Electromechanical Timer Replacement

Reminder Timer for Changing Chemicals in a Water Softener (IRON)

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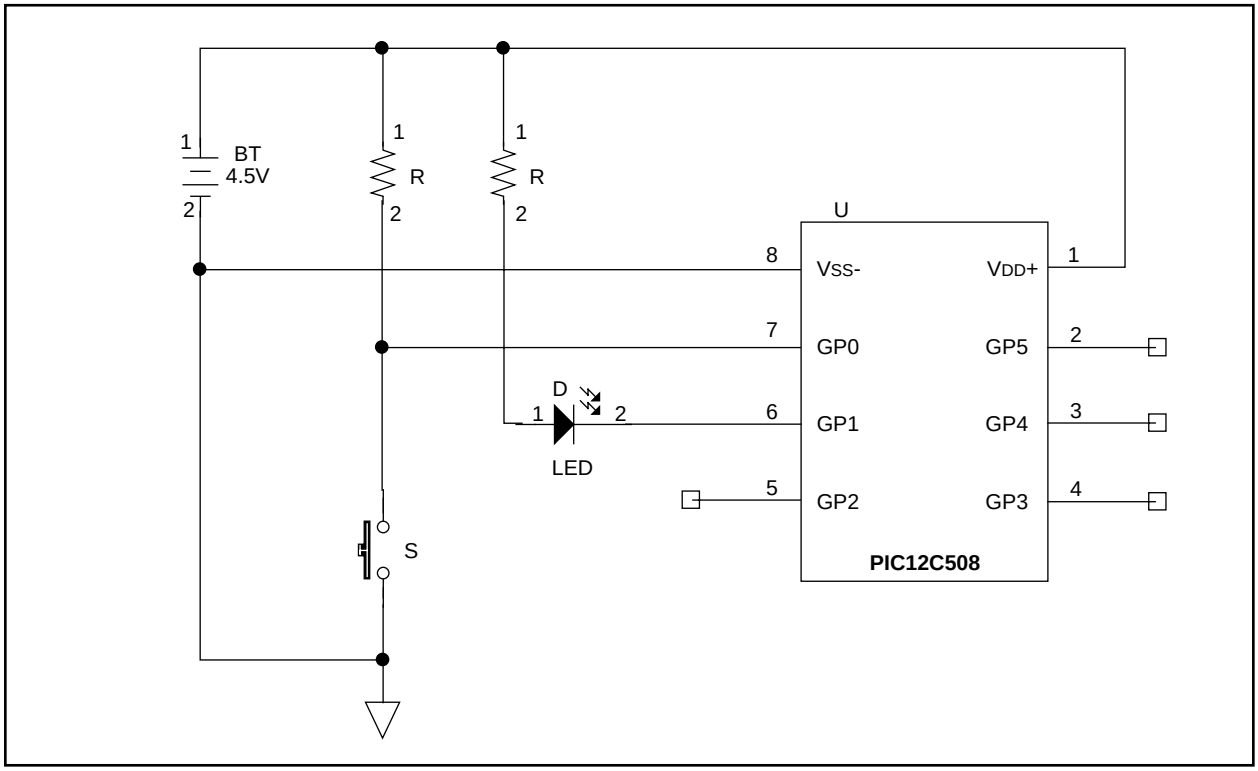
APPLICATION OPERATION:

When the battery is plugged in the unit flashes the LED for 1 second to verify good RAM and power up. A timing cycle then starts, that checks for approximately 180 days. At the end of the time period, the unit is placed in SLEEP mode. The LED flashes on for 100 ms every time it wakes up. Further time keeping is disabled until the battery is replaced. Then the cycle starts over.

This is an actual product that is being used by ECOWATER in Minnesota for reminding people to change the IRON cleaning chemicals in water softeners.

