

MCP6SX2 PGA Thermistor PICtail™ Demo Board User's Guide

© 2006 Microchip Technology Inc.

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in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION, INCLUDING BUT NOT LIMITED TO ITS CONDITION, QUALITY, PERFORMANCE, MERCHANTABILITY OR FITNESS FOR PURPOSE**.** Microchip disclaims all liability arising from this information and its use. Use of Microchip devices in life support and/or safety applications is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip 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, Migratable Memory, MXDEV, MXLAB, 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, Linear Active Thermistor, Mindi, MiWi, MPASM, MPLIB, MPLINK, PICkit, PICDEM, PICDEM.net, PICLAB, PICtail, PowerCal, PowerInfo, PowerMate, PowerTool, REAL ICE, rfLAB, rfPICDEM, Select Mode, Smart Serial, SmartTel, Total Endurance, UNI/O, WiperLock and ZENA 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.

© 2006, 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 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.

© 2006 Microchip Technology Inc.

MCP6SX2 PGA THERMISTOR PICtail™ DEMO BOARD USER'S GUIDE

Table of Contents

Preface 1
Introduction 1
Document Layout 1
Conventions Used in this Guide 2
Recommended Reading 3
The Microchip Web Site 3
Customer Support 4
Document Revision History 4

Chapter 1. Product Overview 5
1.1 Introduction 5
1.2 What is thE MCP6SX2 PGA Thermistor PICtail™ Demo Board? 5
1.3 What the MCP6SX2 PGA Thermistor PICtail™ Demo Board Kit Includes 5
1.4 Associated Tools 6

Chapter 2. Setup and Installation 9
2.1 Introduction 9
2.2 Required Tools 9
2.3 Connecting The MCP6SX2 PGA Thermistor PICtail™ Demo Board 9

Chapter 3. Using the MCP6SX2 PGA Thermistor PICtail™ Demo Board 11
3.1 Introduction 11
3.2 Configuring Board 11

Appendix A. Schematic and Layouts 19
A.1 Introduction 19
A.2 Demonstration Board Description 19
A.3 Additional Comments 20
A.4 Board Schematic 21
A.5 Board - Top Silk-Screen And Metal Layers 22
A.6 Board - Top Metal Layer 23
A.7 Board - Bottom Metal Layer 24

Appendix B. Bill Of Materials (BOM) 25
B.1 Components Installed on PCB 25
B.2 Separately Packaged Components 26

Worldwide Sales and Service 28

© 2006 Microchip Technology Inc.

NOTES:

© 2006 Microchip Technology Inc.

MCP6SX2 PGA THERMISTOR 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.

INTRODUCTION

This chapter contains general information that will be useful to know before using the MCP6SX2 PGA Thermistor 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 MCP6SX2 PGA Thermistor PICtail™ Demo Board as a development tool. The manual layout is as follows:

- **Chapter 1. "Product Overview"** – An introduction to the MCP6SX2 PGA Thermistor PICtail™ Demo Board. It covers the kit contents, associated tools and how they work together.
- **Chapter 2. "Setup and Installation"** – Covers the initial set-up of the MCP6SX2 PGA Thermistor PICtail™ Demo Board. It lists the required tools, shows how to connect this board and demonstates how to verify the set-up.
- **Chapter 3. "Using the MCP6SX2 PGA Thermistor PICtail™ Demo Board"** – Discusses different light sources, using the Signal Analysis PC application and setting up the board as a stand-alone.
- **Appendix A. "Schematic and Layouts"** – Gives detailed information on the MCP6SX2 PGA Thermistor PICtail™ Demo Board. Includes detailed circuit explanation, schematic and board layouts.
- **Appendix B. "Bill Of Materials (BOM)"** – List the parts used to build the MCP6SX2 PGA Thermistor 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) { ... }`

© 2006 Microchip Technology Inc.

RECOMMENDED READING

This user's guide describes how to use the MCP6SX2 PGA Thermistor PICtail™ Demo Board. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

PICkit™ 1 Flash Starter Kit User's Guide (DS40051)

Contains instructions on how to use the PICkit 1 Flash Starter Kit hardware and software.

Signal Analysis PICtail™ Daughter Board User's Guide (DS51476)

Contains instructions on how to use the Signal Analysis PICtail™ Daughter Board's hardware and software.

AN897, "Thermistor Temperature Sensing with MCP6SX2 PGAs" (DS00897)

Explains the functionality and design of this board's circuit. Contains measurement results.

MCP6S21/2/6/8 Data Sheet (DS21117)

Gives detailed information on the MCP6S21/2/3/6/8 Programmable Gain Amplifiers (PGA).

MCP6S91/2/3 Data Sheet (DS21908)

Gives detailed information on the MCP6S91/2/3 PGAs.

PIC16F684 Data Sheet (DS41202)

Gives detailed information on the PICmicro microcontroller used on the Signal Analysis PICtail Daughter Board.

PIC16C745/765 Data Sheet (DS41124)

Gives detailed information on the PICmicro® microcontroller used on the PICkit 1 Flash Starter Kit.

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 (May 2006)

- Updated Bill of Materials (BOM) to show RoHS-compliant part numbers.
- Updated title of this document to match web site board name.

Revision A (October 2004)

- Initial Release of this Document.

© 2006 Microchip Technology Inc.

Chapter 1. Product Overview

1.1 INTRODUCTION

The following name and assembly number are found on the MCP6SX2 PGA Thermistor PICtail™ Demo Board's Printed Circuit Board (PCB):

- MCP6SX2DM-PICTLTH
- 102-00028

This PCB goes by the following title:

- MCP6SX2 PGA Thermistor PICtail™ Demo Board

This board is supported by AN897, *"Thermistor Temperature-Sensing with MCP6SX2 PGAs"*, (DS00897). It uses a BC Components® 2322 640 55103 NTC thermistor to detect temperature. The circuit also includes a voltage divider and a MCP6S22 Programmable Gain Amplifier (PGA).

- Kit Contents
- MCP6SX2 PGA Thermistor PICtail™ Demo Board
- Associated Tools
- Initial Set-up

1.2 WHAT IS THE MCP6SX2 PGA THERMISTOR PICTAIL™ DEMO BOARD?

The MCP6SX2 PGA Thermistor PICtail™ Demo Board contains the analog circuitry represented in Figure 1-1. It uses BC Components' 2322 640 55103 NTC thermistor to convert temperature to resistance. The thermistor is placed in a voltage divider which converts resistance to voltage. This voltage is filtered and placed at the MCP6S22 Programmable Gain Amplifier's (PGA) CH0 input. The PGA gains and buffers this output, which is sent off board (V_{OUT}). Board power is applied at the +5V and GND inputs. The SPI bus makes it possible to control the PGA; its gain and input channel can be set, as desired, from the software.

1.3 WHAT THE MCP6SX2 PGA THERMISTOR PICTAIL™ DEMO BOARD KIT INCLUDES

- MCP6SX2 PGA Thermistor PICtail™ Demo Board – An assembled and tested PCB (102-00028)
- PICkit™ 1 CD-ROM (DS40049) – Contains the files and literature mentioned in this user's guide
- Stand-off, screw and an additional PGA (MCP6S92) provided in an anti-static bag

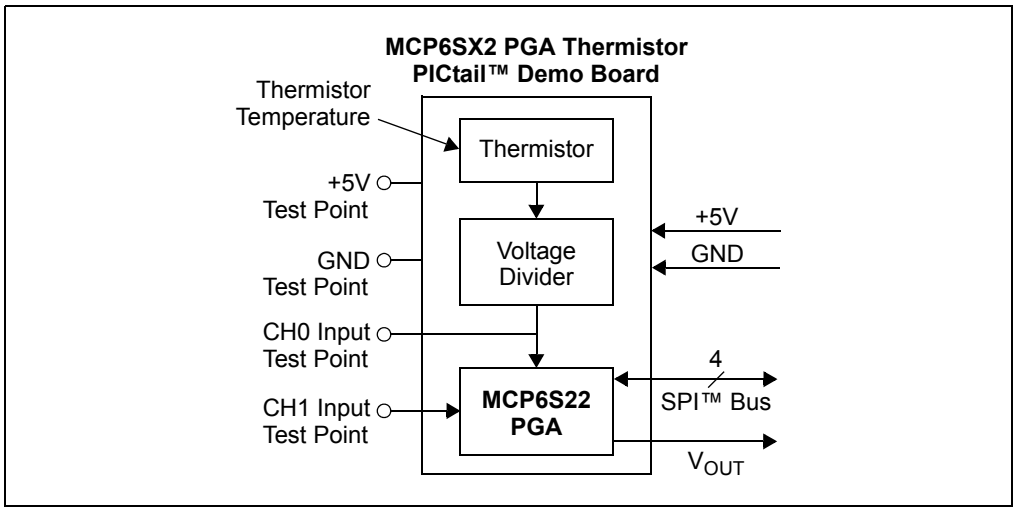


FIGURE 1-1: *MCP6SX2 PGA Thermistor PICtail™ Demo Board Block Diagram.*

The test points make it easier to test key points in the circuit, change the input signals, and to use this as a stand-alone board.

