Lab 4: Samuel Košík

Link to your `Digital-electronics-2` GitHub repository:

GitHub Link

Overflow times

1. Complete table with overflow times.

Module	Number of bits	1	8	32	64	128
Timer/Counter0	8	16u	128u	---	1024u	---
Timer/Counter1	16	4096u	32.768m	---	262.144m	---

Timer/Counter2	8	16u	128u	512u	1024u	2048u

Module	Operation	I/O register(s)	Bit(s)

Module	Operation	I/O register(s)	Bit(s)
Timer/Counter0	Prescaler 8-bit data value Overflow interrupt enable	TCCR0B TCNT0 TIMSK0	CS02 CS01 CS00 (000: stopped, 001: 1, 010: 8, 011: 64, 100: 256, 101: 1024) TCNT0[7:0] TOIE0 (timer enable; 1: enable, 0: disable)
Timer/Counter1	Prescaler 16-bit data value Overflow interrupt enable	TCCR1B TCNT1H, TCNT1L TIMSK1	CS12, CS11, CS10 (000: stopped, 001: 1, 010: 8, 011: 64, 100: 256, 101: 1024) TCNT1[15:0] TOIE1 (1: enable, 0: disable)
Timer/Counter2	Prescaler 8-bit data value Overflow interrupt enable	TCCR2B TCNT2 TIMSK2	CS22 CS21 CS20 (000: stopped, 001: 1, 010: 8, 011: 64, 100: 256, 101: 1024) TCNT2[7:0] TOIE2 (timer enable; 1: enable, 0: disable)

VectorNo.	Address[2]	Source	Interrupt Definition
1	0x0000[1]	RESET	External Pin, Power-on Reset, Brown-out Reset and Watchdog System Reset
2	0x0002	INT0	External Interrupt Request 0
3	0x0004	INT1	External Interrupt Request 1
4	0x0006	PCINT0	Pin Change Interrupt Request 0
5	0x0008	PCINT1	Pin Change Interrupt Request 1
6	0x000A	PCINT2	Pin Change Interrupt Request 2
7	0x000C	WDT	Watchdog Time-out Interrupt
8	0x000E	TIMER2_COMPA	Timer/Counter2 Compare Match A
9	0x0010	TIMER2_COMPB	Timer/Counter2 Compare Match B
10	0x0012	TIMER2_OVF	Timer/Counter2 Overflow
11	0x0014	TIMER1_CAPT	Timer/Counter1 Capture Event
12	0x0016	TIMER1_COMPA	Timer/Counter1 Compare Match A
13	0x0018	TIMER1_COMPB	Timer/Counter1 Compare Match B
14	0x001A	TIMER1_OVF	Timer/Counter1 Overflow
15	0x001C	TIMER0_COMPA	Timer/Counter0 Compare Match A
16	0x001E	TIMER0_COMPB	Timer/Counter0 Compare Match B
17	0x0020	TIMER0_OVF	Timer/Counter0 Overflow
18	0x0022	SPI_STC	SPI Serial Transfer Complete
19	0x0024	USART_RX	USART Rx Complete
20	0x0026	USART_UDRE	USART, Data Register Empty
21	0x0028	USART_TX	USART, Tx Complete
22	0x002A	ADC	ADC Conversion Complete
23	0x002C	EE_READY	EEPROM Ready
24	0x002E	ANALOG_COMP	Analog Comparator
25	0x0030	TWI	2-wire Serial Interface
26	0x0032	SPM_Ready	Store Program Memory Ready

