Electromechanical Timer Replacement

A Simple Programmable Timer with Time Correction Circuit

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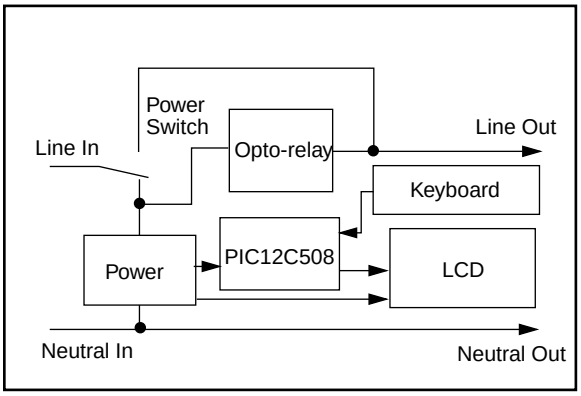
OVERVIEW

The timer discussed in this application note may be used to operate different appliances using AC or DC voltage (battery powered equipment). It is adjustable from 1 second to 99 hours, 59 minutes, 59 seconds and has a time correction circuit to adjust the accuracy of the internal 4 MHz RC oscillator. It is based on the PIC12C508 microcontroller and requires few external components.

The system block diagram is shown in Figure 1. The timer has 3 buttons, an LCD panel, and a power switch. The power switch, in the position shown in Figure 1, will activate the timer, and in the other position the load will be connected directly to the line out, thus switching off the opto-transformer to prevent accumulator overcharge. When switched off, the timer is still operational and may be set. To reduce power consumption, the timer goes to sleep (LCD panel appears blank) in 15 seconds after the last button depression, while in edit mode.

FIGURE 1: SYSTEM BLOCK DIAGRAM



The first keyboard button is “Change Digit.” This button is used to position the cursor to the desired digit. The cursor moves clockwise from the lower seconds digit to the higher hours digit. Separators are skipped. The second button is “Increase Value.” With each depression of this button the digit value is increased. After 9 presses the value rolls over to 0. The third button is “Start/Stop.” This button is used to edit data and to activate the timer. When run in edit mode, with the earlier specified buttons, data may be entered. Once the Start/Stop button is pressed, the timer is activated. It stops if the time expires or the Start/Stop button is pressed again (in both cases this will affect the load). In any case, if the timer is stopped, then the edit mode becomes active and the remaining data may be edited.

This appliance may be used as a simple timer and if used with a normally closed contact opto-relay, it may turn on any load when the time expires.

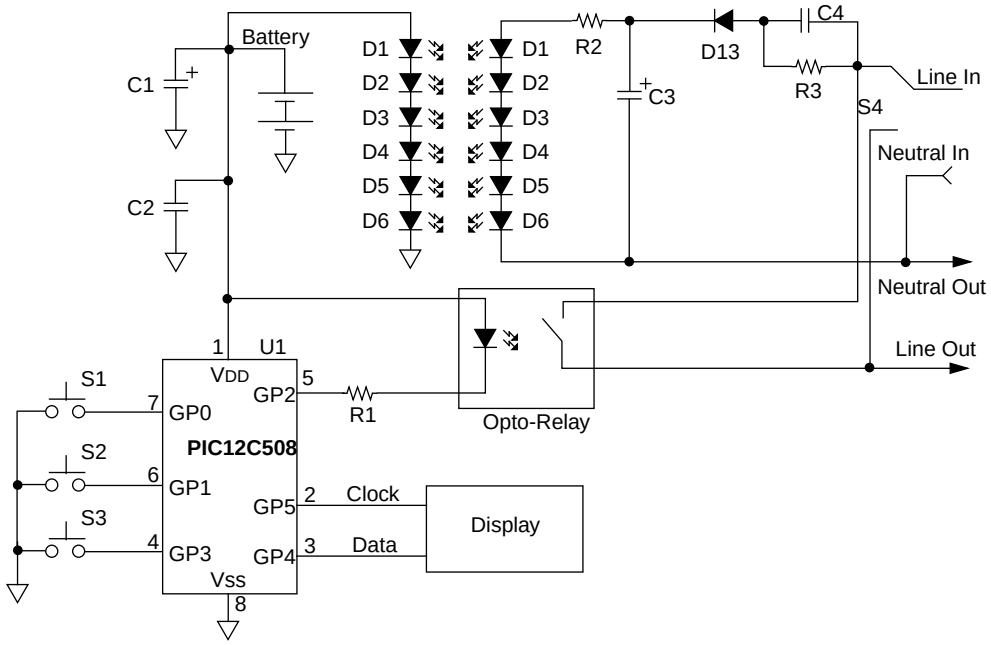
Use an 8-pin socket for the PIC12C508 JW device because it needs to be programmed before putting it in the circuit. The board has three buttons (S1, S2, S3), capacitor (C2), resistor (R1), and an LED (instead of an opto-relay).