- GND Test Point – Connected to the ground plane, it is a convenient ground point for any lab equipment
- +5V Test Point – Allows measurement of the positive supply voltage and provides a means to power this board with a laboratory power supply
- CH0 Test Point – The place to measure the voltage divider's output (also the PGA's CH0 input)
- CH1 Test Point – Makes it possible to send any desired signal to the PGA

More details on the circuit and its design can be found in **Appendix A. "Schematic and Layouts"** and in AN897 (DS00897).

1.4 ASSOCIATED TOOLS

Figure 1-2 shows the block diagram of the hardware and software tools that the MCP6SX2 PGA Thermistor PICtail™ Demo Board is designed to work with. More information on these tools can be found in the **"Recommended Reading"** section.

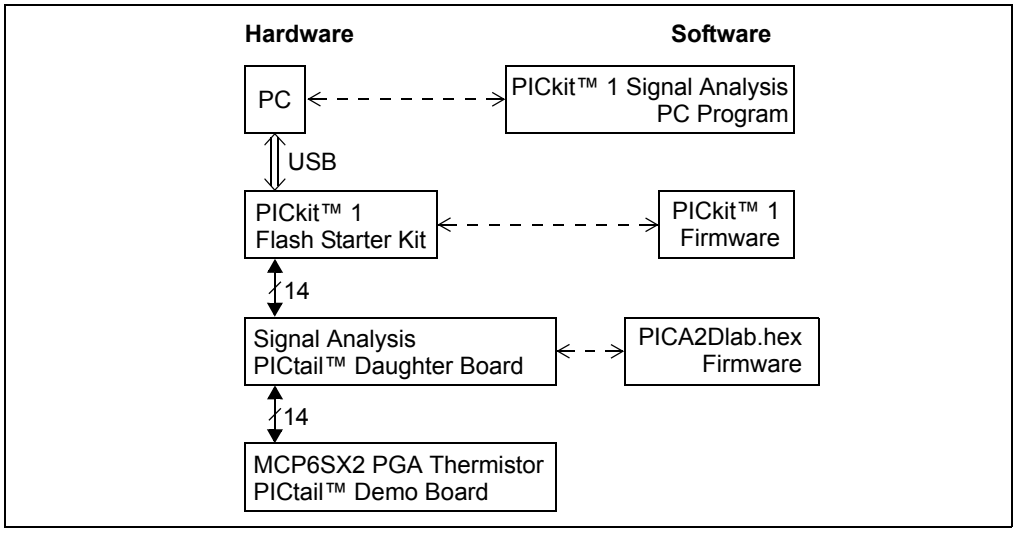


FIGURE 1-2: *Measurement Set-up Block Diagram.*

© 2006 Microchip Technology Inc.

1.4.1 PC Platform

The Personal Computer (PC) shown in Figure 1-2 needs to run on Windows® 98 SE or later. It provides a convenient interface for the user, communicates with the other boards and provides power through the USB connection.

1.4.2 PICkit™ 1 Signal Analysis PC Program

The PICkit™ 1 Signal Analysis PC program configures and programs the PIC16F684 PICmicro® microcontroller on the Signal Analysis PICtail Daughter Board through the USB port on the PICkit 1 Flash Starter Kit. It also imports data through the same connection and displays the data in strip-chart, histogram, FFT plot and oscilloscope plot formats. Data can be output in CSV format for importing into a spreadsheet program.

1.4.3 PICkit 1 Flash Starter Kit

The PICkit 1 Flash Starter Kit (DV164101) programs PICmicro microcontrollers. It uses the PIC16C745's USB port to communicate with the PICkit 1 Signal Analysis PC program. It connects to the Signal Analysis PICtail Daughter Board via a header (see Figure 2-1).

This board provides a single +5V supply voltage for the daughter boards. It can drive up to 5 µF on the supply; a larger capacitance may interfere with program timing.

1.4.4 PICkit 1 Firmware

This software resides on the PICkit 1 Flash Starter Kit's PIC16C745 microcontroller. Use version 2.0.2 or later.

1.4.5 Signal Analysis PICtail Daughter Board

This board is Microchip Development Tool AC164120. It connects to the PICkit 1 Flash Starter Kit, which it uses for both power and as a communications link to the PC. The on-board PIC16F684 has a 10-bit ADC which converts the MCP6SX2 PGA Thermistor PICtail™ Demo Board's output voltage. The results are temporarily stored on the board's 25LC640 serial EEPROM chips.

The +5V single supply voltage from the PICkit 1 Flash Starter Kit board is bypassed with a bulk 1 µF capacitor and local 0.1 µF capacitors for each IC.

1.4.6 Firmware for the Signal Analysis PICtail Daughter Board

`PICA2Dlab.hex` is the standard file that supports the PICkit™ 1 Signal Analysis PC program. The PGA and 10-bit ADC configuration are selected in the Signal Analysis PC program and written to the PIC16F684. The PIC16F684 then sends the command(s) over the SPI™ bus to the PGA. It displays the ADC code on the strip chart.

`Therm_PGA1.hex` implements the first design in AN897. It supports the PICkit™ 1 Signal Analysis PC program, but with reduced functionality; its output can be viewed on the strip chart only. The results need to be manually converted to commonly-seen temperature (codes 0 to 1023 convert to 0.0°C to 102.3°C).

`Therm_PGA2.hex` implements the second design in AN897. It supports the PICkit™ 1 Signal Analysis PC program, but with reduced functionality; its output can be viewed on the strip chart only. The results need to be manually converted to commonly-seen temperature (codes 0 to 1023 convert to 0.0°C to 102.3°C).

1.4.7 Interface Details

A more detailed look at how the MCP6SX2 PGA Thermistor PICtail™ Demo Board interfaces with the other boards is shown in Figure 1-3.

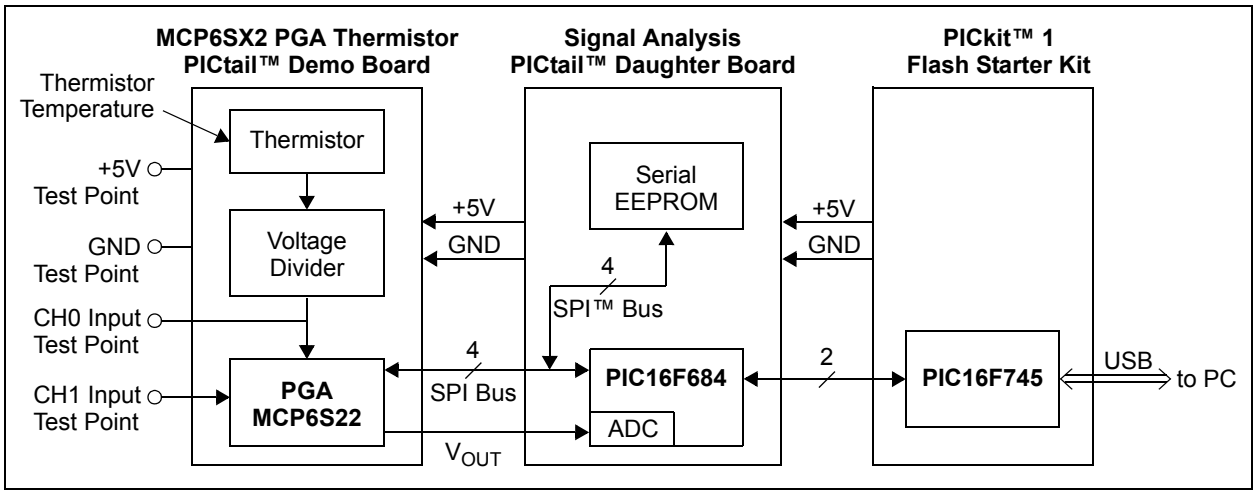


FIGURE 1-3: *Detailed Interface Diagram.*

© 2006 Microchip Technology Inc.

Chapter 2. Setup and Installation

2.1 INTRODUCTION

This chapter shows how to set up the MCP6SX2 PGA Thermistor PICtail™ Demo Board. This chapter discusses:

- Required Tools
- Connecting the MCP6SX2 PGA Thermistor PICtail™ Demo Board
- Set-up Verification

2.2 REQUIRED TOOLS

The PICkit™ 1 Flash Starter Kit User's Guide explains how to set up the PC and the PICkit™ 1 Flash Starter Kit. Use firmware version 2.0.2 or later.

The Signal Analysis PICtail™ Daughter Board User's Guide shows how to install the PICkit 1 Signal Analysis PC Program on the PC and set up the Signal Analysis PICtail Daughter Board. It also covers the features of the PICkit 1 Signal Analysis PC program.

The PICkit 1 CD-ROM (DS40049) contains many of the necessary files.

2.3 CONNECTING THE MCP6SX2 PGA THERMISTOR PICTAIL™ DEMO BOARD

An exploded view of how the different boards connect is shown in Figure 2-1.

