
PICDIM Lamp Dimmer for the PIC12C508

INTRODUCTION

The PIC12CXXX family of devices adds a new twist to the 8-bit microcontroller market by introducing for the first time fully functional microcontrollers in an eight pin package. These parts are not stripped down versions of their larger brethren, they add features in a package smaller than available ever before for microcontrollers. Using the familiar 12-bit opcode width of the PIC16C5X family with the same TMR0 module, Device Reset Timer, and WatchDog Timer (WDT), the PIC12C5XX family adds an internal 4MHz oscillator main clock, serial programming, wake-up on change, user selectable weak pullups, and multiplexing of the MCLR, T0CKI, OSC1, and OSC2 pins.

This combination of familiar and new features in a compact package gives the designer unprecedented flexibility to produce designs which are much cheaper and smaller than ever before possible, and allows the replacement of even mundane devices like timers and discrete components economically.

This reference note describes an application where the use of a microcontroller was not previously economically feasible for any but the highest end products: lamp dimming.

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ACKNOWLEDGMENTS

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HARDWARE OVERVIEW

Lamp dimming using a TRIAC

Logic level TRIACS are a relatively new introduction. They allow a microcontroller to directly drive (through a current limiting resistor) the gate of a TRIAC.

TRIACs can be used to control the brightness of a lamp by switching the AC power on part-way through each half wave (Figure 2 and Figure 3). By controlling where the TRIAC is "fired" during the power-line cycle, the microcontroller can control the average voltage across the filament of the lamp, and thus the brightness.

The TRIAC used for this application is able to handle lamps up to a **maximum of 100W**.

R9 is connected to the "hot" lead of the AC power line and to pin GP4. The ESD protection diodes of the input structure of the GPIO allows this connection without damage (see Figure 1). When the voltage on the AC power line is positive, the protection diode from the input to V_{DD} is forward biased, and the input buffer

will see approximately $V_{DD}+0.7$ volts and the software will read the pin as high. When the voltage on the line is negative, the protection diode from V_{SS} to the input pin is forward biased, and the input buffer sees approximately $V_{SS}-0.7$ volts and the software will read the pin as low. By polling GP4 for a change in state, the software can detect a zero crossing.

Since there is no transformer for power-line isolation, the user must be very careful and assess the risks from line-transients in his application location. The varistor (RV1) will add some protection.

The Power Supply

The power supply used for this design uses only discrete components and has no transformer or voltage regulator making it extremely low cost. It has been designed to handle either 60Hz or 50Hz input power, 120V nominal line voltage.

The caveat to this low cost power supply is that it can not provide large currents, and the user must take care not to overload it.

FIGURE 1: ZERO CROSSING DETECTION

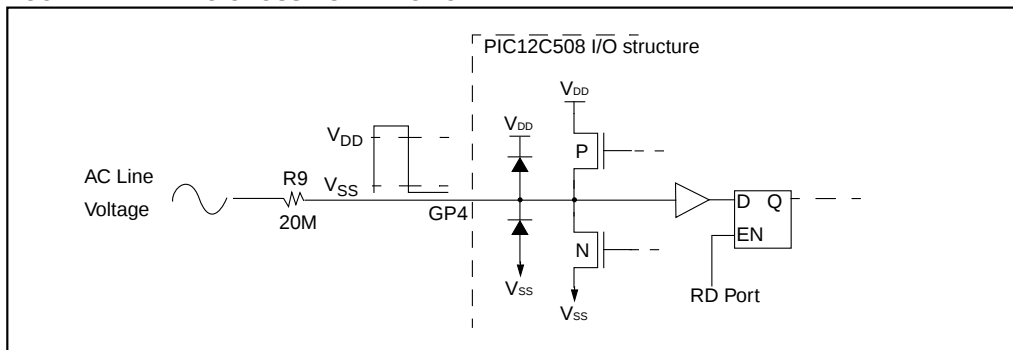


FIGURE 2: WAVEFORMS

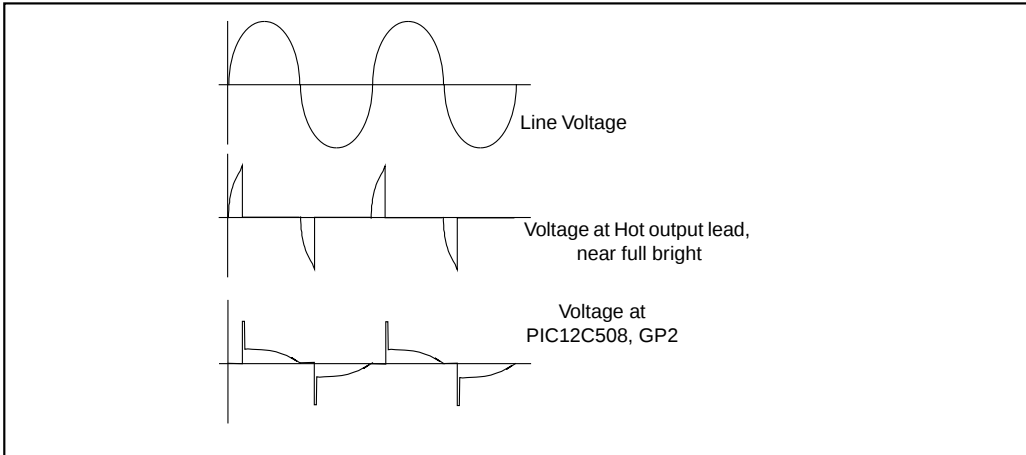
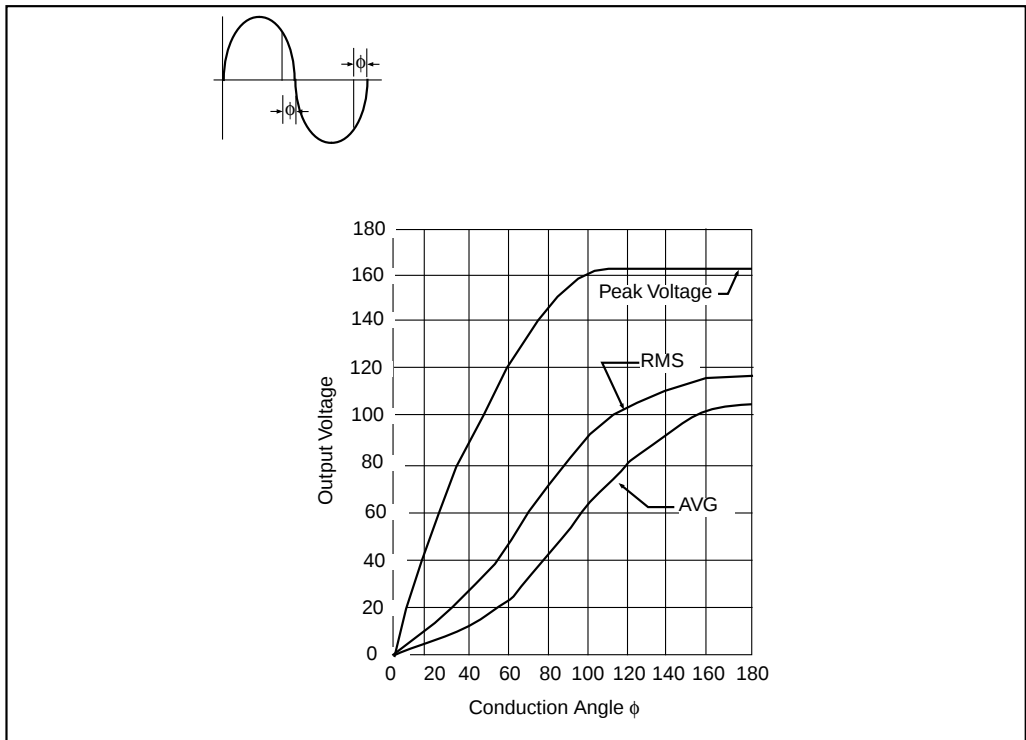


FIGURE 3: OUTPUT VOLTAGE OF FULL-WAVE PHASE CONTROL



SOFTWARE OVERVIEW

The software is written in 'C' using MPLABC, V1.21. There is only a main function and one function called Buttoncheck.

