

MCP1252 Charge Pump Backlight LED Demo Board User's Guide

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Preface

NOTICE TO CUSTOMERS

All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Please refer to our web site (www.microchip.com) to obtain the latest documentation available.

Documents are identified with a "DS" number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is "DSXXXXXA", where "XXXXXX" is the document number and "A" is the revision level of the document.

For the most up-to-date information on development tools, see the MPLAB[®] IDE on-line help. Select the Help menu, and then Topics to open a list of available on-line help files.

INTRODUCTION

This chapter contains general information that will be useful to know before using the MCP1252 Charge Pump Backlight LED Demo Board. Items discussed in this chapter include:

- Document Layout
- · Conventions Used in this Guide
- · Recommended Reading
- The Microchip Web Site
- Customer Support
- · Document Revision History

DOCUMENT LAYOUT

This document describes how to use the MCP1252 Charge Pump Backlight LED Demo Board. The manual layout is as follows:

- Chapter 1. "Product Overview" Important information about the MCP1252 Charge Pump Backlight LED Demo Board.
- Chapter 2. "Installation and Operation" Includes instructions on how to get started with this user's guide and a description of the user's guide.
- Appendix A. "Schematic and Layouts" Shows the schematic and layout diagrams for the MCP1252 Charge Pump Backlight LED Demo Board.
- Appendix B. "Bill-Of-Materials (BOM)" Lists the parts used to build the MCP1252 Charge Pump Backlight LED Demo Board.
- Appendix C. "00016R1.asm Source Code" Provides information about the application firmware and where the source code can be found.

CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

Description	Represents	Examples		
Arial font:				
Italic characters	Referenced books	MPLAB [®] IDE User's Guide		
	Emphasized text	is the only compiler		
Initial caps	A window	the Output window		
	A dialog	the Settings dialog		
	A menu selection	select Enable Programmer		
Quotes	A field name in a window or dialog	"Save project before build"		
Underlined, italic text with right angle bracket	A menu path	<u>File>Save</u>		
Bold characters	A dialog button	Click OK		
	A tab	Click the Power tab		
ʻb <i>nnnn</i>	A binary number where <i>n</i> is a digit	'b00100, 'b10		
Text in angle brackets < >	A key on the keyboard	Press <enter>, <f1></f1></enter>		
Courier font:				
Plain Courier	Sample source code	#define START		
	Filenames	autoexec.bat		
	File paths	c:\mcc18\h		
	Keywords	_asm, _endasm, static		
	Command-line options	-Opa+, -Opa-		
	Bit values	0, 1		
Italic Courier	A variable argument	file.o, where file can be any valid filename		
0xnnnn	A hexadecimal number where <i>n</i> is a hexadecimal digit	0xFFFF, 0x007A		
Square brackets []	Optional arguments	mcc18 [options] file [options]		
Curly brackets and pipe	Choice of mutually exclusive	errorlevel {0 1}		
character: { }	arguments; an OR selection			
Ellipses	Replaces repeated text	<pre>var_name [, var_name]</pre>		
	Represents code supplied by user	<pre>void main (void) { }</pre>		

RECOMMENDED READING

This user's guide describes how to use MCP1252 Charge Pump Backlight LED Demo Board. The following Microchip documents are available and recommended as supplemental reference resources.

MCP1252/3 Data Sheet, "Low Noise, Positive Regulated Charge Pump", (DS21752)

This data sheet provides detailed information regarding the MCP1252/3 product family.

THE MICROCHIP WEB SITE

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- General Technical Support Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip consultant program member listing
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- Field Application Engineer (FAE)
- Technical Support
- Development Systems Information Line

Customers should contact their distributor, representative or field application engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the web site at: http://support.microchip.com In addition, there is a Development Systems Information Line which lists the latest versions of Microchip's development systems software products. This line also provides information on how customers can receive currently available upgrade kits.

