

Embedded Systems – Assignment 3

Problem Description:

Use MPLAB X IDE and the PIC18F45K50's assembly language to convert an analog input into digital and display the digital result (10 bits) on 3 7-segment LED displays.

Pseudocode:

```
// Analog-to-digital conversion result is right-justified.
ms_adres = 0; // Used to hold the most significant ADC result register (MS 2 bits).
nib_0 = 0;    // Used to hold the least significant ADC result register (lower 4 bits).
nib_1 = 0;    // Used to hold the least significant ADC result register (higher 4 bits).

LED_seg[16] = {0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, b, C, d, E, F} // LED segment configuration.

while(true) {
    if ((ADRESH changed) or (ADRESL changed)) {
        ms_adres = ADRESH;
        nib_1 = ADRESL[7 downto 4];
        nib_0 = ADRESL[3 downto 0];

        LED2 = LED_seg[ms_adres]; // LED display for nibble 2 (MS hex digit).
        LED1 = LED_seg[nib_1];   // LED display for nibble 1
        LED0 = LED_seg[nib_0];   // LED display for nibble 0 (LS hex digit).
    }
}
```

Assembly Code:

Code from "ES_A3.asm"; included in .zip file.

```
#include <p18F45K50.inc>

CONFIG WDTEN = OFF      ; Disable the watchdog timer.
CONFIG MCLRE = ON       ; MCLR pin is on.
CONFIG DEBUG = ON       ; Enable debug mode.
CONFIG LVP = ON         ; Low-voltage programming is on.
CONFIG PBAEN = OFF      ; RB[5:0] will be configured as digital inputs (datasheet, pg. 133)
CONFIG FOSC = INTOSC10  ; Internal oscillator (port function on RA6)

; NIB_0 and NIB_1 used for the lower 8 result bits of the ADC.
NIB_0 EQU 0x00
NIB_1 EQU 0x01

MS_ADCRES EQU 0x02

ORG 0

GOTO Start

Lookup_LED0:
    MULLW 0x02
    MOVF PRODL, 0
    ADDWF PCL, 1
    RETLW b'10000001' ; 0
    RETLW b'11001111' ; 1
    RETLW b'10010010' ; 2
    RETLW b'10000110' ; 3
    RETLW b'11001100' ; 4
    RETLW b'10100100' ; 5
    RETLW b'10100000' ; 6
    RETLW b'10001111' ; 7
    RETLW b'10000000' ; 8
    RETLW b'10000100' ; 9
    RETLW b'10001000' ; A (mix of upper and lower-case hex letters)
    RETLW b'11100000' ; b
    RETLW b'10110001' ; c
    RETLW b'11000010' ; d
    RETLW b'10110000' ; e
    RETLW b'10111000' ; f
```

```
    RETLW b'10111000'    ; F

; Look-up table for MS_ADGRES, specifically for PORTE.
Lookup_LED1:
    MULLW 0x02
    MOVF PRODL, 0
    ADDWF PCL, 1
    RETLW b'00000000'    ; 0
