Electromechanical Timer Replacement

99 Minute Timer

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OVERVIEW

This 99 minute timer replaces the electro-mechanical timer. The hardware is made simple and economical. The timer is very simple to operate. Two 7-segment displays are provided to display minutes from 0 to 99. To simplify operation, only two push-on switches are provided to set minutes. Each switch is dedicated to each display.

“TENS OF MIN SW” increments tens of minutes display from 0 through 9 at each push and “UNITS OF MIN SW” increments units of minutes displays from 0 through 9 at each push. Debouncing of switches is taken care by software.

APPLICATION OPERATION

The TMR0 prescaler is set to x16. Software checks TMR0 for 250 rollovers, which happens every 4 msec. 4 msec is counted 25 times to generate 100 msec, from which seconds and minutes are generated.

Every 100 msec the keyboard is read and the required minutes display (TENS or UNITS) is incremented at the rate of 2 Hz.

If the displayed minutes is equal to 0 then relay is put off and UNITS DISPLAY's decimal point is not flashing to indicate the timer is off.

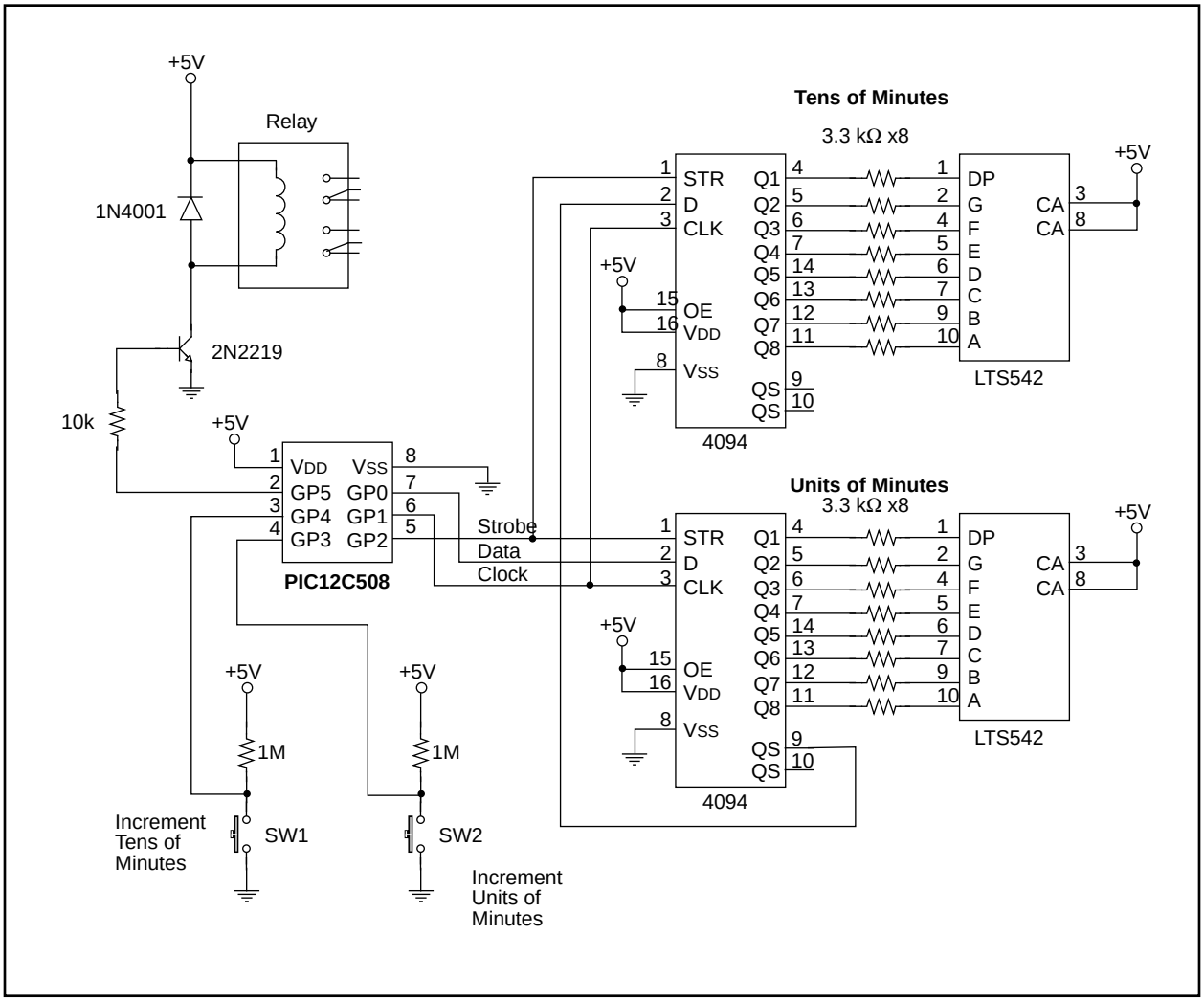
If displayed minutes is not equal to 0, then a relay is turned on and UNITS DISPLAY's decimal point is flashed to indicate the timer is active. During this mode the display decrements every minute till it reaches 0, where the relay is put off.