The Development Systems Information Line numbers are:

1-800-755-2345 - United States and most of Canada

1-480-792-7302 - Other International Locations

DOCUMENT REVISION HISTORY

Revision A (May 2005)

· Initial Release of this Document.

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Chapter 1. Product Overview

1.1 INTRODUCTION

Today's new color displays require a pure white light for backlighting. White light-emmitting diodes have become the component of choice. The MCP1252-ADJ is an excellent choice for biasing the backlighting or driving other LED applications. Light intensity is controlled uniformly through the use of ballast resistors. The peak intensity is set by the feedback (FB) to the the MCP1252-ADJ. Dimming is accomplished by pulse-width modulating the shutdown pin of the device.

This chapter covers the following topics:

- What is the MCP1252 Charge Pump Backlight LED Demo Board?
- What the MCP1252 Charge Pump Backlight LED Demo Board Kit Includes

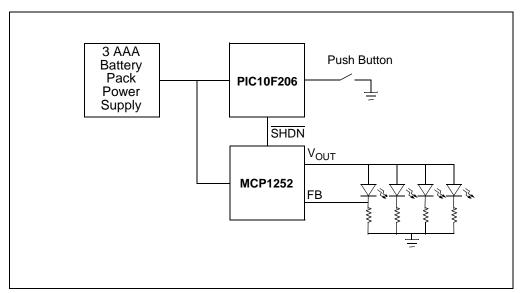


FIGURE 1-1: MCP1252 Charge Pump Backlight LED Demo Board Block Diagram.

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1.2 WHAT IS THE MCP1252 CHARGE PUMP BACKLIGHT LED DEMO BOARD?

The MCP1252 Charge Pump Backlight LED Demo Board demonstrates the use of a charge pump device in a LED application. The board also serves as a platform to evaluate the MCP1252 device generally.

The MCP1252-ADJ device used in this application is an inductorless, positive-regulated charge pump DC/DC converter. The device generates an adjustable output voltage. It is specifically designed for applications requiring low noise and high efficiency, and is able to deliver up to 120 mA output current. In addition, a charge pump is a low-cost, compact and simple solution for an application, as it only requires one external capacitor to transfer charge from the input supply to the regulated output.

The MCP1252 allows the input voltage to be lower or higher than the the output voltage by automatically switching between buck and boost operation. This makes it especially suited for battery applications, allowing the system voltage to be maintained even after the batteries have discharged below the system voltage level, further extending the overall charge life of the battery.

1.3 WHAT THE MCP1252 CHARGE PUMP BACKLIGHT LED DEMO BOARD KIT INCLUDES

This MCP1252 Charge Pump Backlight LED Demo Board kit includes:

- MCP1252 Charge Pump Backlight LED Demo Board (102-00016)
- MCP1252 Charge Pump Backlight LED Demo Board User's Guide (DS51551)



Chapter 2. Installation and Operation

2.1 INTRODUCTION

The MCP1252 Charge Pump Backlight LED Demo Board uses the MCP1252-ADJ to power four white LEDs. A PIC10F206 microcontroller in a SOT23 package is used to provide an enable signal to the MCP1252. It also accepts a push button input that allows the user to adjust the white LEDs to five different light intensities, in addition to placing the system in a standby mode that consumes less than 1 µA of current (typ.).

The PIC10F206 microcontroller is programmable, allowing the user to modify or develop their own firmware routines to further evaluate the MCP1252 in this application.

2.2 FEATURES

The MCP1252 Charge Pump Backlight LED Demo Board has the following features:

- Programmed MCP1252 charge pump control (via the PIC10F206)
- · Four white LEDs
- PIC10F206 microcontroller
 - Enables the MCP1252 charge pump
 - Controls light intensity
 - Places system into Sleep mode (< 1 μA)
- Push button interface for multiple control options
- Baseline Flash Microcontroller Programmer (BFMP) Header for reprogramming the PIC10F206
- 3 AAA battery pack (batteries not included)

2.3 GETTING STARTED

The MCP1252 Charge Pump Backlight LED Demo Board comes fully assembled and tested. The board requires 3 AAA batteries as a power source for the application.