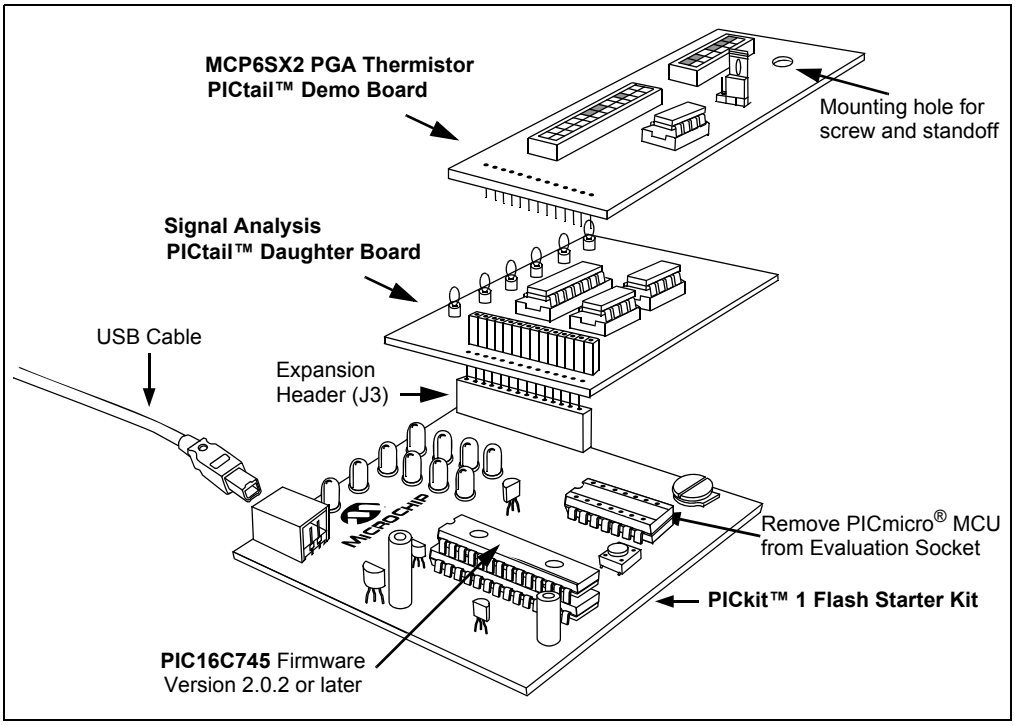


FIGURE 2-1: *Board Connections.*

2.3.1 PCB Standoff

The standoff and screw listed in Table B-2 are installed at the mounting hole shown in Figure 2-1. The standoff goes on bottom, and the screw on top.

2.3.2 PICkit 1 Flash Starter Kit

1. Remove any PICmicro microcontroller that may be in the evaluation socket.
2. Connect the USB cable to the PC and the PICkit 1 Flash Starter Kit board. The status LEDs (green POWER and yellow BUSY in the LED array) should light up.

It is easiest to use this board when it lays directly on a bench top.

2.3.3 Signal Analysis PICtail Daughter Board

This board plugs into the PICkit 1 Flash Starter Kit's expansion header J3 and must not cover the LED array. There should be no change in the status LEDs on the PICkit 1 Flash Starter Kit board after it is plugged in.

2.3.4 MCP6SX2 PGA Thermistor PICtail™ Demo Board

If you would rather use the MCP6S92 PGA, take it out of the anti-static bag and replace the already installed MCP6S22 PGA.

1. Plug this board into, and directly above, the Signal Analysis PICtail Daughter Board. There should be no change in the status LEDs on the PICkit 1 Flash Starter Kit board after it is plugged in.

2.3.4 Set-up Verification

1. Select the **Real Time Mode** radio button.
2. Click on the **Strip Chart** button.
3. Change the sample speed to 20 Sample/Secs.
4. Click on the green **GO** button; the strip chart will show the measured output of the MCP6SX2 PGA Thermistor PICtail™ Demo Board.
5. Change the switch positions (SW_1 and SW_2) and verify that the strip chart changes. Figure 2-2 shows the result when R_A was set to 10 kΩ and Rvar to 0Ω, then 12.8 kΩ, and then 217.6 kΩ (see **Section 3.2 "Configuring Board"**).

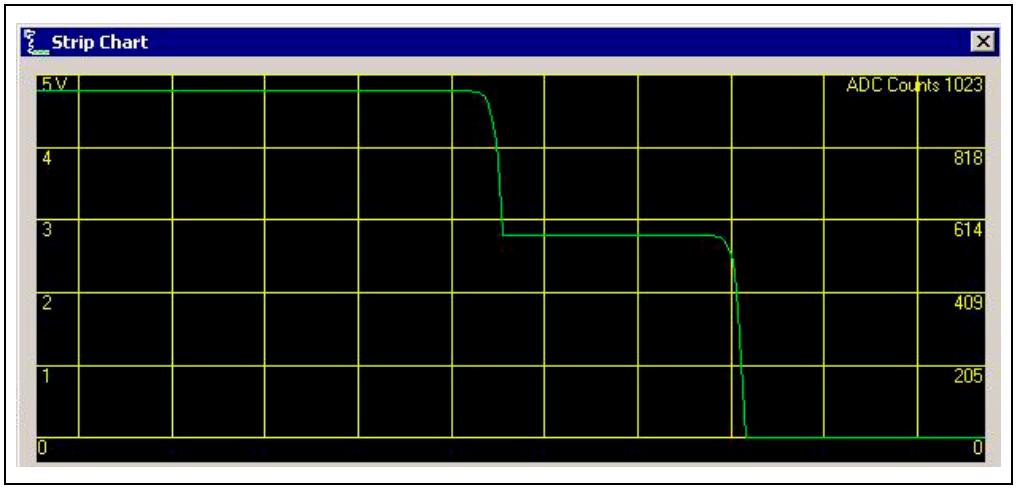


FIGURE 2-2: *Strip Chart.*

© 2006 Microchip Technology Inc.

Chapter 3. Using the MCP6SX2 PGA Thermistor PICtail™ Demo Board

3.1 INTRODUCTION

This demonstration board makes it easy to explore the operation of two thermistor applications using the MCP6S22 PGA. Items discussed in this chapter include:

- Configuring the Board
- Using the Signal Analysis PC Program for This Board
- Stand-Alone Board Set-up

3.2 CONFIGURING BOARD

3.2.1 Configuring Jumper JMP1 (select Thermistor or Rvar)

Figure 3-1 shows how jumper JMP_1 configures the circuit. When the shorting bar is on the right side of jumper JMP_1, the thermistor R_{TH} is connected to the circuit. When it is on the left side of jumper JMP_1, the thermistor emulator Rvar is connected to the circuit.

Refer to Figure A.4 for the complete schematic.

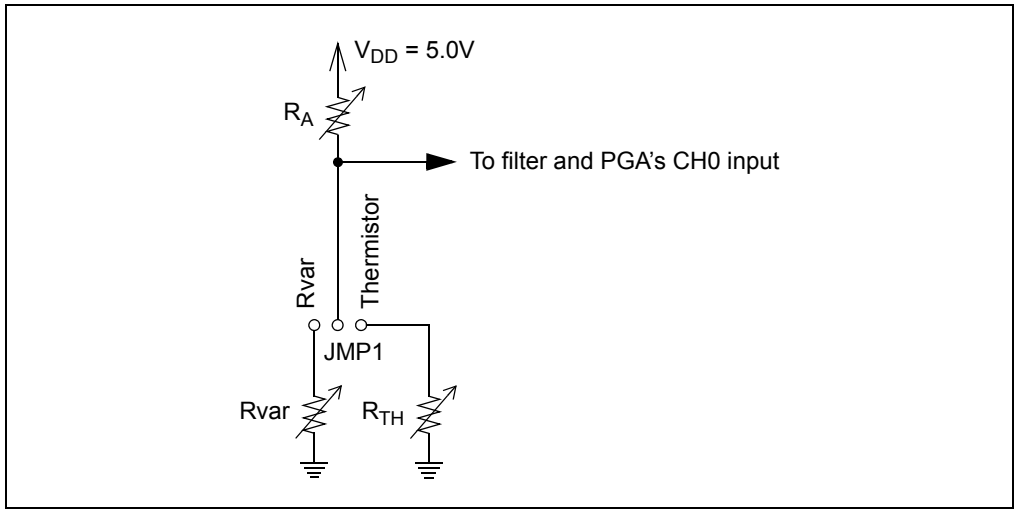


FIGURE 3-1: *Simplified Jumper Circuit.*

3.2.2 Configuring DIP Switch SW1 (R_A)

DIP switch SW_1 and resistors R_1 – R_7 in Figure 3-2 emulate the voltage divider resistor (R_A in Figure 3-1). R_1 is placed in series with the others to prevent shorting the supplies together. These resistors produce a binary sequence of values between 0.5 kΩ and 32.0 kΩ.

Refer to Figure A.4 for the complete schematic.

