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# **TC1047A Temperature-to-Voltage Converter PICtail™ Demo Board User's Guide**

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# TC1047A TEMPERATURE-TO-VOLTAGE CONVERTER PICtail™ DEMO 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](http://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 “XXXX” 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 TC1047A 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 TC1047A Temperature-to-Voltage Converter PICtail™ Demo Board as a development tool. The manual layout is as follows:

- **Chapter 1. “Product Overview”** – Important information about the TC1047A 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 TC1047A Temperature-to-Voltage Converter PICtail™ Demo Board.
- **Appendix B. “Bill Of Materials (BOM)”** – Lists the parts used to build the TC1047A Temperature-to-Voltage Converter PICtail™ Demo Board.

## CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

### DOCUMENTATION CONVENTIONS

| Description                                      | Represents  | Examples  |
|--|---|---|
| <b>Arial font:</b>                               |   |   |
| Italic characters                                | Referenced books  | <i>MPLAB® IDE User's Guide</i>                              |
|  | Emphasized text   | ...is the <i>only</i> 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   | <u><i>File&gt;Save</i></u>                                  |
| Bold characters                                  | A dialog button   | Click <b>OK</b>   |
|  | A tab   | Click the <b>Power</b> 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>   |
| <b>Courier New font:</b>                         |   |   |
| 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   | <i>file.o</i> , where <i>file</i> can be any valid filename |
| Square brackets [ ]                              | Optional arguments  | mcc18 [options] <i>file</i> [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)<br>{ ...<br>}                              |

## RECOMMENDED READING

This user's guide describes how to use TC1047A Temperature-to-Voltage Converter PICtail™ Demo Board. The following Microchip documents are available and recommended as supplemental reference resources.

### **TC1047A Data Sheet, "Precision Temperature-to-Voltage Converter" (DS21498)**

This data sheet provides detailed information regarding the TC1047A device.

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

## DOCUMENT REVISION HISTORY

### Revision B (July 2006)

- Add disclaimer to Bill of Materials regarding RoHS-Compliant part numbers.

### Revision A (June 2004)

- Initial Release of this Document.

NOTES:





# TC1047A TEMPERATURE-TO-VOLTAGE CONVERTER PICtail™ DEMO BOARD USER'S GUIDE

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## Chapter 1. Product Overview

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### 1.1 INTRODUCTION

This chapter provides an overview of the TC1047A Temperature-to-Voltage Converter PICtail™ Demo Board, and covers the following topics:

- What is the TC1047A Temperature-to-Voltage Converter PICtail™ Demo Board?
- What the TC1047A Temperature-to-Voltage Converter PICtail™ Demo Board Kit includes

### 1.2 WHAT IS THE TC1047A TEMPERATURE-TO-VOLTAGE CONVERTER PICKIT™ DEMO BOARD?

The TC1047A Temperature-to-Voltage Converter PICtail™ Demo Board demonstrates how to interface the TC1047A to a PICmicro® microcontroller using the PICKit™ 1 Flash Starter Kit as a platform. A PIC16F676 14-pin Flash-based 8-bit CMOS microcontroller device is included with the Demo Board that can be used with PICKit 1 Flash Starter Kit, along with firmware that provides the interface to the TC1047A and the voltage-to-temperature conversion routines.

The TC1047A Temperature-to-Voltage Converter PICtail™ Demo Board can also be used as a “stand-alone” module to quickly add thermal sensing capability 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 TC1047A TEMPERATURE-TO-VOLTAGE CONVERTER PICTAIL™ DEMO BOARD KIT INCLUDES

This TC1047A Temperature-to-Voltage Converter PICtail™ Demo Board Kit includes:

- The TC1047A Temperature-to-Voltage Converter PICtail™ Demo Board
- TC1047A Temperature-to-Voltage Converter PICtail™ Demo Board User's Guide (DS51483)
- AN938, “Interfacing a TC1047A Analog Output Temperature Sensor to a PICmicro Microcontroller”, DS00938
- PIC16F676 14-pin Flash-based 8-bit CMOS Microcontroller
- PIC16F676 Firmware (TC1047A PICtail.HEX)

NOTES:

## Chapter 2. Installation and Operation

### 2.1 INTRODUCTION

The TC1047A Temperature-to-Voltage Converter PICtail™ Demo Board demonstrates how to interface the TC1047A device to a microcontroller for use by the system designer as an example of how to integrate an analog temperature sensor into their system.