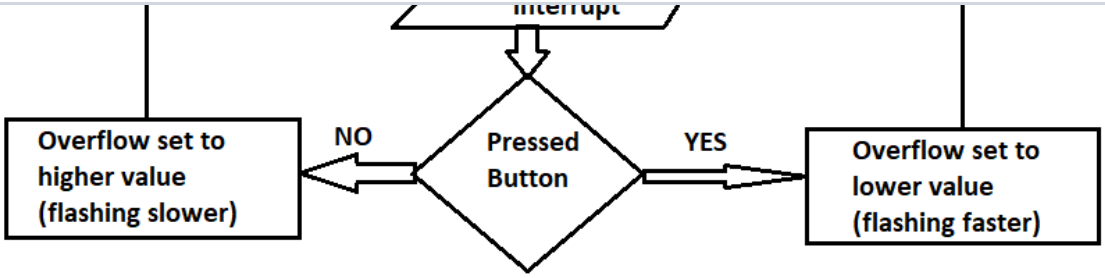
Timer library

1. In your words, describe the difference between common C function and interrupt service routine.
    - Function = je súbor príkazov, ktoré sa vykonávajú postupne po zavolaní danej funkcie v hlavnej main funkcii.
    - Interrupt service routine = Vykonáva príkazy, ktoré prikazujú hardwaru zastaviť vykonávanú úlohu a vykonať jednoduché* príkazy, ktoré obsahuje.
2. Part of the header file listing with syntax highlighting, which defines settings for Timer/Counter1, Timer/Counter0 and Timer/Counter2:

```
* @name  Definitions for 16-bit Timer/Counter1
 * @note  t_OVF = 1/F_CPU * prescaler * 2^n where n = 16, F_CPU = 16 MHz

/** @brief Stop timer, prescaler 000 --> STOP */
#define TIM1_stop()           TCCR1B &= ~((1<<CS12) | (1<<CS11) | (1<<CS10));
/** @brief Set overflow 4ms, prescaler 001 --> 1 */
#define TIM1_overflow_4ms()   TCCR1B &= ~((1<<CS12) | (1<<CS11)); TCCR1B |= (1<<C
/** @brief Set overflow 33ms, prescaler 010 --> 8 */
#define TIM1_overflow_33ms()  TCCR1B &= ~((1<<CS12) | (1<<CS10)); TCCR1B |= (1<<C
/** @brief Set overflow 262ms, prescaler 011 --> 64 */
```

