

Introduction to Pulse Width Modulation (PWM)

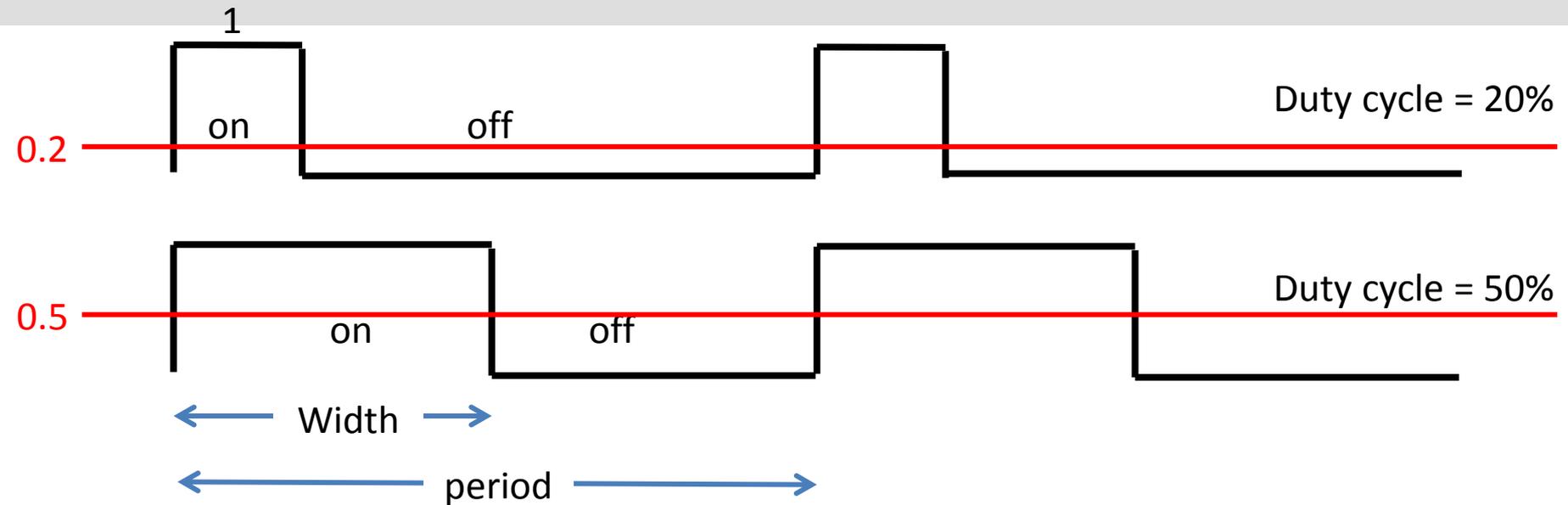


What is PWM

- Output signal alternates between on and off within specified period.
- Control the power received by a device.
- The voltage seen by the load is directly proportional to the source voltage.

