



# **TC72 Digital Temperature Sensor 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.

---

Information contained in this publication regarding device applications and the like is intended through suggestion only and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. No representation or warranty is given and no liability is assumed by Microchip Technology Incorporated with respect to the accuracy or use of such information, or infringement of patents or other intellectual property rights arising from such use or otherwise. Use of Microchip's products as critical components in life support systems is not authorized except with express written approval by Microchip. No licenses are conveyed, implicitly or otherwise, under any intellectual property rights.

#### **Trademarks**

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


Amplab, FilterLab, MXDEV, MXLAB, PICMASTER, 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, dsPICDEM, dsPICDEM.net, dsPICworks, ECAN, ECONOMONITOR, FanSense, FlexROM, fuzzyLAB, In-Circuit Serial Programming, ICSP, ICEPIC, Migratable Memory, MPASM, MPLIB, MPLINK, MPSIM, PICKit, PICDEM, PICDEM.net, PICLAB, PICtail, PowerCal, PowerInfo, PowerMate, PowerTool, rLAB, rfPICDEM, Select Mode, Smart Serial, SmartTel and Total Endurance 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.

© 2004, 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 quality system certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona and Mountain View, California in October 2003. 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.*



# TC72 DIGITAL TEMPERATURE SENSOR PICtail™ DEMO BOARD USER'S GUIDE

## Table of Contents

<b>Preface .....</b>	<b>1</b>
<b>Chapter 1. Product Overview .....</b>	<b>3</b>
1.1 Introduction and Highlights .....	3
1.2 What is the TC72 Digital Temperature Sensor PICtail Demo Board? .....	3
1.3 What the TC72 Digital Temperature Sensor PICtail Demo Board Kit Includes .....	3
<b>Chapter 2. TC72 Digital Temperature Sensor PICtail Demo Board .....</b>	<b>5</b>
2.1 Introduction .....	5
2.2 Features .....	5
2.3 Getting Started .....	5
<b>Appendix A. Schematic and Layouts .....</b>	<b>11</b>
A.1 Introduction and Highlights .....	11
A.2 Board Schematic .....	12
A.3 Board - Top Layer .....	12
A.4 Board - Silkscreen Layer .....	13
A.5 Board - Bottom Layer .....	13
<b>Appendix B. Bill Of Materials (BOM) .....</b>	<b>15</b>
<b>Worldwide Sales and Service .....</b>	<b>16</b>

NOTES:



# TC72 DIGITAL TEMPERATURE SENSOR PICtail™ DEMO BOARD USER'S GUIDE

---

## Preface

---

### INTRODUCTION AND HIGHLIGHTS

This section contains general information that will be useful to know before using the TC72 Digital Temperature Sensor PICtail Demo Board and covers the following topics:

- About this Guide
- Recommended Reading
- The Microchip Internet Web Site
- Customer Support

### ABOUT THIS GUIDE

#### Document Layout

This document describes how to use the TC72 Digital Temperature Sensor PICtail™ Demo Board User's Guide.

The User's Guide layout is as follows:

- **Chapter 1: Product Overview** – Important information about the TC72 Digital Temperature Sensor PICtail Demo Board.
- **Chapter 2: TC72 Digital Temperature Sensor PICtail Demo Board** – This chapter includes instructions on how to get started, with a detailed description of each of the board's functions.

#### Appendices:

- **Appendix A: Schematic and Layouts** – Shows the schematic and layout diagrams for the TC72 Digital Temperature Sensor PICtail Demo Board.
- **Appendix B: Bill of Materials** – Lists the parts used to build the TC72 Digital Temperature Sensor PICtail Demo Board.
- **Worldwide Sales and Service** – Gives the address, telephone and fax number for Microchip Technology Inc. sales and service locations throughout the world.

### RECOMMENDED READING

For more information regarding the TC72 device, the following is recommended reading.

#### TC72 Data Sheet (DS21743)

This data sheet provides detailed information regarding the TC72 device.

## THE MICROCHIP INTERNET WEB SITE

Microchip provides easy access to our documentation and on-line support through our Worldwide Web Site at [www.microchip.com](http://www.microchip.com). You can download files from the web site or from our FTP site at <ftp://ftp.microchip.com>

## CUSTOMER SUPPORT

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Corporate Applications Engineer (CAE)
- Hot Line

Customers should call their distributor, representative or field application engineer (FAE) for support. Local sales offices are also available to help customers. See the back cover for a listing of sales offices and locations.

Corporate applications engineers (CAEs) may be contacted at (480) 792-7627.

In addition, there is a Systems Information and Upgrade Line. This line provides system users a listing of the latest versions of all of Microchip's development systems software products. Plus, this line provides information on how customers can receive any currently available upgrade kits.

The Hot Line Numbers are:

- 1-800-755-2345 for U.S. and most of Canada, and
- 1-480-792-7302 for the rest of the world.



