# MCP9700 Temperature-to-Voltage Converter PICtail™ Demo 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 copyrighted work, you may have a right to sue for relief under that Act.



**Trademarks**



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 Mountain View, California. The Company's quality system processes and procedures are for its PICmicro® 8-bit MCUs, 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.*

# MCP9700 PICtail™ DEMO BOARD USER'S GUIDE

## Table of Contents

**NOTES:**

# MCP9700 PICtail™ DEMO 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 "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 MCP9700 Temperature-to-Voltage Converter PICtail™ Demo 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 MCP9700 Temperature-to-Voltage Converter PICtail™ Demo Board. The manual layout is as follows:

- **Chapter 1. "Product Overview"** – Important information about the MCP9700 Temperature-to-Voltage Converter PICtail™ Demo Board.
- **Chapter 2. "Installation and Operation"** – This chapter includes instructions on how to get started, with a detailed description of each of the board's functions.
- **Appendix A. "Schematic and Layouts"** – Shows the schematic and layout diagrams for the MCP9700 Temperature-to-Voltage Converter PICtail™ Demo Board.
- **Appendix B. "Bill Of Materials (BOM)"** – Lists the parts used to build the MCP9700 Temperature-to-Voltage Converter PICtail™ Demo 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 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 |
| 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> |
| **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 the MCP9700 Temperature-to-Voltage Converter PICtail™ Demo Board. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

**MCP9700 Data Sheet, *"Low-Power Linear Active Thermistor ICs"* (DS21942)**

This data sheet provides detailed information regarding the MCP9700 device.

## 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
- Development Systems Information Line

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 B (March 2006)

- Updated Bill of Materials (BOM) to show RoHS-compliant part numbers.

### Revision A (March 2005)

- Initial Release of this Document.

**NOTES:**

# Chapter 1. Product Overview

## 1.1 INTRODUCTION

This chapter provides an overview of the MCP9700 Temperature-to-Voltage Converter PICtail™ Demo Board and covers the following topics:

- What is the MCP9700 Temperature-to-Voltage Converter PICtail™ Demo Board?
- What the MCP9700 Temperature-to-Voltage Converter PICtail™ Demo Board Kit includes

## 1.2 WHAT IS THE MCP9700 TEMPERATURE-TO-VOLTAGE CONVERTER PICtail™ DEMO BOARD?

The MCP9700 Temperature-to-Voltage Converter PICtail™ Demo Board demonstrates how to interface the MCP9700 to a PICmicro® microcontroller using the PICkit™ 1 Flash Starter Kit as a platform. A PIC16F676 14-pin, Flash-based, 8-bit CMOS microcontoller device is included with the demo board that can be used with the PICkit 1 Flash Starter Kit, along with firmware that provides the interface to the MCP9700 Temperature-to-Voltage Converter PICtail™ Demo Board and the voltage-to-temperature conversion routines.

The MCP9700 Temperature-to-Voltage Converter PICtail™ Demo Board can also be used as a "stand-alone" module to quickly add thermal sensing capablity to any existing application. This basic sensor functionality is implemented on a small Printed Circuit Board (PCB) and an interface via a standard 100 mil header.

## 1.3 WHAT THE MCP9700 TEMPERATURE-TO-VOLTAGE CONVERTER PICtail™ DEMO BOARD KIT INCLUDES

This MCP9700 Temperature-to-Voltage Converter PICtail™ Demo Board Kit includes:

- The MCP9700 Temperature-to-Voltage Converter PICtail™ Demo Board
- MCP9700 Temperature-to-Voltage Converter PICtail™ Demo Board User's Guide (DS51542)
- AN981, *"Interfacing a MCP9700 Analog Output Temperature Sensor to a PICmicro® Microcontroller"* (DS00981)
- PIC16F676 14-pin, Flash-based, 8-bit CMOS Microcontroller
- PIC16F676 Firmware (`00059R1.HEX`)

**NOTES:**

# Chapter 2. Installation and Operation

## 2.1 INTRODUCTION

The MCP9700 Temperature-to-Voltage Converter PICtail™ Demo Board demonstrates how to interface the MCP9700 to a microcontroller for use by the system designer as an example of how to integrate an analog temperature sensor into their system.

