Zero Crossing Detector

Using PIC16f876 to design a ZCD for power system applications

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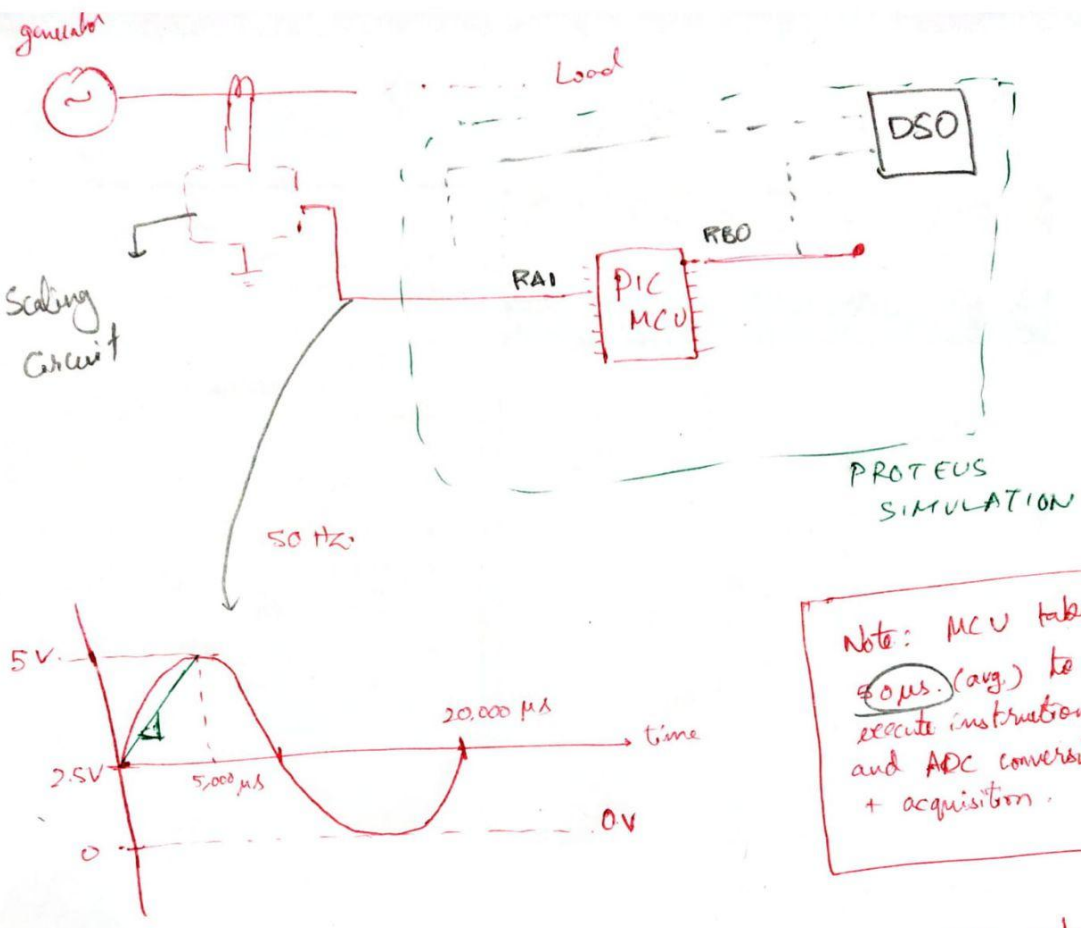
INTRODUCTION

The mini project requires to build a Zero Crossing Detector (ZCD). Here an attempt has been made to design a ZCD capable of working for power system applications which typically work around the frequency of 50 Hz.

Tools/Softwares used

- MPLAB X IDE
  - Mpasm assembler toolchain
- Proteus 8 Design suite

Calculations



Note: MCU takes 50 μs. (avg.) to execute instructions and ADC conversion + acquisition.

$\frac{\Delta V}{\Delta t} = \frac{2.5\ V}{5{,}000\ \mu s} = \frac{50\ mV}{100\ \mu s} = \frac{25\ mV}{50\ \mu s}$.

So, we need to make sure, that our code has tolerance of that much of data.

ADC resolution : $\frac{5}{1024} = 4.8828125$ mV.

So, 25 mV → $\frac{25}{4.88} \approx$ 6 bits. 6 = 0b110

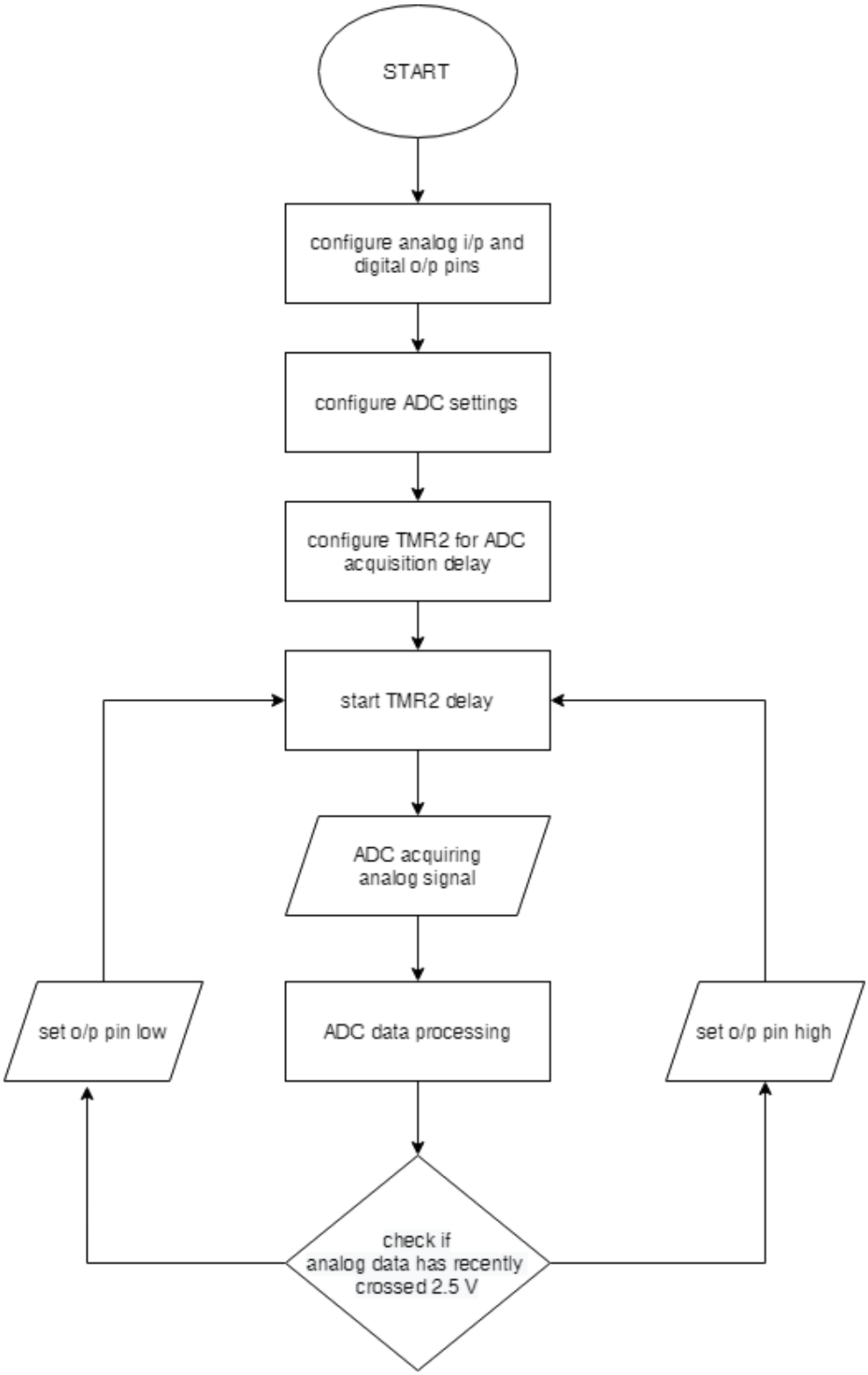
As we know, 2.5 V = (10000000 00)b

our ADC may take value at any time between [2.5, 2.5 ± 25mV]

