CENG 412 Embedded Systems
Lab 12 Event Counting and Interrupt Programming

Name _____

Signature Part A _____ **Part B** _____

Introduction

In the first part of this lab you will use the Pulse Accumulator function of the HCS12 to count the pulses produced at the Quad encoded output of a DC motor. nd duty cycles. The second part of this lab will explore interrupt programming.

Procedure A – Event Counting - C Code Implementation

Create a C project in CodeWarrior to configure a 16 bit Pulse Accumulator function of the HCS12. The program will use PT7 of Port T. The count will be displayed on Port H until the count reaches zero at which point the code will print-out a message. Connect a DC voltage to the M+ and M- terminals to power the DC motor so that the motor is rotating slow enough that you can easily count motor rotations. Connect a 1 kΩ pull-up resistor to +5V and either of the ChA or ChB quadrature outputs of the motor. Be sure to connect VCC (+5 V) and ground to the quadrature circuitry. Connect the ChA (or ChB as appropriate) output to the PT7 pin.

You will need to do the necessary work to allow the printf function to be used in your code. See previous labs for details.

What pin number is used for PT7 of Port T? _____

```
/*****************************************
;*      Event Counting Lab
;*  This program reads the QUAD output of a DC motor
;*  using the 16 bit Pulse Accumulator of the HCS12.
;*
;*  The C program sets a value that determines how many rotations
;*  of the motor will occur before a message is printed out.
;*
;*****************************************/

#include <hidef.h>          /* common defines and macros */
#include "derivative.h"     /* derivative-specific definitions */
#include <stdio.h>

 void main(void) {
   unsigned int count=900;     //set count value
   count=~count+1;             //2's comp of count
   DDRH=0xFF;                  //initialize PORTH as O/P
   DDRT&=~0x80;                //make PT7 input
   PACTL=0x??;                 //enable 16 bit event count, ni, rising edge
   PACN32=count;               //load count into Pulse Accum register

   while(PACN32)
   {
      PTH=PACN32;              //display value until count=0
```

```
    }

   printf("The count is done \n\r");   /* \n=LF  \r=CR  */

   asm("swi");
}
```

Testing Your Program

How many pulses/rotation does the DC motor's Quad output produce? _____

What is the value of the Count parameter in the code? _____

How many rotations will the motor make before printing out the message? _____

Download the program and at the same time as you execute the program start counting motor rotations until the message prints out.

How many rotations did you count? _____

Demonstrate your program and have your lab sheet signed.

Part B – Interrupt Programming – Assembly Code Implementation

This part of the lab will introduce a structure for Interrupt Programming in Assembly language. The lab uses the IRQ hardware interrupt.

You will need the Switch/LED I/O board. Connect the switches to Port B and the LEDs to Port A using ribbon cables. Connect +5 V and ground to the Switch/LED I/O board.

The Main or foreground program in the code reads a value from the switches and displays the value on the LEDs. A TTL signal at 1 Hz from a function generator is connected to the IRQ interrupt pin. The code enables this interrupt and selects to respond to a signal edge. Each TTL signal transition causes an interrupt to occur that executes the Interrupt Service Routine. The ISR will increment a counter and display the value of the count at Port H.

Fill in the missing information in the code.

What is the Demo board pin number used for the IRQ interrupt? _____

What is the address of INTCR (Interrupt Control Register)? _____

What is the address of IRQ Interrupt in the DBug 12 vector table? _____

What is the configuration byte needed for INTCR? _____

Download the program before you connect the function generator.

Connect the function generator.

Run the program and test the code according to the instructions on the last page.

```
;*****************************************************************
;*  Program Name: IRQInterruptAssembler
;*  This Assembly program uses the IRQ interrupt on the HCS 12.
;*
;*  A 1 Hz TTL wave form is connected to a pin on the H2 header.
;*  Each edge causes an interrupt that increments a counter connected to Port H.
;*
;*  Note: The code cannot be downloaded to the HCS12 with the signal present
;*****************************************************************

       include mc9s12dp256.inc

;register addresses defined in the file mc9s12dp256.inc

UserIRQ:      equ  $????    ;IRQ interrupt vector address for DeBUG 12

stack:        equ  $3BFF

                ORG  $1000
count:  ds.b  1                    ;reserve 1 byte for count

                ORG  $2000
       lds  #stack                 ;set up stack pointer
       movb  #$00,DDRA             ;configure port A as input
       movb #$FF,DDRB              ;configure port B as output
       bset PUCR,$02               ;enable Pull-up resistors for Port B
       movw #IRQISR,UserIRQ        ;set up Interrupt vector in RAM
       clr  count                  ;zero counter
       movb  #$FF,DDRH             ;configure port H as output
       movb  count,PTH             ;send count to LEDs/Port H
       movb #$??,INTCR             ;enable IRQ pin interrupt, set edge triggering
       cli                         ;clear I bit in CCR - disables all interrupts

;main program – reads switches at Port B and mirrors value to Port A

again:
       ldab    PORTB               ;read Port B
       stab    PORTA               ;send value to Port A
       bra again
       swi                         ;code never reaches here

;Interrupt Service Routine

IRQISR:
       inc count
       movb count,PTH              ;send count to LEDs/Port H
       rti
       end
```

Testing Your Program

Verify the main program operation
Change the switch settings and observe that the LEDS mirror these settings.

Verify the ISR operation
Each pulse from the function generator should cause an interrupt to occur in the program which will increment the Count and display the Count value at Port H.

Observe the count on the LEDs at Port H.

Are the LEDs counting up in a uniform manner? _____

What happens if you increase the function generator frequency to 5 Hz? _____

Demonstrate your program and have your lab sheet signed.

Lab Exercise
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