# TC72 DIGITAL TEMPERATURE SENSOR PICtail™ DEMO BOARD USER'S GUIDE

---

## Chapter 1. Product Overview

---

### 1.1 INTRODUCTION AND HIGHLIGHTS

This chapter provides an overview of the TC72 Digital Temperature Sensor PICtail Demo Board and covers the following topics:

- What is the TC72 Digital Temperature Sensor PICtail Demo Board?
- What the TC72 Digital Temperature Sensor PICtail Demo Board kit includes

### 1.2 WHAT IS THE TC72 DIGITAL TEMPERATURE SENSOR PICtail DEMO BOARD?

The TC72 Digital Temperature Sensor PICtail Demo Board demonstrates how to interface the device 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, which can be used with the PICkit™ 1 Flash Starter Kit, along with firmware that provides the SPI™ interface and temperature conversion routines, to communicate with the TC72 and convert the serial data to temperature.

The TC72 Digital Temperature Sensor 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 interface via a standard 100 mil header.

### 1.3 WHAT THE TC72 DIGITAL TEMPERATURE SENSOR PICtail DEMO BOARD KIT INCLUDES

This TC72 Digital Temperature Sensor PICtail Demo Board Kit includes:

- The TC72 Digital Temperature Sensor PICtail Demo Board
- TC72 Digital Temperature Sensor PICtail Demo Board User's Guide, DS51482
- AN940, “Interfacing the TC72 Digital Temperature Sensor to a PICmicro® Microcontroller”, DS00940
- PIC16F676 14-pin Flash-based 8-bit CMOS Microcontroller
- PIC16F676 Firmware (TC72 PICtail.HEX)

NOTES:

## Chapter 2. TC72 Digital Temperature Sensor PICtail Demo Board

### 2.1 INTRODUCTION

The TC72 Digital Temperature Sensor PICtail Demo Board demonstrates how to interface the TC72 to a microcontroller, for use by the system designer as an example of how to integrate a digital temperature sensor into their system.

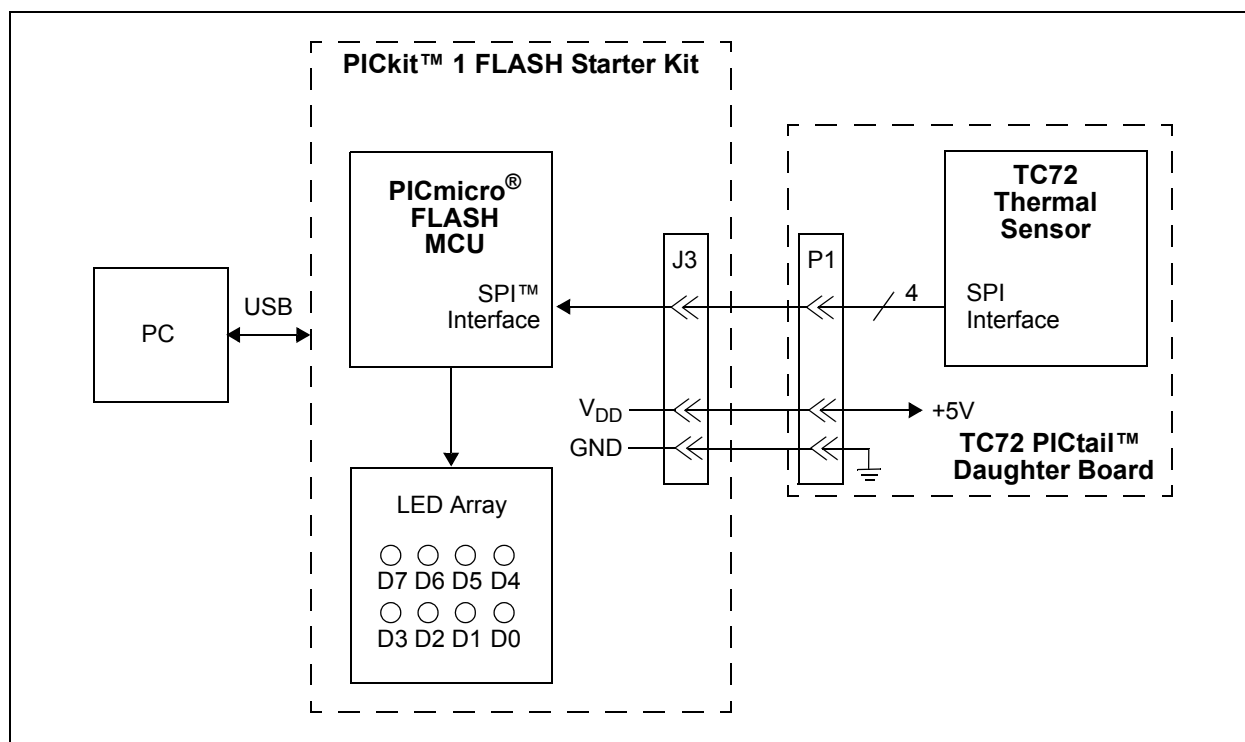
### 2.2 FEATURES

The TC72 Digital Temperature Sensor 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