Note 1: Total instruction time [one loop]: Approximately 375 µsec, maximum.

2: Set Processor configuration word as `0000 0000 1010b`.

a) $\overline{MCLR}$ tied to V_{DD} (internally).
b) Code protection off.
c) WDT disabled.
d) Internal RC oscillator.

FIGURE 1: SCHEMATIC



MICROCHIP TOOLS USED

Assembler/Comilier Version

MPASM 1.50 released.

APPENDIX A: SOURCE CODE

```
;              define ram ports and data ;              ************************ ;
DEFINE PORT
;               ***********
;DEFINE PORTS
;************
gp0             equ     0
gp1             equ     1
gp2             equ     2
gp3             equ     3
gp4             equ     4
gp5             equ     5
;DISPLAY PORT
;************
disp_data       equ     gp0
disp_clk        equ     gp1
disp_strobe     equ     gp2
;KEYBOARD PORT
;*************
;units_key      equ     gp3
;tens_key       equ     gp4
;RELAY PORT
;**********
relay           equ     gp5
;*****************************************************
;DEFINE RAM
units           equ     08h             ;minutes unit display
tens            equ     units+1         ;minutes tens display
counter_4ms     equ     tens+1          ;incremented every 4 msec
counter_100ms   equ     counter_4ms+1   ;incremented every 100 msec
seconds         equ     counter_100ms+1
oldkey          equ     seconds+1       ;for key debouncing
newkey          equ     oldkey+1        ;-------- ,, ------
key             equ     newkey+1        ;key pressed data
digit_inc       equ     key+1           ;inc units display if bo = 1
                                        ;inc tens display if b1 = 1
tmr_comp        equ     digit_inc+1     ;tmr0 comparator register
scrtch0         equ     tmr_comp+1
scrtch1         equ     scrtch0+1
scrtch2         equ     scrtch1+1
;*****************************************************
;DEFINE FLAGS AND BITS
b0      equ     0
b1      equ     1
b2      equ     2
b3      equ     3
b4      equ     4
b5      equ     5
b6      equ     6
b7      equ     7
;key
;***
;               equ     b0
;               equ     b1
;               equ     b2
units_key       equ     b3
tens_key        equ     b4
;               equ     b5
;               equ     b6
;               equ     b7
;digit_inc
;*********
units_inc       equ     b0
tens_inc        equ     b1
;               equ     b2
```

```
;               equ     b3
;               equ     b4
;               equ     b5
;               equ     b6
;               equ     b7
;****************************************
#define data_hi         bsf     GPIO, disp_data
#define data_lo         bcf     GPIO, disp_data
#define clk_hi          bsf     GPIO, disp_clk
#define clk_lo          bcf     GPIO, disp_clk
#define strobe_hi       bsf     GPIO, disp_strobe
#define strobe_lo       bcf     GPIO, disp_strobe
#define relay_on        bsf     GPIO, relay
#define relay_off       bcf     GPIO, relay
;************** EOF DEF_RAM.ASM ***********
;               SUBS.ASM
;               ********
;read key port in key
read_keys       movf    newkey, w       ;debouncing taken care by s/w
                movwf   oldkey
                movf    GPIO, w         ;read newkeys
                andlw   00011000b       ;gp3, gp4 are key ports
                movwf   newkey
                comf    newkey, f       ;complement since active low
                andwf   oldkey, w       ;key=oldkey AND compl(newkey)
                movwf   key
;indicate to display routine units or tens key pressed
                btfsc   key, units_key
                bsf     digit_inc, units_inc
                btfsc   key, tens_key
                bsf     digit_inc, tens_inc
                return
;*********************************************************
init_ports      movlw   0               ;all lo
                movwf   GPIO
                movlw   00011000b       ;port g0-g2,g5 o/p & gp3,gp4 i/p
                tris    GPIO
                clrf    TMR0            ;clr tmr0 & prescaler
                movlw   11000011b       ;tmr0 enable with 1:16 prescaler
                option
                return
;***************** EOF SUBS.ASM ******************************
;               TABLES.ASM
;               **********
;7 segments decoded data. lo is segment on & hi is segment off
get_seg         addwf   PCL, f
;                       ABCDEFGP        ;P is decimal point
retlw   00000011b       ;0
retlw   10011111b       ;1
retlw   00100101b       ;2
retlw   00001101b       ;3
retlw   10011001b       ;4
retlw   01001001b       ;5
retlw   01000001b       ;6
retlw   00011111b       ;7
retlw   00000001b       ;8
retlw   00011001b       ;9
dec_pt          equ     11111110b       ;decimal point bit
;*************** EOF TABLES.ASM ************************
```

```
;               TIMER.ASM
;               *********
; [ milindhp@tifrvax.tifr.res.in ]
;Set Processor configuration word as = 0000 0000 1010 b.
;   a] -MCLR tied to VDD (internally).
;   b] Code protection off.
;   c] WDT disabled.
;   d] Internal RC oscillator [4 MHZ].
list    p=12c508, r=dec
               include "d:\pic\mpasm\p12c508.inc"
;define ram
               include "def_ram.asm"
;processor start
               org     0
               goto    start
;define legends and table
               include "tables.asm"
;subroutines
               include "subs.asm"
;initialize and start
start           clrf    key
                clrf    oldkey
                clrf    newkey
                clrf    digit_inc
                clrf    units
                clrf    tens
                clrf    counter_4ms
