Lab 8: Rotary Dial and PWM Signals

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Lab 8: Rotary Dial and PWM Signals

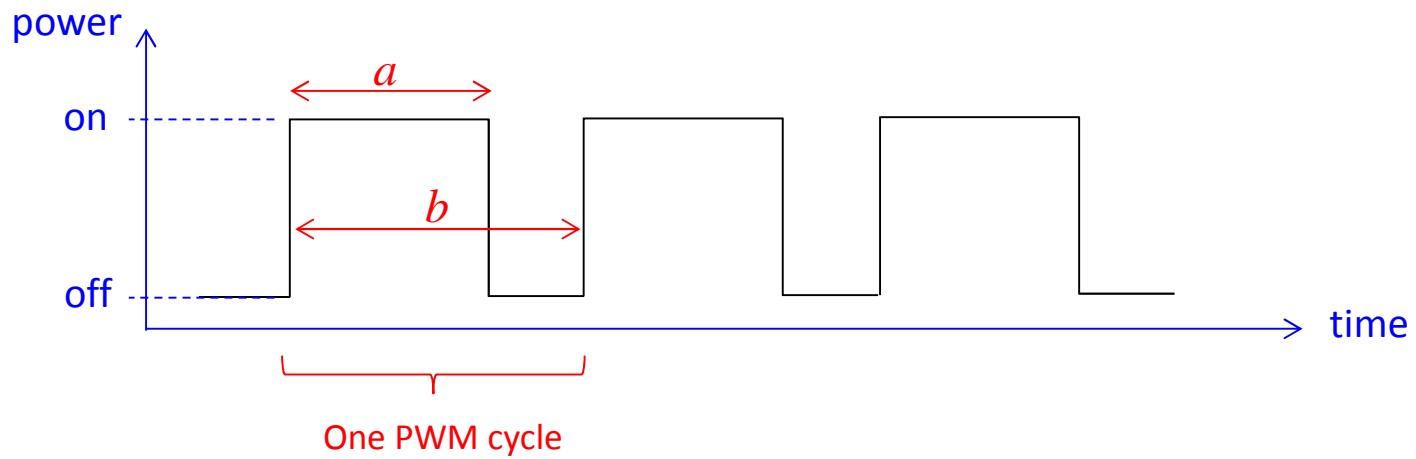
- In this lab, you will design a circuit to control the brightness of the LEDs through the rotary dial
- You will demo the design to your TA during the lab hours on 11/30

Control of LED Brightness

- The LED device in the Spartan-3e Starter Board can only be fully lit (full power) or turned off (zero power), you can not set it to different levels of brightness
- To trick your eyes to see different levels of brightness, you can send a Pulse Width Modulation (PWM) signal to its power input
  - The PWM signal will turn the LED on-an-off quickly such that the persistence of human visions will not see any flickering but different levels of brightness

A PWM Signal

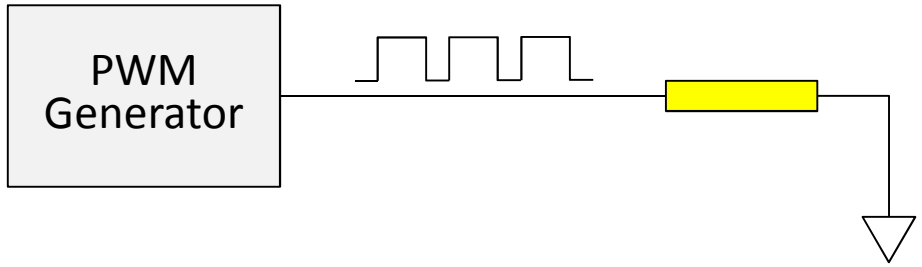
- A PWM signal is simply a square wave signal:



- Duty-cycle: the percentage of one cycle of PWM that is in "on" state (i.e., $(a/b)\times 100\%$ in the figure)
  - 50% duty-cycle means the signal is "on" half of the time