Main Function

Initialization

The main function begins by initializing all of the RAM registers used, and setting the TRIS register so that the zero crossing sense, dim button, and bright button pins are set as inputs, and so that the TRIAC drive pin is set to be an input. The OPTION register is set to assign the prescaler to the timer with a ratio of 1:64, timer to increment on internal clock, and enable the weak pull-up resistors on GP0, GP1, and GP3.

The next statement sets the output latch of GP2 (the output to the TRIAC) high. Note that this statement only sets the output latch high. Since it is set to be an input at this point, the pin will be at high-impedance.

Because the internal RC oscillator of the PIC12C508 can vary with temperature and supply voltage (the Vdd supply should be fairly constant at 5V), the program constantly keeps track of the total Timer0 count of each half cycle of the AC line. If this were not done and the count was too long for maximum dimming, the TRIAC would be fired shortly after the next half-cycle had begun and actually cause the lamp to be on full bright instead of full dim. The rest of the code before entering the main program loop synchronizes the Timer0 count with the line voltage so that the line frequency/Timer0 count is known.

Main Program Loop

The main program loop counts the line cycles and calls Buttoncheck after DelayCnt cycles. If it is not time to call Buttoncheck, two short routines are run, one for the positive and one for the negative half-cycle of the AC line. The routines are identical except for the line polarity checking, so only one will be described.

The line phase is checked to see if the next half-cycle has already begun. If it has, Maxdim is incremented and a wait state is initiated to re-synch with the line voltage. If it hasn't, the program waits for the line voltage to cross zero and when it does, resets Maxdim to match the half-cycle time. If the selected on-percentage is selected to be greater than full dim, it is reset to give full dim.

The timer is set to time out when the TRIAC should be fired for the desired brightness. The program then goes into a loop to wait for either the timer to roll over to zero, or for the AC line half cycle to expire.

The TRIAC is then fired by setting the pin connected to it's gate to be an output (the output latch was already set high) to supply current into the gate. A short delay is initiated to widen the firing pulse before again setting the pin to a high-impedance. The TRIAC will shut off when the AC line voltage next crosses zero.

Buttoncheck Subroutine

This subroutine checks for presses of the BRT and DIM buttons and increments or decrements Percenton based on their states.

If both buttons are pressed and the lamp is not off, it is turned off. If it is already off, it is turned on full bright.

In addition to taking commands from the buttons, a test function is built in to this routine. The test mode is entered by holding both buttons, and then releasing and pressing DIM again. The test will run for 255 cycles or until the DIM button is pressed. The test runs in a cycle of brightening to full bright, dimming to full dim and then flashing full bright twice.

After the section of Buttoncheck where the test cycling is done if the program is in test mode, the program checks the buttons for the sequence to enter test mode, and looks for a both pressed for instant on or off. Following this code is the single button up and down commands with checking for more than full bright and less than full dim.

DESIGN MODIFICATIONS

This reference design will work for many applications without modification. It is anticipated that customers may want to customize its functionality, however, and this section offers suggestions for modification:

- The software was written for a 60Hz line frequency and might work on a 50HZ line, but has not been tested at anything but 60Hz.
- Modify the circuit to use a single button. For this modification, pressing the button would turn the lamp on and off, and if held, would gradually brighten the lamp to full bright, then gradually dim to full dim. The brightness would stay at whatever level it was at when the button was released.
- Add a light level sensor such that if full darkness was sensed when the button was pressed, the lamp would gradually brighten to avoid shocking eyes adjusted for darkness.
- Add a sensor to automatically switch the lamp on and off based on the room occupancy.
- Use the two available pins to add a serial bus for control from remote computer.
- Add a "Halloween" mode that would flash the lamp at random times for a short period to simulate spooky lightning and such.
- Add a photo sensor to maintain a given brightness level in a room depending on ambient light.

