# MCP9700 Temperature-to-Voltage Converter PICtail™ Demo Board User's Guide

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# MCP9700 PICtail™ DEMO BOARD USER'S GUIDE

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# 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.


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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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- Technical Support
- Development Systems Information Line

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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:**


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# 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:**


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# 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.

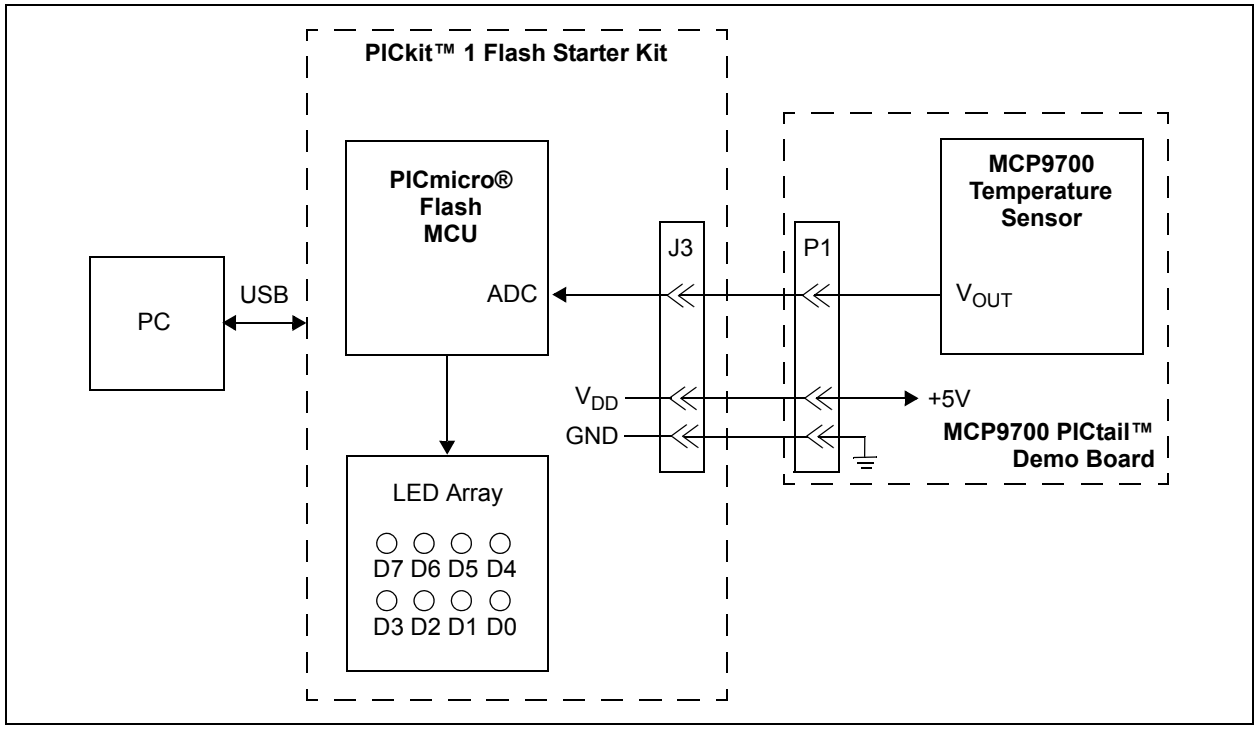


***FIGURE 2-1:*** *MCP9700 Temperature-to-Voltage Converter PICtail™ Demo Board Block Diagram.*

### 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.

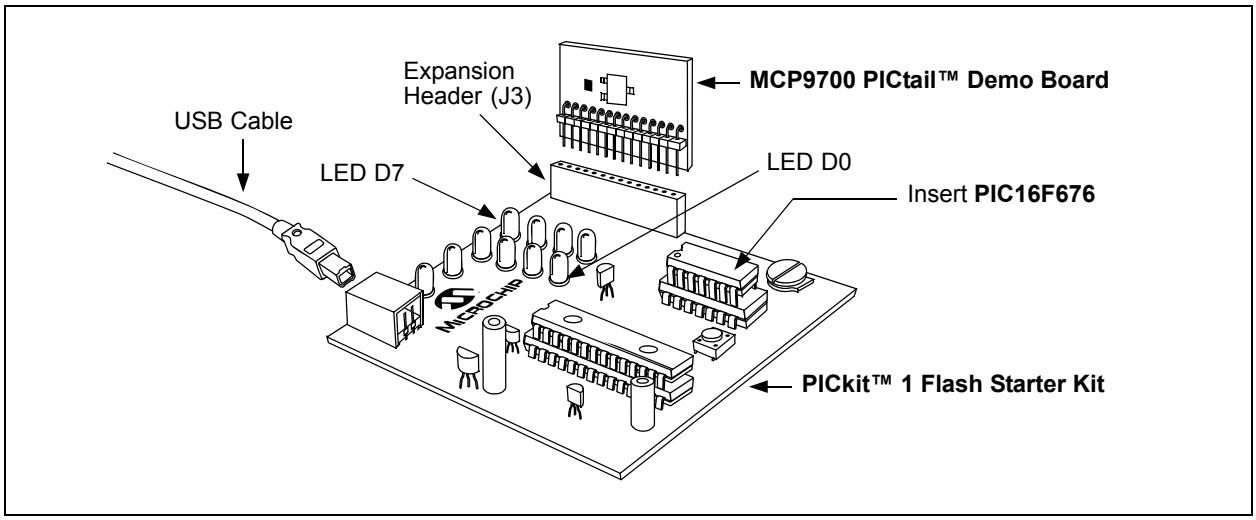


***FIGURE 2-2:*** *MCP9700 PICtail™ Demo Board and PICkit™ 1 Flash Starter Kit.*

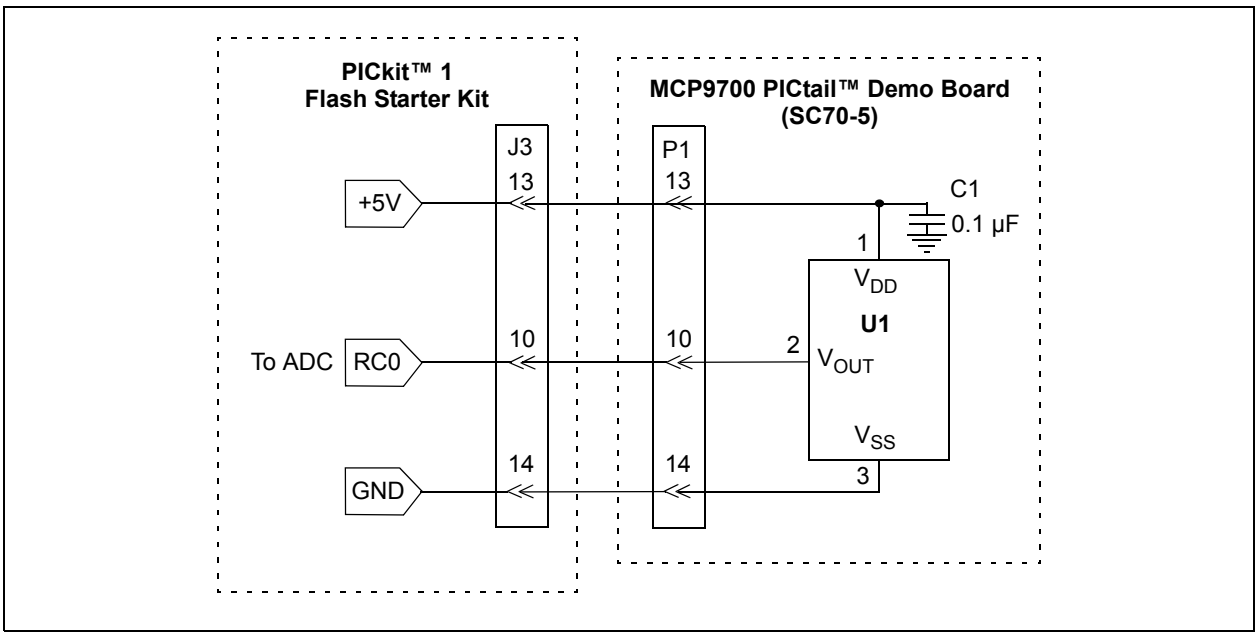


***FIGURE 2-3:*** *Simplified MCP9700 PICtail™ Demo Board Schematic.*


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### 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.

