

# MCP9904 Temperature Sensor Evaluation Board User's Guide

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Carlson Date

Derek Carlson **VP Development Tools** 

NOTES:



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### Preface

### NOTICE TO CUSTOMERS

All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Please refer to our web site (www.microchip.com) 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 "DSXXXXXXA", where "XXXXXXX" is the document number and "A" is the revision level of the document.

For the most up-to-date information on development tools, see the MPLAB<sup>®</sup> IDE online help. Select the Help menu, and then Topics to open a list of available online help files.

#### INTRODUCTION

This chapter contains general information that will be useful to know before using the MCP9904 Temperature Sensor Evaluation 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 MCP9904 Temperature Sensor Evaluation Board as a development tool to emulate and debug firmware on a target board. The manual layout is as follows:

- **Chapter 1. "Product Overview**" Important information about the MCP9904 Temperature Sensor Evaluation Board.
- Chapter 2. "Installation and Operation" Includes instructions on installing and starting the Microchip Technology Incorporated Chip Manager application.
- Chapter 3. "Hardware Description" Shows hardware details of the MCP9904 Temperature Sensor Evaluation Board.
- Chapter 4. "Software Description" Describes the main operations in the Microchip Chip Manager software.
- Appendix A. "Schematic and Layouts" Shows the schematic and layout diagrams for the MCP9904 Temperature Sensor Evaluation Board.
- Appendix B. "Bill of Materials (BOM)" Lists the parts used to build the MCP9904 Temperature Sensor Evaluation 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 <sup>®</sup> 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	<u>File&gt; Save</u>		
Bold characters	A dialog button	Click OK		
	A tab	Click the <b>Power</b> tab		
N'Rnnnn	A number in verilog format, where N is the total number of digits, R is the radix and n is a digit.	4'b0010, 2'hF1		
Text in angle brackets < >	A key on the keyboard	Press <enter>, <f1></f1></enter>		
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	OxFF, `A'		
Italic Courier New	A variable argument	file.o, where file can be any valid filename		
Square brackets []	Optional arguments	<pre>mcc18 [options] file [options]</pre>		
Curly brackets and pipe character: {   }	Choice of mutually exclusive arguments; an OR selection	errorlevel {0 1}		
Ellipses	Replaces repeated text	<pre>var_name [, var_name]</pre>		
	Represents code supplied by user	<pre>void main (void) { }</pre>		

#### **RECOMMENDED READING**

This user's guide describes how to use the MCP9904 Temperature Sensor Evaluation Board. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources:

- MCP990X Data Sheet "MCP990X Multi-Channel Low-Temperature Remote Diode Sensor" (DS20005382)
- AN10.14 "Using Temperature-Sensing Diodes with Remote Thermal Sensors" (DS00001839)
- AN12.14 "Remote Thermal Sensing Diode Selection Guide" (DS00001838)
- AN13.19 "Resistance Error Correction" (DS00001852)
- AN14.0 *"Microchip Dedicated Slave Devices in I<sup>2</sup>C Systems"* (DS00001853)
- AN16.4 "Using Anti-Parallel Diodes (APD) with Microchip's Remote Temperature Sensing Devices" (DS00001828)

#### THE MICROCHIP WEB SITE

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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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#### **CUSTOMER SUPPORT**

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- · Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

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://www.microchip.com/support.

#### **DOCUMENT REVISION HISTORY**

#### Revision A (January 2017)

• Initial Release of this Document.



### **Chapter 1. Product Overview**

#### 1.1 INTRODUCTION

The MCP9904 Temperature Sensor Evaluation Board provides an easily-accessible platform to test the various features of the MCP9904. The System Management Bus (SMBus) communication is accomplished using a Universal Serial Bus (USB) bridge, providing a standard interface for the application code interface. The board is populated with an 10-Lead 3x3 VDFN version of the MCP9904 device.