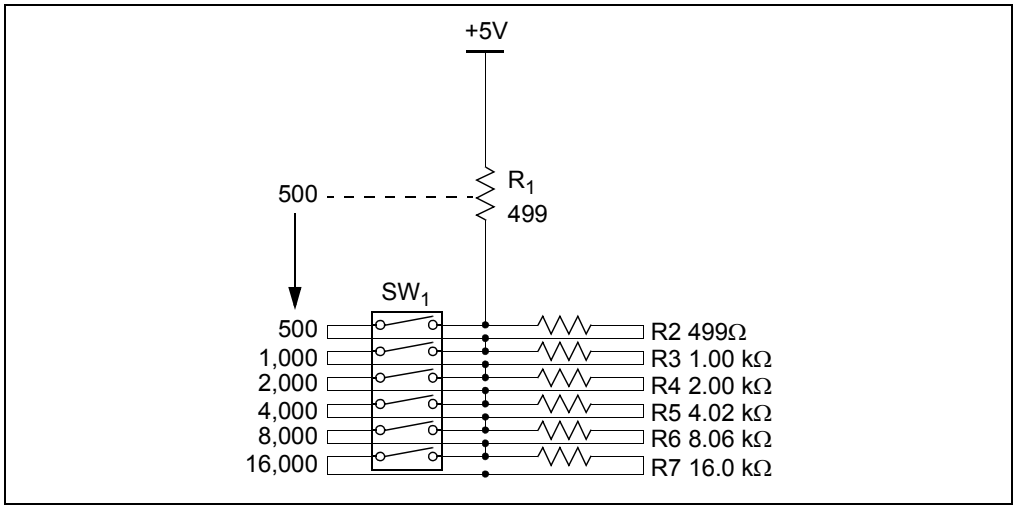


FIGURE 3-2: *R_A Emulator.*

Each resistor with its switch (in SW_1) pointing to the right, away from the silk screen resistor values, is not added into the total for R_A (it shorts that resistor).

Each resistor with its switch (in SW_1) pointing to the left, towards the silk screen resistor values, is added into the total for R_A.

As an example, if the top four switches are to the right, and the bottom two are to the left, then R_A is calculated as 500 + 0 + 0 + 0 + 0 + 8,000 + 16,000 = 24,500Ω.

3.2.3 Using the Thermistor (R_{TH})

R_{21} in **Section A.4 "Board Schematic"** is the thermistor (R_{TH} in Figure 3-1). The resistance changes depending on temperature; see AN897, *"Thermistor Temperature Sensing with MCP6SX2 PGAs"* (DS00897).

 © 2006 Microchip Technology Inc.

3.2.4 Configuring DIP Switch SW2 (R_{TH} Emulator, Rvar)

DIP switch SW2 and resistors R_8 – R_{19} in Figure 3-3 comprise the thermistor emulator (Rvar in Figure 3-1). Rvar produces a binary sequence of resistances between 0Ω and 409.5 kΩ.

Refer to Figure A.4 for the complete schematic.

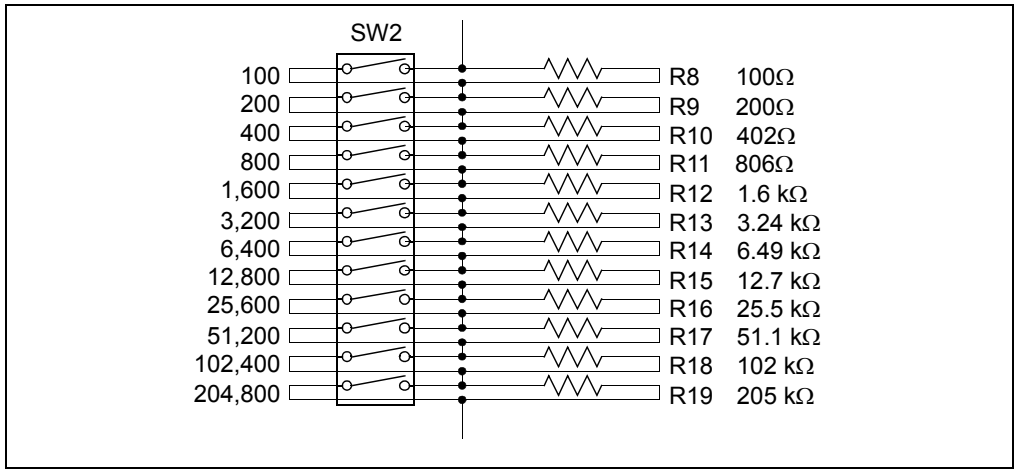


FIGURE 3-3: *R_{TH} Emulator (Rvar).*

Each resistor with its switch (in SW_2) pointing to the right, away from the silk screen resistor values, is not added into the total for R_A (it shorts that resistor).

Each resistor with its switch (in SW_2) pointing to the left, towards the silk screen resistor values, is added into the total for R_A.

As an example, if the top ten switches are to the right, and the bottom two are to the left, then Rvar is calculated as 0 + 0 + ... + 0 + 102,400 + 204,800 = 307,200Ω.

AN897, *"Thermistor Temperature Sensing with MCP6SX2 PGAs"* (DS00897) contains information on converting this resistance to the equivalent, nominal thermistor temperature, and visa-versa.

3.2.5 Using the Signal Analysis PC Application for This Board

See **"Chapter 2. Using the PICkit™ Signal Analysis PC Application"** of the *"Signal Analysis PICtail™ Daughter Board User's Guide"* (DS51476) for details on displaying measured results. The possible formats include: oscilloscope, FFT, histogram and strip-chart.

The measured results can then be interpreted as temperature; see AN897, *"Thermistor Temperature Sensing with MCP6SX2 PGAs"* (DS00897).

3.2.6 Choosing Firmware for the Signal Analysis PICtail Daughter Board

Use the standard `PICA2Dlab.hex` file to measure and analyze the PGA's output voltage. This file supports all of the display functionality of the PICkit 1 Signal Analysis PC application program.

Use `Therm_PGA1.hex` to implement the first design shown in AN897, *"Thermistor Temperature Sensing with MCP6SX2 PGAs"* (DS00897). Its output can only be viewed on the strip chart. The results need to be manually converted to commonly-seen temperatures (codes 0 to 1023 convert to 0.0°C to 102.3°C).

Use `Therm_PGA2.hex` to implement the second design in AN897, *"Thermistor Temperature Sensing with MCP6SX2 PGAs"* (DS00897). Its output can only be viewed on the strip chart. The results need to be manually converted to commonly-seen temperatures (codes 0 to 1023 convert to 0.0°C to 102.3°C).

 © 2006 Microchip Technology Inc.

3.2.7 Configure the PGA

The PICkit 1 Signal Analysis PC program can configure the PGA; see Figure 3-4. The MCP6S22 PGA defaults to a gain of 1 and CH0.

Note: The MCP6S92 PGA powers up to a random state; it must have its gain and input written to it before it will operate as expected.

1. Open the PGA window by clicking the **External Devices** button.
2. Select the correct PGA from the indicated pull-down list.
3. Select the desired PGA input. Usually the selection will be CH0 for the thermistor output, but it can be CH1 when another input source is provided at the CH1 test point (Figure 1-1).
   a. Select **Write to Register** from the indicated pull-down list. (Figure 3-4, #5)
   b. Set A0 = 1. (Figure 3-4, #6)
   c. Set C2:C0 to all zeros. (Figure 3-4, #7)
   d. Execute the command by clicking on the **Write to PGA** button. (Figure 3-4, #8)
4. Select the desired PGA gain.
   a. Select **Write to Register** from the indicated pull-down list. (Figure 3-4, #5)
   b. Set A0 = 0. (Figure 3-4, #6)
   c. Select PGA gain from the pull-down list. (Figure 3-4, #4))
   d. Execute the command by clicking on the **Write to PGA** button. (Figure 3-4, #8)

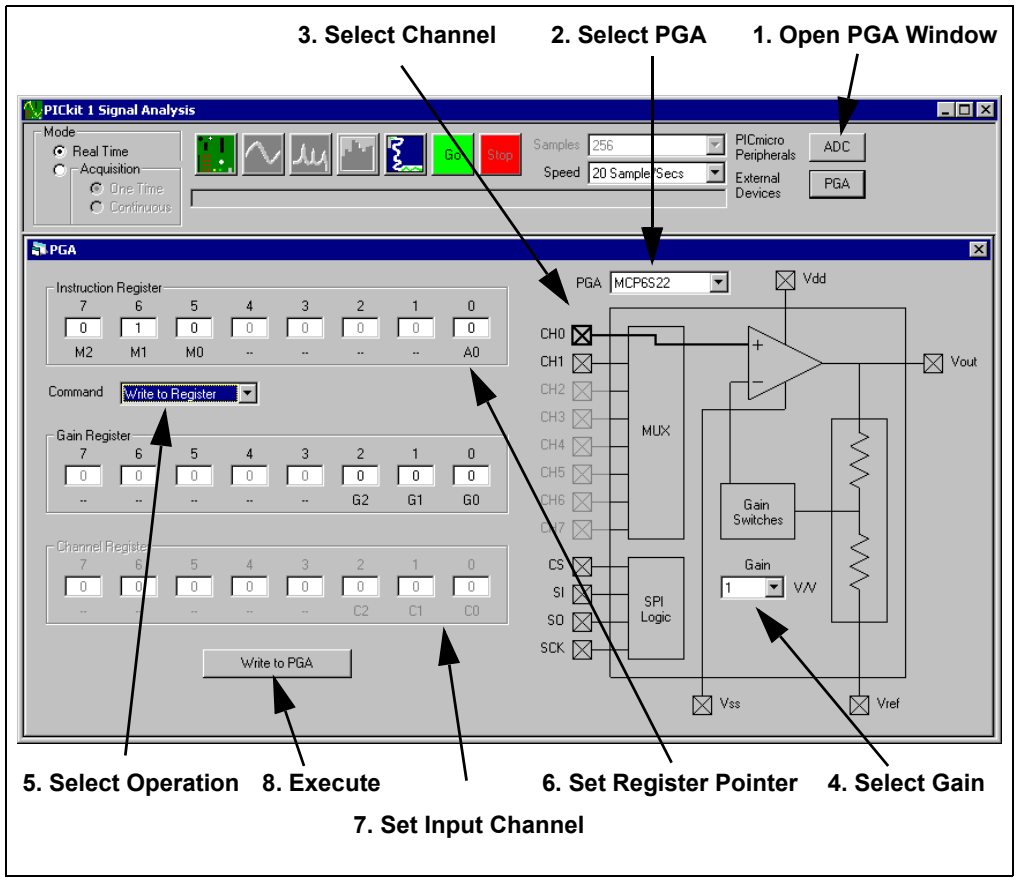


FIGURE 3-4: *PGA Configuration.*

3.2.8 Configure the ADC

The ADC is automatically setup by the PICkit 1 Signal Analysis PC program. The two possible inputs are shown in Figure 3-5.

1. If in the Real Time Mode of operation (Strip Chart), select the **Number of Samples** from the first pull-down list.
2. Select the **Sample Rate** from the second pull-down list.

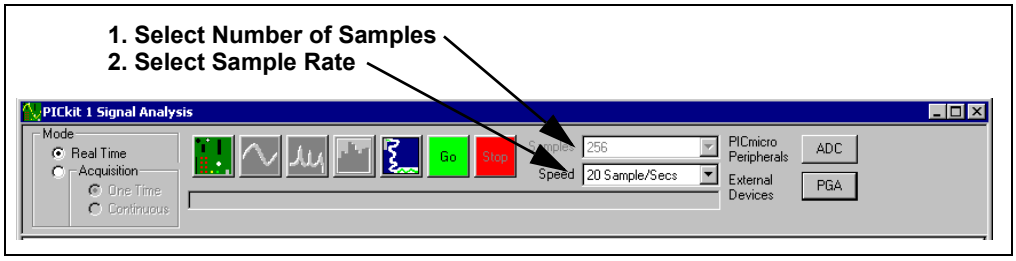


FIGURE 3-5: *Standard ADC Options.*

The PICkit 1 Signal Analysis PC program allows the user to manually configure the ADC.

1. Clicking the ADC button (see Figure 3-6) opens the ADC configuration window. This window starts at the power-on default conditions for the ADC; therefore, it must be configured before use.

See the PIC16F684 data sheet (DS41202) for more information on configuring the registers.

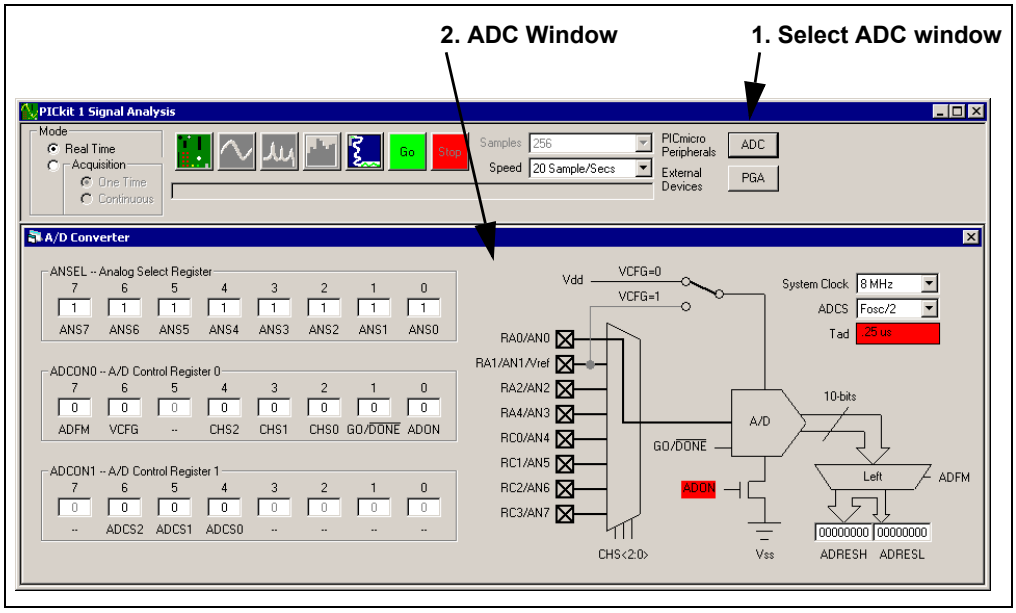


FIGURE 3-6: *Manual ADC Configuration.*

 © 2006 Microchip Technology Inc.

3.2.9 Measurement Example

Jumper JMP_1 was configured to select the thermistor, R_{21} (R_{TH} in Figure 3-1). R_A was set at 10 kΩ (Design # 1). The thermistor was at room temperature. The MCP6S22 PGA was at its default settings, input CH0 and gain = 1. The results using the `PICA2Dlab.hex` file (**Section 3.2.6 "Choosing Firmware for the Signal Analysis PICtail Daughter Board"**) are shown in Figure 3-7. The output voltage is 2.568V.

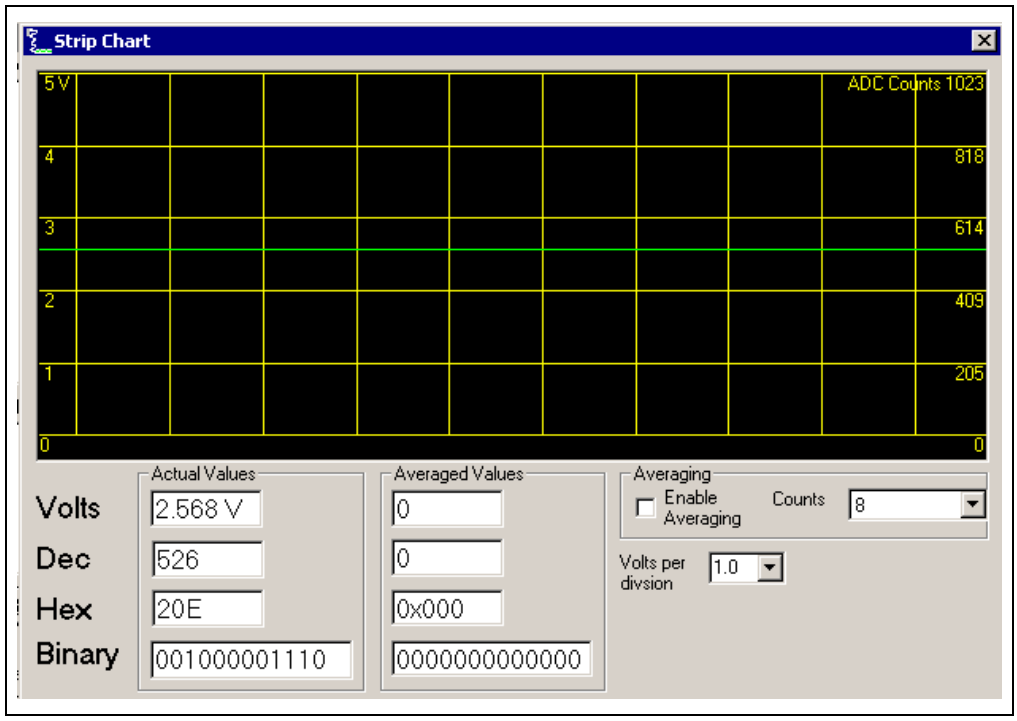


FIGURE 3-7: *Measurement Results.*

The output voltage was used to calculate $R_{TH} \approx 10.56$ kΩ and $T_{TH} \approx 23.5$°C (74.3°F). See AN897, *"Thermistor Temperature Sensing with MCP6SX2 PGAs"* (DS00897).

3.2.10 Stand-Alone Board Setup

Figure 3-8 shows one possible method for using the MCP6SX2 PGA Thermistor PICtail™ Demo Board as a stand-alone (without the accompanying tools shown in Figure 1-2). Most of the probes from the lab equipment (on the left) connect to the test points. The oscilloscope (O-Scope) probe to V_{OUT} connects to header J2's pin # 10 (labeled RC0).

