

CSCE 236 Embedded Systems, Spring 2015

Homework 5

Started: Tuesday, April 7th, 2015

Due: Thursday, April 16th, 2015 (start of class)

Instructions: This homework is an individual assignment, collaboration is not allowed. If you discuss any problems with others, please note this on the assignment as described in the syllabus. Also note any materials outside of lecture notes, course textbooks, and datasheets that you used. Show your work and describe your reasoning to get partial credit if your solution is incorrect. This homework is due on the date listed above before the start of class.

Name:

Problem 1 (5pts). *(To be completed at end of assignment) Approximately how much time did the total assignment take? Which problem took longest and how much time did it take?*

Problem 2. *Interrupts*

a) (5pts). *Give the C code to configure the registers to generate an interrupt from `Timer0`. Also give function definition for the interrupt handler for this interrupt.*

b) (5pts). *What are the steps that occur to switch from executing the main code to executing an interrupt handler code when an interrupt occurs?*

c) (5pts). *On the Arduino, how do you disable all interrupts? How do you enable them?*

d) (5pts). *On the Arduino, `timer0` is configured to generate an interrupt every millisecond to enable counting how many milliseconds have elapsed since startup (using the `millis()` function). If global interrupts are disabled for 0.5ms every other millisecond will the time reported by `millis()` be accurate? Explain your answer for full credit.*

e) (5pts). *If an interrupt requires 10 clock cycles to enter the interrupt handler, 30 clock cycles for the code to execute, and 10 to return to the prior code execution, then what is the maximum frequency that this interrupt can be handled if the processor is running at 10MHz?*

f) (5pts). *Describe two benefits of using interrupts in your code.*

g) (5pts). *Describe two problems and their causes that can occur when using interrupts in your code.*

h) (10pts). *What problem could occur with the below code? Describe one approach to fix it. Assume the serial port with RX interrupts is already configured properly.*

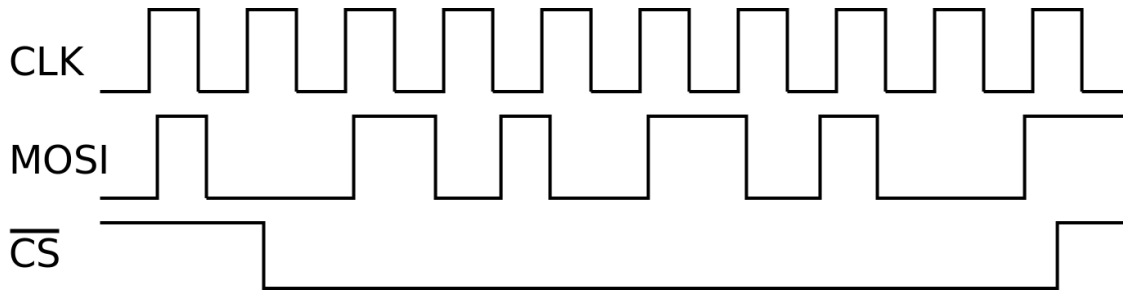
```
SIGNAL(USART_RX_vect){
    char t;
    if(!(UCSROA & (1<<RXCO))) return;
    if(Queue_ISFULL(uartORxQueue)) t = DEQUEUE(uartORxQueue);
    ENQUEUE(uartORxQueue,UDRO);
}

int8_t uartReceiveByte(char *c){
    if(Queue_ISEMPTY(uartORxQueue)) return 0;
    *c = DEQUEUE(uartORxQueue);
    return 1;
}

loop(){
    char c;
    if(uartReceiveByte(&c) == 1){
        uartSendByte(c);
    }
}
```

Problem 3. *Communication*

a) (5pts). *What are two advantages of parallel communication over serial communication methods?*



b) (5pts). In the above signal, what is the data stream (bit values) processed by the slave device if it is configured for data to be valid on the rising edge? What about for falling edge? Note that the \overline{CS} ("not CS") line means the device is active low, in other words it is selected when the line is low.

c) (5pts). Describe how SPI supports multiple slave devices.

d) (5pts). What is the fastest UART baud rate that could be generated on an Arduino with a 18MHz clock speed when in asynchronous normal mode? What about in double speed mode?

e) (5pts). How many bytes could be sent per second with a baud rate of 115200 when configured as:

```
//Use double speed here
UCSR0A = (1<<U2X0);
//Enable tx and rx
UCSR0B = (1<<RXEN0)|(1<<TXEN0);
//Set frame format to 8 data, 1 stop bits
UCSR0C = (3<<UCSZ00);
```

f) (5pts). *On an Arduino with a clock speed of 14MHz, what value does the serial port UBRRO register need to be set to in order to communicate with a baud rate of 38400 when in normal speed mode? What is the error associated with this setting?*

g) (5pts). *What does open-drain mean and why is it needed in I²C? Are both SCL and SDA open-drain?*

h) (5pts). *In I²C, how does the master tell the slave if it wants to write or read?*

i) (10pts). *In I²C, describe how arbitration works when there are multiple masters?*

Do not forget to fill in the amount of time you spent on this assignment in Question 1.