## 2.2 FEATURES

The MCP9700 Temperature-to-Voltage Converter PICtail™ Demo Board has the following features:

- Small PCB layout
- Standard 100 mil 14-pin header (P1) for easy interface to PICkit 1 Flash Starter Kit or custom application

## 2.3 GETTING STARTED

This section describes how to quickly set up the MCP9700 Temperature-to-Voltage Converter PICtail™ Demo Board and PICkit 1 Flash Starter Kit. A block diagram of the setup is presented in Figure 2-1. Refer to AN981, "Interfacing a MCP9700 Analog Output Temperature Sensor to a PICmicro® Microcontroller" (DS00981), for detailed information on the MCP9700 Temperature-to-Voltage Converter PICtail™ Demo Board and the `00059R1.HEX` firmware.

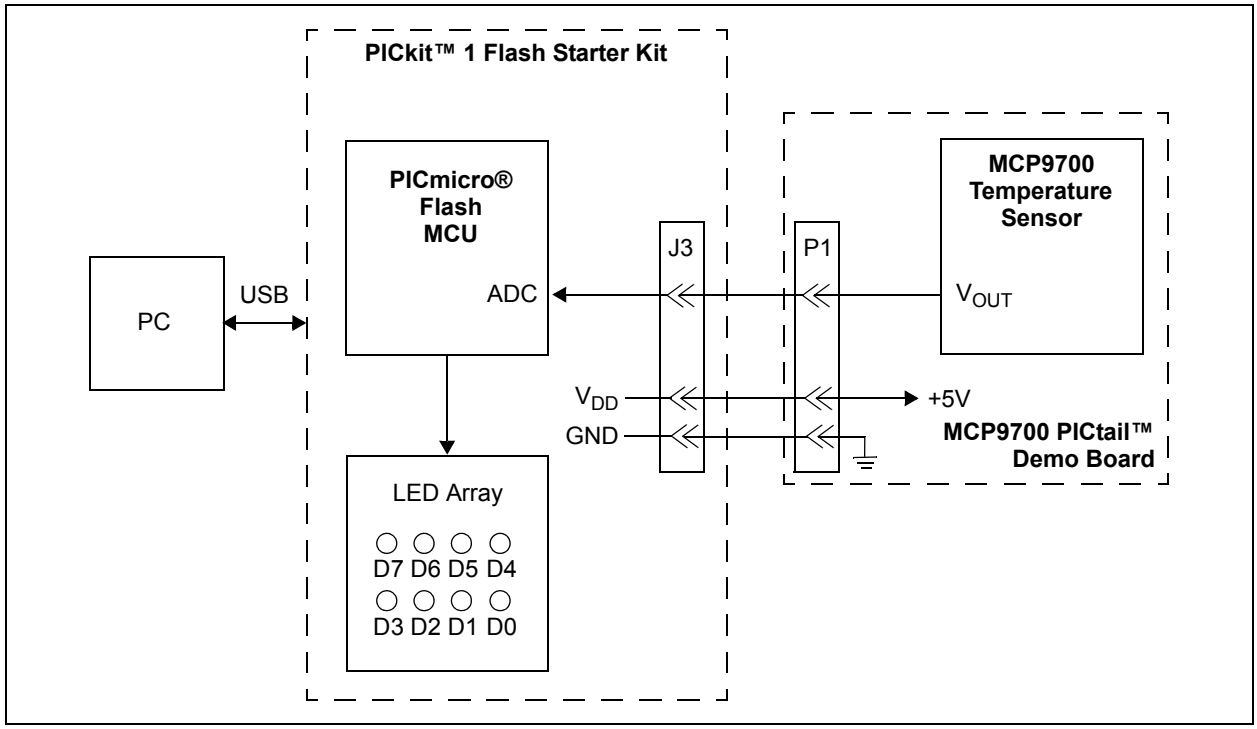



***FIGURE 2-1:*** *MCP9700 Temperature-to-Voltage Converter PICtail™ Demo Board Block Diagram.*

### 2.3.1 Hardware Setup

1. Connect the P1 header of the MCP9700 Temperature-to-Voltage Converter PICtail™ Demo Board to the J3 connector on the PICkit 1 Flash Starter Kit board. Refer to Figure 2-2 for proper orientation of the MCP9700 Temperature-to-Voltage Converter PICtail™ Demo Board and Figure 2-3 for the simplified board schematic.
2. Insert the PIC16F676 into the evaluation socket of the PICkit 1 Flash Starter Kit board.
3. Connect the PICkit 1 Flash Starter Kit USB cable from the USB port of the PC to the USB port (J1) on the PICkit 1 Flash Starter Kit board. +5V power is supplied to the PICkit 1 Flash Starter Kit board via the USB cable. The green **POWER** LED and the red **BUSY** LED will turn on, indicating that power is being supplied to the board.

