STONY BROOK UNIVERSITY
DEPARTMENT OF COMPUTER AND ELECTRICAL ENGINEERING

ESE 381.L02

Lab 2: Bitwise Logical Operations in C

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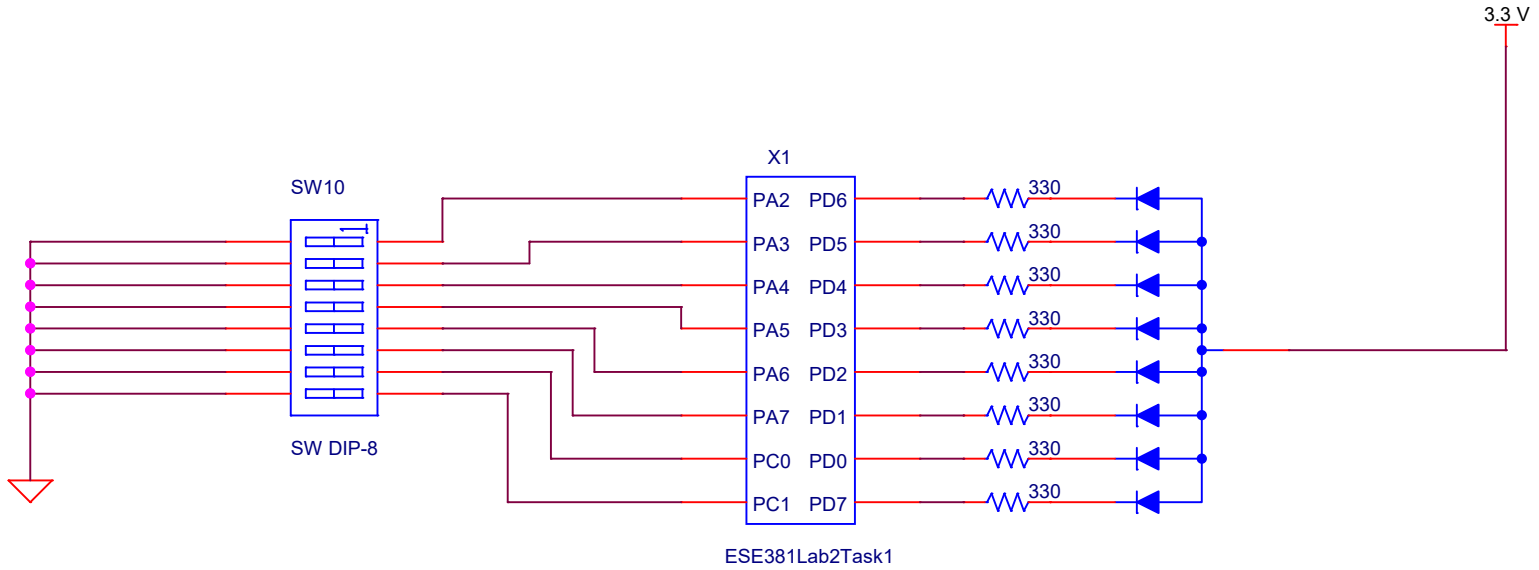
Due Date: 10 Feb. 2022 by 9PM



Title	ESE 381 Lab 2 Task 1 Schematic	
Size A	Document Number <Doc>	Rev <RevCo
Date: Monday, February 07, 2022	Sheet 1 of 1	

```c
/*
 * parallel_in_parallel_out_flat.c
 *
 * Created: 1/28/2022 9:58:44 PM
 * Author : Jason
 *
 */

#include <avr/io.h>


int main(void)
{
    //pointer to PIN2CTRL array of pin configuration registers
    uint8_t* ptr = (uint8_t*)&PORTA.PIN2CTRL;
    PORTC_PIN0CTRL = 0x08;  //Enable internal pull up for PC0
    PORTC_PIN1CTRL = 0x08;  //Enable internal pull up for PC1

    //DIR is what configure the port pins as inputs or outputs
    VPORTA_DIR = 0x00;  //Configure PORTA pins ( PA7, PA6, PA5, PA4, PA3, PA2) as the
      inputs
    VPORTC_DIR = 0x00;   //Configure PORTC pins ( PC1, PC0) as the inputs
    VPORTD_DIR = 0xFF;   //Configure PORD pins (PD07 through PD00) as output pins

    //Configure PA7 - PA2 as input buffers with internal pull up resistors
    for(uint8_t i = 0; i < 8; i++){
        *(ptr + i) |= PORT_PULLUPEN_bm;
    }


    while (1)
    {

        VPORTD_OUT = ~((VPORTA_IN & 0xFC) | (VPORTC_IN & 0x03) );  //For the purpose
          of reading for PA7-PA2 and for PC1-PC0 and negating when
                                                                   //changing value
                    bit when switch is on and off

    }
}
```

```c
/*
 * parallel_in_parallel_out_struct.c
 *
 * Created: 2/3/2022 10:39:54 PM
 * Author : Jason Tan
 */

#include <avr/io.h>


int main(void)
{
    //pointer to PIN2CTRL array of pin configuration registers
    uint8_t* ptr = (uint8_t*)&PORTA.PIN2CTRL;