FIGURE 4: SOFTWARE FLOWCHART, MAIN PROGRAM LOOP

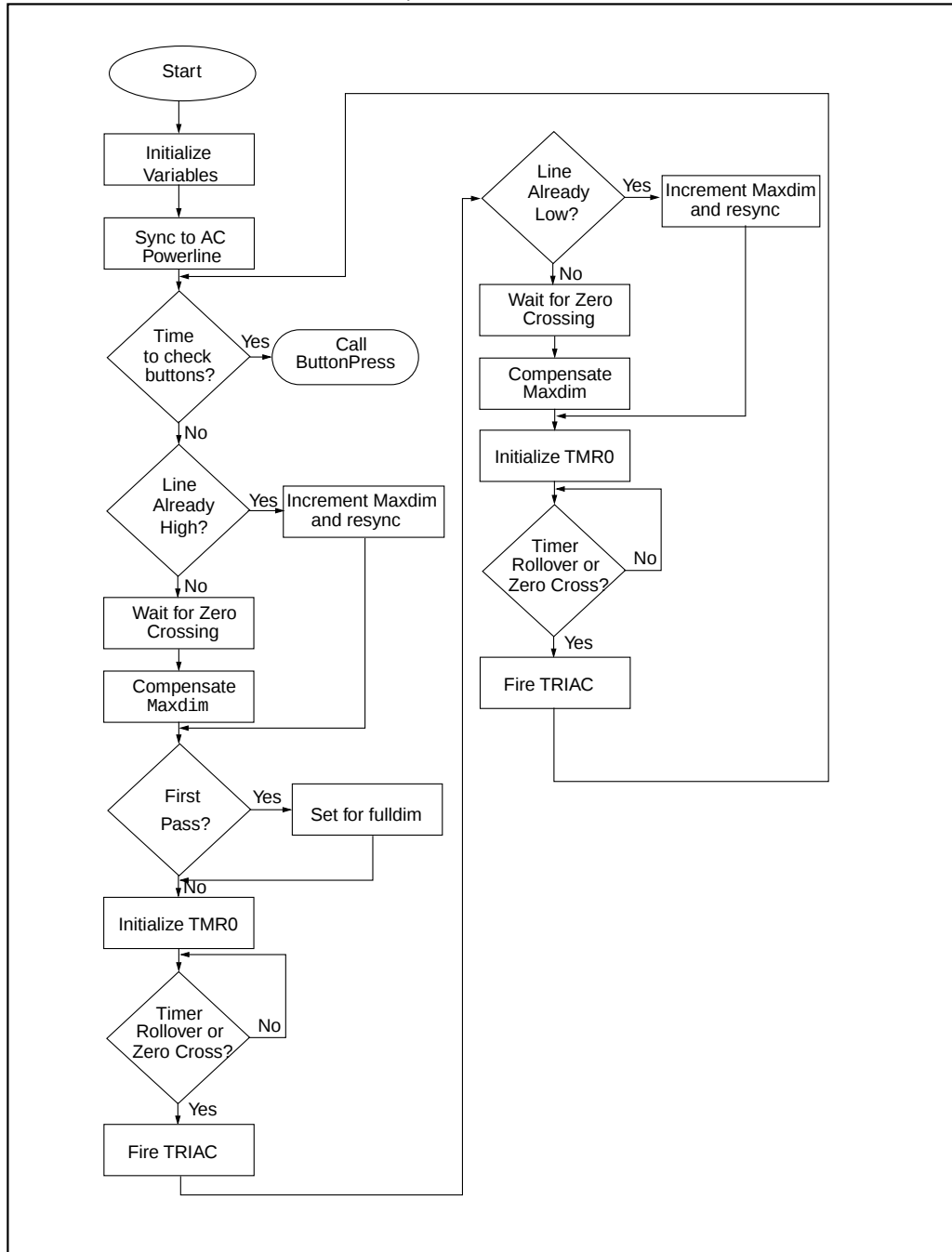
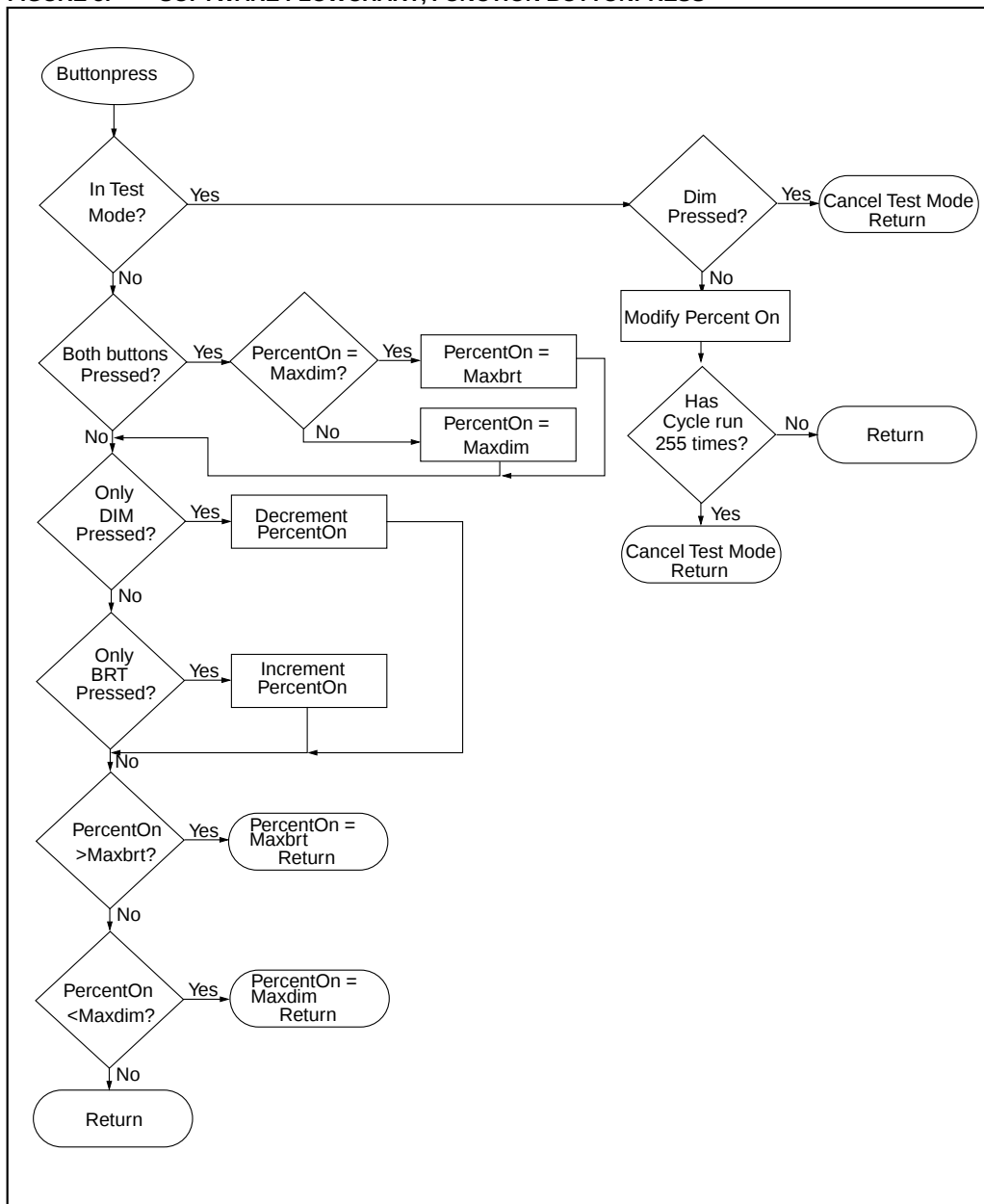


FIGURE 5: SOFTWARE FLOWCHART, FUNCTION BUTTONPRESS



NOTES:

APPENDIX A: SYSTEM SPECIFICATIONS

The following is a list of specifications for the Lamp dimmer:

AC Input: 120 VAC $\pm$ 10%, 60Hz $\pm$ 3Hz

Output: 100W, resistive load only!

APPENDIX B: BILL OF MATERIALS

Description	Qty	Designators	Part #, Manufacturer, Contact #
Resistor, 1/4 Watt, 47ohm, Axial Lead	1	R1	Generic
Resistor, 1/4 Watt, 475ohm, Axial Lead	3	R4, R5, R6	Generic
Resistor, 1/4 Watt, 1Mohm, Axial Lead	1	R2	Generic
Resistor, 1/4 Watt, 20Mohm, Axial Lead	1	R3	Generic
8 Pin, 8-Bit, CMOS, Microcontroller	1	U1	12C508, Microchip Technology, Inc. (602) 786-7200
Logic Triac, TO-202AB, 400V	1	Q1	L4004F51, Teccor Electronics Inc. (214) 580-1515
Zener Diode, 5.1V, DO-35	1	D3	1N5231BCT, Diodes Incorporated/Digi-Key (800) 344-4539
Diode	2	D1, D2	1N4001, Generic
Keyswitch, Momentary PCB Mount	2	S1, S2	BF3-1000, Omron (847) 843-7900
ZNR Transient/Surge Absorbers, 1250A Surge, 300VDC, 230VAC	1	RV1	ERZ-V07D361, Panasonic (206) 395-7343
Aluminum Electrolytic Capacitor, 220uF, 35V	1	C1	ECE-A1VU221, Panasonic (206) 395-7343
Axial Ceramic Capacitor, 0.01uF, 50V	1	C2	A103Z15Z5UFVVA, Philips (602) 820-2225
Polyester & Foil Capacitor, 0.1uF, 200V	1	C3	ECQ-M2104KZ, Panasonic (206) 395-7343

