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MCP4725 PICtail Plus Daughter Board User's Guide

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MCP4725 PICtail[™] Plus DAUGHTER BOARD USER'S GUIDE

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MCP4725 PICtail[™] Plus DAUGHTER BOARD USER'S GUIDE

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 "DSXXXXA", 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 MCP4725 PICtail[™] Plus Daughter 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 MCP4725 PICtail[™] Plus Daughter Board as a development tool to emulate and debug firmware on a target board. The manual layout is as follows:

- Chapter 1. "Quick Start Instructions" this chapter provides an overview of the MCP4725 PICtail[™] Plus Daughter Board and instructions on how to program the DAC register and EEPROM of the MCP4725 device.
- Appendix A. "Schematics and Board Layouts" shows the schematic and layout diagrams for the MCP4725 PICtail™ Plus Daughter Board.
- Appendix B. "Bill Of Materials (BOM)" lists the parts used to build the MCP4725 PICtail[™] Plus Daughter Board.

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 "Save project before dialog	
Underlined, italic text with A menu path right angle bracket		<u>File>Save</u>
Bold characters	A dialog button	Click OK
	A tab	Click the Power tab
N'Rnnnn	A number in verilog format, where N is the total number of digits, R is the radix and n is a digit.	4'b0010, 2'hF1
Text in angle brackets < >	A key on the keyboard	Press <enter>, <f1></f1></enter>
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
	Constants	OxFF, `A'
Italic Courier New	A variable argument	<i>file.</i> o, where <i>file</i> can be any valid filename
Square brackets []	Optional arguments	<pre>mcc18 [options] file [options]</pre>
Curly brackets and pipe character: { }	Choice of mutually exclusive arguments; an OR selection	errorlevel {0 1}
Ellipses	Replaces repeated text	<pre>var_name [, var_name]</pre>
	Represents code supplied by user	<pre>void main (void) { }</pre>

RECOMMENDED READING

This user's guide describes how to use MCP4725 PICtail[™] Plus Daughter Board. The following Microchip documents are available and recommended as supplemental reference resources.

PICkit[™] Serial Analyzer User's Guide (DS51647)

Consult this document for instructions on how to use the PICkit Serial Analyzer hardware and software.

MCP4725 Data Sheet, "12-Bit DAC with EEPROM Memory in SOT-23-6" (DS22039)

This data sheet provides detailed information regarding the MCP4725 product family.

MCP4725 SOT-23 Evaluation Board User's Guide (DS51669)

PIC24FJ128GA010 Family Data Sheet (DS39747)

Explore 16 Development Board User's Guide (DS51589)

AN1079, "Using the C3 Compiler and the I2C Peripheral to Interface Serial EEPROMs with dsPIC33F" (DS01079)

PICkit[™] Serial Analyze User's Guide (DS51647)

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- 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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- Field Application Engineer (FAE)
- Technical Support

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 A (March 2008)

• Initial Release of this Document.



MCP4725 PICtail[™] Plus DAUGHTER BOARD USER'S GUIDE

Chapter 1. Quick Start Instructions

1.1 INTRODUCTION

The following sections provide an overview of the MCP4725 PICtail[™] Plus Daughter Board and demonstrate how to use (a) the MCP4725 device in a 16-bit MCU environment and (b) evaluate the MCP4725 device features using the PICkit[™] Serial Analyzer (P/N: DV164122). The MCP4725 PICtail[™] Plus Daughter Board is designed to work with both the Explorer 16 Development Board (P/N: DV164033) and the PICkit[™] Serial Analyzer (P/N: DV164122).

