HW-SW-Development Task

- Solve the following, more or less independent tasks in the given order
- Once you have solved the first task, raise your hand so you can show your solution to the experts. If the task has solved correctly, you can begin with the next, etc.
- No code of the task will reviewed
- Aids such as examples and utilities are allowed; internet access is not allowed

Tasks:

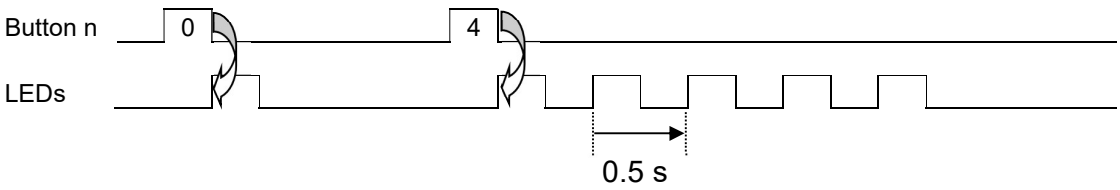
1. LED BLINK

Button 0 to button 7 can be pressed. Let the corresponding LED (0...7) blink with the frequency of 1 Hz as long the button is pressed; the LEDs are otherwise OFF. More buttons can pressed at the same time.

2. Number of blinks:

Button 0 to button 7 can be pressed, but only one at a time:

- All LEDs blink ***n+1*** times, ***n*** equals to the pressed button number
- Blinking period = 0.5s
- The blinking has to start when the button is released
- Any pressed button during the blink must be ignored



3. BCD Decoder

The LEDs 0-3 and 4-7 form two digits of a BCD (Binary Coded Decimal) display. The display shows the position of the potentiometer in percent. This range is 0 to 99.

Examples:

Potentiometer	LEDs (7…0)
99%	●○○●●○○●
28%	○○●○●○○○

4. HW – LED

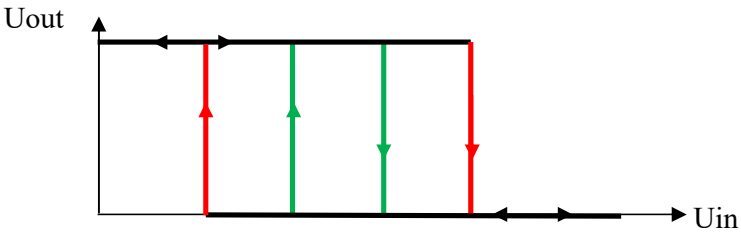
Calculate the resistors, so the green LED gets a current of 10mA and the red LED gets a current of 5mA at 5VDC. The tolerance is +/- 2mA. Build the circuit with the material in the bag on your own breadboard. The resistors can be ordered from the Expert according to the table on the additional sheet. Show the experts your measurements of both currents (live). There are no spare parts!

5. HW – Comparator

Hysteresis value:

- **2V – 3V**
- **1.3V – 3.7V**

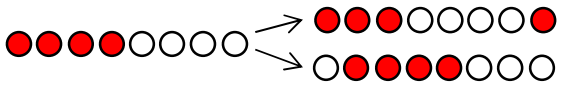
All values are +/- 0.3V



You have to design a circuit with two comparators (LM339) and with the two hysteresis described above. The input signal U_{in} is from 0 … 5VDC (from your own potentiometer) and the output signal U_{out} is 0V (low) or 5V (high).
There is an application Note with formula, you can also simulate or find the way to the solution with practical testing (but there are also no spare parts!).
However you get a solution, build the circuit with the material you got in the bag on your own breadboard. The resistors can be ordered from the Expert.
Add additionally the two LEDs from task 4 to the outputs of LM339 (cathodes of LEDs), so the colours of the LEDs match with the colour of the diagram and the experts see that your comparators are switching.
Show the experts your measurements of all 4 reference voltages (2V & 3V, as 1.3V & 3.7V). In this task you will get the half points if at least one comparator works correctly and you can go further.

6. Running light:

- One to four adjacent LEDs are on.
- The quantity of LEDs can selected with the buttons 0 to 3 (0 = 1 LED, 1 = 2 LEDs, etc…)
- The position of the lighting LEDs is continuously rotated every 0.2s +/- 10%
- When button 4 is pressed, the rotation direction is LED 0 to LED 7
- When button 5 is pressed, the rotation direction is LED 7 to LED 0
- If LED 0 is on and a rotation occurs, the position moves to LED 7 or LED 1 depending on the rotation direction



- By power on: 1 LED rotates from D0 to D7. The buttons should only pressed shortly and illogical usage of the buttons can ignored.

