Department of Electrical and Computer Engineering

EE 3710 Lab 7

Title: Digital Thermostat.

Objective: The student should be able to write and test a program that reads
                an A/D converter, scales the data as appropriate and displays it on
                the LCD, then uses that data to make control decisions.

Parts: Project from Lab 6
                1 or 2 – 50k potentiometer

Preparation: Write the title and a short description of this lab in your lab book.
                Make sure the page is numbered and make an entry in the table of
                contents for this lab.

                Design a circuit that uses the 2.4V reference from the C8051F020,
                the analog ground and a potentiometer to generate an analog
                voltage that is proportional to the potentiometer setting. Feed this
                voltage into an A/D converter input on the C8051F020. Record
                your schematic in your lab book.

                Mount the potentiometer on the project board. All of the necessary
                connection points (voltage reference, analog ground and A/D
                inputs) can be found on J24.

                Write an 8051 assembly program (thermost.asm) that meets the
                following requirements:

                1. The internal temperature sensor of the C8051F020 shall be read
                at a rate of at least twice per second. The result shall be used to
                compute the temperature in Fahrenheit, and that result shall be
                displayed continuously on the LCD.

                2. The analog voltage on the potentiometer shall be read at a rate
                of at least twice per second. This value shall be scaled to a range
                of 55-85 degrees and be displayed continuously as the thermostat
                set-point.

                3. If the temperature is less than the set point, all LEDs shall be
                turned on, otherwise all LEDs shall be turned off.

                Note: You will have to configure the A/D converter and turn on the
                voltage reference. Refer to the datasheet for details about how this
                is done.

Note: For best results, read each analog input (temperature sensor and potentiometer) at least 256 times and compute the average. This will greatly reduce noise and flicker.

Create a project file for this lab, Add thermost.asm to your project and build it. Make sure there are no assembly errors, then print a copy of your assembly code and affix it to your lab book.

Lab Work: Connect to your project and download your program.

Verify that after reset, the LCD shows the current temperature. (The voltage reference on the C8051F020 is not very precise, so expect some error in your displayed temperature.)

Using the potentiometers, adjust the set point from 55° to 85° to verify the full range. Set the temperature set-point equal to the current temperature and verify all LEDs are off. Set the temperature set-point one degree less than the current temperature and verify that all LEDs are on.

Gently heat the C8051F020 and verify that the displayed temperature rises and the LED turns off.

Use component cooler spray to cool the C8051F020 (or simply remove the heat source) and verify that the displayed temperature falls and that the LEDs turn back on.

Write a summary/conclusion for this lab in your lab book.

Demonstrate your working system lab instructor.