The following topics are covered:

- Description of the MCP4725 PICtail™ Plus Daughter Board
- How to use the MCP4725 PICtail[™] Plus Daughter Board with the Explorer 16 Starter Kit
- How to use MCP4725 PICtail[™] Plus Daughter Board with the PICkit[™] Serial Analyzer

1.2 DESCRIPTION OF THE MCP4725 PICtail[™] Plus DAUGHTER BOARD

The MCP4725 PICtail[™] Plus Daughter Board (P/N MCP4725DM-PTPLS) contains an MCP4725 12-bit Digital-to-Analog Converter (DAC). This daughter board has the following two interfaces:

- Explorer 16 Starter Kit (P/N: DV164033) for 16-bit MCU environment
- PICkit[™] Serial Analyzer (P/N: DV164122) for reading and writing the DAC register and observing the DAC output

The user can connect this daughter board to one of the above tools and perform their own experiments.

The board has test points for SDL, SDA, and V_{OUT}. By connecting an oscilloscope to these test points (to SCL, SDA, V_{OUT}) or Digital Multimeter to V_{OUT}, the user can examine the data communications through the I^2C^{TM} bus line and observe the resulting DAC output (V_{OUT}). Refer to **Appendix A.** "Schematic and Layouts"

1.2.1 I²C Address Bits and A0 Address Bit Selection

The I²C device code and address bits of the MCP4725 device are:

- Device Code: `1100'
- A2, A1, A0 Address Bits: `00X', where X is for the A0 bit which is determined by the logic state of the A0 pin

Note that the first two address bits (A2 and A1) are programmed at factory during device production and A0 bit is programmed by the user during applications. The A2 and A1 address bits of the MCP4725 device used for the MCP4725 PICtail[™] Plus Daughter Board are programmed at the factory to `00'. The JMP1 connector on the MCP4725 PICtail[™] Plus Daughter Board selects the A0 bit. The following conditions show the A0 bit selection:

- A0 bit = `1' if JMP1 is connected to V_{DD}
- A0 bit = `0' if JMP1 is connected to V_{SS} (Default setting)
- Address bits A2, A1 = `00'

Based on the above information, the combined device code and address bits for the $\rm I^2C$ Serial Communication are:

- 1100-001W/R: if JMP1 is connected to V_{DD}
- 1100-000W/R: if JMP1 is connected to V_{SS}
- Where W/R is write("0") or read (`1') bit.

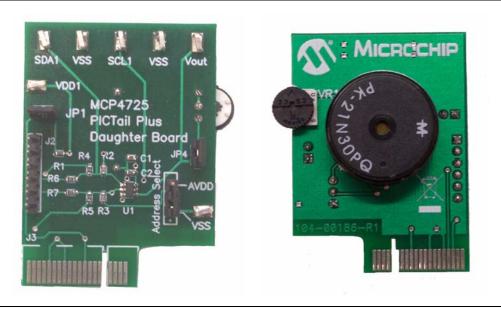


FIGURE 1-1: Front and Back Views of the MCP4725 PICtail[™] Plus Daughter Board.

1.3 GETTING STARTED WITH EXPLORER 16 DEVELOPMENT BOARD

Figure 1-2 shows the MCP4725 PICtail[™] Plus Daughter Board with the Explorer 16 Development Board. When they are connected, the user can program the 16-bit PIC24FJ128 MCU on the Explorer 16 Starter Kit. The Explorer 16 Development Board sends I²C serial communication commands to the MCP4725 PICtail[™] Plus Daughter Board for the MCP4725 DAC output. The Explorer 16 MCU firmware for this MCP4725 PICtail[™] Plus Daughter Board writes to the DAC input register continuously in 1 LSB increments. The user can see the DAC output (V_{OUT}) changes using an oscilloscope. Also, a buzzer on the MCP4725 PICtail[™] Plus Daughter Board driven by the DAC output (V_{OUT}).

1.3.1 Connecting to the Explorer 16 Starter Kit

1. Connect the MCP4725 PICtail[™] Plus Daughter Board to the J5 socket on the Explorer 16 Development Board as shown in Figure 1-2.

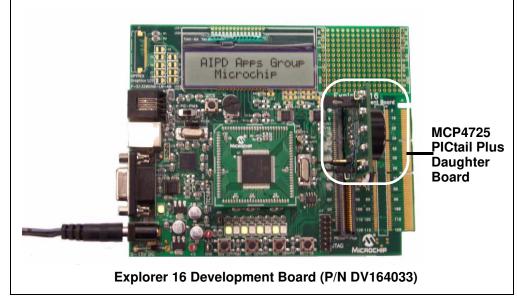


FIGURE 1-2: Connecting the MCP4725 PICtail[™] Plus Daughter Board to the Explorer 16 Development Board.