    RETLW b'00000001'    ; 1
    RETLW b'00000010'    ; 2
    RETLW b'00000000'    ; 3

Start:
    CLRF PORTA
    CLRF LATA
    CLRF TRISA

    CLRF PORTB
    CLRF LATB
    CLRF TRISB    ; PORTB used for NIB_0 LED.

    CLRF PORTC
    CLRF LATC
    CLRF TRISC    ; PORTC used for MS_ADGRES LED segments a, e, f, g.

    CLRF PORTD
    CLRF LATD
    CLRF TRISD    ; PORTD used for NIB_1 LED.

    CLRF PORTE
    CLRF LATE
    CLRF TRISE    ; PORTE used for MS_ADGRES LED segments b, c, d.

    BSF TRISA, 0
    BSF ANSELA, 0

    BSF TRISA, 7    ; Using RA7 LED to monitor potentiometer input.

Main:
```

```
Main:
    MOVLW B'10101100'    ; Right-justified, 12 T_AD acq. time, F_OSC / 4
    MOVWF ADCON2

    MOVLW B'00000000'    ; Internal positive and negative voltage referenced.
    MOVWF ADCON1

    MOVLW B'00000001'    ; AN0 used as analog input, GO = 0, ADC turned on
    MOVWF ADCON0

ADC_Start:
    BSF ADCON0, GO        ; GO = 1; start conversion.

ADC_Waiting:
    BTFSC ADCON0, GO      ; Test if GO == 0; if true, skip next instruction.
    BRA ADC_Waiting

    MOVFF ADRESH, MS_ADCRES ; Store ADC high result in MS_ADCRES.
    MOVFF ADRESL, NIB_0    ; Store ADC low result in NIB_0 and NIB_1.
    MOVFF ADRESL, NIB_1

    ; Separate high and low nibble in the WREG.
    MOVF NIB_0, 0          ; Move NIB_0 to WREG.
    ANDLW 0x0F             ; Mask WREG to extract low nibble.
    MOVWF NIB_0            ; Move low nibble to NIB_0.

    SWAPF NIB_1, 0         ; Swap nibbles in NIB_1 and move it to WREG.
    ANDLW 0x0F             ; Mask WREG to extract the high nibble.
    MOVWF NIB_1            ; Move high nibble to NIB_1

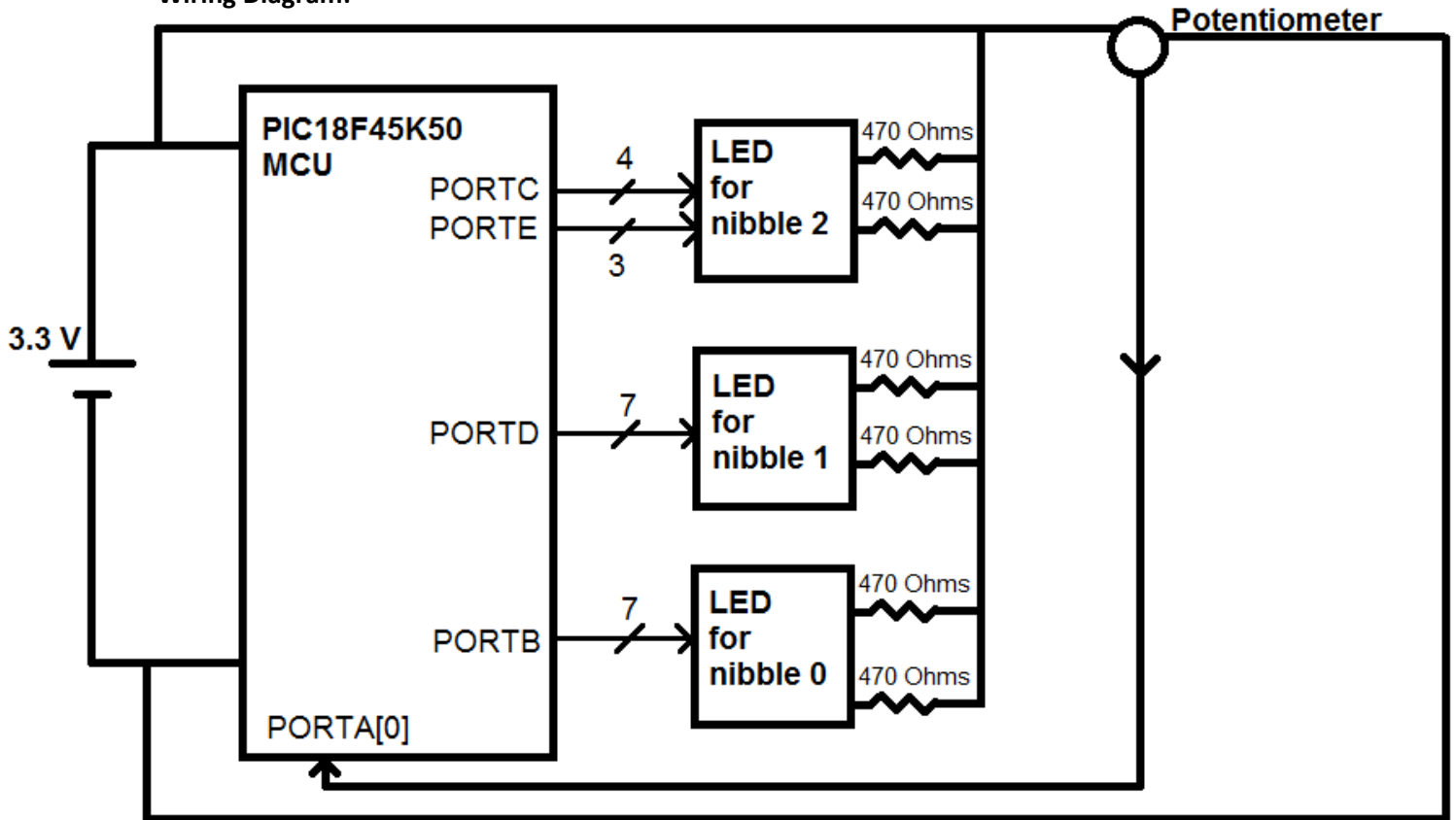
    ; Look up the LED equivalent for MS_ADCRES
    MOVF MS_ADCRES, 0
    CALL Lookup_LED0
    MOVWF PORTC            ; Light a, e, f, g segments in the MS_ADCRES LED.

    MOVF MS_ADCRES, 0
    CALL Lookup_LED1
    MOVWF PORTE            ; Light b, c, d segments in the MS_ADCRES LED.
```

```
MOVWF PORTE           ; Light b, c, d segments in the MS_ADGRES LED.  
  
; Look up the LED equivalent for NIB_1.  
MOVF NIB_1, 0  
CALL Lookup_LED0  
MOVWF PORTD           ; Light segments in the NIB_1 LED.  
  
; Look up the LED equivalent for NIB_0.  
MOVF NIB_0, 0  
CALL Lookup_LED0  
MOVWF PORTB  
  
BRA ADC_Start
```

end

Wiring Diagram:



System's Picture:

