Micro Assembly Language Programming
Lab 5
Simple I/O with the HCS12

Name _________________ Lab Group: _______ Signed _____________________

Introduction

The purpose of this exercise is to write some simple HCS12 programs to demonstrate output capabilities of the S12 board. We will use the LEDs on the DEMO board that is part of the HCS12 workstation. LED segments 0-7 are connected to port H of the microcontroller. To output to the LEDs you must first configure Port H to be an output port by writing 1s to the Port H Data Direction Register found at address $262. Once the data direction register is configured the data written to Port H at address $260 will be output to the LEDs. A “1” will turn on the LED and a “0” will turn it off.

```
PORTH: equ   $260 ;port H data register
DDRH:  equ   $262 ;port H data direction register (0-input, 1-output)
```

Figure 1: Basic Port H Registers

Part 1: Flashing LEDs

1. We can explore the control of the LEDs using the D-Bug12 monitor. Try the following commands:

   mm 262 FF (set all 8 bits of port H data direction register for output)
   mm 260 FF (turn on all 8 LED segments)
   mm 260 01 (turn on only LED 0)
   mm 260 55 (turn on every other LED)
   mm 260 00 (turn off all LEDs)

   Try some other LED patterns. What data will turn on only LED 7? ________________
   What data will turn on LED 0 and 7? ____________________

2. Enter the program shown at the end of the lab into AsmIDE. Modify it to include your name and the date. This program uses the delay loop we developed in class. Look at the values of the variables Pattern1 and Pattern2 and make a prediction of what you should see on the display.

   The E clock on our HCS12 boards is 24 MHz, what is the period of one cycle of the E clock? _________________

   The **opt C** directive in the program delay subroutine causes the assembler to display the number of clock cycles required for each instruction in the listing file.

   How many clock cycles are used for each loop of the delay routine? ___________

   Calculate the time for the delay loop to execute once. __________________

   Show work

   Calculate the time for the complete Delay subroutine to execute. ___________________

   Show work

The Delay subroutine is using register X for the delay constant. What is the maximum value that can be placed in Register X? _____________

3. Assemble your program, download it to the HCS12 board and run the program. Describe what you see.

This program, adapted from a microcontroller using a 1 MHz clock, was designed to give a clearly visible output.

Are you able to see the pattern alternating? Yes/No

Why or Why Not?

Part 2: Longer Delay

1. The flashing LEDs in Part 1 are too fast. The single loop delay is not long enough. Modify the delay routine to use nested loops to allow a longer delay. Use the B register to control an outer loop. Use the inner loop as given in Part 1 with the X value of 40000. Write the nested Delay loop to make a 1 second delay.

   What value has to be in B to make a 1 second delay? ____________

   Test your program and confirm that the delay is working properly.

   It is possible to use your nested delay loop to make longer delays. Yes/No

   What is the maximum value you can place in the B register? ________________

   Calculate the maximum delay possible with the maximum value only loaded into the B register (X loaded with 40000). ________________

   Show work

   Calculate the maximum delay possible with the maximum values loaded into the X and the B registers. _____________

   Show work

   Demonstrate the working program.

Question:

1. Why are our calculations of the time delay values only seen as approximations?

Part 3: A 4-bit Counter

Write a program to create and display a 4 bit binary up-counter (counts from 0000 to 1111 in binary) on the LEDs. Call the Delay subroutine each time you output a count and when the Delay is complete increment the counter. When the counter reaches 1111 it starts over with 0000 and runs continuously. Use the modified Delay subroutine from Part 2.

Hint: Start with an 8-bit counter program code from Lab 1 and edit the program to go back to 0000 after it reaches 1111.

Demonstrate the working program.

Lab Evaluation

1. Demonstrate the working program for Part 2 and 3 to your instructor.
2. Documentation of programs is important. The header must give the program name and description, your name and the date. Comments in the code should describe what the program is doing, NOT what the machine instructions are doing.
3. Print the .asm files for the programs (Part 2 and Part 3 only). Hand in the printouts together with these lab sheets.

```
;***************************************************************
;
;   Program Name:  Lab5-1 - Output LED Pattern
;
;   This program outputs alternating "on-off" patterns to the LEDs
;   connected to Port H.
;
;****************************************************************
STACK:      equu   $3C00
REGBLK:     equ    $0000

PORTH:      equ    $260 ;port H data register
DDRH:       equ    $262 ;port H direction register (0-input, 1-output)

Pattern1:  equ   $55
Pattern2:  equ   $AA

           org   $2000

start:      lds    #STACK          ; initialize stack
            ldx    #REGBLK         ; initialize X to point to registers

            ldaa   #$FF            ; make port H pins output
            staa   DDRH,x
repeat:     ldaa   #Pattern1
            staa   PORTH,x
            bsr    Delay
            ldaa   #Pattern2
            staa   PORTH,x
            bsr    Delay
            bra    repeat
            swi

;************************************
;
; Delay - a simple delay subroutine
;
;*************************************
            opt    c

Delay:      PSHX
            LDX    #60000
do_again:   NOP                    ;1 clock cycle
            NOP                    ;1 clock cycle
            NOP                    ;1 clock cycle
            DEX                    ;1 clock cycle
            BNE    do_again        ;3 clock cycles
            PULX
            RTS

            end
```