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MCP402X
Digital Potentiometer Evaluation 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 "XXXXX" 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 MCP402X Digital Potentiometer Evaluation 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 MCP402X Digital Potentiometer Evaluation Board. The manual layout is as follows:

- **Chapter 1. "Product Overview"** – Important information about the MCP402X Digital Potentiometer Evaluation Board.
- **Chapter 2. "Installation and Operation"** – Includes instructions on how to get started with this evaluation board.
- **Appendix A. "Schematic and Layouts"** – Shows the schematic and layout diagrams for the MCP402X Digital Potentiometer Evaluation Board.
- **Appendix B. "Bill-Of-Materials (BOM)"** – Lists the parts used to build the MCP402X Digital Potentiometer Evaluation Board.
- **Appendix C. "00066_MCP402XEV.ASM Source Code"** – Provides information about the application firmware and where the source code can be found.

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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	*File>Save*
Bold characters	A dialog button	Click **OK**
	A tab	Click the **Power** tab
'b*nnnn*	A binary number where *n* is a digit	'b00100, 'b10
Text in angle brackets < >	A key on the keyboard	Press <Enter>, <F1>
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
`0x`*`nnnn`*	A hexadecimal number where *`n`* is a hexadecimal digit	`0xFFFF, 0x007A`
Square brackets [ ]	Optional arguments	`mcc18 [options]` *`file`* `[options]`
Curly brackets and pipe character: { | }	Choice of mutually exclusive arguments; an OR selection	`errorlevel {0|1}`
Ellipses...	Replaces repeated text	`var_name [, var_name...]`
	Represents code supplied by user	`void main (void) { ... }`

RECOMMENDED READING

This user's guide describes how to use MCP402X Digital Potentiometer Evaluation Board. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

MCP4021/22/23/24, *"Low-Cost NV Digital POT in SOT-23 with WiperLock™ Technology"* Data Sheet, DS21945

PIC10F200/202/204/206, *"6-Pin, 8-Bit Flash Microcontrollers"* Data Sheet, DS41239

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Preface

THE MICROCHIP WEB SITE

Microchip provides online support via our web site at www.microchip.com. This web site is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the web site contains the following information:

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip consultant program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

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- Distributor or Representative
- Local Sales Office
- 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 (April 2005)

- Initial Release of this Document.

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Chapter 1. Product Overview

1.1 INTRODUCTION

This chapter provides an overview of the MCP402X Digital Potentiometer Evaluation Board and covers the following topics:

- What is the MCP402X Digital Potentiometer Evaluation Board?
- What the MCP402X Digital Potentiometer Evaluation Board includes

1.2 WHAT IS THE MCP402X DIGITAL POTENTIOMETER EVALUATION BOARD?

The MCP402X Digital Potentiometer Evaluation Board (MCP402XEV) allows the system designer to quickly evaluate the operation of Microchip Technology's MCP402X Digital Potentiometer products.

The MCP402X Digital Potentiometer Evaluation Board PCB was designed to support the 8-pin 150 mil SOIC MCP4021-XXX/SN devices, the SOT-23-6 MCP4022-XXX/OT devices, the SOT-23-6 MCP4023-XXX/OT devices and the SOT-23-5 MCP4024-XXX/OT devices. In addition to supporting the MCP402X, the MCP402XEV also utilizes the SOT-23-6 PIC10F20X microcontroller. The PIC10F20X is supplied with example firmware that debounces the INCR and DECR push buttons and generates the simple U/$\overline{D}$ protocol required by the MCP402X to increment, decrement, lock and unlock the potentiometer's wiper.

1.3 WHAT THE MCP402X DIGITAL POTENTIOMETER EVALUATION BOARD KIT INCLUDES

This MCP402X Digital Potentiometer Evaluation Board Kit includes:

- One populated Printed Circuit Board (PCB)
  - MCP4021-103/OT
  - PIC10F206-I/OT with `00066_MCP402XEV.HEX` programmed into memory
  - Two push button switches: one for Increment commands (INCR), one for Decrement commands (DECR)
  - Decoupling capacitors
  - 5 resistors to isolate the switches & create a voltage divider with the MCP4021-103/OT
- One blank PCB to allow rapid prototyping of a specific digital potentiometer configuration
- 2 samples each of the MCP4021-202/OT, MCP4021-502/OT, MCP4021-103/OT and MCP4021-503/OT
- 1 sample of the PIC10F20X-I/OT
- MCP4021/4022/4023/4024 User's Guide (electronic version on CD) (DS51546)

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Chapter 2. Installation and Operation

2.1 INTRODUCTION

The MCP402X Digital Potentiometer Evaluation Board provides a tested, out-of-the-box example of a MCP402X application. The circuit description is described in **Section 2.2 "PCB Description"**, while the test and operating instructions are described in **Section 2.3 "Test and Operating Instructions"**. A supplied blank PCB allows rapid prototyping of the designer's specific MCP402X device along with other desired passive components (resistor and capacitors) and connection posts.

2.2 PCB DESCRIPTION

The MCP402X Digital Potentiometer Evaluation Board has the following features:

- 150 mil, 8-pin SOIC pinout (U1) supports the MCP4021 devices
- SOT-23-6 pinout (U2) supports the MCP4022/4023/4024 devices
- SOT-23-6 pinout (U3) supports the PIC10F206 devices
- Connection terminals can be left unpopulated for easy connection using small alligator clip leads (clamped across the edge of the board) or populated with either through-hole or surface-mount terminals
- Footprints for optional passive components for:
  - Power supply filtering
  - Device bypass capacitor
  - Terminal "A" pull-up resistor
  - Terminal "B" pull-down resistor
- Footprints for two switches:
  - "INCR" button operation can be detected by the PIC10F206 to generate Increment commands (move wiper toward terminal "A")
  - "DECR" button operation can be detected by the PIC10F206 to generate Decrement commands (move wiper toward terminal "B")
- Button sequence instructions are printed on the back of the PCB

Appendix A.2 "Schematic" illustrates the schematic for the MCP402XEV.

Note:	The PIC10F206 firmware (`00066_MCP402XEV.HEX`) must be programmed into the microcontroller before the MCP402XEV is functional.

2.2.1 Evaluating the MCP4021

The MCP4021-XXXI/SN is an 8-pin digital potentiometer device with terminals A, B and W available on the device pins. Footprint U1 supports the 150 mil SOIC package. Do not populate U2 if using U1. Resistors R2 and R3 are 2.5 kΩ on the populated PCB, along with the 10 kΩ MCP4021-103I/SN digital pot. This creates a "windowed" voltage divider with a transfer function illustrated in Equation 2-1.

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EQUATION 2-1: WINDOWED POTENTIOMETER – VOLTAGE DIVIDER CALCULATION

$$V_{wiper} = \frac{V_{DD} \cdot (R_{wb} + R3)}{R2 + R3 + R_{nom}} = \frac{5.0V \cdot ((d \cdot 10k)/63 + 2.5k)}{2.5k + 2.5k + 10k}$$

Where:

d = the wiper setting (0 to 63)

2.2.2 Evaluating the MCP4022

The MCP4022-XXXI/OT is a 6-pin, stand-alone digital rheostat with terminals A and W available on the device pins. Footprint U2 supports the SOT-23-6 package. Do not populate U1 if using U2. An "INCR" command moves the wiper toward terminal A, thus causing the resistance across the rheostat to decrease. A "DECR" command moves the wiper toward terminal B, thus causing the resistance across the rheostat to increase.

Note: The included MCP4021 digital potentiometer samples could be used to evaluate the MCP4022 simply by not populating R3 and letting terminal B float.

2.2.3 Evaluating the MCP4023

The MCP4023-XXXI/OT is a 6-pin, grounded digital potentiometer with terminals A and W available on the device pins. Footprint U2 supports the SOT-23-6 package. Do not populate U1 if using U2. Populating R2 will create a voltage divider with a transfer function illustrated in Equation 2-2.

Note: The included MCP4021 digital potentiometer samples could be used to evaluate the MCP4023 simply by not populating shorting terminal B to GND.