1.3.2 Programming the PIC24FJ128 MCU

The Explorer 16 Development Board contains the PIC24FJ128 MCU. The user can download the firmware to the MCU using the MPLAB ICD2 programmer. Refer to Chapter 2 of the Explorer 16 Development Board User's Guide (DS51589) for details on the programming of the Explorer 16 Development Board.

1.3.2.1 THE PIC24FJ128 MCU FIRMWARE FOR THE MCP4725 PICtail™ Plus DAUGHTER BOARD

The original firmware for the Explorer 16 Development Board is modified for the MCP4725 PICtail[™] Plus Daughter Board demonstration. The firmware uses most of the original codes for the Explorer 16 Development Board except the I²C peripheral control routines for the PIC24FJ128 MCU.

The following four routines are added or modified from the original Explorer 16 Development Board firmware.

- PIC24ExplDemo_MCP4725_Main.c
- MCP4725_i2C_Func.c
- Banner_MCP4725.c
- i2C_MCP4725.h

The user can modify the above routines for their own application.

The source code is compiled by using Microchip's C30 Compiler and the hex code is programmed to the MCU using the MPLAB ICD 2. Figure 1-3 shows connection of the MPLAB ICD 2 and the Explorer 16 Development Board. Figure 1-4 shows the MPLAB IDE programming environment.

1.3.2.2 FIRMWARE FLOW CHART FOR THE MCP4725 DAUGHTER BOARD

Figure 1-5 shows the flow chart of the firmware. Once the MCU firmware is programmed, the user can observe the following events:

- 1. V_{OUT} changes as the MCU rewrites the DAC codes. See Figure 1-6 for the VOUT waveform.
- 2. Audible sounds (Buzzer) if JP4 is connected.
- 3. I²C data communication (SDA and SCL) waveform over the I²C bus line. See Figure 1-6 and Figure 1-7.

1.3.3 DAC Output (V_{OUT})

The MCU sends write commands for EEPROM and DAC input register.

The MCU writes EEPROM only once, but writes continuously the DAC input register. The EEPROM is written for the $V_{OUT} = V_{DD}/2$, and the DAC input register is continuously written for the V_{OUT} to be ramp: The DAC input code is written from "000h" to "FFFh" with 1 LSB increment. When it reaches "FFFh", resets to "000h" and repeats the writing from "000h" to "FFFh" with 1 LSB again.

The user can observe the V_{OUT} at the V_{OUT} test pin using a digital voltmeter or oscilloscope. Figure 1-7 shows the I²C clock (SCL) and data (SDA) signals, and DAC output waveform.

The DAC input register is written with fast mode write command which does not affect the EEPROM. The user can confirm the data written in EEPROM ($V_{OUT} = V_{DD}/2$) by disconnecting the MCP4725 PICtailTM Plus Daughter Board from the Explorer 16 Development Board. When the board is first powered, the MCP4725 device loads the EEPROM data to the DAC input register by itself and then outputs an analog voltage determined by the EEPROM data.

1.3.4 Audible Buzzer

The MCP4725 PICtailTM Plus Daughter Board includes a buzzer. This buzzer is directly connected to the V_{OUT}. The user can disable the buzzer by disconnecting JP4. The buzzer sounds also can be adjusted by VR1.

