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MCP9800
Temperature Data Logger Demo Board User's Guide

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MCP9800 TEMPERATURE DATA LOGGER USER'S GUIDE

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MCP9800 TEMPERATURE DATA LOGGER 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 MCP9800 Temperature Data Logger 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 MCP9800 Temperature Data Logger Demo Board. The manual layout is as follows:

- **Chapter 1. "Product Overview"** – Important information about the MCP9800 Temperature Data Logger Demo Board.
- **Chapter 2. "Installation and Operation"** – This chapter includes a detailed description of each function of the demo board and instructions for how to begin using the board.
- **Appendix A. "Schematic and Layouts"** – Shows the schematic and layout diagrams for the MCP9800 Temperature Data Logger Demo Board.
- **Appendix B. "Bill Of Materials (BOM)"** – Lists the parts used to build the MCP9800 Temperature Data Logger 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]`
Ellipses...	Replaces repeated text	`var_name [, var_name...]`
	Represents code supplied by user	`void main (void) { ... }`

RECOMMENDED READING

This user's guide describes how to use MCP9800 Temperature Data Logger Demo Board. The following Microchip documents are available and recommended as supplemental reference resources.

MCP9800/1/2/3 Data Sheet, *"2-Wire High-Accuracy Temperature Sensor"* (DS21909)

This data sheet provides detailed information regarding the MCP9800 device.

AN1001 Application Note, *"IC Temperature Sensor Accuracy Compensation with a PICmicro® Microcontroller"* (DS01001)

This application note provides detailed information regarding how to compensate the MCP9800 output for higher accuracy.

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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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- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support
- Development Systems Information Line

Customers should contact their distributor, representative or field application engineer (FAE) 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 A (December 2005)

- Initial Release of this Document.

NOTES:

Chapter 1. Product Overview

1.1 INTRODUCTION

This chapter provides an overview of the MCP9800 Temperature Data Logger Demo Board and covers the following topics:

- What is the MCP9800 Temperature Data Logger Demo Board?
- What the MCP9800 Temperature Data Logger Demo Board Kit Includes

1.2 WHAT IS THE MCP9800 TEMPERATURE DATA LOGGER DEMO BOARD?

The MCP9800 Temperature Data Logger Demo Board demonstrates how to use the MCP9800 and an on-board EEPROM to log temperature data. A PIC16F684 14-pin Flash-based 8-bit CMOS PICmicro® microcontroller (MCU) device is used with the sensor and stores the temperature data in the EEPROM. The PICmicro microcontroller also communicates with the the Personal Computer (PC) using the PICkit1™ Flash Starter Kit. The temperature data stored in the EEPROM can be transferred to a PC using the PICkit 1 software and saved in *.csv format. The data file can be opened using Microsoft® Excel® software.

The MCP9800 Temperature Data Logger Demo Board can also be used as a "stand-alone" module, powered with a lithium battery, to measure ambient temperature and store up to 4096 temperature samples over an extended period of time.

1.3 WHAT THE MCP9800 TEMPERATURE DATA LOGGER DEMO BOARD KIT INCLUDES

This MCP9800 Temperature Data Logger Demo Board Kit includes:

- The MCP9800 Temperature Data Logger Demo Board
- PIC16F684 Firmware
- "MCP9800 Temperature Data Logger Demo Board User's Guide", (DS51593)
- MCP9800/1/2/3 Data Sheet, *"2-Wire High-Accuracy Temperature Sensor",* (DS21909)
- 24XX1025 Data Sheet, *"1024K I^2C™ CMOS Serial EEPROM"*, (DS21941)
- PIC16F684 Data Sheet, *"14-Pin Flash-Based, 8-Bit CMOS Microcontrollers with nanoWatt Technology"*, (DS40202)

NOTES:

Chapter 2. Installation and Operation

2.1 INTRODUCTION

The MCP9800 Temperature Data Logger Demo board allows the user to store up to 4096 temperature readings from the MCP9800 sensor to the 24LC1025, Microchip's 1024 Kbit EEPROM. The PIC16F684 PICmicro microcontroller is used to communicate with the sensor and EEPROM. In addition, the PICmicro microcontroller interfaces to a PC using the PICkit™ 1 Flash Starter Kit and transfers the temperature readings from the EEPROM to the PC. The data can be viewed using Microsoft Excel software. The PICkit™ 1 Flash Starter Kit can also be used to reprogram the on-board PICmicro microcontroller. The user can specify the number of measurements and measurement duration. The MCP9800 Temperature Data Logger Demo board can be powered using an external supply, the PICkit™ 1 Flash Starter Kit, or a 24 mm Lithium cell. The battery allows stand-alone operations.