                clrf    counter_100ms
                clrf    seconds
                movlw   250             ;4000us tmr0 (1:16 prescaler * 250 )
                movwf   tmr_comp
                call    init_ports      ;init ports & timer
main            movf    tmr_comp, w     ;is tmr0 = tmr_comp (4 msec over?)
                xorwf   TMR0, w
                btfss   STATUS, Z       ;skip if = 250
                goto    main
                movlw   250
                addwf   tmr_comp, f     ;update 4 msec compare register
                incf    counter_4ms, f
                movlw   25
                xorwf   counter_4ms, w  ;is 4ms * 25 = 100ms over ?
                btfss   STATUS, Z       ;skip if = 100ms
                goto    main
                clrf    counter_4ms
;************** 100 MSEC OVER *********************************
                incf    counter_100ms, f
                movlw   10
                xorwf   counter_100ms, w ;is 100ms * 10 = 1sec over ?
                btfss   STATUS, Z       ;skip if 1 sec over
                goto    main21          ;jmp if 1 sec not over
                clrf    counter_100ms   ;1 sec over
                incf    seconds, f
                movlw   60
                xorwf   seconds, w      ;is 1 minute over ?
                btfss   STATUS, Z       ;skip if 1 min over
                goto    main21
;************** 1 MINUTE OVER *********************************
                clrf    seconds
     ;process relay and display
     ;if tens & units both = 0 then rly off and out
     ;else relay on & decrement display & out
                movf    tens, w
                iorwf   units, w
                btfss   STATUS, Z
                goto    main1
                relay_off
```

```
                goto    main21
main1           relay_on
                movf    units, f
                btfss   STATUS, Z
                goto    main2
                movlw   9
                movwf   units
                decf    tens, f
                goto    main21
main2           decf    units, f
;************** EXECUTED EVERY 100 MSEC *************
main21          call    read_keys
;** DISPLAY ROUTINE TO BE EXECUTED EVERY 500 MSEC **
     ;process display every 500 msec
     ;if unit key pressed increment unit display
     ;if tens key pressed increment tens display
     ;flash unit display's dec. pt. every second if units & tens
     ;not equal to zero i.e. indicate timer is active
     ;execute display routine in counter_100ms = 0 or 5
                movf    counter_100ms, w
                btfsc   STATUS, Z
                goto    main3
                xorlw   5
                btfss   STATUS, Z
                goto    main
     ;if units_key pressed then inc units display between 0 thr. 9
     ;if tens_key pressed then inc tens display between 0 thr. 9
main3           btfss   digit_inc, units_inc
                goto    main4
                bcf     digit_inc, units_inc
     ;inc units display. if units = 10 then units = 0
                incf    units, f
                movlw   10
                xorwf   units, w
                btfsc   STATUS, Z       ;skip if not equal
                clrf    units
main4           btfss   digit_inc, tens_inc
                goto    main5
                bcf     digit_inc, tens_inc
     ;inc tens display. if tens = 10 then tens = 0
                incf    tens, f
                movlw   10
                xorwf   tens, w
                btfsc   STATUS, Z       ;skip if not equal
                clrf    tens
     ;convert decimal in units & tens to decoded segment data
     ;for led display in scrtch1 & 2 for transmission
main5           movf    tens, w
                call    get_seg
                movwf   scrtch1
                movf    units, w
                call    get_seg
                movwf   scrtch2
     ;flash (toggle) decimal point every 500ms if timer active
     ;i.e. if timer not equal to zero i.e. relay on, then flash
     ;decimal point else, do not to indicate relay off
                movf    tens, w
                iorwf   units, w
                btfsc   STATUS, Z       ;skip to flash dp
                goto    main6           ;jmp if 0 to no flash
                movf    counter_100ms, f
                btfss   STATUS, Z       ;toggle-on dec pt if counter_100ms = 0
                goto    main6           ;else jmp out to toggle-off
     ;flash dp of units display
                movlw   dec_pt
                andwf   scrtch2, f
```

```
     ;transmit data from scrtch1 thr scrtch1 to display circuit (msb first).
main6           movlw   16              ;no of bit to tx
                movwf   scrtch0
main61          rlf     scrtch2, f      ;check msb
                rlf     scrtch1, f
                btfsc   STATUS, C       ;data hi if cy=1 else lo
                goto    main62
                data_lo
                goto    main63
main62          data_hi
main63          nop                     ;delay
                nop
                clk_hi                  ;toggle clk to push data
                nop
                nop
                clk_lo
                nop
                nop
                decfsz  scrtch0, f      ;next bit
                goto    main61
                strobe_hi               ;strobe data nop
                nop
                strobe_lo
                data_lo                 ;leave data lo
                goto    main
                end
; ************* EOF MAIN.ASM *******************************
```

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