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MCP401X/2X Digital Potentiometer Evaluation Board User's Guide

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MCP401X/2X 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.

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. "Using the BFMP Programmer to Power the Board"** – Shows how to interface the BFMP board with the MCP402X Digital Potentiometer Evaluation Board.
- **Appendix D. "Potential Programming Issue of the MCP402XEV"** – Discusses possible programming issues with Rev 1 and Rev 2 of the MCP402X Digital Potentiometer Evaluation Board.
- **Appendix E. "00066_MCP402XEV.ASM Source Code"** – Provides information about the application firmware, as well as the location of the source code.

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 New font:		
Plain Courier New	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 New	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 the MCP402X Digital Potentiometer Evaluation Board. The following Microchip documents are available and recommended as supplemental reference resources.

MCP4011/2/3/4, *"Low-Cost, 64-Step Volatile Digital POT in SOT-23"* Data Sheet (DS21978).

MCP4021/2/3/4, *"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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- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip consultant program member listing
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- Field Application Engineer (FAE)
- Technical Support
- Development Systems Information Line

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

Technical support is available through the web site at: http://support.microchip.com

DOCUMENT REVISION HISTORY

Revision B (December 2005)

- Updated to include MCP401X devices
- Enhancement of Operation Description
- Added **Appendix C. "Using the BFMP Programmer to Power the Board"** - Programming the MCP402X Digital Potentiometer Evaluation Board
- Added **Appendix D. "Potential Programming Issue of the MCP402XEV"**- A description of potential programming issues (and their solutions) with the MCP402X Digital Potentiometer Evaluation Board

Revision A (April 2005)

- Initial Release of this Document

NOTES:

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 MCP401X/2X Digital Potentiometer products.

The MCP402X Digital Potentiometer Evaluation Board PCB was designed to support:

- 8-pin, 150 mil SOIC MCP4021-XXX/SN devices
- SOT-23-6 MCP4022-XXX/OT devices
- SOT-23-6 MCP4023-XXX/OT devices
- SOT-23-5 MCP4024-XXX/OT devices
- 8-pin, 150 mil SOIC MCP4011-XXX/SN devices
- SOT-23-6 MCP4012-XXX/OT devices
- SOT-23-6 MCP4013-XXX/OT devices
- SOT-23-5 MCP4014-XXX/OT devices

In addition to supporting the MCP401X/2X, 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 MCP401X/2X to increment and decrement the potentiometer's wiper. It also generates the simple U/$\overline{D}$ protocol required by the MCP402X to 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 and 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 PIC10F20X-I/OT sample
- MCP401X/2X Digital Potentiometer Evaluation Board User's Guide (electronic version on CD) (DS51546)

Chapter 2. Installation and Operation

2.1 INTRODUCTION

The MCP402X Digital Potentiometer Evaluation Board provides a tested, out-of-the-box example of a MCP401X/2X 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 MCP401X/2X 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 and MCP4011 devices
- SOT-23-6 pinout (U2) supports the MCP4022/23/24 and MCP4012/13/14 devices
- SOT-23-6 pinout (U3) supports the PIC10F20X 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 PIC10F20X to generate Increment commands (move wiper toward terminal A)
  - **DECR** button operation can be detected by the PIC10F20X 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 PIC10F20X firmware (`00066_MCP402XEV.HEX`) must be programmed into the microcontroller before the MCP402XEV is functional.

2.2.1 Evaluating the MCP4021 and MCP4011

The MCP4021/11-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. Resistors R2 and R3 are 2.5 kΩ on the populated PCB, along with the 10 kΩ MCP4021-103I/SN digital potentiometer. This creates a "windowed" voltage divider with a transfer function illustrated in Equation 2-1.

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)

Note 1: **DO NOT** populate U2 if using U1.

2: The MCP4011 has high-voltage tolerant pins and, therefore, accepts high-voltage Increment and Decrement commands. Since this device is nonvolatile, the WiperLock™ Technology feature is not present.

2.2.2 Evaluating the MCP4022 and MCP4012

The MCP4022/12-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. 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 1: **DO NOT** populate U1 if using U2.

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

3: The MCP4012 has high-voltage tolerant pins and, therefore, accepts high-voltage Increment and Decrement commands. Since this device is nonvolatile, the WiperLock™ Technology feature is not present.

2.2.3 Evaluating the MCP4023 and MCP4013

The MCP4023/13-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. Populating R2 will create a voltage divider with a transfer function illustrated in Equation 2-2.