2.2 FEATURES

The MCP9800 Temperature Data Logger Demo board has the following features:

- The MCP9800 Sensor with 0.25°C/LSb resolution
- Store 4096 temperature samples to serial EEPROM
- Standard 100 mil 14-pin header (P1) for easy interface to the PICkit™ 1 Flash Starter Kit or custom application
- PIC16F6784 PICmicro Microcontroller
- Temperature Alert LED indicator and measurement progress LED Indicator

2.3 GETTING STARTED

This section describes how to quickly configure the MCP9800 Temperature Data Logger Demo board and PICkit™ 1 Flash Starter Kit. A simplified block diagram of the configuration is provided in Figure 2-1.

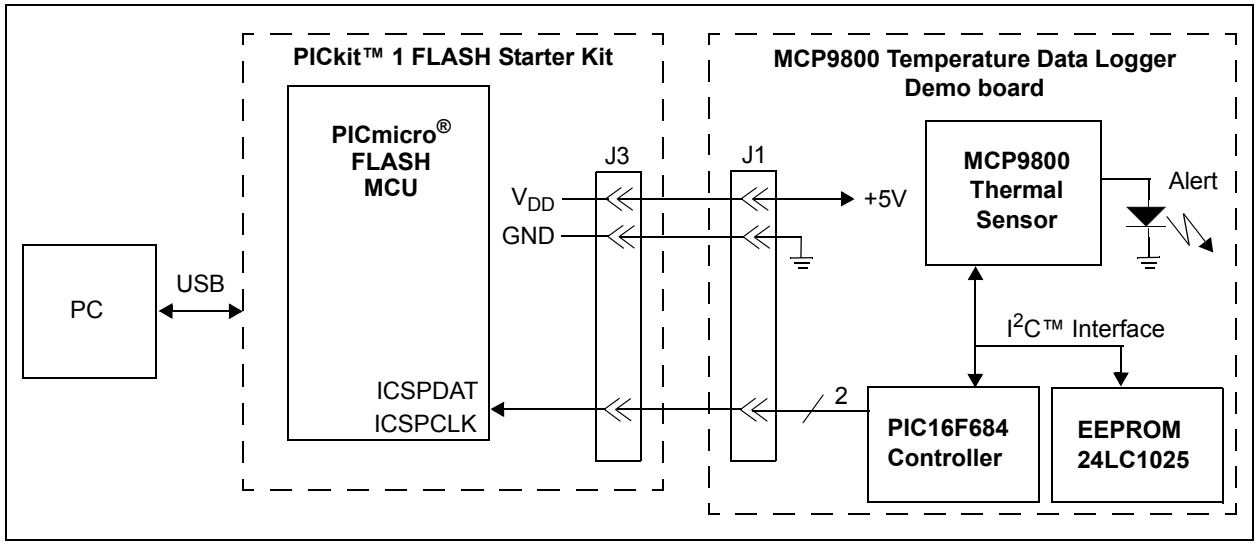

FIGURE 2-1: *MCP9800 Temperature Data Logger Demo Board Simplified Block Diagram.*

2.3.1 Hardware Setup

1. Connect the P1 header of the MCP9800 Temperature Data Logger Demo board to the J3 connector on the PICkit™ 1 Flash Starter Kit board. Refer to Figure 2-2 for proper orientation of the MCP9800 Temperature Data Logger Demo board and Figure 2-3 for a simplified board schematic.
2. 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.