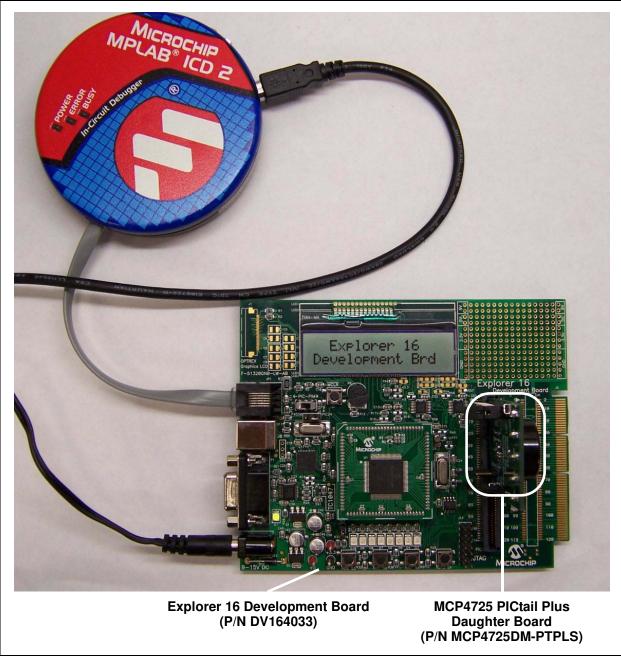


FIGURE 1-3: MPLAB ICD2 connection to Explorer 16 Development Board with the MCP4725 PICtail[™] Plus Daughter Board for programming.

MCP4725 PICtail[™] Plus Daughter Board User's Guide

File Edit View Project Debugger Programmer Tools (Taofiarwa Wiedaw Halo
rile Edit view Project Debugger Programmer Tools (zonnigare window Help
🕒 🗠 🐚 🗠 🗠 🐨 🖌 🕹 🛛 Release 🖸	- 🖆 🚘 🔛 🥵 🕚 😻
Checksum: 0×4e55	
PIC24ExpDemo_MCP4725.mcw - 🗆 🗙 C	: DevKit\DAC\Explore16\Youbok\PIC24ExplDemo
	/**************************************
🖃 🛄 PIC24ExpDemo_MCP4725.mcp	*
A Source Files	* Explorer 16 Development Board Demo
adc.c	* Modified the original PIC16 Explore
banner_MCP4725.c	*
S buttons.c	* Modified for PIC24FJ64GA004 family
eeprom.c	* This modified version does the foll
	 * Inis modified Version does the following the second secon
iomapping.c	* (2) Program this firmware
E lcd.c	* (3) The DAC outoput will ramp until
MCP4725_i2c_Func.c	* When it reaches its max, it sta
PIC24ExplDemo_MCP4725_main.c	* You can see the followings:
-S rtcc.c	* (1) Buzzer will beep
spimpol.c	* (2) Voutout can be seen using Oscil
tbanner.c	*
timer.c	******
uart2.c	* FileName: PIC24ExplDemo_MCP4
vbanner.c	* Dependencies: system.h, i2c_MCP4
😑 🧰 Header Files	* Processor: PIC24
adc.h	* Compiler: MPLAB C30 v2.04 or * Linker: MPLAB LINK30
buttons.h	* Company: Nicrochip Technolo
eeprom.h	*
	* Software License Agreement
- 🕒 lcd.h	* The software supplied herewith by N
	* (the "Company") is intended and sup
spimpol.h	 * customer, for use solely and exclus * by the Company.
system.h	*
Limer.h	* The software is owned by the Compar
uart2.h	* protected under applicable copyrigh
Diject Files	* Any use in violation of the foregoing
Library Files	* user to criminal sanctions under an
Linker Scripts	* civil liability for the breach of t * license.
p24FJ128GA010.gld	*
Other Files	* THIS SOFTWARE IS PROVIDED IN AN "AS
	+ DEPRESE BUDDRCC THDITED OD CEASURC

FIGURE 1-4: MPLAB IDE Programming Environment.

