SNS COLLEGE OF ENGINEERING
(Autonomous)
DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Unit 2- ARM Processors and Peripherals

Timer Unit and Pulse with Modulation Unit

Timer Unit:

ARM microcontrollers and processors incorporate timer units within their peripherals to manage time-related operations such as creating delays, generating periodic interrupts, and measuring time intervals.

ARM systems typically include several types of timers, such as **SysTick Timer**, **General-purpose Timers**, **Watchdog Timers**, and **Low-Power Timers**, each with its own specialized function for different use cases in embedded systems.

ARM systems typically include several types of timers, such as **SysTick Timer**, **General-purpose Timers**, **Watchdog Timers**, and **Low-Power Timers**, each with its own specialized function for different use cases in embedded systems.

Common features of ARM timers include **pre scalers**, **auto-reload registers**, **interrupt handling**, and **capture modes**, providing flexibility in applications ranging from timekeeping to complex signal generation.

Timers/Counters: Timers and counters are designed for counting the PCLK (peripheral clock) cycles & optionally produce interrupts based on 4-match registers.

This LPC2148 microcontroller has two timers or counters. These timers are 32 bit and are programmable with 32bit pre scaler value as well as it also has one externa l event counter.

Each timer has four 32bit capture channels which take the snapshot of timer value during the transition of any input signal.

With the help of this capture event the interruption could be also generate.

Watchdog Timer LPC2148 microcontroller contains watchdog timer is used for resetting the microcontroller in a reasonable sum of time.

When it is allowed then the timer will produce a reset of a system if the consumer program does not succeed to reload the timer in a fixed sum of time

RTC-Real-time Clock The RTC in LPC2148 is intended for providing counters to calculate the time when the idle or normal operating method is chosen.

The RTC uses a small amount of power and designed for appropriate battery power-driven arrangements where the central processing unit is not functioning constantly.

Power Control

- These microcontrollers support two condensed power modes such as power-down mode and idle mode. In Idle mode, instructions execution is balanced until an interrupt or RST occurs.
- The functions of peripheral maintain operation throughout idle mode & can produce interrupts to cause the CPU to restart finishing. Idle mode removes the power utilized by the CPU, controllers, memory systems, and inner buses.
- In power down mode, the oscillator is deactivated and the IC gets no inner clocks. The peripheral registers, processor condition with registers, inner SRAM values are conserved during Power-down mode & the chip logic levels output pins stay fixed.
- This mode can be finished and the common process restarted by specific interrupts that are capable to work without clocks. Because the chip operation is balanced, Power-down mode decreases chip power utilization to almost zero

Timer Event Handling:

1.Overflow/Underflow:

1. Most timers will generate an interrupt when they overflow or underflow. For example, a 16-bit timer might overflow when it reaches its maximum value (65535), and a 32-bit timer might overflow when it reaches 4294967295.
2. Timers in **down-counting mode** will generate an interrupt when they reach zero.

2.Match/Compare Events:

1. When the timer's counter reaches a specific value in the compare or match register, a specified action can be triggered, such as an interrupt or a PWM signal.

3.PWM Generation:

1. Timers are often used to generate PWM signals. By adjusting the match values (thresholds) and the counter’s period, you can generate signals with varying frequency and duty cycle.

Timer Clock Source:

System Clock:

- Most timers use the system clock (also called the core clock) as their main clock source. The system clock frequency is typically set by the microcontroller’s oscillator or PLL (Phase-Locked Loop).
- The system clock is the fastest available clock in the system, and timers count based on this clock.

External Clock:

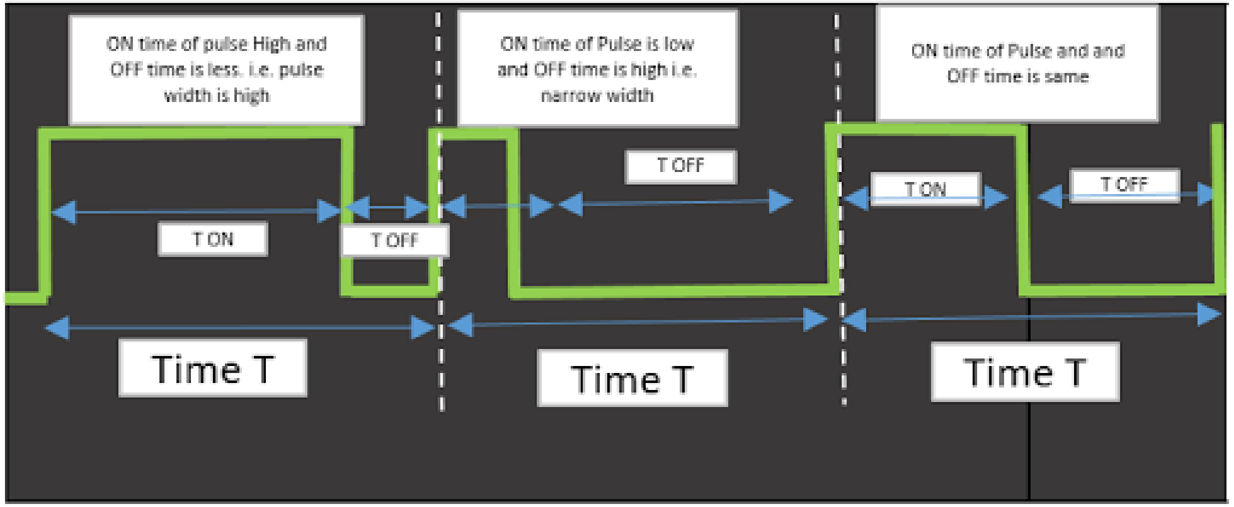
- Some timers can use an external clock source, such as a crystal oscillator or an external clock signal (e.g., from another device or sensor).
- This is useful in applications where precise time measurements are needed, or where the microcontroller needs to synchronize with external events.

Low-Speed Oscillator (LSO):

- Certain ARM-based microcontrollers support low-frequency oscillators (e.g., 32.768 kHz crystals) to provide a lower power consumption clock source for certain timers like RTCs

Pulse width modulation Unit

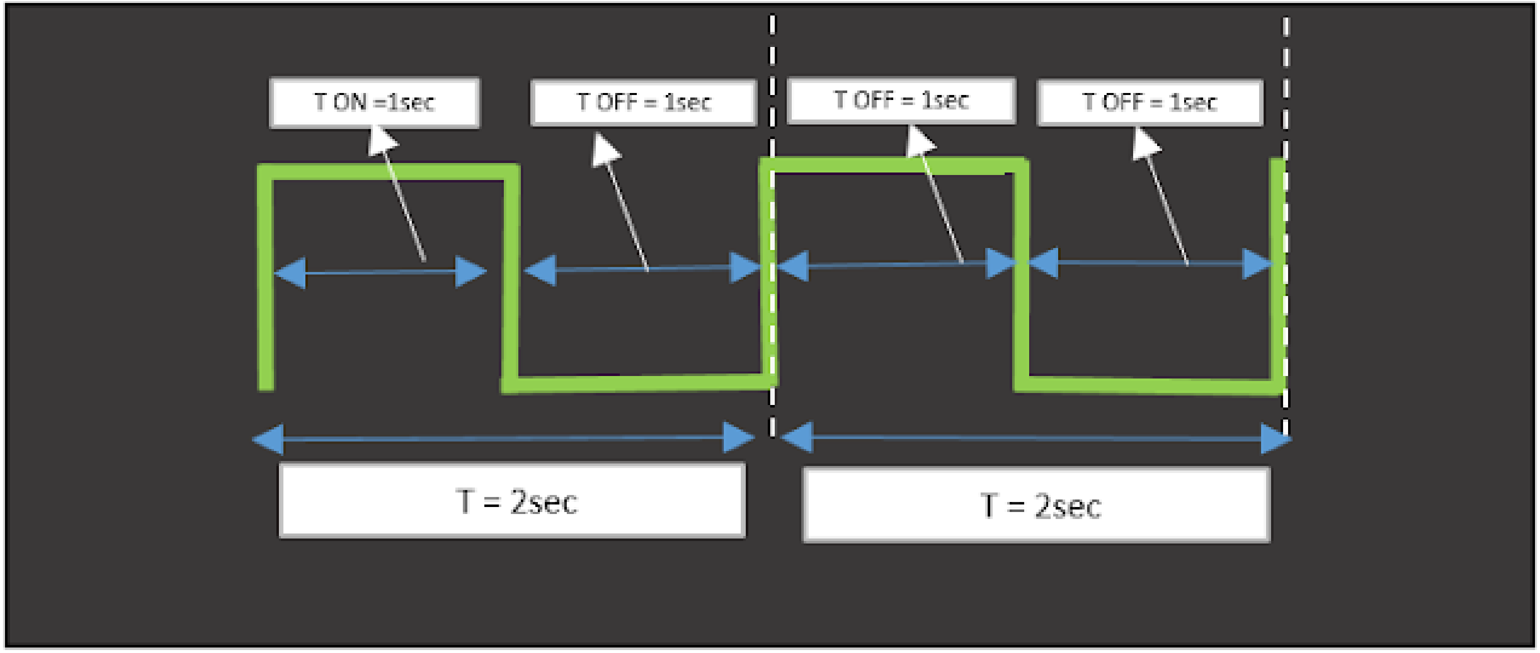
Full form of PWM is **pulse width modulation**, i.e. in PWM **width of the pulse is varied by keeping period of pulse constant.**