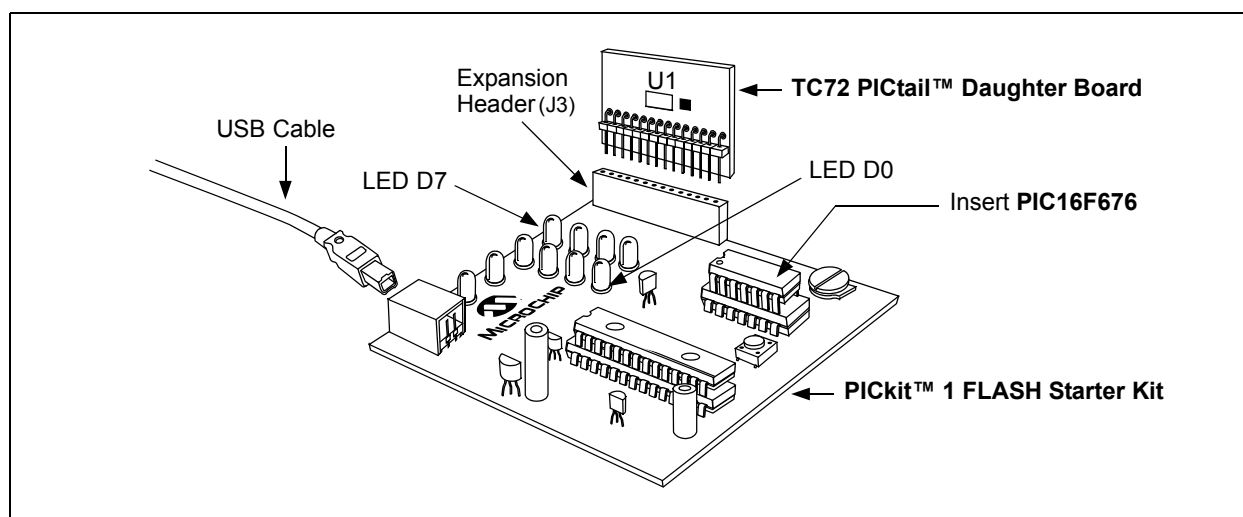
This section describes how to quickly set up the TC72 Digital Temperature Sensor PICtail Demo Board and PICKit 1 Flash Starter Kit. A block diagram of the setup is presented in Figure 2-1. Refer to Application Note 940, "Interfacing the TC72 Digital Temperature Sensor to a PICmicro® Microcontroller", for detailed information on the TC72 Digital Temperature Sensor PICtail Board and the TC72 PICtail.HEX firmware.



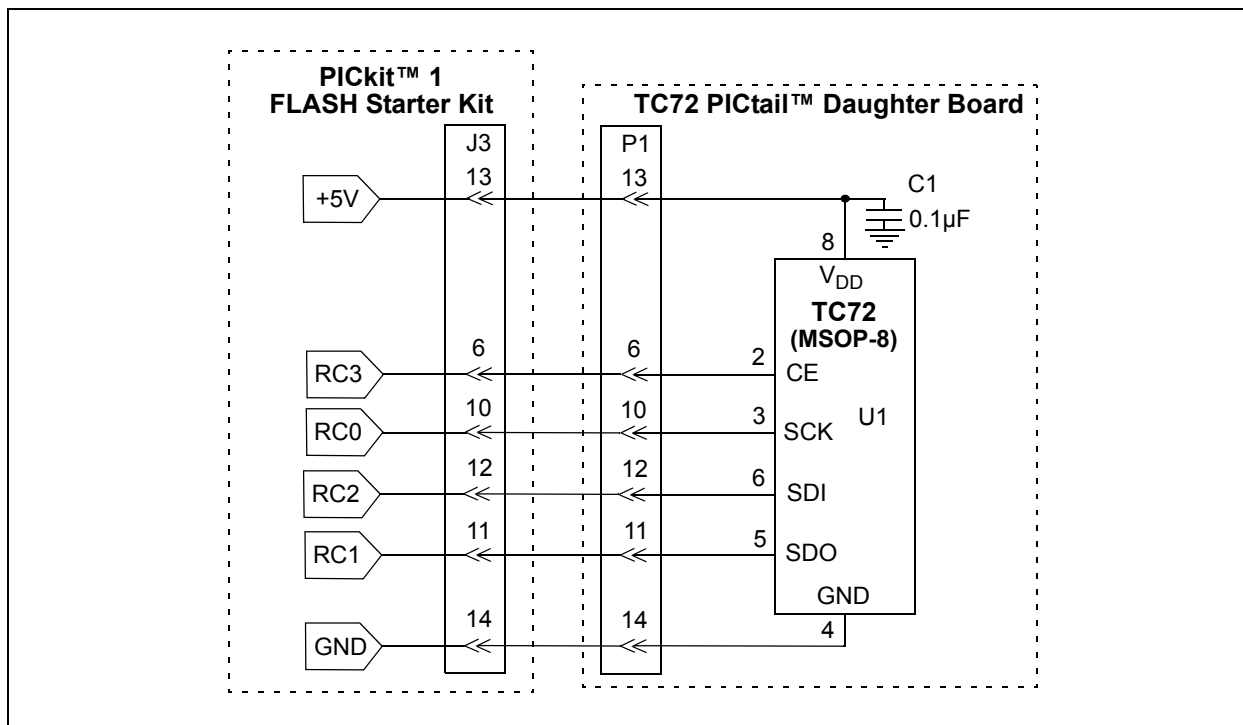
**FIGURE 2-1:** TC72 Digital Temperature Sensor PICtail™ Demo Board Block Diagram.