TABLE 1: BUTTON FUNCTIONS

Button	Function
BRT	Brighten
DIM	Dim
Hold DIM, Press BRT	If off: turn full on, if on: turn off
Hold BRT, Press, release, and press DIM again. To exit test mode, press DIM.	Enter test/demo mode

The diagram illustrates a 12V LED driver circuit. It begins with a 12V AC input connected to a transformer (T1) with a 47:1 ratio. The secondary winding provides a 'hot' line and a 'white (return)' line. The 'hot' line passes through a 47Ω resistor (R1) and a 1μF capacitor (C3) before reaching a variable resistor (RV1, labeled 'VARISTOR'). The 'white (return)' line is connected to the non-wiper terminal of RV1. The wiper of RV1 is connected to the VDD pin (pin 1) of the 12C508 IC. The VSS pin (pin 8) is connected to ground. The IC's GP0 pin (pin 2) is connected to the 'hot' line, and the GP1 pin (pin 6) is connected to the 'white (return)' line. The GP2 pin (pin 5) is connected to the wiper of RV1. The GP3 pin (pin 4) is connected to ground. The GP4 pin (pin 3) is connected to the 'hot' line, and the GP5 pin (pin 7) is connected to the 'white (return)' line. The output of the IC is connected to the anode of an LED (O1, L4004F51) through a 470Ω resistor (R6). The cathode of the LED is connected to the 'white (return)' line. A potentiometer (JP1) is connected to the 'hot' line and the 'white (return)' line, with its wiper connected to the 'white (return)' line. The potentiometer is controlled by two switches: S1 (Bright/Dim) and S2 (Bright/Dim). A warning label 'DANGER! Electrocutation Hazard' is present in the bottom right corner.

APPENDIX C: SOFTWARE PROGRAM

```
#pragma option v;
#include <12C508.h>
/*****
/* DIMMER.C
/*
/* Lamp dimmer for the 12C508.
/* This program uses the internal 4MHz oscillator
/* To drive TRIAC, the output is taken high
/* or put in high-impedance(open drain) to release it
/*
/* NOTE: This program is designed to work with a 60Hz
/* line frequency, it must be modified if used
/* on a 50Hz AC line.
/*
/* GPIO<0> = Dim button
/* GPIO<1> = No Connect
/* GPIO<2> = Output to TRIAC
/* GPIO<3> = Bright Button
/* GPIO<4> = Zero Crossing sense input
/* GPIO<5> = No Connect
*****/
#define Brtbut GPIO.0 //Brighten button
#define Output GPIO.2 //Output to TRIAC
#define Dimbut GPIO.3 //Dim button
#define LineInput GPIO.4 //AC line zero crossing sense

void Buttoncheck(void); //Button check routine

unsigned int PercentOn, Maxdim; //Global variables
unsigned int TestCheck, Outcount, TestCount;
unsigned int DelayCnt;
unsigned int LastBoth, FirstPass;
unsigned int Count;
const Maxbrt = 0xFD, NotInTest = 3;
void main()
{
    PercentOn = 0xD0; //On Period
    Maxdim = 0x70; //Value of Maximum dimming
    TestCheck = 0; //Test mode check counter
    Outcount = 0; //Counter for test mode exit
    TestCount = 0; //Test mode counter
    DelayCnt = NotInTest; //Delay count
    LastBoth = 0; //Both buttons pressed last time flag
    FirstPass = 1; //Indicate power-up
    Count = 0; //General counter

    for(Count = 0; Count < 60; Count++) //Allow power supply to stabilize
    {
        while(LineInput == 1);
        while(LineInput == 0);
        CLRWDT;
    }
    WREG = 0x85;
    #asm ( OPTION); //1:64 tmr0 prescaler, pullups enabled
    WREG = 0x1D;
    #asm ( TRIS GPIO); //Set up I/O

    GPIO = 0x04; //Set TRIAC output latch high

    while(LineInput == 1) //Synch to line phase
        CLRWDT;
    TMR0 = PercentOn; //Get Delay time
    while(TMR0 >= 3 && LineInput == 0) //Delay to enter main at proper point
        CLRWDT;
    while(1) //Stay in this loop
```

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```
{
    Count = 0;
    while (Count++ < DelayCnt)                                //Check for button press every
                                                                DelayCnt zero crossings
    {
        if(LineInput == 1)                                    //Check for AC line already high
        {
            Maxdim += 5;                                       //If so, increment Maxdim
            while(LineInput == 1);                             // and re-sync with line
            while(LineInput == 0)
                CLRWDT;
        }
        else
        {
            while(LineInput == 0)                             //Wait for zero crossing
                CLRWDT;
            Maxdim = PercentOn - TMR0 + 2;                     //Compensate full dim value for line
                                                                // frequency vs osc. speed
        }
        if(FirstPass == 1)                                    //If first pass, go to full dim
        {
            FirstPass = 0;
            PercentOn = Maxdim;
        }
        if(PercentOn < Maxdim)                                //If maxdim moved, fix brightness
            PercentOn = Maxdim;
        TMR0 = PercentOn;                                       //Get delay time
        while(TMR0 >= 3 && LineInput == 1) //Delay TRIAC turn on (wait for Counter rollover)
            CLRWDT;

        GPIO = 0x04;                                           //Set TRIAC output latch high
WREG = 0x19;
#asm ( TRIS GPIO);                                           //Fire TRIAC
        NOP;                                                    //Delay for TRIAC fire pulse
        NOP;
        NOP;
        NOP;
        NOP;
        NOP;
        NOP;
WREG = 0x1D;
#asm ( TRIS GPIO);                                           //Release TRIAC fire Signal
        CLRWDT;

        if(LineInput == 0)                                    //Check for AC line already low
        {
            Maxdim += 5;                                       //If so, increment Maxdim
            while(LineInput == 0);                             // and re-sync with line
            while(LineInput == 1)
                CLRWDT;
        }
        else
        {
            while(LineInput==1)                                //Wait for zero crossing
                CLRWDT;
            Maxdim = PercentOn - TMR0 + 2;                     //Compensate full dim value for line
                                                                // frequency vs osc. speed
        }
        if(PercentOn < Maxdim)                                //If maxdim moved, fix brightness
            PercentOn = Maxdim;
        TMR0 = PercentOn;                                       //Get Delay time
        while(TMR0 >= 3 && LineInput == 0)                     //Delay TRIAC turn on
            CLRWDT;
        GPIO = 0x04;                                           //Set TRIAC output latch high
WREG = 0x19;
#asm ( TRIS GPIO);                                           //Fire TRIAC
    }
```