7. Read and show distance

Read distance from the sensor HC-SR04 and display it on the 8 LEDs on your board like follow:

- from 270mm to infinite: 8 LEDs ON
- from 240mm to 269mm: 7 LEDs ON
- from 210mm to 239mm: 6 LEDs ON
- ...
- from 60mm to 89mm: 1 LED ON

8. Read and display distance

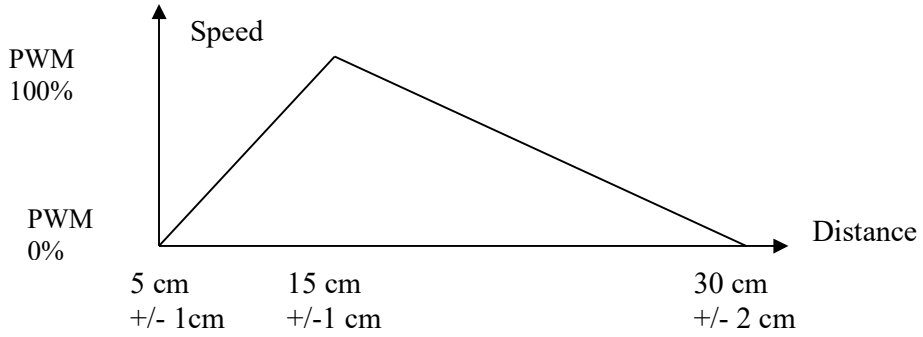
The distance between your hand and the sensor HC-SR04 has to be displayed on your own display from 50mm to 300mm, each 10mm. Write to the display "***Distance: x cm***", where x is the measured distance in cm.
At the same time, the brightness of LED 0 will be control with a PWM signal in a resolution of 25 steps. Distance: 50mm: PWM = 0%, distance: 300mm: PWM = 100%. PWM frequency: 1 kHz.

The experts will check the PWM-Signals on three certain distances. You have to measure it and you have to show the respective PWM-Signal (T & t_{ON}) on your oscilloscope.

9. Hand speed motor control

You can reuse your code from task 8 and adapt it to the new PWM-Signal as showed in the diagram below.
Additionally you have to build a circuit that can control a motor speed dependent of the distance between your hand and the sensor. The motor you have is a 2.5V – 6V DC motor whose speed can controlled via a PWM-Signal. The PWM frequency is 1 kHz. You can use a successive channel of the ULN2803. If not think about that, a motor is an inductive load and that this could destroy your output pin. That is why the ULN2803 has some build-in protection diodes (but works only if you connect the COM pin to Vcc).

The behaviour must be like follow:



The experts will check the behaviour of your SW and HW as before in task 8.

10. People counter

You control a barrier that gives access to a carousel area. Make a microcontroller program to set up a maximum number of people allowed to go inside.

- Read the buttons 0-3 on a reset-command (button 6 released) and display this amount (binary code = max number of people) on the upper 4 LEDs. Default value at power-on is 0xf0. Also clear the people counter on the lower 4 LEDs.
- Simulate people entering (one at a time) by pressing the button 7 and display the number on the lower 4 LEDs. When the max amount is reached make blink the number continuously (1 Hz) only on the lower 4 LEDs and disable further access until the reset button is pressed.

11. Exercise select-replace:

The goal is to order every digit as you like. For example, you can change the order from 0 to 7 to 7 to 0 or swap odd and even digits.

In the example below, we want to change digit 3 with digit 6. We select digit 3, move it 3 positions to right and replace digit 6 with digit 3 (swap the two digits).

Buttons “arrows”, “Select/Place” and “reset” are buttons of your choice.

Start display status:

- When the system is turned on the display shows this:

0	1	2	3	4	5	6	7

- The digit “0” and the cursor symbol “■” are blinking with the following succession: “0” – “■” – “0” – “■” … with a frequency of 0.5 Hz and duty-cycle of 50%

Task:

- By power-on: set up the start display status
- The arrows buttons move the cursor (■) left and right on the 8 digits
  The cursor will always blinking with the digit over which it is
- Choose one digit by positioning the cursor on it and select the digit by pressing the “Select/Place” button
  ⇨ Now the digit is blinking without cursor: “3” – “ ” – “3” – “ ”
- With the right and left arrow buttons move the digit to the position you want to place it. The selected digit (3) is blinking on each new position, while the old position remains empty (" ")
- By pressing the “Select/Replace” button again, the selected digit (3) and the replacing digit (6) swap their positions. The cursor (■) starts again blinking on the selected digit (3) at its new position.
- The “reset” button allows to set the start display status

The experts will give you any number and you have handle your HW so the display shows the desired number.