so, PIC MCU should be able to accept 0b1000 000XXX for zero crossing point

Flowchart

A primitive flowchart is shown to explain overall working of code in simple



Code

Code file can also be obtained from this link.

```
    LIST p = 16F876
    #include p16f876.inc
    __CONFIG _FOSC_XT & _WDTE_ON & _PWRTE_OFF & _CP_OFF & _BOREN_ON & _LVP_ON & _CPD_OFF & _WRT_ON

RES_VECT  CODE    0x0000            ; processor reset vector
    GOTO    START                   ; go to beginning of program

MAIN_PROG CODE                      ; let linker place main program

START       BSF         STATUS,     RP0             ; Bank 1
            MOVLW       0x001B                      ; 0b00011011
            MOVWF       TRISA                       ; Set AN0,1,3 as i/p
            MOVLW       0x0000                      ;
            MOVWF       TRISB                       ; Set PORTB as o/p
            BCF         ADCON1,     ADFM            ; Left Justified
            BSF         ADCON1,     PCFG2           ; A/D Port Configuration Control bits
            BCF         STATUS,     RP0             ; Bank 0
            BSF         ADCON0,     ADON            ; A/D converter module is operating
            BSF         ADCON0,     CHS0            ; Selecting Analog Channel RA1
            BSF         STATUS,     RP0             ; Bank 1
            MOVLW       0x014                       ;
            MOVWF       PR2                         ; TMR2 Delay 20 us
            BCF         STATUS,     RP0             ; Bank 0
TMRSTART    BSF         T2CON,      TMR2ON          ; Start TMR2

LOOP        BTFSS       PIR1,       TMR2IF          ; Wait for TMR2 == PR2
            GOTO        LOOP                        ;
            BCF         PIR1,       TMR2IF          ; Clear Interrupt flag
            BSF         ADCON0,     GO_DONE         ; Start A/D conversion

ADC_PARSE   BTFSS       PIR1,       ADIF            ; Wait for A/D conversion
            GOTO        ADC_PARSE                   ;
            BCF         PIR1,       ADIF            ; Clear Interrupt flag
            MOVF        ADRESH,     0               ;
            ANDLW       0xF8                        ; Masking most significant 7 bits of Wreg
            XORLW       0x80                        ; W xor 0b10000000
            BTFSC       STATUS,     Z               ; skip if W == 0x80
            GOTO        PULLUP                      ;
            BCF         PORTB,      RB0             ; set RB0 as low
            GOTO        TMRSTART                    ;

PULLUP      BSF         PORTB,      RB0             ;
            GOTO        TMRSTART                    ;

            END
```