#### 1.2 MCP9904 DEVICE FEATURES

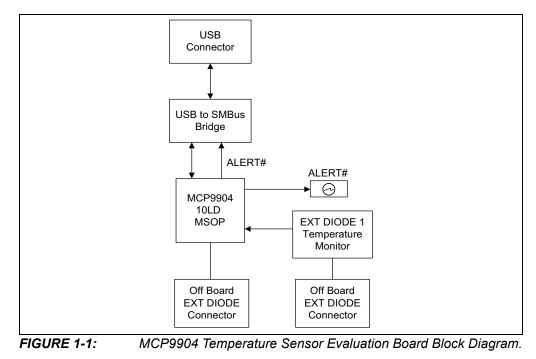
The MCP9904 device is a four-channel SMBus temperature sensor featuring both pin-selectable and fixed SMBus address capability. The communications bus is also compatible with I<sup>2</sup>C communication protocol.

**Note:** Refer to Microchip application note AN14.0 - "Microchip Dedicated Slave Devices in I2C Systems" (DS00001853) for details on the differences between the Microchip SMBus implementation and standard I2C/SMBus.

Three externally connected temperature diodes and one internal diode are available for temperature sensing. THERM and ALERT outputs have programmable temperature limits.

#### 1.3 WHAT IS THE MCP9904 TEMPERATURE SENSOR EVALUATION BOARD?

All functions of the MCP9904 device can be tested and observed using the USB-based MCP9904 Temperature Sensor Evaluation Board. Figure 1-1 shows the block diagram of this board.



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The evaluation system is composed of the MCP9904 Temperature Sensor Evaluation Board and the Microchip Chip Manager application. The MCP9904 Temperature Sensor Evaluation Board has the following features:

- Two headers for connecting an external diode or CPU/GPU
- USB-to-SMBus bridge for power and communications

The user can perform the following operations using the Chip Manager:

- Viewing and changing register values
- · Saving settings of all registers, allowing for quick configuration at a later time
- Graphing of any register

The evaluation board was designed for ease of use and experimentation purposes. Figure 1-2 shows the top silk screen of the MCP9904 Temperature Sensor Evaluation Board.

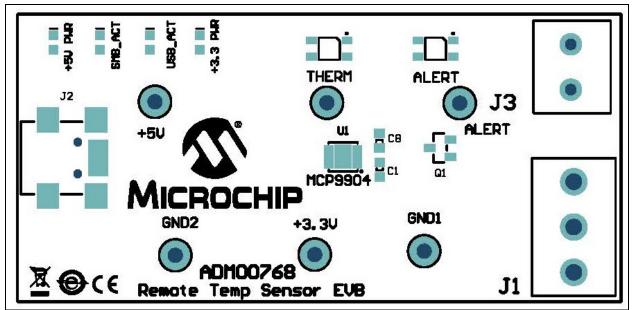


FIGURE 1-2: MCP9904 Temperature Sensor Evaluation Board – Top Silk Screen.

#### 1.4 WHAT DOES THE MCP9904 TEMPERATURE SENSOR EVALUATION BOARD KIT CONTAIN?

This MCP9904 Temperature Sensor Evaluation Board kit includes:

- MCP9904 Temperature Sensor Evaluation Board (ADM00768)
- USB to Micro-USB Cable
- Important Information Sheet
- 2N3904 for remote diode temperature sensing.
- TO-92 BJT.



### **Chapter 2. Installation and Operation**

#### 2.1 GETTING STARTED

#### 2.1.1 System Requirements

To use the MCP9904 Temperature Sensor Evaluation Board, the following are required:

- A PC running the Microsoft<sup>®</sup> Windows<sup>®</sup> operating system
- A display resolution of 800x600 or larger, for viewing several windows simultaneously
- An available USB port

#### 2.1.2 Installing the Evaluation Board

Follow these steps to install the Microchip Chip Manager:

1. Before installing and running Chip Manager, the MCP2221 driver and utility package needs to be installed on the local machine. If the driver and utility package have already been installed, this step may be skipped. The MCP2221 driver and utility package are located at:

http://www.microchip.com/wwwproducts/Devices.aspx?product=MCP2221, under "Documentation & Software". Follow the on-screen instructions to complete the installation process for the appropriate OS.