EQUATION 2-2: GROUNDED POTENTIOMETER – VOLTAGE DIVIDER CALCULATION

$$V_{wiper} = \frac{V_{DD} \cdot R_{wb}}{R2 + R_{nom}} = \frac{5.0V \cdot (d \cdot 10k/63)}{2.5k + 10k}$$

Where:

d = the wiper setting (0 to 63)

2.2.4 Evaluating the MCP4024

The MCP4024-xxxI/OT is a 5-pin grounded digital rheostat with the W terminals available on the device pins. Footprint U2 supports the SOT-23-5 package. Do not populate U1 if using U2. An "INCR" command moves the wiper toward terminal A, thus causing the resistance across the rheostat to increase. A "DECR" command moves the wiper toward terminal B, thus causing the resistance across the rheostat to decrease.

Note: The included MCP4021 digital potentiometer samples could be used to evaluate the MCP4024 simply by not populating R_2, letting terminal A float and by shorting terminal B to GND.

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2.3 TEST AND OPERATING INSTRUCTIONS

The populated PCB is configured to create a voltage divider from V_{DD} to V_{SS} using a 2.5 kΩ pull-up resistor, the MCP4021-103I/SN (10 kΩ) and a 2.5 kΩ pull-down resistor. To quickly evaluate the digital potentiometer's performance, the follow test equipment is required:

- 2.7V to 5.5V power supply
- Voltmeter

2.3.1 Test Setup

1. Connect the power supply "+" to V_{DD} and the "–" to GND.
2. Connect the voltmeter to the W terminal and V_{SS}.

The voltmeter should reflect the wiper setting with respect to Equation 2-3.

EQUATION 2-3: POPULATED PCB – VOLTAGE DIVIDER CALCULATION

$$V_{wiper} = \frac{V_{DD} \cdot (R_{wb} + R3)}{R2 + R3 + R_{nom}} = \frac{5.0V \cdot ((d \cdot 10k)/63 + 2.5k)}{2.5k + 2.5k + 10k}$$

Where:

d = the wiper setting (0 to 63)

Using R2 and R3 = 2.5 kΩ:

- If a 2 kΩ MCP4021 is utilized, the output range will be approximately 1.79V to 3.21V
- If a 5 kΩ MCP4021 is utilized, the output range will be approximately 1.25V to 3.75V
- If a 10 kΩ MCP4021 is utilized, the output range will be approx. 0.83V to 4.17V
- If a 50 kΩ MCP4021 is utilized, the output range will be approx. 0.23V to 4.77V

2.3.2 Operating Instructions

The `00066_MCP402XEV.HEX` firmware programmed into the PIC10F206 provides a very simple interface to operate the MCP402X digital pot. There are ten basic commands supported for the user to exercise the MCP402X digital pot:

- Pressing the "INCR" button for <2s will generate a Low-Voltage (LV) Increment command. This will increment the MCP402X's wiper one step (move W toward A) and store the new wiper setting in the MCP402X's EEPROM, assuming the WiperLock™ feature is disabled.
- Pressing the "INCR" button for >2s will generate 64 LV Increment commands and store the new wiper setting in the MCP402X's EEPROM, assuming the WiperLock™ feature is disabled. This effectively assures the wiper to be set to terminal A
- Pressing the "DECR" button for <2s will generate a LV Decrement command. This will decrement the MCP402X's wiper one step (move W toward B) and store the new wiper setting in the MCP402X's EEPROM, assuming the WiperLock feature is disabled.
- Pressing the "DECR" button for >2s will generate 64 LV Decrement commands and store the new wiper setting in the MCP402X's EEPROM, assuming the WiperLock feature is disabled. This effectively assures the wiper to be set to terminal B

Note: High-Voltage commands require V_{DD} = 5.0V to allow the simple voltage-doubling charge pump to generate a V_{PP} > 8.0V.

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- The following sequence is used to generate a High-Voltage (HV) Increment command with WiperLock™ technology disabled. Press and hold the "INCR" button (for <2s), press and hold the "DECR" button (for <2s), release the "INCR" button and release the "DECR" button.
- The following sequence is used to generate 64 HV Increment without WiperLock™ technology commands. Press and hold the "INCR" button (for <2s), press and hold the "DECR" button (for >2s), release the "INCR" button and release the "DECR" button.
- The following sequence is used to generate a HV Decrement command with WiperLock technology disabled. Press and hold the "DECR" button (for <2s), press and hold the "INCR" button (for <2s), release the "DECR" button and release the "INCR" button.
- The following sequence is used to generate 64 HV Increment without WiperLock technology commands. Press and hold the "DECR" button (for <2s), press and hold the "INCR" button (for >2s), release the "DECR" button and release the "INCR" button.
- The following sequence is used to generate a HV Increment command with WiperLock technology enabled. Press and hold the "INCR" button (for <2s), press and hold the "DECR" button (for <2s), release the "DECR" button and release the "INCR" button.
- The following sequence is used to generate a HV Decrement command with WiperLock™ technology enabled. Press and hold the "DECR" button (for <2s), press and hold the "INCR" button (for <2s), release the "INCR" button and release the "DECR" button.

Power can be cycled on the PCB to test the non-volatile wiper storage feature.

2.4 FIRMWARE DESCRIPTION

The `000066_MCP402XEV.ASM` source code was written using assembly language for the PIC10F206 microcontroller. Refer to **Appendix C. "00066_MCP402XEV.ASM Source Code"**. The firmware initializes its I/O so that it can poll the "INCR" and "DECR" buttons every millisecond. If the button has been depressed for 40 ms out of 50 ms, it is considered to be debounced and asserted. The button state is used to determine if a new "Action State" is desired. This simple state machine then decodes the desired action. Once the desired command has been determined, a subroutine that performs the desired command is executed. The low-voltage commands are driven directly from the PIC10F206 I/O, but the high-voltage commands require some additional hardware to generate the required 8V signal.

When a high-voltage command is required, the PIC10F206's unique OSCOUT feature is utilized. The OSCOUT function allows the instruction clock to be driven on GP2/OSCOUT under software control. A simple charge pump consisting of 2 – 0.01 µF capacitors and a BAV99 dual diode is constructed as seen in **Appendix A.2 "Schematic"**. When the OSCOUT is enabled, a 1 MHz clock drives the charge pump that produces an 8.4V signal on the MCP402X's $\overline{CS}$ pin (assuming V_{DD} = 5.0V. Utilizing such a charge pump requires special attention to the timing of $\overline{CS}$ & U/$\overline{D}$ signals.

Refer to the comments in `00066_MCP402XEV.ASM` source code for more details on the firmware's operation. Refer to **Appendix C. "00066_MCP402XEV.ASM Source Code"**.

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Appendix A. Schematic and Layouts