RESULTS

Fig.1 Complete setup in proteus simulation software

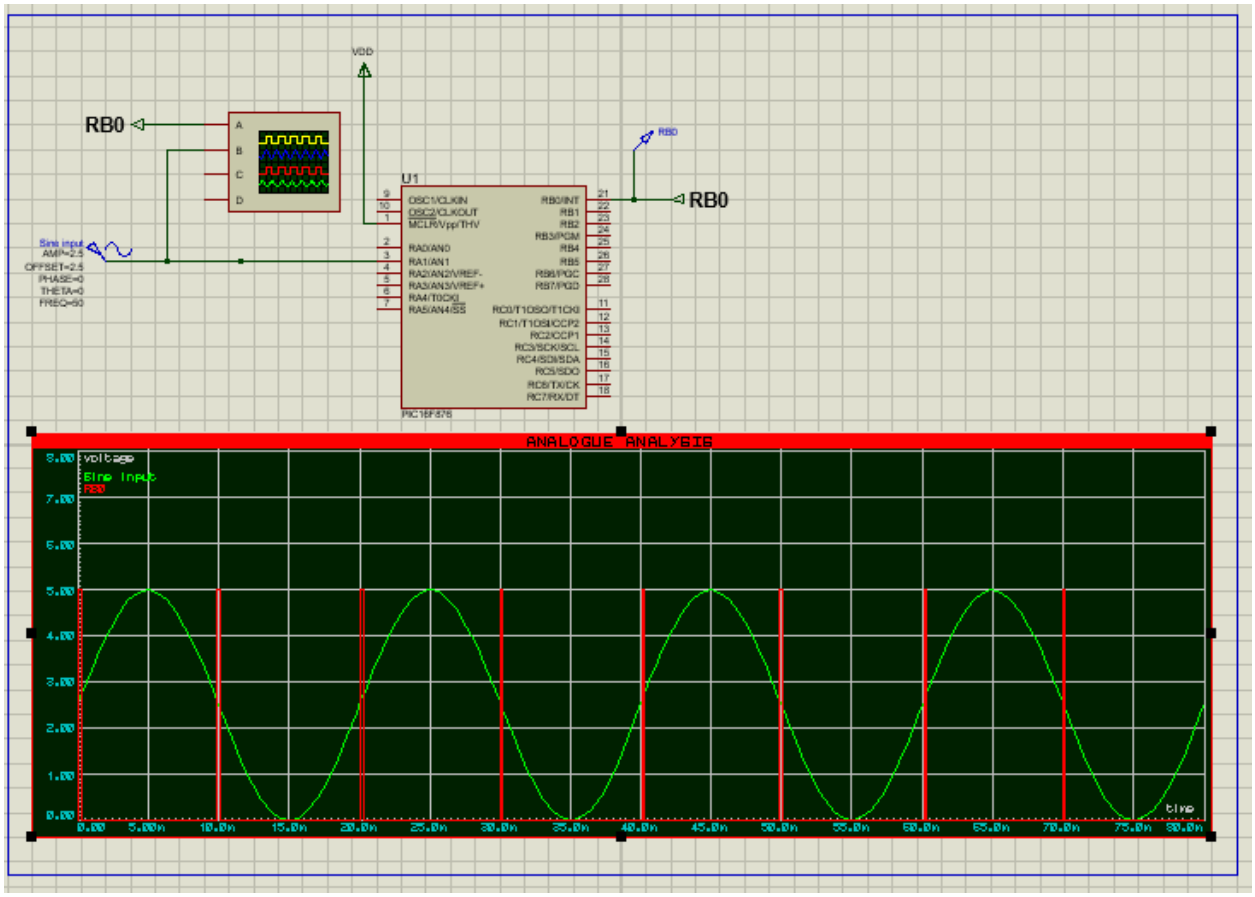
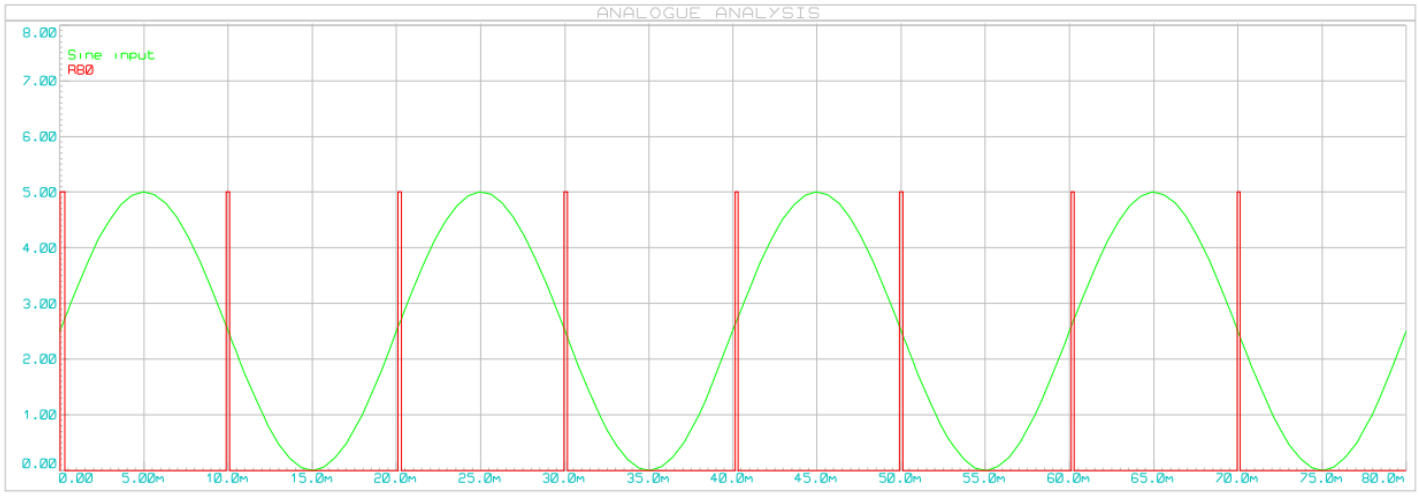
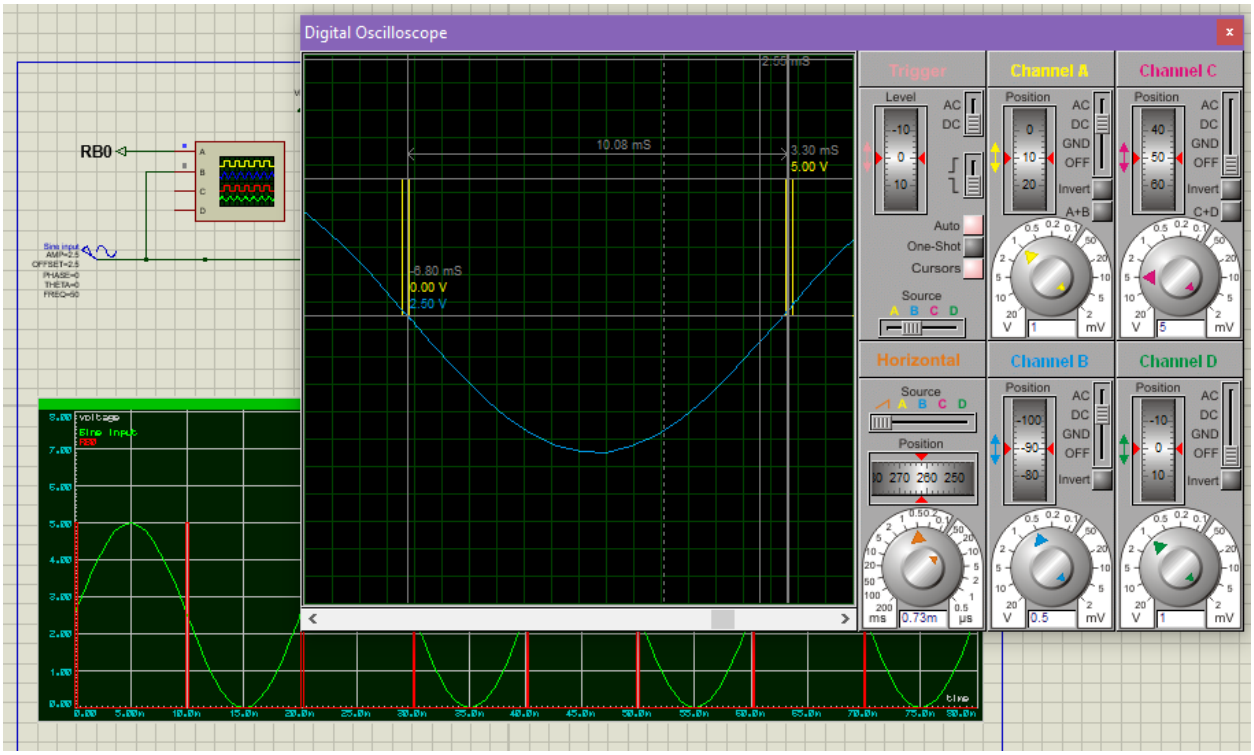


Fig. 2 Graph red pulses are obtained on zero detection point



The above graph is more clearly exported from the software, the file can be found here.

Fig.3 Image of the same using an Oscilloscope



CONCLUSION

A zero crossing detector has been developed and successfully tested with simulations.