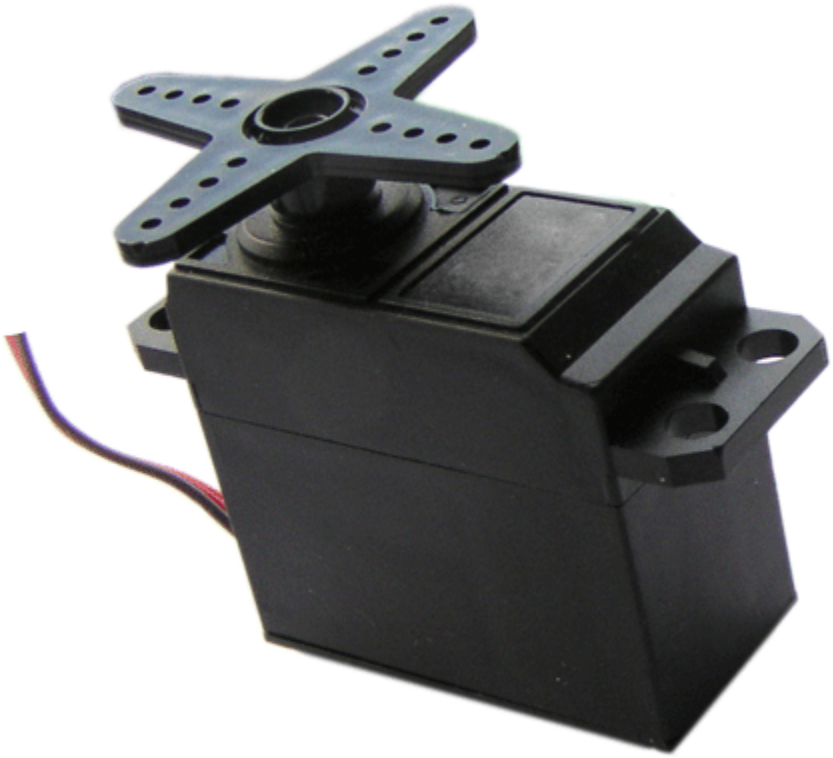
TTK4155

Industrial and Embedded Computer Systems Design

NTNU – Trondheim
Norwegian University of
Science and Technology



Lab lecture 6

- Controlling a servo
- Detecting lost ball

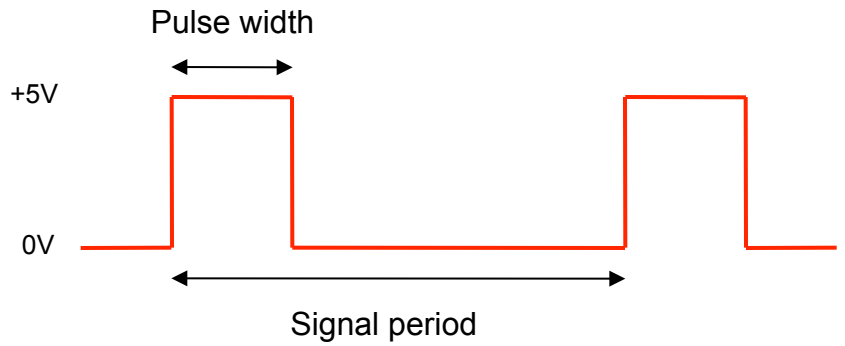
Exercise 7: Controlling servo and IR

- In this exercise you will
  - Use the ATmega128 to generate a PWM signal to control a servo
  - Use the joystick to control the pulse width of the PWM
  - Read the signal from an IR photo-diode
  - Detect when the IR-beam is blocked and count the score

Pulse Width Modulation (PWM)

- A way for the MCU to generate an analog voltage
- Used a lot within motor control since it enables maximum torque with low speeds