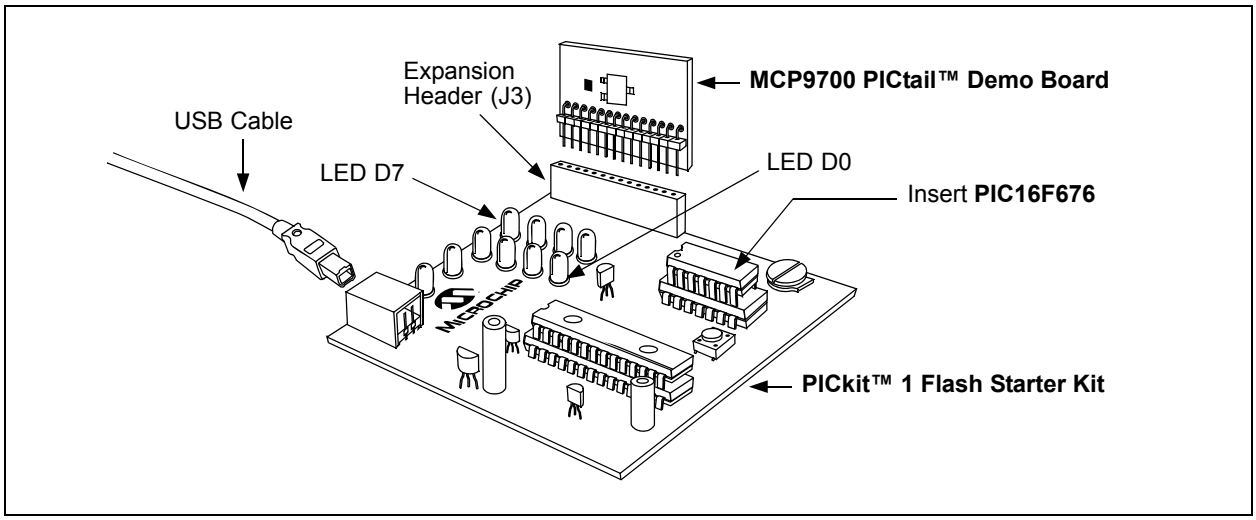



***FIGURE 2-2:*** *MCP9700 PICtail™ Demo Board and PICkit™ 1 Flash Starter Kit.*

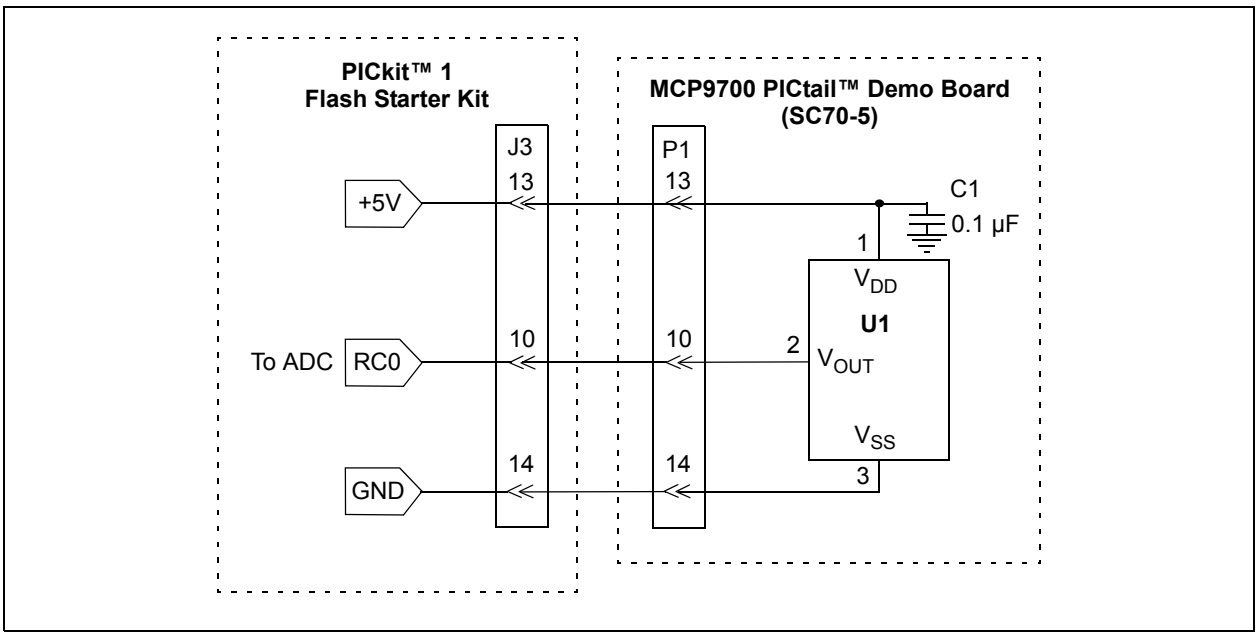



***FIGURE 2-3:*** *Simplified MCP9700 PICtail™ Demo Board Schematic.*

### 2.3.2 Programming the PIC16F676

1. Download and install the PICkit 1 Flash Starter Kit software to your PC.
2. Copy the `00059R1.HEX` file supplied on the CD that came with this kit to your PC.
3. Once the PICkit 1 Flash Starter Kit is started, the main window will be displayed on the PC, as indicated in Figure 2-4.

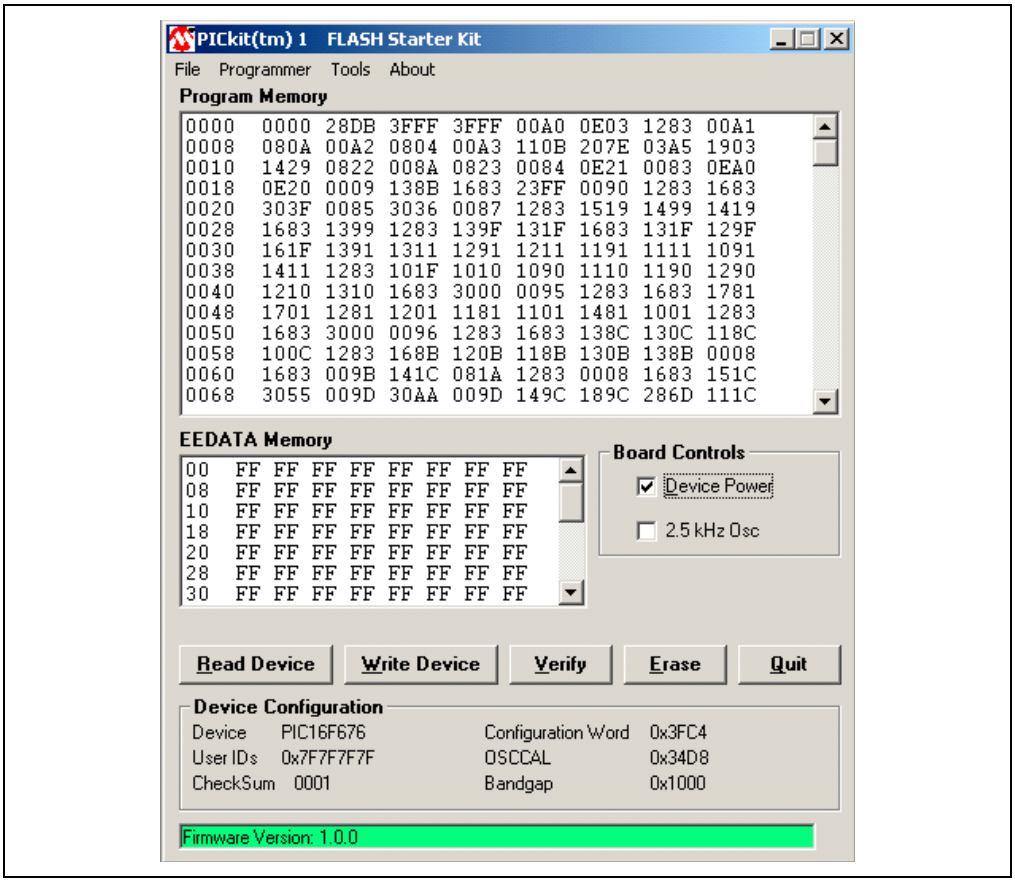



***FIGURE 2-4:*** *PICkit™ 1 Flash Starter Kit GUI Window on the PC.*

4. Toggle device power to off by unchecking the **Device Power** box under **Board Controls** in the PICkit 1 Flash Starter Kit window (Figure 2-4). The **BUSY** LED on the PICkit 1 Flash Starter Kit board will turn off once the device power is turned off.
5. Click on the **Erase** button in the window to ensure that the PIC16F676 device has been erased.
6. From the **File** pull down menu, select **Import HEX**. A file window will appear. Select and open "**00059R1.HEX**".
7. Click on the **Write Device** button in the PICkit 1 Flash Starter Kit window. The PIC16F676 device will be written to with the `00059R1.HEX` firmware. When completed, the status bar at the bottom of the window will indicate **Write Successful**.
8. Toggle the device power on by checking the **Device Power** box under **Board Controls** in the PICkit 1 Flash Starter Kit window. The **BUSY** LED on the PICkit 1 Flash Starter Kit board will turn on once the device power is turned on. Some of the red LEDs (D7-D0) will turn on as well.