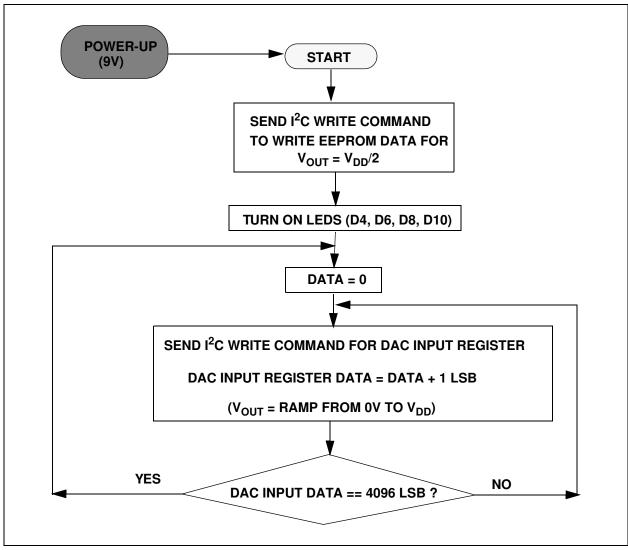
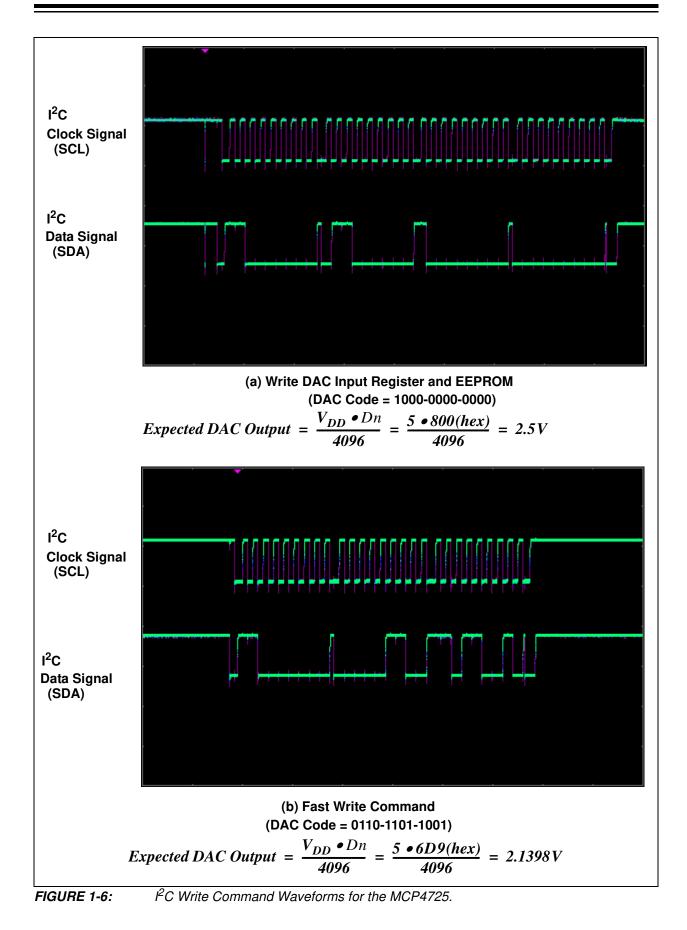
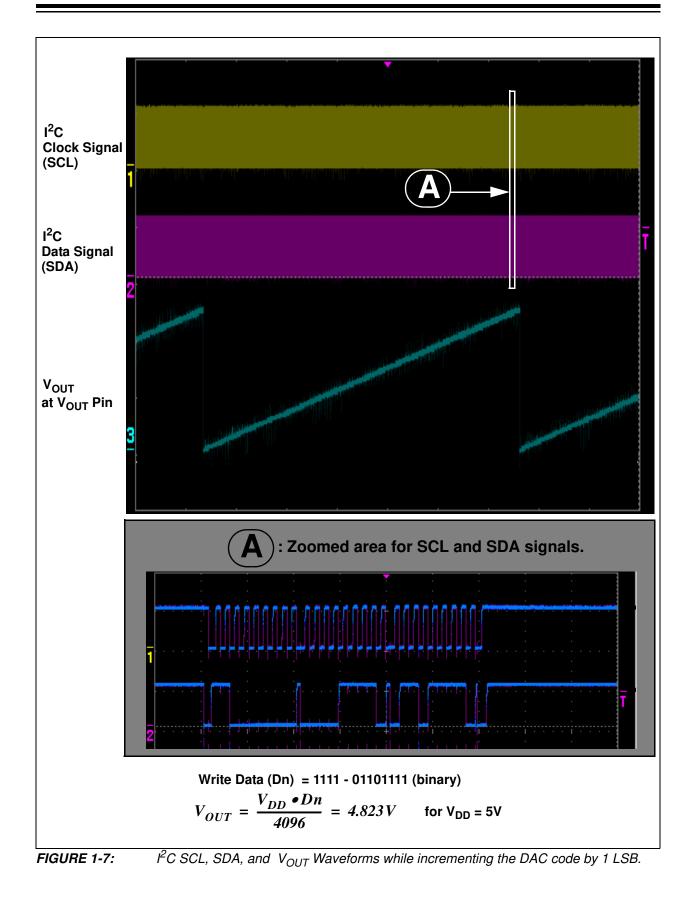