- Signal period
- Pulse width
- Duty cycle

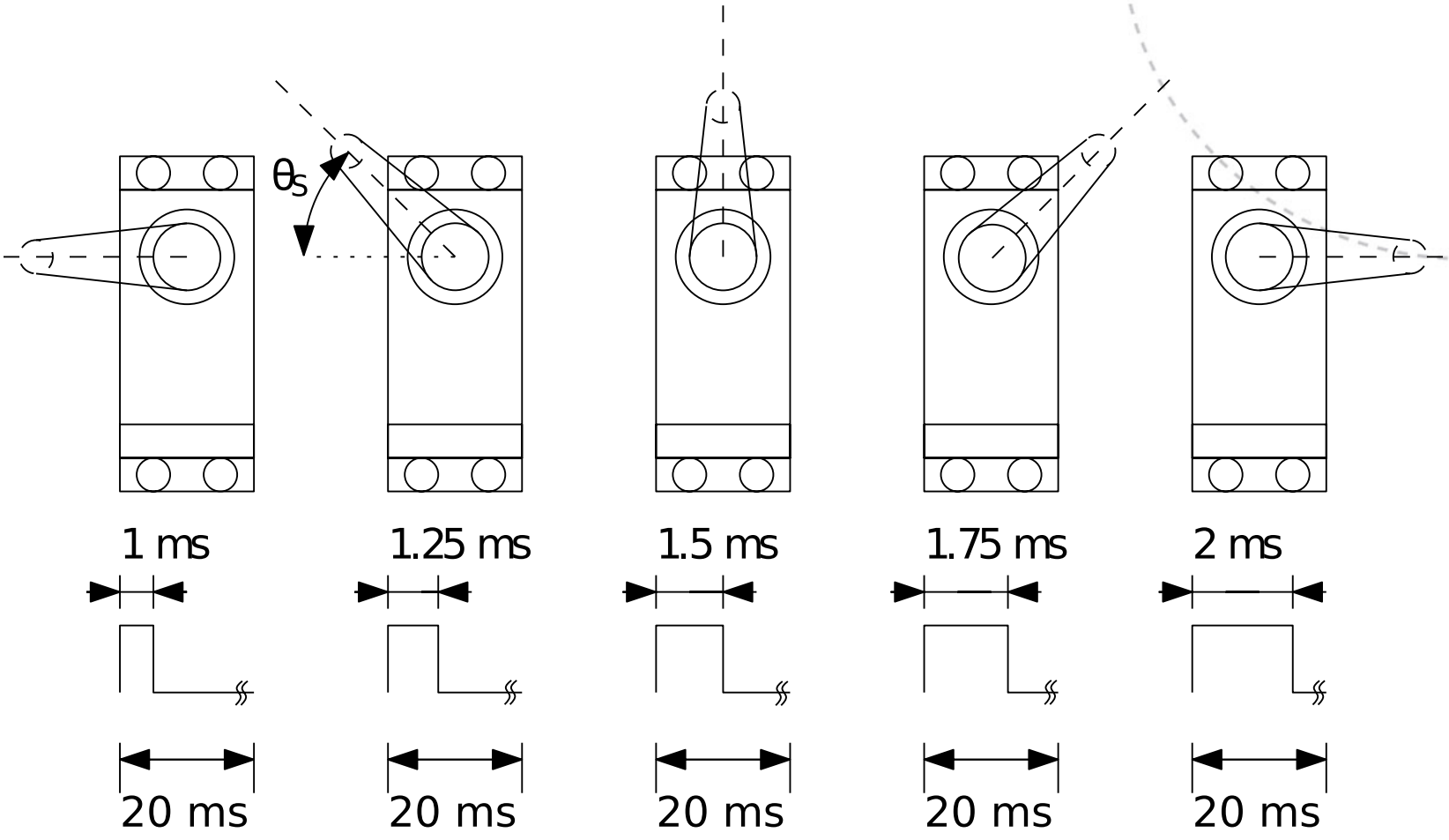


Duty cycle = Pulse width/Signal period

- Average voltage = 5V · Duty cycle

Controlling the servo

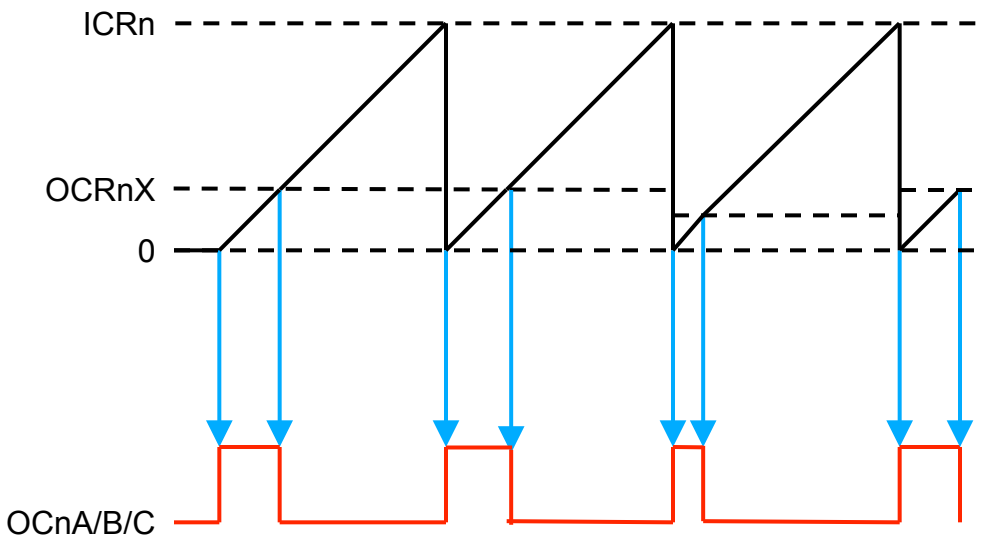
- The servo is controlled using a 50 Hz signal (signal period = 20 ms)
- The angle of the servo is determined by the pulse width (1.5 ms corresponds to centre position)
- By varying the pulse width we can control the angle
- The pulse width must never be outside the range 0.9-2.1 ms
- Make sure your driver complies with the spec before connecting the servo



How to generate a PWM signal

- 8-/16-bit timers/counters clocked internally via prescalers
- These count independently of the processor
- One of many possible applications is PWM

