Lab 8: Pulse Width Modulation

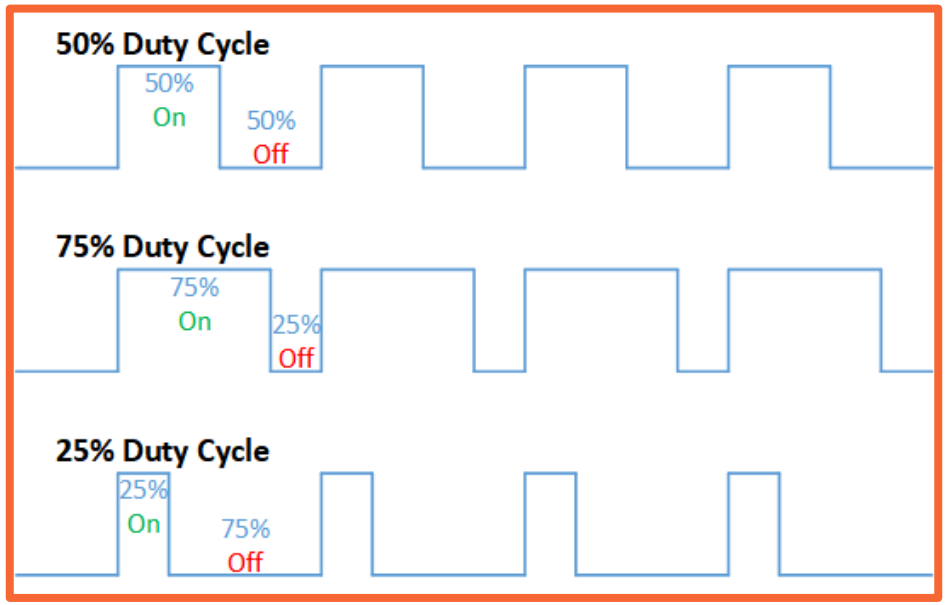
ECE 3720

Preview

The output compare peripheral will be used to produce a PWM signal to control the speed of a motor via a motor driver. A button-triggered interrupt will be used to select the duty cycle of the PWM signal.

Pulse Width Modulation (PWM)

- By turning a digital output on and off in a regular pattern, an average voltage can be produced that is proportional to the percentage of time the output is HIGH.
  - The percentage is called the duty cycle, as seen below.
- This is used to control the speed of DC motors, the position of servos, the brightness of LEDs, etc.



Output Compare (OC)

- The PIC32 does not have a dedicated PWM peripheral. However, the output compare peripheral can be used to generate PWM signals.
- Output compare works with the MC's timers to trigger an event at a specified point the timer's cycle.
  - Recall that the timer counts up in the TMRx register until it reaches the value in PRx.
  - Similarly, output compare triggers an event when TMRx matches OCxR

Registers:

- **OCxCON** (datasheet pg. 164)
  - Used to enable OC, select the timer, and select the mode of operation
- **OCxR**
  - Holds the value to be compared to TMRx
  - **Similar to PRx, this register should not be written to while the timer is running**
- **OCxRS**
  - Copies its value to OCxR when previous PWM cycle completes
  - **You should write the desired OCxR value here**