A.1 INTRODUCTION

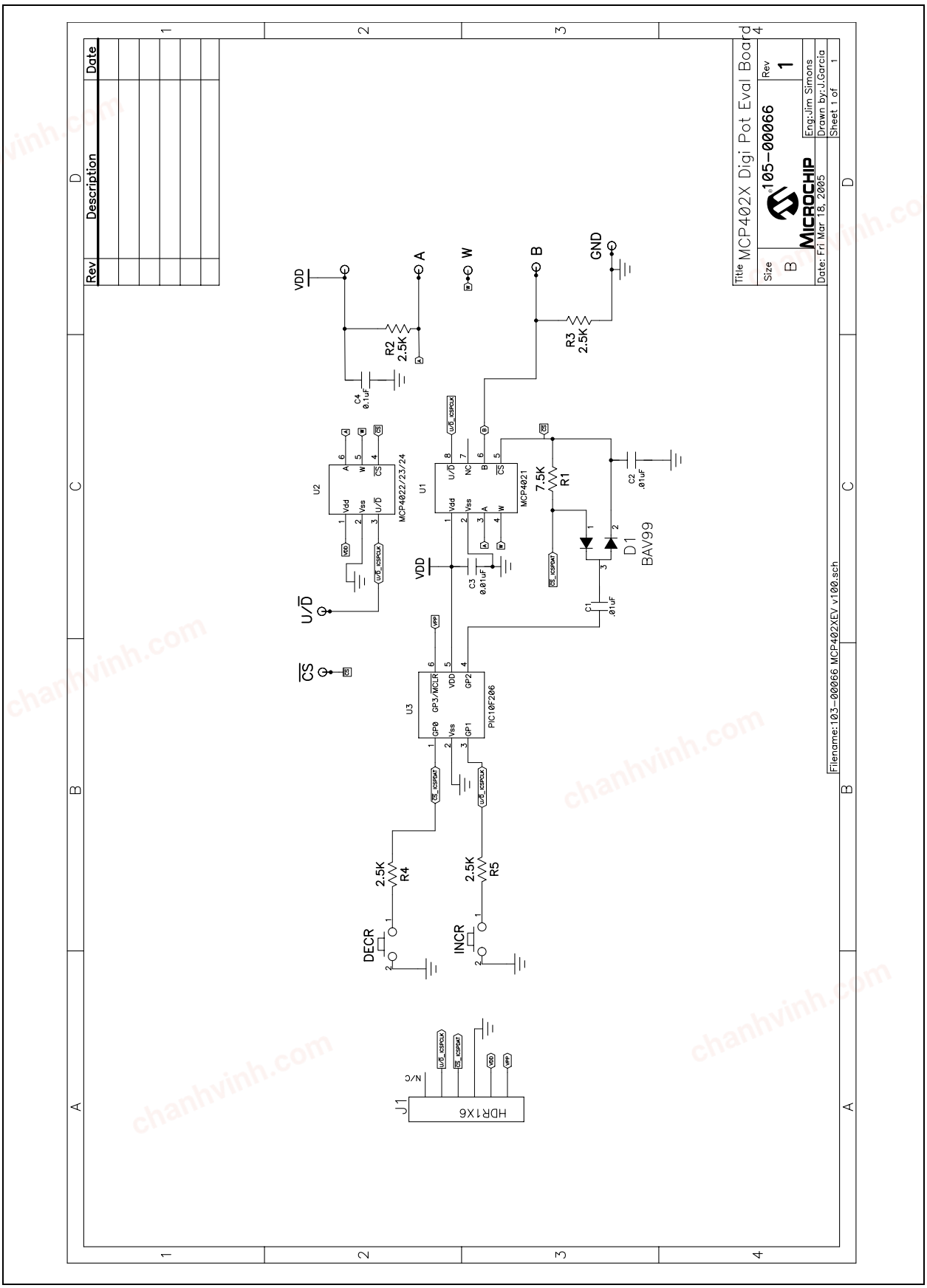
This appendix contains the following schematics and layouts for the MCP402X Digital Potentiometer Evaluation Board.

- Schematic – shows the schematic to support the MCP402X Digital Potentiometer Evaluation Board. The populated PCB was built using this schematic.
- Board Layout – Top Layer + Silk-Screen
- Board Layout – Top Silk-Screen
- Board Layout – Bottom Layer + Silk-Screen
- Board Layout – Bottom Layer

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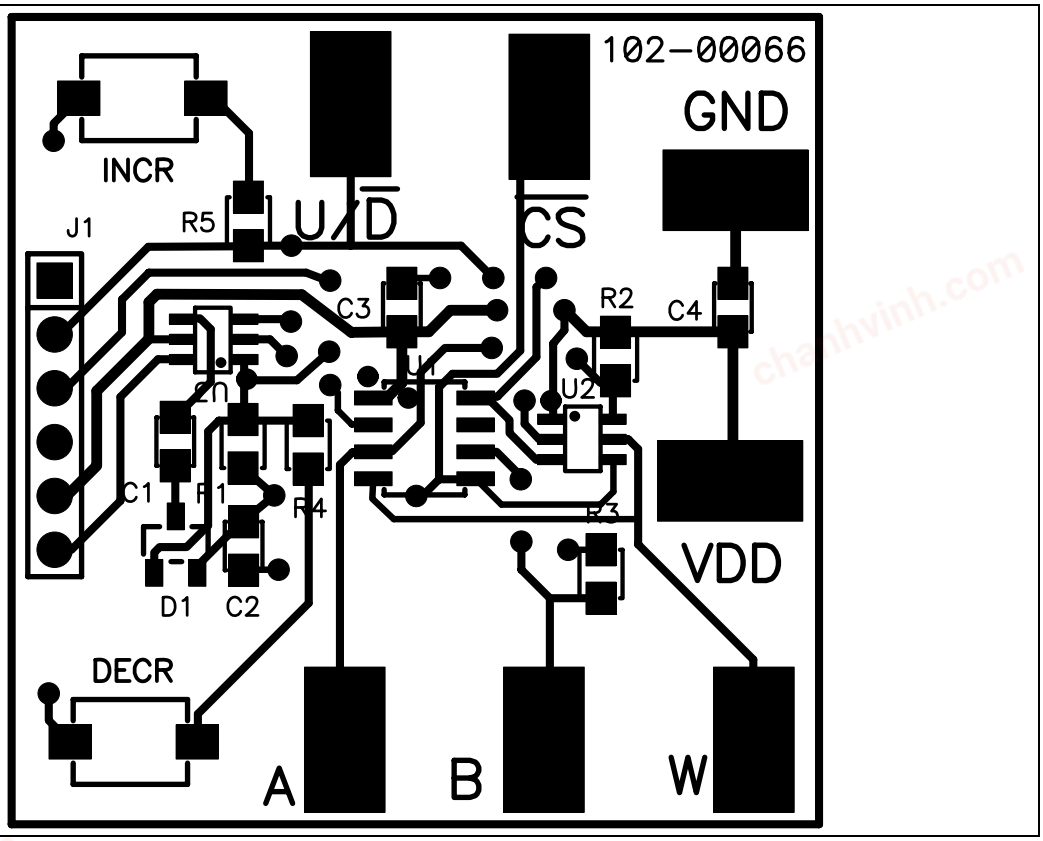
A.2 SCHEMATIC



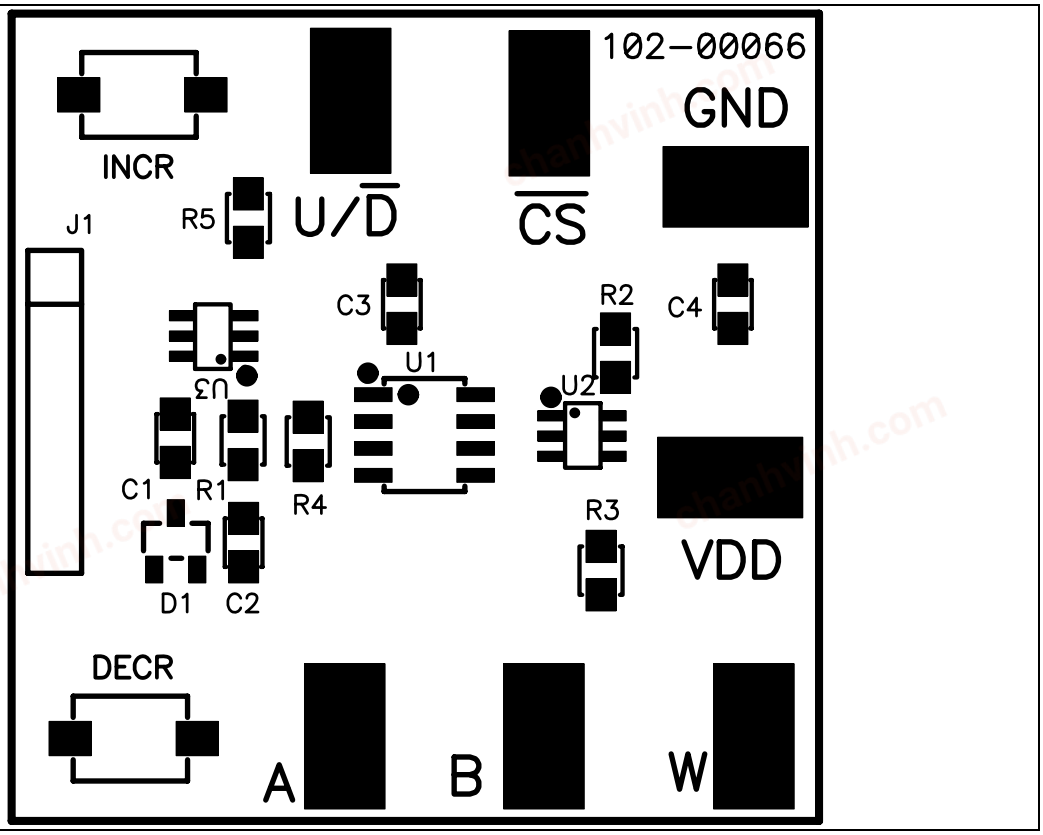
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A.3 MCP402X BOARD LAYOUT – TOP LAYER + SILK-SCREEN