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)

Note 1: **DO NOT** populate U1 if using U2.

2: The included MCP4021 digital potentiometer samples could be used to evaluate the MCP4023 simply by shorting terminal B to GND.

3: The MCP4013 has high-voltage tolerant pins and, therefore, accepts high-voltage Increment and Decrement commands. Since this device is nonvolatile, the WiperLock™ Technology feature is not present.

2.2.4 Evaluating the MCP4024 and MCP4014

The MCP4024/14-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. 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 1: **DO NOT** populate U1 if using U2.

2: 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.

3: The MCP4014 has high-voltage tolerant pins and, therefore, accepts high-voltage Increment and Decrement commands. Since this device is nonvolatile, the WiperLock™ Technology feature is not present.

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 (R2), the MCP4021-103I/SN (10 kΩ) and a 2.5 kΩ pull-down resistor (R3). To quickly evaluate the digital potentiometer's performance, the following test equipment is required:

- 2.7V to 5.5V power supply
- Voltmeter or Digital Multimeter (DMM)

Figure 2-1 shows the Digital Potentiometer Evaluation Board PCB, components and the connection points that will be used in the step-by-step demonstration.

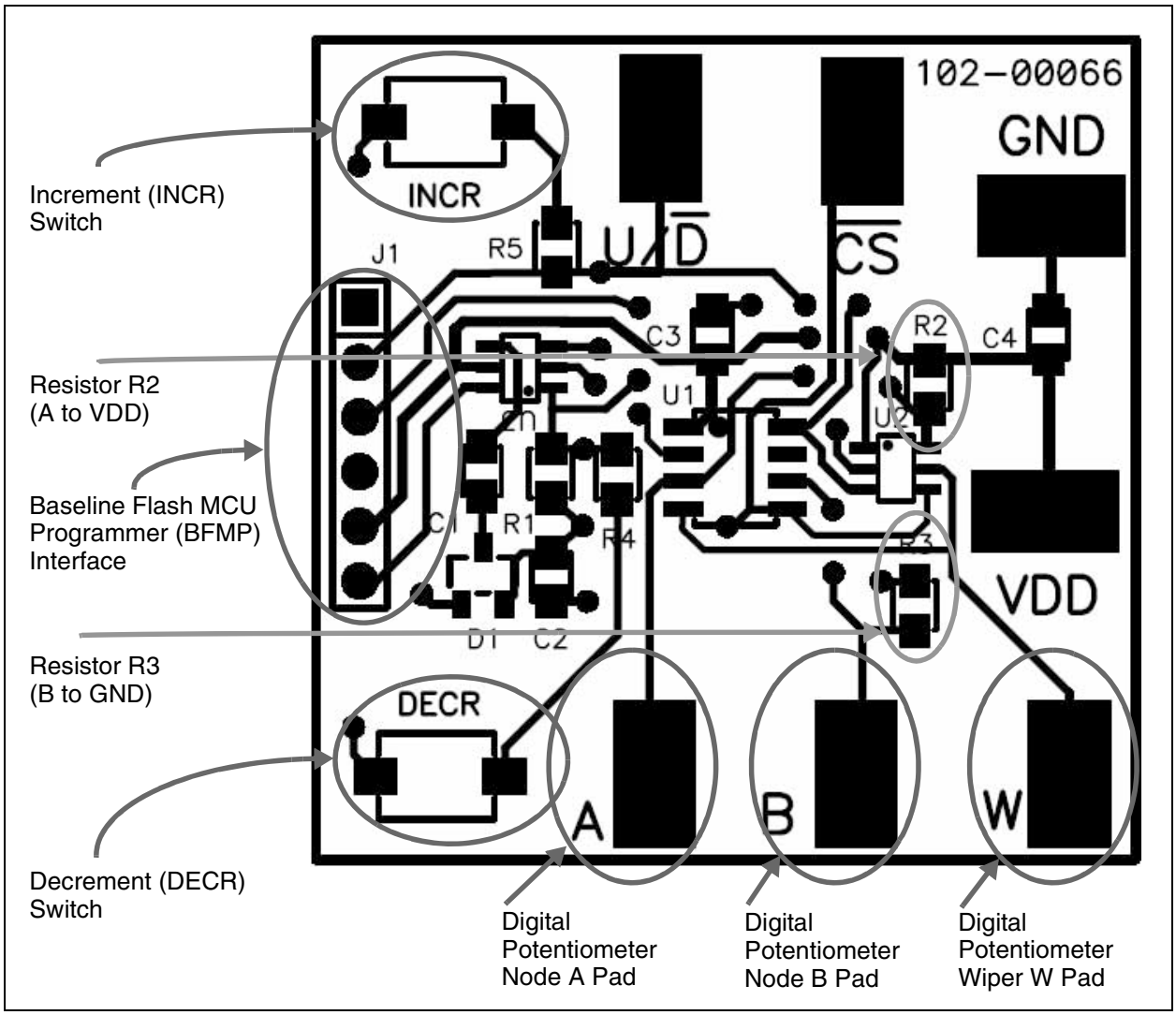


FIGURE 2-1: *Digital Potentiometer Evaluation Board Overview.*

2.3.1 Test Setup

1. Connect the power supply “+” to VDD and the “–” to GND.
2. Connect the voltmeter to the W terminal and GND.

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

EQUATION 2-3: POPULATED PCB – VOLTAGE DIVIDER CALCULATION

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

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 approximately 0.83V to 4.17V.
- If a 50 kΩ MCP4021 is utilized, the output range will be approximately 0.23V to 4.77V.

2.3.2 MCP402X Digital Potentiometer Evaluation Board Firmware Operation