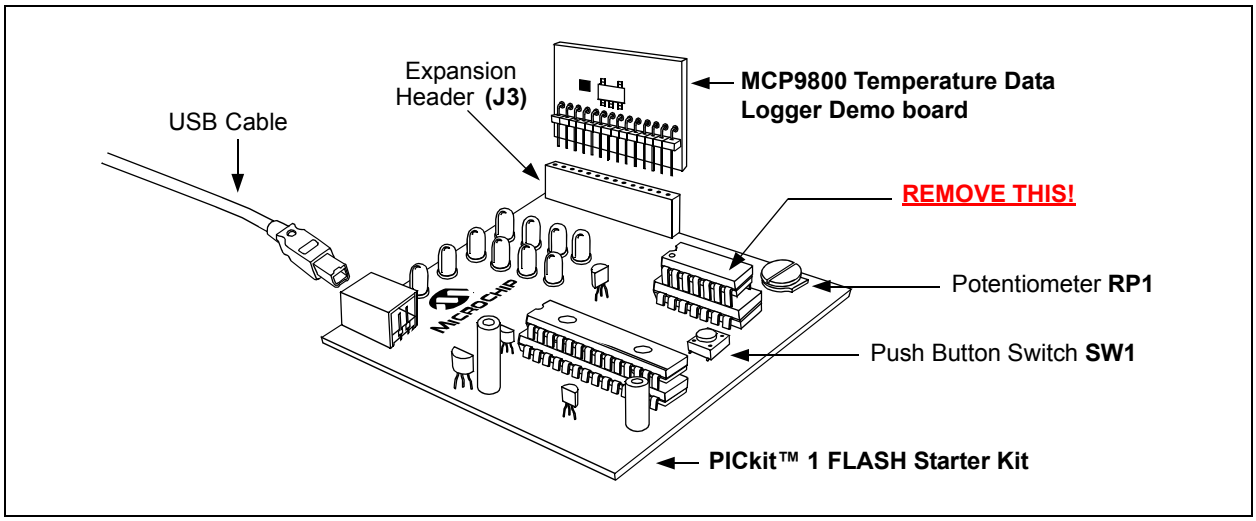

FIGURE 2-2: *MCP9800 PICtail™ Daughter Board and PICkit™1 FLASH Starter Kit.*

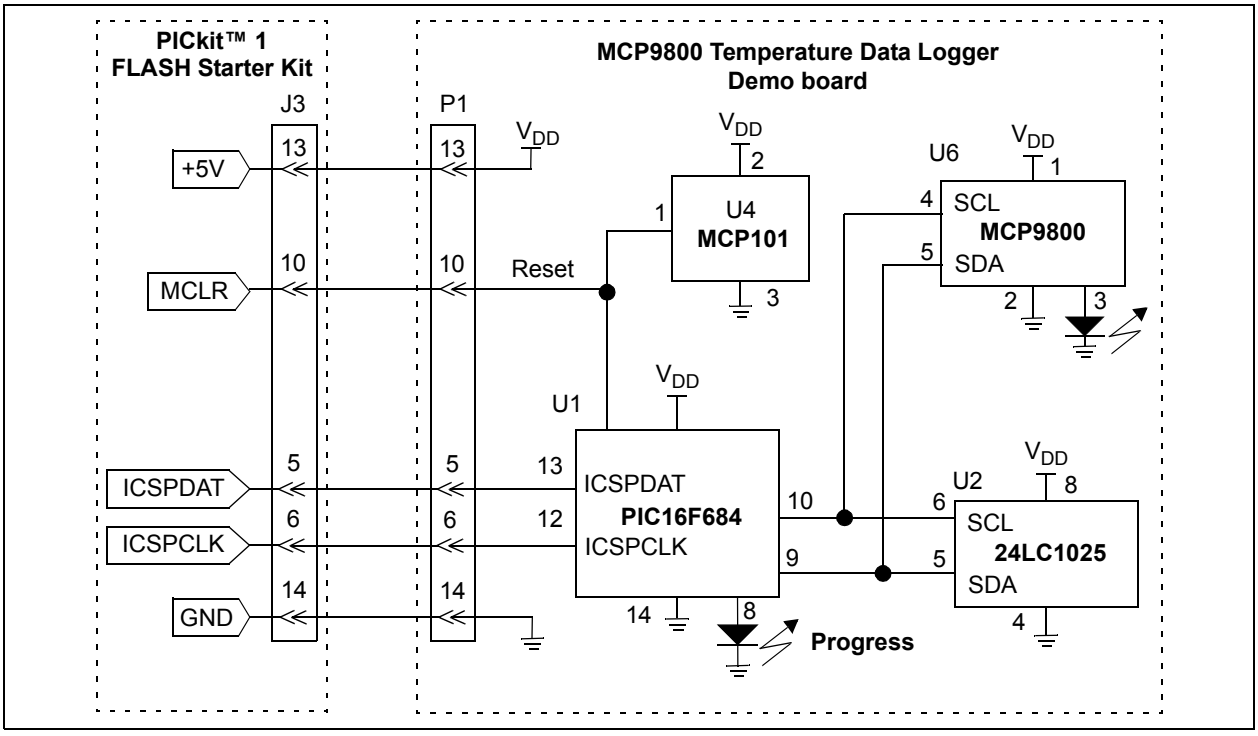

FIGURE 2-3: *Simplified MCP9800 PICtail™ Daughter Board Schematic.*

2.3.2 Programming the PIC16F684

3. Download and install the PICkit™ 1 Flash Starter Kit software to your PC.
4. Copy the `00083R1.HEX` file supplied on the CD that came with this kit to your PC.