```

        NOP;                                //Delay for TRIAC fire pulse
        NOP;
        NOP;
        NOP;
        NOP;
        NOP;
        NOP;
        WREG = 0x1D;
        #asm ( TRIS GPIO);                  //Release TRIAC fire signal
            CLRWDT;
        }
        Buttoncheck();                      //Check for button press
    }
}
/*****
/* ButtonCheck
/*
/* This subroutine checks for presses on the BRT and DIM
/* buttons and increments or decrements PercentOn.
/*
/* If both buttons are pressed and the lamp
/* is not off, it is turned off, if off, it is set to
/* to max bright.
/*
/* In addition, a test function is built in. If both
/* buttons are pressed, the dim let go and then pressed
/* again, test mode is entered. If dim is pressed
/* (alone), the program goes to normal operation at max
/* dim. The test mode brightens to full bright, dims to
/* full dim, flashes full bright twice, and repeats.
*****/
void Buttoncheck()
{
    NOP;                                //Bugfix for MPLABC V1.10
    if(TestCheck == 3)                  //Check test mode flag
    {
        DelayCnt = 2;                    //Reset the delay count
        if(Brtbut && !Dimbut)            //If Dimbutton pressed, exit test mode
        {
            TestCheck = 0;                //Clear Test mode flag
            DelayCnt = 5;
            return;
        }
        if(TestCount == 0)                //Ramp up to full dim
        {
            if(++PercentOn > Maxbrt)      //Check for full bright
            {
                PercentOn = Maxbrt;
                ++TestCount;
                return;
            }
            else
                return;
        }
        if(TestCount == 1)                //Ramp down to full dim
        {
            if(--PercentOn <= Maxdim)    //Check for full dim
            {
                PercentOn = Maxbrt;
                ++TestCount;
                return;
            }
            else
                return;
        }
        while(TestCount++ < 5)            //Delay

```

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```
        return;
while(TestCount++ < 10)                //Turn off for a short period
{
    PercentOn = Maxdim;
    return;
}
while(TestCount++ < 15)                //Turn On for a short period
{
    PercentOn = Maxbrt;
    return;
}
while(TestCount++ < 20)                //Turn off for a short period
{
    PercentOn = Maxdim;
    return;
}
while(TestCount++ < 25)                //Turn on for a short period
{
    PercentOn = Maxbrt;
    return;
}
while(TestCount++ < 30)                //Turn off for a short period
{
    PercentOn = Maxdim;
    return;
}
PercentOn = Maxdim;
TestCount = 0;
if(++Outcount == 255)                  //Reset to beggining of test sequence
{                                     //Run 255 cycles of test mode
    TestCheck = 0;
    DelayCnt = NotInTest;
    Outcount = 0;
}                                     //Clear Test mode flag
return;
}

if(TestCheck)                          //If Test mode not entered quickly,
{                                     // quit checking
    DelayCnt = NotInTest;
    Outcount = 0;
    TestCheck = 0;
}

if(!TestCheck && !Brtbut && !Dimbut)    //Check bright & dim at same time
    TestCheck = 1;                    //If both pressed, set to look for next combo
if(TestCheck == 1 && !Brtbut && Dimbut) //Check for only bright button pressed
    TestCheck = 2;                    //If pressed, set to look for next combo
if(TestCheck == 2 && !Brtbut && !Dimbut) //Check for both pressed again
{
    TestCheck = 3;                    //Enable test mode
    TestCount = 0;
    PercentOn = Maxdim;
    Outcount = 0;
}

if(!Dimbut && !Brtbut)                  //If both pressed
{
    if(LastBoth == 0)                  //Don't flash if held
    {
        LastBoth = 1;
        if(PercentOn == Maxdim)        //If full off...
            PercentOn = Maxbrt;        // turn full on...
        else
            PercentOn = Maxdim;        // otherwise turn off
    }
}
}
```

```
    else
        LastBoth = 0;
    if(!Brtbody && Dimtbody)                //Check for brighten cmd
        PercentOn ++;
    if(Brttbody && !Dimtbody)                //Check for dim cmd
        PercentOn --;
    if(PercentOn > Maxbrt)                   //If greater than full bright
        PercentOn = Maxbrt;
    if(PercentOn < Maxdim)                   //If less than full dim
        PercentOn = Maxdim;
}
```

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NOTES:

APPENDIX D: DIM508.LST FILE

MPLAB-C "C" COMPILER V1.21 Released

PAGE 1

```

#pragma option v;
#include <12C508.h>
#ifndef _12C508_H
/*
PIC12C508 Standard Header File, Version 1.02
(c) Copyright 1996 Microchip Technology, Inc., Byte Craft Limited
RAM locations reserved for temporary variables: 0x07
*/
#pragma option +l;
#endif
/*****
*/ DIMMER.C */
/*
*/
/* Lamp dimmer for the 12C508. */
/* This program uses the internal 4MHz oscillator */
/* To drive TRIAC, the output is taken high */
/* or put in high-impeadance(open drain) to release it*/
/*
*/
/* NOTE: This program is designed to work with a 60Hz */
/* line frequency, it must be modified if used */
/* on a 50Hz AC line. */
/*
*/
/* GPIO<0> = Dim button */
/* GPIO<1> = No Connect */
/* GPIO<2> = Output to TRIAC */
/* GPIO<3> = Bright Button */
/* GPIO<4> = Zero Crossing sense input */
/* GPIO<5> = No Connect */
*****/

0007 #define Brtbut GPIO.0 //Brighten button
0008 #define Output GPIO.2 //Output to TRIAC
0009 #define Dimbut GPIO.3 //Dim button
000A #define LineInput GPIO.4 //AC line zero crossing sense

void Buttoncheck(void); //Button check routine
0008 0009 unsigned int PercentOn, Maxdim; //Global variables
000A 000B 000C unsigned int TestCheck, Outcount, TestCount;
000D unsigned int DelayCnt;
000E 000F unsigned int LastBoth, FirstPass;
0010 unsigned int Count;
007E 0001 const Maxbrt = 0xFD, NotInTest = 3;
void main()
{
0001 0CD0 MOVLW D0h PercentOn = 0xD0; //On Period
0002 0028 MOVWF 08
0003 0C70 MOVLW 70h Maxdim = 0x70; //Value of Maximum dimming
0004 0029 MOVWF 09
0005 006A CLRF 0A TestCheck = 0; //Test mode check counter
0006 006B CLRF 0B Outcount = 0; //Counter for test mode exit
0007 006C CLRF 0C TestCount = 0; //Test mode counter
0008 0C03 MOVLW 03h DelayCnt = NotInTest; //Delay count
0009 002D MOVWF 0D
000A 006E CLRF 0E LastBoth = 0; //Both buttons pressed last time flag
000B 0C01 MOVLW 01h FirstPass = 1; //Indicate power-up
000C 002F MOVWF 0F
000D 0070 CLRF 10 Count = 0; //General counter
000E 0070 CLRF 10 for(Count = 0; Count < 60; Count++) //Allow power supply
to stabilize

000F 0C3C MOVLW 3Ch
0010 0090 SUBWF 10,W
0011 0603 BTFSF 03,0
0012 0A1A GOTO 001Ah
}

