

Exercise 5 Prep

Output Compare, PWM and Servo
Motors

Purpose

- Generate an approximate analog signal output with a digital signal.
 - Apply variable voltage (and current) to a load.



Exercise Overview

- Hardware
 - Microstick II kit
 - Positional and Continuous Servo Motor
 - 6V (4 AA batteries) pack
 - Logic Analyzer (Intronix or Kingst)
- Software
 - Generate constant PWM signal on OC1
 - Generate changing PWM signal on OC1

Review – Pulse Width Modulation

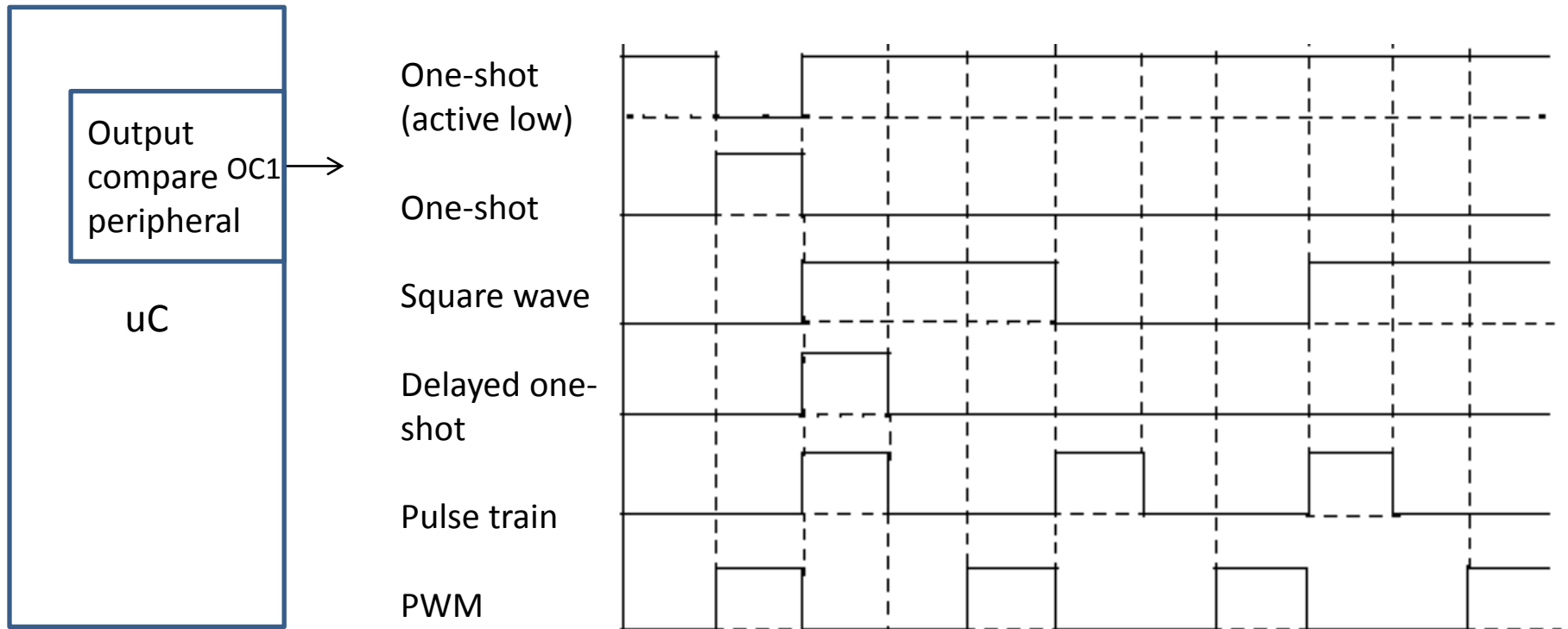
- What is a PWM Signal?
- What is a servo motor?
- What are two kinds of servo motors?
- How do we control them?