Note: The PIC16F684 firmware is factory programmed with `00083R1.HEX`, therefore, it is not necessary to program it out of the box.

5. When the PICkit™ 1 Flash Starter Kit is started, the main window will be displayed on the PC as indicated in Figure 2-4.

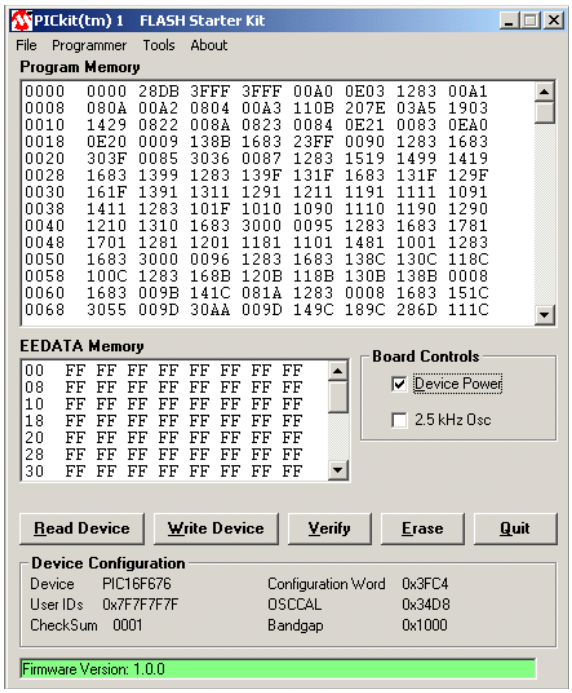

FIGURE 2-4: *PICkit™ 1 Flash Starter Kit GUI Window on the PC.*

6. 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.
7. Click on the **Erase** button in the window to ensure that the PIC16F684 device has been erased.
8. From the **File** pull down menu, select **Import HEX**. A file window will appear. Select and **Open** `00083R1.HEX`.
9. Click on the **Write Device** button in the PICkit™ 1 Flash Starter Kit window. The PIC16F684 device will be written to with the **MCP9800** `00083R1.HEX` firmware. Once completed, the status bar at the bottom of the window will indicate **Write Successful**.
10. 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.
11. The PICmicro microcontroller starts measuring temperature and storing the data in the EEPROM.

Note: The J2 connector can be used to program the PICmicro microcontroller using PICkit™ 2 Microcontroller Programmer.

2.4 FUNCTIONAL DESCRIPTION

2.4.1 The MCP9800 Temperature Data Logger Demo board

The MCP9800 Temperature Data Logger Demo board uses the PIC16F684 to measure ambient temperature using the MCP9800 temperature sensor and store the temperature data to the 24LC1025 serial EEPROM. The number of samples and the sampling duration is specified by the user. Once the specified number of samples are stored, the controller waits for a command from the PICkit™ 1 Flash Starter Kit signal analysis tool to transmit the samples to the PC. The software tool can be used to save the data in *.csv format, which allows the user to view the data using Microsoft Excel software.

There are two LEDs on-board, D_1 and D_2. D_1 indicates an overtemperature alert. It turns on when the ambient temperature rises above the user specified limit and it remains lit until the temperature falls below the user specified hysteresis limit. (see **Section 2.4.2.3**). D_2 indicates that the PICmicro microcontroller is in the process of sampling temperature. During this time, it turns on momentarily every time temperature is sampled. Once all samples are acquired, D_2 will remain off.

The RESET switch, S1, is used to reset the PICmicro microcontroller. Clicking **GO** in the signal analysis software also resets the PICmicro microcontroller.

There are three sources of power connections to the data logger. Power can be supplied by connecting the 14-pin header to the PICKit™ 1 Flash Starter Kit board. The user can also connect a +5V supply using the on-board test points. In addition, this board supports a 24 mm 3V Lithium cell for stand-alone operation. To use the battery, the "Battery On" jumper JP1 will need to be connected.

In order to prevent power contention between the power supply and on-board battery, a dual Schottky diode, U5, is used to limit the current path. The diode ensures normal operation if the board is connected to a +5V supply, while the Battery On jumper is connected. There is about a 100 mV (typical) drop across the Schottky diode. The output of the diode is referred to as V_{DD}.