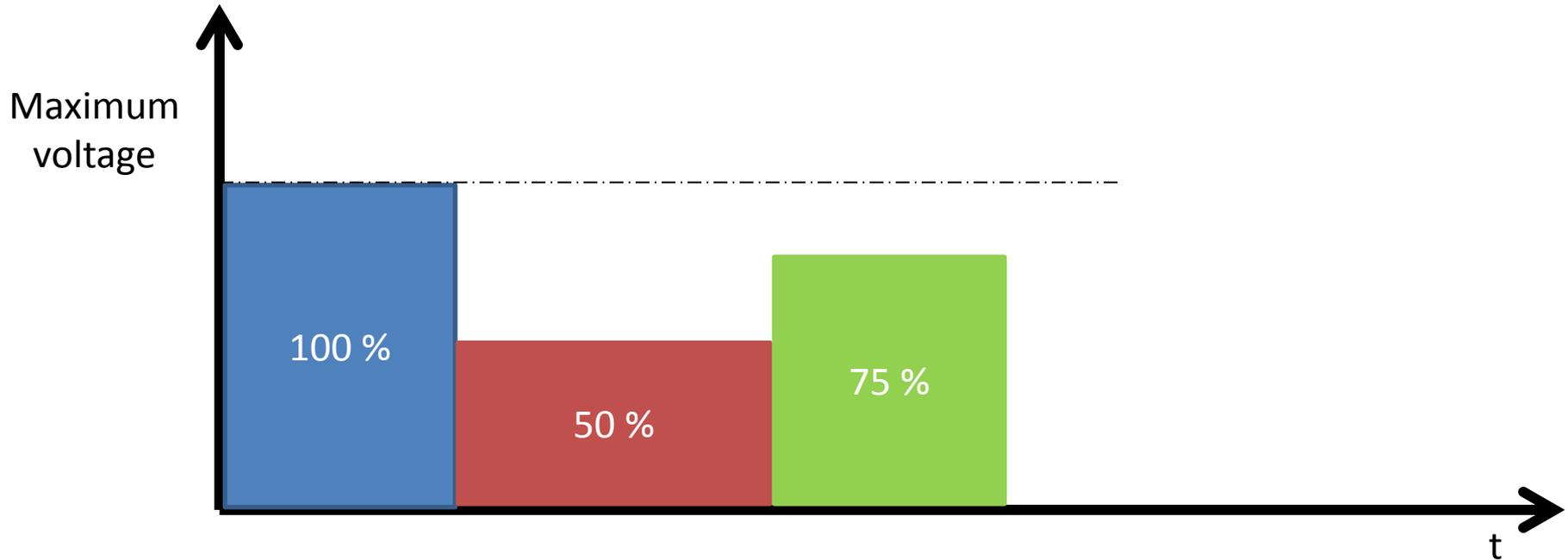


What is PWM?



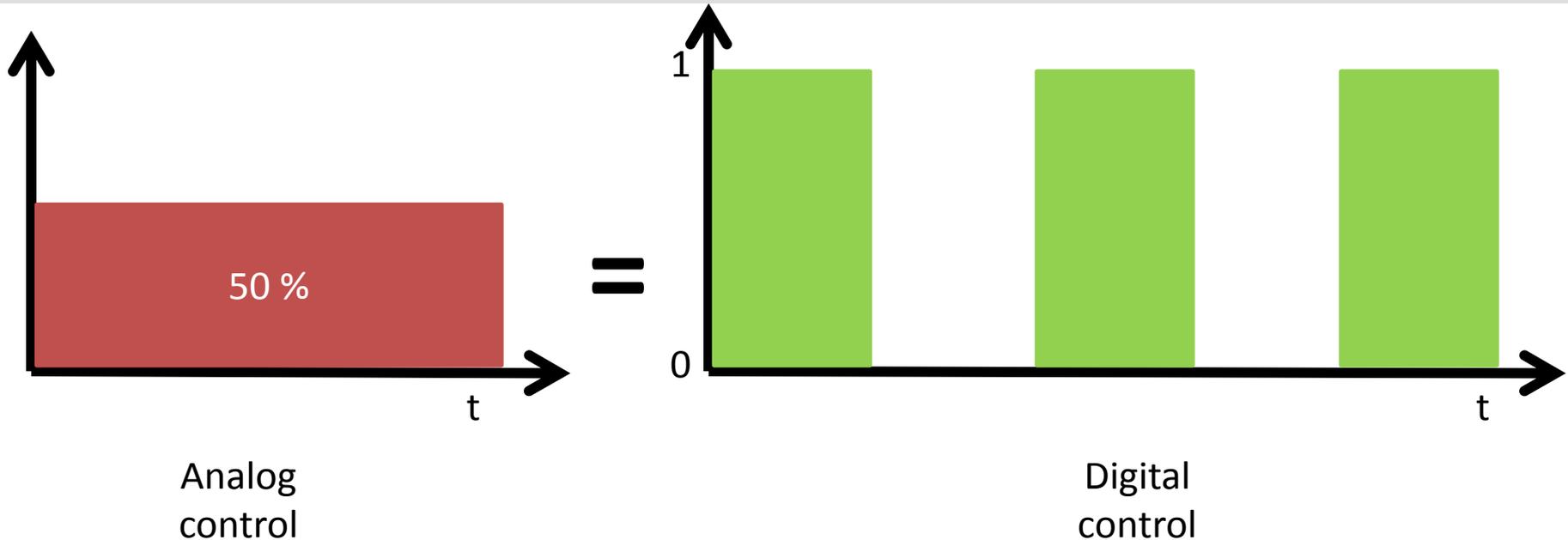
- Depending on the requirement the width of the pulse is modulated (adjusted).
- Duty cycle = $t_{\text{on}} / (t_{\text{on}} + t_{\text{off}})$.

Why PWM?



- Analog voltage control:
 - Voltage can be changed to control the motor speed
 - Can NIOS change voltage ?

Why PWM?



- Digital voltage control:
 - Can only control '1' and '0'
 - $X\%$ of maximum analog voltage = $X\%$ of duty cycle

PWM Control Example

- Disco gate:
 - 100 % open gate = 10 persons per second
 - 50% open gate = 5 persons per second
- Analog control:
 - Open 50 % gate
 - Total how many people can go in 10 seconds?
- Digital control:
 - Open 100 % gate on every odd second (1,3,5,7,9, ..)
 - Total how many people can go in 10 seconds?



Usage of PWM

- Motor Control
- Intensity of LED



How to generate PWM signal ?

