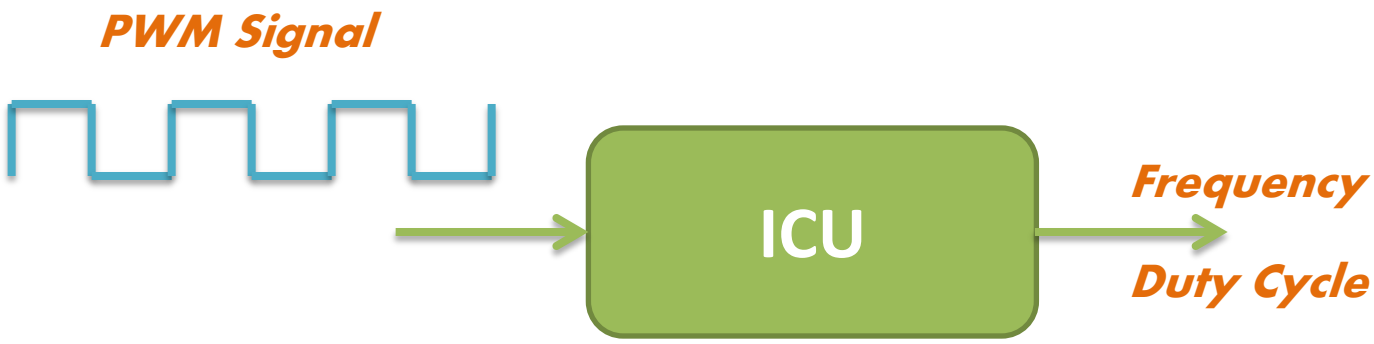
Embedded system interfacing

Lecture ten

Pulse Width Modulation

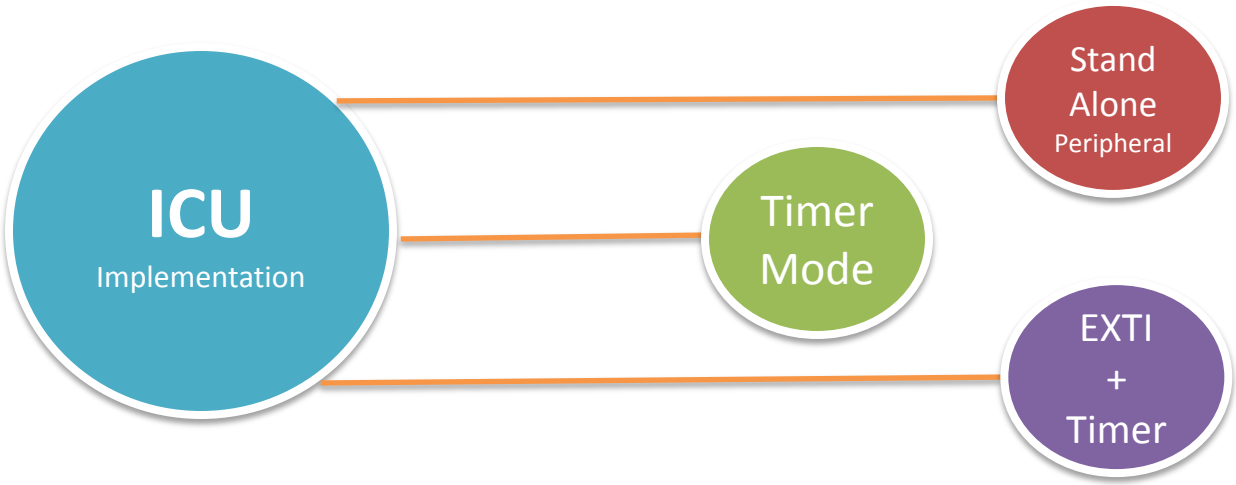
Input Capture Unit

The input capture unit (ICU) is a peripheral that used to identify the parameters of an input PWM signal. ICU receives an input PWM signal and detects its frequency and duty cycle.