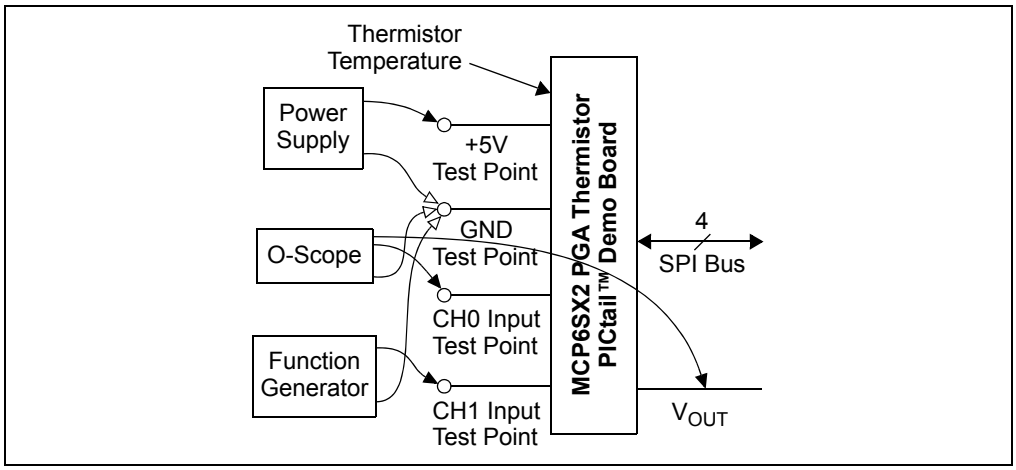


FIGURE 3-8: *MCP6SX2 PGA Thermistor PICtail™ Demo Board Block Diagram.*

The PGAs' power supply range is between 2.5V and 5.5V. The SPI bus needs to be connected to a microcontroller with the appropriate firmware. The MCP6S22 PGA powers up to input CH0 and 1 V/V gain. The MCP6S92 needs to be initialized after power-up.

 © 2006 Microchip Technology Inc.

Appendix A. Schematic and Layouts

A.1 INTRODUCTION

This appendix contains the schematics and layouts for the MCP6SX2 PGA Thermistor PICtail™ Demo Board.

The MCP6SX2-PICTLTH demonstration board is constructed using a two-layer Printed Circuit Board (PCB). The top layer is for components and traces, while the bottom layer is the ground plane.

Information on this board includes:

- Board Schematic
- Board - Top Silk-Screen And Metal Layers
- Board - Top Metal Layer
- Board - Bottom Metal Layer

A.2 DEMONSTRATION BOARD DESCRIPTION

A simplified block diagram of this board is shown in Figure 1-1. The detailed schematic is given in Figure A.4.

DIP switch SW_1 and resistors R_1 – R_7 emulate the voltage divider's series resistor (R_A in Figure 3-1). R_1 is placed in series with the others to prevent shorting the supplies together. Resistors R_1 – R_7 produce a binary sequence of values between 0.5 kΩ and 32.0 kΩ.

R_{21} is the thermistor (R_{TH} in Figure 3-1).

DIP switch SW_2 and resistors R_8 – R_{19} (labeled Rvar in top silk screen) emulate the thermistor. Rvar produces a binary sequence between 0Ω and 409.5 kΩ.

The jumper JMP_1 selects either the thermistor or its emulator Rvar. R_{20} and C_1 are the low-pass analog filters used to minimize noise. They also act as anti-aliasing filters for the ADC.

U_1 is either the MCP6S22 or the MCP6S92 Programmable Gain Amplifier (PGA). The PGA buffers the transimpedance amplifier output and makes it possible to gain up weak signals before conversion by the ADC. J_2 connects this board to the Signal Analysis board. C_2 and C_3 are bypass capacitors that minimize power supply noise.

The demonstration board includes test points for convenience on the bench. The +5V and GND test points connect to the board's supply voltages. The CH0 test point connects to the PGA's CH0 input; it is also connected to the voltage divider's output (with filtering). The CH1 test point allows the user to place any desired signal at the PGA's CH1 input.

Note: While headers J1, J2, and J3 are shown together in the schematic (see Figure A.4), J2 is installed (see Table B-1), while J1 and J3 are not. J2 and J3 are placeholders only.

A.3 ADDITIONAL COMMENTS

The demonstration board includes test points for convenience on the bench. The +5V and GND test points connect to the board's supply voltages. The CH0 test point connects to the PGA's CH0 input; it is also connected to the voltage divider's output (with filtering). The CH1 test point allows the user to place any desired signal at the PGA's CH1 input.

The PIC16F684 (and 10-bit ADC) are not part of the demo board schematic; see Figure 1-3 instead.

The PICkit 1 Flash Starter Kit provides a +5V single supply voltage. It can drive up to 5 µF on the supply; a larger capacitive load causes current loading and timing issues.

The PICkit 1 Flash Starter Kit Signal Analysis PICtail Daughter Board uses the +5V single supply voltage. It has 0.1 µF local bypass capacitors for each IC, and a 1 µF bulk bypass capacitor for the entire board.

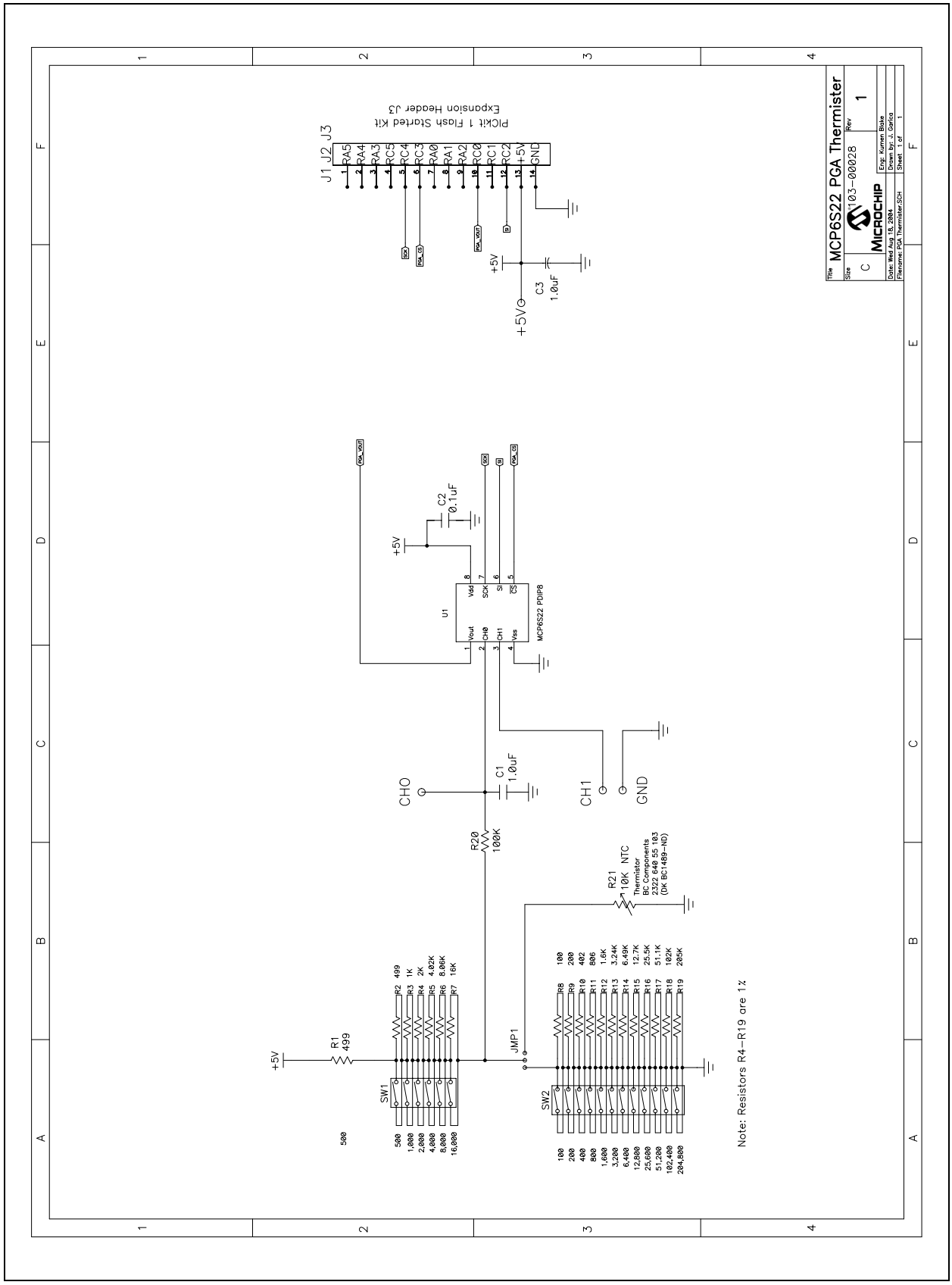
This demonstration board also uses the +5V single supply voltage. It has a 0.1 µF local bypass capacitor for the PGA, and a 1 µF bulk bypass capacitor for the entire board. A solid ground plane provides a good ground for the PGA.

