®

# MICROCHIP

# TC77 Thermal Sensor
# PICtail™ Demo Board
# User's Guide

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# TC77 THERMAL SENSOR PICtail™ DEMO BOARD USER'S GUIDE

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# TC77 THERMAL SENSOR 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.**

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## INTRODUCTION

This chapter contains general information that will be useful to know before using the TC77 Thermal Sensor 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 TC77 Thermal Sensor PICtail™ Demo Board as a development tool. The manual layout is as follows:

• **Chapter 1. "Product Overview"** – Important information about the TC77 Thermal Sensor PICtail™ Demo Board.
• **Chapter 2. "Installation and Operation"** – Includes instructions on how to get started with the TC77 Thermal Sensor PICtail™ Demo Board.
• **Appendix A. "Schematic and Layouts"** – Shows the schematic and board layout diagrams for the TC77 Thermal Sensor PICtail™ Demo Board.
• **Appendix B. "Bill Of Materials (BOM)"** – Lists the parts used to build the TC77 Thermal Sensor PICtail™ Demo Board

# TC77 Thermal Sensor PICtail™ Demo Board User's Guide

## 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

The following Microchip documents are recommended as supplemental reference resources.

**TC77 Data Sheet** *"Thermal Sensor with SPI Interface"* **(DS20092)**

This data sheet provides detailed information regarding the TC77 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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- 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 (May 2006)

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

### Revision A (June 2004)

- Initial Release of this Document.

**NOTES:**

# Chapter 1. Product Overview

## 1.1 INTRODUCTION

This chapter provides an overview of the TC77 Thermal Sensor PICtail™ Demo Board and covers the following topics:

• What is the TC77 Thermal Sensor PICtail™ Demo Board?
• What the TC77 Thermal Sensor PICtail™ Demo Board Kit includes

## 1.2 WHAT IS THE TC77 THERMAL SENSOR PICtail™ DEMO BOARD?

The TC77 Thermal Sensor PICtail™ Demo Board demonstrates how to interface the TC77 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 and can be used with the PICkit 1 Flash Starter Kit. Firmware that provides the SPI interface and temperature conversion routines to communicate with the TC77 and convert the serial data to temperature is also included.

The TC77 Thermal Sensor 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 TC77 THERMAL SENSOR PICtail™ DEMO BOARD KIT INCLUDES

This TC77 Thermal Sensor PICtail™ Demo Board Kit includes:

• The TC77 Thermal Sensor PICtail™ Demo Board (102-00004)
• TC77 Thermal Sensor PICtail™ Demo Board User's Guide (DS51484)
• AN913, "Interfacing the TC77 Thermal Sensor to a PICmicro® Microcontroller", (DS00913).
• PIC16F676 14-pin Flash-based 8-bit CMOS Microcontroller
• PIC16F676 Firmware

**NOTES:**

# Chapter 2. Installation and Operation

## 2.1 INTRODUCTION

The TC77 Thermal Sensor PICtail™ Demo Board demonstrates how to interface the TC77 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 TC77 Thermal Sensor PICtail™ Demo Board has the following features:

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

## 2.3 GETTING STARTED

This section describes how to quickly configure the TC77 Thermal Sensor PICtail™ Demo Board and PICkit 1 Flash Starter Kit. A block diagram of the configuration is provided in Figure 2-1. Refer to Application Note 913, *"Interfacing the TC77 Thermal Sensor to a PICmicro® Microcontroller"* (DS00913), for detailed information on the TC77 Thermal Sensor PICtail Board and the TC77 PICtail.HEX firmware.
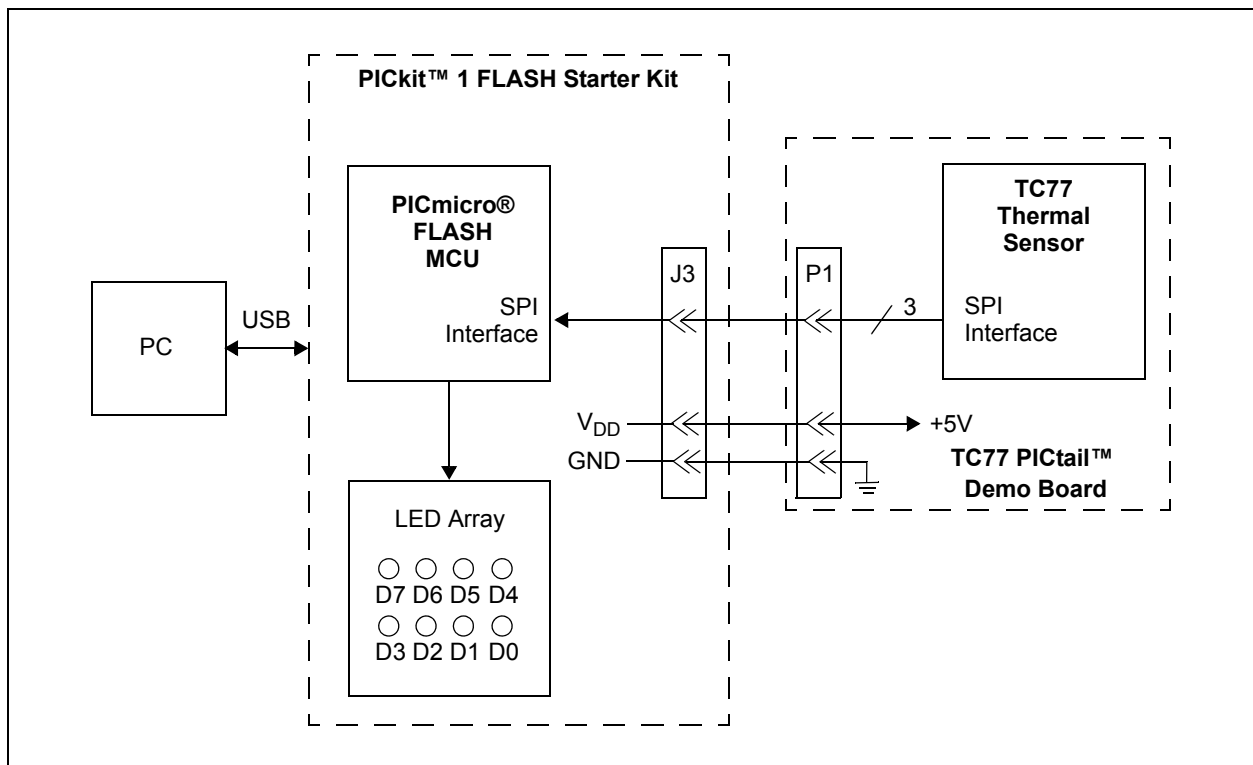


*FIGURE 2-1:*     *TC77 Thermal Sensor PICtail™ Demo Board Block Diagram.*

### 2.3.1 Hardware Setup

1. Connect the P1 header of the TC77 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 TC77 Thermal Sensor PICtail™ Demo Board and Figure 2-3 for a 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.
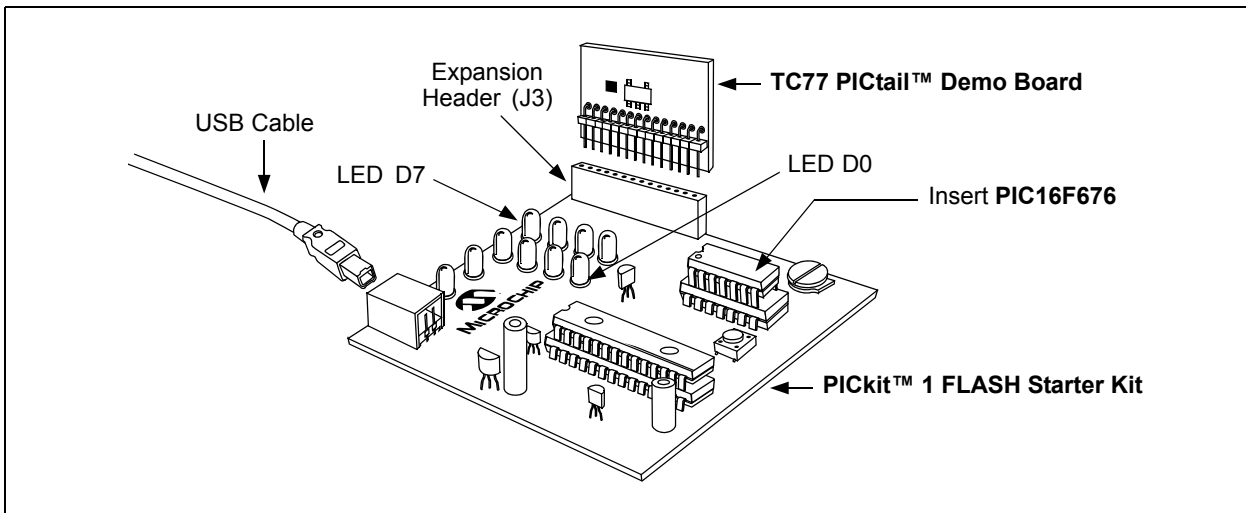