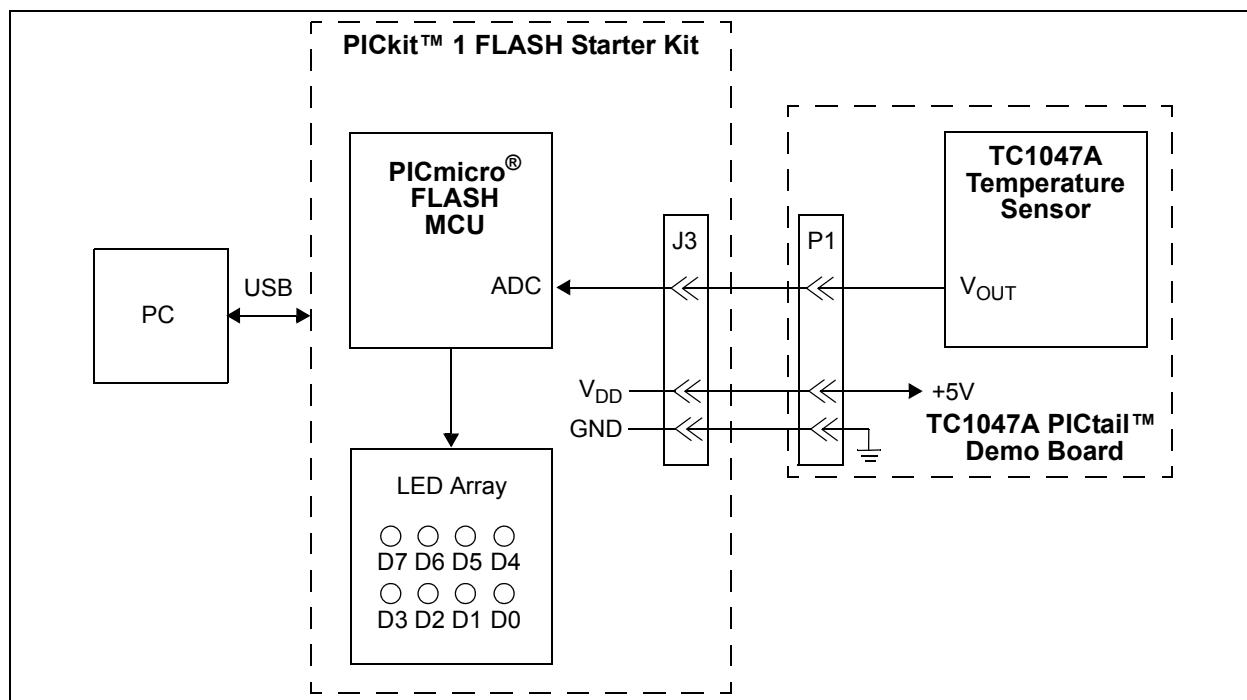
### 2.2 FEATURES

The TC1047A 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

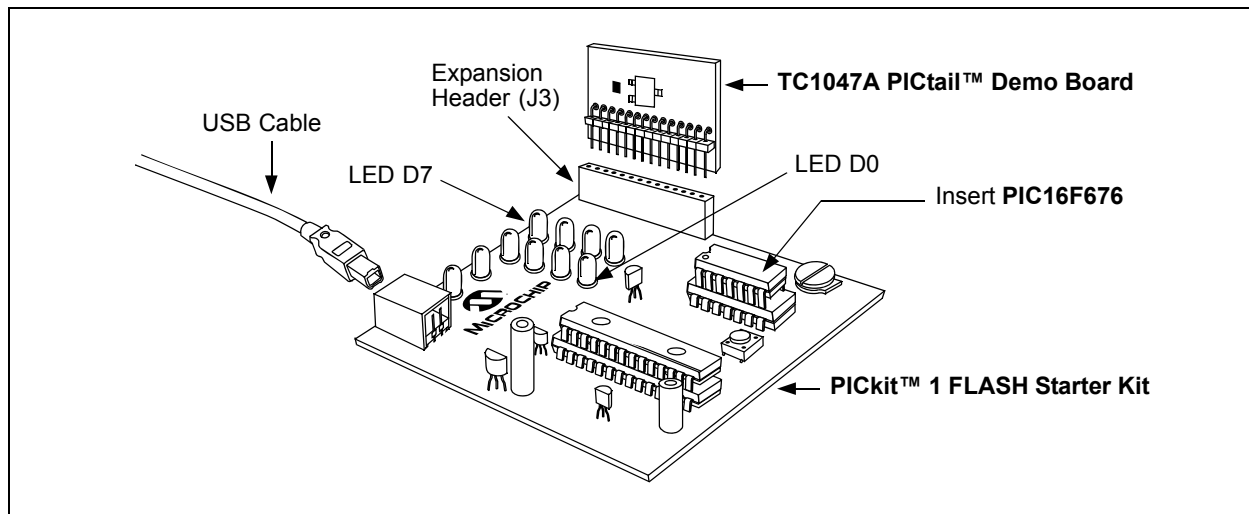
This section describes how to quickly set up the TC1047A Temperature-to-Voltage Converter PICtail™ Demo Board and PICkit 1 Flash Starter Kit. A block diagram of the setup is presented in Figure 2-1. Refer to Application