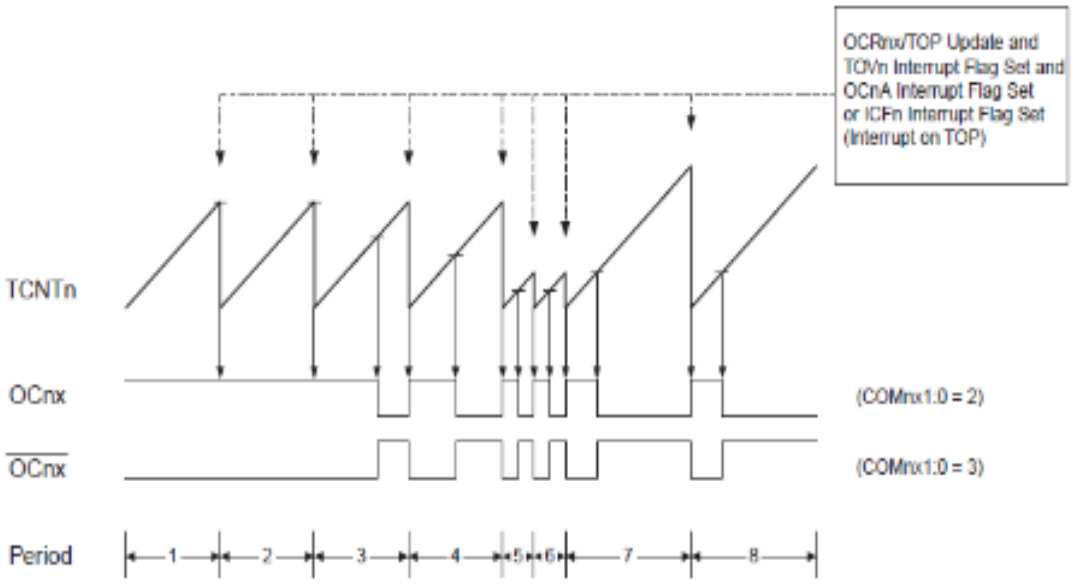
Generating PWM to Control the Brightness

Introduction:

In this lab, we will still use the Output Compare Unit but with fast Pulse Width Modulator (PWM) mode to generate the PWM signal on the output compare pin OC1.

In Fast PWM mode, the Counter TCTN1 counts from BOTTOM (TCTN1=0) to TOP (TCTN1=TOP) and restarts from BOTTOM. Please look at Figure 16-7 below, the Compare Match happens when TCTN1 = OCR1A.

Figure 16-7. Fast PWM Mode, Timing Diagram



The pin OC1A can be cleared to be 0 on Compare Match and is set to be 1 when TCTN1=0 (at BOTTOM). In the Table 16-2 in the datasheet, you can set the corresponding bits in TCCR1A register to allow the pin OC1A to behave in the above mentioned manner.

Table 16-2. Compare Output Mode, Fast PWM[1]

COM1A1/COM1B1	COM1A0/COM1B0	Description
0	0	Normal port operation, OC1A/OC1B disconnected.
0	1	WGM13:0 = 14 or 15: Toggle OC1A on Compare Match, OC1B disconnected (normal port operation). For all other WGM1 settings, normal port operation, OC1A/OC1B disconnected.
1	0	Clear OC1A/OC1B on Compare Match, set OC1A/OC1B at BOTTOM (non-inverting mode)
1	1	Set OC1A/OC1B on Compare Match, clear OC1A/OC1B at BOTTOM (inverting mode)

Note: 1. A special case occurs when OCR1A/OCR1B equals TOP and COM1A1/COM1B1 is set. In this case the compare match is ignored, but the set or clear is done at BOTTOM. See "Fast PWM Mode" on page 123 for more details.

Then you can set the TOP value to be fixed and change the value of OCR1A to change the on-time, off-time duration of the pin OC1A. In order to set it to Fast PWM mode and set the TOP value, you need to set the register **TCCR1A and TCCR1B** (check table 16-4).

Table 16-4. Waveform Generation Mode Bit Description[1]

Mode	WGM13	WGM12 (CTC1)	WGM11 (PWM11)	WGM10 (PWM10)	Timer/Counter Mode of Operation	TOP	Update of OCR1x at	TOV1 Flag Set on
0	0	0	0	0	Normal	0xFFFF	Immediate	MAX
1	0	0	0	1	PWM, Phase Correct, 8-bit	0x00FF	TOP	BOTTOM
2	0	0	1	0	PWM, Phase Correct, 9-bit	0x01FF	TOP	BOTTOM
3	0	0	1	1	PWM, Phase Correct, 10-bit	0x03FF	TOP	BOTTOM
4	0	1	0	0	CTC	OCR1A	Immediate	MAX
5	0	1	0	1	Fast PWM, 8-bit	0x00FF	BOTTOM	TOP
6	0	1	1	0	Fast PWM, 9-bit	0x01FF	BOTTOM	TOP
7	0	1	1	1	Fast PWM, 10-bit	0x03FF	BOTTOM	TOP
8	1	0	0	0	PWM, Phase and Frequency Correct	ICR1	BOTTOM	BOTTOM
9	1	0	0	1	PWM, Phase and Frequency Correct	OCR1A	BOTTOM	BOTTOM
10	1	0	1	0	PWM, Phase Correct	ICR1	TOP	BOTTOM
11	1	0	1	1	PWM, Phase Correct	OCR1A	TOP	BOTTOM
12	1	1	0	0	CTC	ICR1	Immediate	MAX

Don't forget to set the prescaler to be 1. A similar function is also applied to output pin **OC0A(PORTD6), OC0B(PORTD5), OC1B(PORTB2), OC2A(PORTB3), OC2B(PORTD3)**.

Pre Lab Tasks:

1. Read the ATmega328 datasheet (Chapter 16.9.3 Timer/Counter1- Fast PWM Mode)
2. Draft a design which gradually makes an LED brighter and brighter.

Lab Assignments:

1. Control the brightness of an LED on OC1A by Fast PWM Mode
2. Gradually make an LED on OC1A brighter and brighter.

Lab Report: The requirements are the same as the previous lab.