PWM pulse has ON time i.e. TON and OFF time i.e. TOFF. ON time is time for which PWM pulse is high and OFF Time is time for which PWM pulse is low. In PWM we can change time duration of TON or TOFF and hence width of the pulse is varied but period of pulse is constant i.e. T(Period of pulse)= TON+TOFF.

- Consider PWM pulse with TON=1 sec and TOFF =1sec. Period of Pulse is TON+TOFF = 1sec +1sec = 2sec. i.e. frequency of PWM pulse is 0.5 Hz

- Now you can change TON and TOFF like :
  TON = 1.5 sec and TOFF=0.5 sec by keeping period of pulse unchanged i.e. T=2sec
  TON = 0.5 sec and TOFF=1 sec. by keeping period of pulse unchanged i.e. . T=2sec



What is Duty Cycle :

Now variation of TON and TOFF can be measured by **duty cycle** :

Duty cycle(%) = (TON/(TON+TOFF))*100

i.e. duty cycle represents, for how much time pulse is high, out of total pulse period.

So ,

50% duty cycle means TON= 1sec and TOFF = 1sec

75% duty cycle means TON= 1.5sec and TOFF = 0.5 sec

25% duty cycle means TON= 0.5 sec and TOFF = 1.5sec

Calculation of TON and TOFF based on Duty Cycle :

Consider above example, P**WM with frequency of 0.5Hz** and **duty cycle is 10%** then

10% duty cycle means TON is for 10% period and TOFF is for 90% period

i.e. 10%2 sec = 10/100*2 sec = 0.2sec TON
90%2 sec = 90/100*2 sec = 0.8sec TOFF

TON = 0.2sec and TOFF= 0.8sec

What is frequency of PWM :

Frequency of PWM is calculated as Fpwm = 1/(TON+TOFF).

What is the use of PWM?

PWM is used to control analog circuit digitally (as PWM is digital) Now in real life you can control LED brightness using PWM which shows a micro-controller connected to LED. PIN to which LED connected is having PWM functionality i.e. output of PIN is PWM. Now we will see how brightness of LED is controlled by PWM.

PWM is digital pulse and lets consider voltage of PWM is 5V or 0V i.e. digital 1 or digital 0 (Vout of PIN is 5V or 0V). Consider 0% duty cycle, 25% duty cycle,50% duty cycle and 100% duty cycle, as shown in figure

