ECE 265
Computer Problem #5

In this computer problem, you will add two additional features to the programmable home thermostat (PHT). In particular, you will use the M68HC11’s on-board A/D converter to read the room temperature and display it on the LCD panel. You will also add an ON/OFF feature for the furnace. When the room temperature (TEMP) is below the temperature setting (TEMP_SET), the furnace will be turned on (ON/OFF = 1). Otherwise, the furnace will be off (ON/OFF = 0).

The furnace is interfaced through Port B of the M68HC11 while the temperature transducer is interfaced to Port E, Bit 4 (PE4) so that the result is available in register ADR1:

\[
\begin{array}{c|c}
\text{ADR1} & \text{ADR1} \\
\hline
\text{1004} & 0 \\
\text{1031} & 7
\end{array}
\]

The control for the A/D converter should be set up for continuous conversion of Channel 4 only.

When the PHT is operating properly, typical results may appear as follows:

![Typical result image]

The temperature setting is shown at 69°F and may be changed through Port C and STRA (CHANGE_TEMP). The room temperature is 67°F, and since it is below the desired temperature setting, the furnace is turned on (ON/OFF = PB0 = 1).
The following template may be used to develop your program:

*  
* Computer Problem #5, ECE 265  
*  
* Your Name  
* Your Partner’s Name  
*  
STACK EQU $00FF ; set up the stack and port  
PIOC EQU $1002 ; addresses  
PORTC EQU $1003  
PORTB EQU $1004  
PORTCL EQU $1005  
ADCTL EQU $1030  
ADR1 EQU $1031  
OPTION EQU $1039  
LCDDATA EQU $1040  
LCDCtrl EQU $1041  

ORG 0  
TEMP_DEF FCB $72 ; set the default temperature  
TEMP_SET RMB 1 ; desired temperature setting  
TEMP RMB 1 ; room temperature  
TMP1 RMB 1  
TMP2 RMB 2  

ORG $E000  
MAIN: LDS #STACK ; initialize the stack pointer  

; initialize port control  

LDAA PORTC ; read Port C  
JSR INIT_TEMP ; initialize TEMP_SET  

; enable interrupts
LOOP:  JSR  PRINT  ; print TEMP_SET to LCD  
        ; display  
JSR  A_TO_D  ; determine TEMP  
JSR  PRINT_TEMP  ; print TEMP to LCD display  
JSR  FURNACE  ; turn furnace ON or OFF  

BRA  LOOP

Note that subroutine UP_DOWN is not explicitly called by the main program (polling) since it is used on an interrupt basis.

In addition to printing the desire temperature setting (TEMP_SET) and room temperature (TEMP) on the LCD display, the main loop determines the room temperature (subroutine A_TO_D) and turns the furnace on or off (subroutine FURNACE). Subroutine FURNACE simply turns the furnace on (ON/OFF=1) if TEMP is less than TEMP_SET; otherwise, the furnace should be off.

Subroutine A_TO_D reads the voltage from the temperature transducer on PE4, which is available in the ADR1 register, scales the input to compute the room temperature in binary, and converts the room temperature to BCD and stores it in TEMP. To scale the input, the temperature reading in ADR1 should be divided by 2, and the remainder discarded. Further, the scaled value should be limited to 99 (63) before converting it to BCD to determine TEMP. The room temperature (TEMP) displayed on the LCD panel then, has a range of 0-99°F.

Use the appropriate slider bar on the Sliders E Port input device to furnish a temperature voltage (0-5v FSR). After you have successfully written and tested the program to produce the desired results, then upload the assembly language program (pht5.asm) to the Computer Problem #5 dropbox on Carmen. Be sure that all features from the previous computer problems for the PHT are working properly. Also, print copies of the following three pages and turn them in during class on the due date:

1. pht5.LST
2. THRSim11 IO Box Window
3. Sliders E Port Window

The THRSim11 IO Box Window should show some typical results. Only one hardcopy of the program and results needs to be turned in for each group, but each person should upload pht5.asm through their Carmen account.