VUT FEKT

Name and Surname: *Kreshnik Shala*

Person ID: *226108*

[BPA-DE2] Digital Electronics 2

Assignment 3

Date: Monday, October 12, 2020

GitHub: *https://github.com/ShalaKreshnik*

**Dear Professor, I'm still waiting for you to accept my invitation on GitHub (I made my repository private)*

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Lab assignment 3

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1.1 Preparation tasks. Submit:

1.1.1 Table with data types:

Data type:	Number of bits	Range	Description:
uint8_t	8	0, 1, ..., 255	Unsigned 8-bit integer
int8_t	8	-128, +127	Signed 8-bit integer
uint16_t	16	0, 1, …, 65535	Unsigned 16-bit integer
Int16_t	16	-32768, + 32767	Signed 16-bit integer
float	32	-3.4e+38, …, 3.4e+38	Single-precision floating-point

Void pointer size varies system to system. If the system is 16-bit, size of void pointer is 2 bytes. If the system is 32-bit, size of void pointer is 4 bytes. If the system is 64-bit, size of void pointer is 8 bytes.

Here is an example of how to find the size of the void pointer in the C language:

```
#include <stdio.h>

int main() {
        void *ptr;

        printf("Pointer size value is: %d", sizeof(ptr));
        return 0;
}
```

Output:

“Pointer size value is: 8”

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1.1.2 Completed source code from the example:

```
#include <avr/io.h>

// Function declaration (prototype)
uint16_t calculate(uint8_t, uint8_t);

int main(void)
{
	uint8_t a = 156;
	uint8_t b = 14;
	uint16_t c;

	// Function call
	c = calculate (a, b);

	while (1)
	{
	}
	return 0;
}

// Function definition (body)
uint16_t calculate(uint8_t x, uint8_t y)
{
	uint16_t result;	// result = x^2 + 2xy + y^2

	result = x*x + 2*x*y + y*y;

	return result;
}
```

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1.2 GPIO library. Submit:

1.2.1 C code of the application main.c:

```
/*////////////////////////////////////////////////////////////////////////////////
///                                                                              ///
/// VUT FEKT                                  Name and Surname: Kreshnik Shala   ///
/// [BPA-DE2] Digital Electronics 2           Person ID: 226108                  ///
/// Date: Monday, October 12, 2020                                               ///
/// GitHub: https://github.com/ShalaKreshnik                                     ///
///                                                                              ///
*////////////////////////////////////////////////////////////////////////////////


/*********************************************************************
 *
 * Alternately toggle two LEDs when a push button is pressed. Use
 * functions from GPIO library.
 * ATmega328P (Arduino Uno), 16 MHz, AVR 8-bit Toolchain 3.6.2
 *

 *********************************************************************/

/* Defines -----------------------------------------------------------*/
#define LED_GREEN   PB5            // AVR pin where green LED is connected
#define LED_RED             PC0
#define BTN                 PD0
#define BLINK_DELAY 500
#ifndef F_CPU
#define F_CPU 16000000      // CPU frequency in Hz required for delay
#endif

/* Includes ----------------------------------------------------------*/
#include <util/delay.h>     // Functions for busy-wait delay loops
#include <avr/io.h>         // AVR device-specific IO definitions
#include "gpio.h"           // GPIO library for AVR-GCC

/* Function definitions ----------------------------------------------*/
/**
 * Main function where the program execution begins. Toggle two LEDs
 * when a push button is pressed. Functions from user-defined GPIO
 * library is used instead of low-level logic operations.
 */
int main(void)
{
    /* GREEN LED */
```

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```
    GPIO_config_output(&DDRB, LED_GREEN);
    GPIO_write_low(&PORTB, LED_GREEN);  // LED off, because active-high



    /* second LED */
 GPIO_config_output(&DDRC, LED_RED);
 GPIO_write_low(&PORTC, LED_RED);  // LED off, because active-high

    /* push button */
       GPIO_config_input_pullup(&DDRD, BTN);


    // Infinite loop
    while (1)
    {
        // Pause several milliseconds
        _delay_ms(BLINK_DELAY);

        // WRITE YOUR CODE HERE
             if(GPIO_read(&PORTD, BTN)== 1) // This will check if the button (PIN 0
OF PORTD) has been pressed (Return value is 1 in the function)
             {
             GPIO_toggle(&PORTB, LED_GREEN); // Toggle Green LED PIN 5 of PORTB
             GPIO_toggle(&PORTC, LED_RED);   // Toggle RED LED PIN 0 of PORTC
             }
    }

    // Will never reach this
    return 0;
}
```

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1.2.2 Listing of library source file gpio.h:

```
/*////////////////////////////////////////////////////////////////////////////////
///                                                                             ///
/// VUT FEKT                                  Name and Surname: Kreshnik Shala  ///
/// [BPA-DE2] Digital Electronics 2           Person ID: 226108                 ///
/// Date: Monday, October 12, 2020                                              ///
/// GitHub: https://github.com/ShalaKreshnik                                    ///
///                                                                             ///
*////////////////////////////////////////////////////////////////////////////////