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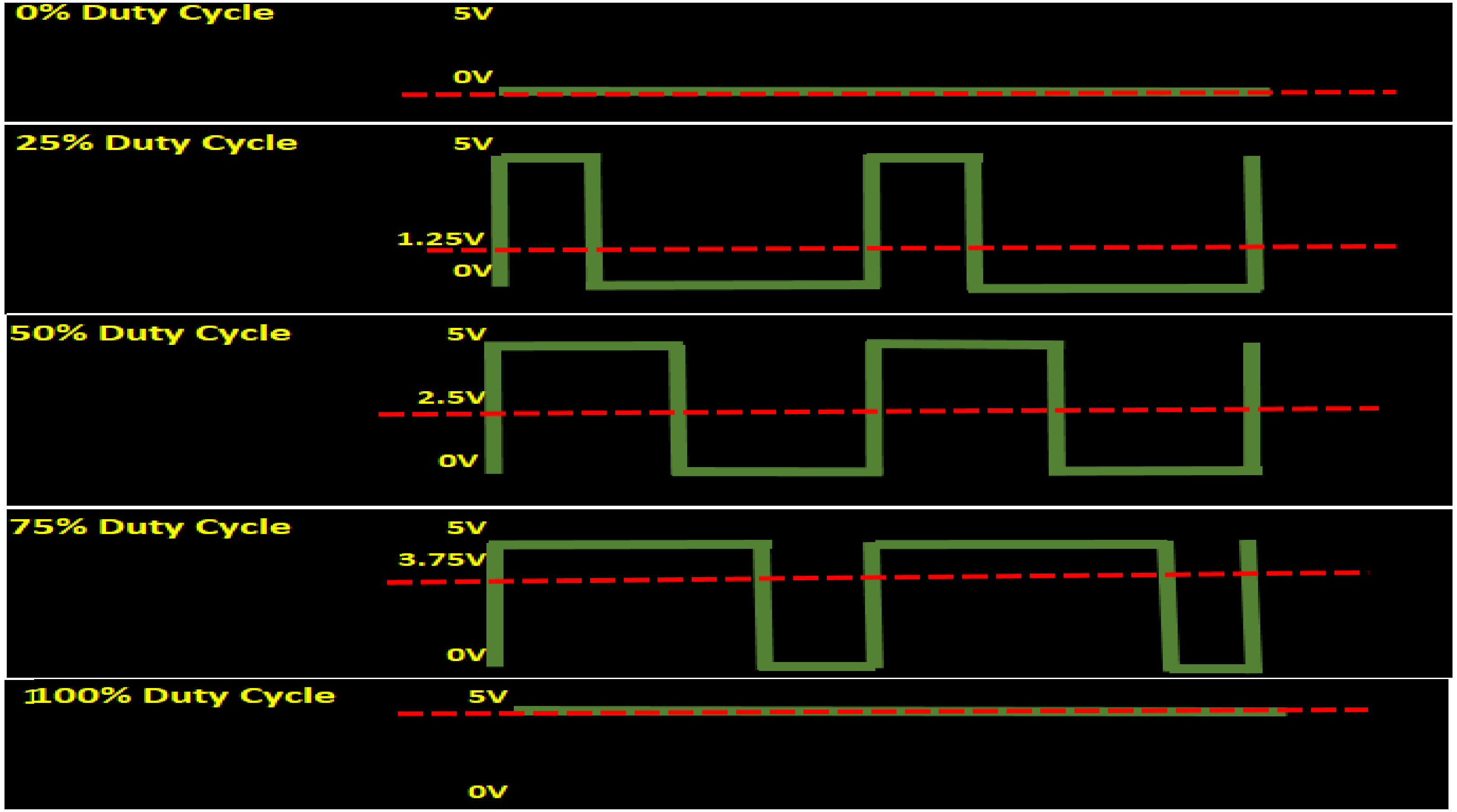

By applying PWM pulse to LED, an Average Voltage is applied to LED. **Average voltage of PWM wave is shown by dotted line. Average Voltage :**

Vout(Average Voltage) = Vmax*duty cycle.

Vmax is 5V (maximum output voltage of MCU Pin)

PWM duty cycle kept as 0% **then Vout (Average Voltage) = 5*0/100 = 0V**

PWM duty cycle kept as 25% **then Vout (Average Voltage) = 5*25/100 = 1.25V**

PWM duty cycle kept as 50% **then Vout (Average Voltage) = 5*50/100 = 2.5V**

PWM duty cycle kept as 75% **then Vout (Average Voltage) = 5*75/100 = 3.7.5V**

PWM duty cycle kept as 100% **then Vout (Average Voltage) = 5*100/100 = 5V**

LED brightness can be controlled using PWM by varying duty cycle i.e. by varying average out voltage.

Thank you