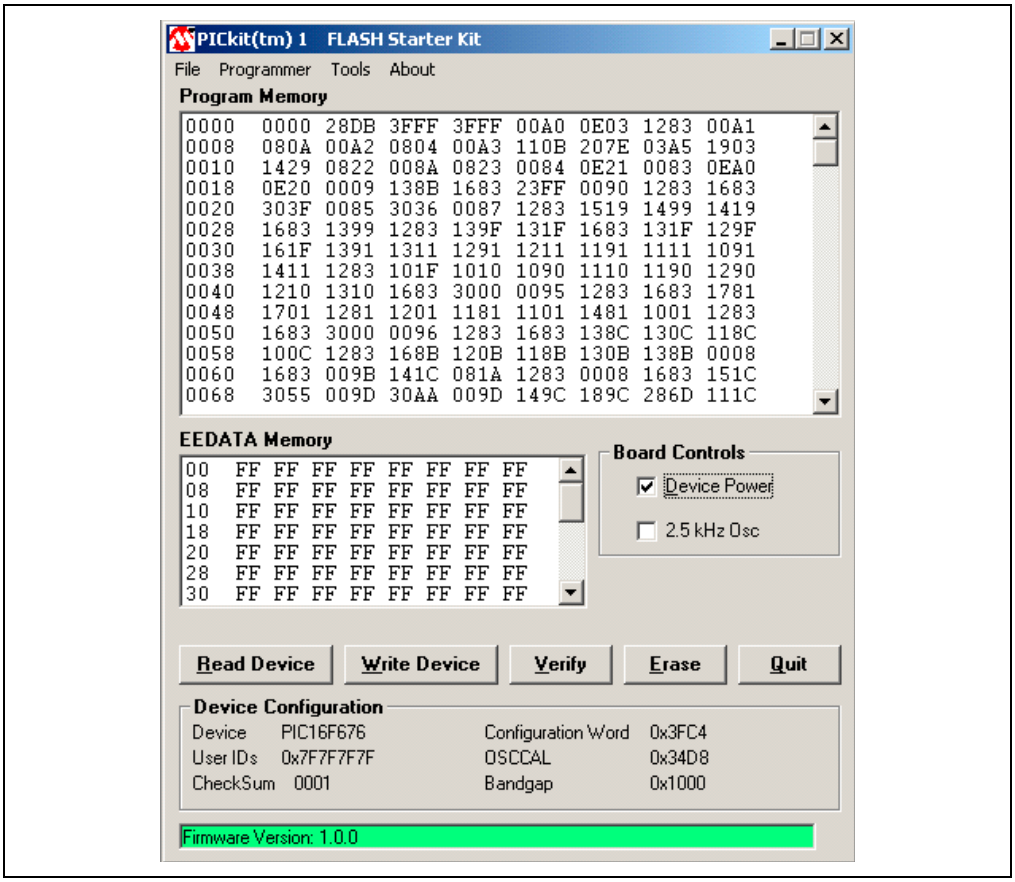


***FIGURE 2-4:*** *PICkit™ 1 Flash Starter Kit GUI Window on the PC.*

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.