At this point, the PIC16F676 is reading the temperature data from the MCP9700 and displaying the temperature on the eight red LEDs (D7-D0) on the PICkit 1 Flash Starter Kit board. The ten's digit of the temperature data is represented by bits D7-D4, with D7 being defined as the Most Significant bit (MSb). The one's digit is defined by bits D3-D0, with D3 serving as the MSb.

The temperature can be displayed in degrees Celsius or Fahrenheit. The board defaults to the temperature being displayed in Celsius. To display the temperature in Fahrenheit, press the **SW1** push button switch on the PICkit 1 Flash Starter Kit board. The display will change back to Celsius once the **SW1** push button switch is released.

Table 2-1 provides a list of the LED patterns that correspond to the Binary Code Decimal (BCD) coding representation of the temperature measurement.

**TABLE 2-1: BCD CODE REPRESENTATION ON PICkit™ 1 FLASH STARTER KIT LEDS**

| Binary | BCD Number | D7 D3 | D6 D2 | D5 D1 | D4 D0 |
|---|---|---|---|---|---|
| 0000 | 0 | OFF | OFF | OFF | OFF |
| 0001 | 1 | OFF | OFF | OFF | ON |
| 0010 | 2 | OFF | OFF | ON | OFF |
| 0011 | 3 | OFF | OFF | ON | ON |
| 0100 | 4 | OFF | ON | OFF | OFF |
| 0101 | 5 | OFF | ON | OFF | ON |
| 0110 | 6 | OFF | ON | ON | OFF |
| 0111 | 7 | OFF | ON | ON | ON |
| 1000 | 8 | ON | OFF | OFF | OFF |
| 1001 | 9 | ON | OFF | OFF | ON |

For example, a temperature reading of 75°F will be displayed by turning on LEDs D6, D5, D4, D2 and D0 (LEDs D7, D3 and D1 will be turned off), as indicated in Figure 2-5.

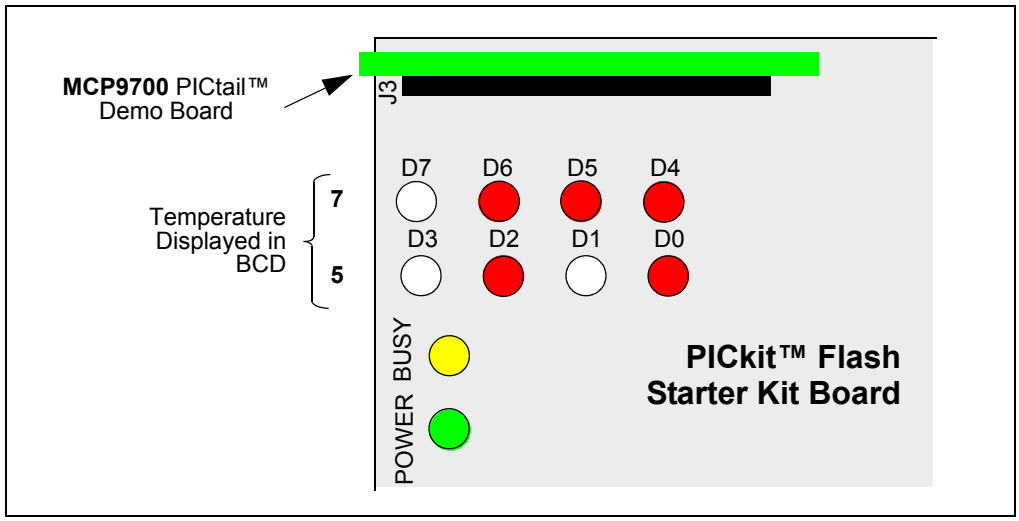



***FIGURE 2-5:*** *PICkit™ 1 Flash Starter Kit LED Display of 75°F.*

The temperature display will change when the temperature of the MCP9700 is varied. A simple example of this can be seen by pressing your finger on the MCP9700 device (U1) mounted on the MCP9700 Temperature-to-Voltage Converter PICtail™ Demo Board. More dramatic changes can be seen by applying heat to the MCP9700 with a hair dryer, hot air gun or by cooling the device down.