PIC24 Output Compare Overview

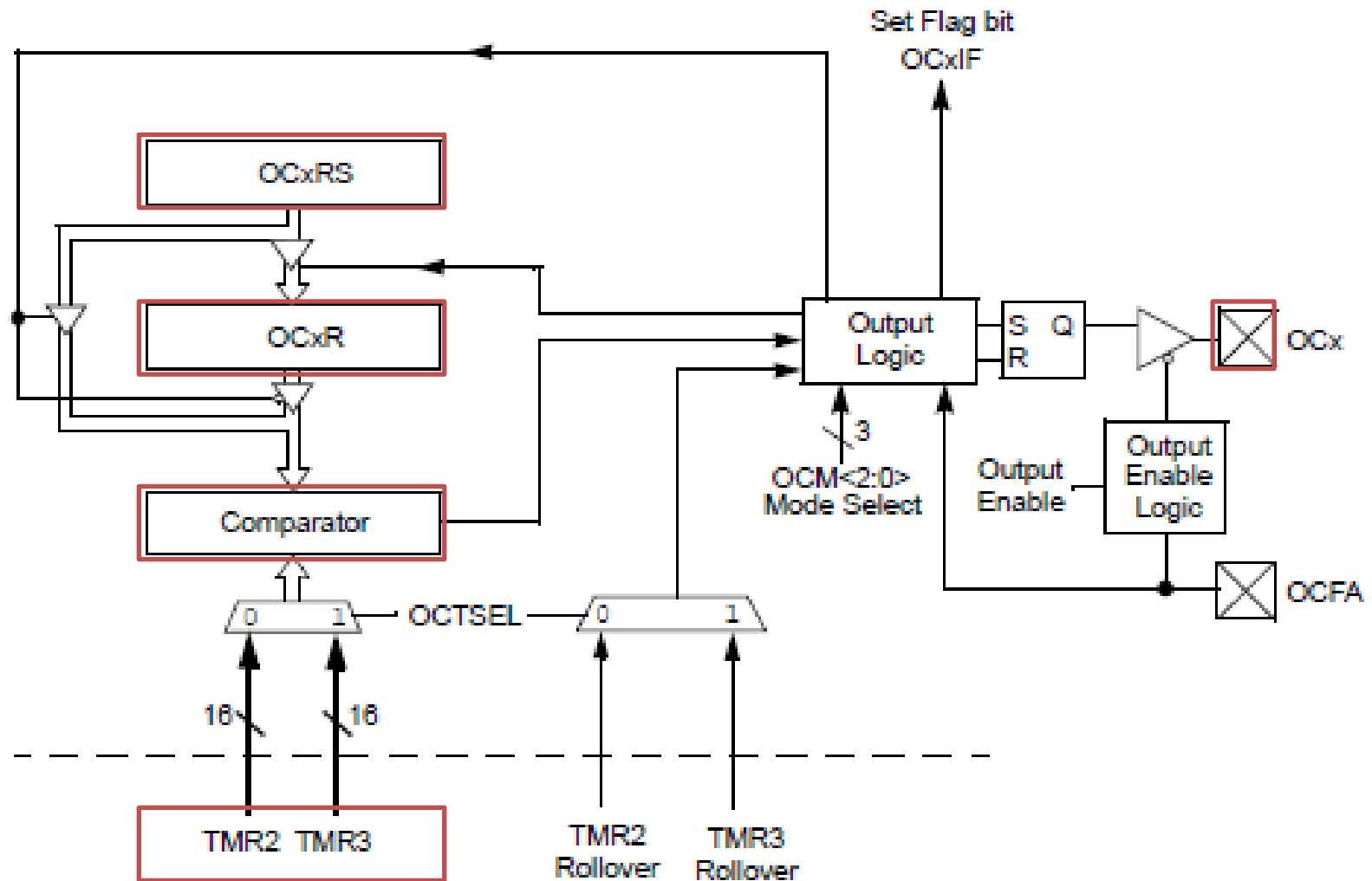
- Four Output Compare channels (pins) (OC1-OC4) or OCx, where $x = 1, 2, 3$ or 4
- Timer2 or Timer3 used with OCx modules
- Output Compare registers: OCxRS, OCxR
- Output Compare control registers: OCxCON