2.3.1 Powering the MCP1252 Charge Pump Backlight LED Demo Board

Insert three AAA batteries into the battery pack on the bottom of the board. As soon as the system powers up, the internal program of the PIC10F206 will initialize and remain in a low-power sleep mode (<1 μ A) until the S1 button is pressed by the user.

The MCP1252 Charge Pump Backlight LED Demo Board does not need a power switch or power jumper because of the "standby" or "sleep" mode of the PIC10F206 microcontroller. Upon entering Sleep mode, the system requires less than 1 μ A (typ) of current. So, with three AAA batteries used in the application (at 1250 mAh per battery), the system's power requirements in Sleep mode are minimal (the "shelf life" of an alkaline battery is 5-7 years, whereas the system current load in Sleep mode would discharge the battery pack in about 400 years!).

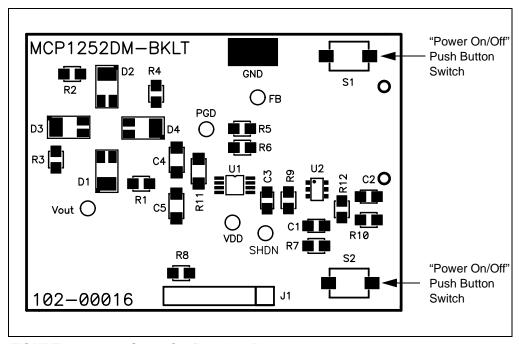


FIGURE 2-1: Setup Configuration Diagram.

Activating Application and Changing the LED intensity

- To activate the LEDs, simply press the S1 push button. The LEDs will turn on at a low intensity level when the push button is pressed, gaining intensity when the push button is pressed again. There are 5 levels of LED intensity (plus the "off" state).
 - The intensity of the LEDs are controlled via the SHDN input pin of the MCP1252. A Pulse-Width Modulated (PWM) signal is generated by the PIC10F206 and routed to the SHDN input pin of the MCP1252. The MCP1252 is actually pulsed, and the duty cycle of the PWM waveform is varied, such that narrow pulses create a low-intensity condition, while wider pulses create a high-intensity condition.
- 2. The LEDs will be turned off, and the system will enter Sleep mode, when the LEDs are in the high-intensity state and the push button is pressed. Subsequent push button presses will cycle the LEDs as described in Step 1.

Evaluating the Application

The best way to evaluate the MCP1252 Charge Pump Backlight LED Demo Board is to dig into the circuit. Measure voltages and currents with a DVM and probe the board with an oscilloscope. Test points have been provided to simplify this task. The test points correspond to the pins of the MCP1252: PGD (= PGOOD), Vout, V_{DD} (= V_{IN}), GND, SHDN and FB.

The firmware program in the PIC10F206 can also be edited to modify the operation of the application. For example, the output signal that is routed from GP0 of the PIC10F206 to SHDN of the MCP1252 can be changed to implement different light intensities, slowly blinking the LEDs on/off or provide some other pattern. There is also an optional push button (S2) that can be used to provide additional control options to the system

Firmware

The PIC10F206 comes preprogrammed with firmware to operate the system as described above. The program file can be found on the CD that comes with the kit. The file listing and firmware flow diagram are shown in **Appendix C. "00016R1.asm Source Code"**.

The program is fairly simple and straightforward. There is an initialization routine at the beginning of the program. The constants allow for five LED intensity levels to be adjusted to the appropriate light intensity (LED_HI_ON, LED_MEDHI_ON, etc.), set the PWM period (PERIOD) and maximum time (MAX_TIME) before the unit switches back to Sleep mode. The variables track what mode the unit is in (MODE), implement counters (COUNTER, TIMERH, TIMERL), etc.