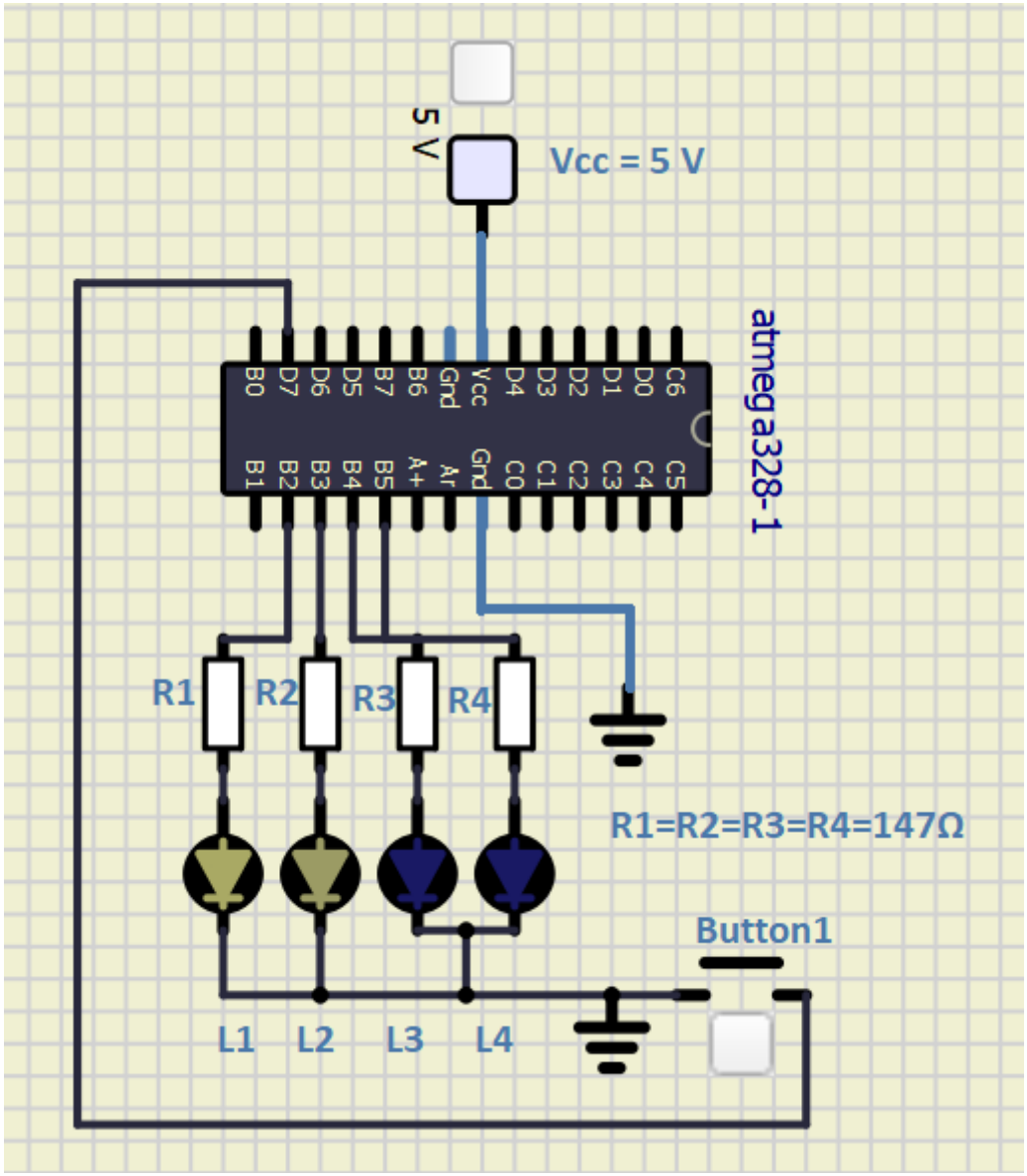
```
#define TIM1_overflow_262ms() TCCR1B &= ~(1<<CS12); TCCR1B |= (1<<CS11) | (1<<CS1
/** @brief Set overflow 1s, prescaler 100 --> 256 */
#define TIM1_overflow_1s()    TCCR1B &= ~((1<<CS11) | (1<<CS10)); TCCR1B |= (1<<C
/** @brief Set overflow 4s, prescaler // 101 --> 1024 */
#define TIM1_overflow_4s()    TCCR1B &= ~(1<<CS11); TCCR1B |= (1<<CS12) | (1<<CS1
/** @brief Enable overflow interrupt, 1 --> enable */
#define TIM1_overflow_interrupt_enable()  TIMSK1 |= (1<<TOIE1);
/** @brief Disable overflow interrupt, 0 --> disable */
#define TIM1_overflow_interrupt_disable() TIMSK1 &= ~(1<<TOIE1);

/**
 * @name  Definitions for 8-bit Timer/Counter0
 * @note  t_OVF = 1/F_CPU * prescaler * 2^n where n = 8, F_CPU = 16 MHz
 */
/** @brief Stop timer, prescaler 000 --> STOP */
#define TIM1_stop()           TCCR0B &= ~((1<<CS02) | (1<<CS01) | (1<<CS00));
/** @brief Set overflow 4ms, prescaler 001 --> 1 */
#define TIM1_overflow_4ms()   TCCR0B &= ~((1<<CS02) | (1<<CS01)); TCCR0B |= (1<<C
/** @brief Set overflow 33ms, prescaler 010 --> 8 */
#define TIM1_overflow_33ms()  TCCR0B &= ~((1<<CS02) | (1<<CS00)); TCCR0B |= (1<<C
/** @brief Set overflow 262ms, prescaler 011 --> 64 */
#define TIM1_overflow_262ms() TCCR0B &= ~(1<<CS02); TCCR0B |= (1<<CS01) | (1<<CS0
/** @brief Set overflow 1s, prescaler 100 --> 256 */
#define TIM1_overflow_1s()    TCCR0B &= ~((1<<CS01) | (1<<CS00)); TCCR0B |= (1<<C
/** @brief Set overflow 4s, prescaler // 101 --> 1024 */
#define TIM1_overflow_4s()    TCCR0B &= ~(1<<CS01); TCCR0B |= (1<<CS02) | (1<<CS0
/** @brief Enable overflow interrupt, 1 --> enable */
#define TIM1_overflow_interrupt_enable()  TIMSK0 |= (1<<TOIE0);             //log
/** @brief Disable overflow interrupt, 0 --> disable */
#define TIM1_overflow_interrupt_disable() TIMSK0 &= ~(1<<TOIE0);            //log

/**
 * @name  Definitions for 8-bit Timer/Counter2
 * @note  t_OVF = 1/F_CPU * prescaler * 2^n where n = 8, F_CPU = 16 MHz
 */
/** @brief Stop timer, prescaler 000 --> STOP */
#define TIM1_stop()           TCCR2B &= ~((1<<CS22) | (1<<CS21) | (1<<CS20));
/** @brief Set overflow 4ms, prescaler 001 --> 1 */
#define TIM1_overflow_4ms()   TCCR2B &= ~((1<<CS22) | (1<<CS21)); TCCR2B |= (1<<C
/** @brief Set overflow 33ms, prescaler 010 --> 8 */
#define TIM1_overflow_33ms()  TCCR2B &= ~((1<<CS22) | (1<<CS20)); TCCR2B |= (1<<C
/** @brief Set overflow 262ms, prescaler 011 --> 64 */
#define TIM1_overflow_262ms() TCCR2B &= ~(1<<CS22); TCCR2B |= (1<<CS21) | (1<<CS2
/** @brief Set overflow 1s, prescaler 100 --> 256 */
#define TIM1_overflow_1s()    TCCR2B &= ~((1<<CS21) | (1<<CS20)); TCCR2B |= (1<<C
/** @brief Set overflow 4s, prescaler // 101 --> 1024 */
#define TIM1_overflow_4s()    TCCR2B &= ~(1<<CS21); TCCR2B |= (1<<CS22) | (1<<CS2
/** @brief Enable overflow interrupt, 1 --> enable */
#define TIM1_overflow_interrupt_enable()  TIMSK2 |= (1<<TOIE2);
/** @brief Disable overflow interrupt, 0 --> disable */
#define TIM1_overflow_interrupt_disable() TIMSK2 &= ~(1<<TOIE2);
```