**FIGURE 2-2:** *TC77 Thermal Sensor PICtail™ Demo Board and PICkit™1 FLASH Starter Kit.*
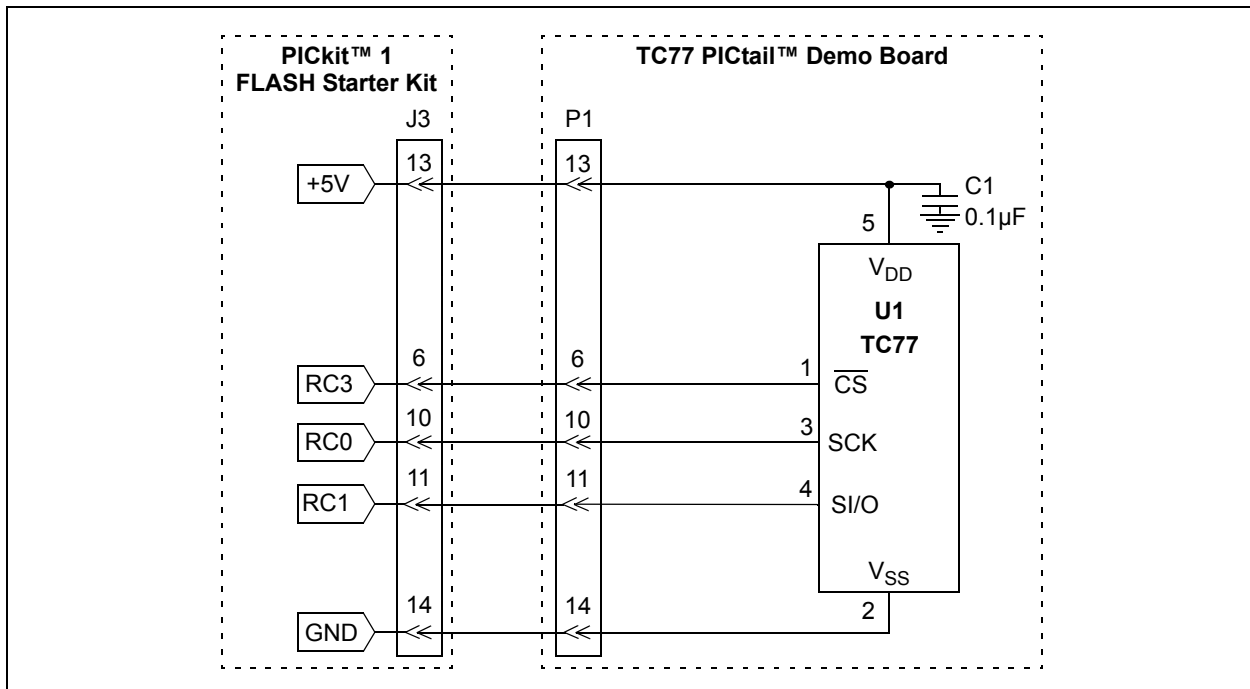


