Chapter 13. CCP Module and PWM

This chapter covers the CCP (Capture/Compare/PWM) module of PIC 16F877, however, our main focus is on PWM (Pulse Width Modulation). PWM is a technique of controlling analog circuits using digital output from microcontroller. In other words, PWM a digital encoder of analog signal level. The duty cycle of a square wave generated by microcontroller is modulated to encode a specific analog signal level. The analog signal level is determined by means of a repeating series of on and off pulses of the square wave. The on-time is the time during which the digital value is applied, and the off-time is the period during which that supply is switched off. The duty-cycle is defined as the ratio of on-time and the sum of on-time and off-time, which is the pulse width. Once can control motor speed and light dimmer among other applications using PWM technique.

The focus of this chapter on PWM is how to generate different duty-cycle of different pulse width using the built-in module of CCP in 16F877. We first discuss about CCP module and then concentrate our discussion on the PWM mode of the module.

1. CCP (Capture/Compare/PWM) Module of 16F877

As noted above, CCP module has 3 different modes of operation. Before we proceed, we list necessary file registers for the operations of the CCP module. First we have to know that 16F877 has two CCP modules: CCP1 and CCP2. As noted in the pin diagram, there are two CCP pins: CCP1 and CCP2 pin. When CCP1 module is used for PWM mode, for example, the digital pulse would be generated from the CCP1 pin.

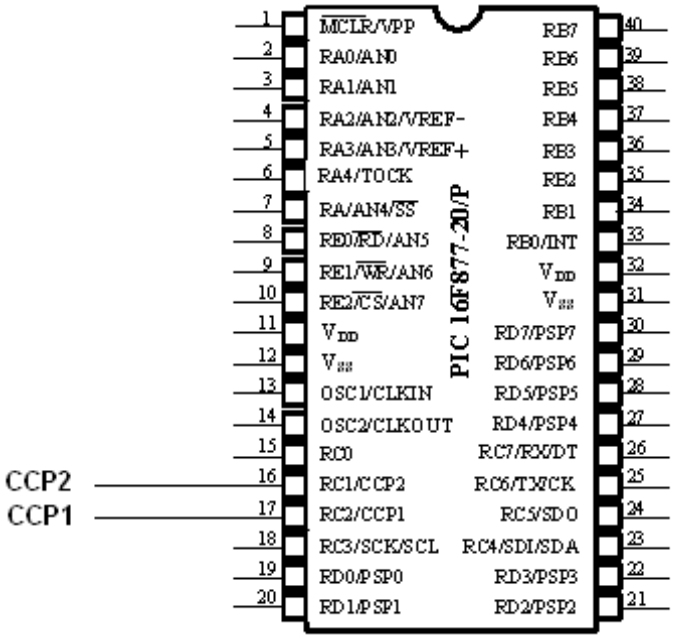

Fig. 85 CCP pins of PIC 16F887

Each CCP module has a 16-bit register which can operate as 16-bit capture register (in Capture Mode), or 16-bit compare register (in Compare Mode), or 16-bit PWM duty cycle register. As

we know there could not be a 16-bit register in 16F877 since the microcontroller is an 8-bit processor. Therefore, two 8-bit register are used to form a 16-bit register:CCPR1H and CCPR1L for upper and lower byte of the 16-bit register for CCP1 module, and CCPR2H and CCPR2L for CCP2 module.

CCP modules are controlled by CCP control registers: CCP1CON for CCP1, and CCP2CON for CCP2. In this chapter, when we refer any one of the modules without specifying either CCP1 or CCP2, then we use 'x' to indicate either one. For example, the generic symbol CCPx indicates either one of two CCP modules. Similarly, CCPxCON can be either CCP1CON or CCP2CON, depending upon with module you use.
The RAM addresses of the CCP register are listed below:

Address	Register Name	Functions
0C	PIR1	Peripheral Interrupt Request 1
0D	PIR2	Peripheral Interrupt Request 2
8C	PIE1	Peripheral Interrupt Enable 1
8D	PIE2	Peripheral Interrupt Enable 2
11	TMR2	Timer2 Module
92	PR2	Timer2 Module Period
12	T2CON	Timer2 Module Control
15	CCPR1L	Lower Byte of CCP1 Register
16	CCPR1H	Upper Byte of CCP2 register
17	CCP1CON	CCP1 Module Control
18	CCPR2L	Lower Byte of CCP2 Register
1C	CCPR2H	Upper Byte of CCP2 Register
1D	CCP2CON	CCP2 Module Control

The details of CCP1CON register is illustrated here. As we can see, CCPM3:CCPM0 decide the three modes in CCP module. Also, DCB1:DCB0 are used only for PWM as the last two LSBs for 10-bit PWM duty cycle.

CCP1CON Register

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Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Bits 7:6 **Not Used**

Bits 5:4 **DCB1:DCB0** Used only for PWM mode. These two bits are the two LSB bits of 10-bit PWM duty cycle. The upper 8 bits are found in CCPR1L.

Bits 3:0 **CCPM3:CCPM0** CCP1 Mode Selection Bits
0000 CCP off