    PORTC.PIN0CTRL = 0x08;  //Enable internal pull up for PC0
    PORTC.PIN1CTRL = 0x08;  //Enable internal pull up for PC1

    //DIR is what configure the port pins as inputs or outputs
    VPORTA.DIR = 0x00;  //Configure PORTA pins ( PA7, PA6, PA5, PA4, PA3, PA2) as the
      inputs
    VPORTC.DIR = 0x00;   //Configure PORTC pins ( PC1, PC0) as the inputs
    VPORTD.DIR = 0xFF;   //Configure PORD pins (PD07 through PD00) as output pins

    //Configure PA7 - PA2 as input buffers with internal pull up resistors
    for(uint8_t i = 0; i < 8; i++){
        *(ptr + i) |= PORT_PULLUPEN_bm;
    }


    while (1)
    {
        VPORTD.OUT = ~((VPORTA_IN & 0xFC) | (VPORTC_IN & 0x03));
    }
}
```

```c
/*
 * read_modify_write_sftw_sw0.c
 *
 * Created: 2/3/2022 11:49:03 PM
 * Author : Jason Tan
 */

#include <avr/io.h>


int main(void)
{

    //pointer to PIN2CTRL array of pin configuration registers
    uint8_t* ptr = (uint8_t*)&PORTA.PIN2CTRL;
    PORTC_PIN0CTRL = 0x08;  //Enable internal pull up for PC0
    PORTC_PIN1CTRL = 0x08;  //Enable internal pull up for PC1

    //DIR is what configure the port pins as inputs or outputs
    VPORTA_DIR = 0x00;  //Configure PORTA pins ( PA7, PA6, PA5, PA4, PA3, PA2) as the inputs
    VPORTC_DIR = 0x00;   //Configure PORTC pins ( PC1, PC0) as the inputs
    VPORTD_DIR = 0xFF;   //Configure PORTD pins (PD07 through PD00) as output pins

    VPORTB_DIR = 0x08;   //PB3 output for LED0
    PORTB_PIN2CTRL = 0x08;  //Pull up enable for SW0

    //Configure PA7 - PA2 as input buffers with internal pull up resistors
    for(uint8_t i = 0; i < 8; i++){
        *(ptr + i) |= PORT_PULLUPEN_bm;
    }



    uint8_t n = 3;  //Field value starting from 3
    uint8_t field_mask = 0x0F; //Field mask
    uint8_t field_val; //Read PA3-PA2 and PC1-PC0.