Upon resetting the processor, the ports are initialized and registers are configured in the INIT_PORTS routine. If the device has come out of Sleep mode, the MODE variable is set so the LEDs will be at low intensity. The OPTION register is configured to wake-up on Port pin change. The GPIO port is configured to set GP0 (PWM to the MCP1252) as an output and GP1, GP2 and GP3 (push button) as inputs. The processor will reset on power-up or due to a wake-up from Sleep mode. Therefore, the STATUS register needs to be tested to determine the source of the reset. If the reset occurred due to powering up the system for the first time, the program proceeds to the INIT_VARS subroutine, where the program variables are initialized. If the reset occurred due to a wake-up from Sleep mode, the program proceeds to the WAKE subroutine.

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The WAKE routine tests the GPIO push button input to determine if the button has been pressed. If it has, the program goes to the INC_MODE subroutine to set the new LED intensity mode. The INC_MODE and MODE_SELECT routines determine the appropriate light intensity when the device is reset, comes out of Sleep mode, or button S1 is pressed to increment the light intensity. The LED_FULL, LED_HIGH, LED_MEDHI, LED_MED, LED_LOW, and LED_OFF routines set one of six LED settings (five light intensity settings and "off").

Programming

Header JP1 is provided for in-system circuit programming. This is an optional feature since the demo board comes pre-programmed with F/W to operate the system. The PIC10F206 can be reprogrammed with the Baseline Flash Microcontroller Programmer (BFMP).

The BFMP is a simple and easy-to-use in-circuit serial programmer intended to be used with any of Microchip's new baseline Flash PIC[®] microcontrollers, specifically, the PIC10F200/202/204/206, PIC12F508/509, PIC16F505 and PIC16F54/57/59. The BFMP provides a 6-pin linear In-Circuit Serial Programming™ (ICSP™) header for standard ICSP support, as well as stand-alone programming support for the PIC10F family when paired with the PIC10F2XX programmer adapter, providing the least expensive method of programming. The BFMP utilizes USB and does not require an external power supply. The included Graphical User Interface (GUI) allows you to read, write and verify the microcontroller to be programmed.

Please refer to Microchip's web site (www.microchip.com) for additional information on the BFMP.