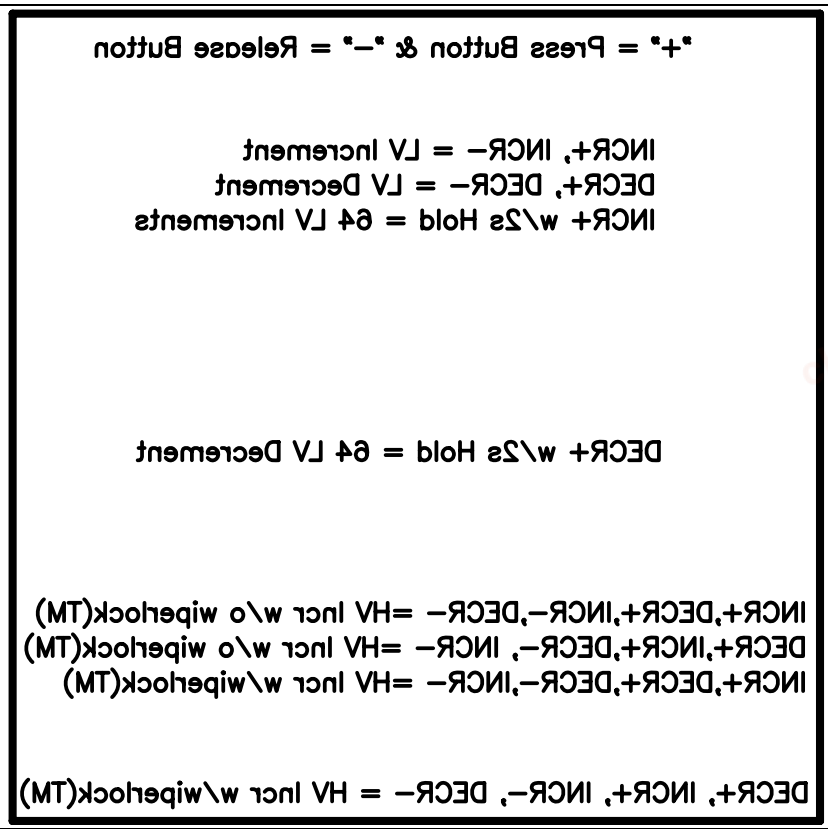


A.4 MCP402X BOARD LAYOUT – TOP SILK-SCREEN

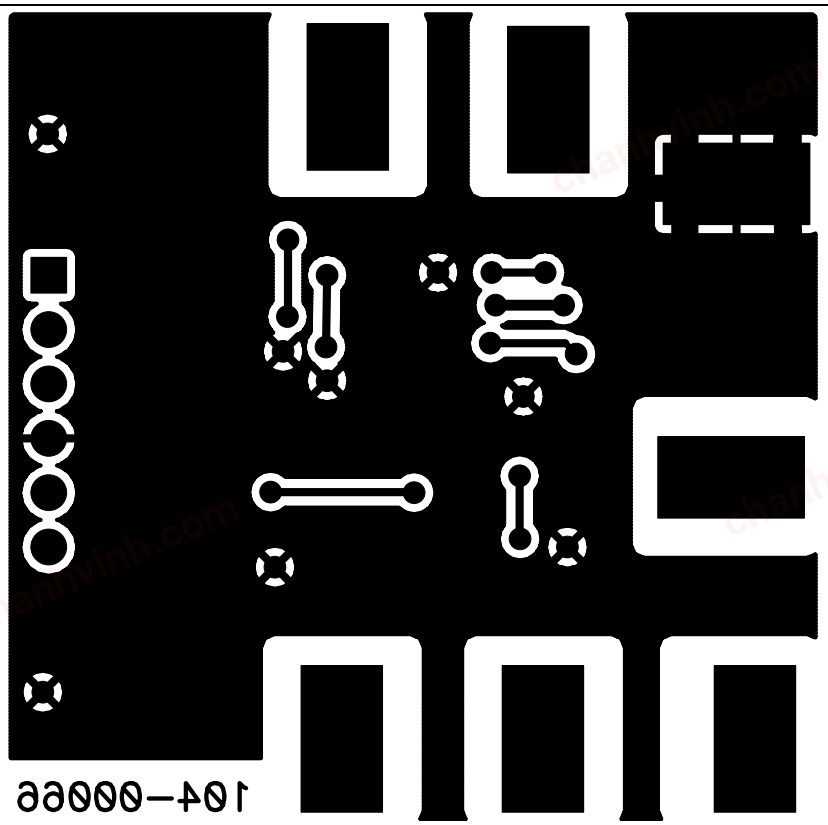


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A.5 MCP402X BOARD LAYOUT – BOTTOM LAYER + SILK-SCREEN



A.6 MCP402X BOARD LAYOUT – BOTTOM LAYER



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Appendix B. Bill-Of-Materials (BOM)

TABLE B-1: BILL-OF-MATERIALS

Qty	Reference	Description	Manufacturer	Part Number
2	C1,C2,C3	CAP 0.01uF 50V CERAMIC X7R 0805	Kemet®	C0805C103K5RACTU
1	C4	CAP .1uF 25V CERAMIC X7R 0805	Panasonic® Corporation – ECG	ECJ-2VB1E104K
1	R1	RES 7.5kΩ 1/10W 1% 0805 SMD	Panasonic Corporation – ECG	ERJ-6ENF5111V
2	R2,R3	RES 2.5kΩ 1/10W 1% 0805 SMD	Panasonic Corporation – ECG	ERJ-6ENF5111V
2	R4,R5	RES 2.5kΩ 1/10W 1% 0805 SMD	Panasonic Corporation – ECG	ERJ-6ENF5111V
1	D1	Dual Diode, SOT-23-3, May substitute with Fairchild BAV99	ON Semiconductor®	BAV99LT1
2	INCR, DECR	Switch LT Touch 6X3.5 100GF SMD	Panasonic Corporation – ECG	EVQ-PJS04K
1	U1	MCP4021-103/SN 10kΩ Digital Potentiometer	Microchip Technology Inc.	MCP4021-103/SN
1	U3	PIC10F206, 6-Pin, 8-Bit Flash Microcontrollers	Microchip Technology Inc.	PIC10F206-I/OT
1	U2	MCP4022/23/24 5/6 Pin Digital Potentiometer (Optional)	Microchip Technology Inc.	MCP4024-502/OT
7	A,B,W,VDD,GND, U/D,CS,	TEST POINT PC COMPACT SMT (Optional)	Keystone® Electronics	5016
1	J1	CONN HEADER 6POS .100 VERT TIN (Optional)	Molex®/Waldom® Electronics Corp	22-28-4061

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Appendix C. 00066_MCP402XEV.ASM Source Code

C.1 INTRODUCTION

This appendix documents the example PIC10F20X source code used on the populated PCB. The source code is described in detail by the comments within the .ASM file. The 00066_MCP402XEV.ASM, PIC10F206.INC and MCP402XEV.HEX files can be found on the Microchip web site (www.microchip.com) and on the included CD.