**FIGURE 2-3:** *Simplified TC77 Thermal Sensor PICtail™ Demo Board Schematic.*

### 2.3.2    Programming the PIC16F676

1. Download and install the PICkit 1 Flash Starter Kit software to your PC.
2. Copy the `TC77 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.
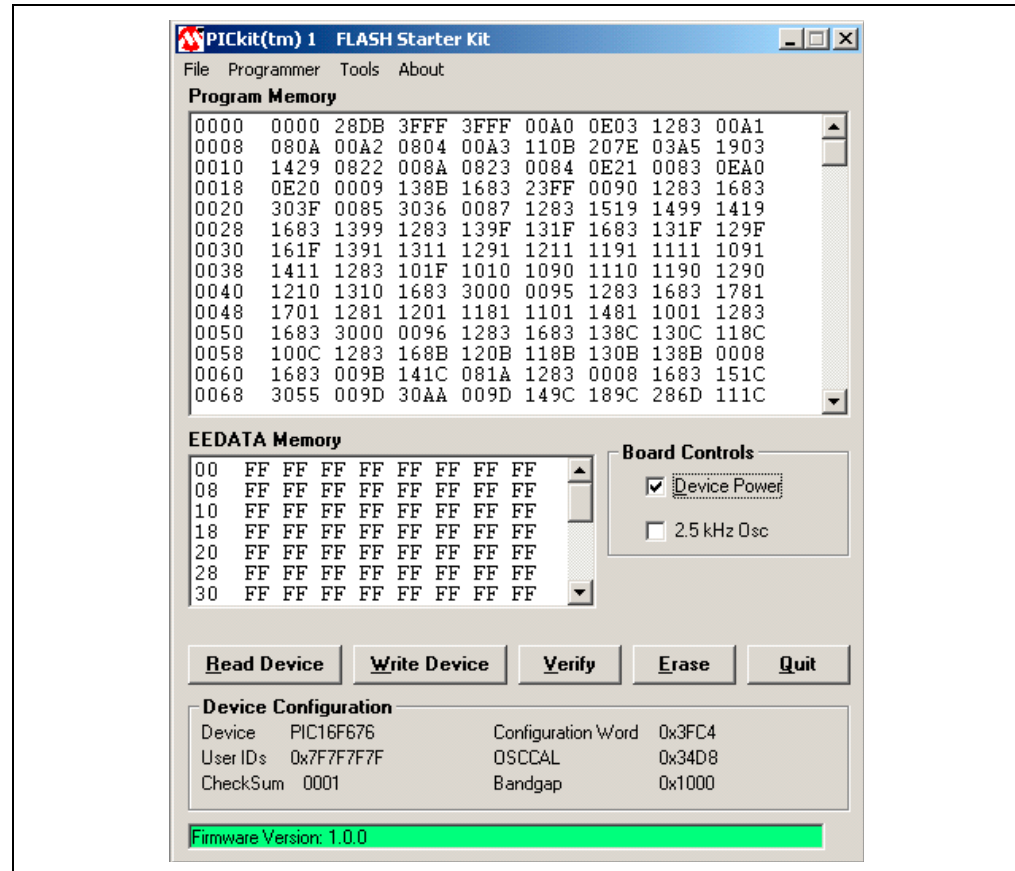