- 2. Download the Chip Manager from the board web page. Unzip the archive. The application's revision history and install/uninstall notes may be found in the readme.txt file.
- 3. To install the Chip Manager application and the device driver on the PC, run ChipMan-windows-installer.exe file.
- 4. Connect the supplied USB cable to an available USB port on the PC. Plug the mini-B end of the USB cable into the board connector J2. The +5V PWR, +3.3V PWR and USB\_ACT LEDs should illuminate.
- If the USB Bridge driver has not previously been installed on the selected USB port, the Driver Software Installation window pops up, prompting for the driver install (see Figure 2-1).

Driver Software Installation		×		
Driver Software Installation				
Installing device driver software				
USB Composite Device	Ready to use			
MCP2221 USB-I2C/UART Combo	Searching Windows Update			
MCP2221 USB-I2C/UART Combo	OSearching Windows Update			
Obtaining device drives after the Window				
Obtaining device driver software from Window Skip obtaining driver software from Windows				
g				
		· · · · · · · · · · · · · · · · · · ·		
		Close		
	Driver Software Installation			×
	Your device is ready to use			
		X		
	USB Composite Device	Ready		
	USB Serial Port (COM10)	Ready		
	USB Input Device	Ready	to use	
				Close
				:
FIGURE 2-1: Driver S	Software Installation	Vindow		

6. After the driver installation is complete, the initial setup screen for the Chip Manager application appears (see Figure 2-2). Click **Next** to start the installation.

Open File - Security Warning							
Do you	want to run this file?						
	Name:904 EVB\ChipMan\ChipMan-v4.16.8-windows-installer.exe						
	Publisher: Microchip Technology Inc.						
	Type: Application						
	From: F:\Development\Remote Diode\MCP990x\MCP9904 EVB\						
	Run Cancel						
🗸 Alwa	✓ Always ask before opening this file						
۲	While files from the Internet can be useful, this file type can potentially harm your computer. Only run software from publishers you trust. What's the risk?						

#### FIGURE 2-2: Application Install Window.

7. To proceed with the installation, read the License Agreement and accept by clicking the radio button corresponding to "I accept the agreement", then click **Next**.

Microchip Chip Manager v	v4.16.8 Setup		- • ×
License Agreement			
Please read the following Li terms of this agreement bef	-		
MICROCHIP IS WILLING TO LIC DOCUMENTATION TO YOU ONLY O THE FOLLOWING TERMS. TO AC "I ACCEPT" AND PROCEED WITH NOT ACCEPT THESE LICENSE TE NOT DOWNLOAD OR INSTALL THI	N THE CONDITIO CEPT THE TERMS THE DOWNLOAD RMS, CLICK "I	N THAT YOU AC OF THIS LICE OR INSTALL.	CEPT ALL OF NSE, CLICK IF YOU DO
Do you accept this license?	<ul> <li>I accept th</li> <li>I do not a</li> </ul>	e agreement ccept the agre	ement
BitRock Installer			
	< Back	Next >	Cancel
FIGURE 2-3: License Agre	ement Dialog.		

8. On the Installation Directory dialog, browse for the desired location or click **Next** to install in the default location (see Figure 2-4).

Vicrochip Chip Man	ager v4.16.8 Setup	
Installation Directory		<u> </u>
Please specify the dire installed.	ctory where the Microchip Chip I	Vanager will be
Installation Directory	C:\Program Files (x86)\Microchi	p\ChipMan
BitRock Installer	< Back Next > tion Directory Dialog.	Cancel
👺 Microchip Chip Man	ager v4.16.8 Setup	
Ready to Install		<u> </u>
Setup is now ready to b your computer.	begin installing the Microchip Ch	ip Manager on

< Back

Next >

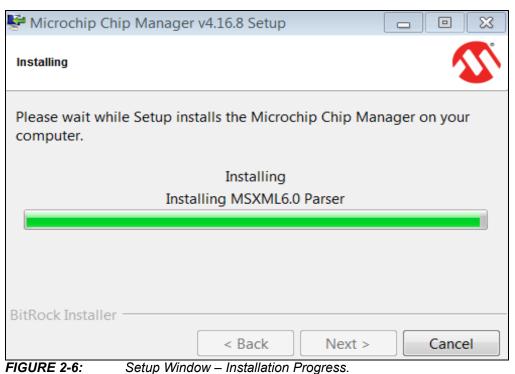
FIGURE 2-5: Ready to Install Dialog.