The opto-relay may be replaced with an opto-triac (AC operation only). Using a triac or an ordinary mechanical relay with an opto-relay or an opto-triac will power-up the output (DS00559). The opto-relay may be replaced with an ordinary mechanical relay, but most of them need a higher voltage and a transistor amplifier to activate their coil.

HARDWARE

The schematic diagram is shown in Figure 2.

FIGURE 2: SCHEMATIC DIAGRAM



Note 1: GND symbol is circuit common; it is not tied to AC ground.
2: In case of DC input voltage, C4 should be replaced with a resistor to limit current flow through the LEDs (R3 may be removed).
3: If the input voltage is 36V or less, the opto-transformer may be removed.
4: DISPLAY means AY0438 IC with LCD panel added.
5: A FUSE is required in-Line In-circuit.

The Timer Parts List

Capacitors:

C1, C3 = 47 µF electrolytic
C2 = 0.1 µF ceramic
C4 = 1 µF (depends on the current flow limits through LEDs)

Diodes:

D1 – D6 = Any type IR photo diodes
D7 – D12 = Any type IR light emitting diodes
D13 = 1N4001 general purpose 1A rectifier

Resistors:

R1 = Depends on the type of opto-relay:
- V_O = PICmicro™ output low voltage (0.6V max)
- V_{LED} = Input opto-relay IR LED voltage (0.8V typical)
- I_{LED} = LED current (10 mA typical)

$$R1 = \frac{3 - V_{LED} - Vo}{I_{LED}} = 160\Omega$$

R2 = 100Ω (depends on the current flow limits through transformer LEDs and output voltage of photo diodes battery to provide minimal charge current for the battery)
R3 = 1 MΩ, used to discharge capacitor C4

Miscellaneous:

Battery = 3V Accumulator
Opto-relay = Any opto-relay or opto-triac matching above specified requirements
S1 – S3 = Normally open push button switches
S4 = Two position switch
U1 = PIC12C508 programmed with `MyTimer` code

MICROCHIP TOOLS USED

Assembler/Compiler Version:

MPASM version 1.40

APPENDIX A: SOURCE CODE

```
;A Simple Timer with Time Correction Circuit
;Author: Kirill Yelizarov

          LIST          P=PIC12C508, R=DEC
          INCLUDE       <p12c508.inc>

          __CONFIG _HS_OSC & _WDT_OFF & _CP_OFF & _MCLRE_OFF

;                       ------------ D A T A ------------

TimerStatus         equ          0x07          ;Timer status flags
SecondsLow          equ          0x08          ;Seconds low digit
SecondsHigh         equ          0x09          ;Seconds high digit
MS_Separator        equ          0x0a          ;Minutes/Seconds separator
MinuteLow           equ          0x0b          ;Minutes low digit
MinuteHigh          equ          0x0c          ;Minutes high digit
HM_Separator        equ          0x0d          ;Hours/Minutes separator
HourLow             equ          0x0e          ;Hours low digit
HourHigh            equ          0x0f          ;Hours high digit
TimerCount          equ          0x10          ;Timer count
Digit               equ          0x11          ;Used in ShowDigit to send data using RRF command
Count               equ          0x12          ;Multipurpose count
TimePatch           equ          0x13
TimeCorrection      equ          0x14

;                  ------------ Timer Status Flags ------------

SleepFlag           equ          7             ;If set then the sleep command is activated
SetTimeFlag         equ          6             ;Flag is raised when it's time to update time
StartStopFlag       equ          5             ;If raised the timer runs else it may be edited
TimerFlag           equ          4             ;this flag is raised when TMR0 seventh bit is set
;                   equ          3
;                   equ          2
;                   equ          1
;                   equ          0

;            ------------ KeyBoard & LCD hardware bits ------------

LCD_Clock           equ          5                   ;LCD clock
LCD_Data            equ          4                   ;LCD data
StartStop           equ          3                   ;Start/Stop button
Relay               equ          2                   ;Relay
IncValue            equ          1                   ;Increase digit value button
NextDigit           equ          0                   ;Set next digit button


;                       ------------ C O D E ------------

          org           0
          clrf          TimerStatus                 ;Reset all flags
          goto          ResetTimer                  ;Reset timer and read time correction value

;                      ------------ T A B L E S ------------
;Decode data to 8 segment LCD
DecodeValue
      addwf           PCL,F
      retlw           b'00111111'                   ;0
      retlw           b'00000110'                   ;1
      retlw           b'01011011'                   ;2
      retlw           b'01001111'                   ;3
      retlw           b'01100110'                   ;4
      retlw           b'01101101'                   ;5
      retlw           b'01111101'                   ;6
      retlw           b'00000111'                   ;7
```

```
      retlw         b'01111111'                 ;8
      retlw         b'01101111'                 ;9
      retlw         b'00000000'                 ;blank
      retlw         b'01000000'                 ;hours/minutes separator
      retlw         b'01000000'                 ;minutes/seconds separator
      retlw         b'00001000'                 ;cursor

;Time correction table
;In correction mode the timer outputs 250 kHz signal on pin LCD_clock
;This may be tested and a new correction value be programmed
;If bit <6> is zeroed then the next value is fetched (because 1's may be programmed many times)
TimeCorrectionTable

      addwf         PCL,F

;bit  <7> 1 = Correction mode                  ; 0 = Normal timer operation
;bit  <6> 1 = Read this value                  ; 0 = Skip this value
;bits <5,0> Time correction value

      retlw         b'11000111'                 ; Set time correction value to 7
      retlw         b'11111111'
      retlw         b'11111111'
      retlw         b'11111111'
      retlw         b'11111111'
      retlw         b'11111111'
      retlw         b'11111111'
      retlw         b'11111111'
      retlw         b'11111111'
      retlw         b'11111111'

;               ------------ S U B R O U T I N E S ----------
;Send timer data from lowest digit to the highest including separators to AY0438
ShowTime
      bcf           TimerStatus,SetTimeFlag     ;reset SetTimeFlag bit
      movlw         0x0a
      movwf         FSR                         ;get first digit (seconds low)
ShowNextDigit:
      movf          INDF,W
      call          DecodeValue
      btfsc         TimerStatus,SleepFlag       ;If Sleep mode activated
      movlw         0x10                        ;then set display blank
      call          ShowDigit
      incf          FSR,F                       ;get next digit
      btfss         FSR,4                       ;terminate if the 4th bit is set
      goto          ShowNextDigit               ;(You should not move timer data in RAM
      return                                    ;for this function to work properly)

;Transmit one digit data to AY0438 (see PIC16/17 Microcontroller Data Book 95/96 AY0438 page 4-6)
;Load input should be tied high
ShowDigit
      movwf         Digit                       ;Save current digit value
      movlw         0x08
      movwf         Count                       ;Set Count to 8 (8 segment LCD)
NextBit:
      bcf         GPIO,LCD_Data                 ;clear Data bit
      rrf         Digit,F
      btfsc       STATUS,C                      ;If bit is clear then skip
      bsf         GPIO,LCD_Data                 ;Else set Data bit
      bsf         GPIO,LCD_Clock                ;Toggle Clock, the data to be read by AY0438
      bcf         GPIO,LCD_Clock
      decfsz      Count,F
      goto        NextBit
      return

;Get current time from TMR0
GetTime
```

```
      btfss        TMR0,7                  atch for the TMR0 seventh bit getting set
      return
      btfsc        TimerStatus,TimerFlag   ;and TimerFlag is not set
      return
      bsf          TimerStatus,TimerFlag   ;then set this flag, this will prevent from coming
                                          ;here again till the seventh bit is reset and set again
      decfsz       TimerCount,F
      return
      bsf          TimerStatus,SetTimeFlag ;Set the flag to update time value
      movlw        30
      btfsc        SecondsLow,0            ;add to odd values extra count to increase accuracy
      movlw        31
      movwf        TimerCount
      decfsz       TimePatch,F             ;This patch will increase accuracy
      return                               ;which is quite suitable for a timer
      movlw        59                      ;After every 59th second an extra count
      movwf        TimePatch               ;will be assigned to timer count
      incf         TimerCount,F
      return

;                ------------- Reset Timer and Main Loop -------------
ResetTimer:
      movlw        0x0a
      movwf        HM_Separator            ;set Hours/Minutes separator to 11
      movlw        0x0b
      movwf        MS_Separator            ;set Minutes/Seconds separator to 12
      bcf          TimerStatus,SetTimeFlag ;reset SetTimeFlag bit to avoid mistakes
      bsf          TimerStatus,TimerFlag   ;to run a complete first second
      movlw        b'10000000'             ;timer will start from the value of 128
      movwf        TMR0         ;and the time will be updated every time the seventh bit is set
      movlw        b'00000110'             ;set prescaler to 1:128
      option
      movlw          0xff                  ;set Count to 255
      movwf          Count
NewValue:
      incf          Count,F                ;this will make Count = 0 for the first fetch
      call          TimeCorrectionTable
      movwf         Digit                  ;save time correction value
      btfss         Digit,6                ;if the value is valid (bit <6>)
      goto          NewValue               ;if not get the next one
      andlw         b'00001111'
      movwf         TimeCorrection
      swapf         TimeCorrection,F
      btfsc         Digit,7                 ;analize mode
      goto          CorrectionSignal        ;skip for the normal operation
Main:
      btfsc         TimerStatus,StartStopFlag
      call          GetTime                      ;Change time if StartStopFlag is set
      btfss         TimerStatus,SetTimeFlag
      goto          Main
      decf          SecondsLow,F
      call          ShowTime                     ;Update time if SetTimeFlag is set
      goto          Main
CorrectionSignal:                                ;250 kHz correction signal
      bsf           GPIO,LCD_Clock
      nop
      nop
      nop
      bcf           GPIO,LCD_Clock
      nop
      goto          CorrectionSignal
      org           0x1ff
      movlw         b'01110000'
      end
```

NOTES:

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