HOCHSCHULE
RHEIN-WAAL
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LABORATORY

Microelectronic Control Systems

EXPERIMENT:

Rotor

Please read the whole document before starting the experiment. This document contains 4 preparation jobs. It is mandatory to make all preparation jobs in written form! Without a written document that includes all preparation jobs it is not possible to pass this experiment.

1 The experiment set-up

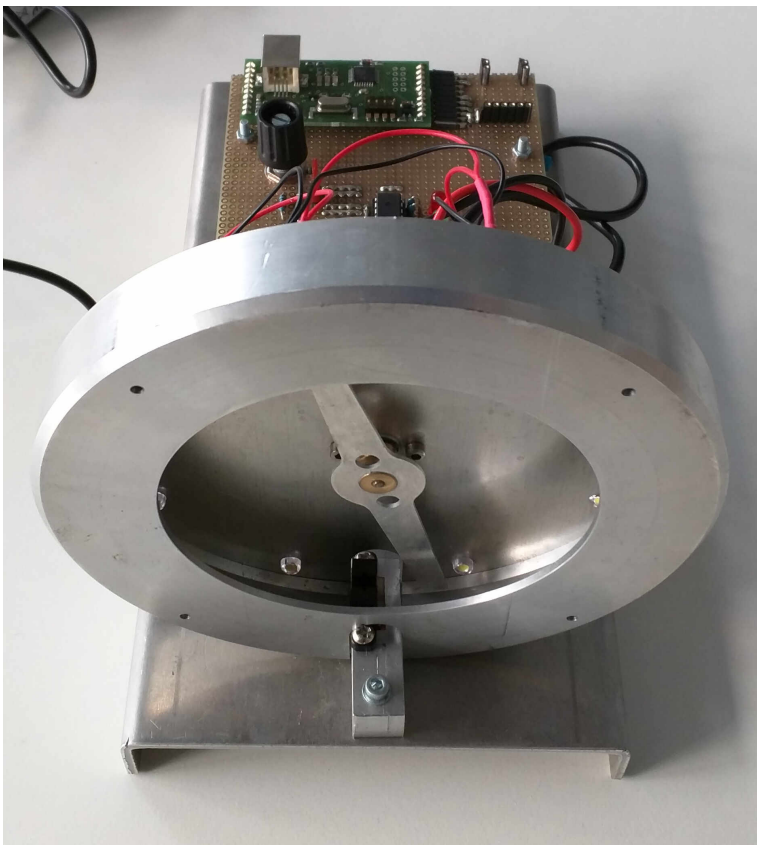

Figure 1: The experiment setup

In this experiment there is a rotor, that is directly mounted on the axis of a DC motor. This rotor is inside a case with LED illumination, see Figure 1. The DC motor can be regulated with a PWM signal. The LEDs can be switched on and off.

So we have:

- Actors:
  - LEDs
  - DC motor with PWM speed control
- Sensor: one light barrier that will be interrupted two times per rotation

A schematic drawing of the mechanical part is in Figure 2.

When the LEDs are flashing with the same frequency of the rotation, it looks like that the rotor stands still, this is called the stroboscopic effect. The human eyes will only see the moments when the light is on.

You can find more information about this effec here: https://en.wikipedia.org/wiki/Stroboscopic_effect