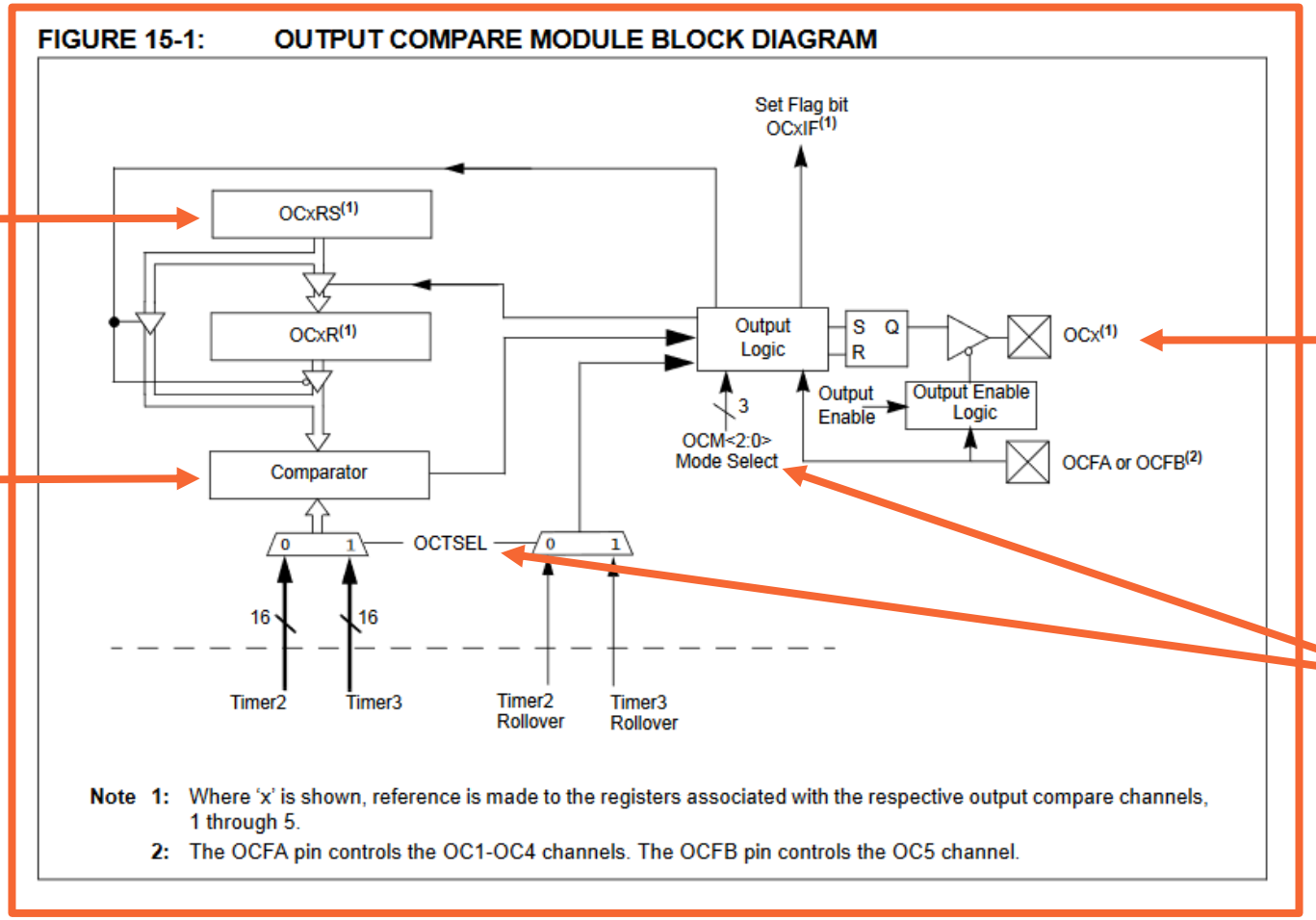
> The Output Compare module is used to generate a single pulse or a train of pulses in response to selected time base events. For all modes of operation, the Output Compare module compares the values stored in the OCxR and/or the OCxRS registers to the value in the selected timer. When a match occurs, the Output Compare module generates an event based on the selected mode of operation.

PIC32 datasheet, pg. 163

Output Compare Diagram

OCxRS is copied to OCxr

OCxR is compared to timer value



OC output can be mapped to a pin with PPS

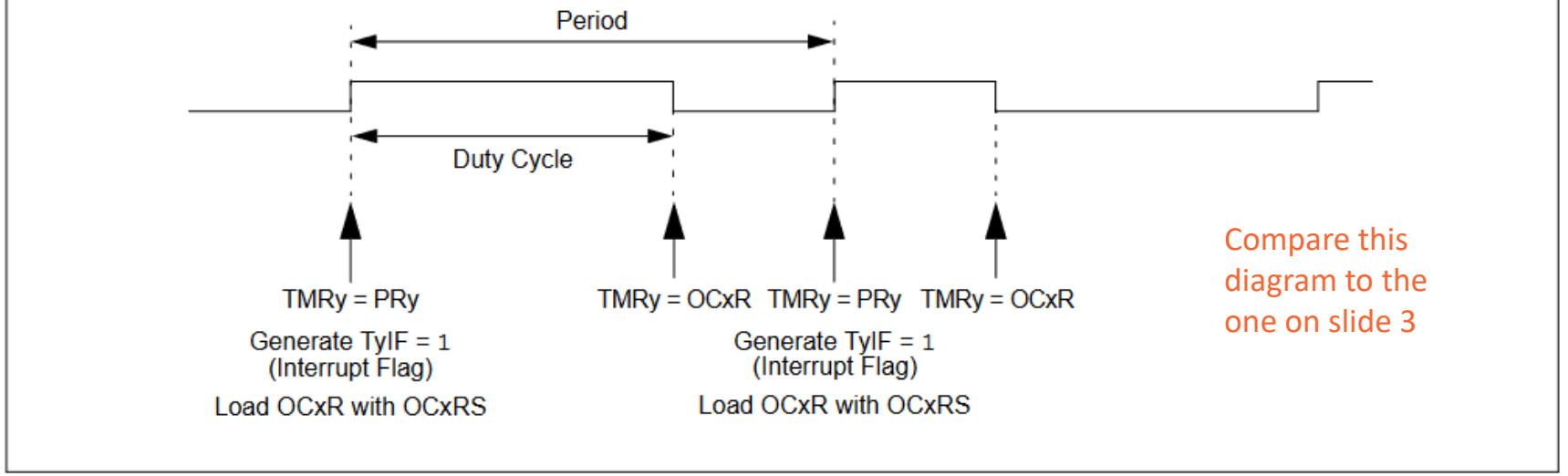
Values in OCxCON select timer and output logic

