HACETTEPE UNIVERSITY

ELECTRICAL AND ELECTRONICS ENGINEERING

ELE417 – EMBEDDED SYSTEM DESIGN

EXPERIMENT II – TIMER USAGE ON MSP430

PRELIMINARY WORK II

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Q1.)

A timer in the embedded system concept is a special type of clock used to measure time intervals. A timer that counts up from zero to measure elapsed time is often called a stopwatch. A device that counts down from a specified time interval and is used to create a time delay, for example an hourglass is a timer.

Usages of timers:

1. Measuring the interval of time between two-time instants.
2. Frequency of a specific signal
3. Implementing a PWM output
4. Controlling the sampling rate of the ADCs

Q2.)

Using any loop is not a reliable way to measure or pass the required time. The Loops are not an efficient way as processing time is difficult to detect, can vary by hardware, and uses unnecessary processing units.

On the other hand, timers provide precise measurement times and intervals. Because only hardware is used and it works asynchronously with the code. Thus, timers are more accurate and efficient than idle loops, leaving the CPU free for other processes.

Q3.)

The main function of the watchdog timer is to protect the system against malfunctions. The Watchdog timer can be used instead of interval timers. Also, if we need to soft reset the chip, we can use the Watchdog timer.

The Watchdog timer does not have a compare mode whereas Timer A has the TAxCCR and TAxCCTLy register to compare the value of the timer with a predefined value.

Timer A is a special type of clock used to measure specific time intervals. On the other hand, a monitoring timer essentially ensures that the embedded system is not constantly in a state of software or hardware failure.

Timer B can drive outputs such as pulse width modulation (PWM), while the Watchdog timer cannot.

Q4.)

MSP-EX430G2ET LaunchPad kits are required by practitioners at Hacettepe University. MSP430G2553 microcontroller is used in LaunchPad kit.

	Register Name	**Definition**
Watchdog Timer	**WDTCTL**	Watchdog timer control register, 16-bit
Timer A	**TAxCCR0/1/2**	Capture/compare registers. Three for each timer
	TAxCCTL0/1/2	Capture/compare control registers. Three for each timer
	TAxR	Timer A counter register
	TAxCTL	Timer A control register, 16-bit
	TAxIV	Timer A interrupt vector

Q5.)

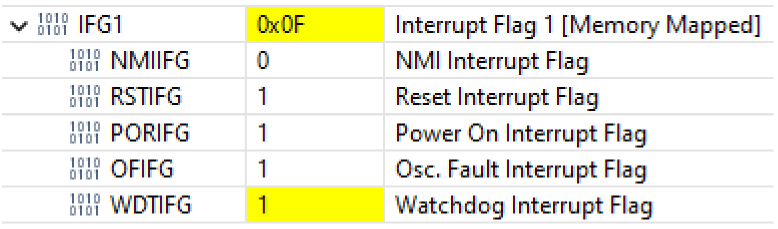
A soft reset clears any information in the random access memory of the device related to the applications. A soft reset can help in fixing malfunctioning applications, solve problems of slowness in the device, fix incorrect settings or help in solving software related problems. It can often help
in cases where the device appears frozen or is running inefficiently.

There are several ways to reset an MSP430 in software. Some of them:

1. Enable the Watchdog and make an empty loop. This will cause a watchdog reset.
2. Writing to the WDT register without usign the proper password. This will cause a password violation reset.
3. Writing to flash while flash write flags are disabled generates a fault that cause a NMI,very similar to a reset.

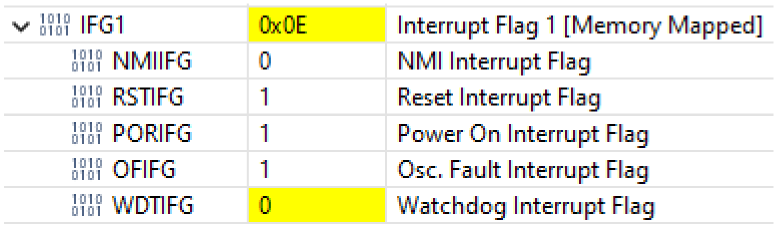
Q6.)

```
#include <msp430.h>
#define GreenLed BIT0
#define RedLed BIT6

void main(void){

    WDTCTL = WDT_ADLY_1000;                  // WDT is set for 1 second intervals
    P1DIR |= (GreenLed|RedLed);              // P1.0 and P1.6 are configured as outputs

    P1OUT &= ~(GreenLed|RedLed);             // All Leds OFF.
    while(1){
        while(!(IFG1 & WDTIFG));             // Wait for WDT to reach the limit

        // Reaches the limit.
        IFG1 &= ~WDTIFG;                     // Clear WDT interrupt flag when counter
        P1OUT ^= (GreenLed|RedLed);          // Toggle the LEDs.
    }
}
```



IFG1	0x0F	Interrupt Flag 1 [Memory Mapped]
NMIIFG	0	NMI Interrupt Flag
RSTIFG	1	Reset Interrupt Flag
PORIFG	1	Power On Interrupt Flag
OFIFG	1	Osc. Fault Interrupt Flag
WDTIFG	1	Watchdog Interrupt Flag