Notes: The following assembly file contains a 5x8 pixel font for characters 20H (space) up through 7EH (tilde) that may be of some use to you. The least significant bit is on the top, so you may have to swap the bits, depending on how you orient your LCD. Note that character 7F is usually unprintable (DEL), but in this font it is a degree (°) symbol.

```
font5x8:
  db  000H, 000H, 000H, 000H, 000H ;
  db  000H, 006H, 05FH, 006H, 000H ; !
  db  007H, 003H, 000H, 007H, 003H ; "
  db  024H, 07EH, 024H, 07EH, 024H ; #
  db  024H, 02BH, 06AH, 012H, 000H ; $
  db  063H, 013H, 008H, 064H, 063H ; %
  db  036H, 049H, 056H, 020H, 050H ; &
  db  000H, 007H, 003H, 000H, 000H ; '
  db  000H, 03EH, 041H, 000H, 000H ; (
```

```
db  000H, 041H, 03EH, 000H, 000H ; )
db  008H, 03EH, 01CH, 03EH, 008H ; *
db  008H, 008H, 03EH, 008H, 008H ; +
db  000H, 0E0H, 060H, 000H, 000H ; ,
db  008H, 008H, 008H, 008H, 008H ; -
db  000H, 060H, 060H, 000H, 000H ; .
db  020H, 010H, 008H, 004H, 002H ; /
db  03EH, 051H, 049H, 045H, 03EH ; 0
db  000H, 042H, 07FH, 040H, 000H ; 1
db  062H, 051H, 049H, 049H, 046H ; 2
db  022H, 049H, 049H, 049H, 036H ; 3
db  018H, 014H, 012H, 07FH, 010H ; 4
db  02FH, 049H, 049H, 049H, 031H ; 5
db  03CH, 04AH, 049H, 049H, 030H ; 6
db  001H, 071H, 009H, 005H, 003H ; 7
db  036H, 049H, 049H, 049H, 036H ; 8
db  006H, 049H, 049H, 029H, 01EH ; 9
db  000H, 06CH, 06CH, 000H, 000H ; :
db  000H, 0ECH, 06CH, 000H, 000H ; ;
db  008H, 014H, 022H, 041H, 000H ; <
db  024H, 024H, 024H, 024H, 024H ; =
db  000H, 041H, 022H, 014H, 008H ; >
db  002H, 001H, 059H, 009H, 006H ; ?
db  03EH, 041H, 05DH, 055H, 01EH ; @
db  07EH, 011H, 011H, 011H, 07EH ; A
db  07FH, 049H, 049H, 049H, 036H ; B
db  03EH, 041H, 041H, 041H, 022H ; C
db  07FH, 041H, 041H, 041H, 03EH ; D
db  07FH, 049H, 049H, 049H, 041H ; E
db  07FH, 009H, 009H, 009H, 001H ; F
db  03EH, 041H, 049H, 049H, 07AH ; G
db  07FH, 008H, 008H, 008H, 07FH ; H
db  000H, 041H, 07FH, 041H, 000H ; I
db  030H, 040H, 040H, 040H, 03FH ; J
db  07FH, 008H, 014H, 022H, 041H ; K
db  07FH, 040H, 040H, 040H, 040H ; L
db  07FH, 002H, 004H, 002H, 07FH ; M
db  07FH, 002H, 004H, 008H, 07FH ; N
db  03EH, 041H, 041H, 041H, 03EH ; O
db  07FH, 009H, 009H, 009H, 006H ; P
db  03EH, 041H, 051H, 021H, 05EH ; Q
db  07FH, 009H, 009H, 019H, 066H ; R
db  026H, 049H, 049H, 049H, 032H ; S
db  001H, 001H, 07FH, 001H, 001H ; T
db  03FH, 040H, 040H, 040H, 03FH ; U
db  01FH, 020H, 040H, 020H, 01FH ; V
db  03FH, 040H, 03CH, 040H, 03FH ; W
db  063H, 014H, 008H, 014H, 063H ; X
db  007H, 008H, 070H, 008H, 007H ; Y
db  071H, 049H, 045H, 043H, 000H ; Z
db  000H, 07FH, 041H, 041H, 000H ; [
db  002H, 004H, 008H, 010H, 020H ; \
db  000H, 041H, 041H, 07FH, 000H ; ]
db  004H, 002H, 001H, 002H, 004H ; ^
db  080H, 080H, 080H, 080H, 080H ; _
db  000H, 003H, 007H, 000H, 000H ; `
db  020H, 054H, 054H, 054H, 078H ; a
```

```
        db  07FH, 044H, 044H, 044H, 038H ; b
        db  038H, 044H, 044H, 044H, 028H ; c
        db  038H, 044H, 044H, 044H, 07FH ; d
        db  038H, 054H, 054H, 054H, 008H ; e
        db  008H, 07EH, 009H, 009H, 000H ; f
        db  018H, 0A4H, 0A4H, 0A4H, 07CH ; g
        db  07FH, 004H, 004H, 078H, 000H ; h
        db  000H, 000H, 07DH, 040H, 000H ; i
        db  040H, 080H, 084H, 07DH, 000H ; j
        db  07FH, 010H, 028H, 044H, 000H ; k
        db  000H, 000H, 07FH, 040H, 000H ; l
        db  07CH, 004H, 018H, 004H, 078H ; m
        db  07CH, 004H, 004H, 078H, 000H ; n
        db  038H, 044H, 044H, 044H, 038H ; o
        db  0FCH, 044H, 044H, 044H, 038H ; p
        db  038H, 044H, 044H, 044H, 0FCH ; q
        db  044H, 078H, 044H, 004H, 008H ; r
        db  008H, 054H, 054H, 054H, 020H ; s
        db  004H, 03EH, 044H, 024H, 000H ; t
        db  03CH, 040H, 020H, 07CH, 000H ; u
        db  01CH, 020H, 040H, 020H, 01CH ; v
        db  03CH, 060H, 030H, 060H, 03CH ; w
        db  06CH, 010H, 010H, 06CH, 000H ; x
        db  09CH, 0A0H, 060H, 03CH, 000H ; y
        db  064H, 054H, 054H, 04CH, 000H ; z
        db  008H, 03EH, 041H, 041H, 000H ; {
        db  000H, 000H, 077H, 000H, 000H ; |
        db  000H, 041H, 041H, 03EH, 008H ; }
        db  002H, 001H, 002H, 001H, 000H ; ~
        db  006H, 009H, 009H, 006H, 000H ; °
```