PIC32 datasheet, pg. 163

Using OC for PWM

- The OC's PWM mode can be selected in OCxCON. Note that we do not need fault detection for this lab.
- Use peripheral pin select (covered in Lab 6) to map OC's output to a pin.
- The diagram below illustrates how the timer and OC registers are utilized in PWM application.

Figure 4-17: PWM Output Waveform

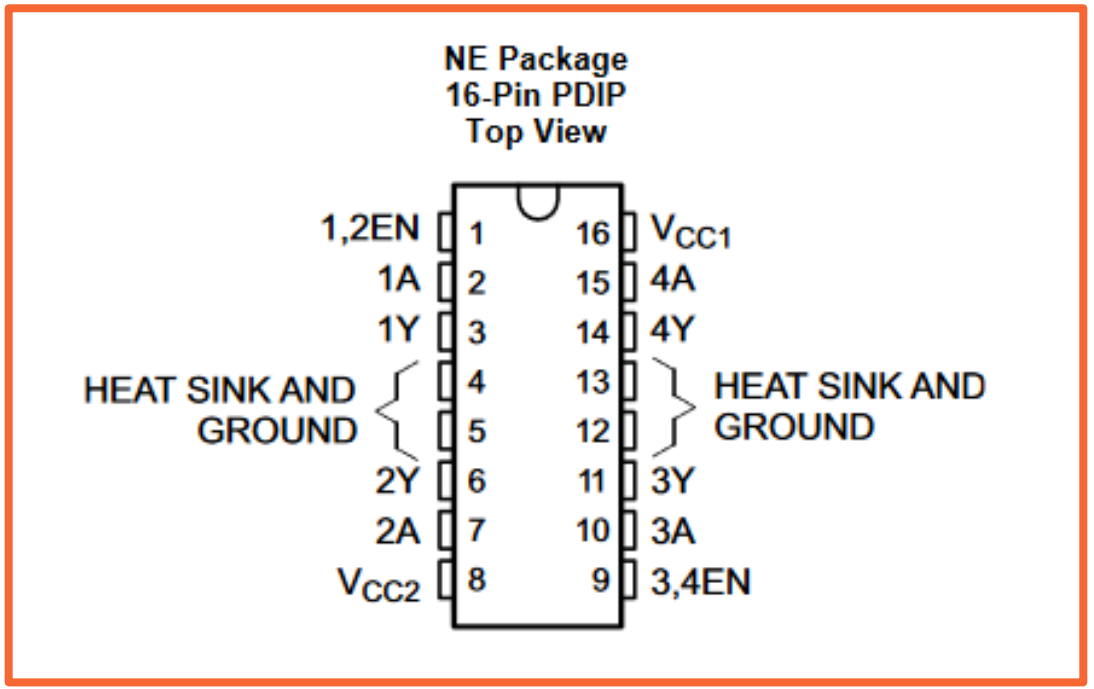


Compare this diagram to the one on slide 3

PIC33 Output Compare reference manual, pg. 26

L293DNE

- Datasheet available here
- Rather than attempt to drive a motor with the PIC32's limited output power, we use a motor driver IC.
- Power for the motor is supplied to the driver, while the MC provides the PWM input that will control the driver output and the motor's speed.
- **You should reference the pin descriptions on page 3 of the L293 datasheet, as well as the overview and functional block diagram on page 7.**



L293DNE datasheet, pg. 5

Lab Goals

- Set up the output compare and timer peripherals to output a PWM signal to the L293DNE.
  - OC should not be enabled before the timer.
  - Neither should be enabled until after its registers are set up.
- Wire the driver and motor as shown on page 7 of the L293 datasheet.
  - This will require the use of a diode.
- Set up an external interrupt to be triggered by a button.
- On each press of the button, the PWM duty cycle should increase by 25% .
  - When the duty cycle is at 100%, it should next go back to 0%.
  - Note that a duty cycle of 25% likely will not cause the motor to turn, but you should be able to hear it attempting to do so.

Simple Diagram