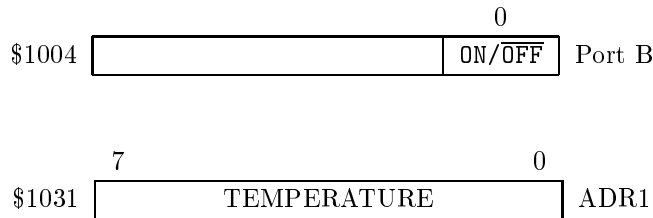


# ECE 265

## Computer Problem #5

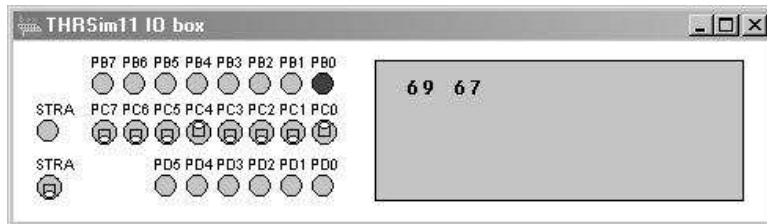
In this computer problem, you will add two additional features to the programmable home thermostat (PHT). In particular, you will use the M68HC11's on-board A/D converter to read the room temperature and display it on the LCD panel. You will also add an  $\text{ON}/\overline{\text{OFF}}$  feature for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

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:



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:



The temperature setting is shown at 69° F and may be changed through Port C and STRA ( $\text{CHANGE\_TEMP}$ ). The room temperature is 67° F, and since it is below the desired temperature setting, the furnace is turned on ( $\text{ON}/\overline{\text{OFF}}=\text{PB0}=1$ ).

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 desired 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 ( $\text{ON}/\overline{\text{OFF}}=1$ ) 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.