Output Compare Peripheral Basics

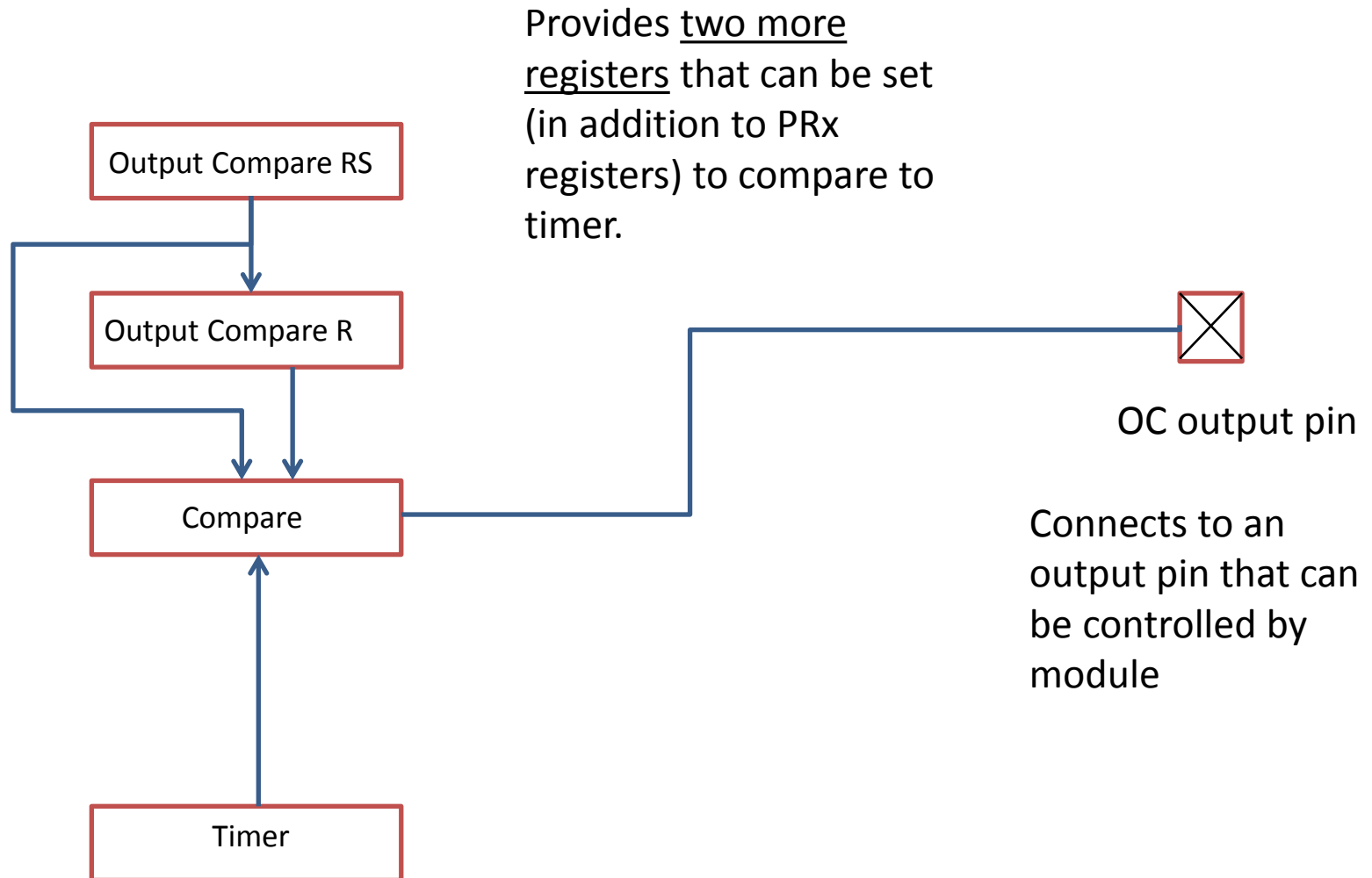
Provides a way to output waveforms on an output pin.



PIC24 Output Compare Peripheral



How it Works – The Basics



Output Compare Control Registers

REGISTER 15-1: OCxCON: OUTPUT COMPAREx CONTROL REGISTER (x = 1, 2, 3 OR 4)