ICU Implementation

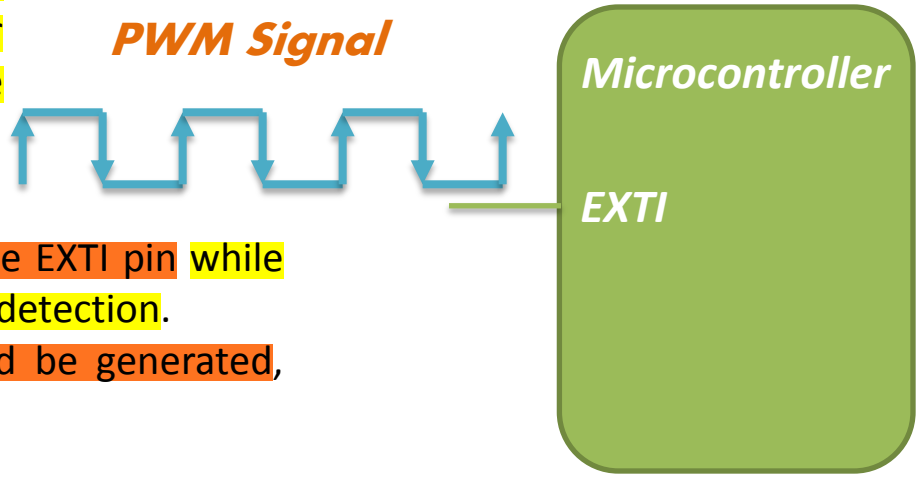
In the microcontroller world, the ICU may be a ***stand alone peripheral*** or a ***mode of a timer*** or it may be not exist. If the ICU peripheral is not exist in the microcontroller, we still can implement the functionality using ***External Interrupt Peripheral and Normal Timer***.



Input Capture Unit Implementation

Using EXTI + Timer

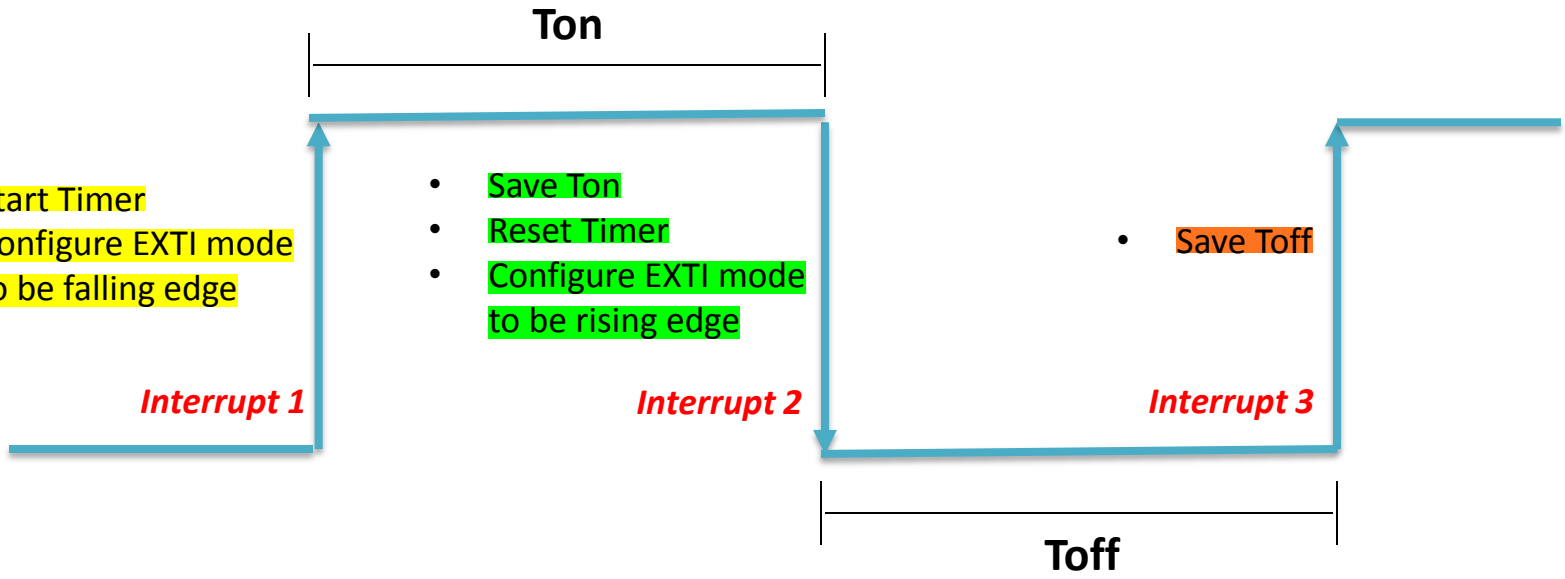
This method doesn't require a dedicated peripheral for the ICU, it uses a normal timer and a external interrupt peripheral with the following algorithm:



- Apply the PWM signal to be measure on the EXTI pin while configuring the EXTI mode to be rising edge detection.
- At the first rising edge, an interrupt would be generated, inside the ISR do the following:
  - Enable the timer to start count.
  - Configure the EXTI to detect falling edge
- With the falling edge, another interrupt would be generated, inside the ISR do the following:
  - Read the value of the timer and save it in a variable called Ton
  - Reset the timer to count from 0 again
  - Configure the EXTI to detect rising edge
- With the next rising edge, and interrupt would be generated, inside the ISR do the following:
  - Read the value of the timer and save it in a variable called Toff

Input Capture Unit Implementation

Using EXTI + Timer



$$\text{Signal Duty Cycle} = \frac{\text{Ton}}{\text{Ton} + \text{Toff}}$$

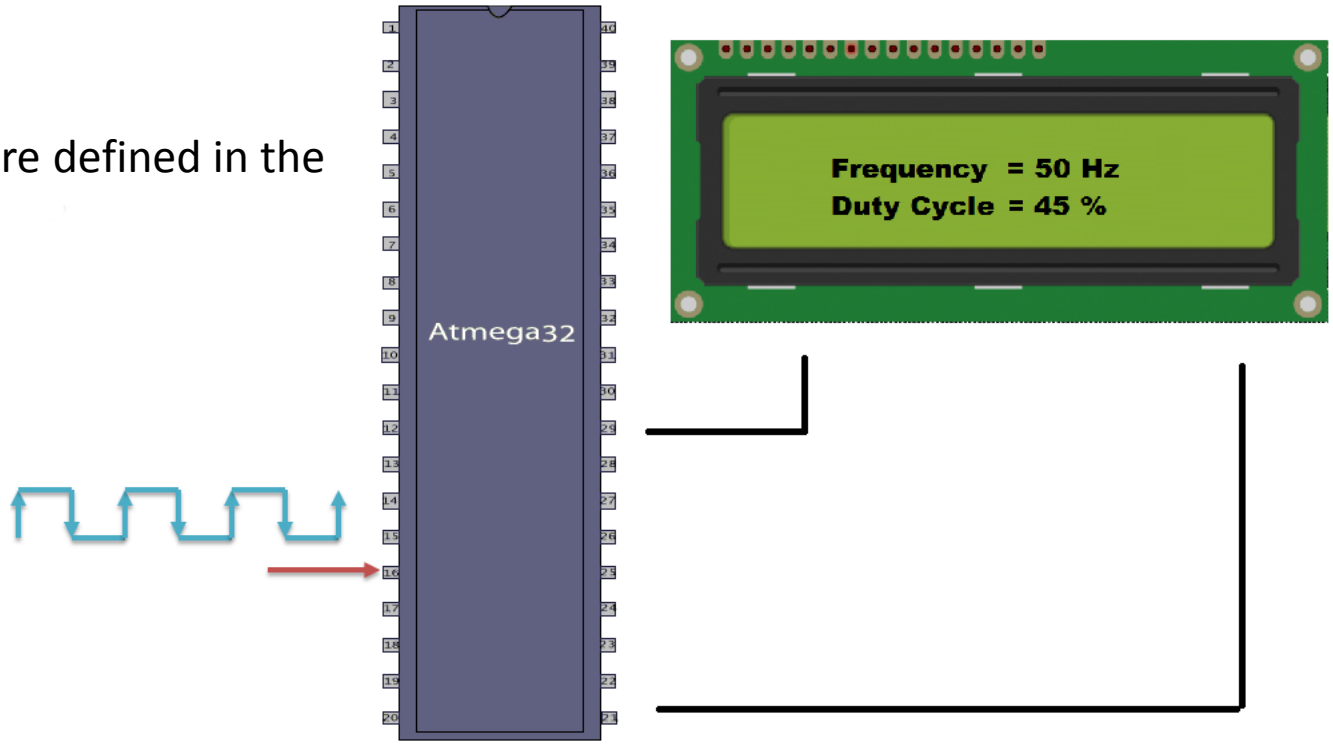
$$\text{Signal Frequency} = \frac{1}{\text{Ton} + \text{Toff}}$$