**BitRock Installer** 

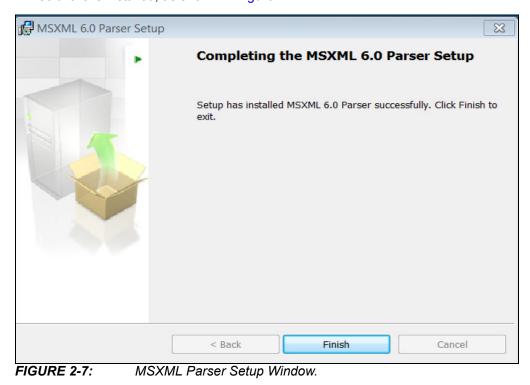
Cancel

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9. The application setup window appears, showing the installation progress (see Figure 2-6).



10. After the setup is complete, the MSXML Parser used by the Chip Manager software is installed, as shown in Figure 2-7.



11. Once the setup completes successfully, press **Finish** to exit the installer (see Figure 2-8).

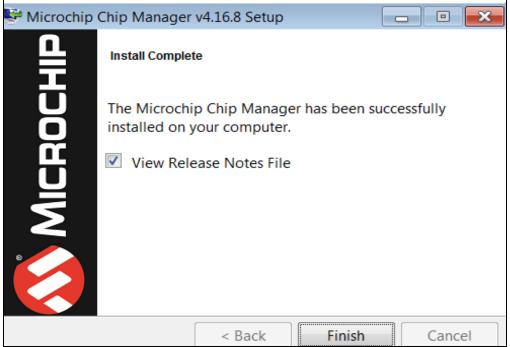


FIGURE 2-8: Install Complete Dialog.

 Start the software by either going to Windows <u>Start button > All Programs ></u> <u>Microchip > Microchip Chip Manager</u> or by clicking the software icon (<sup>(</sup>)) on the desktop. The evaluation board software will initialize while the Microchip Chip Manager with the Quick Help screen appears (see Figure 2-9).

File	View	Options	Control	Help	
		¢ ?	2		
					Quick Help:
					The purpose of this utility is to allow the user to view and edit MCHP device registers in the Windows environment.
					To view a group of registers, select the appropriate group in the left pane. To edit the value of a register, double click the value in the "Last Value" column in the right upper pane. Type in the desired value. The register will be updated with the new value once the cursor leaves the edit window. Read only registers are denoted by "R" in the "R/W" column and editing of these register values is disallowed.
					Some registers have bit field definitions. They are displayed in the lower right pane. If the register is not read only (i.e. read/write) the value of each field can be edited by double clicking on the field value in the "Last Value" column of this pane. Type in the desired value to update the bit(s) of the reg The field may also be changed by making a selection from the field's drop of if a drop down list is available for this field, a combo box style button will allow you to s a setting for the bit field from a drop down list.
					The current values of the registers can be saved to an external text file by using the Export feature. The saved text file can also be read back to the device by using the Import feature. Import only affects read/write registers.

 If a message stating that no device has been selected appears, click Yes to select a device. Alternatively, go to the Chip Manager's main menu, select <u>Options > Select Device</u>. In either case, the Select Device window displays, as shown in Figure 2-10.

In the "Device" list of the "Select Device" window, choose "MCP9904". The "Master Controller" drop-down list should highlight "USB SMBus Bridge". Click **OK** to complete the device selection.

Microchip Chip Manager	Select Device
No device has been selected Would you like to select a device?	Device Remote Device: MCP9904
Yes No	Configuration Address: Select automatically SMBus Settings Slave Addresses: Block Registers Slave Address HWM 02:FF 98
	Select automatically Master Controller: USB SMBus Bridge
	OK Cancel

FIGURE 2-10: Select Device Window.