## 2.3.1 Hardware Setup

1. Connect the P1 header of the TC72 Thermal Sensor board to the J3 connector on the PICkit 1 Flash Starter Kit board. Refer to Figure 2-2 for proper orientation of the TC72 Digital Temperature Sensor 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.



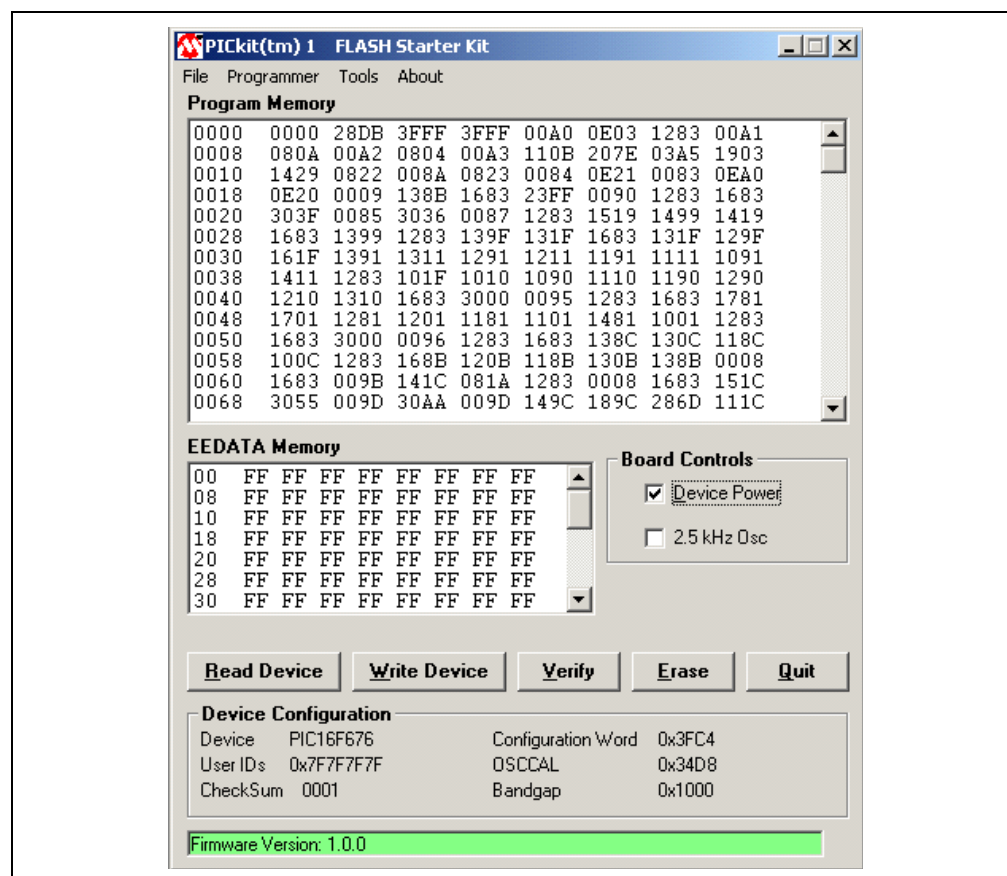
**FIGURE 2-2:** TC72 PICtail™ Daughter Board and PICkit™ 1 FLASH Starter Kit.



**FIGURE 2-3:** Simplified TC72 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 TC72 PICtail.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 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 "TC72 PICtail.HEX".
7. Click on the **Write Device** button in the PICkit 1 Flash Starter Kit window. The PIC16F676 device will be written to by the TC72 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 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 TC72 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.