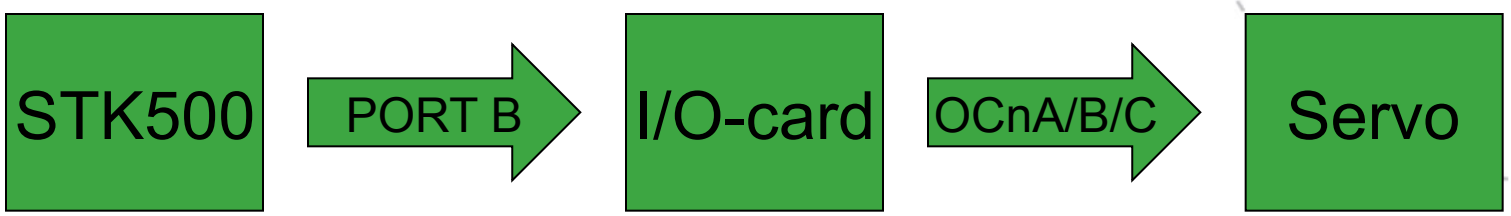
PWM

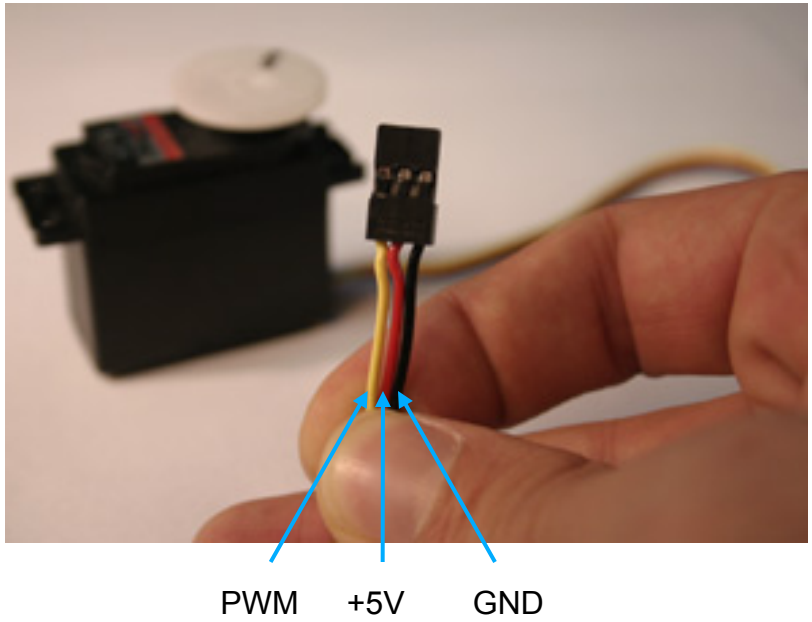


Get the right pulse width and period

- Why use prescaling?
  - 16 bit timer → largest value in top register = $2^{16} - 1 = 65\,535$
  - Largest period = 65 535 · 1/8 000 000 sec = 0,008192 sec
  - Choose a prescaler and a top value that gives a period > 0,020 sec
- Use mode 14 in table 61

Connecting the servo





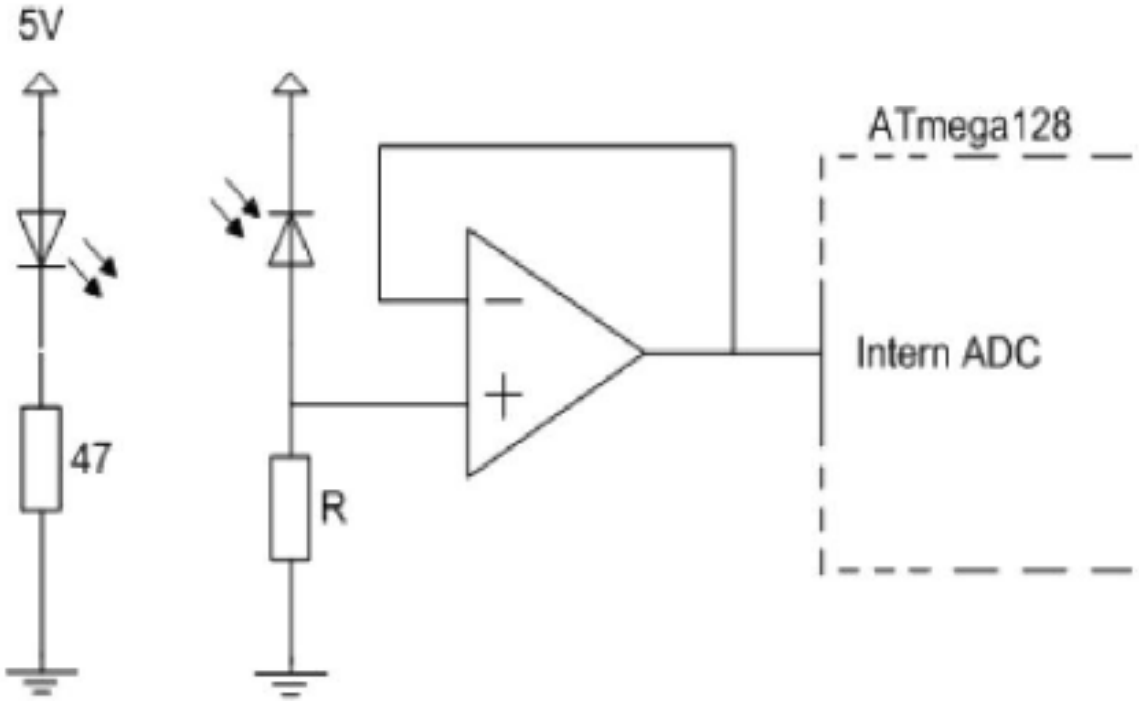
IR

- IR diode (sender)
- IR photo-diode (receiver)
- The current through the photo-diode is dependent on the amount of light received
- To measure the current, we need a resistor to measure the voltage over
- Choose the resistor value based on the information given in the photo-diode's datasheet

Connecting the IR circuitry

- Use the small bread-board
- Use a voltage follower (op amp)
- Connect it as close to the photo-diode as possible to increase immunity to noise
- Use the internal ADC on the ATmega128
- Check that the IR diode is working using a digital camera (e.g. mobile phone)

Schematic



Internal ADC

- 10-bit resolution
- 8 available channels on Port F
- Use AVCC as reference
- Use single conversion
- The ADC's operation is well described in the datasheet
- Use digital filtering ($y_n = ¼(x_n + x_{n-1} + x_{n-2} + x_{n-3})$)

Questions?