MCP4725
SOT-23-6
Evaluation Board
User’s Guide
Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip’s Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as “unbreakable.”

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip’s code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyright work, you may have a right to sue for relief under that Act.

Information contained in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION, INCLUDING BUT NOT LIMITED TO ITS CONDITION, QUALITY, PERFORMANCE, MERCHANTABILITY OR FITNESS FOR PURPOSE. Microchip disclaims all liability arising from this information and its use. Use of Microchip devices in life support and/or safety applications is entirely at the buyer’s risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights.

Trademarks

The Microchip name and logo, the Microchip logo, Accuron, dsPIC, Keeloq, Keeloq logo, microD, MPLAB, PIC, PICmicro, PICSTART, PRO MATE, rPIC and SmartShunt are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

AmpLab, FilterLab, Linear Active Thermistor, Migratable Memory, MXDEV, MXLAB, SEEVAL, SmartSensor and The Embedded Control Solutions Company are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Analog-for-the-Digital Age, Application Maestro, CodeGuard, dsPICDEM, dsPICDEM.net, dsPICworks, dsSPEAK, ECAN, ECONOMONITOR, FanSense, FlexROM, fuzzyLAB, In-Circuit Serial Programming, ICSP, ICEPIC, Mindi, MiWi, MPASM, MPLAB Certified logo, MPLIB, MPLINK, PICkit, PICDEM, PICDEM.net, PICLAB, PICtail, PowerCal, PowerInfo, PowerMate, PowerTool, REAL ICE, rLAB, Select Mode, SmartSerial, SmartTel, Total Endurance, UNI/O. WiperLock and ZENA are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

All other trademarks mentioned herein are property of their respective companies.

© 2007, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

Printed on recycled paper.

QUALITY MANAGEMENT SYSTEM CERTIFIED BY DNV

ISO/TS 16949:2002

Microchip received ISO/TS-16949:2002 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company’s quality system processes and procedures are for its PIC® MCUs and dsPIC® DSCs, Keeloq® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip’s quality system for the design and manufacture of development systems is ISO 9001:2000 certified.
# Table of Contents

## Preface
- Introduction .................................................................................................. 1
- Document Layout ......................................................................................... 1
- Conventions Used in this Guide ................................................................. 2
- Recommended Reading .................................................................................. 3
- The Microchip Web Site ................................................................................ 3
- Customer Support .......................................................................................... 3
- Document Revision History .......................................................................... 4

## Chapter 1. Quick Start Instructions
- 1.1 Introduction ............................................................................................. 5
- 1.2 What is the MCP4725 SOT-23-6 Evaluation Kit ....................................... 5
- 1.3 Getting Started with PICkit Serial Analyzer .............................................. 5

## Appendix A. Schematics and Board Layouts
- A.1 Introduction ............................................................................................. 21
- A.2 Board - Schematic .................................................................................. 22
- A.3 Board - Top Layer .................................................................................... 23
- A.4 Board - Top Silk Layer ............................................................................. 24
- A.5 Board - Bottom Layer .............................................................................. 25

## Appendix B. Bill Of Materials (BOM)
- ....................................................................................................................... 27

## Worldwide Sales and Service
- ....................................................................................................................... 28
INTRODUCTION

This chapter contains general information that will be useful to know before using the MCP4725 SOT-23-6 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 MCP4725 SOT-23-6 Evaluation 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 SOT-23-6 Evaluation 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 SOT-23-6 Evaluation Board.
- Appendix B. “Bill Of Materials (BOM)” – lists the parts used to build the MCP4725 SOT-23-6 Evaluation Board.
# CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

## DOCUMENTATION CONVENTIONS

<table>
<thead>
<tr>
<th>Description</th>
<th>Represents</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arial font:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Italic characters</td>
<td>Referenced books</td>
<td><em>MPLAB® IDE User’s Guide</em></td>
</tr>
<tr>
<td></td>
<td>Emphasized text</td>
<td><em>...is the only compiler...</em></td>
</tr>
<tr>
<td>Initial caps</td>
<td>A window</td>
<td>the Output window</td>
</tr>
<tr>
<td></td>
<td>A dialog</td>
<td>the Settings dialog</td>
</tr>
<tr>
<td></td>
<td>A menu selection</td>
<td>select Enable Programmer</td>
</tr>
<tr>
<td>Quotes</td>
<td>A field name in a window or dialog</td>
<td>“Save project before build”</td>
</tr>
<tr>
<td>Underlined, italic text with right angle bracket</td>
<td>A menu path</td>
<td><em>File&gt;Save</em></td>
</tr>
<tr>
<td>Bold characters</td>
<td>A dialog button</td>
<td>Click OK</td>
</tr>
<tr>
<td></td>
<td>A tab</td>
<td>Click the <em>Power</em> tab</td>
</tr>
<tr>
<td>N’Rnnnn</td>
<td>A number in verilog format, where N is the total number of digits, R is the radix and n is a digit.</td>
<td>4'b0010, 2'hF1</td>
</tr>
<tr>
<td>Text in angle brackets &lt; &gt;</td>
<td>A key on the keyboard</td>
<td>Press &lt;Enter&gt;, &lt;F1&gt;</td>
</tr>
</tbody>
</table>

## 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 | `0xFF, ‘A’` |
| Italic Courier New | A variable argument | *file.o*, where *file* can be any valid filename |
| 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 MCP4725 SOT-23-6 Evaluation 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.

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

CUSTOMER SUPPORT

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers should contact their distributor, representative or field application engineer 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 (October 2007)

- Initial Release of this Document.
Chapter 1. Quick Start Instructions

1.1 INTRODUCTION
The following sections provide an overview of the MCP4725 SOT-23-6 Evaluation Board and instruction how to program the DAC register and EEPROM of the MCP4725 device using the PICkit Serial Analyzer. The following sections cover the following topics:
- What is the MCP4725 SOT-23-6 Evaluation Board?
- How to use the MCP4725 SOT-23-6 Evaluation Board with the PICkit Serial Analyzer

1.2 WHAT IS THE MCP4725 SOT-23-6 EVALUATION KIT
The MCP4725 SOT-23-6 Evaluation Board contains the MCP4725 single channel 12-Bit Digital-to-Analog Converter (DAC) and I^2C loading resistors.
The purpose of this board is:
- **Quick evaluation of the MCP4725 features using the PICkit Serial Analyzer:** The user can program the DAC Register or EEPROM using the PICkit Serial Analyzer and measure the MCP4725 device analog output voltage using a voltmeter
- **Easy handling of the MCP4725 device in a tiny SOT23-6 package:** The MCP4725 device is available in a small SOT-23-6 package. This board makes it easy to handle the small package device for user’s application evaluations. The user can simply connect the J1 pins on the evaluation board to the user’s test board for a quick evaluation of the MCP4725 device. The MCP4725 supports standard mode (100 kHz), fast mode (400 kHz), and high speed mode (3.4 MHz). This evaluation board is using 5 kΩ for the I^2C pull-up resistors. This 5 kΩ supports up to 400 kHz. The user can replace the R1 and R3 with lower values (less than 1 kΩ) for the high-speed mode (3.4 MHz)

1.3 GETTING STARTED WITH PICKIT SERIAL ANALYZER
The user can use the MCP4725 SOT-23-6 Evaluation Board in two different ways: (a) together with the PICkit Serial Analyzer or (b) by connecting this board to the user’s target board directly.
*Figure 1-1* shows the MCP4725 SOT-23-6 Evaluation Board. The SCL, SDA, V_DD, and V_SS pins in the J1 connector are connected to the MCP4725 device.
The MCP4725 SOT-23-6 Evaluation Kit contains two MCP4725 SOT-23-6 Evaluation Boards. This board can easily be programmed using the PICkit Serial Analyzer (DV164122). It is highly recommended that the user order the MCP4725 SOT-23-6 Evaluation Board and the PICkit Serial Analyzer at the same time.
On the MCP4725 SOT-23-6 Evaluation Board, the R1 and R3 are the I^2C pull-up load resistors for the SDA and SCL, respectively. The user can replace them with their own component values of interest. It is also recommended that these pull-up resistors be removed if the user’s test board has the pull-up resistors already. The MCP4725 SOT-23-6 Evaluation Board also has footprints for additional pull-up resistors (in parallel with the R1 and R3) and loading capacitors. The user can populate the board with their own components.
FIGURE 1-1:  MCP4725 SOT-23-6 Evaluation Board.

- **JP1: A0 selection jumper:** Picture shown here is connected to the GND (A0 = 0)
- **MCP4725 in SOT-23-6 package**
- **Ground Terminal**
- **J1 Connector**
- **Analog Output Terminal (V_{OUT})**
- **V_{DD} Terminal**
- **R1 (Pull-up Resistor for SDA)**
- **R3 (Pull-up Resistor for SCL)**
1.3.1 Getting Started with PICkit Serial Analyzer

This section describes how to evaluate the MCP4725 device using the PICkit Serial Analyzer.

1.3.1.1 HARDWARE SET-UP

1. Connect the MCP4725 SOT-23-6 Evaluation Board and the PICkit Serial Analyzer together using the J1 connector.
2. Connect a USB cable between the PICkit Serial Analyzer and a Personal Computer.
3. Connect a Digital Voltmeter to $V_{OUT}$ and GND terminals on the MCP4725 SOT-23-6 Evaluation Board. Figure 1-2 shows the connection example.

FIGURE 1-2: MCP4725 SOT-23-6 Evaluation Board Test Set Up.
1.3.1.2 PICKIT SERIAL ANALYZER PC SOFTWARE SET-UP FOR DAC DEVICE PROGRAMMING AND ANALOG VOLTAGE OUTPUT MEASUREMENT

1. Install the PICkit Serial Analyzer software in your computer.
2. Connect the USB cable between the PICkit Serial Analyzer and your PC.
3. Run the PICkit Serial PC Software: It will open up the following graphic user interface (GUI). Click Next > and follow the instructions:

4. Select the I2C Master option radio button for the Communication Mode type and click the Next > button.
5. Select either **100 kHz** option or **400 kHz** option radio button and click the **Next >** button.

![Configuration Wizard](image)

**Communication Speed - Page 2 of 4**
Select your I2C communication speed

- **100 kHz**
- **400 kHz**

Communication speed may also be adjusted by using the 'Configure Mode' page from the 'PICkit Serial Analyzer' menu dropdown after completing the Configuration Wizard.

6. Select **No** on Device Pullups and click the **Next >** button.

![Configuration Wizard](image)

**Device Pullups - Page 3 of 4**
Do you need to enable pullups for your device?

- **Enable Pullups**
  - **Yes**
  - **No**

**Note:** The MCP4725 SOT-23-6 Evaluation Board supports the I2C bus data rate up to 3.4 MHz, but the current version of the PICkit Serial Analyzer only supports the I2C bus data rate up to 400 kHz.

**Note:** The MCP4725 SOT-23-6 Evaluation Board has its own pull-up resistors.
7. Select the **Voltage Source** option for the MCP4725 SOT-23-6 Evaluation 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** option, and the **5 Volt** option as shown below, the MCP4725 SOT-23-6 Evaluation Board is powered by the 5 VDC from the PICkit Serial Analyzer through the J1 connector. In this case, make sure that the JP2 jumper on the MCP4725 SOT-23-6 Evaluation Board is connected.

You can also click on the **Other** option and move the slide bar for other than 5 volts.

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

If you want to provide your own V_{DD} voltage through the V_{DD} terminal on the MCP4725 SOT-23-6 Evaluation Board, then do not select the **PICkit Serial will power my device** option. In this case, you have to remove the JP2 jumper on the board and provide the V_{DD} at the V_{DD} terminal.
8. Click the **OK** button. You have done all PICkit Serial Analyzer Configuration Set-up. You are now ready to program the MCP4725 device using the PICkit Serial Analyzer.

![Configuration Wizard](image)

You're Done!

Press ‘OK’ to complete the Configuration Wizard.

- Do not show this wizard on startup again

Wizard may be accessed anytime from menu dropdown PICkit Serial Analyzer → Run Configuration Wizard.
1.3.2 Creating Script File to program the DAC Register and EEPROM Data

1. From the Communications tab, select the Script option and go to the Script Builder.
2. You need to create a script file using the following instructions.
   a) Type in any script name (i.e., MCP4725_Write) in the space below the **Script Name** menu item.
   b) Type in the following parameters in order in the text box area provided in the **Script Detail** box.

   ![Script Detail](image)

   **Note:** You can choose any data you want for the 2nd and 3rd write bytes. If you use the above write data, the MPC4725 device will output:

   \[ V_{OUT} = V_{DD} \times 0.5V. \]
3. Programming DAC Register (Fast Mode)
   a) Change 2nd and 3rd data bytes you want in the Script Detail.
   b) Click **Execute Script** Menu item.
   c) The device gives an analog output voltage ($V_{OUT}$) at the VOUT terminal on the board.
4. Programming DAC Register and EEPROM

a) Type in the following parameters in order in the spaces below the **Script Detail** menu and click on the **Execute Script** button.

<table>
<thead>
<tr>
<th>Script Detail</th>
<th>I2CSTART</th>
<th>I2CWRTBYT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>04</td>
<td>C0</td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>00</td>
<td>I2CSTOP</td>
</tr>
</tbody>
</table>

-----------> This means Master will send four bytes
-----------> 1st Write Byte: Address byte = 1100-0000
-----------> 2nd Write Byte: 0110-0000
-----------> 3rd Write Byte: 1000-0000
-----------> 4th Write Byte: 0000-0000

**Example I2C Scripts**

- ReadAddrA8
- WriteAddrA8
- ReadBlockAddrA8
- WriteBlockAddrA8

**Script Detail**

- I2CSTART
- I2CWRTBYT
- 04
- C0
- 60
- 80
- 00
- I2CSTOP

**Sent script from Script Builder page, 11**

\[04][CC][60][00][80][P_]

\[\]

**Sent script from Script Builder page, 11**

\[04][CC][60][00][80][P_]
5. Verifying the EEPROM Data.

After sending the EEPROM write command in Step 4, the device holds the data in the EEPROM. The data in the EEPROM is non-volatile. To check this non-volatile data, you can remove the V\textsubscript{DD} from the MCP4725 SOT-23-6 Evaluation Board once, and bring back up the V\textsubscript{DD} again. You will see the same analog voltage output at the V\textsubscript{OUT} terminal.
6. Reading the DAC Register Data using the PICkit Serial Analyzer

This experiment can be done in two steps:

(a) Write the DAC Register with Fast Mode Command.
(b) Send Read Command and see the results on the PICkit Serial Transactions page.

![Image of PICkit Serial Analyzer interface]

- **Written Data using a Write Command**
  
  
  \[ \text{[S}_-\text{][W}_-\text{][03][C0][00][00][P}_-\text{]} \]

- **Reading Data using a Read Command**
  
  \[ \text{[S}_-\text{][W}_-\text{][01][C1][RN][03][P}_-\text{]} \]

\[ \text{[S}_-\text{][C0][80][00][P}_-\text{]} \]
7. Reading both the DAC Register and EEPROM data.
   
   This experiment can be done by two steps:
   
   (a) Write the DAC Register and EEPROM data using a write command.
   (b) Send Read Command (Request 5 bytes) and see the results on the PICkit Serial Transactions page.
1.3.3 Examples of the MCP4725 Programming

**FIGURE 1-3:** MCP4725 Device Address Byte.

<table>
<thead>
<tr>
<th>1</th>
<th>1</th>
<th>0</th>
<th>0</th>
<th>A2</th>
<th>A1</th>
<th>A0</th>
<th>R/W</th>
</tr>
</thead>
</table>

**Device Code**

**Address Byte**: A2 = A1 = 0 for Default Samples
A0 = 0 if A0 pin is Grounded
= 1 if A0 pin is tied to VDD

**EXAMPLE:**

- **Write Mode**: 0XC0 FOR (A2 = A1 = A0)
- **0XC2** FOR (A2 = A1 = 0, A0 = TIED TO VDD)
- **Read Mode**: 0XC1 FOR (A2 = A1 = A0)
- **0XC3** FOR (A2 = A1 = 0, A0 = TIED TO VDD)

**FIGURE 1-4:** Fast Mode (Write Command) for VOUT = 2.5V when VREF = 5V.

\[
DAC\ Output = \frac{V_{REF} \times D_N}{4096} = \frac{5V \times 2^{11}}{4096} = 2.5V
\]

Start 0xC0 ACK 0 0 PD1 PD0 D11 D10 D9 D8 ACK D8 D7 D6 D5 D4 D3 D2 D1 D0 ACK STOP

Address Byte: when A2 = A1 = A0 = 0

0x08

0x00

= 2^{11}
FIGURE 1-5: Write Command Example for EEPROM and DAC Register for $V_{OUT} = 2.5V$ when $V_{REF} = 5V$.

DAC Output $= \frac{V_{REF} \times D_N}{4096} = \frac{5V \times 2^{11}}{4096} = 2.5V$
Appendix A. Schematics and Board Layouts

A.1 INTRODUCTION

This appendix contains the following schematics and layouts for the MCP4725 SOT-23-6 Evaluation Board:

- Board – Schematic
- Board – Top Layer
- Board – Top Silk Layer
- Board – Bottom Metal Layer
A.5 BOARD - BOTTOM LAYER
## Appendix B. Bill Of Materials (BOM)

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

<table>
<thead>
<tr>
<th>Qty</th>
<th>Reference</th>
<th>Description</th>
<th>Manufacturer</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>C1, C2</td>
<td>Not Populated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>GND, VDD VOUT</td>
<td>TEST POINT PC COMPACT SMT</td>
<td>Keystone Electronics</td>
<td>5016</td>
</tr>
<tr>
<td>1</td>
<td>J1</td>
<td>CONN HEADER 6POS .100 R/A GOLD</td>
<td>Molex/Waldom Electronics Corp</td>
<td>22-28-8062</td>
</tr>
<tr>
<td>2</td>
<td>JP1,JP2</td>
<td>CONN HEADER 2POS .100 VERT TIN</td>
<td>Molex/Waldom Electronics Corp</td>
<td>22-28-4020</td>
</tr>
<tr>
<td>2</td>
<td>JP1,JP2</td>
<td>CONN JUMPER SHORTING GOLD FLASH</td>
<td>Sullins Electronics Corp.</td>
<td>SPC02SYAN</td>
</tr>
<tr>
<td>1</td>
<td>PCB</td>
<td>RoHS Compliant Bare PCB, MCP4725 SOT23-6 Eval Board</td>
<td>—</td>
<td>104-000149</td>
</tr>
<tr>
<td>2</td>
<td>R1,R3</td>
<td>RES 4.99K OHM 1/8W 1% 0805 SMD</td>
<td>Panasonic® - ECG</td>
<td>ERJ-6ENF4991V</td>
</tr>
<tr>
<td>2</td>
<td>R2,R4</td>
<td>Not Populated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>U1</td>
<td>MCP4725_SOT-23-6</td>
<td>Microchip Technology Inc.</td>
<td>MCP4725_SOT-23-6</td>
</tr>
</tbody>
</table>

**Note 1:** The components listed in this Bill of Materials are representative of the PCB assembly. The released BOM used in manufacturing uses all RoHS-compliant components.
Microchip:
MCP4725EV