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TABLE C-1: 00066_MCP402XEV.ASM SOURCE CODE

```
  TITLE "MCP402XEV Firmware"
;*******************************************************************************************
; Author:   Jim Simons
; Tools:    MPLAB(r) 7.10 using MPLINK(tm)
; Editor:   ComicSans 8pt w/8 character Tabs
; Files:    00066_MCP402XEV.asm
;           p10f206.inc
;
; Description:  Exercise the MCP402x devices using the MCP402x EV board.
;               Simply use the INCR & DECR buttons to execute the INCR & DECR serial commands.
;
; Serial Commands      Action                                                        State
; _______________      ______                                                        _____
; LV Increment w/EE    Depress UP, Release UP    LVwEE = 1                           3
; LV Decrement w/EE    Depress DOWN, Release DOWN  LVwEE = 1                         4
; LV Increment w/o EE  Depress UP, Release UP    LVwEE = x                           3
; LV Decrement w/o EE  Depress DOWN, Release DOWN  LVwEE = x                         4
; LV 64 Increments     Depress UP, Hold for 2s, Release UP                           1
; LV 64 Decrements     Depress DOWN, Hold for 2s, Release DOWN                       2
; HV Incr w/o WL       Depress UP, Depress DOWN, Release UP, Release DOWN            11
; HV Decr w/o WL       Depress DOWN, Depress UP, Release DOWN, Release UP            12
; HV 64 Incr w/o WL    Depress UP, Depress DOWN, Hold for 2s, Release UP, Release DOWN   5
; HV 64 Decr w/o WL    Depress DOWN, Depress UP, Hold for 2s, Release DOWN, Release UP   6
; HV Incr w/WL         Depress UP, Depress DOWN, Release DOWN, Release UP            13
; HV Decr w/WL         Depress DOWN, Depress UP, Release UP, Release DOWN            14
;
```

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TABLE C-1: 00066_MCP402XEV.ASM SOURCE CODE (CONTINUED)

```
;*****************************************************************************************************
; Connections/Schematic
;*****************************************************************************************************
;
; MCP pin    MCP4021    MCP4022    MCP4023    MCP4024
; _______    _______    _______    _______    _______
; 1          Vdd        Vdd        Vdd        Vdd
; 2          Vss        Vss        Vss        Vss
; 3          A          U/D        U/D        U/D
; 4          W          CS         CS         CS
; 5          CS         W          W          W
; 6          B          A          A          -
; 7          -          -          -          -
; 8          U/D        -          -          -
;
; MCP402x    PIC10F206                  Ext Components
; _______    _________                  ______________
; Vdd        Vdd                        0.1uF - Vss
; Vss        Vss                        -
; A          -                          2.5k - Vdd
; W          -                          -
; B          -                          2.5k - Vss
; CS         GP0/ICSPDAT (int pu)       2.5k - DECR - Vss, 7.5k - CS & BAV99
; U/D        GP1/ICSPCLK (int pu)       2.5k - INCR - Vss
; -          GP2/OSCOUT                 0.01uF - BAV99 - 0.01uF - Vss
; -          GP3/Vpp (int pu)           optional SW or Jumper put on BFMP header pins 4 & 6
;
;*****************************************************************************************************
; Assemble Time Variables
SaveWiper   equ   1   ; comment this line prevent LV commands from Saving the Wiper
;
;*****************************************************************************************************
; Configure the PIC
;*****************************************************************************************************

  list      p=10F206    ; list directive to define processor
  #include <p10F206.inc>  ; processor specific variable definitions

  __CONFIG  _MCLRE_OFF & _CP_OFF & _WDT_ON

  ERRORLEVEL -302
```


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TABLE C-1: 00066_MCP402XEV.ASM SOURCE CODE (CONTINUED)

```
;*****************************************************************************************
; General Pupose Register Definitions
;*****************************************************************************************
GPRS        UDATA
State         res     1     ; variable to track the "state" value
                            ; this code functions as a state machine
                            ; bits 3:0 stores the state 0-15 indicator
                            ; bits 7:6 stores the debounced button states
OldState      res     1     ; allows program to see if State changed
Exit          res     1     ; variable to count the number ms to test for a button press
DebounceUP    res     1     ; variable to count the number of ms UP was pressed
DebounceDOWN  res     1     ; variable to count the number of ms DOWN was pressed
DLYCNT1       res     1     ; variable for the delay subroutines
DLYCNT2       res     1     ; variable for the delay subroutines

 #define      UD      GPIO,1     ; GP1 tied to UD & has "INCR" switch connected via 2.2k resistor
 #define      CS      GPIO,0     ; GP0 tied to CS & has "DECR" switch connected via 2.2k resistor
 #define      UP      GPIO,1     ; Momentary switch UP
 #define      DOWN    GPIO,0     ; Momentary switch DOWN
 #define      CP      GPIO,2     ; OSCOUT pin for Charge Pump
 #define      PowerDown GPIO,3   ; Vpp for programming & PowerDown input to put uC to SLEEP

 #define     HV_CS    OSCCAL,FOSC4  ; Drives CS to HVDD (drive CS high first)

 #define     UP_State   State,7   ; Debounced UP State - using bits 5:4 are critical
 #define     DOWN_State State,6   ; Debounced DOWN State - using bits 5:4 are critical

;*****************************************************************************************
; Reset Code
;*****************************************************************************************
RESET     CODE              ; processor reset vector + 1
;ResetVector                 ; Device resets to 0x1FF to get the factory calibration
    goto    Start           ; Lower half of memory reserved for subroutines

;*****************************************************************************************
; Main Code
;*****************************************************************************************
MAIN      CODE
Start
Init_Oscillator
; Internal RC calibration value is placed at location 0xFF by Microchip
; as a movlw k, where the k is a literal value.
    movwf   OSCCAL          ; update register with factory cal value
;   bcf     OSCCAL,FOSC4    ; make sure the FOSC4 is disabled to shut charge pump off

StateMachineReset
    movlw   b'11110011'     ; Disable the Comparator & make inputs digital
    movwf   CMCON0
;   bcf     CMCON0, CMPON   ; needs to be on to get GP2 as a General Purpose Output
    movlw   b'10011010'     ; disable Wake-Up on Pin Change,
                            ; enable weak pullups for button inputs
                            ; T0CS must be 0 for GP2 TRIS to be active
                            ; set up for 72ms WDT
    option
Init
    clrf    State
    clrf    OldState
    call    InitGPIO        ; make GP0/DECR/CS & GP1/INCR/UD outputs, block undesired U/D commands
```

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TABLE C-1: 00066_MCP402XEV.ASM SOURCE CODE (CONTINUED)

```
ButtonCheck                 ; Debounce Buttons
    btfss   PowerDown       ; If pulled low, put uC to SLEEP
    goto    LowPowerMode
    bsf     UP_State
    bsf     DOWN_State      ; initialize Button_State to indicate no button pressed
    movlw   .50             ; debounce the buttosns for 50mS to see if pressed
    movwf   Exit
    movlw   .40             ; if pushed for 40 of 50 tests, then valid UP
    movwf   DebounceUP
    movwf   DebounceDOWN
DebounceLoop
    call    GPIO_TestUP     ; make GP1/INCR/UD an input (w/pu enabled)
    movlw   .99
    call    VAR5TcyDELAY    ; 5 + (99*5) = 500us
    btfss   UP
    decfsz  DebounceUP,f
    goto    CheckDOWN
    bcf     UP_State        ; UP Button Pressed
CheckDOWN
    call    GPIO_TestDOWN   ; make GP0/DECR/CS an input (w/pu enabled)
    movlw   .99
    call    VAR5TcyDELAY    ; 5 + (99*5) = 500us
    btfss   DOWN
    decfsz  DebounceDOWN,f
    goto    DebounceLoopTest
    bcf     DOWN_State      ; DOWN Button Pressed
DebounceLoopTest
    decfsz  Exit,f
    goto    DebounceLoop

    call    InitGPIO        ; make GP0/DECR/CS & GP1/INCR/UD outputs, block undesired U/D commands
    movf    State,w
    call    DetermineState      ; subroutine to determine the next state
    movwf   State
    xorwf   OldState,w
    btfss   STATUS,Z
    call    PerformState        ;State changed, now do something
    movlw   .5
    call    VAR1000TcyDELAY     ; Make sure EE Write Cycle has finished
    movf    State,w
    movwf   OldState
    goto    ButtonCheck         ; Loop for button presses

;*****************************************************************************************
; State Machine Code
;*****************************************************************************************
State0      goto    StateMachineReset ; State 0, no action, shouldn't get here

State1                          ; UP button pressed
    movlw   .200                ; 200x10mS = 2s
    movwf   Exit
```