```

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0013	0686	BTFSC	06,4	while(LineInput == 1);
0014	0A13	GOTO	0013h	
0015	0786	BTFSS	06,4	while(LineInput == 0);
0016	0A15	GOTO	0015h	
0017	0004	CLRWDT		CLRWDT;
				}
0018	02B0	INCF	10	
0019	0A0F	GOTO	000Fh	
				WREG = 0x85;
001A	0C85	MOVLW	85h	#asm (OPTION);
001B	0002	OPTION		
				WREG = 0x1D;
001C	0C1D	MOVLW	1Dh	#asm (TRIS GPIO);
001D	0006	TRIS	PORTB	
				// __OPTION(0x85); //1:64 tmr0 prescaler, pullups enabled
				// __TRIS(0x1D,GPIO); //Set up I/O
001E	0C04	MOVLW	04h	GPIO = 0x04; //Set TRIAC output latch high
001F	0026	MOVWF	06	
				while(LineInput == 1) //Synch to line phase
0020	0786	BTFSS	06,4	
0021	0A24	GOTO	0024h	
0022	0004	CLRWDT		CLRWDT;
0023	0A20	GOTO	0020h	
0024	0208	MOVF	08,W	TMR0 = Percent0n; //Get Delay time
0025	0021	MOVWF	01	
0026	0C03	MOVLW	03h	while(TMR0 >= 3 && LineInput == 0) //Delay to enter main at proper point
0027	0081	SUBWF	01,W	
0028	0703	BTFSS	03,0	
0029	0A2E	GOTO	002Eh	
002A	0686	BTFSC	06,4	
002B	0A2E	GOTO	002Eh	
002C				CLRWDT;
002C	0004	CLRWDT		
002D	0A26	GOTO	0026h	
				while(1) //Stay in this loop
				{
002E	0070	CLRF	10	Count = 0;
002F				while (Count++ < DelayCnt) //Check for button press every DelayCnt zero crossings
				{
002F	0210	MOVF	10,W	
0030	02B0	INCF	10	
0031	008D	SUBWF	0D,W	
0032	0743	BTFSS	03,2	
0033	0703	BTFSS	03,0	
0034	0AA5	GOTO	00AA5h	
0035				if(LineInput == 1) //Check for AC line already high
0035	0786	BTFSS	06,4	{
0036	0A40	GOTO	0040h	
0037	0C05	MOVLW	05h	Maxdim += 5; //If so, increment Maxdim
0038	01E9	ADDWF	09	
0039	0686	BTFSC	06,4	while(LineInput == 1); // and re-sync with line
003A	0A39	GOTO	0039h	
003B	0686	BTFSC	06,4	while(LineInput == 0)
003C	0A3F	GOTO	003Fh	
003D				CLRWDT;
003D	0004	CLRWDT		
003E	0A3B	GOTO	003Bh	
				}
003F	0A4A	GOTO	004Ah	else
				{
0040	0686	BTFSC	06,4	while(LineInput == 0) //wait for zero crossing
0041	0A44	GOTO	0044h	
0042				CLRWDT;
0042	0004	CLRWDT		

```

0043 0A40    GOTO    0040h
0044 0201    MOVF     01,W                Maxdim = PercentOn - TMR0 + 2; //Compensate full dim
                                           value for line

0045 0088    SUBWF    08,W
0046 0027    MOVWF    07
0047 0C02    MOVLW    02h
0048 01C7    ADDWF    07,W
0049 0029    MOVWF    09

                                           // frequency vs osc. speed
                                           }
004A 0C01    MOVLW    01h                if(FirstPass == 1) //If first pass, go to full dim
004B 008F    SUBWF    0F,W
004C 0743    BTFSS    03,2
004D 0A51    GOTO     0051h
004E                                     {
004E 006F    CLRWF    0F                FirstPass = 0;
004F 0209    MOVF     09,W                PercentOn = Maxdim;
0050 0028    MOVWF    08
                                           }
0051 0209    MOVF     09,W                if(PercentOn < Maxdim) //If maxdim moved, fix brightness
0052 0088    SUBWF    08,W
0053 0743    BTFSS    03,2
0054 0603    BTFSC    03,0
0055 0A58    GOTO     0058h
0056 0209    MOVF     09,W                PercentOn = Maxdim;
0057 0028    MOVWF    08
0058 0208    MOVF     08,W                TMR0 = PercentOn; //Get delay time
0059 0021    MOVWF    01
005A 0C03    MOVLW    03h                while(TMR0 >= 3 && LineInput == 1) //Delay TRIAC turn on
                                           (wait for Counter rollover)

005B 0081    SUBWF    01,W
005C 0703    BTFSS    03,0
005D 0A62    GOTO     0062h
005E 0786    BTFSS    06,4
005F 0A62    GOTO     0062h
0060                                     CLRWDT;
0060 0004    CLRWDT
0061 0A5A    GOTO     005Ah

0062 0C04    MOVLW    04h                GPIO = 0x04; //Set TRIAC output latch high
0063 0026    MOVWF    06

WREG = 0x19;
#asm ( TRIS GPIO);

0064 0C19    MOVLW    19h
0065 0006    TRIS     PORTB

//      __TRIS(0x19,GPIO); //Fire Triac
0066 0000    NOP;                        NOP; //Delay for TRIAC fire pulse
0067 0000    NOP;
0068 0000    NOP;
0069 0000    NOP;
006A 0000    NOP;
006B 0000    NOP;
006C 0000    NOP;
WREG = 0x1D;
#asm ( TRIS GPIO);

//      __TRIS(0x1D,GPIO); //Release TRIAC fire signal
006D 0C1D    MOVLW    1Dh
006E 0006    TRIS     PORTB
006F 0004    CLRWDT

0070 0686    BTFSC    06,4
0071 0A7B    GOTO     007Bh
0072                                     {
0072 0C05    MOVLW    05h                Maxdim += 5; //If so, increment Maxdim
0073 01E9    ADDWF    09
0074 0786    BTFSS    06,4
0075 0A74    GOTO     0074h                while(LineInput == 0); // and re-sync with line

                                           while(LineInput == 1)

```

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```

0076 0786    BTFSS    06,4
0077 0A7A    GOTO     007Ah
0078 0004    CLRWDI;
0079 0A76    GOTO     0076h
                                }
007A 0A85    GOTO     0085h
                                else
                                {
                                while(LineInput==1) //Wait for zero crossing

007B 0786    BTFSS    06,4
007C 0A7F    GOTO     007Fh
007D 0004    CLRWDI;
007E 0A7B    GOTO     007Bh
007F 0201    MOVF     01,W
                                Maxdim = PercentOn - TMR0 + 2; //Compensate full dim value for
                                                line

