Electromechanical Switch Replacement

Optical Pyrometer

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APPLICATION OPERATION

An optical pyrometer is a device that allows non-contact measurement of temperature in the range from less than 1000° F to more than 3000° F. It operates on the principle of comparing a hot filament against a background of the object to be measured using a simple optical system similar to half of a binocular.

Normally, these devices use no electronics at all, they consist of a power rheostat, an analog meter calibrated to read temperature and on/off switch. As portability is normally a requirement, a battery source such as alkaline 'C' or 'D' cells is used to power the device.

Incorporating a PIC12C5XX into an optical pyrometer has the following benefits:

- Improved battery life from using a PWM MOSFET to control power to the filament, thus saving typically half the energy consumed.
- Elimination of the power-wasting rheostat with two inexpensive momentary pushbuttons.
- Elimination of the on/off switch.
- Automatic power-off, thus saving the batteries should the user accidentally leave the filament on.

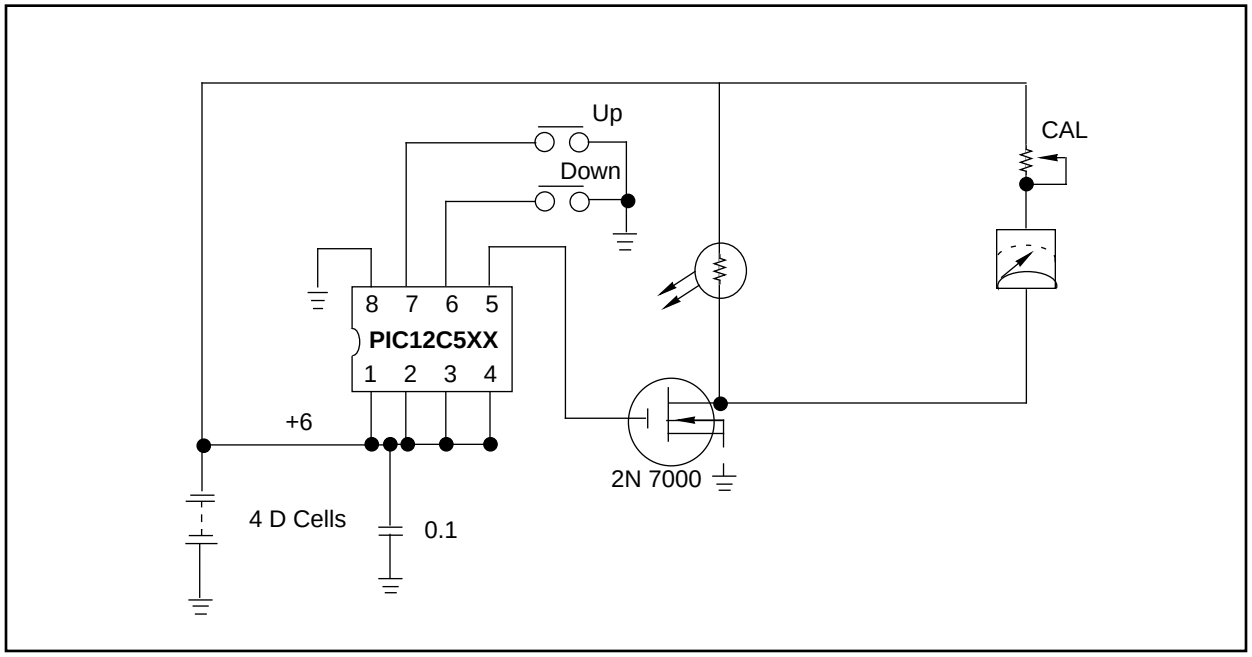
Only four external components are required to implement the above functions, including the momentary switches. The internal RC clock and reset circuitry of the PIC12C5XX are more than adequate for this application. The internal pull-ups on inputs and the wake-up on pin change functions are extremely useful in this application.

Functions

Pressing either the up or down key will "wake up" the PICmicro™ MCU and turn the unit on. The power to the filament is retained from the last measurement. The power can be adjusted up or down by holding down the appropriate key. Pressing both keys at once for more than a certain amount of time (0.8 second) will turn the unit off when the keys are released. If no keys are pressed for more than a certain amount of time (2.5 minutes), the unit will turn itself off. Power draw in the "off" condition is negligible compared to battery internal self-discharge leakage.

GRAPHICAL HARDWARE PRESENTATION

The hardware used is shown below. No supply regulation is used since the PICmicro will operate over a wide range of supply voltage and the analog meter reads the actual average voltage on the filament. The weak pullup on GP3 also serves GP4 and GP5.



MICROCHIP TOOLS USED

Development Tools:

PISTART® Plus

Assembler/Compiler Version:

MPLAB 3.22, MPASM 1.5

APPENDIX A: SOURCE CODE

```
;*****************************************************************************
;
;   This program is for a PIC2C5XX microcontroller that will control a simple
;   optical pyrometer using PWM and providing timed auto-off and on/off
;   functions.
;
;   (C) 1997 Spehro Pefhany, all rights reserved
;
;   Rev. A
;
;   -   verified current in "off" state is less than 1uA
;   -   15.544 msec execution for bigloop in simulator
;
;*****************************************************************************
    listp=12c509, r=HEX
    include <P12C509.INC>; sfr definitions

#definePOWER_TIME0x26; desired time in seconds, divided by 3.96 (2.5min)
#define BOTHKEY_TIME0x1F; desired time in seconds, divided by 0.01554 (0.5 sec)

ctr equ 09  ; counter generates time ramp for comparison
c_valequ0A  ; current value of PWM from 0..FF
repeatsequ0B; number of times to repeat the PWM loop
pwr_preequ0C; power off prescaler
pwr_ctrequ0D; power off counter
bothky_ctrequ0E; timer for both keys pressed to power off

    org 0

coldstart:
;*****************************************************************************
; Setup options
;*****************************************************************************
  movwfOSCCAL; may as well use calibrated time
  movlwH'00'

  btfss7,STATUS; if a wake up , don't reset the set value
  movwfc_val

  movwfSTATUS; make sure that the page bit is cleared, of course it
       ; is supposed to be

  movlwH'FB'; only GP2 is an output, other are inputs
  trisGPIO; do it

  movlwH'00'; set up for weak pullups and wake up on pin change
  option
 ;*****************************************************************************
; Now set up the power off timer to full time
;*****************************************************************************
  movlwH'FF'
  movwfpwr_pre; set up prescaler
  movlwPOWER_TIME
  movwfpwr_ctr; set up counter
;*****************************************************************************
; And the bothky timer
;*****************************************************************************
   movlwBOTHKEY_TIME
   movwfbothky_ctr; set up counter
;*****************************************************************************
;  The central PWM loop for controlling the filament intensity
;
;  We only check for zero outside the tight inner loops
```

```
;*******************************************************************************
bigloop:
   movlwD'20'; number of times to repeat
   movwfrepeats
   movfc_val,w; get the current value
   btfscSTATUS,2; skip if not zero
  gotoiszero
reploop:
;*******************************************************************************
; Inner PWM loop.. if c_val is 0, don't even start
;
; The below gives exactly the same time to completion, regardless of
; on and off times, with some overhead where the output is off-- except
; for 0 input, must simulate that.
;*******************************************************************************
  movfc_val,w; do it again for the loop
  movwfctr
  bsfGPIO,2; turn the output on
onloop:
  decfszctr,f
  gotoonloop
  bcfGPIO,2; turn the output off

  comfc_val,w; get complement of current value
  movwfctr
  incfctr,f; add 1 to it
offloop:
  decfszctr,f
  gotooffloop
  decfszrepeats,f
  goto reploop; repeat multiple times
  gotocontinue
;*******************************************************************************
;   Here we handle the special case of a zero c_val
;
;   We even the time out exactly, even though it isn't critical in this case
;*******************************************************************************
iszero:
reploop1:
  bcfGPIO,2; just to be sure

  movlwH'00'; counter
  movwfctr
offloop1:
  decfszctr,f
  gotooffloop1
  nop      ; even out the delay to make it exactly the
           ; same as the controlled on/off time loops
  nop
  nop      ; even it out exactly
  decfszrepeats,f
  gotoreploop1; repeat multiple times
  nop      ; even time out exactly
continue:
;*******************************************************************************
; The "extra" delay loop for limiting the maximum light intensity
; with new batteries
;*******************************************************************************
  ; code goes in here, if required
;*******************************************************************************
; Now poll keys, check for time-out of power-off timer and
; do any key operations required.
;*******************************************************************************
  btfssGPIO,0; skip if no up key
  gotoupkeyp
  btfssGPIO,1; skip if no down key
```

```
  gotodownkeyp
;*******************************************************************************
; Check to see if we are in timeout situation on bothkey timer
;*******************************************************************************
  movfbothky_ctr,f
  btfscSTATUS,2; if not timed out, then continue
  gotosnooze
;*******************************************************************************
; Reset the timer
;*******************************************************************************
  movlwBOTHKEY_TIME
  movwfbothky_ctr; reset the timer for both keys pressed

;*******************************************************************************
; There are no keys pressed, so count the power-off timer down and
; delay so it is the same as the other paths
;
; We hit this roughly every 16ms.. power off delay should be 2-3 minutes,
; so we need a count of 9,400 to get 2.5 minutes, a divide by 255 will
; give roughly 4 second per secondary count.
;
;*******************************************************************************
  decfszpwr_pre; count down prescaler
  gotoback
  gotodeccount
back:nop
  nop
  nop
  nop
  gotobigloop
deccount:
  nop       ; keep time same as other cycles
  decfszpwr_ctr,f; count down main counter
  gotobigloop
;*******************************************************************************
; Now we have the power-off timer timeout, so we put the micro to
; sleep. It will wake upon a pin change.
;*******************************************************************************
snooze:
  bcfGPIO,2 ; just to be sure
  movfGPIO,w; read all pins, as manual recommends
  sleep     ; goes to reset on wake-up
;*******************************************************************************
; upkeyp handles an up key
;*******************************************************************************
upkeyp:btfssGPIO,1; this keeps time same as downkeyp as well
  gotobothkeyp
  comfc_val,w; see if it was FF
  btfscSTATUS,2; skip if it wasn't FF
  decfc_val,f
  incfc_val,f
  gotocommon1

;*******************************************************************************
; downkeyp handles a down key
;*******************************************************************************
downkeyp:
  movfc_val,w; see if it is zero
  btfscSTATUS,2; skip if it wasn't zero
  incfc_val,f
  decfc_val,f
  gotocommon1

;*******************************************************************************
; bothkeyp handles situation where both keys are pressed
;
```

```
;*******************************************************************************
bothkeyp:
  movfbothky_ctr,w; check if already zero
  btfssSTATUS,2
  decfbothky_ctr,f; if not already zero, decrement
  nop       ; keep same time as others
  gotocommon
;*******************************************************************************
; Common ending for upkeyp and downkeyp and bothkeyp
;*******************************************************************************
common1:nop; keep all the times the same
common:
;*******************************************************************************
; Set up the power off timer to full time again
;*******************************************************************************
  movlwH'FF'
  movwfpwr_pre; set up prescaler
  movlwPOWER_TIME
  movwfpwr_ctr; set up counter

  gotobigloop

  end
```

NOTES:

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