    VPORTD_OUT = ~((VPORTA_IN & 0xFC) | (VPORTC_IN & 0x03));

    while (1)
    {
        //Check for if SW0 is press meaning that sends a logic 0
        field_val = ((VPORTC_IN & 0x03 ) | (VPORTA_IN & 0x0C));
        if(!(VPORTB_IN & PIN2_bm)){
            //                          0b1000 0111           0b1111 PA3 PA2 PC1 PC0 -> 1 PA3 PA2 PC1 PC0 000
            VPORTD_OUT = (VPORTD_OUT & ~(field_mask << n)) | (((field_val & field_mask) << n) ^ 0x78);
        }

    }
}
```

```c
/*
 * xor3_logic_ops.c
 *
 * Created: 2/6/2022 4:02:10 PM
 * Author : jason
 */

#include <avr/io.h>


int main(void)
{

    //pointer to PIN5CTRL array of pin configuration registers
    uint8_t* ptr = (uint8_t*)&PORTA.PIN2CTRL;

    //DIR is what configure the port pins as inputs or outputs
    VPORTA_DIR = 0x00;  //Configure PORTA pins ( PA7, PA6, PA5) as the inputs

    VPORTD_DIR = PIN7_bm;   //Configure (PD7) as output pin

    /*
    PA7 is "C"
    PA6 is "B"
    PA5 is "A"
    PD7 is "F"
    */

    //Configure PA7 - PA5 as input buffers with internal pull up resistors
    for(uint8_t i = 3; i < 8; i++){
        *(ptr + i) |= PORT_PULLUPEN_bm;
    }

    while (1)
    {
        uint8_t C = PORTA_IN & PIN7_bm;
        uint8_t B = (PORTA_IN & PIN6_bm) << 1;   //Shift left by 1 to bit 6 compare
          the bit 5 position (B) to bit 4 position (A)
        uint8_t A = (PORTA_IN & PIN5_bm) << 2;  //Shift left by 1 to compare the bit 5
           position (B) to bit 4 position (A)
        //Aligns the bit 7, bit 6 and bit 5 positions to compare


        PORTD_OUT = (((~C) ^ (~B) ^ (A)) ^ 0xFF ) | (((~C) ^ (B) ^ (~A)) ^ 0xFF ) |
          ( ((C) ^ (~B) ^ (~A)) ^ 0xFF) | (((C) ^ (B) ^ (A)) ^ 0xFF );


    }
}
```

```
/*
 * data.h
 *
 * Created: 2/6/2022 4:46:15 PM
 *  Author: Jason
 */


#ifndef DATA_H_
#define DATA_H_

typedef union {

    uint8_t byte;        //member used for register access

    struct{
        uint8_t bit0: 1;  //bit0
        uint8_t bit1: 1;    //bit1
        uint8_t bit2: 1;    //bit2
        uint8_t bit3: 1;//bit3
        uint8_t bit4: 1;//bit4
        uint8_t bit5: 1;//bit5
        uint8_t bit6: 1;//bit6
        uint8_t bit7: 1;//bit7


        }bvals;

    } Named_bits;



#endif /* DATA_H_ */
```

```c
/*
 * xor3_named_bits.c
 *
 * Created: 2/6/2022 4:32:55 PM
 * Author : Jason Tan
 */

#include <avr/io.h>
#include "data.h"


int main(void)
{
    //pointer to PIN5CTRL array of pin configuration registers
    uint8_t* ptr = (uint8_t*)&PORTA.PIN2CTRL;

    //DIR is what configure the port pins as inputs or outputs
    VPORTA_DIR = 0x00;  //Configure PORTA pins ( PA7, PA6, PA5) as the inputs
    VPORTD_DIR = 0x80;   //Configure (PD7) as output pin

    /*
    PA7 is "C"
    PA6 is "B"
    PA5 is "A"
    PD7 is "F"
    */

    //Configure PA7 - PA5 as input buffers with internal pull up resistors
    for(uint8_t i = 3; i < 8; i++){
        *(ptr + i) |= PORT_PULLUPEN_bm;
    }

    Named_bits data;   //Data to be processed

    uint8_t temp_in = 0xFF;  //Initialize the LED to be off
    uint8_t temp_out = 0x00;  //Initialize the temp output to be all 0x00

    while (1)
    {
        uint8_t C = PORTA_IN & PIN7_bm;
        uint8_t B = (PORTA_IN & PIN6_bm) << 1;
        uint8_t A = (PORTA_IN & PIN5_bm) << 2;

        data.byte = temp_in;  //Set that register as the initial output value



        //Canonical sum of products of the 3 input truth table and store that into
        data.byte =  (((~C) ^ (~B) ^ (A)) ^ 0xFF ) | (((~C) ^ (B) ^ (~A)) ^ 0xFF ) |
          (((C) ^ (~B) ^ (~A)) ^ 0xFF ) | (((C) ^ (B) ^ (A)) ^ 0xFF );

        //Store that bit result after doing the canonical sum of product
```

```
        temp_out = data.byte;

        //To output the result
        PORTD_OUT = temp_out;

    }
}
```