3. Flowchart figure for function `main()` and interrupt service routine `ISR(TIMER1_OVF_vect)` of application that ensures the flashing of one LED in the timer interruption. When the button is pressed, the blinking is faster, when the button is released, it is slower. Use only a timer overflow and not a delay library.



Knight Rider

1. Scheme of Knight Rider application with four LEDs and a push button, connected according to Multi-function shield. Connect AVR device, LEDs, resistors, push button, and supply voltage. The image can be drawn on a computer or by hand. Always name all components and their values!



2. ISR for Knight Rider

```
ISR(TIMER1_OVF_vect)        //co vykonava prerusenie
{
    static uint8_t i = 0;
    static uint8_t q = 0;

    switch(i){
        case(0):
            GPIO_write_high(&PORTB, LED_D1);
            GPIO_write_low(&PORTB, LED_D4);
            GPIO_write_low(&PORTB, LED_D3);
            GPIO_write_low(&PORTB, LED_D2);

            q = 0;
            i++;
            break;
        case(1):
            GPIO_write_low(&PORTB, LED_D1);
            GPIO_write_high(&PORTB, LED_D2);
            GPIO_write_low(&PORTB, LED_D3);
```

```
            if(q == 0)
                i++;
            else i--;
            break;
        case(2):
            GPIO_write_low(&PORTB, LED_D2);
            GPIO_write_high(&PORTB, LED_D3);
            GPIO_write_low(&PORTB, LED_D4);
            if(q == 0)
                i++;
            else i--;
            break;
         case(3):
            GPIO_write_low(&PORTB, LED_D3);
            GPIO_write_high(&PORTB, LED_D4);
            q = 1;
            i--;
            break;
        default:;

    }
}
```