FIGURE 1-5:

Flow Chart for the MCP4725 PICtail™ Plus Daughter Board Firmware.





1.4 GETTING STARTED WITH PICKIT[™] SERIAL ANALYZER

The user can use the MCP4725 PICtail[™] Plus Daughter Board with the PICkit[™] Serial Analyzer by setting up as shown in Figure 1-8.

The following describes how to use them together:

- 1. Connect the MCP4725 PICtail[™] Plus Daughter Board's J2 pin socket to the PICkit[™] Serial Analyzer.
- 2. Connect a Digital Voltmeter to V_{OUT} pin and V_{SS}.

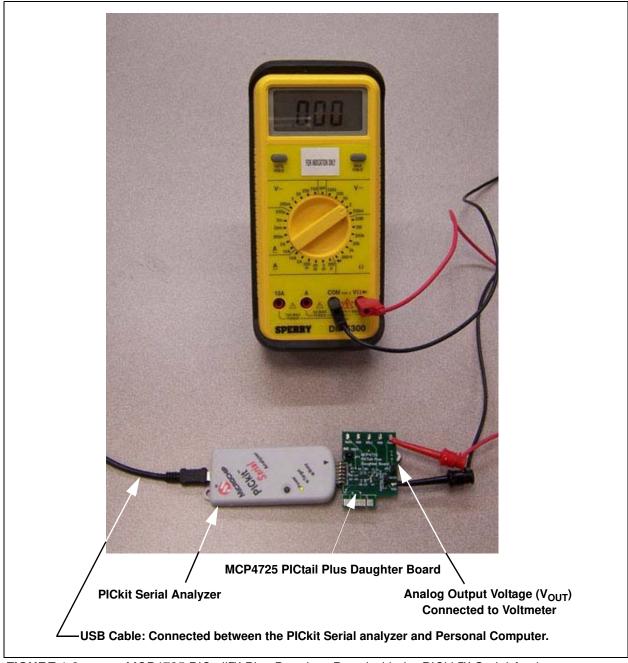


FIGURE 1-8: MCP4725 PICtail[™] Plus Daughter Board with the PICkit[™] Serial Analyzer.

1.4.1 PICkit[™] Serial Analyzer PC Software Set-Up for the MCP4725 Daughter Board

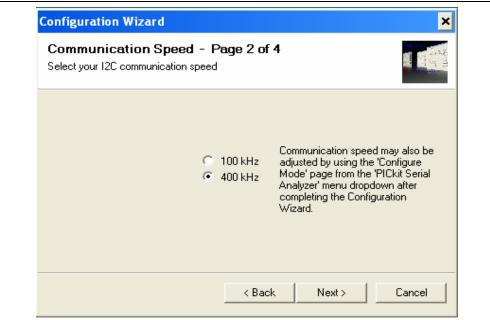
The following steps describe how to set and use the PICkit[™] Serial Analyzer PC Graphic User Interface (GUI) to control the MCP4725 PICtail[™] Plus Daughter Board.