The `00066_MCP402XEV.HEX` firmware programmed into the PIC10F20X provides a very simple interface to operate the MCP402X digital potentiometer. There are ten basic commands supported for the user to exercise the MCP402X digital potentiometer.

Table 2-1 shows the firmware commands of the Digital Potentiometer Evaluation Board.

TABLE 2-1: DIGITAL POTENTIOMETER EVALUATION BOARD FIRMWARE INCREMENT/DECREMENT COMMANDS

Command									Button Sequence			
#	Increment/Decrement - (Low Voltage/High Voltage)	# of Steps	Saves Wiper Value in EEPROM	High Voltage on $\overline{CS}$ and U/$\overline{D}$ pins?	After Command Wiper is		Works when Wiper is "locked"	MCP401x will INCR/DECR	#1 (Depress)[5]	#2 (Depress)[5]	#3 (Release)	#4 (Release)
					"locked"	"unlocked"						
1	INCR - (Low Voltage)	1[1]	Yes	No	—	—	No	Yes	INCR (**for < 2 sec**)	—	—	—
2	INCR - (High Voltage)[6]	1[1]	Yes	Yes	—	Yes	Yes	Yes	INCR (**for < 2 sec**)	DECREMENT (**for < 2 sec**)	INCR	DECR
3	INCR - (High Voltage)[6]	1[1]	Yes	Yes	Yes	—	Yes	Yes	INCR (**for < 2 sec**)	DECREMENT (**for < 2 sec**)	DECR	INCR
4	INCR - (Low Voltage)	64[2]	Yes	No	—	—	No	Yes	INCR (**for > 2 sec**)	—	—	—
5	INCR - (High Voltage)[6]	64[2]	Yes	Yes	—	Yes	Yes	Yes	INCR (**for < 2 sec**)	DECREMENT (**for > 2 sec**)	INCR	DECR
6	DECR - (Low Voltage)	1[3]	Yes	No	—	—	No	Yes	DECR (**for < 2 sec**)	—	—	—
7	DECR - (High Voltage)[6]	1[3]	Yes	Yes	—	Yes	Yes	Yes	DECR (**for < 2 sec**)	INCR (**for < 2 sec**)	DECR	INCR
8	DECR - (High Voltage)[6]	1[3]	Yes	Yes	Yes	—	Yes	Yes	DECR (**for < 2 sec**)	INCR (**for < 2 sec**)	INCR	DECR
9	DECR - (Low Voltage)	64[4]	Yes	No	—	—	No	Yes	DECR (**for > 2 sec**)	—	—	—
10	DECR - (High Voltage)[6]	64[4]	Yes	Yes	—	Yes	Yes	Yes	DECR (**for < 2 sec**)	INCR (**for > 2 sec**)	DECR	INCR

Note 1: Move wiper W towards node A (Increment wiper 1 step).

2: Move wiper W to node A (Increment wiper 64 steps). Forces the wiper setting to "full-scale" (wiper W = node A).

3: Move wiper W towards node B (Decrement wiper 1 step).

4: Move wiper W to node B (Decrement wiper 64 steps). Forces the wiper setting to "zero scale" (wiper W = node B).