*FIGURE 2-4:        PICkit™ 1 Flash Starter Kit GUI Window on the PC.*

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 when 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 **TC77 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 `TC77 PICtail.HEX` firmware. Once 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 is reading the temperature data from the TC77 and displaying that 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 when **SW1** 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.
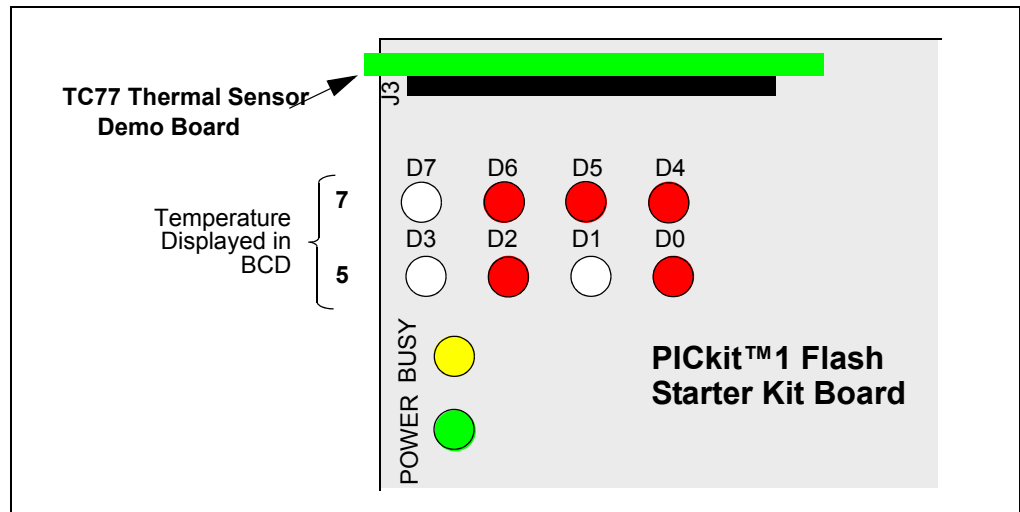
**FIGURE 2-5:** *PICkit™ 1 Flash Starter Kit LED Display of 75°F.*

The temperature display will change when the temperature of the TC77 is varied. A simple example of this can be seen by pressing your finger on the TC77 device (U1) on the TC77 Thermal Sensor PICtail™ Demo Board. More dramatic changes can be seen by applying heat to the TC77 with a hair dryer or hot air gun, or cooling the device down.

Refer to the TC77 Data Sheet, *"Thermal Sensor with SPI™ Interface"* (DS20092) for more information on the TC77 and Application Note 913, *"Interfacing the TC77 Thermal Sensor to a PICmicro® Microcontroller"* (DS00913) for more information on the TC77 Thermal Sensor PICtail™ Demo Board and the `TC77 PICtail.HEX` firmware.

