EEL 4742C: Embedded Systems
Homework 2

QUESTION 1. **(10 points)**

a) Timer_A is using a 500 KHz (500,000 Hz) clock signal. What is the timer's period (in seconds) if the continuous mode is used? Give the answer for all values of ID (Input Divider).

b) Timer_A is using a 500 KHz (500,000 Hz) clock signal. We're aiming at a timer period of 0.4 seconds using the up mode. Find suitable values of TACCR0 and ID (Input Divider). Give all the possible solutions.

QUESTION 2. **(10 points)**

a) Timer_A is using ACLK configured to a 8 KHz (8,192 Hz) crystal. What is the timer period if the continuous mode is used? Give the answer for all the values of ID (Input Divider).

b) Timer_A is using an 6 MHz (6,000,000 Hz) clock signal. Can we configure the timer to (directly) generate a delay of 0.5 seconds? Show your analysis.

QUESTION 3. **(10 points)**

To answer the questions below, look in the MSP430FR6989 Data Sheet (document: slas789c)

a) What is the FRAM (nonvolatile memory) size? (page 7)
b) What is the SRAM size?
c) How many Timer_A modules with 3 channels does this chip have? (page 7)
d) How many Timer_A modules with 5 channels does this chip have?
e) The eUSCI communication module consists of Channel A (UART, SPI) and Channel B (I2C, SPI). How many eUSCI modules does this chip have?
f) What is the "absolute maximum ratings" Vcc value? (page 29)
g) What is the "recommended operating conditions" Vcc range?
h) Is it acceptable to run the chip based on the absolute maximum ratings? Explain.

QUESTION 4. **(10 points)**

This question is a continuation of the previous question.

a) The VLO is an internal RC clock that has the lowest power consumption. What is the current drawn by VLO? What is the typical frequency and min/max frequency values of VLO? (page 44)
b) The MODOSC (Module Oscillator) is an internal RC clock. What is the current drawn by MODOSC? What is the typical frequency and min/max frequency values of MODOSC?
c) What is the typical resistor value (and min/max values) of the built-in resistor at the pins? (page 47)
d) What is the maximum current and corresponding power that can be drawn from the pin when Vcc=2.2V? What about Vcc=3.0V? (page 48)
e) Which vector has a higher interrupt priority Timer0_A's A0 or A1 vector? Give the word address for each of these vectors. (page 78)
f) Which timer has higher interrupt priority, Timer0_A or Timer1_A?
g) The variable P1DIR (like many others) is memory-mapped. To what address is this variable mapped? Compute the address in this way: base+offset = address. (page 135)

QUESTION 5. **(10 points)**

a) The rollback-to-zero event, Channels 1 and 2 share the vector A1. Who is responsible for clearing the interrupt flag?
b) The Channel 0 has its own vector. Who is responsible for clearing the interrupt?
c) Code #1 is running and interrupt occurs. Explain what happens regarding saving the status of the CPU.
d) Low-power mode 3 is engaged and an interrupt occurs. Explain what happens regarding saving the status of the CPU.
e) By default, are interrupts in MSP430 preemptable? Explain.
f) How is the interrupt priority in MSP430 determined?
g) What is the 'reset vector'? Where is it located?
h) A button is interfaced in the active low configuration using the built-in resistor. Should the resistor be pulled-up or pulled-down? What about the active high configuration?

Practice Questions

Do not submit; these questions were solved in the class.

PRACTICE 1.

a) *Using the continuous mode…*

Write a C code that uses Timer_A in the continuous mode. Use ACLK based on the 12 KHz (12,000) VLO. Within the timer, adjust the clock signal so that is becomes 6,000 Hz. Each time TAR rolls back to zero, toggle the red LED, which is mapped to Port 1.0 and is active high. What is the timer's period? **Use polling, i.e., poll the timer flag to find out when the duration has elapsed.**

Before writing the code, fill the configuration below by looking at the help sheet.

Configuration
TASSEL =
ID =
Mode =
TACLR =

b) Using the up mode…

Write a C code that uses Timer_A in the up mode. Use ACLK based on the 12 KHz VLO. Within the timer, adjust the clock signal so that is becomes 3,000 Hz. Our goal is to generate a delay of 0.5 seconds. How many cycles does this correspond to? When the duration of the timer elapses, toggle the red LED, which is mapped to Port 1.0 and is active high. **Use polling, i.e., poll the timer flag to find out when the duration has elapsed.**

Before writing the code, fill the configuration below by looking at the help sheet.

Configuration
TASSEL =
ID =
Mode =
TACLR =
TACCR0 =

```
If you run this code on the basic LaunchPad (G2553), use these lines
to divert ACLK to the 12 KHz VLO.

// Code that sets ACLK to VLO @ 12 KHz
// Write this at the top of the main
BCSCTL1 &= ~XTS;          // Set XTS=0
BCSCTL3 &= ~LFXT1S_3;     // Clear LFXT1S
BCSCTL3 |= LFXT1S_2;      // Set LFXT1S=2 (VLO)
```

PRACTICE 2.

Write a C code that uses Timer_A based on SMCLK (set to ~1 MHz by default). Our goal is to generate a 4-second delay. The problem is that this clock frequency is very high and a 4-second delay is a huge number of cycles that can't be measured with a 16-bit register. First, divide the clock by 8 to slow it down. Then, use the 'up mode' to generate a delay of 0.4 seconds. Then, write a code that counts ten such delays to get a 4-second delay. Upon the 4-second interval, flash the red LED, which is mapped to P1.0 (active high). **Use polling, i.e., poll the timer flag to find out when the duration has elapsed.**

Start by writing the timer's configuration.

Configuration
TASSEL =
ID =
Mode =
TACLR =
TACCR0 =