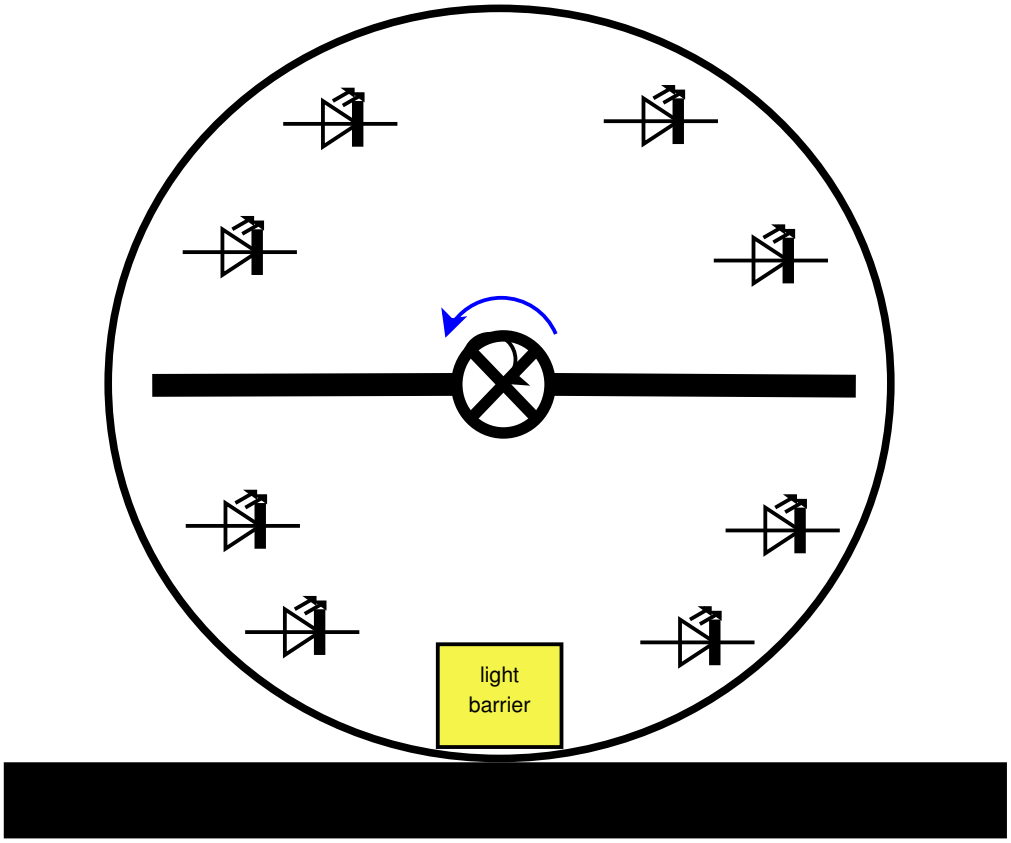

Figure 2: The mechanical part

1.1 Electronic

The electronic circuit is shown in Figure 3. Please take a look at this schematic diagram. The two LEDs (red and green) at the ports PB0 and PD7 are for software debugging. You can use this LEDs like you want. The USB to UART part is for add-ons you will not need it for this experiment.

Prepare 1: Write down the used ports for the input and output.

Prepare 2: Between the potentiometer and the microcontroller is the resistor R1. This resistor has no effect to the analog value. What could be the reason that therre is a resistor?

Prepare 3: The filter FB1 protects the microcontroller against high frequency oscillation from the motor. What effect does this filter have on the response characteristic of the motor?