0080 0088    SUBWF    08,W
0081 0027    MOVWF    07
0082 0C02    MOVLW    02h
0083 01C7    ADDWF    07,W
0084 0029    MOVWF    09
                                // frequency vs osc. speed
                                }
0085 0209    MOVF     09,W
                                if(PercentOn < Maxdim) //If maxdim moved, fix brightness
0086 0088    SUBWF    08,W
0087 0743    BTFSS    03,2
0088 0603    BTFSC    03,0
0089 0A8C    GOTO     008Ch
008A 0209    MOVF     09,W
                                PercentOn = Maxdim;
008B 0028    MOVWF    08
                                TMR0 = PercentOn; //Get Delay time
008C 0208    MOVF     08,W
                                while(TMR0 >= 3 && LineInput == 0) //Delay TRIAC turn on
008D 0021    MOVWF    01
008E 0C03    MOVLW    03h
008F 0081    SUBWF    01,W
0090 0703    BTFSS    03,0
0091 0A96    GOTO     0096h
0092 0686    BTFSC    06,4
0093 0A96    GOTO     0096h
                                CLRWDI;
0094
0094 0004    CLRWDI;
0095 0A8E    GOTO     008Eh
0096 0C04    MOVLW    04h
                                GPIO = 0x04; //Set TRIAC output latch high
0097 0026    MOVWF    06
                                WREG = 0x19;
                                #asm ( TRIS GPIO);
0098 0C19    MOVLW    19h
0099 0006    TRIS     PORTB
                                //      __TRIS(0x19,GPIO); //Fire TRIAC
                                NOP; //Delay for TRIAC fire pulse
009A 0000    NOP;
009B 0000    NOP;
009C 0000    NOP;
009D 0000    NOP;
009E 0000    NOP;
009F 0000    NOP;
00A0 0000    NOP;
                                WREG = 0x1D;
                                #asm ( TRIS GPIO);
00A1 0C1D    MOVLW    1Dh
00A2 0006    TRIS     PORTB
                                //      __TRIS(0x1D,GPIO); //Release TRIAC fire signal
                                CLRWDI;
00A3 0004    CLRWDI;
00A4 0A2F    GOTO     002Fh
00A5 09A8    CALL     00A8h
00A6 0A2E    GOTO     002Eh
00A7 0800    RETLW    00h
                                }
                                /* *****
                                /* ButtonCheck */
                                /* */
                                /* This subroutine checks for presses on the BRT and DIM*/
                                /* buttons and increments or decrements PercentOn. */

```

```

/*                                     */
/* If both buttons are pressed and the lamp      */
/* is not off, it is turned off, if off, it is set to */
/* to max bright.                                     */
/*                                     */
/* In addition, a test function is built in. If both */
/* buttons are pressed, the dim let go and then pressed */
/* again, test mode is entered. If dim is pressed */
/* (alone), the program goes to normal operation at max */
/* dim. The test mode brightens to full bright, dims to*/
/* full dim, flashes full bright twice, and repeats. */
/*****
void Buttoncheck()
{
    NOP;                                     //Bugfix for MPLABC V1.10
    if(TestCheck == 3)                      //Check test mode flag

    {
        DelayCnt = 2;                      //Reset the delay count

        if(Brtbut && !Dimbut)              //If Dimbutton pressed, exit test mode

        {
            TestCheck = 0;                  //Clear Test mode flag
            DelayCnt = 5;

            return;
        }
        if(TestCount == 0)                  //Ramp up to full dim

        {
            if(++PercentOn > Maxbrt)        //Check for full bright

            {
                PercentOn = Maxbrt;

                ++TestCount;
                return;
            }
            else
                return;
        }
        if(TestCount == 1)                  //Ramp down to full dim

        {
            if(--PercentOn <= Maxdim) //Check for full dim

            {
                PercentOn = Maxbrt;

```

00A8	0000	NOP
00A9	0C03	MOVLW 03h
00AA	008A	SUBWF 0A,W
00AB	0743	BTFSS 03,2
00AC	0B1B	GOTO 011Bh
00AD		
00AD	0C02	MOVLW 02h
00AE	002D	MOVWF 0D
00AF	0706	BTFSS 06,0
00B0	0AB7	GOTO 00B7h
00B1	0666	BTFSC 06,3
00B2	0AB7	GOTO 00B7h
00B3		
00B3	006A	CLRF 0A
00B4	0C05	MOVLW 05h
00B5	002D	MOVWF 0D
00B6	0800	RETLW 00h
00B7	022C	MOVF 0C
00B8	0743	BTFSS 03,2
00B9	0AC5	GOTO 00C5h
00BA		
00BA	02A8	INCF 08
00BB	0CFD	MOVLW FDh
00BC	0088	SUBWF 08,W
00BD	0743	BTFSS 03,2
00BE	0703	BTFSS 03,0
00BF	0AC4	GOTO 00C4h
00C0		
00C0	0CFD	MOVLW FDh
00C1	0028	MOVWF 08
00C2	02AC	INCF 0C
00C3	0800	RETLW 00h
00C4	0800	RETLW 00h
00C5	0C01	MOVLW 01h
00C6	008C	SUBWF 0C,W
00C7	0743	BTFSS 03,2
00C8	0AD5	GOTO 00D5h
00C9		
00C9	00E8	DECF 08
00CA	0208	MOVF 08,W
00CB	0089	SUBWF 09,W
00CC	0643	BTFSC 03,2
00CD	0AD0	GOTO 00D0h
00CE	0703	BTFSS 03,0
00CF	0AD4	GOTO 00D4h
00D0		
00D0	0CFD	MOVLW FDh
00D1	0028	MOVWF 08

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00D2 02AC	INCF	0C		++TestCount;	
00D3 0800	RETLW	00h		return;	
				}	
				else	
00D4 0800	RETLW	00h		return;	
				}	
00D5 020C	MOVF	0C,W		while(TestCount++ < 5)	//Delay
00D6 02AC	INCF	0C			
00D7 0027	MOVWF	07			
00D8 0C05	MOVLW	05h			
00D9 0087	SUBWF	07,W			
00DA 0703	BTFSS	03,0			
00DB				return;	
00DB 0800	RETLW	00h		while(TestCount++ < 10)	//Turn off for a short period
				{	
00DC 020C	MOVF	0C,W			
00DD 02AC	INCF	0C			
00DE 0027	MOVWF	07			
00DF 0C0A	MOVLW	0Ah			
00E0 0087	SUBWF	07,W			
00E1 0603	BTFSC	03,0			
00E2 0AE6	GOTO	00E6h			
00E3				PercentOn = Maxdim;	
00E3 0209	MOVF	09,W			
00E4 0028	MOVWF	08			
00E5 0800	RETLW	00h		return;	
				}	
				while(TestCount++ < 15)	//Turn On for a short period
				{	
00E6 020C	MOVF	0C,W			
00E7 02AC	INCF	0C			
00E8 0027	MOVWF	07			
00E9 0C0F	MOVLW	0Fh			
00EA 0087	SUBWF	07,W			
00EB 0603	BTFSC	03,0			
00EC 0AF0	GOTO	00F0h			
00ED				PercentOn = Maxbrt;	
00ED 0CFD	MOVLW	FDh			
00EE 0028	MOVWF	08			
00EF 0800	RETLW	00h		return;	
				}	
				while(TestCount++ < 20)	//Turn off for a short period
				{	
00F0 020C	MOVF	0C,W			
00F1 02AC	INCF	0C			
00F2 0027	MOVWF	07			
00F3 0C14	MOVLW	14h			
00F4 0087	SUBWF	07,W			
00F5 0603	BTFSC	03,0			
00F6 0AFA	GOTO	00FAh			
00F7				PercentOn = Maxdim;	
00F7 0209	MOVF	09,W			
00F8 0028	MOVWF	08			
00F9 0800	RETLW	00h		return;	
				}	
				while(TestCount++ < 25)	//Turn on for a short period
				{	
00FA 020C	MOVF	0C,W			
00FB 02AC	INCF	0C			
00FC 0027	MOVWF	07			
00FD 0C19	MOVLW	19h			
00FE 0087	SUBWF	07,W			
00FF 0603	BTFSC	03,0			
0100 0B04	GOTO	0104h			
0101				PercentOn = Maxbrt;	
0101 0CFD	MOVLW	FDh			
0102 0028	MOVWF	08			
0103 0800	RETLW	00h		return;	
				}	