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TABLE C-1: 00066_MCP402XEV.ASM SOURCE CODE (CONTINUED)

```
Loop1_2sec
    call    GPIO_TestDOWN     ; make GP0/DECR/CS an input (w/pu enabled)
    movlw   .5                ; 5ms delay
    call    VAR1000TcyDELAY
    btfss   DOWN              ; if DOWN gets pressed, exit
    retlw   .1
    call    GPIO_TestUP       ; make GP1/INCR/UD an input (w/pu enabled)
    movlw   .5                ; 5ms delay
    call    VAR1000TcyDELAY
    btfsc   UP                ; if UP gets released, exit
    retlw   .1
    decfsz  Exit,f
    goto    Loop1_2sec
    call    InitGPIO      ; make GP0/DECR/CS & GP1/INCR/UD outputs, block undesired U/D commands
    movlw   .64
    call    LV_Increment
;   movlw   .4
;   call    VAR1000TcyDELAY   ; add a 4mS delay for E/W cycle
    call    GPIO_TestUP       ; make GP1/INCR/UD an input (w/pu enabled)
LV_IncrExit
    clrwdt
    btfss   UP                ; if UP gets released, exit
    goto    LV_IncrExit
    clrf    State
    retlw   .1
State2                        ; DOWN button pressed
    movlw   .200              ; 200x10mS = 2s
    movwf   Exit
Loop2_2sec
    call    GPIO_TestUP       ; make GP1/INCR/UD an input (w/pu enabled)
    movlw   .5                ; 5ms delay
    call    VAR1000TcyDELAY
    btfss   UP                ; if UP gets pressed, exit
    retlw   .2
    call    GPIO_TestDOWN     ; make GP0/DECR/CS an input (w/pu enabled)
    movlw   .5                ; 5ms delay
    call    VAR1000TcyDELAY
    btfsc   DOWN              ; if DOWN gets released, exit
    retlw   .2
    decfsz  Exit,f
    goto    Loop2_2sec
    call    InitGPIO      ; make GP0/DECR/CS & GP1/INCR/UD outputs, block undesired U/D commands
undesired U/D commands
    movlw   .64
    call    LV_Decrement
;   movlw   .4
;   call    VAR1000TcyDELAY  ; add a 4mS delay for E/W cycle
    call    GPIO_TestDOWN    ; make GP0/DECR/CS an input (w/pu enabled)
LV_DecrExit
    clrwdt
    btfss   DOWN              ; if DOWN gets released, exit
    goto    LV_DecrExit
    clrf    State
    retlw   .2
State3                        ; LV Increment
    call    InitGPIO      ; make GP0/DECR/CS & GP1/INCR/UD outputs, block undesired U/D commands
    movlw   .1
    call    LV_Increment
    clrf    State
    retlw   .3
```

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TABLE C-1: 00066_MCP402XEV.ASM SOURCE CODE (CONTINUED)

```
State4                          ; LV Decrement
    call    InitGPIO        ; make GP0/DECR/CS & GP1/INCR/UD outputs, block undesired U/D commands
    movlw   .1
    call    LV_Decrement
    clrf    State
    retlw   .4
State5                          ; Both buttons pressed
    movlw   .200                ; 200x10mS = 2s
    movwf   Exit
Loop5_2sec
    call    GPIO_TestUP         ; make GP1/INCR/UD an input (w/pu enabled)
    movlw   .5                  ; 5ms delay
    call    VAR1000TcyDELAY
    btfsc   UP                  ; if UP gets released, exit
    retlw   .5
    call    GPIO_TestDOWN       ; make GP0/DECR/CS an input (w/pu enabled)
    movlw   .5                  ; 5ms delay
    call    VAR1000TcyDELAY
    btfsc   DOWN                ; if DOWN gets released, exit
    retlw   .5
    decfsz  Exit,f
    goto    Loop5_2sec
    call    InitGPIO        ; make GP0/DECR/CS & GP1/INCR/UD outputs, block undesired U/D commands
    movlw   .64
    call    HV_Increment_WL_Disable
;   movlw   .4
;   call    VAR1000TcyDELAY  ; add a 4mS delay for E/W cycle
HV_IncrExit clrwdt
    call    GPIO_TestDOWN       ; make GP0/DECR/CS an input (w/pu enabled)
    movlw   .10
    call    VAR1000TcyDELAY  ; add a 10mS delay for settling time
    btfss   DOWN                ; if DOWN gets released, exit
    goto    HV_IncrExit
    call    GPIO_TestUP         ; make GP1/INCR/UD an input (w/pu enabled)
    movlw   .10
    call    VAR1000TcyDELAY  ; add a 10mS delay for settling time
    btfss   UP                  ; if UP gets released, exit
    goto    HV_IncrExit
    clrf    State
    retlw   .5
State6
    movlw   .200                ; 200x10mS = 2s
    movwf   Exit
Loop6_2sec
    call    GPIO_TestUP         ; make GP1/INCR/UD an input (w/pu enabled)
    movlw   .5                  ; 5ms delay
    call    VAR1000TcyDELAY
    btfsc   UP                  ; if UP gets released, exit
    retlw   .6
    call    GPIO_TestDOWN       ; make GP0/DECR/CS an input (w/pu enabled)
    movlw   .5                  ; 5ms delay
    call    VAR1000TcyDELAY
    btfsc   DOWN                ; if DOWN gets released, exit
    retlw   .6
    decfsz  Exit,f
    goto    Loop6_2sec
    call    InitGPIO        ; make GP0/DECR/CS & GP1/INCR/UD outputs, block undesired U/D commands
    movlw   .64
    call    HV_Decrement_WL_Disable
;   movlw   .4
;   call    VAR1000TcyDELAY   ; add a 4mS delay for E/W cycle
```


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TABLE C-1: 00066_MCP402XEV.ASM SOURCE CODE (CONTINUED)

```
HV_DecrExit clrwdt
    call    GPIO_TestUP       ; make GP1/INCR/UD an input (w/pu enabled)
    movlw   .10
    call    VAR1000TcyDELAY   ; add a 10mS delay for settling time
    btfss   UP                ; if UP gets released, exit
    goto    HV_DecrExit
    call    GPIO_TestDOWN     ; make GP0/DECR/CS an input (w/pu enabled)
    movlw   .10
    call    VAR1000TcyDELAY   ; add a 10mS delay for settling time
    btfss   DOWN              ; if DOWN gets released, exit
    goto    HV_DecrExit
    clrf    State
    retlw   .6
State7
State8
State9
State10
State11                       ; HV Increment w/o WL
    call    InitGPIO      ; make GP0/DECR/CS & GP1/INCR/UD outputs, block undesired U/D commands
    movlw   .1
    call    HV_Increment_WL_Disable
    clrf    State
    retlw   .11
State12                       ; HV Increment w/o WL
    call    InitGPIO      ; make GP0/DECR/CS & GP1/INCR/UD outputs, block undesired U/D commands
    movlw   .1
    call    HV_Decrement_WL_Disable
    clrf    State
    retlw   .12
State13                       ; HV Decrement w/WL
    call    InitGPIO      ; make GP0/DECR/CS & GP1/INCR/UD outputs, block undesired U/D commands
    call    HV_Increment_WL_Enable
    clrf    State
    retlw   .13
State14                       ; HV Decrement w/WL
    call    InitGPIO      ; make GP0/DECR/CS & GP1/INCR/UD outputs, block undesired U/D commands
    call    HV_Decrement_WL_Enable
    clrf    State
    retlw   .14
State15
    goto    StateMachineReset

;*****************************************************************************************************
; Low Power Mode
;*****************************************************************************************************
LowPowerMode
    movlw   b'11111000'       ; make all I/O pins an output
    tris    GPIO
    movlw   b'11111111'
    movwf   GPIO              ; output high
    movlw   b'10011111'       ; disable Wake-Up on Pin Change,
                              ; enable weak pullups for button inputs
                              ; T0CS must be 0 for GP2 TRIS to be active
                              ; set up for 2.3ms WDT
    option
    sleep                     ; put into lowest power setting
    goto    Start             ; shouldn't get here

SUBS    CODE
```