High-frequency design practices are used to minimize digital interference:

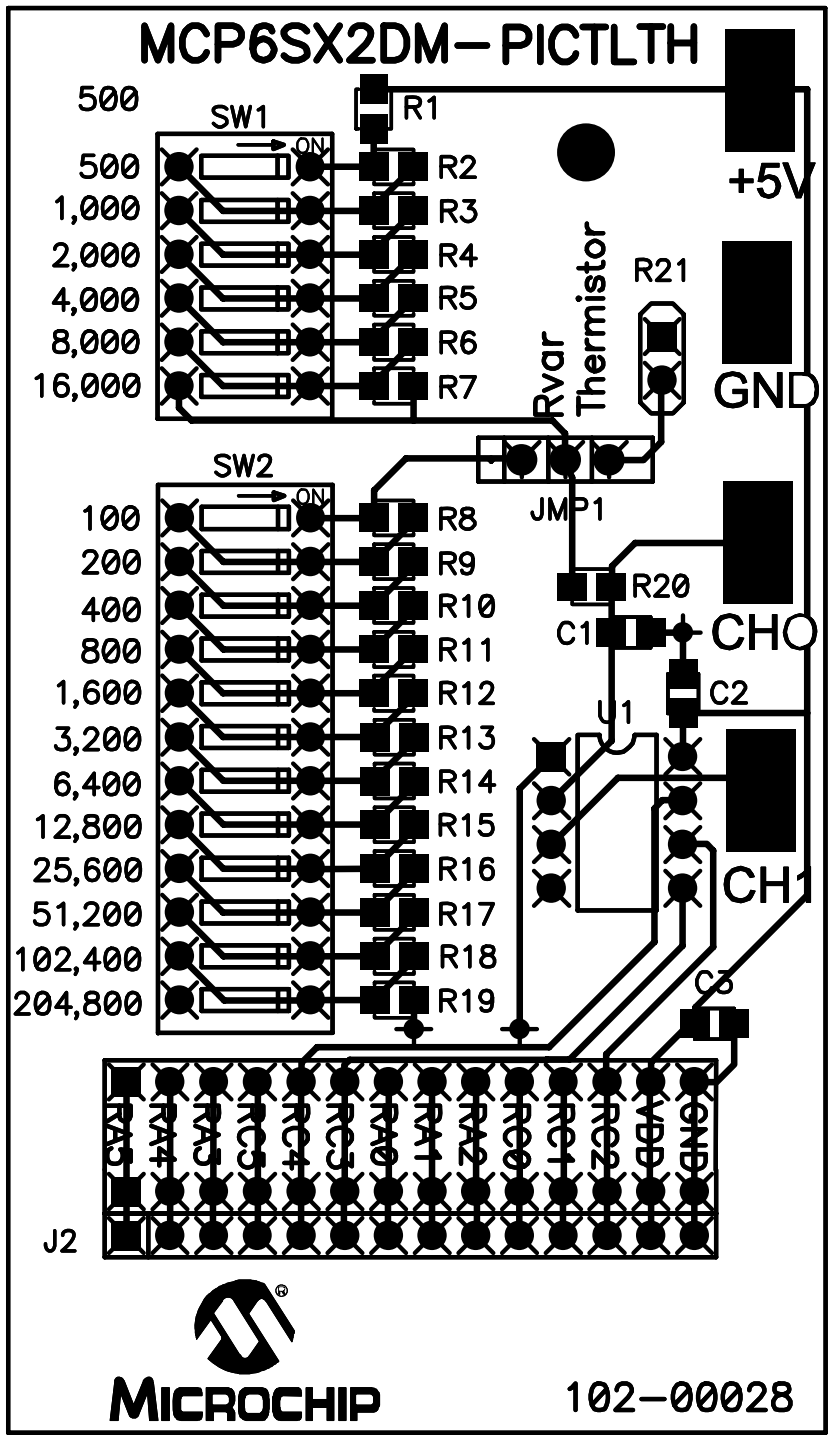
- Solid ground plane
- Surface-mount devices
- Separate digital and analog lines and sections
- Straight and short lines to the PGA

© 2006 Microchip Technology Inc.