The MCP9800 Temperature Data Logger Demo board also uses Microchip's MCP101 supervisor to reset the controller if V_{DD} drifts below 2.5V.

2.4.2 User Selectable Features

There are several user selectable features, all require changing the code and recompiling the firmware. Steps 8, 9 and 10 of **2.3.2 "Programming the PIC16F684"** will then have to be repeated to reprogram the PICmicro microcontroller.

The `userVariables.inc` file includes all variables.

2.4.2.1 STAND-ALONE

The MCP9800 Temperature Data Logger Demo board can be powered with a lithium cell and operate as a stand-alone temperature data logger. To enable this feature, set the stand-alone variable in the `userVariable.inc` file to "`1`", compile the code and program the PICmicro microcontroller. Set the variable to "`0`" to disable this feature.

In Stand-Alone mode, momentarily pressing the on-board reset push button switch will overwrite previously stored data.

In order to retrieve the logged data, refer to **Section 2.4.2.4**.

2.4.2.2 SETTING NUMBER OF SAMPLES AND SAMPLING TIME

The minimum number of samples that can be logged are 256 samples. The sample size can be increased by multiples of 256 up to 4096 samples. The data logger board can store up 128000 samples, however, currently the software tool does not support data transfer size greater than 4096 samples.

The minimum measurement duration is 60 ms. The duration can be increased by a multiple of 60 ms. Table 2-1 shows the user variable description as shown in the `userVariable.inc` file.

TABLE 2-1: USER SELECTABLE VARIABLE DESCRIPTION

Sample Size		Sampling Time	
`Sample.Size`	**Size**	`Sampling.Time`	**Time (ms)**
1	256	1	60
2	517	2	120
3	1024	10	600
4	2048	100	6,000
5	4096	6,000	360,000

Note 1: When downloading the data to the PC, select the corresponding sample size from the pull down menu provided in the signal analysis software.

2.4.2.3 SETTING TEMPERATURE ALERT LIMIT AND HYSTERESIS

The MCP9800 provides an open-drain temperature alert output. When the temperature rises above the user specified limit, the output toggles and it remains set until the temperature falls below the user specified hysteresis limit.

To set the limits, open the `userVariables.inc` file and select a decimal number that corresponds to the temperature of interest to the defined variables, `MCP9800_Temperature.set` and `MCP9800_Temperature.hysteresis`. For example, if the temperature limit is 30°C and the hysteresis limit is 27°C, define '`.30`' and '`.27`' for the variables, respectively.

2.4.2.4 LOADING SAMPLES TO THE PC

1. Connect the data logger to the PICkit™ 1 Flash Starter Kit J3 connector.
2. Select Acquisition mode as shown below and select the Oscilloscope display, as shown in Figure 2-5.
3. Click **GO** to start acquisition. When the acquisition is complete, the data in the EEPROM is transferred to the PC. In Stand-Alone mode, when clicking **GO**, the acquisition is bypassed and the data in the EEPROM is transferred to the PC.

The Samples pull-down list provided in the signal analysis software defines the number of temperature samples to be taken. In Stand-Alone mode, the samples need to match the user specified sample size (Table 2-1). The Speed pull-down list does not change the minimum temperature sampling speed of 60 ms.

FIGURE 2-5: *Loading the Data from the On-board EEPROM to the PC.*

The oscilloscope display shows the ambient temperature data from the MCP9800. This display does not support negative numbers. Therefore, the data is offset by 1024. In addition, the tool does not support 11-bit and 12-bit temperature data.

Note:	The progress bar hangs for about 5-6 seconds for 256 temperature samples. This is due to timing differences between the PC and the PICmicro microcontroller. The delay increases as the number of samples increase. The GUI expects acquisition at 100 samples/sec, however, temperature is acquired at 16 samples/sec.

2.4.2.5 REAL-TIME DISPLAY ON PC

The stripchart tool available on the PICkit™ 1 Flash Starter kit software can be used to display real time temperature data. This is done by selecting the strip chart tool on the software and clicking **GO**.

FIGURE 2-6: *Selecting the Strip Chart Tool for Real-time Temperature Display.*

This display does not support negative numbers. Therefore, the data is offset by 1024. In addition, the tool does not support 11-bit and 12-bit data.

The real-time display does not operator in the Stand-Alone mode.