5: If there is more than one sequence, the button sequence #1 must continue to be held down while progressing to sequence #2. Example: Command # 2. requires the **INCR** button to be depressed. Then, before 2 seconds elapses, the **DECR** button must be depressed. Next, before 2 seconds elapses, the **INCR** button must be released. The **DECR** button can then be released.

6: High-voltage commands require a system voltage (V_{DD}) greater than 5.0V to allow the simple charge pump to generate the $V_{IHH\ MIN}$ voltage for the $\overline{CS}$ pin.

2.3.3 Running the Ratiometric Voltage Demo

Table 2-2 provides step-by-step instructions to perform a demonstration of the MCP402X Digital Potentiometer Evaluation Board. Measuring Ratiometric Voltage

TABLE 2-2: MEASURING RATIOMETRIC VOLTAGE

Step	Action	Result
1	Power up the populated Digital Potentiometer Evaluation Board. Voltage calculations use a system voltage of 5V.	—
	Board can be powered via a valid voltage (such as 5V) on the VDD and GND PCB Pads, or by connecting a BFMP programmer that is connected to an active PC's USB port (powered via the USB connection).	
2	Set DMM to measure the required voltage range (0V to 5.5V). Connect the DMM ground connection to the evaluation board GND terminal and the DMM V/Ω connection to terminal W of the evaluation board.	—
3	Turn on DMM.	On DMM: DMM will display the voltage determined by the current non-volatile setting of the wiper.
4	On the Digital Potentiometer Evaluation Board: Implement Command #5 (see Table 2-1).	On the Digital Potentiometer Evaluation Board: WiperLock™ Technology is disabled and the wiper is incremented from power-on position.
		On DMM: Voltage increments approximately 0.05V.
5	On the Digital Potentiometer Evaluation Board: Implement Command #4 (see Table 2-1).	On the Digital Potentiometer Evaluation Board: Wiper is forced to the full-scale position (Wiper W = node A).
		On DMM: Voltage equals approximately 4.17V.
6	On the Digital Potentiometer Evaluation Board: Implement Command #6 (see Table 2-1).	On the Digital Potentiometer Evaluation Board: Wiper is decremented one position from the full-scale position.
		On DMM: Voltage equals approximately 4.12V.
7	On the Digital Potentiometer Evaluation Board: Implement Command #6 (see Table 2-1) 15 more times.	On the Digital Potentiometer Evaluation Board: Wiper is decremented to the 25% position from node A (full-scale) to node B (zero-scale).
		On DMM: Voltage equals approximately 3.33V.
8	On the Digital Potentiometer Evaluation Board: Turn off/disconnect power supply.	On DMM: Voltage equals approximately 0V.
9	On the Digital Potentiometer Evaluation Board: Reapply power to Digital Potentiometer Evaluation Board.	On DMM: Voltage equals approximately 3.33V. This shows that the MCP4021 retained the last selected wiper setting.
10	On the Digital Potentiometer Evaluation Board: Implement Command #3 (see Table 2-1).	On the Digital Potentiometer Evaluation Board: Wiper is incremented one position and the wiper is locked (WiperLock Technology is enabled).
		On DMM: Voltage equals approximately 3.38V.

TABLE 2-2: MEASURING RATIOMETRIC VOLTAGE (CONTINUED)

Step	Action	Result
11	On the Digital Potentiometer Evaluation Board: Implement Command #1 (see Table 2-1).	On the Digital Potentiometer Evaluation Board: Wiper is NOT moved due to the wiper being locked (WiperLock™ Technology is enabled).
		On DMM: Voltage equals approximately 3.38V.
12	On the Digital Potentiometer Evaluation Board: Turn off/disconnect power supply.	On DMM: Voltage equals approximately 0V.
13	On the Digital Potentiometer Evaluation Board: Re-apply power to Digital Potentiometer Evaluation Board.	On DMM: Voltage equals approximately 3.38V. This shows that the MCP4021 retained the last saved wiper setting.

2.3.4 Wiper Voltages

Table 2-3 shows the relation between the wiper position and the voltage on the wiper when 5.0 volts is applied to the MCP402X Digital Potentiometer Evaluation Board where the resistors R2 and R3 are 2500Ω and the MCP4011 resistor value (R_{AB}) is 10 kΩ. Equation 2-4 shows the formula for these calculations.