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TABLE C-1: 00066_MCP402XEV.ASM SOURCE CODE (CONTINUED)

```
;*****************************************************************************************************
; State Machine Subroutines
;*****************************************************************************************************
DetermineState
    swapf   State,f
    rrf     State,f
    rrf     State,w
    andlw   b'00111111'   ; mask invalid states
    addwf   PCL,f
S0_00   retlw   .0      ; both buttons pressed at same time, shouldn't be here
S0_01   retlw   .1      ; UP button pressed, change state
S0_10   retlw   .2      ; DOWN button pressed, change state
S0_11   retlw   .0      ; no change
S1_00   retlw   .5      ; both buttons pressed, change state
S1_01   retlw   .1      ; no change
S1_10   retlw   .0      ; shouldn't be here, reset state
S1_11   retlw   .3      ; UP button released, change state
S2_00   retlw   .6      ; both buttons pressed, change state
S2_01   retlw   .0      ; shouldn't be here, reset state
S2_10   retlw   .2      ; no change
S2_11   retlw   .4      ; DOWN button released, change state
S3_00   retlw   .0      ; shouldn't be here, reset state
S3_01   retlw   .0      ; shouldn't be here, reset state
S3_10   retlw   .0      ; shouldn't be here, reset state
S3_11   retlw   .0      ; shouldn't be here, reset state
S4_00   retlw   .0      ; shouldn't be here, reset state
S4_01   retlw   .0      ; shouldn't be here, reset state
S4_10   retlw   .0      ; shouldn't be here, reset state
S4_11   retlw   .0      ; shouldn't be here, reset state
S5_00   retlw   .5      ; no change
S5_01   retlw   .7      ; DOWN button released, change state
S5_10   retlw   .9      ; UP button released, change state
S5_11   retlw   .0      ; shouldn't be here, reset state
S6_00   retlw   .6      ; no change
S6_01   retlw   .10     ; DOWN button released
S6_10   retlw   .8      ; UP button released
S6_11   retlw   .0      ; shouldn't be here, reset state
S7_00   retlw   .5      ; both buttons pressed again, change state
S7_01   retlw   .7      ; no change
S7_10   retlw   .0      ; shouldn't be here, reset state
S7_11   retlw   .13     ; UP button released, change state
S8_00     retlw   .6      ; both buttons pressed again, change state
S8_01     retlw   .0      ; shouldn't be here, reset state
S8_10     retlw   .8      ; no change
S8_11     retlw   .14     ; DOWN button released, change state
S9_00     retlw   .5      ; both buttons pressed again, change state
S9_01     retlw   .0      ; shouldn't be here, reset state
S9_10     retlw   .9      ; no change
S9_11     retlw   .11     ; DOWN button released, change state
S10_00    retlw   .6      ; both buttons pressed again, change state
S10_01    retlw   .10     ; no change
S10_10    retlw   .0      ; shouldn't be here, reset state
S10_11    retlw   .12     ; DOWN button released, change state
S11_00    retlw   .0      ; shouldn't be here, reset state
S11_01    retlw   .0      ; shouldn't be here, reset state
S11_10    retlw   .0      ; shouldn't be here, reset state
S11_11    retlw   .0      ; shouldn't be here, reset state
S12_00    retlw   .0      ; shouldn't be here, reset state
S12_01    retlw   .0      ; shouldn't be here, reset state
S12_10    retlw   .0      ; shouldn't be here, reset state
S12_11    retlw   .0      ; shouldn't be here, reset state
S13_00    retlw   .0      ; shouldn't be here, reset state
S13_01    retlw   .0      ; shouldn't be here, reset state
```


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TABLE C-1: 00066_MCP402XEV.ASM SOURCE CODE (CONTINUED)

```
S13_10    retlw   .0      ; shouldn't be here, reset state
S13_11    retlw   .0      ; shouldn't be here, reset state
S14_00    retlw   .0      ; shouldn't be here, reset state
S14_01    retlw   .0      ; shouldn't be here, reset state
S14_10    retlw   .0      ; shouldn't be here, reset state
S14_11    retlw   .0      ; shouldn't be here, reset state
S15_00    retlw   .0      ; shouldn't be here, reset state
S15_01    retlw   .0      ; shouldn't be here, reset state
S15_10    retlw   .0      ; shouldn't be here, reset state
S15_11    retlw   .0      ; shouldn't be here, reset state


PerformState
    movf    State,w
    andlw   b'00001111'   ; mask all states >15
    addwf   PCL,f         ; jump to desired State
    retlw   .0            ; State 0, no action
    goto    State1        ; (2s for repeating LV increment)
    goto    State2        ; (2s for repeating LV decrement)
    goto    State3
    goto    State4
    goto    State5        ; (2s for repeating HV increment)
    goto    State6        ; (2s for repeating HV decrement)
    retlw   .7            ; State 7, no action
    retlw   .8            ; State 8, no action
    retlw   .9            ; State 9, no action
    retlw   .10           ; State 10, no action
    goto    State11
    goto    State12
    goto    State13
    goto    State14
    goto    StateMachineReset ; State 15... shouldn't be here

;*****************************************************************************************
InitGPIO
    movlw   b'00001011'   ; initialize UP and DOWN switches to be high & CP to be low.
    movwf   GPIO
    movlw   b'11111100'   ; make GP0/DECR/CS & GP1/INCR/UD outputs, block undesired U/D commands
    tris    GPIO
    retlw   b'11000000'
GPIO_TestUP
    movlw   b'00001011'   ; initialize UP and DOWN switches to be high & CP to be low.
    movwf   GPIO
    movlw   b'11111100'   ; make both GP0/DECR/CS & GP1/INCR/UD outputs, prevent undesired U/D
commands
    tris    GPIO
    movlw   b'11111110'   ; make GP1/INCR/UD an input (w/pu enabled)
    tris    GPIO
    retlw   b'10000000'
GPIO_TestDOWN
    movlw   b'00001011'   ; initialize UP and DOWN switches to be high & CP to be low.
    movwf   GPIO
    movlw   b'11111100'   ; make both GP0/DECR/CS & GP1/INCR/UD outputs, prevent undesired U/D
commands
    tris    GPIO
    movlw   b'11111101'   ; make GP0/DECR/CS an input (w/pu enabled)
    tris    GPIO
    retlw   b'01000000'
```

