Using PWM for Dimmer Function in LED Lighting

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Keywords

- *Dimmer*
- *LED Lighting*
- *PWM*
- *Timer*
- *CC1110Fx*
- *CC1111Fx*
- *CC2510Fx*
- *CC2511Fx*
- *CC2430*
- *CC2431*

1 Introduction

This design note shows how to use CC251x PWM for dimmer functions in LED lighting applications. As the popularity of LED lighting increases, the CC251x single chip solution not only provides the wireless remote control functions but also dimmer function by using one of its built-in PWMs. By configuring the timer peripheral to PWM and set the corresponding registers for frequency and pulse width, the desired PWM signal can be generated. It can highly reduce the complexity of the control code and the effort on software.

Although this design note discusses the CC251x in particular, the same principles apply to CC111x and CC243x as well.

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2 Abbreviations

PWM	Pulse Width Modulation
LED	Light Emitting Diode
SoC	System On Chip

3 Timer

CC251xFx, CC111xFx, CC243x are RF system-on-chip (SoC) design for low power wireless applications. It incorporates RF transceiver and 8051 MCU with peripherals. The CC251x includes, among others, ADC, I2S interface, USART and Timers.
Timer 1 of CC251x is an independent 16-bit timer which supports typical timer/counter functions such as input capture, output compare and PWM functions. This design note will discuss how to use timer 1 in PWM mode for dimmer function of LED lighting.

3.1 Timer 1 in PWM mode

Timer 1 provides three running modes including free-running, modulo and up/down. To control the frequency of the PWM, modulo mode is selected. In modulo mode, the counter on timer 1 starts from 0x0000 and increments at each active clock edge. When the counter reaches the terminal count value set in T1CC0 register, the counter is loaded with 0x0000 on the next timer tick and continues incrementing its value. Therefore, the frequency of the PWM signal can be set by using T1CC0 register as shown in Figure 1.

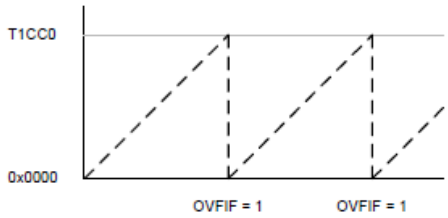

Figure 1. Frequency in Modulo Mode

The pulse width of the PWM signal can be controlled by using Timer 1 in output compare mode. The I/O pin associated with the channel is set/clear/toggled automatically according to the mode selected. After the timer has been started, the contents of the counter are compared with the contents of the 16-bit channel compare register T1CCnH:T1CCnL. If the compare register equals the counter contents, the output pin is set, reset or toggled according to the compare output mode setting. Thus, the pulse width of the PWM signal can be set by T1CCnH:T1CCnL as shown in the Figure 2.