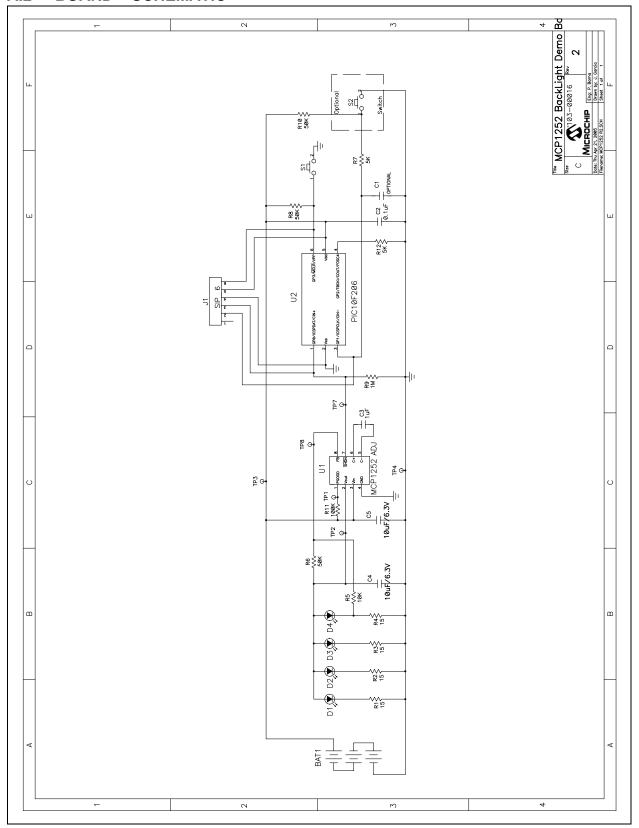
Appendix A. Schematic and Layouts

A.1 INTRODUCTION

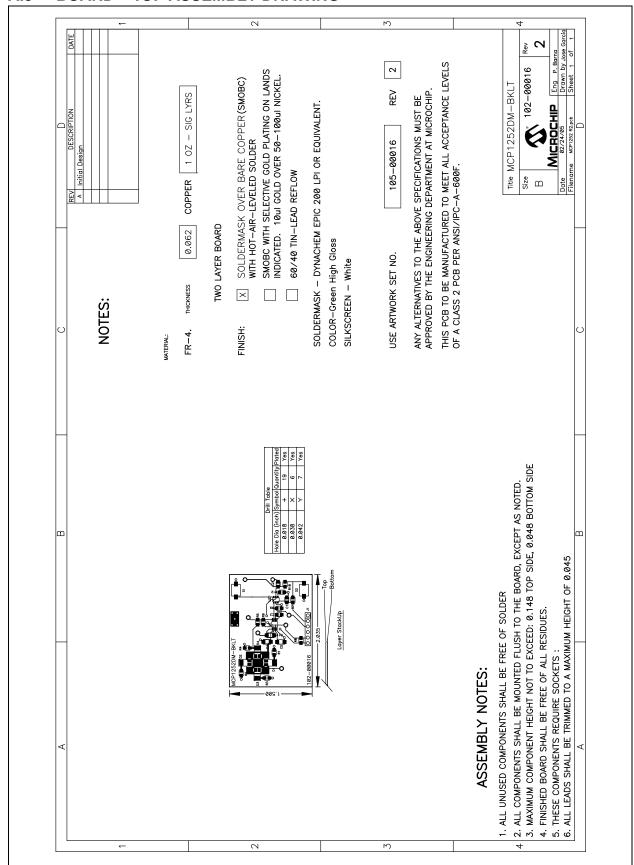
This appendix contains the following schematics and layouts for the MCP1252 Charge Pump Backlight LED Demo Board:

- Board Schematic
- Board Top Assembly Drawing
- Board Top Layer + Silk-Screen
- Board Bottom Layer

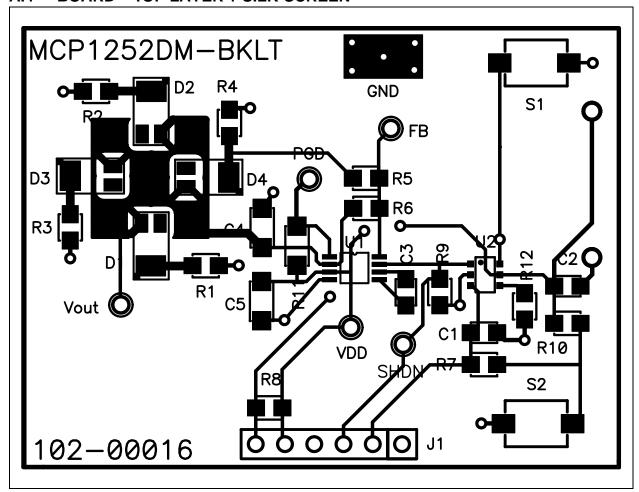
A.2 BOARD - SCHEMATIC



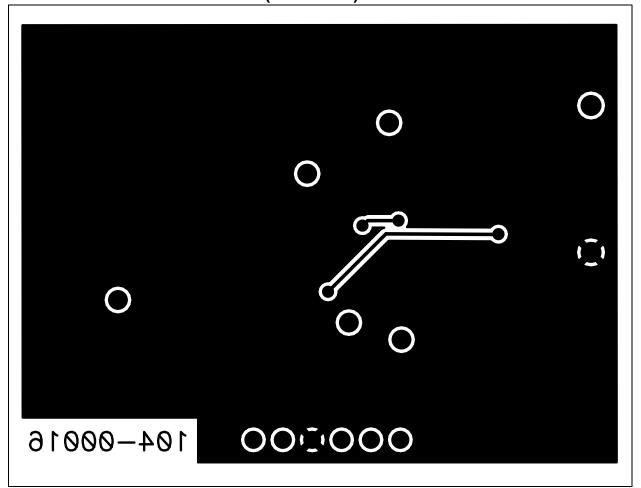
A.3 BOARD - TOP ASSEMBLY DRAWING



A.4 BOARD - TOP LAYER + SILK-SCREEN



A.5 BOARD - BOTTOM LAYER (FROM TOP)