- 1. Install the PICkit[™] Serial Analyzer software onto your personal computer (PC).
- 2. Connect the USB cable between the PICkit[™] Serial Analyzer and your PC.
- 3. Run the PICkit[™] Serial PC Software: It will open up to the following graphic user interface (GUI). Click the **Next** button and follow the instructions:

PICKIN Serial	Welcome To The	
	PICkit Serial Analyzer Configuration Wizard	
	The following steps will guide you through the setup of the PICkit Serial Analyzer.	

4. Select the Communication Mode type: I²C Master, and click the **Next** button.

Communication Mode - Page 1 of 4 Choose which mode of communication you wish to use.			
I2C Master			
SPI Master			
O USART Async			
O USART Sync Mas	ter		
	< Back	Next>	Cancel



- Note: The MCP4725 device supports the l²C bus data rate up to 3.4 MHz, but the current version of the PICkit[™] Serial Analyzer supports the l²C bus data rate up to 400 kHz only.
- 6. Select <u>No</u> on Enable Pull-ups, and click the **Next** button.

Note: The MCP4725 PICtail[™] Plus Daughter Board has its own pull-up resistors, therefore, you don't need additional pull-up resistors from the PICkit[™] Serial Analyzer.

Device Pullups - Page 3 of 4 Do you need to enable pullups for your device?			
	able Pullups Yes ⓒ No		
	< Back	Next >	Cancel

5. Select 100 kHz or 400 kHz. Either one will be fine. Click the Next button.

7. Select the V_{DD} voltage of the MCP4725 PICtail[™] Plus Daughter Board and click the_**Next** button.

Case 1: When you use V_{DD} from the PICkit[™] Serial Analyzer:

If you choose **PICkit[™] Serial will power my device** and **5 Volts** as shown below, the the MCP4725 PICtail[™] Plus Daughter Board is powered by the 5V DC from the PICkit[™] Serial Analyer through the JP1 jumper. In this case, make sure that the JP1 jumper on the MCP4725 PICtail[™] Plus Daughter Board is connected.

Case 2: When you use your own V_{DD}:

You can also provide your own V_{DD} voltage by applying a V_{DD} voltage at TP1. In this case, make sure that the JP1 jumper is disconnected.

Voltage Source - Page 4 of 4 Does PICkit Serial need to power your device	e?
Voltage PICkit Serial will power my device ● 5 Volt ● 0ther 5.0V	If PICkit Serial will power your device, select the checkbox to the left, then determine your voltage.
4	:Back Next> Cancel

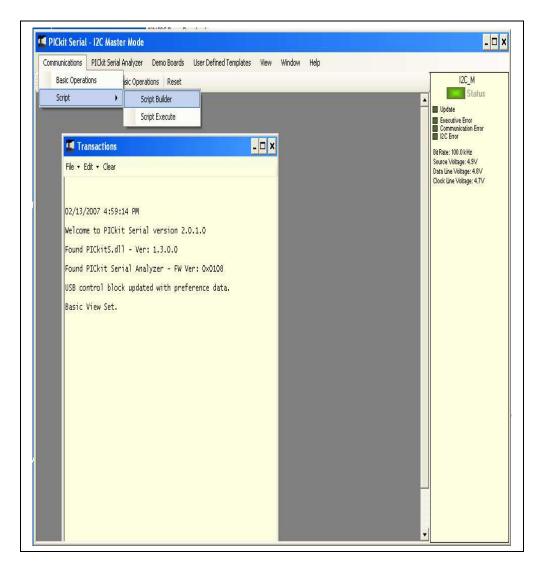
 Click the OK button. You have made all of the PICkit[™] Serial Analyzer Configuration Set-ups. You are now ready to program the MCP4725 PICtail[™] Plus Daughter Board using the PICkit[™] Serial Analyzer.

	You're Done! Press 'OK' to complete the Configuration Wizard.
The second secon	Do not show this wizard on startup again Wizard may be accessed anytime from menu dropdown PICkit Serial Analyzer -> Run Configuration Wizard.
	<back next=""> OK</back>

1.4.2 Creating Script Files

In order to make a communication between the PICkit[™] Serial Analyzer and the MCP4725 PICtail[™] Plus Daughter Board, it needs a script file. The following procedure shows how to create script files and how to use them.