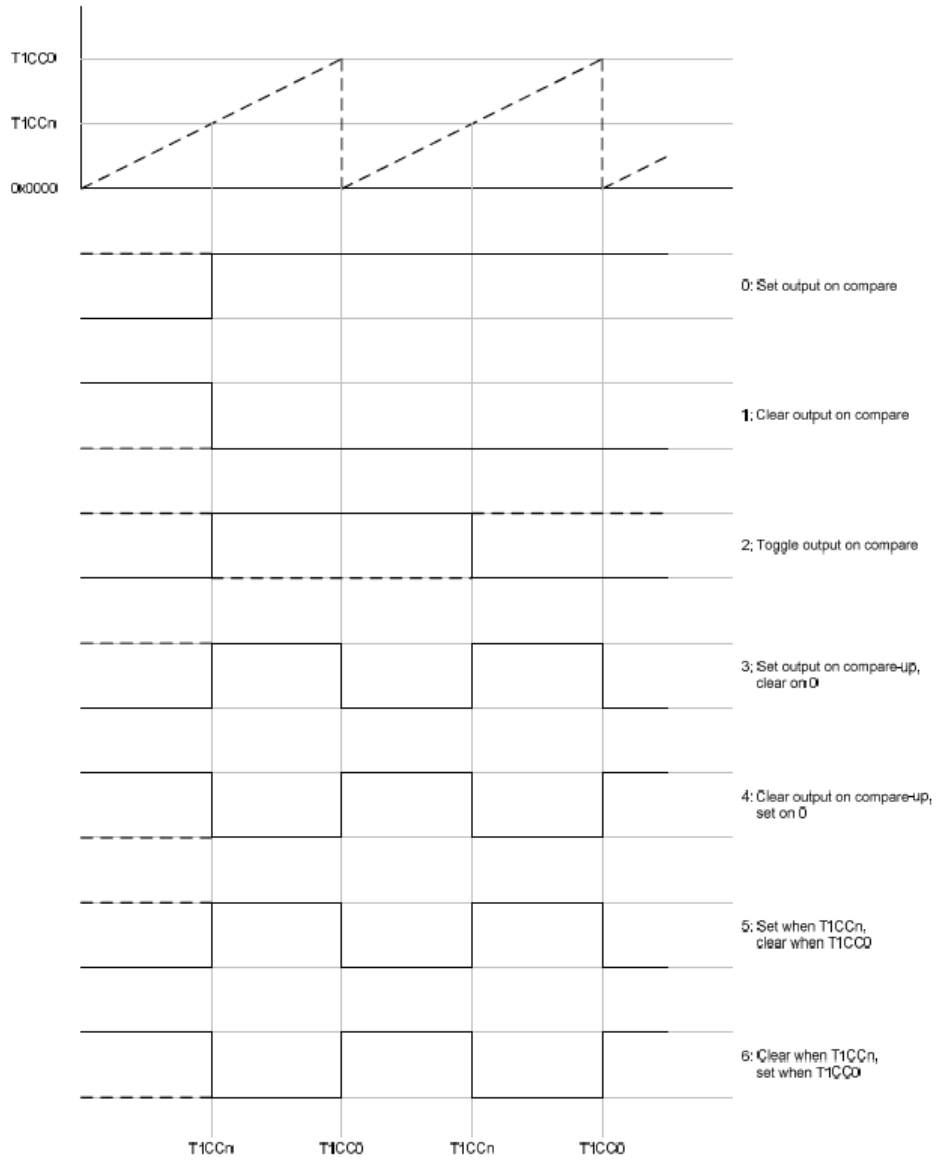

Figure 2. Pulse Width in Modulo Mode

4 Implementation

The CC251x code for initializing Timer 1 is shown below:

```
/* Timer 1 set Modulo Mode, pre-scaler = 128 (set in T1CTL) */
/* Freq. set by T1CC0H:T1CC0L = 0x1ff  */
/* Counter Tick freq = 13MHz / 128 */
/* PWM freq = 13M / 128 / 511 = 198.75 Hz */
T1CC0L = 0xff;
T1CC0H = 0x01;

/* Timer 1 channel 1 set compare mode 4 */
T1CCTL1 |= 0x24;
/* Prescaler set to Tick Freq / 128 */
T1CTL |= 0x0c;

/* Timer 1 CFG set to Alt 2 location */
PERCFG |= 0x40;
/* P1_1 set peripheral func which associated with Timer 1 output */
P1SEL |= 0x2;
```

Timer 1 is set in modulo mode with frequency set in 16-bit register T1CC0H:T1CC0L. Channel 1 is set as output compare mode 4 (Clear output on compare-up, set on 0). The I/O port 1 pin 1 is associated to the Timer 1 for the PWM output. The PWM frequency is controlled by the tick frequency and the prescaler. The frequency is set to around 200Hz. The pulse width of the PWM signal is controlled by the contents in 16-bit register T1CC1H:T1CC1L. For example, to set 1/8 duty, the value to be written to T1CC1H and T1CC1L are 511 / 8 equals to 64 approximately. To set 7/8 duty, the value is 511 * 7 / 8 equals to 447 approximately. Similarly, the desired PWM frequency and duty cycle can be set by modifying the 16-bit registers T1CC0H:T1CC0L and T1CC1H:T1CC1L. The wave forms of 1/8 duty and 7/8 duty are shown in Figure 3 and Figure 4 respectively.