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Appendix B. Bill-Of-Materials (BOM)

TABLE B-1: BILL-OF-MATERIALS (BOM)

QTY	Reference	Description	Manufacture	MFG PART #
1	C2	CAP .1UF 25V CERAMIC X7R 0805	Panasonic [®] – ECG	ECJ-2VB1E104K
1	C3	CAP 1.0UF 10V CERAMIC X7R 0805	Kemet [®]	C0805C105K8RACTU
2	C4,C5	CAP 10UF 6.3V CERAMIC X5R 1206	Kemet	C1206C106K9PACTU
4	R1,R2,R3,R4	RES 15.0 OHM 1/10W 1% 0805 SMD	Panasonic – ECG	ERJ-6ENF15R0V
1	R5	RES 10.0K OHM 1/10W 1% 0805 SMD	Panasonic – ECG	ERJ-6ENF1002V
2	R7,R12	RES 4.99K OHM 1/10W 1% 0805 SMD	Panasonic – ECG	ERJ-6ENF4991V
3	R6,R8,R10	RES 49.9K OHM 1/10W 1% 0805 SMD	Panasonic – ECG	ERJ-6ENF4992V
1	R11	RES 100K OHM 1/10W 1% 0805 SMD	Panasonic – ECG	ERJ-6ENF1003V
1	R9	RES 1.00M OHM 1/10W 1% 0805 SMD	Panasonic – ECG	ERJ-6ENF1004V
4	D1,D2,D3,D4	LED WHITE DIFFUSED 2-PLCC SMD	Osram Opto Semiconductors Inc	LW T67C-T2U2-3C5D
2	S1,S2	SWITCH LT TOUCH 6X3.5 100GF SMD	Panasonic – ECG	EVQ-PJS04K
1	BAT 1	HOLDER BATTERY 3CELL AAA PC MNT	Keystone Electronics®	2479
1	J1	SIP_6 Pin "Do Not Populate"	_	_
1	JP1	CONN HEADER 2POS .100 VERT TIN	Molex [®] /Waldom [®] Electronics Corp	22-28-4021
1	U1	MCP1252	Microchip Technology Inc.	MCP1252-ADJI/MS
1	U2	PIC10F206-E/OTG	Microchip Technology Inc.	PIC10F206-E/OTG

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Appendix C. 00016R1.asm Source Code

C.1 DEVICE FIRMWARE

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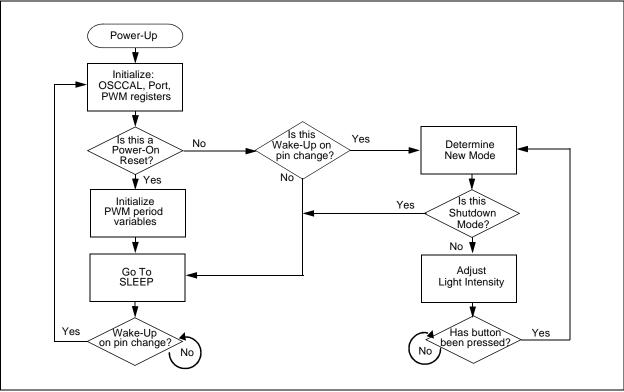


FIGURE C-1: Firmware Flowchart – Page 1.