14. From the Chip Manager main menu, ensure that <u>Options > Auto Refresh</u> <u>Registers</u> is checked. In the left panel, click the hardware monitor "HWM" to expand the content, then select any of the register groups, as shown in Figure 2-11. The SMB\_ACT LED on the board starts blinking when any of the register groups are selected. The register values are automatically updated every second when the Auto Refresh option is on.

File View Options Control Help								
🖻 🖬 🗿 🤋								
∃ <b>■</b> MCP9904	Register Name	Address	R/W	Last Va	Units	Abbreviation	Bus Type	
🖻 🦆 HWM	Internal Temp	00,29	R	88.88	Degrees(C)	TLAM	SMBUS	
<b>\$*</b> 0 : Status	External Diode1 Temp	01,10	R	87.63	Degrees(C)	TLD1	SMBUS	
	External Diode2 Temp	23,24	R	88.25	Degrees(C)	TLD2	SMBUS	
🚽 🛠 2 : Legacy Mode Temperatu	External Diode3 Temp	2A,2B	R	87.50	Degrees(C)	TLD3	SMBUS	
🚽 🕈 3 : Extended Mode Tempera	Internal Temperature High Limit	05	RW	85	Degrees(C)	TALH	SMBUS	
🕈 4 : Device Info	Internal Temperature Low Limit	06	RW	0	Degrees(C)	TALL	SMBUS	
	Internal THERM Limit	20	RW	85	Degrees(C)	THAL	SMBUS	
	External D1 Temperature High Limit	07,13	RW	85.00	Degrees(C)	T1LH	SMBUS	
	External D1 Temperature Low Limit	08,14	RW	0.00	Degrees(C)	T1LL	SMBUS	
	External D2 Temperature High Limit	15,17	RW	85.00	Degrees(C)	T2LH	SMBUS	
	External D2 Temperature Low Limit	16,18	RW	0.00	Degrees(C)	T2LL	SMBUS	
	External D3 Temperature High Limit	2C,2E	RW	85.00	Degrees(C)	T3LH	SMBUS	
	External D3 Temperature Low Limit	2D,2F	RW	0.00	Degrees(C)	T3LL	SMBUS	
	External D1 THERM Limit	19	RW	85	Degrees(C)	TH1L	SMBUS	
	External D2 THERM Limit	1A	RW	85	Degrees(C)	TH2L	SMBUS	
	External D3 THERM Limit	30	RW	85	Degrees(C)	TH3L	SMBUS	
	THERM Hysteresis	21	RW	10	Degrees(C)	THH	SMBUS	
	•							
	Bit Field Name Bit	(s) Last V	al Tr	anslation				

FIGURE 2-11:

Chip Manager – Register Groups.

15. To reveal the register descriptions in Chip Manager, highlight "Configuration" as shown in Figure 2-12. The "Bit Field Name" and "Translation" will be shown in the Chip Manager window. For a detailed description of each register, please refer to the MCP990X Data Sheet.