Note 938, “Interfacing a TC1047A Analog Output Temperature Sensor to a PICmicro® Microcontroller” (DS00938), for detailed information on the TC1047A Temperature-to-Voltage Converter PICtail™ Demo Board and the TC1047A PICtail.HEX firmware.



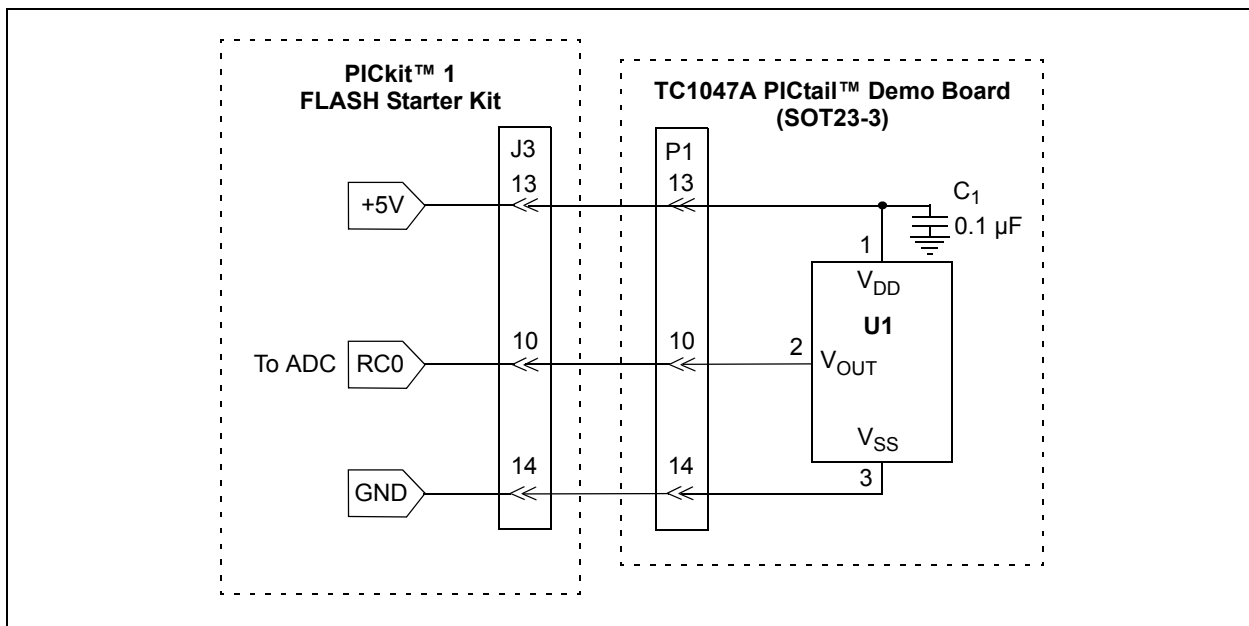
**FIGURE 2-1:** TC1047A Temperature-to-Voltage Converter PICtail™ Demo Board Block Diagram.