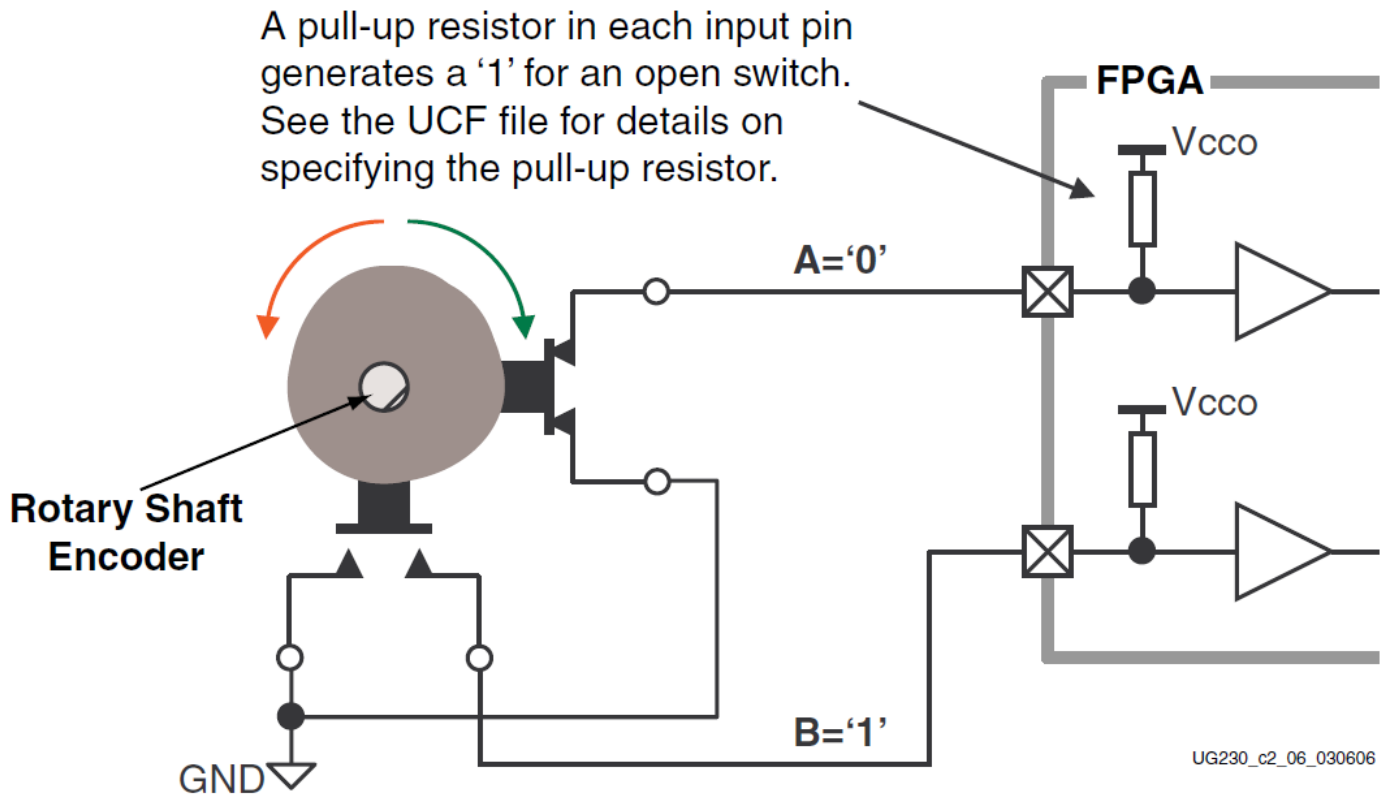
PWM Control of Brightness

- Persistence of visions make most people do not see flickering when the LCD is switching faster than 60 Hz
- We can use a 60 Hz (or higher) PWM signal to control the brightness of an LED
  - The PWM duty cycle determines the brightness of the LED
  - If you see flickering, raise the frequency to, say, 120Hz



Rotary Dial Control

- There is a rotary dial on the Spartan-3e board:

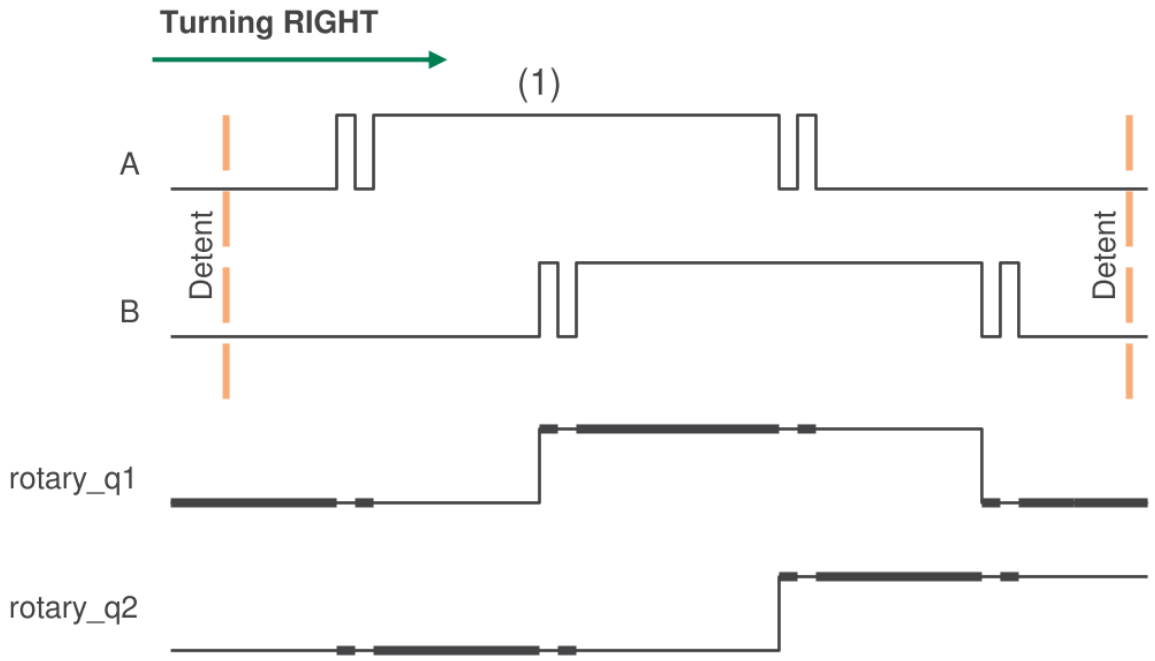


Rotary Controller

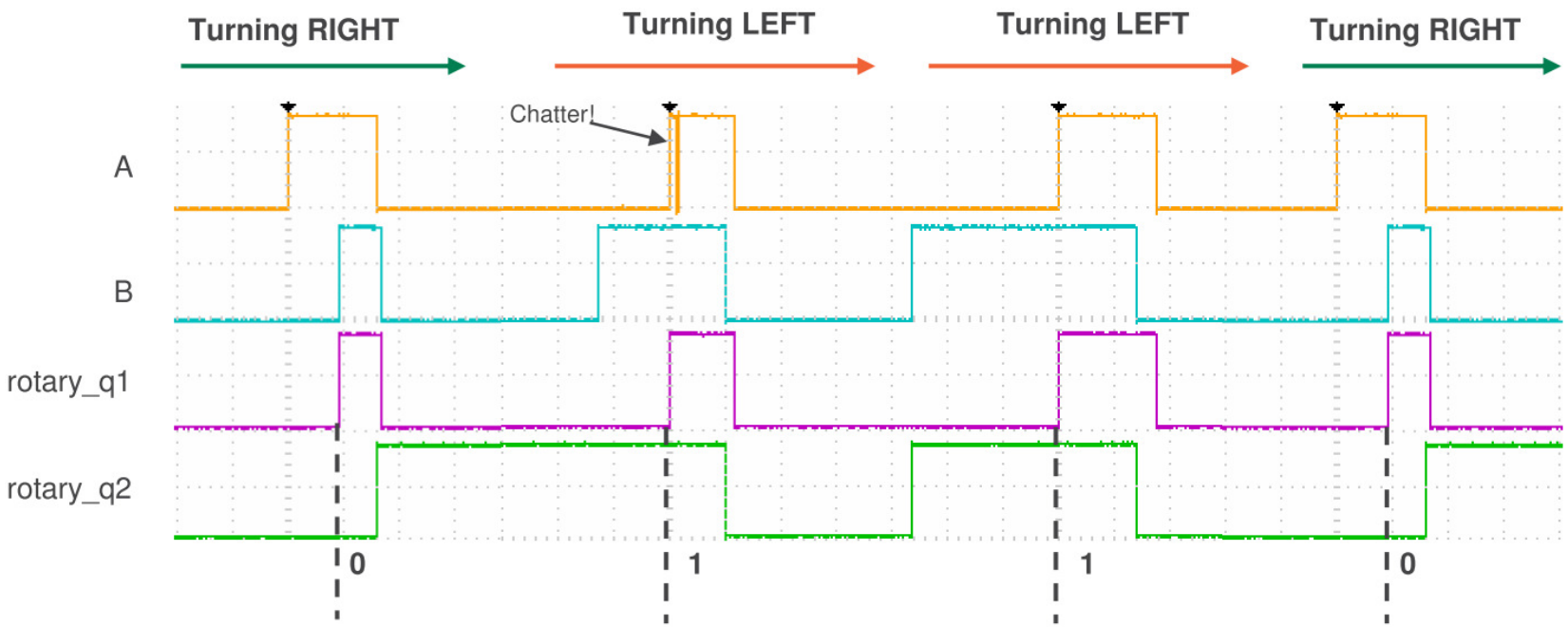
- A rotary controller module will be provided to you:

rotary_q1
Set ('1') when A is High and B is High
Reset ('0') when A is Low and B is Low.

rotary_q2
Set ('1') when A is Low and B is High
Reset ('0') when A is High and B is Low.



Rotary Controller Waveform Examples



Rotary Controller Specification

- The controller module has five ports:

```
module Rotation_direction(
    input CLK,
    input ROT_A,
    input ROT_B,
    output reg rotary_event,
    output reg rotary_right);
```

  - `CLK` is the 50MHz system clock
  - `ROT_A` and `ROT_B` are the two ports connect to the rotary pins
  - `rotary_event == 1` means the user is turning the rotary
  - `rotary_right == 1` means turning right, 0 means turning left

What You Need to Do for Lab 8

- Design a circuit to read the rotary input and use it to control the duty cycle of the PWM signal that feed to LED 4
  - At reset, the duty cycle set to 0%
  - Turn rotary right increase the duty cycle (hence the brightness)
  - Turn rotary left decrease the duty cycle
  - The duty cycle falls between 0% to 100%
- You must make your brightness control as smooth as possible

References

- Ken Chapman, *Rotary Encoder Interface for Spartan-3E Starter Kit*, Feb. 2006:
  - http://www.xilinx.com/products/boards/s3estarter/files/s3esk_rotary_encoder_interface.pdf