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🐼 Microchip Chip Manager - MCHP Confide	ntial								8	X
File View Options Control Help										
🖻 🖬 🔮 📍										
⊡ <b>■</b> MCP9904	Register Name	A	ddress	R/W	Last Va	Units	Abbreviation	Bus Type		
🖻 🤧 HWM	Configuration	0	3	RW	00	Hex	CONF	SMBUS		
🗲 0 : Status	Channel Mask	1	F	RW	00	Hex	CMASK	SMBUS		
👎 1 : Configuration	Conversion Rate	0	4	RW	06	Hex	CVR	SMBUS		
- 📌 2 : Legacy Mode Temperatures	Filter Control	4	0	RW	00	Hex	FILT	SMBUS		
🚽 🕈 3 : Extended Mode Temperatur	Consecutive ALERT Register	2	2	RW	70	Hex	CAR	SMBUS		
🐓 4 : Device Info	Ext 1 Beta Compensation	2	5	RW	<b>0</b> E	Hex	BETA1	SMBUS		
	Ext D2 Beta Compensation	2	6	RW	07	Hex	BETA2	SMBUS		
	External Diode 1 Ideality	2	7	RW	12	Hex	IDEAL1	SMBUS		
	External Diode 2 Ideality	2	8	RW	12	Hex	IDEAL2	SMBUS		
	External Diode 3 Ideality	3	1	RW	12	Hex	IDEAL3	SMBUS		
	One Shot Command	0	F	W	00	Hex	ONESHOT	SMBUS		
	Scratchpad Byte 1	1	1	RW	00	Hex	SB1	SMBUS		
	Scratchpad Byte 2	1	2	RW	00	Hex	SB2	SMBUS		
	•									I
	Bit Field Name	Bit(s)	Last Va	al Ti	ranslation					•
	MASK ALL	7	0	A	LERT pin is	not masked			•	
	Run/Stop	6	0	A	ctive mode				• •	
	ALERT or THERM	5	0	A	LERT pin be	haves as AL	ERT			
	REC D1 Disable	4	0	RI	EC D1 enab	led			•	
	REC D2 D3 Disable	3	0	RI	EC D2 D3 er	nabled			• •	
	Temperature Range Select	2	0	0	to 127.875	degrees				ľ
4	Dynamic Averaging	1	0	D	ynamic ave	raging enab	led		•	
bl click value in Last Value column to edit	· · · · · · · · · · · · · · · · · · ·			Ble	ock HWM /	Group 1 : C	onfiguration			-

FIGURE 2-12: Chip Manager – Configuration Window.



### **Chapter 3. Hardware Description**

#### 3.1 INTRODUCTION

The MCP9904 Temperature Sensor Evaluation Board (EVB) provides the means to demonstrate all features of the MCP9904 device, and allows the registers to be viewed and modified. LEDs indicating status information and test points are included to enable system voltage monitoring using a voltmeter or an oscilloscope.

#### 3.1.1 Power Source

The MCP9904 EVB requires only one universal serial bus (USB) connection for power. An on-board LDO regulates the +5V USB power to +3.3V required by the MCP9904 and other evaluation board circuitry.

#### 3.2 USB-TO-I<sup>2</sup>C/SMBUS BRIDGE

The MCP9904 EVB implements Microchip's MCP2221 protocol converter to ensure communication from USB to  $l^2$ C. Power is delivered to the bridge from the on-board LDO.

#### 3.3 TEST POINTS

The MCP9904 Temperature Sensor Evaluation Board includes test points for the following signals:

- ALERT output
- THERM output
- +5V USB supply
- +3.3V analog supply
- GND

#### 3.4 LED INDICATORS

Table 3-1 details the status of the LEDs for the following signals:

Signal	When LED is OFF	When LED is ON						
ALERT	ALERT is not active - GREEN	ALERT is active – RED						
THERM	THERM is not active - GREEN	THERM is active – RED						
+3.3V PWR	+3.3V analog voltage is not available	+3.3V analog voltage is available – GREEN						
+5V PWR	USB +5V is not available	USB +5V is available – GREEN						
USB_ACT	No Activity on USB port	Activity on USB port – GREEN						
SMB_ACT	No Activity on SMBus	Activity on SMBus – GREEN						

#### TABLE 3-1: LED STATUS INDICATORS

#### 3.5 REMOTE DIODES

The MCP9904 EVB is populated with an on-board transistor (Q1) with the base terminal shorted to the collector terminal. This type of connection is known as a diode-connected transistor. The headers J1 and J3 allow for an off-board connections to a remote diode, a remote CPU or GPU attached with a cable assembly (see Table 3-2).

To connect to an off-board CPU, GPU or cable assembly, remove the on-board transistor, Q1, and refer to Table 3-2 for the proper connections. Ensure a common ground exists between the off-board diode (GPU, etc.) and the evaluation board by connecting to the ground of the EVB via pin 2 of J1. The off-board diode of a CPU or GPU requires proper biasing, so it is recommended to consult the CPU manufacturer's data sheet for guidance on interfacing to the thermal diode.

Please refer to the MCP9904 Temperature Sensor Evaluation Board schematic in **Appendix A. "Schematic and Layouts**" for details on the evaluation board header connections.