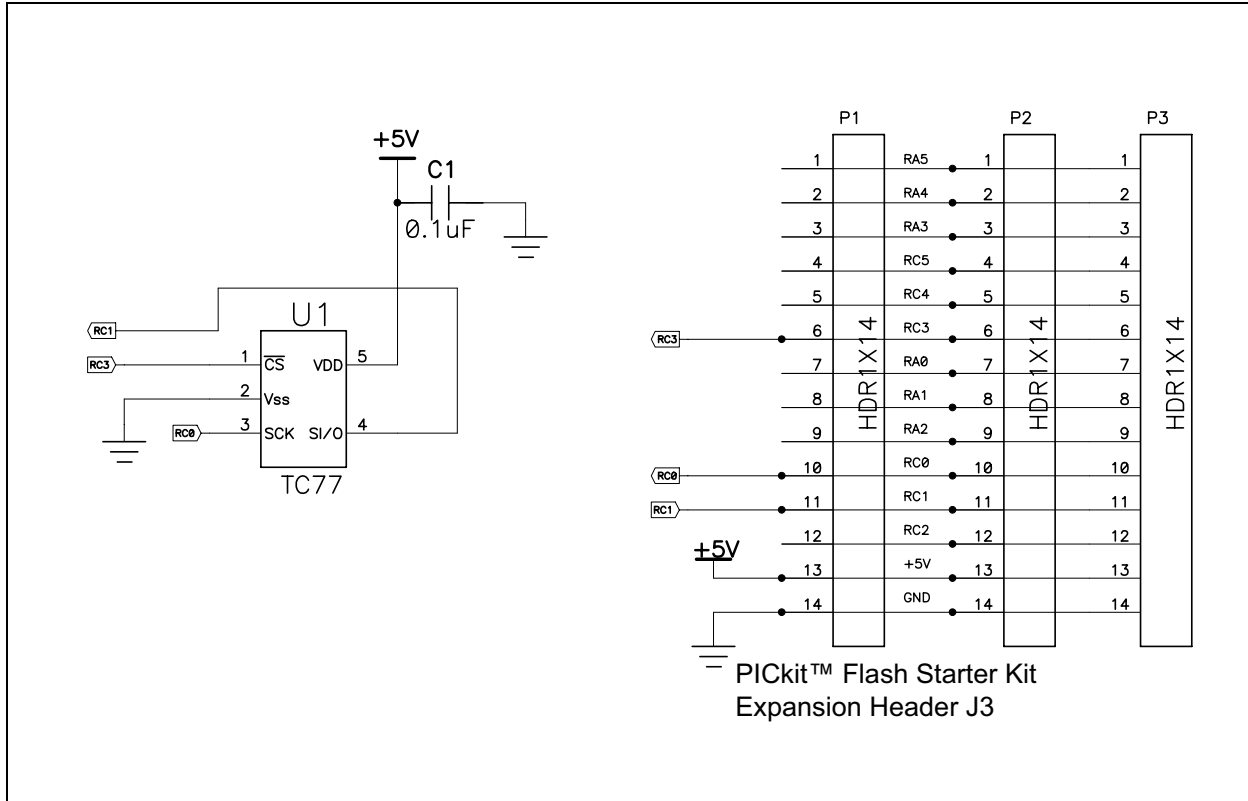**NOTES:**

# Appendix A. Schematic and Layouts

## A.1 INTRODUCTION

This appendix contains the following schematics and layouts for the TC77 Thermal Sensor PICtail™ Demo Board:
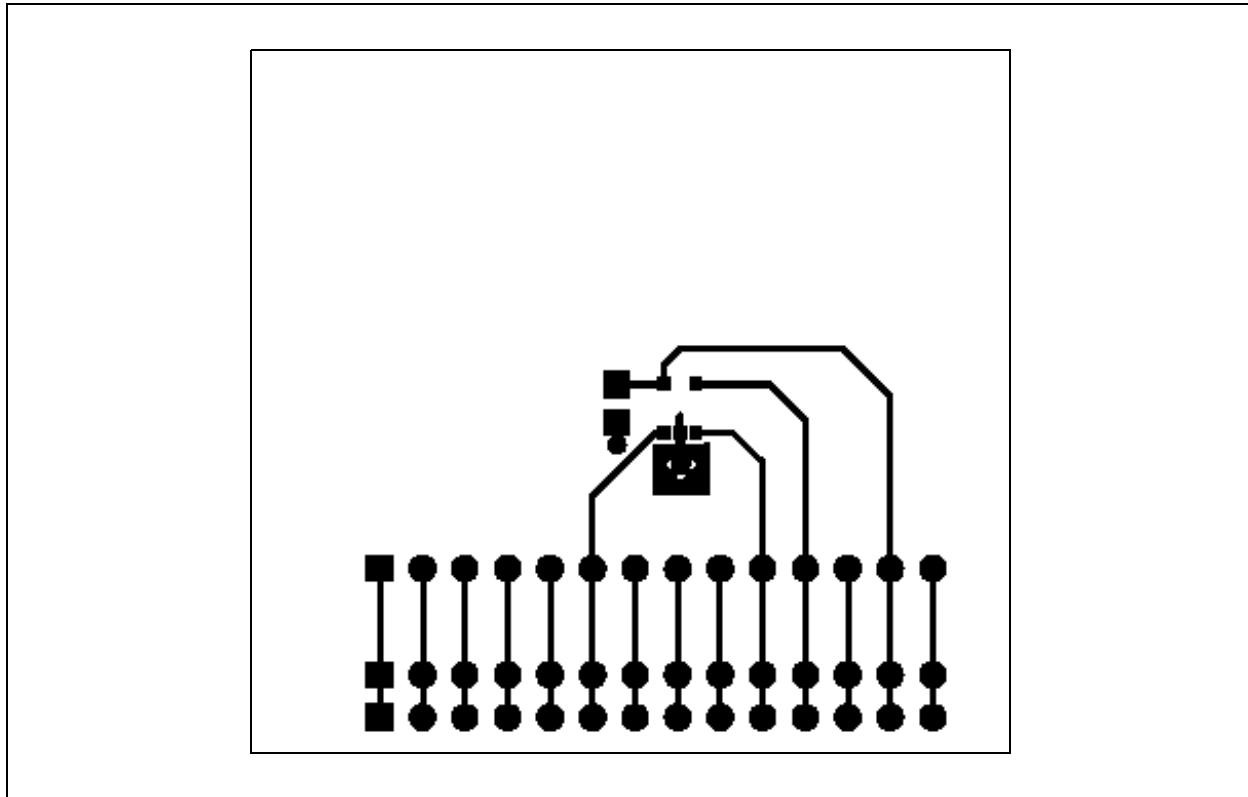
- Board Schematic
- Board - Top Layer
- Board - Silk screen Layer
- Board - Bottom Layer