## 2.3.1 Hardware Setup

1. Connect the P1 header of the TC1047A 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 TC1047A 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.



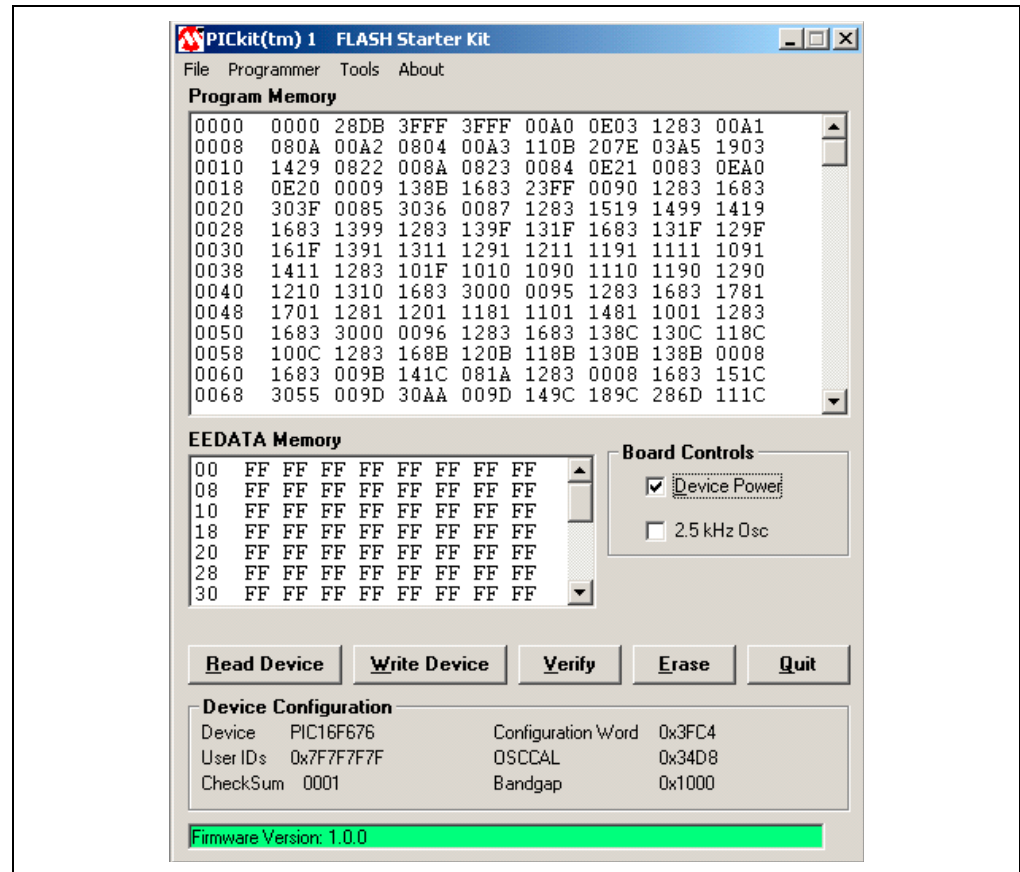
**FIGURE 2-2:** TC1047A PICtail™ Daughter Board and PICKit™ 1 Flash Starter Kit.



**FIGURE 2-3:** Simplified TC1047A PICtail™ Daughter 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 TC1047A PICtail.HEX file, supplied on the CD that came with this kit, to your PC.
3. When 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 "TC1047A PICtail.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 TC1047A PICtail.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 when device power is turned on. Some of the red LEDs (D7-D0) will turn on as well.

At this point, the PIC16F676 device is reading the temperature data from the TC1047A 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 Fahrenheit or Celsius. The board defaults to the temperature being displayed in Fahrenheit. To display the temperature in Celsius, depress the **SW1** push button switch on the PICkit 1 Flash Starter Kit board. The display will change back to Fahrenheit once the **SW1** push button switch is released.