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TABLE C-1: 00066_MCP402XEV.ASM SOURCE CODE (CONTINUED)

```
;*****************************************************************************************
; Button Isolation Subroutines
;*****************************************************************************************
; Low Voltage Increment & Decrement Subroutines
;*****************************************************************************************
LV_Increment
    movwf   Exit          ; load the loop counter
    bsf     UD
    goto    $+1           ; creates a 3us total delay
    bcf     CS
    movlw   .100          ; 5*100 = 500us delay to pull down CS
    movwf   DLYCNT1
DLOOP_LVI
    clrwdt                ;or NOP
    nop
    decfsz   DLYCNT1,f
    goto     DLOOP_LVI
LV_IncrLoop
    bcf      UD
    goto    $+1
    bsf     UD
    goto    $+1            ; creates a 3us total delay
    decfsz  Exit,f         ; Have we incremented the wiper enough?
    goto    LV_IncrLoop
 IFDEF  SaveWiper
    bcf     UD
    goto    $+1            ; creates a 3us total delay
 ENDIF
    bsf     CS
    retlw   0x00           ; Follow w/long delay to ramp CS & EEPROM Write Cycle

LV_Decrement
    movwf   Exit           ; load the loop counter
    bcf     UD
    goto    $+1            ; creates a 3us total delay
    bcf     CS
    movlw   .100           ; 5*100 = 500us delay to pull down CS
    movwf   DLYCNT1
DLOOP_LVD
    clrwdt    ;or NOP
    nop
    decfsz  DLYCNT1,f
    goto    DLOOP_LVD
 IFDEF  SaveWiper
    goto    LV_DecrLoop+4      ; skip first Decrement since final edge is rising
 ENDIF
LV_DecrLoop
    bsf     UD
    goto    $+1                ; creates a 3us total delay
    bcf     UD
    goto    $+1                ; creates a 3us total delay
    decfsz  Exit,f             ; Have we decremented the wiper enough?
    goto    LV_DecrLoop
 IFDEF  SaveWiper
    bsf     UD
    goto    $+1                ; creates a 3us total delay
 ENDIF
    bsf     CS                 ; Follow w/long delay to ramp CS & EEPROM Write Cycle
    retlw   0x01
```


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TABLE C-1: 00066_MCP402XEV.ASM SOURCE CODE (CONTINUED)

```
;*****************************************************************************************
; High Voltage Increment & Decrement Subroutines
;*****************************************************************************************
HV_Increment_WL_Disable
    movwf   Exit              ; load the loop counter
    bsf     UD
    goto    $+1               ; creates a 3us total delay
    bsf     HV_CS             ; starts 1Mhz Charge Pump
    movlw   .100              ; 5*100 = 500us delay for Charge Pump ramp time
    movwf   DLYCNT1
DLOOP_HVI
    clrwdt    ;or NOP
    nop
    decfsz  DLYCNT1,f
    goto    DLOOP_HVI
HV_IncrLoop
    bcf     UD
    goto    $+1               ; creates a 3us total delay
    bsf     UD
    goto    $+1               ; creates a 3us total delay
    decfsz  Exit,f            ; Have we incremented the wiper enough?
    goto    HV_IncrLoop
    bcf     HV_CS             ; shut off 1Mhz Charge Pump
    bcf     CS                ; helps pull the signal down from HV
    goto    $+1
    bsf     CS
    retlw   0x02              ; Follow w/long delay to discharge pump & EEPROM Write Cycle

HV_Decrement_WL_Disable
    movwf   Exit              ; load the loop counter
    bcf     UD
    goto    $+1               ; creates a 3us total delay
    bsf     HV_CS             ; starts 1Mhz Charge Pump
    movlw   .100              ; 5*100 = 500us delay for Charge Pump ramp time
    movwf   DLYCNT1
DLOOP_HVD
    clrwdt    ;or NOP
    nop
    decfsz  DLYCNT1,f
    goto    DLOOP_HVD
HV_DecrLoop
    bsf     UD
    goto    $+1             ; creates a 3us total delay
    bcf     UD
    goto    $+1             ; creates a 3us total delay
    decfsz  Exit,f          ; Have we decremented the wiper enough?
    goto    HV_DecrLoop
    bcf     HV_CS           ; shut off 1Mhz Charge Pump
    bcf     CS              ; helps pull the signal down from HV
    goto    $+1
    bsf     CS
    retlw   0x03            ; Follow w/long delay to discharge pump & EEPROM Write Cycle

HV_Increment_WL_Enable
    bsf     UD
    goto    $+1             ; creates a 3us total delay
    bsf     HV_CS           ; starts 1Mhz Charge Pump
    movlw   .100            ; 5*100 = 500us delay for Charge Pump ramp time
    movwf   DLYCNT1
```

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TABLE C-1: 00066_MCP402XEV.ASM SOURCE CODE (CONTINUED)

```
DLOOP_HVIWL
    clrwdt    ;or NOP
    nop
    decfsz  DLYCNT1,f
    goto    DLOOP_HVIWL
    bcf     UD
    goto    $+1             ; creates a 3us total delay
    bsf     UD
    goto    $+1             ; creates a 3us total delay
    bcf     UD
    goto    $+1             ; creates a 3us total delay
    bcf     HV_CS           ; shut off 1Mhz Charge Pump
    bcf     CS              ; helps pull the signal down from HV
    goto    $+1
    bsf     CS
    retlw   0x04            ; Follow w/long delay to discharge pump & EEPROM Write Cycle

HV_Decrement_WL_Enable
    bcf     UD
    bsf     CS
    goto    $+1             ; creates a 3us total delay
    bsf     HV_CS           ; starts 1Mhz Charge Pump
    movlw   .100            ; 5*100 = 500us delay for Charge Pump ramp time
    movwf   DLYCNT1
DLOOP_HVDWL
    clrwdt    ;or NOP
    nop
    decfsz  DLYCNT1,f
    goto    DLOOP_HVDWL
    bsf     UD
    goto    $+1             ; creates a 3us total delay
    bcf     HV_CS           ; shut off 1Mhz Charge Pump
    bcf     CS              ; helps pull the signal down from HV
    goto    $+1
    bsf     CS
    retlw   0x05            ; Follow w/long delay to discharge pump & EEPROM Write Cycle
;*****************************************************************************************
; VARIABLE DELAY SUBROUTINES
;*****************************************************************************************
;   DLYCNT1 = F9h = 249d    DLYCNT2 = W
;   DELAY = T((4 DLYCNT1 + 4) DLYCNT2 + 4)
;
; ex. To create a 300ms delay when using a 4Mhz osc, 300-250 = 50
;   movlw .50   ;load .50 into WREG
;   call  VAR1000TcyDELAY ;call VAR1000TcyDELAY = 50ms delay w/4MHz Osc
;   call  VAR1000TcyDELAY ;call VAR1000TcyDELAY = 250ms delay w/4MHz Osc
;         ;total = 300ms delay
;************
; The value in W at the time of the CALL = x.  Delay = 1000Tcy*x
VAR1000TcyDELAY
    movwf   DLYCNT2          ; LOADS CONTROLLING DLY # INTO PRIMARY COUNTER
DLOOP2
    movlw   .249             ; MAXIMIZES THE SECONDARY DLY COUNTER
    movwf   DLYCNT1
DLOOP1
    clrwdt    ;or NOP
    decfsz  DLYCNT1,f        ; DECREMENT AND TEST SECONDARY LOOP FOR ZERO
    goto    DLOOP1           ; CONTINUE SECONDARY LOOP
    decfsz  DLYCNT2,f        ; DECREMENT AND TEST PRIMARY DLY COUNTER
    goto    DLOOP2           ; CONTINUE PRIMARY LOOP
    retlw   .250             ; preload W for the next CALL VAR1000TcyDELAY
```


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TABLE C-1: 00066_MCP402XEV.ASM SOURCE CODE (CONTINUED)

```
;************
;   VARIABLE 5 Tcy DELAY UP TO 256*5Tcy+5Tcy
;   DLYCNT1 = W
;   DELAY = T(1 + 5 DLYCNT1 - 1) + CALL + RETLW
;
; ex. To create a 250us delay, (250/5)-1 = 49
;   movlw   .49     ;load .49 into WREG
;   call    VAR5TcyDELAY  ;call VAR5TcyDELAY
;************
; The value in W at the time of the CALL = x.  Delay = 5*Tcy + 5Tcy
VAR5TcyDELAY
    movwf   DLYCNT1          ; LOADS CONTROLLING DLY # INTO PRIMARY COUNTER
DLOOP3  clrwdt    ;or NOP
    nop
    decfsz  DLYCNT1,f        ; DECREMENT AND TEST ZERO
    goto    DLOOP3           ; CONTINUE LOOP
    retlw   .250             ; preload W for the next CALL VAR5TcyDELAY
;*****************************************************************************************

   end
```

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