Pulse Width Modulation Example

How to use the HC12’s built in pulse width modulator to control the speed of a motor

What is Pulse Width Modulation?

Pulse width modulation (PWM) is a scheme of expressing analog values with only TTL level pulses. This is accomplished by changing the length of time the pulse is on in proportion to the analog level of the pulse. This is used for many purposes, such as sending analog data on a fiber optic link. The light is either on or off, so the length of the pulses varies to express different voltages. For the purposes of mechatronics, we are interested in varying the speed of a motor.

An important few terms to know here are
- Pulse Train – stream of pulses
- Period – time between pulses in a pulse train
- Duty – fraction of the period that the pulse is high

Using an H-bridge, a microcontroller can either turn a motor on or off. If, however the motor is turned on and off fast enough it does not have time to reach full speed or to slow to a full stop. The motor will come to a speed that is less than its full speed. The more time the motor is on, the closer it will be to full speed and vice versa. Hence, PWM is used to give long pulse lengths to go fast and short lengths to go slow.

Important Registers

There are 4 possible PWM channels on the HC12. These are the lowest 4 bits of Port P. This is how to use them.

PWM Enable Register.
Address $0042
First, naturally, the channels need to be turned on. This is done though the PWM Enable Register. The lowest 4 bits turn on the channels which correspond to the lowest four bits of the P Port, respectively.

PWM Data Direction Register.
Address $0057
Port P is a special port in that it can be for general input/output just like Ports A and B, or can be set to use any of the 4 available PWM channels. Thus, just like Ports A and B, the direction register must be set to output in order to use PWM. Note that any bits in P not used for PWM can still be used as a general I/O port.

PWM Channel Duty Registers 0-3
Address $004C - $004F
These are the registers which specify the duty of the pulse train. The higher the duty, the faster the motor.

PWM Clocks and Concatenate Register.
Address $0040
This port is slightly more difficult to understand. The top two bits are for concatenating the channels. For example, if more accuracy is need than can be provided in 8 bits, bit 7 of the clock and concatenate register can be set high, and instead of two 8 bit PWM channel, there would be one 16 bit channel. The remaining bits of this register are unused in this tutorial. Feel free to learn about them on your own.

Port P Data Register
Address $0056
This port is available as a general I/O port unless the PWM is on. In this case, all bits not used for PWM are still valid general I/O bits.

**Code Example (Check SHE book pp 337 – 345 for PWM control registers)**

```assembly
DDRP   EQU    $0057
PWCLK  EQU    $0040
PWPOL  EQU    $0041
PWEN   EQU    $0042
PWPER0 EQU    $004C
PWDTY0 EQU    $0050

;----------------------------------------------------------------------
;Subroutine to intitialize port P
;----------------------------------------------------------------------
ORG  $0800    ; Start program here
MOVB #$FF,DDRP  ;set port P to all output
MOVB #%00000000,PWCLK  ;initialize PWCLK($40) register
MOVB #%00000001,PWPOL  ;initialize PWPOL($41) register
MOVB #$01,PWEN   ;initialize PWEN($42) register
MOVB #$78,PWPER0   ;set period (P0)
MOVB #$00,PWDTY0   ;set duty cycle (P0)

;----------------------------------------------------------------------
; MAIN PROGRAM
;----------------------------------------------------------------------
DANCE MOVB #$10,PWDTY0
LOOP  BRA LOOP
```