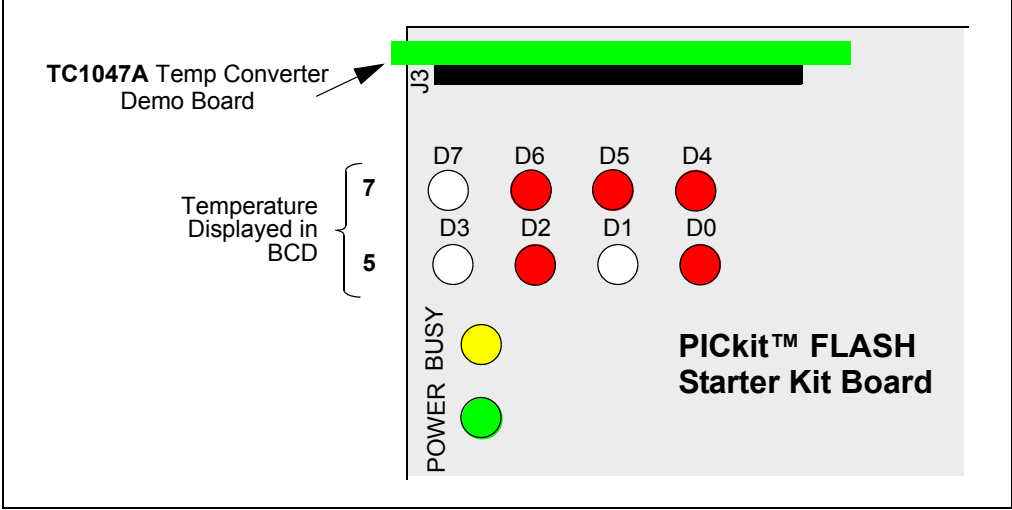
Table 2-1 provides a list of the LED patterns that correspond to the BCD coding representation of the temperature measurement.

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

| Binary | BCD Number | D7<br>D3 | D6<br>D2 | D5<br>D1 | D4<br>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 TC1047A is varied. A simple example of this can be seen by pressing your finger on the TC1047A device (U1) on the TC1047A Temperature-to-Voltage Converter PICTail™ Demo Board. More dramatic changes can be seen by applying heat to the TC1047A with a hair dryer or hot air gun, or by cooling the device down.

Refer to the TC1047A Data Sheet, “Precision Temperature-to-Voltage Converter” (DS21498), for more information on the TC1047A, and Application Note 938, “Interfacing a TC1047A Analog Output Temperature Sensor to a PICmicro<sup>®</sup> Microcontroller”, for more information on the TC1047A Temperature-to-Voltage Converter PICTail™ Demo Board and the TC1047A PICTail.HEX firmware.

### NOTES:





# TC1047A TEMPERATURE-TO-VOLTAGE CONVERTER PICtail™ DEMO BOARD USER'S GUIDE

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## Appendix A. Schematic and Layouts

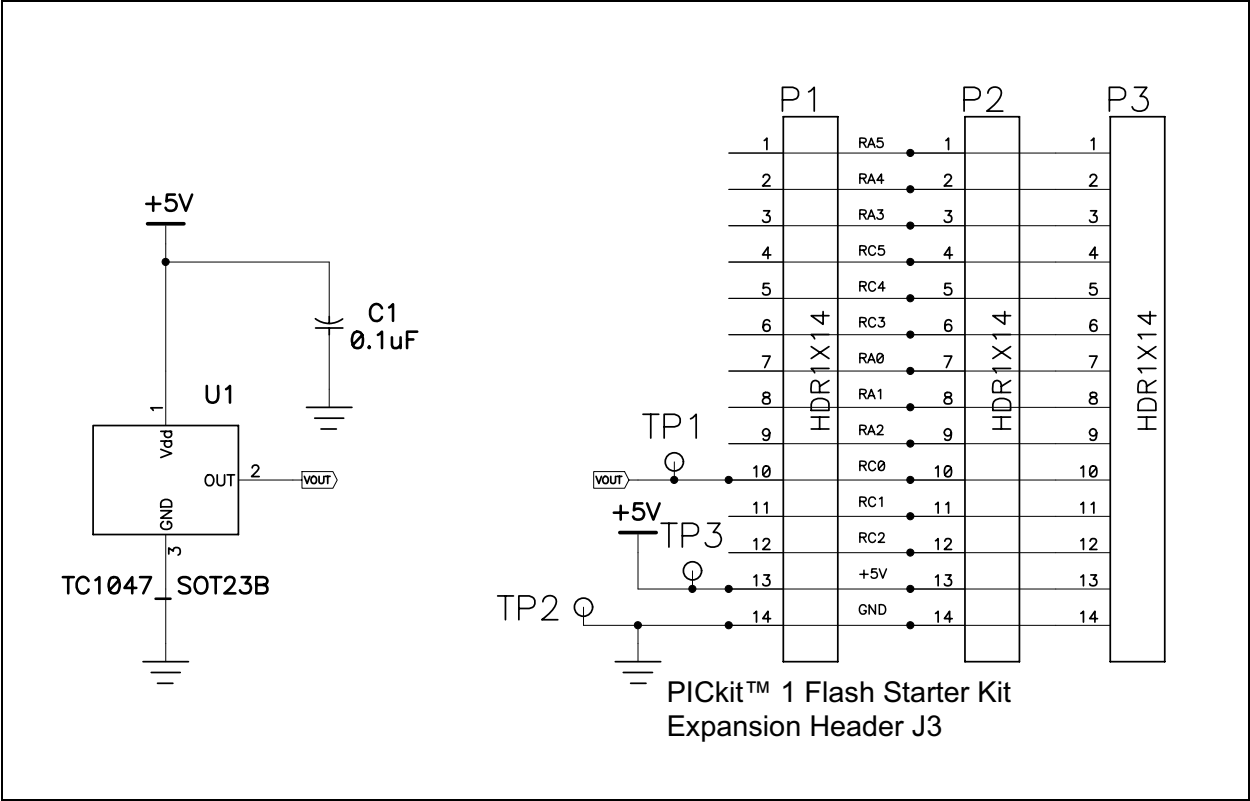
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### A.1 INTRODUCTION