A.4 BOARD SCHEMATIC

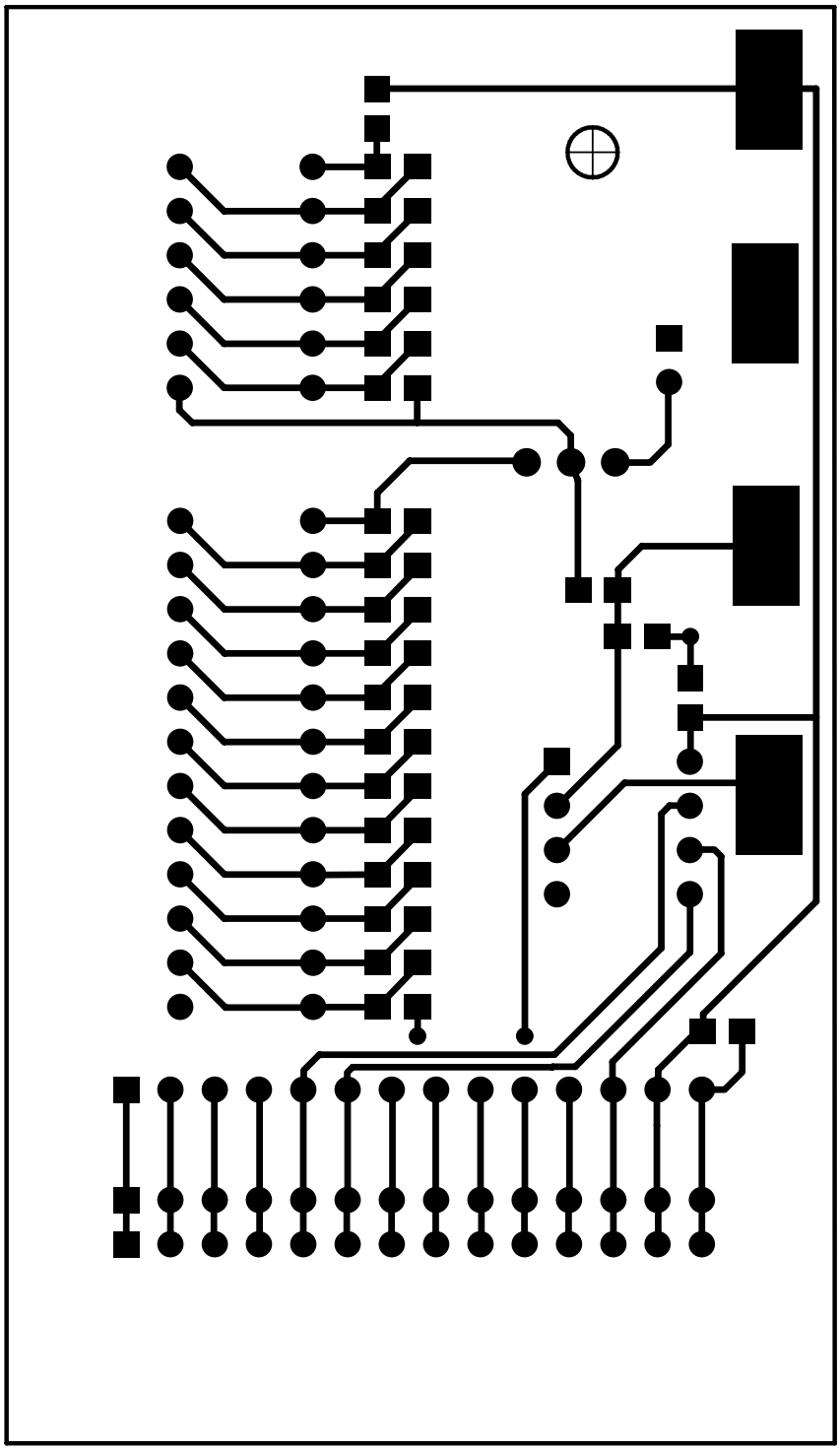


A.5 BOARD - TOP SILK SCREEN AND METAL LAYERS

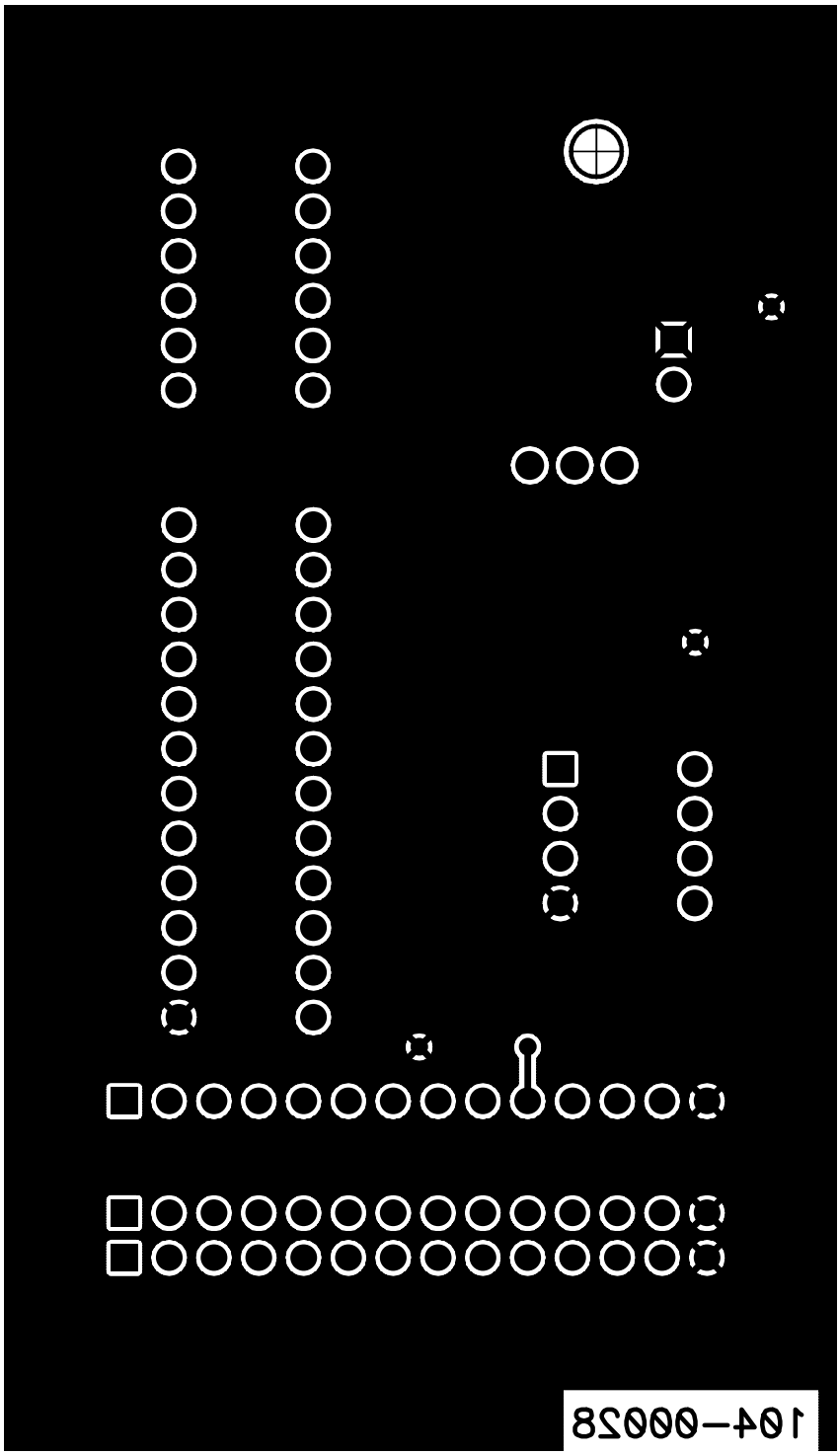


© 2006 Microchip Technology Inc.

A.6 BOARD - TOP METAL LAYER



A.7 BOARD - BOTTOM METAL LAYER



© 2006 Microchip Technology Inc.

Appendix B. Bill Of Materials (BOM)

B.1 COMPONENTS INSTALLED ON PCB

Table B-1 shows the Bill of Materials for the MCP6SX2 PGA Thermistor PICtail™ Demo Board as it comes from Microchip.

TABLE B-1: BILL OF MATERIALS

Qty	Reference	Description	Manufacturer	Part Number
2	C1,C3	1.0 µF, 16V, 10%, X7R, 0805 SMD, Ceramic	Kemet®	C0805C105K4RACTU
1	C2	0.1 µF, 25V, 10%, X7R, 0805 SMD, Ceramic	Panasonic® - ECG	ECJ-2VB1E104K
1	J2	Header, 1 × 14, 0.100" Pitch, Vertical, Tin	AMP®/Tyco® Electronics	1-640454-4
1	JMP1	Header, 1 × 3, 0.100" Pitch, Vertical, Tin	AMP/Tyco Electronics	3-644456-3
1	(for JMP1)	Shunt, 1 × 2, With Handle , Gold	AMP/Tyco Electronics	881545-2
2	R1, R2	499Ω, 1/8W, 1%, 0805 SMD	Panasonic - ECG	ERJ-6ENF4990V
1	R3	1.00 kΩ, 1/8W, 1%, 0805 SMD	Panasonic - ECG	ERJ-6ENF1001V
1	R4	2.00 kΩ, 1/8W, 1%, 0805 SMD	Panasonic - ECG	ERJ-6ENF2001V
1	R5	4.02 kΩ, 1/8W, 1%, 0805 SMD	Panasonic - ECG	ERJ-6ENF4021V
1	R6	8.06 kΩ, 1/8W, 1%, 0805 SMD	Panasonic - ECG	ERJ-6ENF8061V
1	R7	16.2 kΩ, 1/8W, 1%, 0805 SMD	Panasonic - ECG	ERJ-6ENF1622V
1	R8	100Ω, 1/8W, 1%, 0805 SMD	Panasonic - ECG	ERJ-6ENF1000V
1	R9	200Ω, 1/8W, 1%, 0805 SMD	Panasonic - ECG	ERJ-6ENF2000V
1	R10	402Ω, 1/8W, 1%, 0805 SMD	Panasonic - ECG	ERJ-6ENF4020V
1	R11	806Ω, 1/8W, 1%, 0805 SMD	Panasonic - ECG	ERJ-6ENF8060V
1	R12	1.62 kΩ, 1/8W, 1%, 0805 SMD	Panasonic - ECG	ERJ-6ENF1621V
1	R13	3.24 kΩ, 1/8W, 1%, 0805 SMD	Panasonic - ECG	ERJ-6ENF3241V
1	R14.	6.49 kΩ, 1/8W, 1%, 0805 SMD	Panasonic - ECG	ERJ-6ENF6491V
1	R15	12.7 kΩ, 1/8W, 1%, 0805 SMD	Panasonic - ECG	ERJ-6ENF1272V
1	R16	25.5 kΩ, 1/8W, 1%, 0805 SMD	Panasonic - ECG	ERJ-6ENF2552V
1	R17	51.1 kΩ, 1/8W, 1%, 0805 SMD	Panasonic - ECG	ERJ-6ENF5112V
1	R18	102 kΩ, 1/8W, 1%, 0805 SMD	Panasonic - ECG	ERJ-6ENF1023V
1	R19	205 kΩ, 1/8W, 1%, 0805 SMD	Panasonic - ECG	ERJ-6ENF2053V
1	R20	100 kΩ, 1/8W, 1%, 0805 SMD	Panasonic - ECG	ERJ-6ENF1003V
1	R21	Thermistor, NTC, 10 kΩ, 1% tolerance at 25°C, Leaded **(Note 1)**	BC Components	2381 640 55103
1	SW1	DIP Switch, 6 Position, SPST, Extended, Sealed	Grayhill, Inc	78B06ST
1	SW2	DIP Switch, 12 Position, SPST, Extended	Grayhill, Inc	78B12ST
4	CH0, CH1, GND, +5V	PC Test Point, Compact, SMT	Keystone Electronics®	5016

Note 1: When this thermistor is out of stock, the BC Components, 2381 640 54103 thermistor (2%), or equivalent, will be substituted.

TABLE B-1: BILL OF MATERIALS (CONTINUED)

Qty	Reference	Description	Manufacturer	Part Number
1	U1	MCP6S22, PGA, 10 MHz, 2 inputs, PDIP-8	Microchip Technology Inc.	MCP6S22-I/P
1	(for U1)	IC Socket, 8-pin DIP, Tin, 0.300"	AMP/Tyco Electronics	2-641260-1
1	PCB	Lead Free RoHS Compliant PCB	—	104-00028
0	J1, J3	Not Populated	—	—

Note 1: When this thermistor is out of stock, the BC Components, 2381 640 54103 thermistor (2%), or equivalent, will be substituted.

B.2 SEPARATELY PACKAGED COMPONENTS

Table B-2 lists the components that are packaged separately in an anti-static bag.

TABLE B-2: BILL OF MATERIALS – SEPARATELY PACKAGED COMPONENTS

Qty	Reference	Description	Manufacturer	Part Number
1	U1	MCP6S92, PGA, 10 MHz, 2 inputs, PDIP-8 **(Note 1)**	Microchip Technology Inc.	MCP6S92-E/P
1	—	Nylon Standoff, Hex, 1.000", 4-40 Thread **(Note 2)**	Keystone Electronics®	1902E
1	—	Phillips Machine Screw, 3/8", 4-40 Thread **(Note 2)**	Building Fasteners	NY PMS 440 0038 PH

Note 1: **Section 2.3.4 "MCP6SX2 PGA Thermistor PICtail™ Demo Board"** and **Section 3.2.7 "Configure the PGA"** discuss installing and using this PGA.

2: **Section 2.3.1 "PCB Standoff"** describes the installation of these parts.

© 2006 Microchip Technology Inc.

NOTES:

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

© 2006 Microchip Technology Inc.