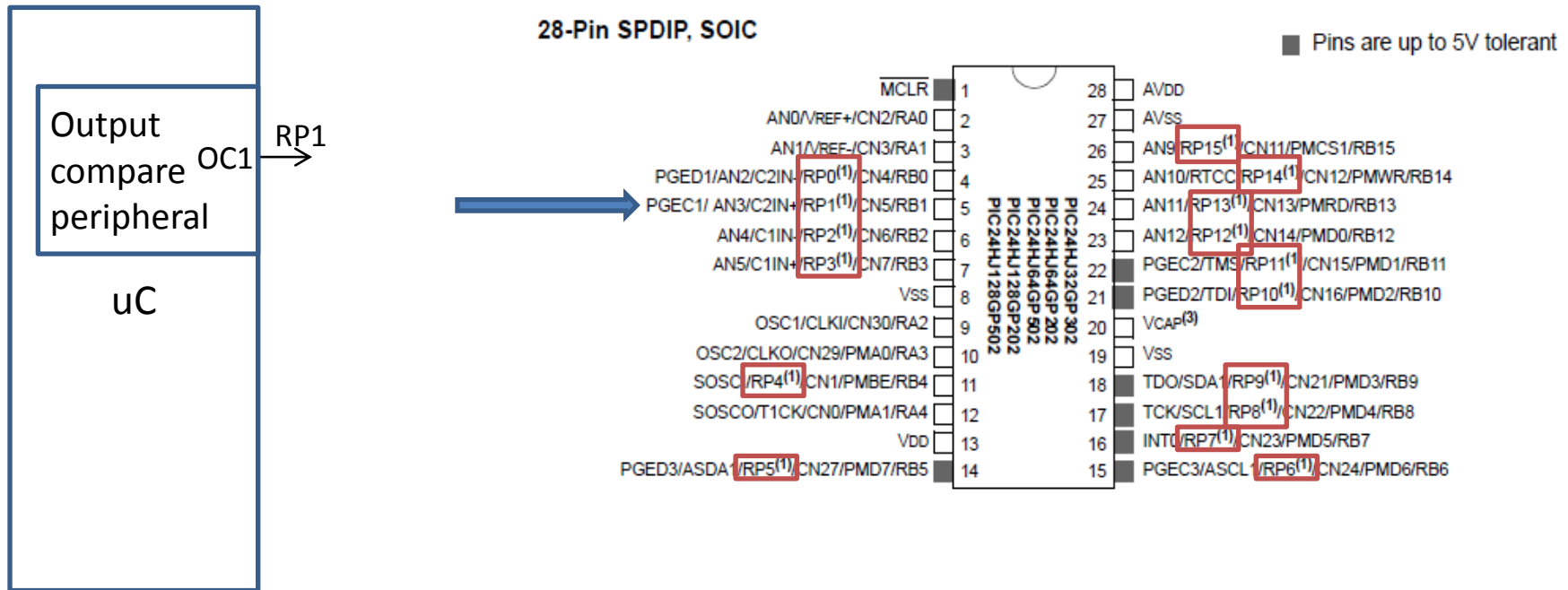
U-0	U-0	R/W-0	U-0	U-0	U-0	U-0	U-0
—	—	OCSIDL	—	—	—	—	—
bit 15						bit 8	

U-0	U-0	U-0	R-0 HC	R/W-0	R/W-0	R/W-0	R/W-0
—	—	—	OCFLT	OCTSEL	OCM<2:0>		
bit 7						bit 0	

- bit 13 **OCSIDL:** Stop Output Compare in Idle Mode Control bit
1 = Output Compare x halts in CPU Idle mode
0 = Output Compare x continues to operate in CPU Idle mode
- bit 4 **OCFLT:** PWM Fault Condition Status bit
1 = PWM Fault condition has occurred (cleared in hardware only)
0 = No PWM Fault condition has occurred
(This bit is only used when OCM<2:0> = 111)
- bit 3 **OCTSEL:** Output Compare Timer Select bit
1 = Timer3 is the clock source for Compare x
0 = Timer2 is the clock source for Compare x
- bit 2-0 **OCM<2:0>:** Output Compare Mode Select bits
111 = PWM mode on OCx, Fault pin enabled
110 = PWM mode on OCx, Fault pin disabled
101 = Initialize OCx pin low, generate continuous output pulses on OCx pin
100 = Initialize OCx pin low, generate single output pulse on OCx pin
011 = Compare event toggles OCx pin
010 = Initialize OCx pin high, compare event forces OCx pin low
001 = Initialize OCx pin low, compare event forces OCx pin high
000 = Output compare channel is disabled

Using Output Compare for PWM

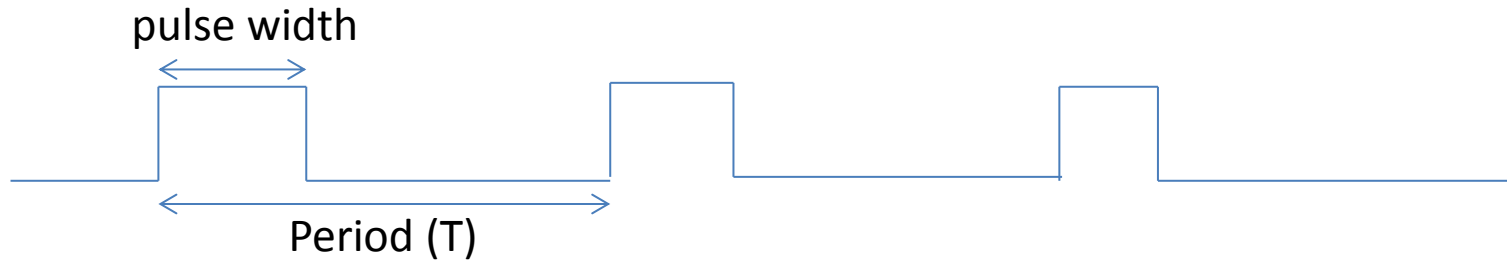
- Configuring OC1 to be connected to remappable Pin, RP1 (note RP1 same pin as RB1)



Use library macros to configure remappable pins:
`CONFIG_OC1_TO_RP(RB1_RP);`

Variable "duty cycle"

PWM Signal



Period is fixed.

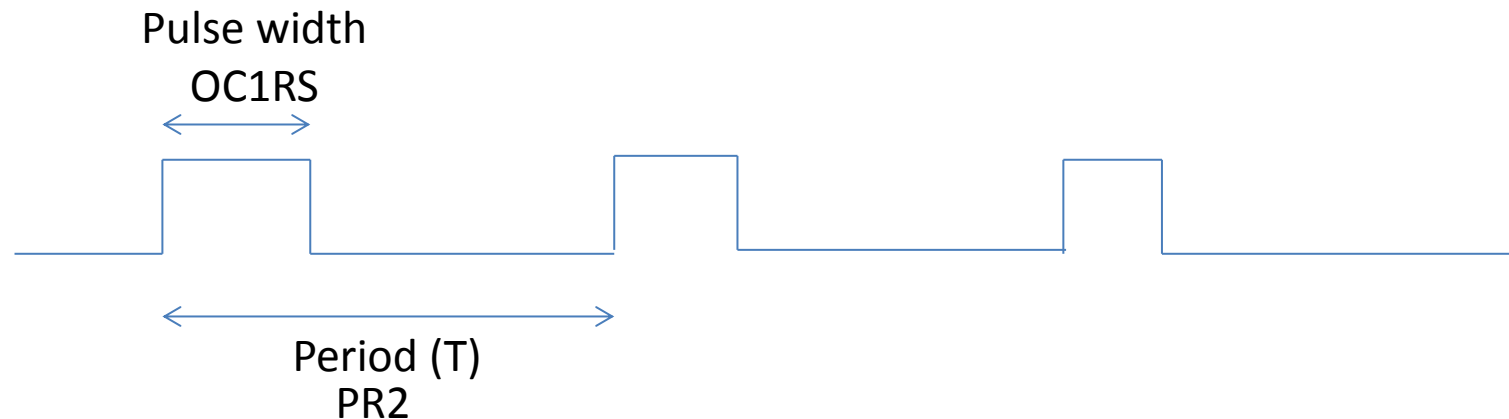
Pulse width varies.

Duty cycle is pulse width as percentage of period.

Average value of signal is proportional to duty cycle.



Output Compare and PWM



- Using OC1 as the PWM signal
- Using Timer 2 as the time base for OC1
- Use OC1RS to define the pulse width
- Use PR2 to define the period

Tasks for Exercise 5

1. Set up hardware – Logic Analyzer and Positional Servo Motor on pin 5 (RP1)
 - Battery pack powers servo
 - Common GND between PIC24 and Servo and Battery pack.
 - **Do NOT connect PIC24 Vdd (3.3V) to battery (6V)!**
 - Logic Analyzer pin assignments available in the Help – Contents – Appendix – Connector Pins

Tasks for Exercise 5

2. Calculate p_{\min} , p_{\max} . PWM_PERIOD in number of Timer 2 clock cycles (T_{ck})

- (what are these?)
 - Timer 2 Prescale set to 1:256
 - Timer 2 clock cycle: $T_{cy} = 6.4 \mu s$

3. Compose code

Code Steps – Program for Constant PWM

- Constant definitions (PWM_PERIOD, etc)
- Global variable for pulse_width
- Function configOC1() (steps given)
- Function configTimer2() (similar to EX4)
- ISR function for Timer 2 (similar to Ex4)
- Main program
 - Configurations
 - Enable Timer 2 interrupt and clear flag
 - Turn Timer 2 on
 - Set constant pulse_width
 - Infinite loop

Other Programs

- Program to continuously sweep pulse-width from p_{\min} to p_{\max} and back.

- Program to control Continuous Motion servo
 - Calibration program (1.5ms pulse)
 - Sweep from p_{\min} to p_{\max} and back.

References for Output Compare

P24HJ128GP502 Datasheet

- Available on Nexus
- Section 15 describes Output Compare

Output Compare Reference Manual

- Available on Nexus