Lab 1

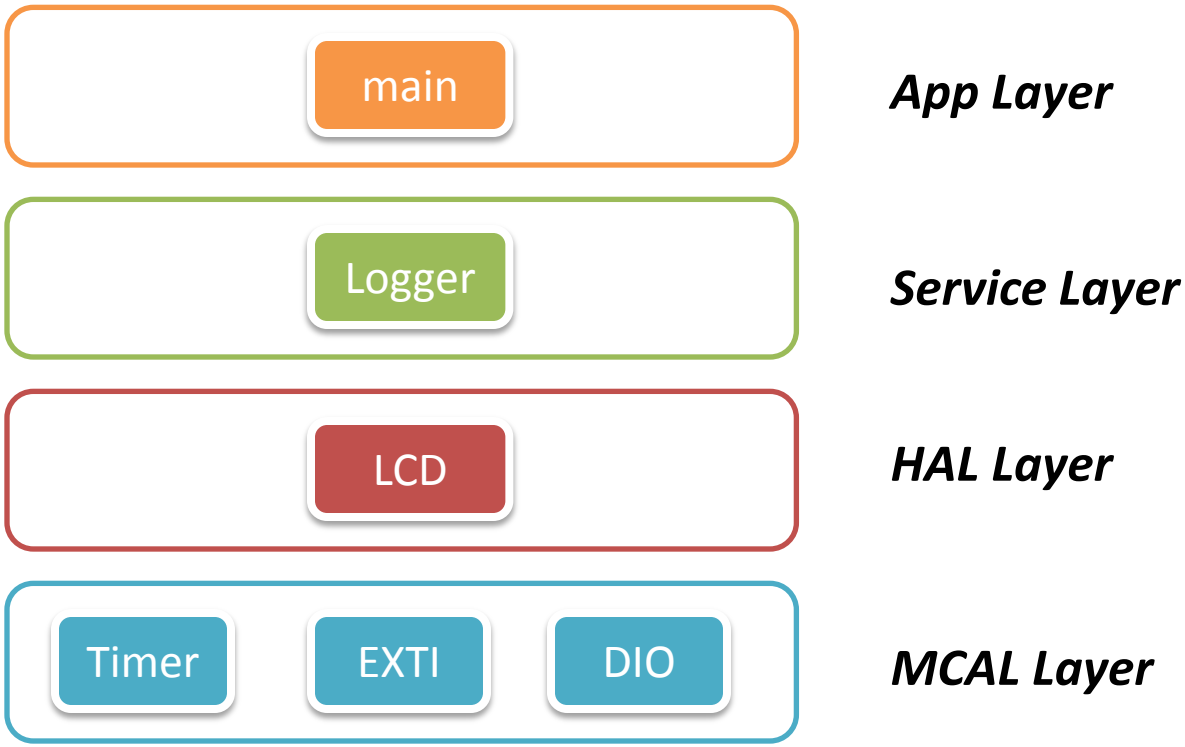
Implement a system that takes an input PWM and display its frequency and duty cycle on a character LCD. Use timer 1 and EXTI 0 of your atmega32 microcontroller to implement the ICU and use timer 0 to generate the PWM desired.