Refer to the MCP9700 data sheet, *"Low-Power Linear Active Thermistor ICs"*, (DS21942) for more information on the MCP9700 and AN981, *"Interfacing a MCP9700 Analog Output Temperature Sensor to a PICmicro® Microcontroller"* (DS00981) for more information on the MCP9700 Temperature-to-Voltage Converter PICtail™ Demo Board and `00059R1.HEX` firmware.

**NOTES:**

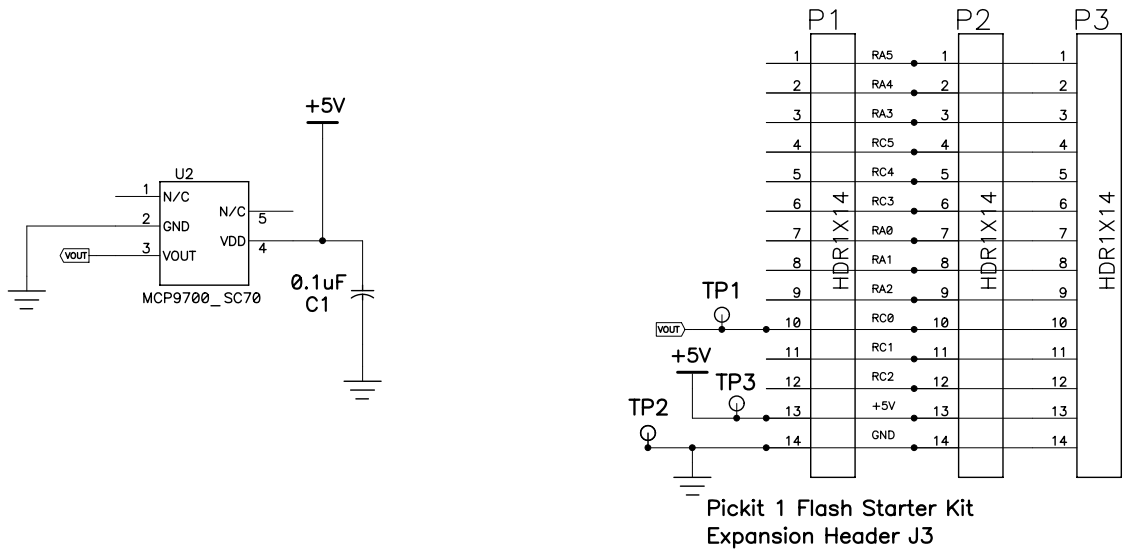
# Appendix A. Schematic and Layouts

## A.1 INTRODUCTION

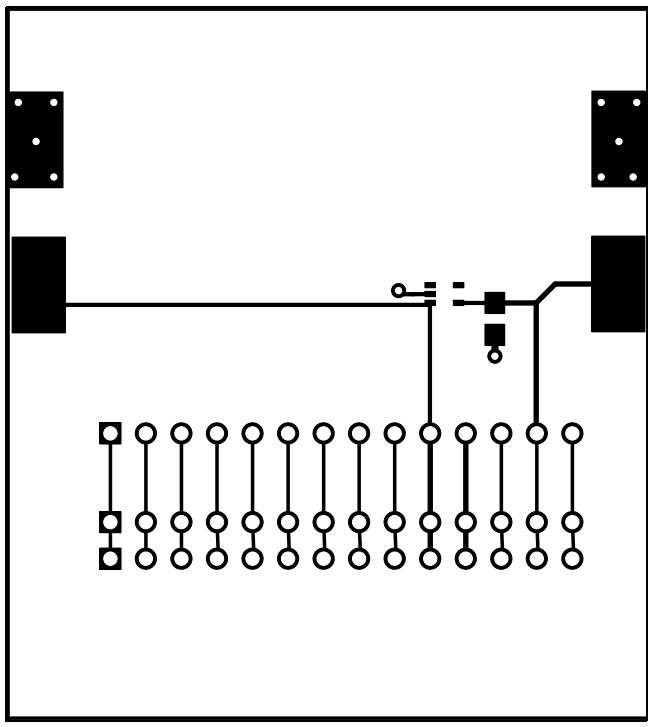
This appendix contains the following schematics and layouts for the MCP9700 Temperature-to-Voltage Converter PICtail Demo Board:

- Board Schematic
- Board – Top Layer
- Board – Silk Screen Layer
- Board – Bottom Layer

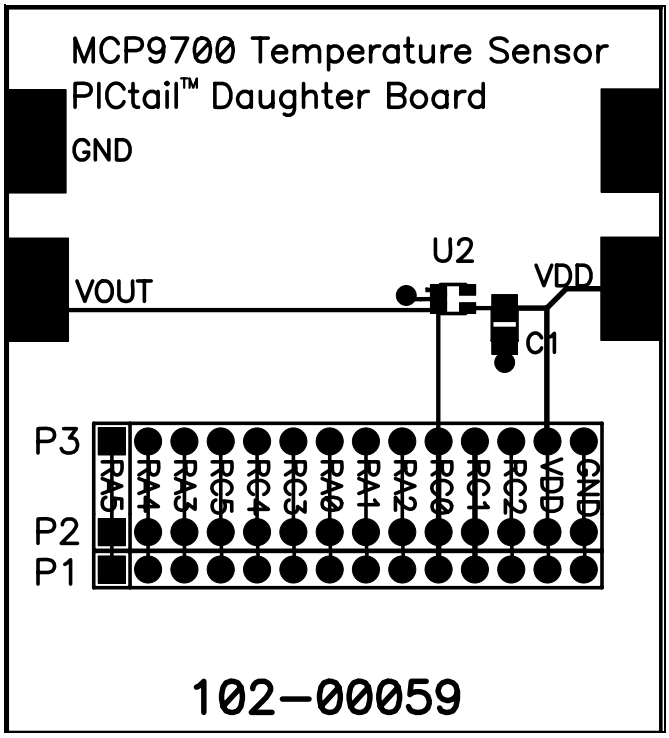
## A.2 BOARD SCHEMATIC




## A.3 BOARD – TOP LAYER



## A.4 BOARD – SILK SCREEN LAYER




## A.5 BOARD – BOTTOM LAYER

**NOTES:**

# Appendix B. Bill Of Materials (BOM)

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

| Qty | Reference | Description | Manufacturer | Part Number |
|---|---|---|---|---|
| 1 | C1 | CAP .1UF 25V CERAMIC X7R 0805 | Panasonic® - ECG | ECJ-2VB1E104K |
| 1 | P1 | HDR 1X14 CONN HEADER 14POS .100 VERT TIN<br>* Note Installation on Bottom Side | Molex®/Waldom® Electronics | 22-28-4140 |
| 2 | P2, P3, | Header, single pin (unpopulated) | N/A | N/A |
| 4 | $V_{DD}$, $V_{OUT}$& GNDs | **"UNPOPULATED"** PC TEST POINT COMPACT SMT | Keystone Electronics® | 5016 |
| 1 | U2 | MCP9700 Tiny Analog Temperature Sensor | Microchip Technology, Inc. | MCP9700T-E/LT |

# WORLDWIDE SALES AND SERVICE

## AMERICAS

**Corporate Office**
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200
Fax: 480-792-7277
Technical Support:
http://support.microchip.com
Web Address:
www.microchip.com