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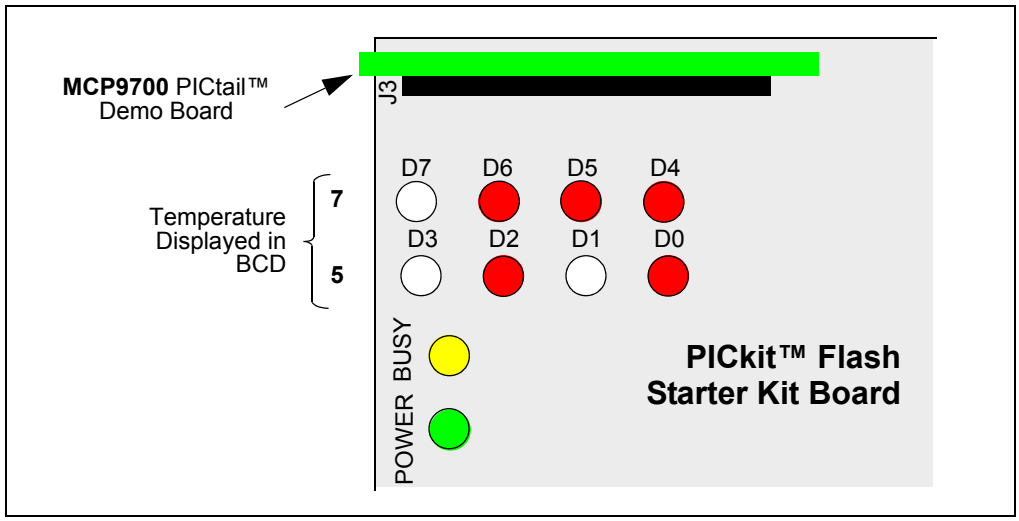


***FIGURE 2-5:*** *PICkit™ 1 Flash Starter Kit LED Display of 75°F.*

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:**


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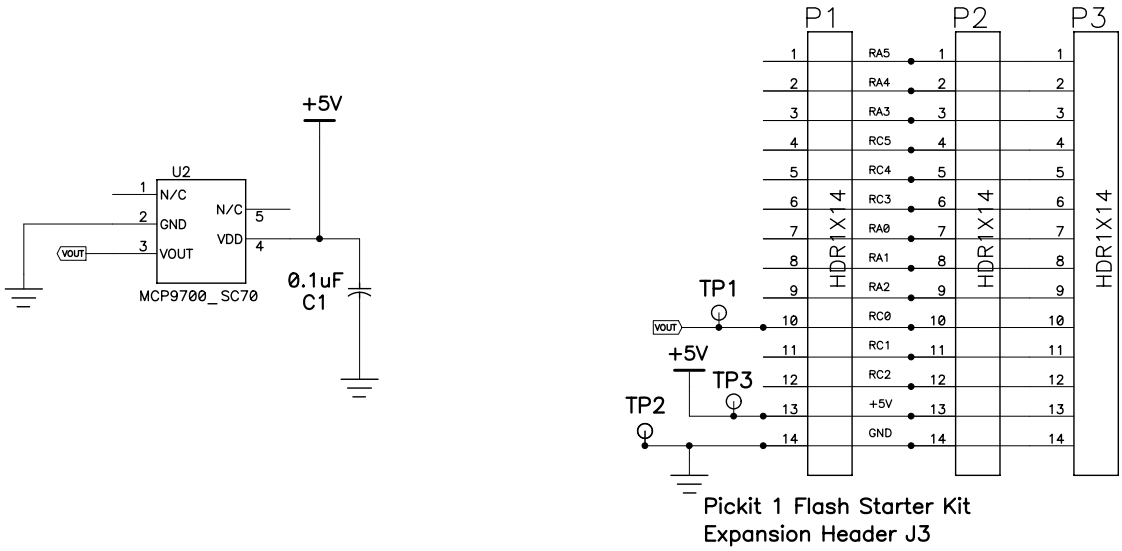
# Appendix A. Schematic and Layouts