Appendix A. Schematic and Layouts

A.1 INTRODUCTION

This appendix contains the following schematics and layouts for the MCP9800 Temperature Data Logger Demo Board:

- Board Schematic
- Board - Top Layer
- Board - Silk-screen Layer
- Board - Bottom Layer

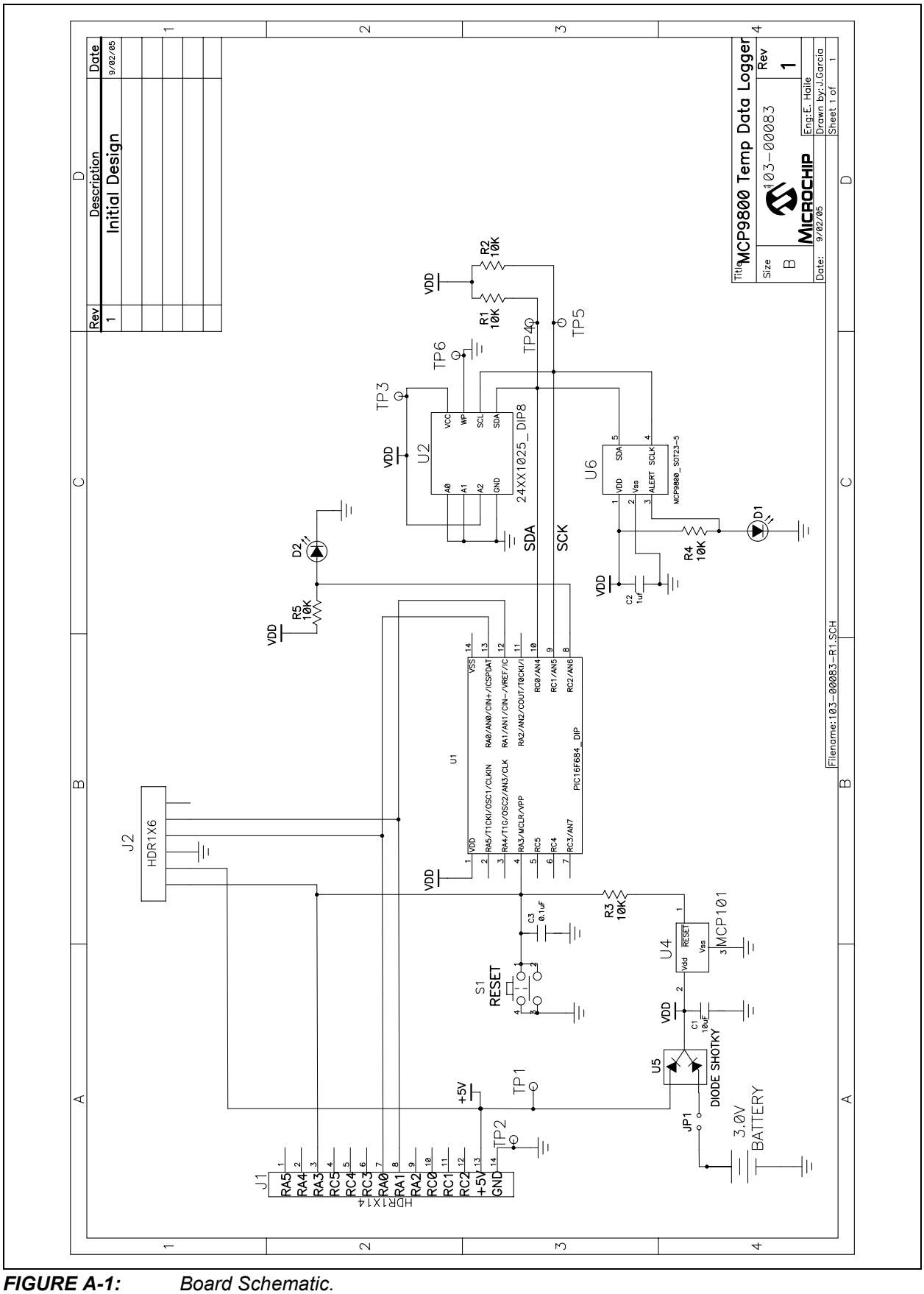

FIGURE A-1: *Board Schematic.*

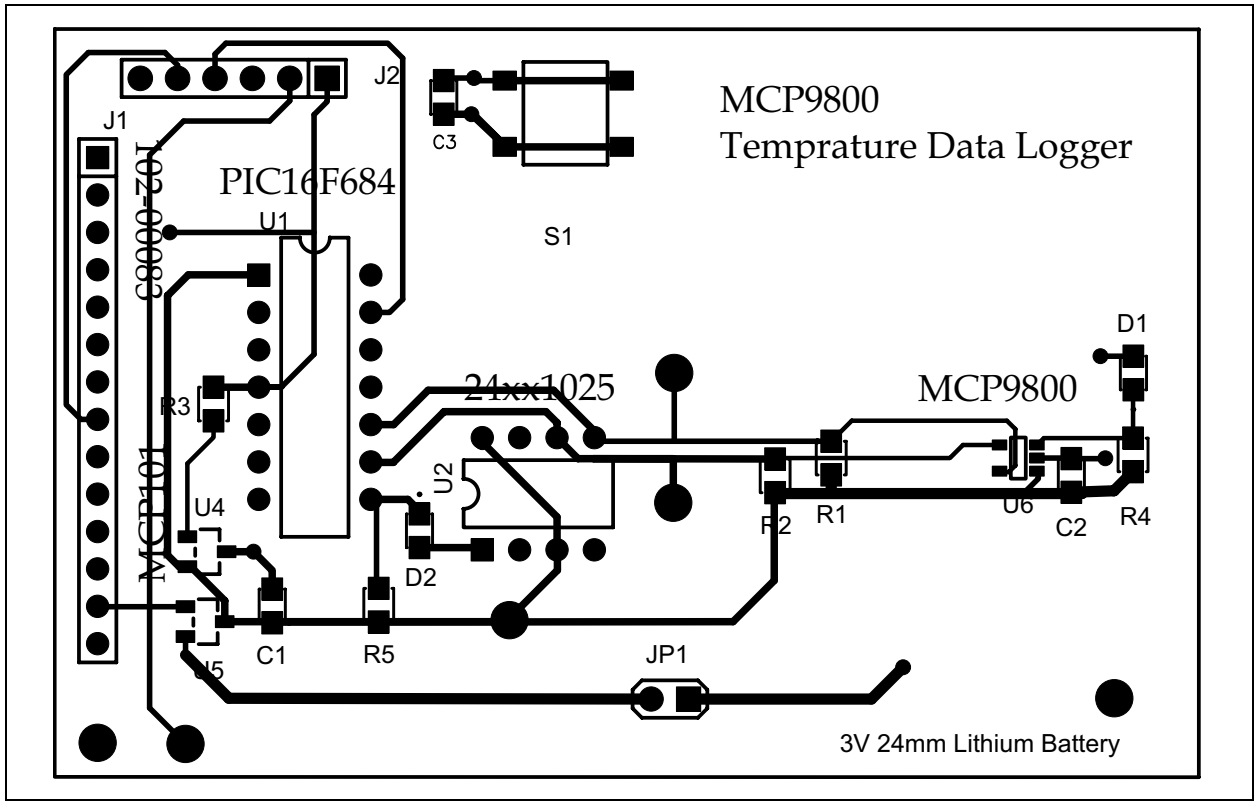

FIGURE A-2: *Board - Silk-screen Layer.*

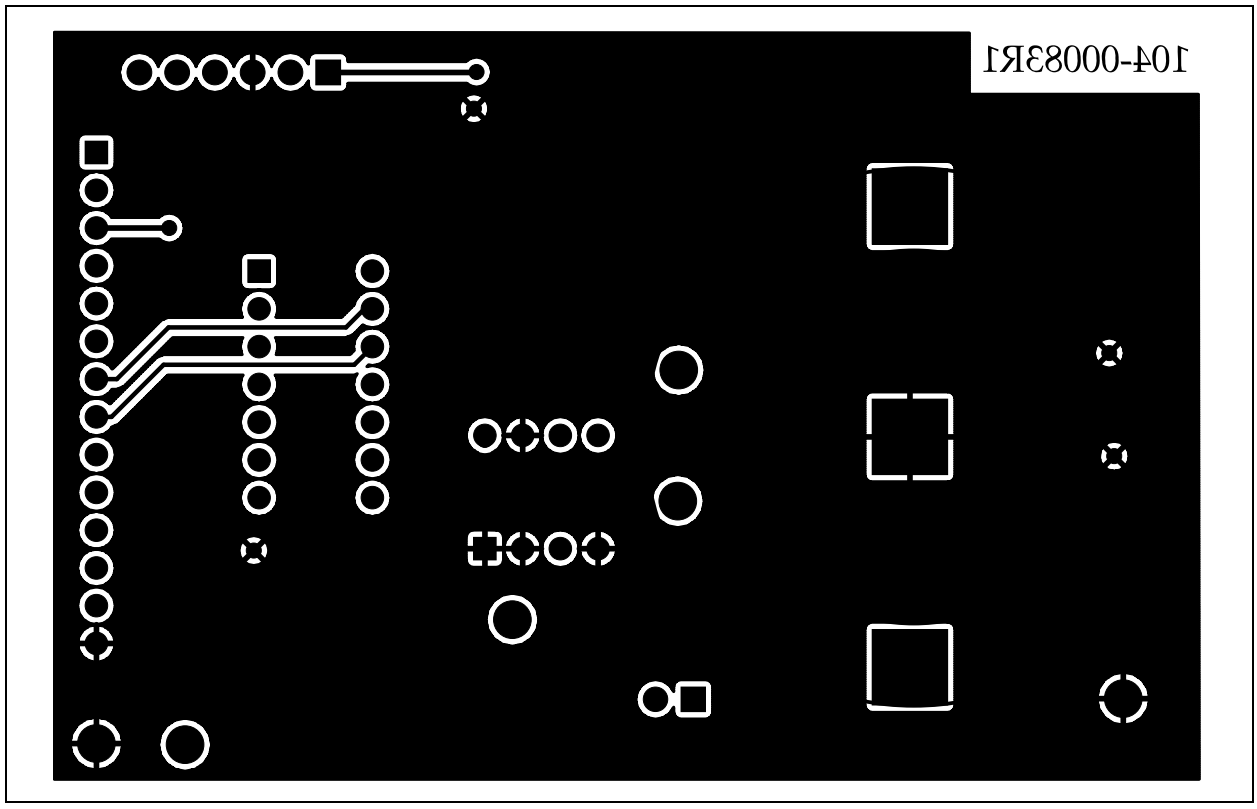

FIGURE A-3: *Board - Bottom Layer*

NOTES:

Appendix B. Bill Of Materials (BOM)

TABLE B-1: BILL OF MATERIALS

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part Number
1	C1	CAP CER 10UF 10V Y5V 0805	Murata Electronics North America	GRM21BF51A106ZE15L
1	C2	CAP 1UF 16V CERAMIC Y5V 0805	Panasonic - ECG	ECJ-2VF1C105Z
1	C3	CAP .1UF 25V CERAMIC X7R 0805	Panasonic - ECG	ECJ-2VB1E104K