Header	Configuration	Pin 1	Pin 2	Pin 3
J1/J3	On-board diode (Q1)	Collector/Base Shorted	N/A	Emitter
	Diode with Shielded Cable Assembly	Collector/Base Shorted	Shield Ground	Emitter
	Diode without Shielded Cable Assembly	Collector/Base Shorted	N/A	Emitter
	CPU/GPU Diode	Emitter	Ground	Base

TABLE 3-2:REMOTE DIODE CONFIGURATIONS

#### 3.6 OTHER SENSOR FEATURES

Other features, such as conversion rate, dynamic averaging and digital filtering, can be controlled with the MCP9904 registers. For details on the register description, refer to the MCP9902/3/4 Data Sheet.



### **Chapter 4. Software Description**

#### 4.1 CHIP MANAGER APPLICATION OVERVIEW

Chip Manager is a Microchip Technology Inc. application that enables the user to display temperature readings, set temperature limits and read/write configuration register values. Chip Manager initially displays a Quick Help screen. For detailed information on application features and usage, select <u>Help > Contents</u> to display the HTML-based Help document.

#### 4.1.1 Real-Time Register Graphs

The Chip Manager software has the ability to plot register values in real time, up to a continuous rate of 4 Hz.

#### 4.1.2 Selecting Registers to Plot

 To plot a register, right-click the desired register name or value. Select Add Register(s) to Plot from the context menu (see Figure 4-1), to add the register or value to the plot list.

Degrees(C) TL Degrees(C) TL Degrees(C) TL Degrees(C) TA Degrees(C) TA Degrees(C) TA Degrees(C) TA Degrees(C) TA Degrees(C) T1 Degrees(C) T1 Degrees(C) T2 Degrees(C) T2 Degrees(C) T3 Degrees(C) T3 Degrees(C) T3	HAL SMBUS LH SMBUS LL SMBUS LH SMBUS LL SMBUS LH SMBUS	
Degr         Add Re           Degrees(C)         TLI           Degrees(C)         TA           Degrees(C)         TA           Degrees(C)         TA           Degrees(C)         TA           Degrees(C)         TA           Degrees(C)         TA           Degrees(C)         T1           Degrees(C)         T1           Degrees(C)         T2           Degrees(C)         T3           Degrees(C)         T3	egister(s) to Plot D3 SMBUS ALH SMBUS ALL SMBUS IAL SMBUS LH SMBUS LL SMBUS LH SMBUS ILL SMBUS ILL SMBUS ILL SMBUS ILL SMBUS	
Degress(C)     TLI       Degrees(C)     TLI       Degrees(C)     TA       Degrees(C)     TA       Degrees(C)     TA       Degrees(C)     TA       Degrees(C)     TI       Degrees(C)     T1       Degrees(C)     T2       Degrees(C)     T2       Degrees(C)     T3       Degrees(C)     T3	D3 SMBUS ALH SMBUS ALL SMBUS HAL SMBUS LH SMBUS LL SMBUS LH SMBUS ILL SMBUS ILL SMBUS ILL SMBUS	
Degrees(C) TLI Degrees(C) TA Degrees(C) TA Degrees(C) TA Degrees(C) TH Degrees(C) T1 Degrees(C) T1 Degrees(C) T2 Degrees(C) T2 Degrees(C) T3 Degrees(C) T3	ALH SMBUS ALL SMBUS HAL SMBUS LH SMBUS LL SMBUS LL SMBUS LL SMBUS LL SMBUS	
Degrees(C) TA Degrees(C) TH Degrees(C) T1 Degrees(C) T1 Degrees(C) T2 Degrees(C) T2 Degrees(C) T3 Degrees(C) T3	ALL SMBUS HAL SMBUS LH SMBUS LL SMBUS LH SMBUS LL SMBUS LL SMBUS LH SMBUS	
Degrees(C) TH Degrees(C) T1 Degrees(C) T1 Degrees(C) T2 Degrees(C) T2 Degrees(C) T3 Degrees(C) T3	HAL SMBUS LH SMBUS LL SMBUS LH SMBUS LL SMBUS LH SMBUS	
Degrees(C) T1 Degrees(C) T1 Degrees(C) T2 Degrees(C) T2 Degrees(C) T3 Degrees(C) T3	LH SMBUS LL SMBUS LH SMBUS LL SMBUS LH SMBUS	
Degrees(C) T1 Degrees(C) T2 Degrees(C) T2 Degrees(C) T3 Degrees(C) T3	LL SMBUS PLH SMBUS PLL SMBUS PLH SMBUS	
Degrees(C) T2 Degrees(C) T2 Degrees(C) T3 Degrees(C) T3	ILH SMBUS ILL SMBUS ILH SMBUS	
Degrees(C) T2 Degrees(C) T3 Degrees(C) T3	ILL SMBUS	
Degrees(C) T3 Degrees(C) T3	ILH SMBUS	
Degrees(C) T3		
	LL SMBUS	
Degrees(C) TH	IL SMBUS	
Degrees(C) TH	12L SMBUS	
Degrees(C) TH	I3L SMBUS	
Degrees(C) TH	H SMBUS	
	]	
	Degrees(C) TH	Degrees(C) THH SMBUS