TABLE C-1: 00016R1.ASM

```
Filename:
                  00016R1.asm
    Date:
                  31aug04
    File Version: pp1
   Author: M Waldron
    Company: MCHP
  10f204/ 10f206 PWM to control LED driver
;***********************
    Files required:
Notes: Changed file name, added led_medhi routine,
          adjusted intensity of various modes. PB 3/29/05
             ********************
   list p=10f206 ; list directive to define processor 
 \#include <p10f206.inc> ; processor specific variable definitions
   __CONFIG _CP_OFF & _WDT_OFF & _MCLRE_OFF & _IntRC_OSC
; ' CONFIG' directive is used to embed configuration data within .asm file.
; The labels following the directive are located in the respective .inc file.
; See respective data sheet for additional information on configuration word.
; constants
; increase led xxx on to increase intensity (value must be less than period value)
;increase period to reduce PWM frequency and increase PWM resolution
led hi on
           = 0x16 ; on loops for high brightness mode
led_hi_off
           = 0x11 ;off loops for high brightness mode, value will be calculated
by the program (10)
led medhi on = 0x08; on loops for medium high brightness mode
led_medhi_off = 0x11 ; off loops for high brightness mode (11)
led med on = 0x06
                     ; on loops for medium brightness mode
led med off = 0x11
                     ;off loops for high brightness mode (11)
            = 0x05
led_low_on
           = 0x12 ;off loops for high brightness mode (12)
= 0x0E ;total loops per PWM period
= 0xff ;on time before unit swithars in
                     ; on loops for low brightness mode
led_low_off = 0x12
        = 0x0E
period
                     ; on time before unit swithces back to sleep
\max_{time}
;variables
         = 0x13 ; current mode ( high, med, lo )
mode
counter
          = 0x14; hi and low time counter
debounce
          = 0x15 ; debounce counter
         = 0x16 ;debounce control flags
flag
```

```
= 0x17
                       ; on timer high byte
timerl
             = 0x18
                       ;on timer low byte
; bits used in the flag variable
                       ; when set a debounced user keypress has been detected
new mode
           = 7
timer ena
            = 6
                       ; when clear the debounce timer will not increment
GPIO pins
button
            = 3
                       ; mode select button
pwm
            = 0
                       ;pwm output
;other
TO
               EQU
                       H'0004'
PD
               EOU
                       H'0003'
GPWU
               EQU
                       H'0007'
GPPU
                     H'0006'
              EQU
COUTEN
                     H'0006'
              EQU
CMPT0CS
              EQU
                     H'0004'
CWU
                       H'0000'
               EQU
org 0x00
               goto reset
org 0x10
reset
           nop
               nop
               bcf OSCCAL, FOSC4 ; GP2/TOCKI/COUT applied to GP2 pin
init_ports movlw 0x01
                          ; initalize mode, upon wake up led will be at low intensity
               movwf mode
               movlw b'00001111'
                                   ; configure for wake on port change
           OPTION
               movlw b'01010011'
                                   ; disable the comparator
               movwf 0x07
                                    ;write to CMCON0
               clrf GPIO
               movlw 0x0E
               tris GPIO
                                   ;configure port
               bcf STATUS, GPWUF
               btfsc STATUS, CWUF ; test for wake up or reset
               goto wake
               btfsc STATUS, GPWUF
               qoto wake
               btfss STATUS, TO
               goto wake
               btfss STATUS, PD
               goto wake
               goto init_vars
                                   ;initialize vars
init vars movlw 0xFF
               movwf timerh
               movwf timerl
               movlw led_hi_on
                                   ; calculate off times based on time remaining in
PWM period
```

```
movwf led hi off
                                     ; add the complement of on time to the window time
                comf led hi off, f
                movlw period
                addwf led_hi_off, f
                movlw led medhi on
                                      ; calculate off times based on time remaining in
PWM period
                movwf led medhi off
                                      ; add the complement of on time to the window
time
                comf led_medhi_off, f
                movlw period
                addwf led medhi off, f
                movlw led_med_on
                                     ; calculate off times based on time remaining in
PWM period
                movwf led med off
                                     ; add the complement of on time to the window time
                comf led med off, f
                movlw period
                addwf led_med_off, f
                movlw led_low_on
                                     ; calculate off times based on time remaining in
PWM period
                movwf led low off
                                     ;add the complement of on time to the window time
