

ECE2049: Homework 4

Due: Tuesday, 14 June 2022 by 2pm EDT

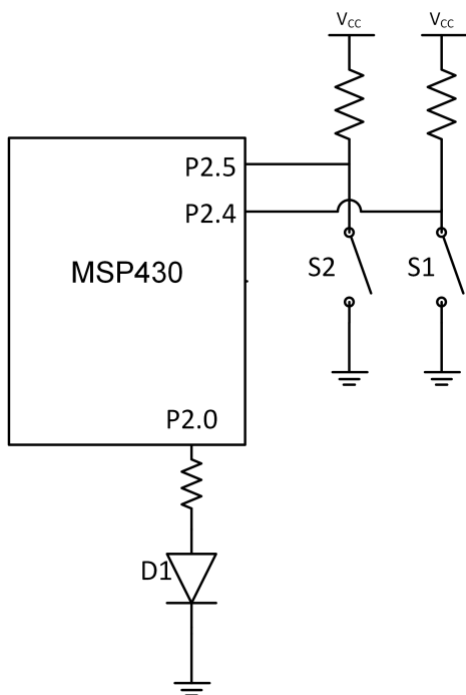
Submission notes:

- For full credit, please show your work and denote your answers with a circle or a box.
 - Always write or draw your diagrams neatly! We cannot be expected to GUESS what you meant to write! Some problems (such as those involving code) must be typed to be graded—the others may be handwritten (neatly!) or typed.
 - Points for each problem are as indicated. Some portions of problems are marked as “BONUS,” which count as extra credit.
1. (5 pts) **MSP430 architecture:** Using our notes from lecture 4, answer the following questions about memory on the MSP430F5529. Your answers should be at most one or two sentences.
- a. The MSP430 has both RAM and flash memory. Why does it need both? (In other words, why not just use one or the other?)
 - b. When you download code from CCS to the MSP430, is the code stored in RAM or Flash? How do you know?
 - c. True or False: The MSP430 CPU core has three sets of memory access instructions to access each region of memory (RAM, Flash, and peripherals). **Explain your reasoning.**

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1. (5 pts) In this example, two switches and a blue LED are connected to an MSP430F5529 running the code shown below. Answer the following questions about the configuration.



```
#include <msp430.h>
void configure_io(void)
{
    P2SEL &= ~(BIT5|BIT4|BIT0);
    P2DIR &= ~(BIT5|BIT4);
    P2DIR |= (BIT0);
}

void main(void)
{
    char val, s;

    configure_io();

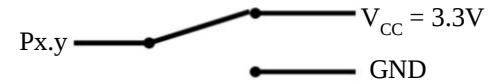
    while(1) {
        val = P2IN;
        s = (val & 0x60) >> 5;

        if(s > 1) {
            P2OUT &= ~BIT0;
        } else {
            P2OUT |= BIT0;
        }
    }
}
```

- a. This configuration example code does not use the P2REN register to enable internal pull-up/pull-down resistors. Does it need to be configured in this case? Explain why or why not.
- b. In the example main(), what happens to the LED (on or off) if `val = 0x7A`? What happens if `val = 0x1C`?

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2. (5 pts) Say you want to connect four slide-switches (also known as “single-pole, double-throw” switches) like the one shown at the right to P7.2 and P4.6-4. The switches operate such that when the switch is slid to the right, the pin is connected to GND (0V), and when slid to the left is connects to V_{CC} (3.3V).



- a. Try to complete the two functions `config_switches()` and `read_switches()` based on the skeleton and comments below. Your code must be typed—you can find this example as a C file on the course website as `switches.c`. We will review and discuss how to do this in detail in class.

```
#include <msp430.h>

// Function prototypes
void config_switches(void);
char read_switches(void);

// Example main() to demonstrate how the functions are used--no need to modify it.
void main(void)
{
    char val;
    WDTCTL = WDTPW + WDTHOLD;    // Stop watchdog timer
    config_switches();

    while(1)
    {
        val = read_switches();
        // Assume something with val happens here...
    }
}

void config_switches(void)
{
    // Configure switches here!
}

// Return a value between 0-Fh corresponding
// to the value of the switches, with the values
// of each switch in the following bit positions:
//      MSB                                LSB
// Bits 7-4   Bit 3   2.   1       0
// 0          P7.2  P4.6  P4.5    P4.4
char read_switches(void)
{
    char ret_val = 0;

    // Read switches and place the output
    // into the appropriate bit here!

    return ret_val;
}
```

- b. Assuming that your program has properly configured the slide switches, what should the function `read_switches()` return given the following register values? (Note, not all of these may be useful!)
- $P7IN = 0x55$, $P7OUT = 0x44$, $P4IN = 0xCF$, $P4OUT = 0xD8$