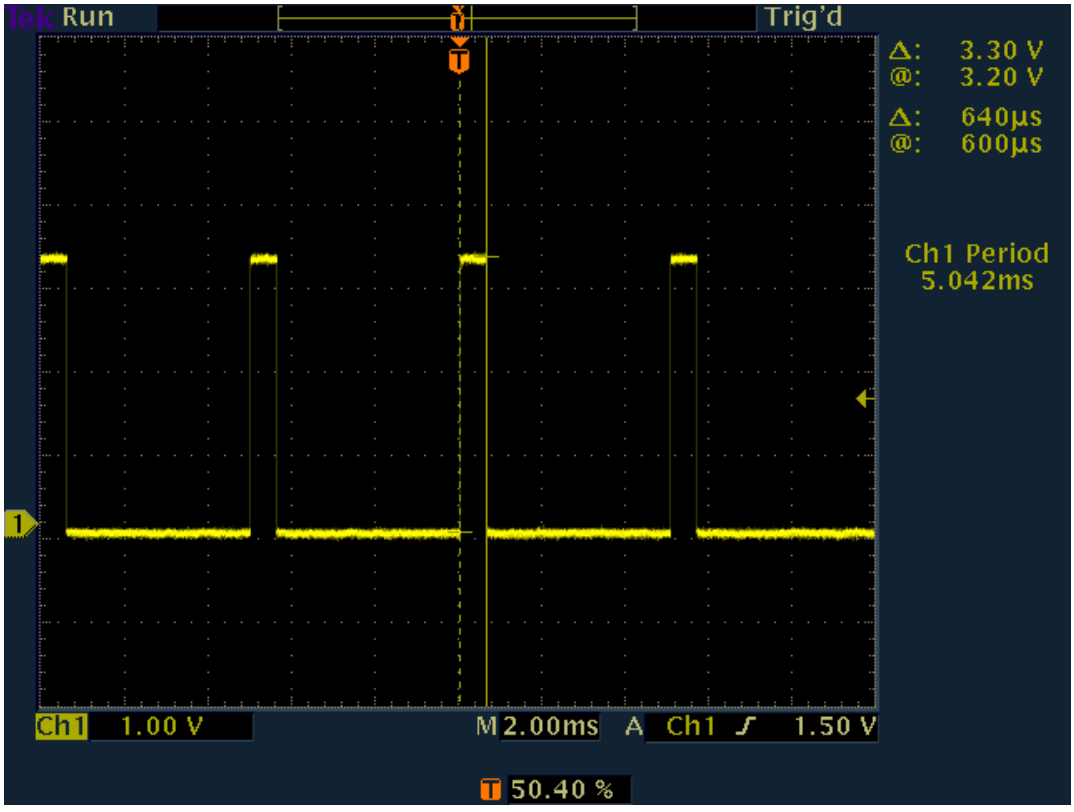

Figure 3. 1/8 duty PWM Signal

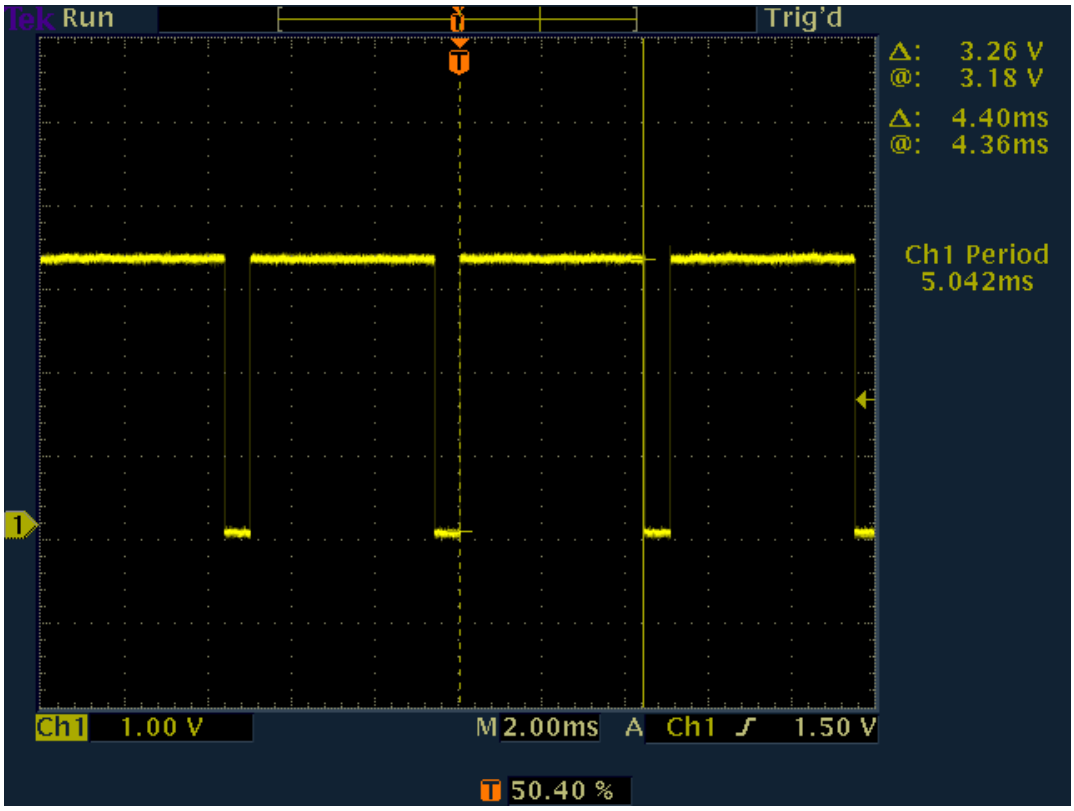

Figure 4. 7/8 duty PWM Signal

5 References

[1] CC2510Fx/CC2511Fx Low-Power SoC (System-on-Chip) with MCU, Memory, 2.4 GHz RF Transceiver, and USB Controller (SWRS055)

6 General Information

6.1 Document History

Revision	Date	Description/Changes
SWRU227	2009.06.12	Initial release.

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