Note:

Use the architecture defined in the next page.



Lab 1


main
App Layer
Logger
Service Layer
LCD
HAL Layer
Timer
EXTI
DIO
MCAL Layer

Input Capture Unit Implementation

Using Timer 1 Mode

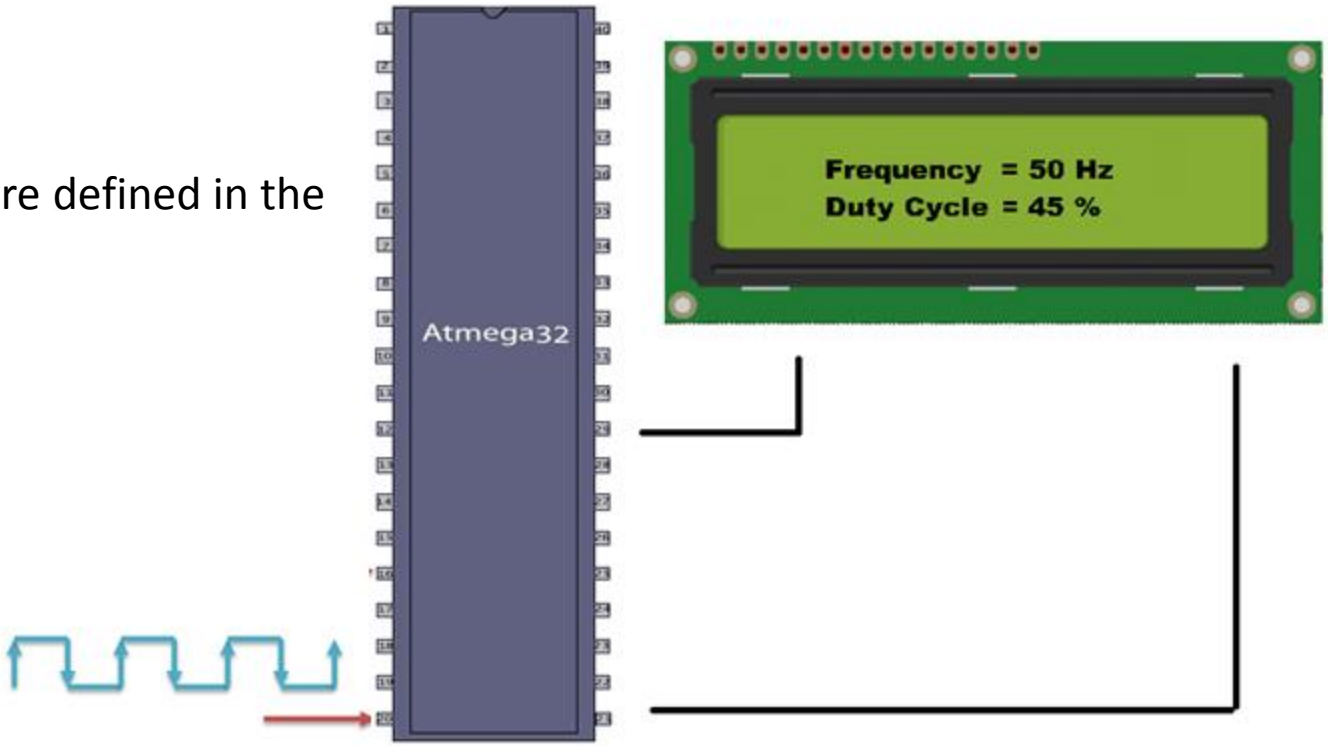
In AVR Atmega32 Microcontroller, there is no dedicated peripheral for ICU, but there is a mode in the timer 1 for ICU functionality, let's explore the datasheet.

Lab 2

Repeat the same previous lab but this time using timer 1 ICU mode

Note:

Use the architecture defined in the next page.



The End …

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