1. Select Communication ----> Script ---> Script Builder.



1.4.2.1 CREATING SCRIPT FILES TO PROGRAM DAC REGISTER

 Click on WriteBlockAddrA8 in "Example I2C Scripts" column. This will fill in the spaces under Script Detail column.

Modifying the Script Details Parameters:

- 2. Under the Script Detail column, select the item in the parameter box.
- Right click the mouse button and an option box appears to the right of your selection. This gives you the options that are available for the parameter selected.
- 4. Select the desired option.
- 5. Keep the parameters in the same order as shown below:

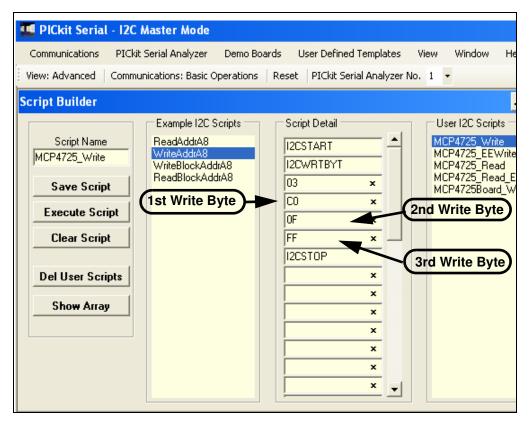
🚾 PICkit Serial - I2C Master Mode					
Communications PICkit Serial Analyzer Demo Boards User Defined Templates View Window H					
View: Advanced Communications: Basic Operations Reset PICkit Serial Analyzer No. 1 -					
Script Builder					
Script Name MCP4725_Write Save Script Execute Scrip Clear Script Del User Scri Show Arra	pt 🕨	Script Detail User I2C Scripts User I2C Scripts USER I2C Scripts USER I2C Scripts MCP4725_EEWrite MCP4725_Read_E MCP4725Board_W CO X OF X FF X I2CSTOP X X X X X X X X X X X X X X X X X X X			

4. Change the parameter value.

Script Detail]
I2CSTART I2CWRTBYT 03 C0 0F FF I2CSTOP	* *> This means there are three bytes to send> 1st Write Byte: Address byte = 1100-0000> 2nd Write Byte: 0000-1111> 3rd Write Byte: 1111-1111 *

Note: All 7 parameters above must be listed in order. The parameters with * are not modifyable. Address bits A2, A1, A0 = 1, 1, 0 if both JMP2 and JMP3 are tied to V_{DD} . You can choose any data you want for the 2nd and 3rd write bytes. If you use the above write data, the MCP4725 device will output:

$$V_{OUT} = \frac{V_{DD} \cdot FFF(hex)(V)}{4096} = V_{DD}(V)$$



- 1.4.2.2 SAVING THE SCRIPT FILE AND PROGRAMMING DAC REGISTER (FAST MODE)
- 1. Change 2nd and 3rd data bytes you want in the Script Detail.
- 2. Type in any script name (i.e., MCP4725_Write) in the space below the **Script Name** menu.
- 3. Click Save Script button.
- 4. Click Execute Script button.

Note: At this point, the PICkit[™] Serial transmits the Fast Write Command to the MCP4725 device. The saved file name will appear in Users I2C Scripts column and can be reused any time by selecting the file name.

- The device provides analog output voltage (V_{OUT}) at the V_{OUT} terminal on the MCP4725 PICtail[™] Plus Daughter Board.
- 6. V_{OUT} can be monitored by using a voltmeter.

Note: When you click on the "Execute Script" menu, the "Busy" LED on the PICkit Serial Analyzer will momentarily turn on and then turn off. If the LED remains ON, a communications problem has occurred. Remove the PICkit Serial Analyzer from the personal computer and recheck the parameter value in the order of the parameters under the **Script Detail** column. Try again until the "Busy" LED goes OFF after executing the write command.