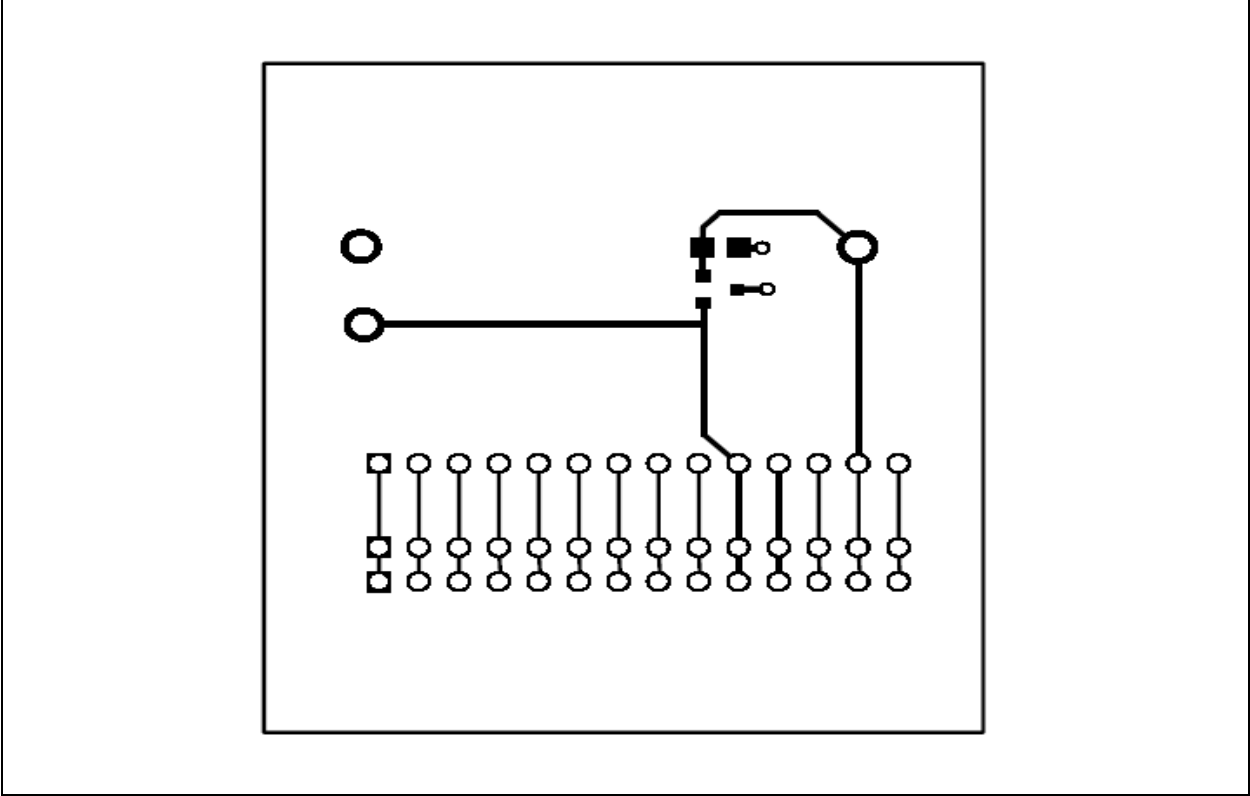
This appendix contains the following schematics and layouts for the TC1047A Temperature-to-Voltage Converter PICtail™ Demo Board User's Guide:

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

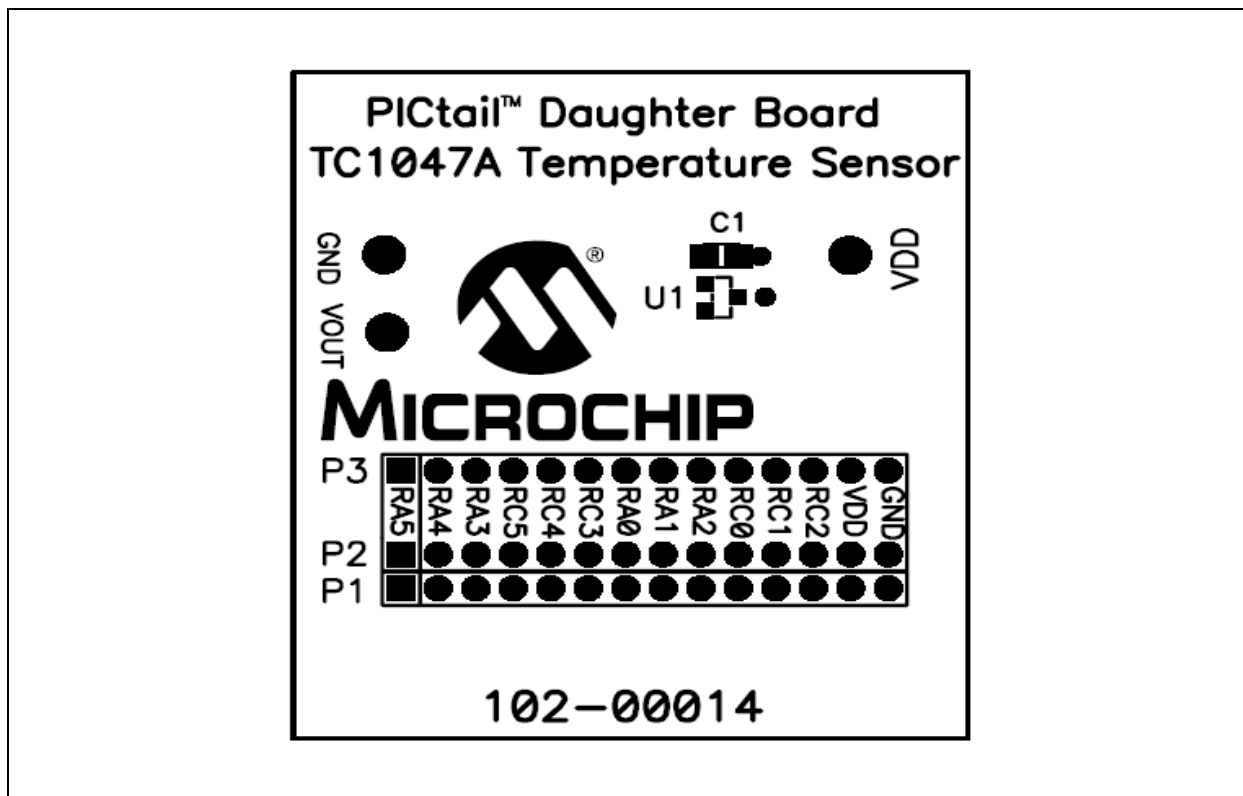
A.2 BOARD SCHEMATIC



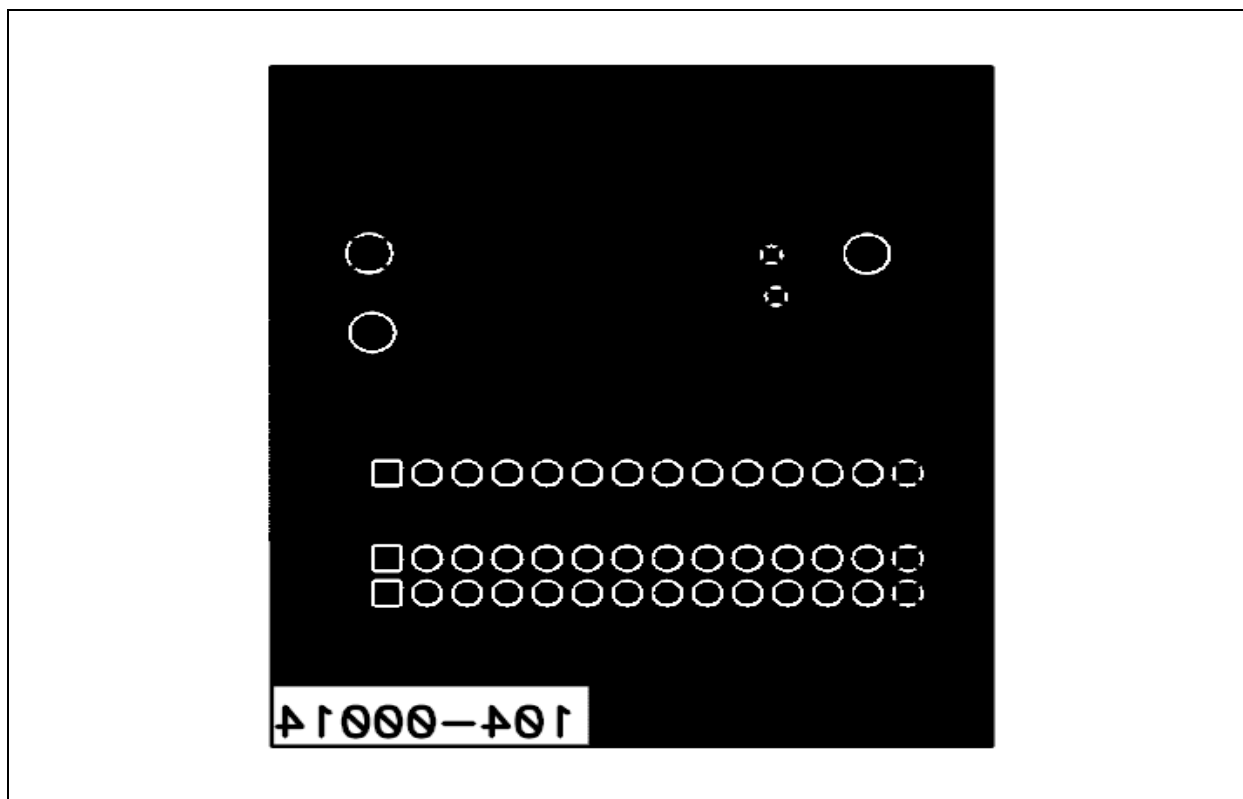
A.3 BOARD - TOP LAYER



## A.4 BOARD - SILK SCREEN LAYER



## A.5 BOARD - BOTTOM LAYER



NOTES:



# TC1047A TEMPERATURE-TO-VOLTAGE CONVERTER PICTail™ DEMO BOARD USER'S GUIDE

## Appendix B. Bill Of Materials (BOM)

TABLE B-1: BILL OF MATERIALS

| Qty | Designator | Description  | Manufacturer                 | Part Number   |
|-----|------------|--|------------------------------|---------------|
| 1   | C1         | Cap., 0.1 $\mu$ F, 25V, Ceramic, X7R 0805          | Panasonic®-ECG               | ECJ-2VB1E104K |
| 1   | P1         | Conn Hdr Brkway .100 40pos RT/A                    | AMP®/Tyco®<br>Electronics    | 4-103765-0    |
| 1   | U1         | TC1047A Precision Temperature To Voltage Converter | Microchip<br>Technology Inc. | TC1047AVNB    |

**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.



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