                comf led_low_off, f
                movlw period
                addwf led_low_off, f
                movf GPIO, w
                                     ; read port before entering sleep mode
          sleep
          btfss GPIO, button
                                     ; only allow a low to bring PIC out of sleep
wake
                goto inc_mode
                movlw 0x20
                call delay
                movf GPIO, w
                sleep
inc_mode incf mode, f
                                     ;it was a pin change, determine new mode
                ;determine current mode
mode select bcf flag, new mode
                                    ; clear new mode flag
                movlw 0x01
                subwf mode, w
                btfsc STATUS, Z
                goto led off
                movlw 0x02
                subwf mode, w
                btfsc STATUS, Z
                goto led_low
                movlw 0x03
                subwf mode, w
                btfsc STATUS, Z
                goto led_med
```

```
movlw 0x04
                subwf mode, w
                btfsc STATUS, Z
                goto led_medhi
                movlw 0x05
                subwf mode, w
                btfsc STATUS, Z
                goto led high
                movlw 0x06
                subwf mode, w
                btfsc STATUS, Z
                goto led full
                movlw 0x01
                                    ; on mode rollover reset to low brightness mode
                movwf mode
                goto mode select
                ;full on
led full bsf GPIO, pwm
                movlw 0x0F
                call delay
                                     ;used as debounce
                call bounce
                btfss flag, new_mode
                goto led_full
                goto mode_select
                ; high brightness routine
led high bsf GPIO, pwm
                                    ;turn on LED(s) for a set time
                movlw led_hi_on
                call delay
                bcf GPIO, pwm
                                    ;turn off LED(s) fo a set time
                movf led_hi_off, w
                call delay
                call bounce
                btfss flag, new_mode
                goto led high
                goto mode select
                ; medium-high brightness routine
led medhi bsf GPIO, pwm
                                     ;turn on LED(s) for a set time
                movlw led medhi on
                call delay
                                    ;turn off LED(s) fo a set time
                bcf GPIO, pwm
                movf led_medhi_off, w
                call delay
                call bounce
                btfss flag, new_mode
                goto led_medhi
                goto mode_select
                ; medium brightness routine
```

```
led med
         bsf GPIO, pwm
                                   ;turn on LED(s) for a set time
               movlw led med on
               call delay
               bcf GPIO, pwm
                                 ;turn off LED(s) fo a set time
               movf led med off, w
               call delay
               call bounce
               btfss flag, new mode
               goto led med
               goto mode_select
               ;low brightness routine
led low
        bsf GPIO, pwm
                                 ;turn on LED(s) for a set time
               movlw led low on
               call delay
               bcf GPIO, pwm
                                 ;turn off LED(s) for a set time
               movf led_low_off, w
               call delay
               call bounce
               btfss flag, new mode
               goto led low
               goto mode_select
               ;led off
led_off movlw 0x20
               call delay
               bcf GPIO, pwm
                                 ;turn off LED(s)
               movf GPIO, w
                                  ;read port before entering sleep mode
               sleep
               ;delay loop for on and off time
       movwf counter
                                  ; Delay = (3 + (3 * counter) + 2) Tcy
delay
       decfsz counter, f
loop
               goto loop
               retlw 0x00
               ; check for button press
         btfss GPIO, button ; Is Button Depressed?
bounce
               goto bounce1 ; Yes, go to "bounce1"
               bsf flag, timer ena; No, allow timer to start
               clrf debounce ; no user entry, reset debounce timer
               retlw 0x00
           btfss flag, timer ena
bounce1
                             ; do not increment as we have not seen the debounce
               retlw 0x00
released yet
               incfsz debounce, f ;inc debounce timer
                                  ;not yet
               retlw 0x00
               bsf flag, new_mode
               incf mode, f ;a valid press has been detected
               bcf flag, timer_ena ;prevent timer from incrementing to prevent
cycling though modes by holding debounce
bounce00 retlw 0x00
end
```

00016R1.asm	Source	Code
-------------	--------	------

	0001	0111.6	3111	ooui c	<i>-</i> 0000
NOTES:					



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