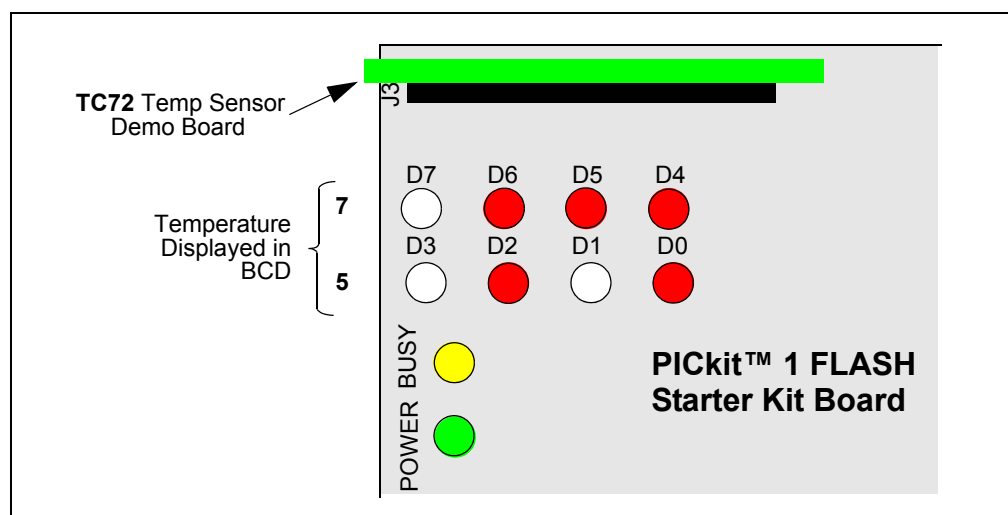
The temperature can be displayed in degrees Fahrenheit or Celsius. The board defaults to the temperature being displayed in Fahrenheit. To display the temperature in Celsius, depress the **SW1** push button switch on the PICkit 1 Flash Starter Kit board. The display will change back to Fahrenheit once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

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 TC72 is varied. A simple example of this can be seen by pressing your finger on the TC72 device (U1) on the TC72 Digital Temperature Sensor PICtail Demo Board. More dramatic changes can be seen by applying heat to the TC72 with a hair dryer or hot air gun, or by cooling the device down.

Refer to the TC72 data sheet, “Digital Temperature Sensor with SPI™ Interface” (DS21743), for more information on the TC72 and Application Note 940, “Interfacing the TC72 Digital Temperature Sensor to a PICmicro® Microcontroller”, for more information on the TC72 Digital Temperature Sensor PICtail Demo Board and the TC72 PICtail.HEX firmware.

NOTES:



# TC72 DIGITAL TEMPERATURE SENSOR PICtail™ DEMO BOARD USER'S GUIDE

---

## Appendix A. Schematic and Layouts

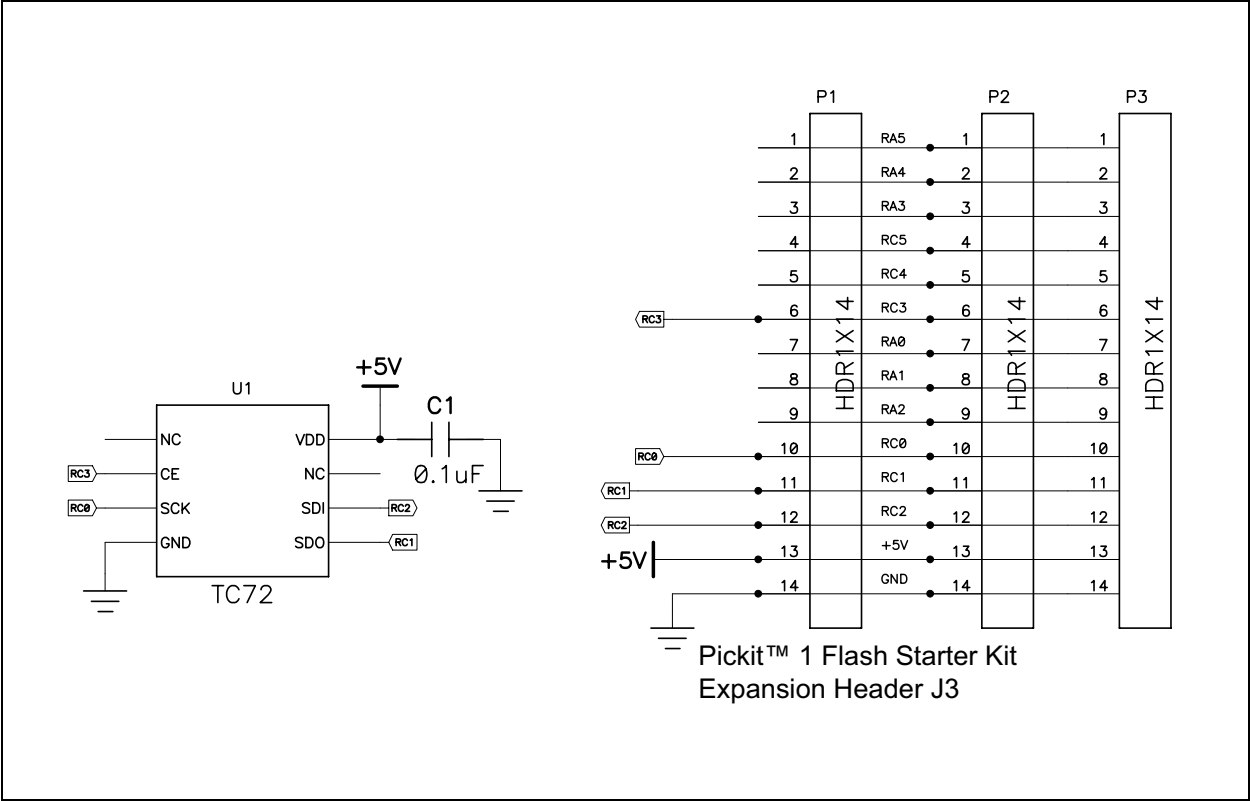
---

### A.1 INTRODUCTION

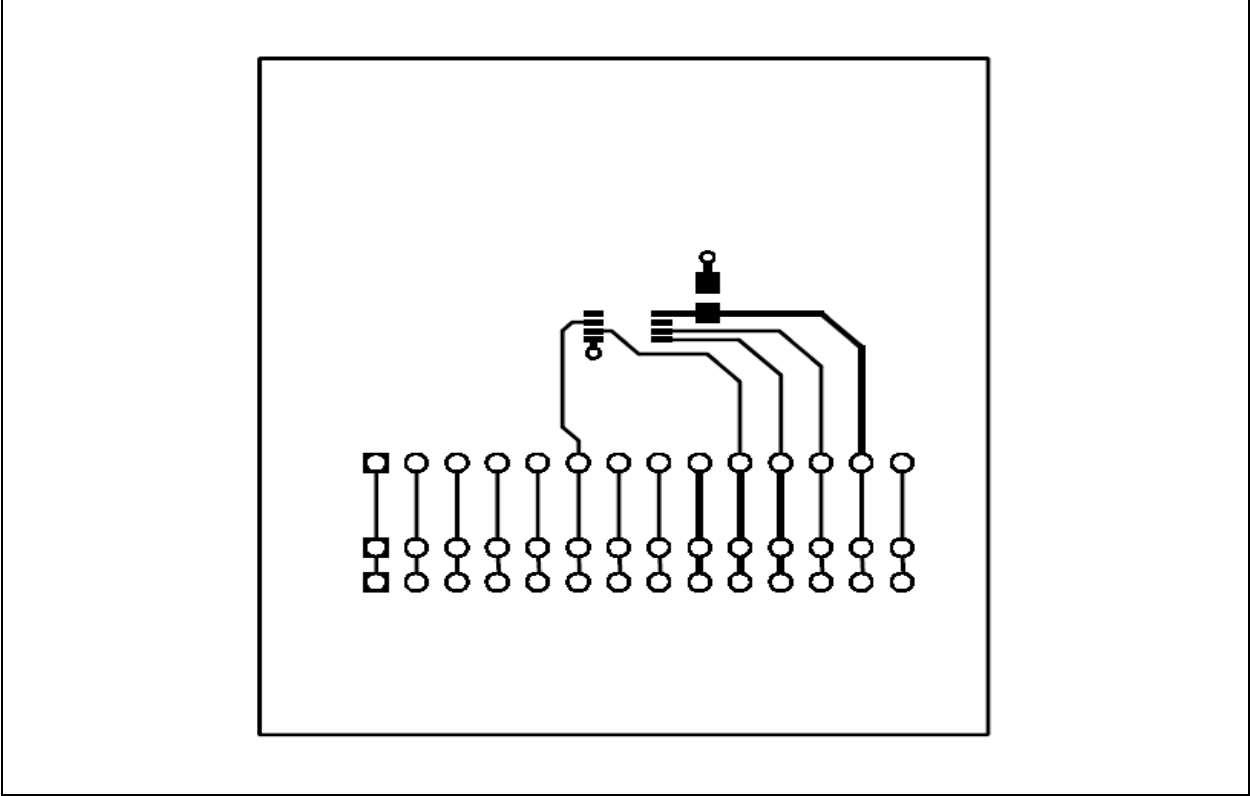
This appendix contains the following schematics and layouts for the TC72 Digital Temperature Sensor PICtail Demo Board :

- Board Schematic
- Board - Top Layer
- Board - Silkscreen Layer
- Board - Bottom Layer