#ifndef GPIO_H
#define GPIO_H

/*************************************************************************
 *
 * GPIO library for AVR-GCC.
 * ATmega328P (Arduino Uno), 16 MHz, AVR 8-bit Toolchain 3.6.2
 *
 ************************************************************************/

/**
 * @file  gpio.h
 * @brief GPIO library for AVR-GCC.
 *
 * @details
 * The library contains functions for controlling AVRs' gpio pin(s).
 *
 * @note
 * Based on AVR Libc Reference Manual. Tested on ATmega328P (Arduino Uno),
 * 16 MHz, AVR 8-bit Toolchain 3.6.2.
 */

/* Includes ----------------------------------------------------------*/
#include <avr/io.h>

/* Function prototypes -----------------------------------------------*/
/**
 * @brief Configure one output pin in Data Direction Register.
 * @param reg_name - Address of Data Direction Register, such as &DDRA,
 *                   &DDRB, ...
 * @param pin_num - Pin designation in the interval 0 to 7
 */
void GPIO_config_output(volatile uint8_t *reg_name, uint8_t pin_num);

/* GPIO_config_input_nopull */

void GPIO_config_input_pullup(volatile uint8_t *reg_name, uint8_t pin_num);
```

```
void GPIO_write_low(volatile uint8_t *reg_name, uint8_t pin_num);



void GPIO_write_high(volatile uint8_t *reg_name, uint8_t pin_num); // Declaration of function (To assign it a value of 1) with parameters *reg_name and pin_num (void does not return any value)

void GPIO_toggle(volatile uint8_t *reg_name, uint8_t pin_num); // Declaration of function (To toggle pin) with parameters *reg_name and pin_num (void does not return any value)


/* GPIO_toggle */
uint8_t GPIO_read(volatile uint8_t *reg_name, uint8_t pin_num);

#endif
```

1.2.3 Listing of library source file gpio.c:

```
/*////////////////////////////////////////////////////////////////////////////////
///                                                                             ///
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/// Date: Monday, October 12, 2020                                              ///
/// GitHub: https://github.com/ShalaKreshnik                                    ///
///                                                                             ///
*////////////////////////////////////////////////////////////////////////////////
/************************************************************************
 *
 * GPIO library for AVR-GCC.
 * ATmega328P (Arduino Uno), 16 MHz, AVR 8-bit Toolchain 3.6.2
 *
 ************************************************************************/

/* Includes ----------------------------------------------------------*/
#include "gpio.h"

/* Function definitions ----------------------------------------------*/
void GPIO_config_output(volatile uint8_t *reg_name, uint8_t pin_num)
{
    *reg_name = *reg_name | (1<<pin_num); // Set bit (or)
}

/*-------------------------------------------------------------------*/
/* GPIO_config_input_nopull */
void GPIO_config_input_nopull(volatile uint8_t *reg_name, uint8_t pin_num)
{
    *reg_name = *reg_name & ~(1<<pin_num);  // Data Direction Register
    *reg_name++;                    // Change pointer to Data Register
```

```
    *reg_name = *reg_name & ~(1<<pin_num);   // Data Register
}



/*-------------------------------------------------------------------*/

void GPIO_config_input_pullup(volatile uint8_t *reg_name, uint8_t pin_num)
{

    *reg_name = *reg_name & ~(1<<pin_num);  // Data Direction Register

    *reg_name++;                    // Change pointer to Data Register
    *reg_name = *reg_name | (1<<pin_num);   // Data Register
}

/*-------------------------------------------------------------------*/
void GPIO_write_low(volatile uint8_t *reg_name, uint8_t pin_num)
{
    *reg_name = *reg_name & ~(1<<pin_num); //Clear bit (and not)
}

/*-------------------------------------------------------------------*/
/* GPIO_write_high */
void GPIO_write_high(volatile uint8_t *reg_name, uint8_t pin_num)
{
       *reg_name = *reg_name | (1<<pin_num); // Set bit (or)
}

/*-------------------------------------------------------------------*/
/* GPIO_toggle */

void GPIO_toggle(volatile uint8_t *reg_name, uint8_t pin_num)
{
      *reg_name = *reg_name ^ (1<<pin_num); // Toggle bit (xor)
}