2	D1,D2	LED RED CLEAR 0805 SMD	LITE-ON INC	LTST-C170CKT
5	R1-R5	RES 10.0K OHM 1/10W 1% 0805 SMD	Panasonic - ECG	ERJ-6ENF1002V
1	U1	14-Pin Flash-Based, 8-Bit CMOS Microcontrollers with nanoWatt Technology	Microchip Technology Inc.	PIC16F684_dip
1	U1 SOCKET	SOCKET,IC,14PIN,MACHINE TOOLED	JAMECO VALUEPRO	6100-14
1	U2	1024K I^2C™ CMOS Serial EEPROM	Microchip Technology Inc.	24LC1025-I/P
1	U2 SOCKET	SOCKET,IC,08PIN,MACHINE TOOLED	JAMECO VALUEPRO	6100-8
1	U4	MCP101 Precision System Supervisors	Microchip Technology Inc.	MCP101T-270I/TT
1	U5	DIODE SCHOTTKY 30V 70MA MINI 3P	Panasonic - SSG	MA3X786E0L
1	U6	MCP9800 2-Wire High-Accuracy Temperature Sensor	Microchip Technology Inc.	MCP9800AOT-M/TOG
1	BAT1	HOLDER BATTERY COIN 24MM DIA SMD	Keystone Electronics	3006
1	Coin Battery	BATTERY LITHIUM COIN 3V CELL	Panasonic - BSG	CR2450
2	GND	TEST POINT PC MULTI-PURPOSE BLK	Keystone Electronics	5011
2	VDD & +5V	TEST POINT PC MULTI-PURPOSE RED	Keystone Electronics	5010
2	SDA & SCK	TEST POINT PC MULTI-PURPOSE WHT	Keystone Electronics	5012
1	J1	Installation on Bottom Side HDR 1X14 CONN HEADER 14POS .100 VERT TIN	Molex/Waldom Electronics	22-28-4140
1	J2	Not Installed HDR 1X6 CONN HEADER 6 POS .100 VERT TIN	Molex/Waldom Electronics	22-28-4060

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Tel: 81-45-471- 6166
Fax: 81-45-471-6122

Korea - Gumi
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Fax: 82-54-473-4302

Korea - Seoul
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Fax: 82-2-558-5932 or
82-2-558-5934

Malaysia - Penang
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Fax: 60-4-646-5086

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