FIGURE 1: SCHEMATIC



MICROCHIP TOOLS USED

Hardware Development Tools:

PICMASTER with PIC12C5xxx probe

Assembler/Compiler Version:

MPLAB 3.22.00

APPENDIX A: SOURCE CODE

```
PICMaster with 12C5XX probe.
Assembler/Compiler version:
Current version shipping with MPLAB 3.22
Include files:
; P12C508.INC  Standard Header File, Version 1.01    Microchip Technology, Inc.
NOLIST
; This header file defines configurations, registers, and other useful bits of
; information for the PIC12C508 microcontroller.
; These names are taken to match the data sheets as closely as possible.
; Note that the processor must be selected before this file is included.
; The processor may be selected the following ways:
;       1. Command line switch:
;               C:\ MPASM MYFILE.ASM /P12C508
;       2. LIST directive in the source file
;               LIST   P=12C508
;       3. Processor Type entry in the MPASM full-screen interface

;==========================================================================
;
;      Revision History
;
;==========================================================================

;Rev:   Date:    Reason:

;1.01   08/21/96 Removed VCLMP fuse, corrected oscillators
;1.00   04/10/96 Initial Release

;==========================================================================
;
;       Verify Processor
;
;==========================================================================

        IFNDEF __12C508
           MESSG "Processor-header file mismatch. Verify selected processor."
        ENDIF

;==========================================================================
;
;       Register Definitions
;
;==========================================================================

    W       EQU     H'0000'
    F       EQU     H'0001'

;----- Register Files ------------------------------------------------------

    INDF    EQU     H'0000'
    TMR0    EQU     H'0001'
    PCL     EQU     H'0002'
    STATUS  EQU     H'0003'
    FSR     EQU     H'0004'
    OSCCAL  EQU     H'0005'
    GPIO    EQU     H'0006'


#DEFINE     GPWUF   STATUS,7

;----- PORT BIT ASSIGNMENTS ------------------------------------------------
GPIO_DIR    EQU     0X019

#DEFINE     S1      GPIO,0      ;IN
```

```
#DEFINE    LED     GPIO,1     ;OUT
#DEFINE    TOGGLE  GPIO,2     ;OUT
#DEFINE    NC      GPIO,3     ;IN

;----- STATUS Bits --------------------------------------------------

#DEFINE    PA2     STATUS,7
#DEFINE    PA1     STATUS,6
#DEFINE    PA0     STATUS,5
#DEFINE    TO      STATUS,4
#DEFINE    PD      STATUS,3
#DEFINE    Z       STATUS,2
#DEFINE    DC      STATUS,1
#DEFINE    C       STATUS,0

;----- OPTION Bits --------------------------------------------------

T0CS       EQU     H'0005'
T0SE       EQU     H'0004'
PSA        EQU     H'0003'
PS2        EQU     H'0002'
PS1        EQU     H'0001'
PS0        EQU     H'0000'

;=========================================================================
;
;       RAM Definition
;
;=========================================================================

        __MAXRAM H'1F'

;=========================================================================
;
;       Configuration Bits
;
;=========================================================================

_MCLRE_ON      EQU     H'0FFF'
_MCLRE_OFF     EQU     H'0FEF'
_CP_ON         EQU     H'0FF7'
_CP_OFF        EQU     H'0FFF'
_WDT_ON        EQU     H'0FFF'
_WDT_OFF       EQU     H'0FFB'
_LP_OSC        EQU     H'0FFC'
_XT_OSC        EQU     H'0FFD'
_IntRC_OSC     EQU     H'0FFE'
_ExtRC_OSC     EQU     H'0FFF'

;*************************************************************************
;*      RAM AREA