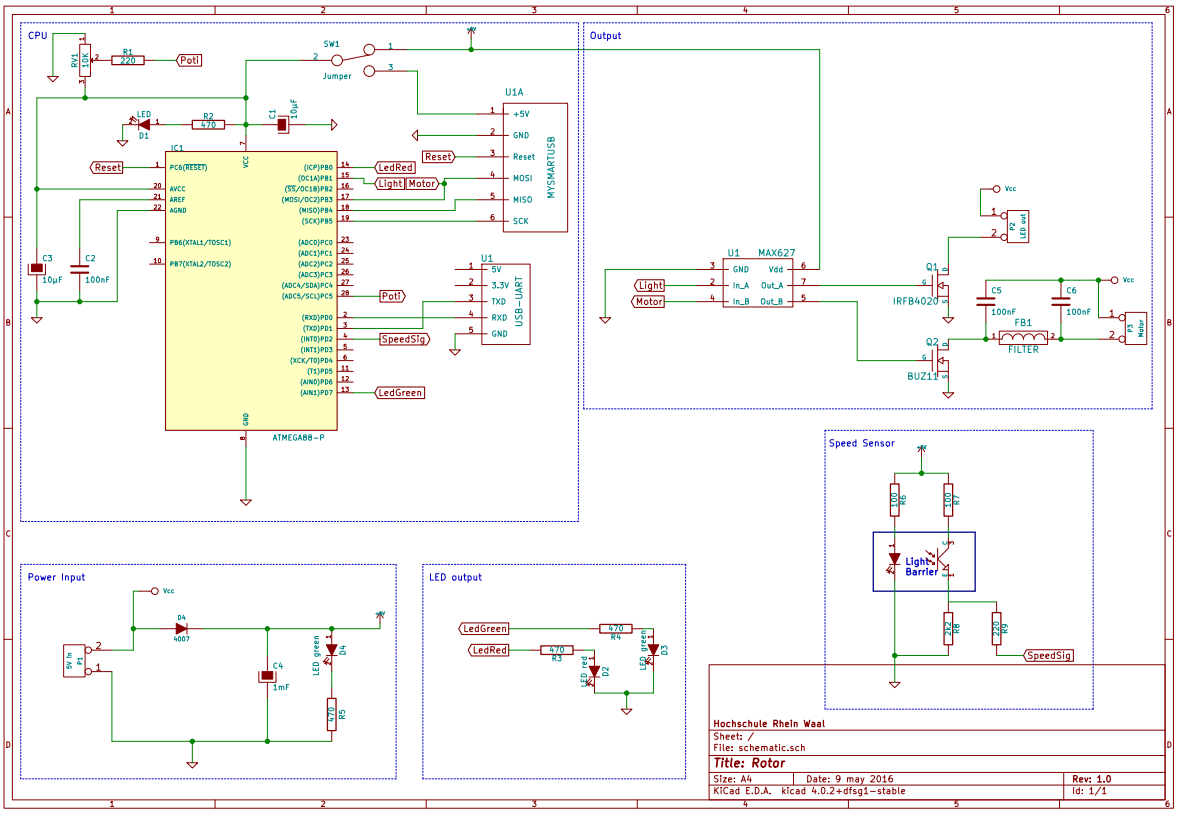

Figure 3: The electronic circuit

2 The challenge

There are two different challenges here!

The fist challenge is to write a program, that flashes the LEDs to make it look like the rotor is standing. The rotation speed can be adjusted with the potentiometer.

Here are the steps to solve:

1. Write a program to get the reading of the potentiometer
2. Use this value to create a PWM signal to set the rotation speed
3. Write a function to measure the rotation speed with the light barrier
4. Let the LEDs flash a short time when the rotor is vertical
5. Then let the LEDs flash a short time when the rotor is horizontal

The second challenge is to write a program, that regulates the rotation speed with and PWM signal that it always looks like the rotor is standing. The flashing speed should be adjustable with a potentiometer.

Read the value from the potentiometer to adjust the flashing frequency from 50Hz to 200Hz. The controller should react when anybody changes the flashing speed and adapt the rotation speed.

Prepare 4: What is the range of the rotation speed for a rotor with two beams?

Here are the steps to solve:

1. Write a program to get the reading of the potentiometer
2. Use this value to create a flashing signal for the LEDs. The on-time should be 5 percent.
3. Write a function to create the PWM signal for the motor
4. Write a function to measure the rotation speed
5. Create the software controller

2.1 Hints

- The rotation speed is between $15\frac{r}{min}$ and $150\frac{r}{min}$
- To let the LEDs flash when the rotor is horizontal the flash must be half a period later than a flash at the vertical position
- To create PWM by software you can use the overflow interrupt of an free Timer/Counter
- The PWM frequency for the motor should be at 1kHz

3 Appendix

Here are some additional information.

3.1 Microcontroller

The used microcontroller in this experiment is from Atmel:

- Type: Atmel Mega88
- Clock rate: 8MHz

To get more information read: http://www.atmel.com/devices/atmega88.aspx