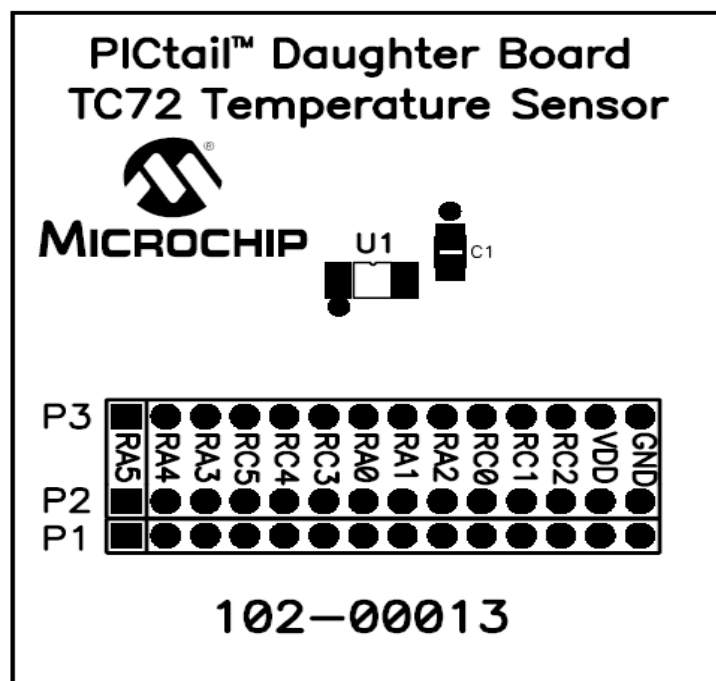
A.2 BOARD SCHEMATIC



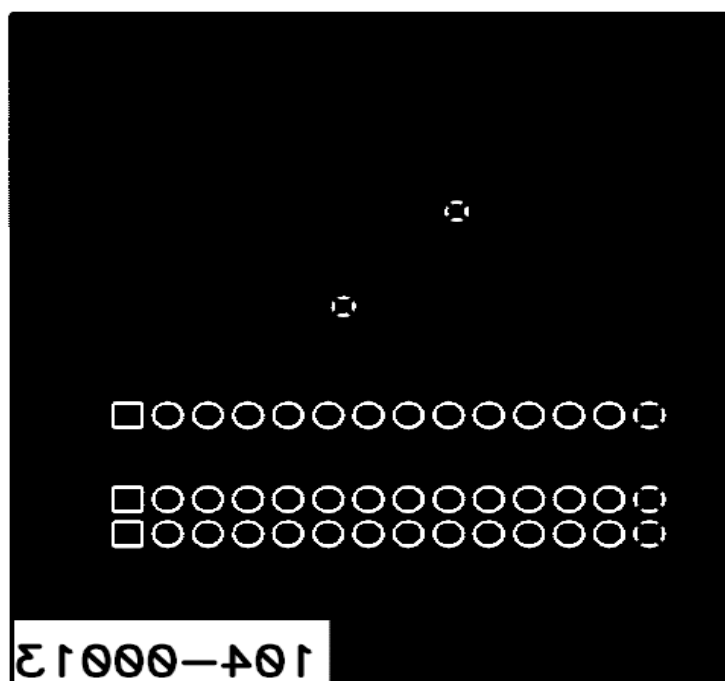
A.3 BOARD - TOP LAYER



#### A.4 BOARD - SILKSCREEN LAYER



#### A.5 BOARD - BOTTOM LAYER



NOTES:



# TC72 DIGITAL TEMPERATURE SENSOR PICtail™ DEMO BOARD USER'S GUIDE

## Appendix B. Bill Of Materials (BOM)

TABLE B-1: BILL OF MATERIALS

Reference Designator	Quantity	Description	Manufacturer	Manufacturer Part Number
C1	1	Cap., 0.1 $\mu$ F, 25V, Ceramic, X7R 0805	Panasonic®-ECG	ECJ-2VB1E104K
P1	1	Conn Hdr Brkway .100 40pos RT/A	AMP/ Tyco™ Electronics	4-103765-0
U1	1	Thermal Sensor with SPI™ Interface	Microchip Technology Inc.	TC72-5.0MUA



## 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: 480-792-7627  
Web Address: www.microchip.com

#### Atlanta

3780 Mansell Road, Suite 130  
Alpharetta, GA 30022  
Tel: 770-640-0034  
Fax: 770-640-0307

#### Boston

2 Lan Drive, Suite 120  
Westford, MA 01886  
Tel: 978-692-3848  
Fax: 978-692-3821

#### Chicago

333 Pierce Road, Suite 180  
Itasca, IL 60143  
Tel: 630-285-0071  
Fax: 630-285-0075

#### Dallas

16200 Addison Road, Suite 255  
Addison Plaza  
Addison, TX 75001  
Tel: 972-818-7423  
Fax: 972-818-2924

#### Detroit

Tri-Atria Office Building  
32255 Northwestern Highway, Suite 190  
Farmington Hills, MI 48334  
Tel: 248-538-2250  
Fax: 248-538-2260

#### Kokomo

2767 S. Albright Road  
Kokomo, IN 46902  
Tel: 765-864-8360  
Fax: 765-864-8387

#### Los Angeles

25950 Acero St., Suite 200  
Mission Viejo, CA 92691  
Tel: 949-462-9523  
Fax: 949-462-9608

#### San Jose

1300 Terra Bella Avenue  
Mountain View, CA 94043  
Tel: 650-215-1444  
Fax: 650-961-0286

#### Toronto

6285 Northam Drive, Suite 108  
Mississauga, Ontario L4V 1X5, Canada  
Tel: 905-673-0699  
Fax: 905-673-6509

### ASIA/PACIFIC

#### Australia

Microchip Technology Australia Pty Ltd  
Unit 32 41 Rawson Street  
Epping 2121, NSW  
Sydney, Australia  
Tel: 61-2-9868-6733  
Fax: 61-2-9868-6755