;*************************************************************************

MS_COUNTER     EQU     0X07
SEC_COUNTER    EQU     0X08
MIN_COUNTER    EQU     0X09
HOUR_COUNTER   EQU     0X0A
DAYS_COUNTER   EQU     0X0B

COUNT_OFF      EQU     0X0C
BITS_COUNT     EQU     0X0D
XMIT_COUNT     EQU     0X0E
BUTTON_MEMORY  EQU     0X0F

COUNT1         EQU     0X010
COUNT2         EQU     0X011
```

```
COUNT3          EQU     0X012

;*****************************************************************
;   MACROS
;*****************************************************************

LED_ON      MACRO
            BCF         LED
            ENDM

LED_OFF     MACRO
            BSF         LED
            ENDM

;Software listing:


LIST    P=12C509, W=2

        #INCLUDE "P12C508.INC"

        __FUSES  _CP   _OFF&_WDT_ON&_LP_OSC&_MCLRE_ON

;   NOTE: CHANGE _CP_OFF TO _CP_ON TO CODE PROTECT PARTS DURING PRODUCTION CYCLE.

;PAC SYSTEM TRANSMITTER

;


;-------------START OF PROGRAM MEMORY AREA-----------------------------

            ORG     0           ;RESET AREA
            GOTO    START

;*****************************************************************
;       SET UP THE I/O CHANNELS
;*****************************************************************

SET_IO      MOVLW   0X08F       ;DISABLE WAKE UP ON I/O CHANGE
                                ;AND ENABLE WEAK PULL UPS
            OPTION              ;
            MOVLW   GPIO_DIR    ;SET UP I/O PORTS
            TRIS    6
            RETURN

;*****************************************************************
;       TURN ON LED - TOTAL TIME 1 SEC
;*****************************************************************

FLASH_LED   LED_ON              ;TURN ON THE LED
            MOVLW   .250        ;PRESET TIMER VALUE
            MOVWF   COUNT1
            MOVLW   .8
            MOVWF   COUNT2
FLASH_LOOP  CLRWDT              ;RESET THE WDT
            DECFSZ  COUNT1
            GOTO    FLASH_LOOP
            DECFSZ  COUNT2
            GOTO    FLASH_LOOP
            LED_OFF             ;TURN OFF THE LED
            RETURN

;*****************************************************************
;       TURN ON LED - TOTAL TIME 100 MS
;*****************************************************************
```

```
FLASH_LED_S    LED_ON             ;TURN ON THE LED
               MOVLW   .205       ;PRESET TIMER VALUE
               MOVWF   COUNT1
               MOVLW   .1
               MOVWF   COUNT2
FLASH_LOOP_S   CLRWDT             ;RESET THE WDT
               DECFSZ  COUNT1
               GOTO    FLASH_LOOP_S
               DECFSZ  COUNT2
               GOTO    FLASH_LOOP_S
               LED_OFF            ;TURN OFF THE LED
               RETURN

;*****************************************************************
;       SLEEP MODE
;*****************************************************************

SLEEP_MODE     MOVLW   0X08F      ;DISABLE WAKE UP ON I/O CHANGE
                                  ;AND ENABLE WEAK PULL UPS
               OPTION             ;
               OPTION             ;NEEDED TO INSURE OPTION REG. LOADED
           SLEEP

;*****************************************************************
;       INITIALIZATION ROUTINE
;*****************************************************************

START          MOVFW   STATUS     ;FIND OUT HOW WE GOT HERE
               ANDLW   0X018      ;MASK OFF TO AND PD
               XORLW   0X00       ;WAS IT WAKE UP FROM SLEEP?
               BTFSC   Z
               GOTO    FLASH_TIME ;YES! FLASH LED
               MOVFW   STATUS     ;FIND OUT HOW WE GOT HERE
               ANDLW   0X018      ;MASK OFF TO AND PD
               XORLW   0X08       ;DID WDT TIME OUT?
               BTFSS   Z
