Introduction to Pulse Width Modulation (PWM)
What is PWM?

- Depending on the requirement the width of the pulse is modulated (adjusted).
- Duty cycle = \( \frac{t_{on}}{t_{on} + t_{off}} \).
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
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
Your tasks

- Create projects in a usual way using provided SOF and SOPCINFO file.
- Type the code in your application project.
- Change duty cycle variable and observe the effect LED, and test it on the car.
- You will get such message when you open the SOF file
  - Click OK
After programming the FPGA, you will get this warning

- **DO NOT** click cancel