**Atlanta**
Alpharetta, GA
Tel: 770-640-0034
Fax: 770-640-0307

**Boston**
Westborough, MA
Tel: 774-760-0087
Fax: 774-760-0088

**Chicago**
Itasca, IL
Tel: 630-285-0071
Fax: 630-285-0075

**Dallas**
Addison, TX
Tel: 972-818-7423
Fax: 972-818-2924

**Detroit**
Farmington Hills, MI
Tel: 248-538-2250
Fax: 248-538-2260

**Kokomo**
Kokomo, IN
Tel: 765-864-8360
Fax: 765-864-8387

**Los Angeles**
Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608

**San Jose**
Mountain View, CA
Tel: 650-215-1444
Fax: 650-961-0286

**Toronto**
Mississauga, Ontario,
Canada
Tel: 905-673-0699
Fax: 905-673-6509

## ASIA/PACIFIC

**Australia - Sydney**
Tel: 61-2-9868-6733
Fax: 61-2-9868-6755

**China - Beijing**
Tel: 86-10-8528-2100
Fax: 86-10-8528-2104

**China - Chengdu**
Tel: 86-28-8676-6200
Fax: 86-28-8676-6599

**China - Fuzhou**
Tel: 86-591-8750-3506
Fax: 86-591-8750-3521

**China - Hong Kong SAR**
Tel: 852-2401-1200
Fax: 852-2401-3431

**China - Qingdao**
Tel: 86-532-8502-7355
Fax: 86-532-8502-7205

**China - Shanghai**
Tel: 86-21-5407-5533
Fax: 86-21-5407-5066

**China - Shenyang**
Tel: 86-24-2334-2829
Fax: 86-24-2334-2393

**China - Shenzhen**
Tel: 86-755-8203-2660
Fax: 86-755-8203-1760

**China - Shunde**
Tel: 86-757-2839-5507
Fax: 86-757-2839-5571

**China - Wuhan**
Tel: 86-27-5980-5300
Fax: 86-27-5980-5118

**China - Xian**
Tel: 86-29-8833-7250
Fax: 86-29-8833-7256

## ASIA/PACIFIC

**India - Bangalore**
Tel: 91-80-4182-8400
Fax: 91-80-4182-8422

**India - New Delhi**
Tel: 91-11-5160-8631
Fax: 91-11-5160-8632

**India - Pune**
Tel: 91-20-2566-1512
Fax: 91-20-2566-1513

**Japan - Yokohama**
Tel: 81-45-471- 6166
Fax: 81-45-471-6122

**Korea - Gumi**
Tel: 82-54-473-4301
Fax: 82-54-473-4302

**Korea - Seoul**
Tel: 82-2-554-7200
Fax: 82-2-558-5932 or
82-2-558-5934

**Malaysia - Penang**
Tel: 60-4-646-8870
Fax: 60-4-646-5086

**Philippines - Manila**
Tel: 63-2-634-9065
Fax: 63-2-634-9069

**Singapore**
Tel: 65-6334-8870
Fax: 65-6334-8850

**Taiwan - Hsin Chu**
Tel: 886-3-572-9526
Fax: 886-3-572-6459

**Taiwan - Kaohsiung**
Tel: 886-7-536-4818
Fax: 886-7-536-4803

**Taiwan - Taipei**
Tel: 886-2-2500-6610
Fax: 886-2-2508-0102

**Thailand - Bangkok**
Tel: 66-2-694-1351
Fax: 66-2-694-1350

## EUROPE

**Austria - Wels**
Tel: 43-7242-2244-399
Fax: 43-7242-2244-393

**Denmark - Copenhagen**
Tel: 45-4450-2828
Fax: 45-4485-2829

**France - Paris**
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

**Germany - Munich**
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

**Italy - Milan**
Tel: 39-0331-742611
Fax: 39-0331-466781

**Netherlands - Drunen**
Tel: 31-416-690399
Fax: 31-416-690340

**Spain - Madrid**
Tel: 34-91-708-08-90
Fax: 34-91-708-08-91

**UK - Wokingham**
Tel: 44-118-921-5869
Fax: 44-118-921-5820

02/16/06

Общество с ограниченной ответственностью «МосЧип» ИНН 7719860671 / КПП 771901001
Адрес: 105318, г.Москва, ул.Щербаковская д.3, офис 1107

**Данный компонент на территории Российской Федерации**

**Вы можете приобрести в компании MosChip.**

Для оперативного оформления запроса Вам необходимо перейти по данной ссылке:

http://moschip.ru/get-element

Вы можете разместить у нас заказ для любого Вашего проекта, будь то серийное производство или разработка единичного прибора.

В нашем ассортименте представлены ведущие мировые производители активных и пассивных электронных компонентов.

Нашей специализацией является поставка электронной компонентной базы двойного назначения, продукции таких производителей как XILINX, Intel (ex.ALTERA), Vicor, Microchip, Texas Instruments, Analog Devices, Mini-Circuits, Amphenol, Glenair.

Сотрудничество с глобальными дистрибьюторами электронных компонентов, предоставляет возможность заказывать и получать с международных складов практически любой перечень компонентов в оптимальные для Вас сроки.

На всех этапах разработки и производства наши партнеры могут получить квалифицированную поддержку опытных инженеров.

Система менеджмента качества компании отвечает требованиям в соответствии с ГОСТ Р ИСО 9001, ГОСТ РВ 0015-002 и ЭС РД 009

**Офис по работе с юридическими лицами:**

105318, г.Москва, ул.Щербаковская д.3, офис 1107, 1118, ДЦ «Щербаковский»

Телефон: +7 495 668-12-70 (многоканальный)

Факс: +7 495 668-12-70 (доб.304)

E-mail: info@moschip.ru

Skype отдела продаж:
moschip.ru
moschip.ru_4
moschip.ru_6
moschip.ru_9