               GOTO    CLEAR_RAM
FLASH_TIME     CALL    SET_IO     ;SET UP I/O PINS
               CALL    FLASH_LED_S
               GOTO    SLEEP_MODE

;--------CLEAR ALL RAM LOCATIONS---------------------------------------

CLEAR_RAM      MOVLW   0X08F      ;DISABLE WAKE UP ON I/O CHANGE
                                  ;AND ENABLE WEAK PULL UPS
               OPTION             ;
               CALL    SET_IO     ;CHECK FOR TEST MODE
               MOVLW   0X07       ;PUT '7' IN THE FSR
               MOVWF   FSR        ;TO INITIALIZE ALL RAM LOCATIONS
LP             CLRW
               CLRF    INDF       ;CLEAR THE INDF REGISTER
               INCF    FSR,F      ;INCREMENT THE ADDRESS POINTER
               MOVLW   0X0E0      ;CHECK FOR LAST BYTE
               XORWF   FSR,W
               BTFSS   Z
               GOTO    LP
               CALL    FLASH_LED

;--------TEST RAM FOR VALID DATA---------------------------------------

           CALL        RAM_TEST   ;CHECK THE RAM THAT WILL BE USED
           BTFSC       S1             ;IS GP0 GROUNDED?
           GOTO        MAIN
           MOVLW       .182           ;PRESET THE DAYS COUNTER
           MOVWF       DAYS_COUNTER
```

```
           MOVLW      .23            ;PRESET THE HOUR COUNTER
           MOVWF      HOUR_COUNTER
           MOVLW      .59            ;PRESET THE MINUTES COUNTER
           MOVWF      MIN_COUNTER
           MOVLW      .45            ;PRESET THE SECONDS COUNTER
           MOVWF      SEC_COUNTER

;*****************************************************************
;       MAIN PROGRAM LOOP
;*****************************************************************

MAIN       NOP
           NOP
           CALL       SET_IO         ;SET UP THE DATA

;--------THIS IS THE MAIN TIMING LOOP SECTION-------------------------

           MOVLW      .200           ;SET TIMING LOOP (HARDWARE)
           MOVWF      COUNT1
MAIN_LOOP  CLRWDT
           DECFSZ     COUNT1
           GOTO       MAIN_LOOP
           NOP

;--------THIS IS THE TIMING SECTION FOR COUNTING TO 180 DAYS-----------

           INCF       MS_COUNTER     ;CHECK FOR VALUE
           MOVLW      .10            ;CHECK 10 COUNTS
           XORWF      MS_COUNTER,W   ;MATCH YET?
           BTFSS      Z
           GOTO       MAIN           ;NO!

;--------TOGGLE OUTPUT PIN--------------------------------------------

           BTFSS      TOGGLE         ;CHECK CURRENT STATE OF PIN
           GOTO       TOGGLE_ON
           BCF        TOGGLE         ;TURN PIN OFF (LOW)
           GOTO       CHECK_TIME
TOGGLE_ON  BSF        TOGGLE         ;TURN PIN ON (HIGH)
           NOP

CHECK_TIME CLRF       MS_COUNTER
           INCF       SEC_COUNTER    ;CHECK FOR 60 SECONDS
           MOVLW      .60
           XORWF      SEC_COUNTER,W  ;MATCH YET?
           BTFSS      Z
           GOTO       MAIN           ;NO!
           CLRF       SEC_COUNTER
           INCF       MIN_COUNTER    ;CHECK FOR 60 MINUTES
           MOVLW      .60
           XORWF      MIN_COUNTER,W  ;MATCH YET?
           BTFSS      Z
           GOTO       MAIN           ;NO!
           CLRF       MIN_COUNTER
           INCF       HOUR_COUNTER   ;CHECK FOR 24 HOURS
           MOVLW      .24
           XORWF      HOUR_COUNTER,W ;MATCH YET?
           BTFSS      Z
           GOTO       MAIN           ;NO!
           CLRF       HOUR_COUNTER
           INCF       DAYS_COUNTER   ;CHECK FOR 180 DAYS
           MOVLW      .183
           XORWF      DAYS_COUNTER,W
           BTFSS      Z
           GOTO       MAIN           ;NO!
           CALL       FLASH_LED_S    ;FLASH THE LED
```

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7/29/97