#### China - Beijing

Unit 706B  
Wan Tai Bei Hai Bldg.  
No. 6 Chaoyangmen Bei Str.  
Beijing, 100027, China  
Tel: 86-10-85282100  
Fax: 86-10-85282104

#### China - Chengdu

Rm. 2401-2402, 24th Floor,  
Ming Xing Financial Tower  
No. 88 TIDU Street  
Chengdu 610016, China  
Tel: 86-28-86766200  
Fax: 86-28-86766599

#### China - Fuzhou

Unit 28F, World Trade Plaza  
No. 71 Wusi Road  
Fuzhou 350001, China  
Tel: 86-591-7503506  
Fax: 86-591-7503521

#### China - Hong Kong SAR

Unit 901-6, Tower 2, Metroplaza  
223 Hing Fong Road  
Kwai Fong, N.T., Hong Kong  
Tel: 852-2401-1200  
Fax: 852-2401-3431

#### China - Shanghai

Room 701, Bldg. B  
Far East International Plaza  
No. 317 Xian Xia Road  
Shanghai, 200051  
Tel: 86-21-6275-5700  
Fax: 86-21-6275-5060

#### China - Shenzhen

Rm. 1812, 18/F, Building A, United Plaza  
No. 5022 Binhe Road, Futian District  
Shenzhen 518033, China  
Tel: 86-755-82901380  
Fax: 86-755-8295-1393

#### China - Shunde

Room 401, Hongjian Building, No. 2  
Fengxiangnan Road, Ronggui Town, Shunde  
District, Foshan City, Guangdong 528303, China  
Tel: 86-757-28395507 Fax: 86-757-28395571

#### China - Qingdao

Rm. B505A, Fullhope Plaza,  
No. 12 Hong Kong Central Rd.  
Qingdao 266071, China  
Tel: 86-532-5027355 Fax: 86-532-5027205

#### India

Divyasree Chambers  
1 Floor, Wing A (A3/A4)  
No. 11, O'Shaughnessy Road  
Bangalore, 560 025, India  
Tel: 91-80-22290061 Fax: 91-80-22290062

#### Japan

Yusen Shin Yokohama Building 10F  
3-17-2, Shin Yokohama, Kohoku-ku,  
Yokohama, Kanagawa, 222-0033, Japan  
Tel: 81-45-471-6166 Fax: 81-45-471-6122

#### Korea

168-1, Youngbo Bldg. 3 Floor  
Samsung-Dong, Kangnam-Ku  
Seoul, Korea 135-882  
Tel: 82-2-554-7200 Fax: 82-2-558-5932 or  
82-2-558-5934

#### Singapore

200 Middle Road  
#07-02 Prime Centre  
Singapore, 188980  
Tel: 65-6334-8870 Fax: 65-6334-8850

#### Taiwan

Kaohsiung Branch  
30F - 1 No. 8  
Min Chuan 2nd Road  
Kaohsiung 806, Taiwan  
Tel: 886-7-536-4816  
Fax: 886-7-536-4817

#### Taiwan

Taiwan Branch  
11F-3, No. 207  
Tung Hua North Road  
Taipei, 105, Taiwan  
Tel: 886-2-2717-7175 Fax: 886-2-2545-0139

#### Taiwan

Taiwan Branch  
13F-3, No. 295, Sec. 2, Kung Fu Road  
Hsinchu City 300, Taiwan  
Tel: 886-3-572-9526  
Fax: 886-3-572-6459

### EUROPE

#### Austria

Durisolstrasse 2  
A-4600 Wels  
Austria  
Tel: 43-7242-2244-399  
Fax: 43-7242-2244-393

#### Denmark

Regus Business Centre  
Lautrup høj 1-3  
Ballerup DK-2750 Denmark  
Tel: 45-4420-9895 Fax: 45-4420-9910

#### France

Parc d'Activite du Moulin de Massy  
43 Rue du Saule Trappu  
Batiment A - 1er Etage  
91300 Massy, France  
Tel: 33-1-69-53-63-20  
Fax: 33-1-69-30-90-79

#### Germany

Steinheilstrasse 10  
D-85737 Ismaning, Germany  
Tel: 49-89-627-144-0  
Fax: 49-89-627-144-44

#### Italy

Via Salvatore Quasimodo, 12  
20025 Legnano (MI)  
Milan, Italy  
Tel: 39-0331-742611  
Fax: 39-0331-466781

#### Netherlands

Waagenburghtplein 4  
NL-5152 JR, Drunen, Netherlands  
Tel: 31-416-690399  
Fax: 31-416-690340

#### United Kingdom

505 Eskdale Road  
Winnesh Triangle  
Wokingham  
Berkshire, England RG41 5TU  
Tel: 44-118-921-5869  
Fax: 44-118-921-5820

07/12/04