/*-------------------------------------------------------------------*/
/* GPIO_read */
uint8_t GPIO_read(volatile uint8_t *reg_name, uint8_t pin_num)
{
      uint8_t result = 0; // Initiallizing result with 0

      if ((PIND&0b00000001)==pin_num) // If (PIN0 of PORTD is pressed)
      {
            result = 1; // Value of result becomes 1 if PD0 is pressed.
      }
      return result; // Return the value stored in result (1 OR 0)
}
```

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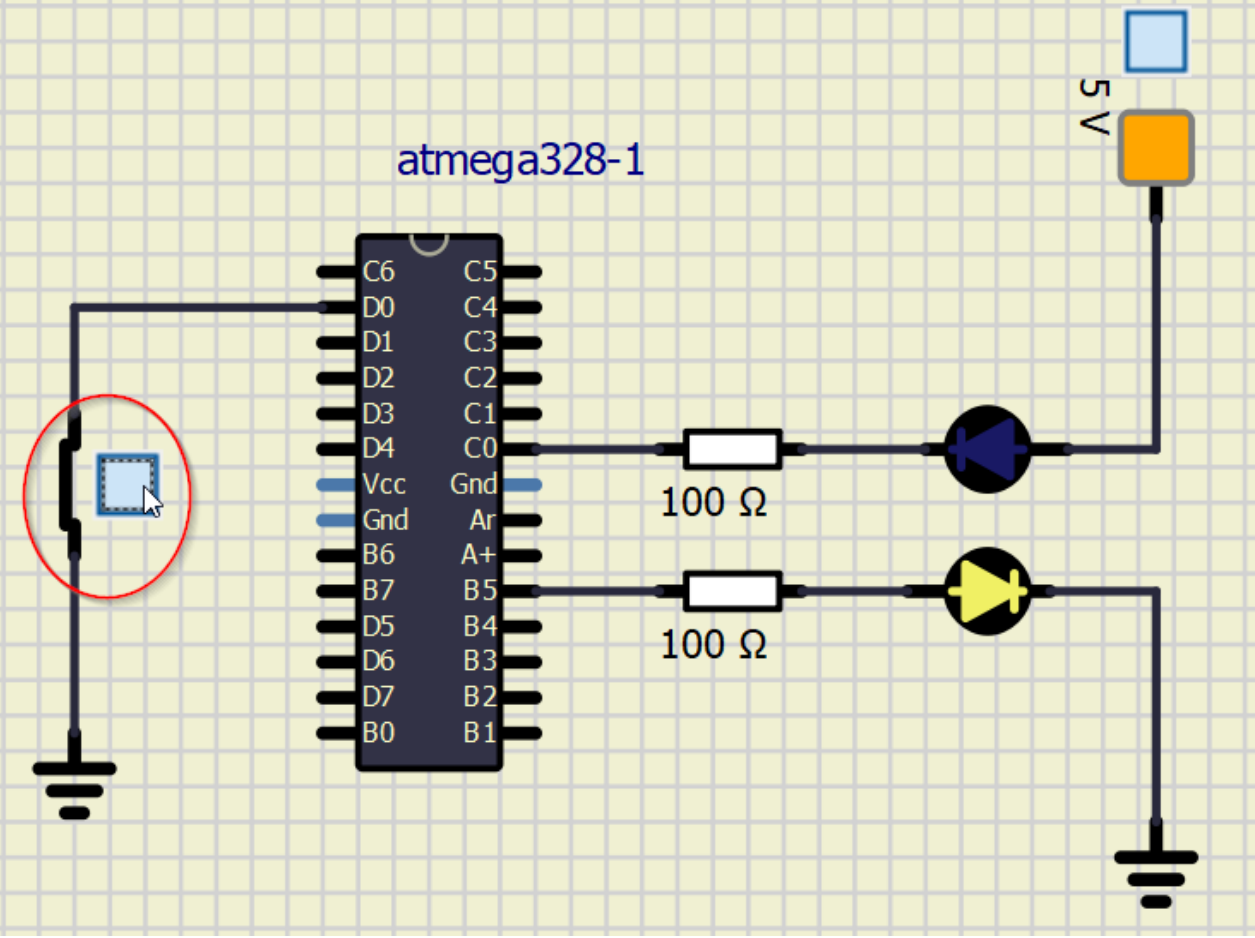
1.2.4 Screenshot_1 of SimulIDE circuit:



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1.2.5 The difference between the declaration and the definition of the function in C. Give an example:

Declaration of a function gives details about the parameters, return type and its name to the compiler but the definition of a function tells the compiler what task it should do.

For example:
This is our function

```
uint8_t GPIO_read(volatile uint8_t *reg_name, uint8_t pin_num)
{
	uint8_t result = 0;
	if ((PIND&0b00000001)==pin_num)
	{
		result = 1;
	}
	return result;
```

- **Declaration** of the function:

  ```
  uint8_t GPIO_read(volatile uint8_t *reg_name, uint8_t pin_num)
  ```

  This tells us **uint8_t** is the return type, **GPIO_read** is the name of function and **(volatile uint8_t *reg_name, uint8_t pin_num)** are the parameters of the function

- **Definition** of the function:

```
uint8_t result = 0;
if ((PIND&0b00000001)==pin_num)
{
	result = 1;
}
return result;
```

The set of these lines of instructions to be performed by the compiler is the definition of the function.