```

                                while(TestCount++ < 30)    //Turn off for a short period
                                {
0104 020C    MOVF    0C,W
0105 02AC    INCF    0C
0106 0027    MOVWF   07
0107 0C1E    MOVLW   1Eh
0108 0087    SUBWF   07,W
0109 0603    BTFSC   03,0
010A 0B0E    GOTO    010Eh
010B
                                PercentOn = Maxdim;
010B 0209    MOVF    09,W
010C 0028    MOVWF   08
010D 0800    RETLW   00h
                                return;
                                }
                                PercentOn = Maxdim;
010E 0209    MOVF    09,W
010F 0028    MOVWF   08
0110 006C    CLRF    0C
                                TestCount = 0;           //Reset to beggining of test sequence
0111 02AB    INCF    0B
                                if(++Outcount == 255)      //Run 255 cycles of test mode
0112 0CFF    MOVLW   FFh
0113 008B    SUBWF   0B,W
0114 0743    BTFSS   03,2
0115 0B1A    GOTO    011Ah
0116
                                {
0116 006A    CLRF    0A
                                TestCheck = 0;           //Clear Test mode flag
0117 0C03    MOVLW   03h
                                DelayCnt = NotInTest;
0118 002D    MOVWF   0D
                                Outcount = 0;
0119 006B    CLRF    0B
                                }
011A 0800    RETLW   00h
                                return;
                                }

011B 022A    MOVF    0A
                                if(TestCheck)              //If Test mode not entered quickly,
011C 0643    BTFSC   03,2
011D 0B27    GOTO    0127h
                                if(++Outcount == 0x60)      // quit checking
011E
                                {
011E 02AB    INCF    0B
011F 0C60    MOVLW   60h
0120 008B    SUBWF   0B,W
0121 0743    BTFSS   03,2
0122 0B27    GOTO    0127h
                                DelayCnt = NotInTest;
0123 0C03    MOVLW   03h
0124 002D    MOVWF   0D
                                Outcount = 0;
0125 006B    CLRF    0B
                                TestCheck = 0;
0126 006A    CLRF    0A
                                }
0127 022A    MOVF    0A
                                if(!TestCheck && !Brtbody && !Dimtbody) //Check bright & dim
                                                                at same time

0128 0743    BTFSS   03,2
0129 0B30    GOTO    0130h
012A 0606    BTFSC   06,0
012B 0B30    GOTO    0130h
012C 0666    BTFSC   06,3
012D 0B30    GOTO    0130h
                                TestCheck = 1;           //If both pressed, set to look for next combo
012E 0C01    MOVLW   01h
012F 002A    MOVWF   0A
                                if(TestCheck == 1 && !Brtbody && Dimtbody) //Check for only bright
0130 0C01    MOVLW   01h
                                                                button pressed

0131 008A    SUBWF   0A,W
0132 0743    BTFSS   03,2
0133 0B3A    GOTO    013Ah
0134 0606    BTFSC   06,0
0135 0B3A    GOTO    013Ah
0136 0766    BTFSS   06,3
0137 0B3A    GOTO    013Ah
                                TestCheck = 2;           //If pressed, set to look for next combo
0138 0C02    MOVLW   02h
0139 002A    MOVWF   0A

```

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```
013A 0C02    MOVLW    02h                if(TestCheck == 2 && !Brtbody
                                           pressed again
013B 008A    SUBWF    0A,W
013C 0743    BTFSS    03,2
013D 0B48    GOTO     0148h
013E 0606    BTFSC    06,0
013F 0B48    GOTO     0148h
0140 0666    BTFSC    06,3
0141 0B48    GOTO     0148h
0142
0142 0C03    MOVLW    03h                {
                                           TestCheck = 3;           //Enable test mode
0143 002A    MOVWF    0A
0144 006C    CLRF     0C
                                           TestCount = 0;
0145 0209    MOVF     09,W
                                           PercentOn = Maxdim;
0146 0028    MOVWF    08
                                           Outcount = 0;
0147 006B    CLRF     0B
                                           }
0148 0666    BTFSC    06,3                if(!Dimbut && !Brtbody
                                           //If both pressed
0149 0B5B    GOTO     0158h
014A 0606    BTFSC    06,0
014B 0B5B    GOTO     0158h
014C
014C 022E    MOVF     0E
                                           {
014D 0743    BTFSS    03,2                if(LastBoth == 0)      //Don't flash if held
014E 0B5A    GOTO     015Ah
                                           {
014F
014F 0C01    MOVLW    01h                LastBoth = 1;
0150 002E    MOVWF    0E
                                           if(PercentOn == Maxdim)  //If full off...
0151 0208    MOVF     08,W
0152 0089    SUBWF    09,W
0153 0743    BTFSS    03,2
0154 0B58    GOTO     0158h
                                           PercentOn = Maxbrtbody
0155 0CFD    MOVLW    Fdh                // turn full on...
0156 0028    MOVWF    08
                                           else
0157 0B5A    GOTO     015Ah                PercentOn = Maxdim; // otherwise turn off
0158 0209    MOVF     09,W
0159 0028    MOVWF    08
                                           }
015A 0B5C    GOTO     015Ch                }
015B 006E    CLRF     0E                else
015C 0606    BTFSC    06,0                LastBoth = 0;
015D 0B60    GOTO     0160h                if(!Brtbody && Dimbut)    //Check for brighten cmd
015E 0666    BTFSC    06,3
015F 02A8    INCF     08
                                           PercentOn ++;
0160 0706    BTFSS    06,0                if(Brtbody && !Dimbut)    //Check for dim cmd
0161 0B64    GOTO     0164h
                                           PercentOn --;
0162 0766    BTFSS    06,3                if(PercentOn > Maxbrtbody    //If greater than full bright
0163 00E8    DECF     08
0164 0CFD    MOVLW    Fdh
0165 0088    SUBWF    08,W
0166 0743    BTFSS    03,2
0167 0703    BTFSS    03,0
0168 0B6B    GOTO     016Bh
                                           PercentOn = Maxbrtbody
0169 0CFD    MOVLW    Fdh
016A 0028    MOVWF    08
                                           if(PercentOn < Maxdim)    //If less than full dim
016B 0209    MOVF     09,W
016C 0088    SUBWF    08,W
016D 0743    BTFSS    03,2
016E 0603    BTFSC    03,0
016F 0B72    GOTO     0172h
                                           PercentOn = Maxdim;
0170 0209    MOVF     09,W
0171 0028    MOVWF    08
0172 0800    RETLW    00h                }
0000 0A01    GOTO     0001h
ROM USAGE MAP
```

0000 to 0172
Total ROM used 0173
Errors : 0
Warnings : 0

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NOTES:

NOTES:



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10/31/97



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