Figure 1. When the Timer Ends



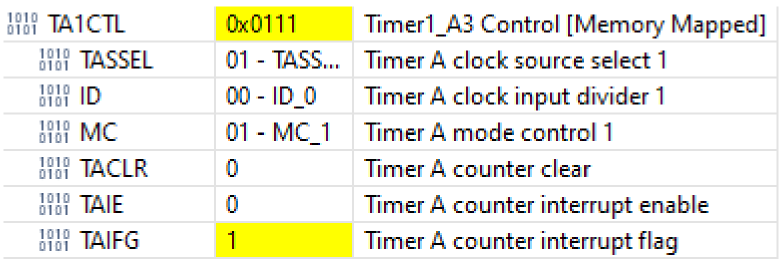
IFG1	0x0E	Interrupt Flag 1 [Memory Mapped]
NMIIFG	0	NMI Interrupt Flag
RSTIFG	1	Reset Interrupt Flag
PORIFG	1	Power On Interrupt Flag
OFIFG	1	Osc. Fault Interrupt Flag
WDTIFG	0	Watchdog Interrupt Flag

Figure 2. Waiting on the Timer

WDTIFG is 0 while waiting on the timer. It becomes 1 when it exits the timer and is set to 0 to enter the timer again.

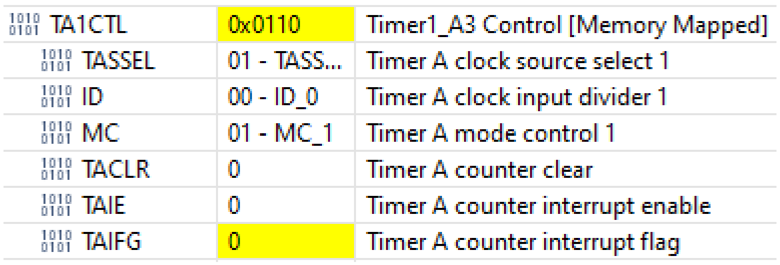
Q7.)

```
#include <msp430.h>
#define GreenLed BIT0
#define RedLed BIT6

void main(void){

    WDTCTL = WDTPW | WDTHOLD;      // Stop Watchdog Timer

    // Timer A is configured to work in up mode and generate 1 second intervals
    // TASSEL_1 selects ACLK (32 KHz), MC_1 selects up mode
    // TACLR is Timer A counter clear and ID_0 is Timer A input divider with 1
    TA1CTL = TASSEL_1 | MC_1 | TACLR | ID_0;
    TA1CCR0 = 31999;                 // Count to 31999

    P1DIR = (GreenLed|RedLed);       //LEDs are configured as outputs
    P1OUT &= ~(GreenLed|RedLed);
    while(1){
        while((TA1CTL & TAIFG) != TAIFG);

        TA1CTL &= ~TAIFG;            // Clear Timer A Interrupt Flag
        P1OUT ^= (GreenLed|RedLed); // Toggle the LEDs
    }
}
```



TA1CTL	0x0111	Timer1_A3 Control [Memory Mapped]
TASSEL	01 - TASS...	Timer A clock source select 1
ID	00 - ID_0	Timer A clock input divider 1
MC	01 - MC_1	Timer A mode control 1
TACLR	0	Timer A counter clear
TAIE	0	Timer A counter interrupt enable
TAIFG	1	Timer A counter interrupt flag

Figure 3. When the Timer Ends



TA1CTL	0x0110	Timer1_A3 Control [Memory Mapped]
TASSEL	01 - TASS...	Timer A clock source select 1
ID	00 - ID_0	Timer A clock input divider 1
MC	01 - MC_1	Timer A mode control 1
TACLR	0	Timer A counter clear
TAIE	0	Timer A counter interrupt enable
TAIFG	0	Timer A counter interrupt flag

Figure 4. Waiting on the Timer

Q8.)

```
#include <msp430.h>
#define GreenLed BIT0

Void TimerA_Delay(int DelayFlag){   // Function to change Timer A delay
    if(DelayFlag){ // Short Delay
        TA1CTL = TA1CTL = TASSEL_1 | MC_1 | TACLR | ID_0;
        TA1CCR0 = 31999;
    }
    else{       // Long Delay
        TA1CTL = TA1CTL = TASSEL_1 | MC_1 | TACLR | ID_1;
        TA1CCR0 = 63999;
    }
    while(!(TA1CTL & TAIFG));
}

void main(void){
    WDTCTL = WDTPW | WDTHOLD;   // Stop Watchdog Timer
    P1DIR = GreenLed;           // P1.0 (Green LED) configured as output
    P1OUT &= ~GreenLed;
    volatile int DelayFlag = 1; // flag controls when to change delay
    while(1){
        if(DelayFlag){
            P1OUT ^= GreenLed;
            TimerA_Delay(DelayFlag);
            P1OUT ^= GreenLed;
            TimerA_Delay(DelayFlag);
            DelayFlag = 0;
        }
        else{
            P1OUT ^= GreenLed;
            TimerA_Delay(DelayFlag);
            P1OUT ^= GreenLed;
            TimerA_Delay(DelayFlag);
            DelayFlag = 1;
        }
    }
}
```

I am specifying LongDelay and ShortDelay using TimerA_Delay function. If I send "1" to the function, Short Delay is applied, if I send "0", LongDelay is applied. Waiting is also done inside the function.