EQUATION 2-4: CALCULATING THE VOLTAGE ON THE MCP402X DIGITAL POTENTIOMETER EVALUATION BOARD

$$Voltage\ at\ Wiper = System\ V_{DD} \bullet \frac{(R3 + (Wiper\ Position \bullet (R_{AB})/63))}{R3 + R_{AB} + R2}$$

Where:

System V_{DD} = 5.0V

R2 = 2.5 kΩ

R3 = 2.5 kΩ

R_{AB} = 10 kΩ

The typical step resistance for the 10 kΩ MCP4021 is approximately 158.73Ω. With a 5V supply and a 15 kΩ total resistance (2.5 kΩ + 2.5 kΩ + 10 kΩ), the delta voltage per step is approximately 0.053V.

TABLE 2-3: WIPER POSITION AND CORRESPONDING VOLTAGE

Wiper			Wiper			Wiper			Wiper	
Position	Voltage (V)		Position	Voltage (V)		Position	Voltage (V)		Position	Voltage (V)
00(1)	0.833		16	1.680		32	2.526		48	3.373
01	0.866		17	1.733		33	2.579		49	3.426
02	0.939		18	1.786		34	2.632		50	3.479
03	0.992		19	1.839		35	2.685		51	3.532
04	1.045		20	1.892		36	2.738		52	3.585
05	1.098		21	1.944		37	2.791		53	3.638
06	1.151		22	1.997		38	2.844		54	3.690
07	1.204		23	2.050		39	2.897		55	3.743
08	1.257		24	2.103		40	2.950		56	3.796
09	1.310		25	2.156		41	3.003		57	3.849
10	1.362		26	2.209		42	3.056		58	3.902
11	1.415		27	2.262		43	3.108		59	3.955
12	1.468		28	2.315		44	3.161		60	4.008
13	1.521		29	2.368		45	3.214		61	4.061
14	1.574		30	2.421		46	3.267		62	4.114
15	1.627		31	2.474		47	3.320		63(2)	4.167

Note 1: This is zero-scale, wiper is connected to terminal B.

2: This is full-scale, wiper is connected to terminal A.

2.4 FIRMWARE DESCRIPTION

The 000066_MCP402XEV.ASM source code was written using assembly language for the PIC10F206 microcontroller. Refer to **Appendix E. "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 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 MCP401X/2X's $\overline{CS}$ pin (assuming V_{DD} = 5.0V). Utilizing such a charge pump requires special attention to the timing of the $\overline{CS}$ & U/$\overline{D}$ signals.

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

NOTES:

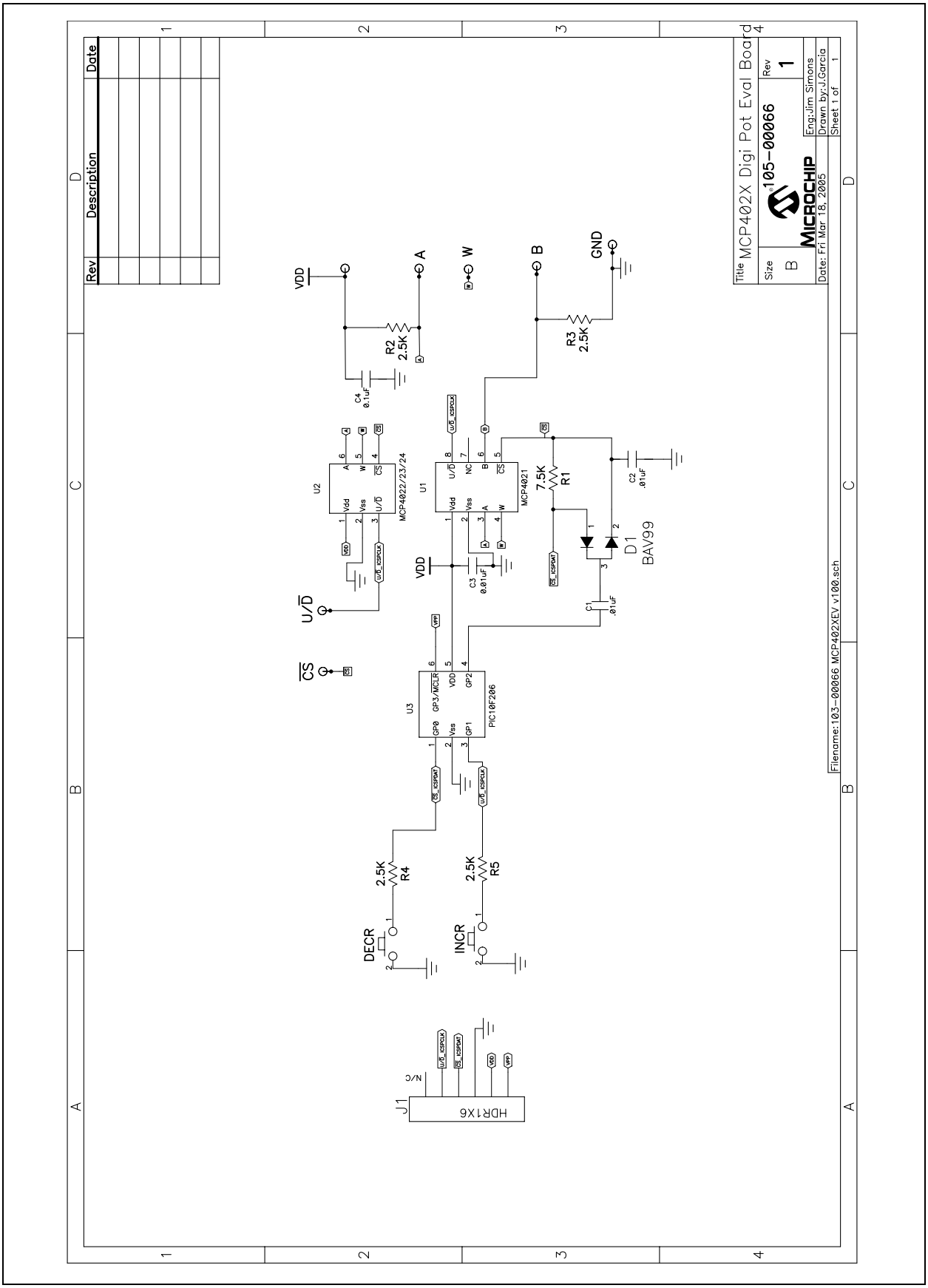
Appendix A. Schematic and Layouts

A.1 INTRODUCTION

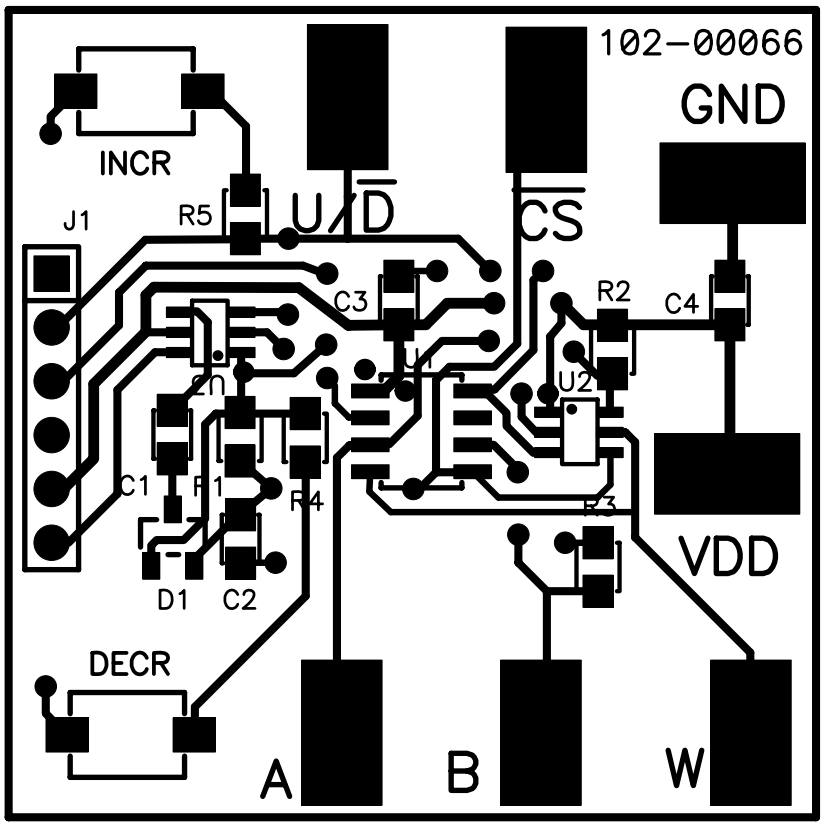
This appendix contains the following schematics and layout diagrams for the MCP402X Digital Potentiometer Evaluation Board.

- Schematic – Shows the schematic of 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

A.2 SCHEMATIC



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



A.4 MCP402X BOARD LAYOUT – BOTTOM LAYER