## A.1 INTRODUCTION

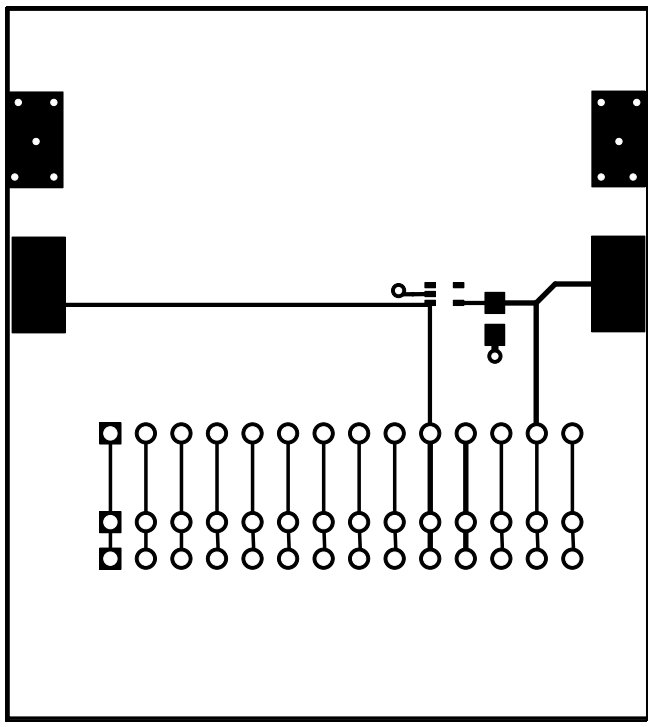
This appendix contains the following schematics and layouts for the MCP9700 Temperature-to-Voltage Converter PICtail Demo Board:

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

## A.2 BOARD SCHEMATIC




## A.3 BOARD – TOP LAYER

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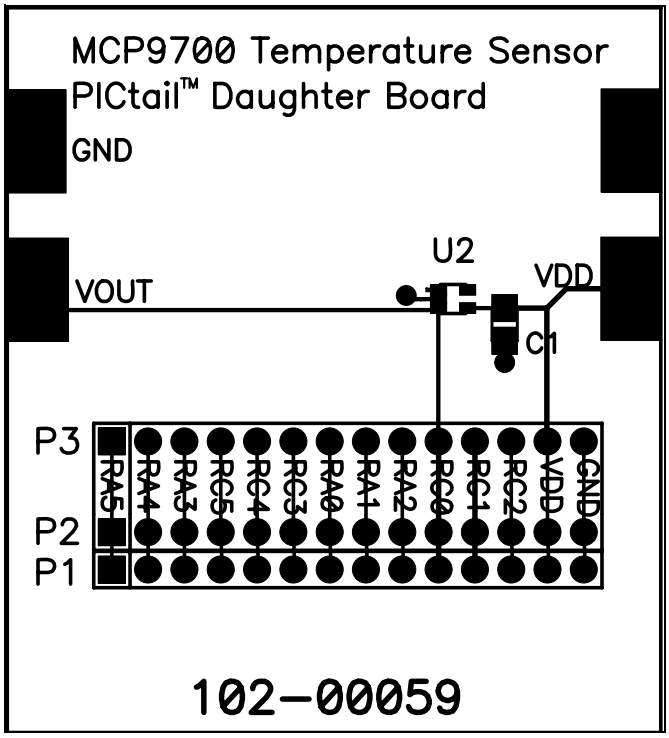
## A.4 BOARD – SILK SCREEN LAYER




## A.5 BOARD – BOTTOM LAYER

**NOTES:**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# 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 |

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# OCEAN CHIPS
## Океан Электроники
## Поставка электронных компонентов

Компания «Океан Электроники» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Поставка оригинальных импортных электронных компонентов напрямую с производств Америки, Европы и Азии, а так же с крупнейших складов мира;
- Широкая линейка поставок активных и пассивных импортных электронных компонентов (более 30 млн. наименований);
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Помощь Конструкторского Отдела и консультации квалифицированных инженеров;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Поставка электронных компонентов под контролем ВП;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Компания «Океан Электроники» является официальным дистрибьютором и эксклюзивным представителем в России одного из крупнейших производителей разъемов военного и аэрокосмического назначения «**JONHON**», а так же официальным дистрибьютором и эксклюзивным представителем в России производителя высокотехнологичных и надежных решений для передачи СВЧ сигналов «**FORSTAR**».

AVIC JONHON

**«JONHON»** (основан в 1970 г.)

Разъемы специального, военного и аэрокосмического назначения:

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ВЧ соединители, коаксиальные кабели, кабельные сборки и микроволновые компоненты:

(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).

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