## A.2    BOARD SCHEMATIC



## A.3    BOARD - TOP LAYER

## A.4    BOARD - SILK SCREEN LAYER
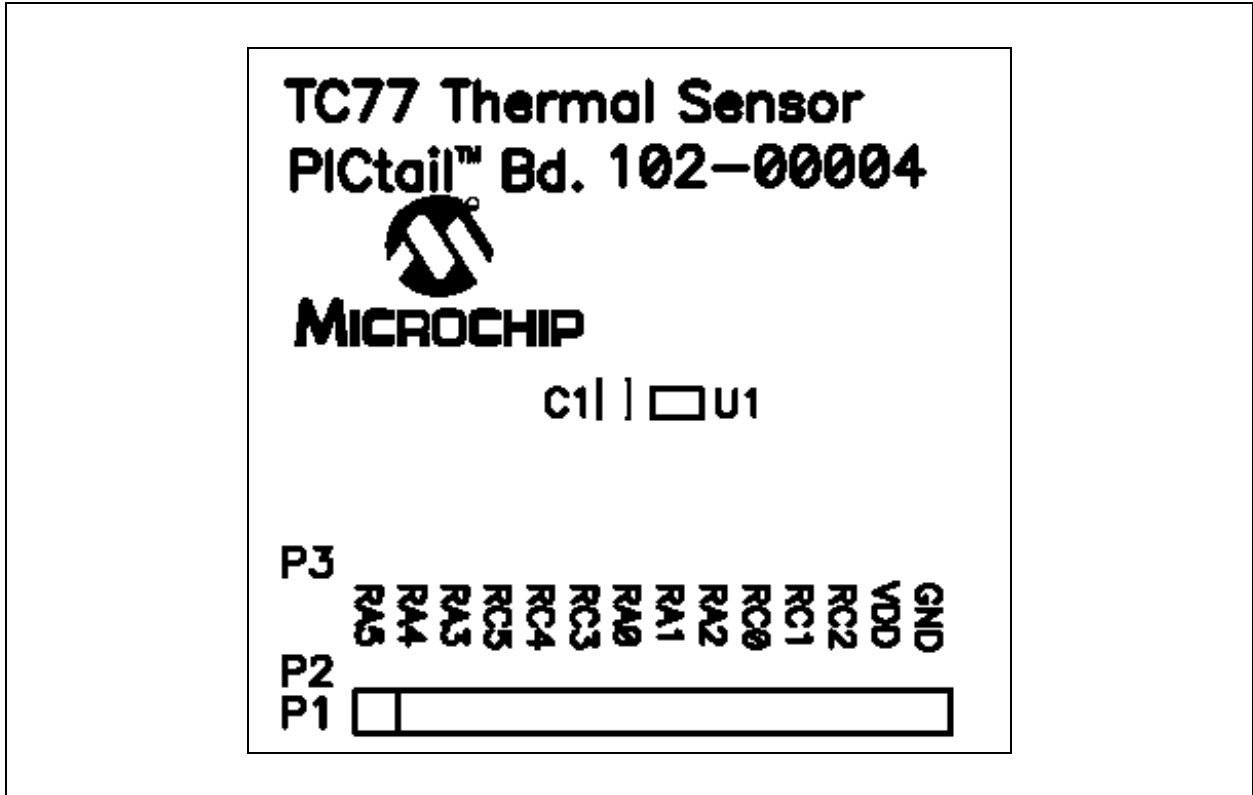


## A.5    BOARD - BOTTOM LAYER
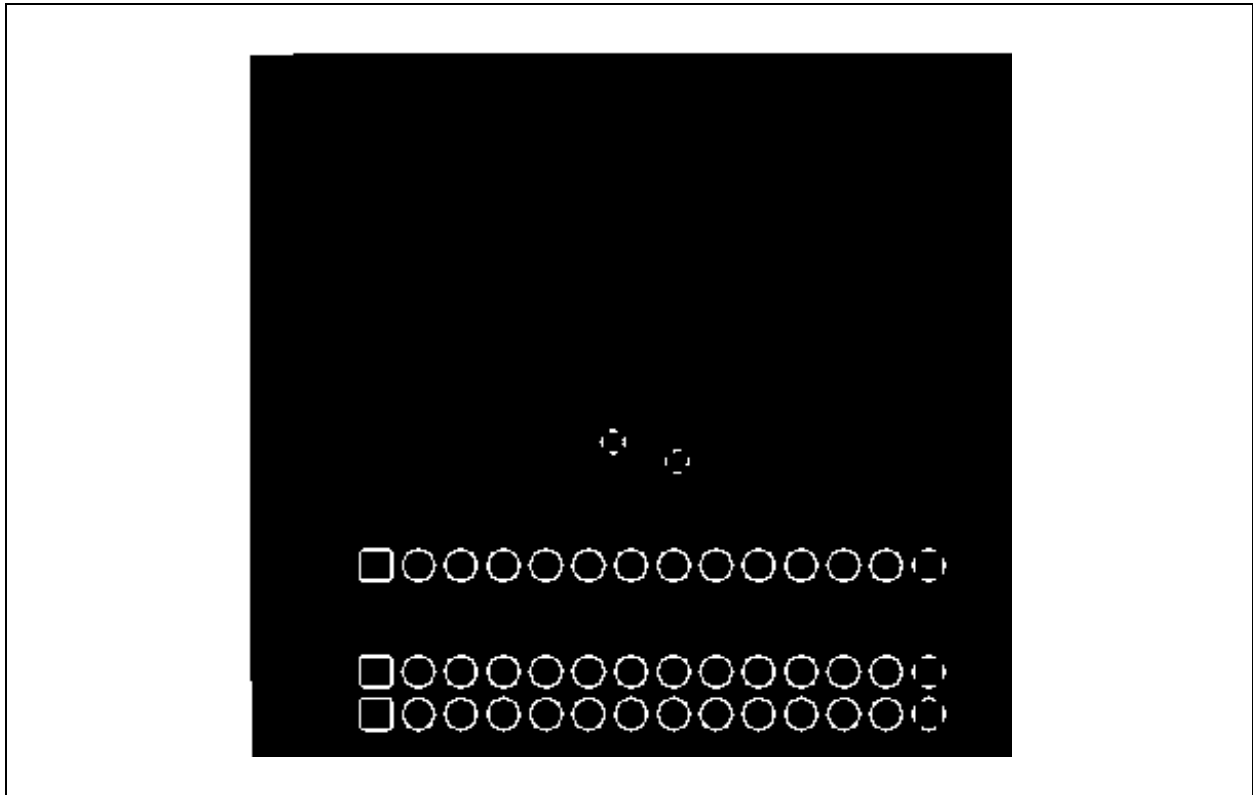
**NOTES:**

# Appendix B. Bill Of Materials (BOM)

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

| Qty | Designator | Description | Manufacturer | Part Number |
|:---:|---|---|:---:|---|
| 1 | C1 | CAP .1UF 25V CERAMIC X7R 0805 | Panasonic® - ECG | ECJ-2VB1E104K |
| 1 | P1 | CONN HEADER .100 SINGL R/A 14POS | Sullins Electronics Corp. | PEC14SBAN |
| 2 | P2,P3, | "Do Not Populate" Header, single pin | N/A | N/A |
| 1 | PCB | Lead Free RoHS Compliant PCBs | N/A | 104-00005 |
| 1 | U1 | TC77 Thermal Sensor with SPI Interface | Microchip Technology Inc | TC77-5.0MCTTR |

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