■ Software method

○ Using counter

- Count to 100 in a loop
- Set the output value to 1 in the beginning of the loop
- Set the output value to 0 as soon as the counter reaches the value of required duty cycle.
- Continue the process

○ Using interrupt

- Home work
- Think about the concept



Questions



Your tasks

- Create projects in a usual way using provided SOPCINFO file.
- Type the code in your application project.
- Change duty cycle variable and observe the effect on oscilloscope or LED.
- Using oscilloscope, verify the duty cycle.
 - Is it precise?
 - Is it efficient?



Software PWM

- Output pin:
 - GPIO_0[10]
 - Using the manual find out the correct pin and observe the resulting PWM on the oscilloscope
 - In C program, use the following instructions to change the output
 - `IOWR(PWM0_BASE, 0, 0); // set output 0`
 - `IOWR(PWM0_BASE, 0, 1); // set output 1`
- Control LED (optional):
 - Apply the PWM signal to LED, observe the intensity



You are 25 % engineer **ALREADY** !

- Start doing things on your own
- Use Google, dictionary to find a solution
- Try hard, do not give up to be an expert engineer
- **I am sure, you all are very hard working and intelligent. You can do the job.**
- **If you have problems call us**



Questions

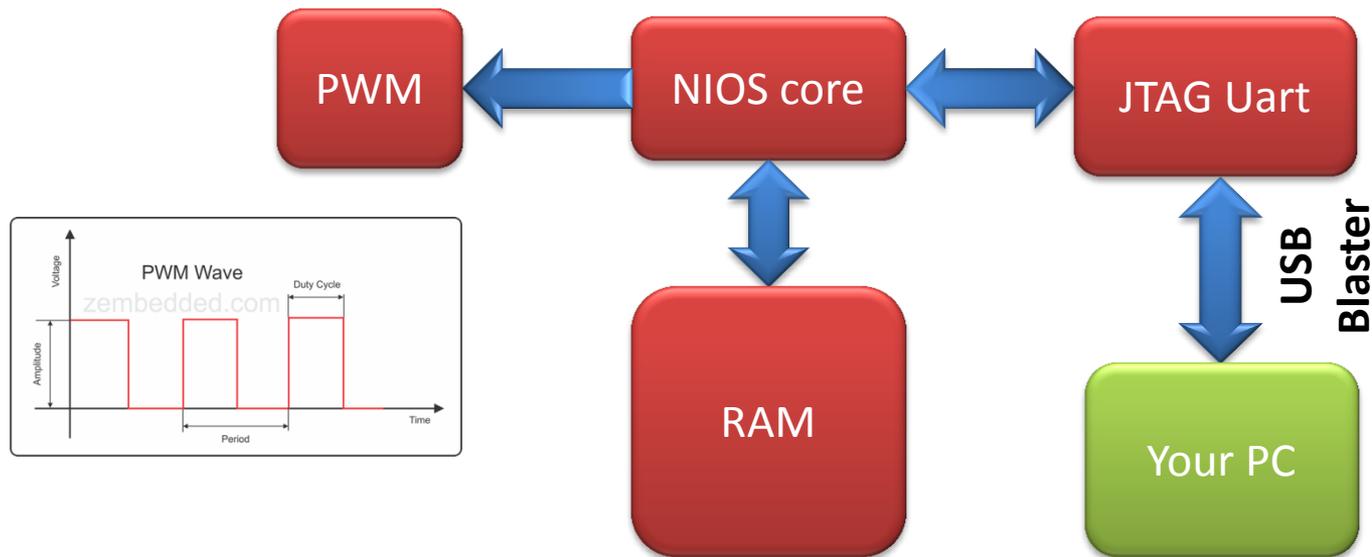


Hardware PWM IP

- Let us use the NIOS processor as a boss
 - Does a boss do work by her/himself?
 - The boss only manages/guides/controls the people to do the job
- Highest smartness is required in managing people
 - *Do not think that your boss is an idiot !* 
 - Why the bosses have highest salary world-wide?
- *Career tip:*
 - Let only people/machines/tools/computers do your job
 - Learn to manage them to get more salary



Hardware PWM IP



- Programmable/configurable
- Precise
- A good obedient, the boss can *RELAX!!!*

Hardware PWM IP

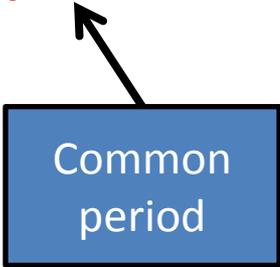
- Follow the simple use sequence
 - Enable
 - Configure
 - Modify
 - Disable
- Only one function for controlling two PWM signals
`motor_setting(phase1, duty1,
 phase2, duty2,
 period, enable);`



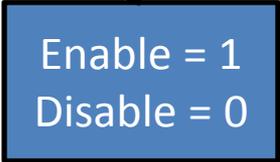
Hardware PWM IP

```
motor_setting(phase1, duty1,  
              phase2, duty2,  
              period, enable);
```

Common
period



Enable = 1
Disable = 0



Questions

