Exercise sheet 4 – Hardware, Processor architecture

Goals:

- Interrupt handling

Exercise 4.1: Processor architecture: Interrupt handling (theoretical)

Given information:

- Interrupt vector address is 0x20
- Position of interrupt service routine (ISR) starts at 0x4000
- Stack pointer (SP) contains 0xFFF74
- Program counter (PC) respectively instruction pointer (IP) contains 0x10000
- Consider a micro controller without an operating system

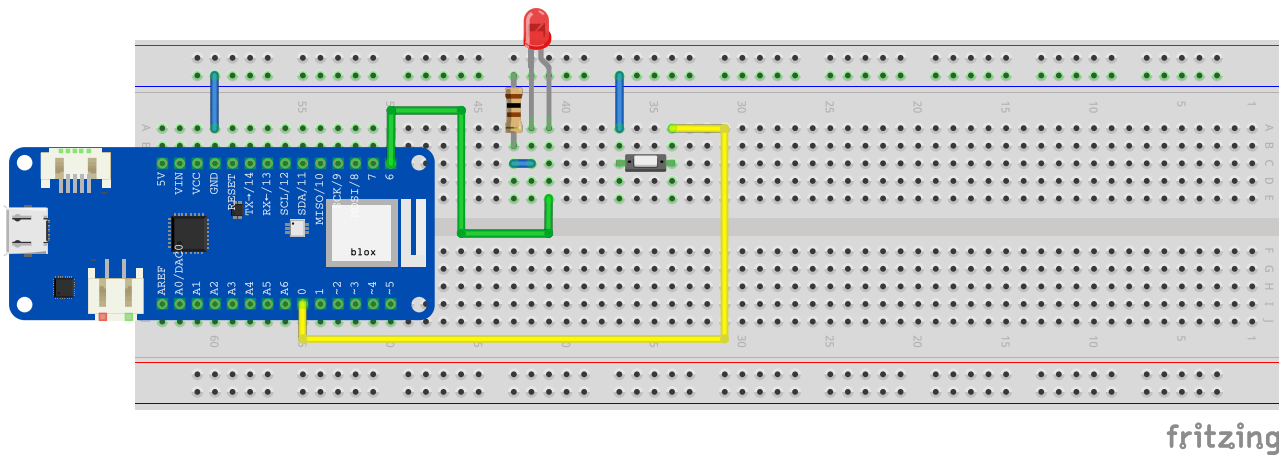
(a) Recapitulate the sequence of an interrupt.

(b) Draw a sketch and show the changes according to the processing of an interrupt in different colours. The drawing should contain at least a memory view including addresses (32 bit: 4 byte with) and the PC and SP registers.

Exercise 4.2: Processor architecture: Interrupt handling (coding)

We want to write an Arduino sketch which toggles the built-in LED when a button is pressed. If the button is pressed, an interrupt occurs which calls an ISR.

(a) Prepare the wiring with the Arduino MKR WiFi 1010 as follows:



(b) Please double check your wiring with the lecturer, before you connect the Arduino MKR WiFi 1010.

(c) Make sure that you have installed the Arduino IDE (`https://www.arduino.cc/en/software`).

(d) Make sure you have installed the board SDK:

- `Tools -> Board: -> Boards Manager...`
- Install (latest version): `Arduino SAMD Boards (32-bits ARM Cortex-M0+)`

(e) Open the skeleton file from
`CA_exercises/sheet_04_interrupts_hw/io_interrupt/io_interrupt.ino`
with the Arduino IDE.

(f) Follow the TODOs in the code. Some configuration depends on your wiring of the I/O pins.
Hint: The Arduino reference contains descriptions of the used functions: ***https://www.arduino.cc/reference/en****.*

(g) Configure the board within the Arduino IDE: `Tools -> Board: -> Arduino MKR WiFi 1010`.

(h) Compile (verify) your sketch within the Arduino IDE. If it compiles then upload it your sketch.

(i) Open the 'Serial Monitor' to see the printed strings and to do some debugging with the text based logging.

(j) Press the button to test your sketch. Does it work as expected?

Exercise 4.3: Processor architecture: Interrupt handling (coding) – additional coding exercise
We want to write an Arduino sketch which toggles the built-in LED when a timer is triggered. If the timer is triggered, an interrupt occurs which calls an ISR. Click here to get information about the timer module for the CPU.

(a) Make sure you have removed any wiring from the Arduino MKR WiFi 1010.

(b) Open the skeleton file from
`CA_exercises/sheet_04_interrupts_hw/timer_interrupt/timer_interrupt.ino`
with the Arduino IDE.

(c) Make sure you have installed the `Adafruit_ZeroTimer` library:
`Sketch -> Include Library -> Manage Libraries... -> Adafruit_ZeroTimer`.

(d) Follow the TODOs in `timer_interrupt.ino`.
Hint 1: The Arduino reference contains descriptions of the used functions: ***https://www.arduino.cc/reference/en****.*
Hint 2: The Adafruit_ZeroTimer github repository examples: ***https://github.com/adafruit/Adafruit_ZeroTimer****.*

(e) To get an interrupt frequency between 1 and 2 seconds, we will use a prescaler of 1024. Search inside the Adafruit_ZeroTimer driver header to find the right enum value to set.

(f) Configure the board in Arduino IDE: `Tools -> Board: -> Arduino MKR WiFi 1010`.

(g) Compile (verify) your sketch within the Arduino IDE. If it compiles, upload your sketch.
Hint: Sometimes it will help to enter the bootloader mode (double press the built-in button) to upload sketches to the MKR Wifi 1010.

(h) Open the „Serial Monitor“ to see the printed strings. Does it work as expected?