František Konečný – ID: 211313 – BPC-DE2

Link to my repository in GitHub

https://github.com/Konecny343/Digital-electronics-2

Table with data types

Data types	Number of bits	Range	Description
uint8_t	8	0 to 255	Unsigned 8-bit integer.
int8_t	8	-128 to 127	Signed 8-bit integer.
uint16_t	16	0 to 65355	Unsigned 16-bit integer.
int16_t	16	-32768 to 32767	Signed 16-bit integer.
float	32	-3,4e38 to 3,4e38	Floating point numbers.
void	-	-	Void function, also called nonvalue-returning function.

Source code from preparation tasks

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

             // Function declaration (prototype)
             uint16_t calculate(uint8_t, uint16_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)
             int 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;
             }
```

Code of source file main.c

```c
/***********************************************************************
 * 
 * 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
 *
 * Copyright (c) 2019-2020 Tomas Fryza
 * Dept. of Radio Electronics, Brno University of Technology, Czechia
 * This work is licensed under the terms of the MIT license.
 * 
 **********************************************************************/

/* Defines -----------------------------------------------------------*/
#define LED_GREEN   PB5          // AVR pin where green LED is connected
#define LED_RED     PB0          // AVR pin where red LED is connected
#define BTN         PD0          // AVR pin where button is connected
#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 */
    GPIO_config_output(&DDRB, LED_GREEN);
    GPIO_write_low(&PORTB, LED_GREEN);

    /* RED LED */
    GPIO_config_output(&DDRC, LED_RED);
    GPIO_write_high(&PORTC, LED_RED);

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

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

       if (GPIO_read(&PIND, BTN) == 0)
       {
             GPIO_toggle(&PORTB, LED_GREEN);
             GPIO_toggle(&PORTC, LED_RED);
       }
    }
    // Will never reach this
    return 0;
}
```

Code of source file gpio.h

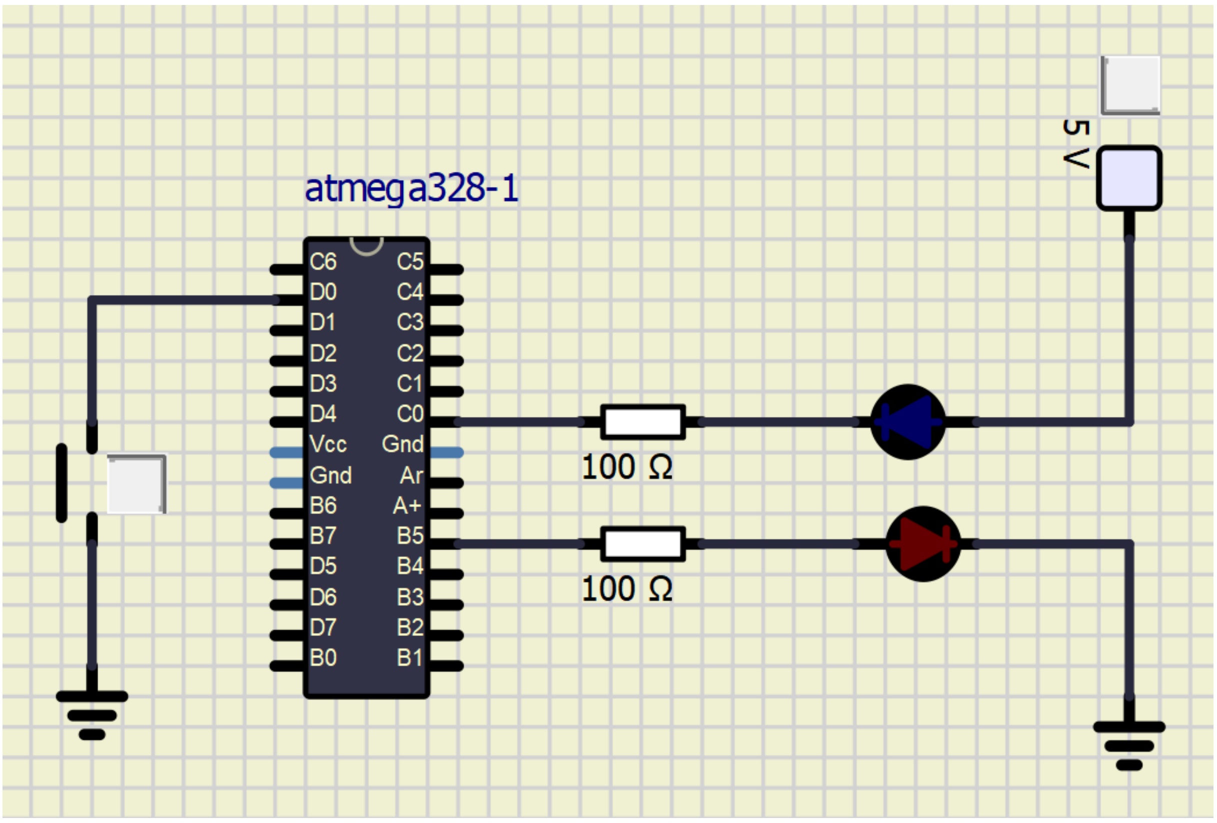
```c
#ifndef GPIO_H
#define GPIO_H

/***********************************************************************
 * 
 * GPIO library for AVR-GCC.
 * ATmega328P (Arduino Uno), 16 MHz, AVR 8-bit Toolchain 3.6.2
 *
 * Copyright (c) 2019-2020 Tomas Fryza
 * Dept. of Radio Electronics, Brno University of Technology, Czechia
 * This work is licensed under the terms of the MIT license.
 *
 **********************************************************************/

/**
 * @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.
 * 
 * @copyright (c) 2019-2020 Tomas Fryza
 * Dept. of Radio Electronics, Brno University of Technology, Czechia
 * This work is licensed under the terms of the MIT license.
 */

/* 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);

void GPIO_config_input_nopull(volatile uint8_t *reg_name, uint8_t pin_num);

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);

void GPIO_toggle(volatile uint8_t *reg_name, uint8_t pin_num);

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

#endif
```

Code of source file gpio.c

```
/***********************************************************************
 * 
 * GPIO library for AVR-GCC.
 * ATmega328P (Arduino Uno), 16 MHz, AVR 8-bit Toolchain 3.6.2
 *
 * Copyright (c) 2019-2020 Tomas Fryza
 * Dept. of Radio Electronics, Brno University of Technology, Czechia
 * This work is licensed under the terms of the MIT license.
 *
 **********************************************************************/

/* 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);
}

/*--------------------------------------------------------------------*/
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);
}

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

/*--------------------------------------------------------------------*/
void GPIO_toggle(volatile uint8_t *reg_name, uint8_t pin_num)
{
       *reg_name = *reg_name ^ (1<<pin_num);
}
```

```
/*--------------------------------------------------------------------*/
uint8_t GPIO_read(volatile uint8_t *reg_name, uint8_t pin_num)
{
	if (bit_is_clear(*reg_name, pin_num))
	{
		return 0;
	}
	else
	{
		return 1;
	}
}
```

Screenshot of SimulIDE circuit



Difference between the declaration and the definition of the function in C

- Definition
  - Contains the part of code to perform a specific task.
  - For example, some kind of calculation.
- Declaration
  - In other words, a function prototype, is simply giving to function a name and parameters.
  - It doesn't contain function body.
- Example
  - Declaration:

```
int f(int);
```

  - Definition:

```
int f(int a)
{
return a;
}
```