FIGURE 4-1:

Adding Registers to Plot.

 Once the desired register is added to plot, a graphic plot window will appear with a legend on top, as shown in Figure 4-2. The two windows can be rearranged independently.

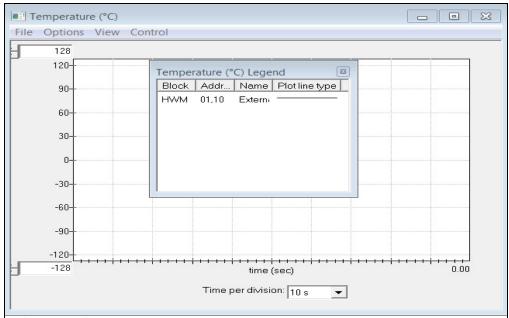


FIGURE 4-2: Register Plot - Temperature Window.

3. To plot additional registers, go back to the Chip Manager main window and repeat Step 1.

#### 4.1.3 Starting the Plots

All plots can be started simultaneously by selecting <u>Control > Plots > Start All Plots</u> from the menu in the main application window. Multiple plots will be in sync if they are started simultaneously.

Individual plots may be paused at any time by clicking <u>Control > Pause</u> in the active plot window. This will not cause loss of captured data on the other plot windows.

For a better view of the plot, select a different "Time per division" value in the drop-down menu at the bottom of the plotting window. This scale change affects both the Real-time mode and the Playback mode, while the rate at which data is recorded remains unaffected.

#### 4.1.4 Sampling a Plot

Figure 4-3 is an example of temperature history. Internal Temperature, External Diode 1 Temperature and External Diode 1 High Limit are selected for plotting. The results after starting the plot are that the External Diode Temperature High Limit is reduced, and the External Diode 1 starts at room temperature and is then heated by simply placing a finger on the external diode Q1.

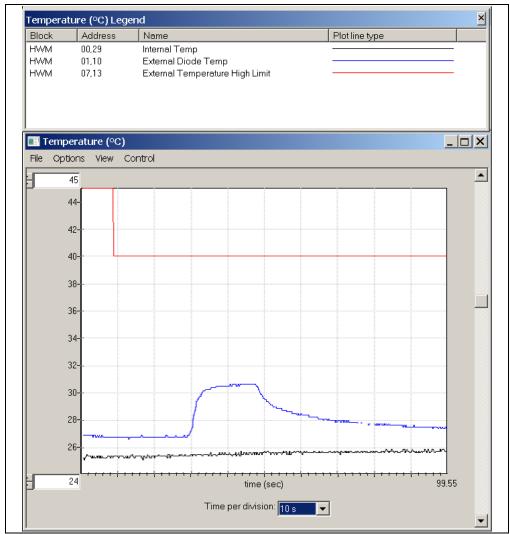


FIGURE 4-3: MCP9904 Temperature History Graph.

#### 4.1.5 Exporting and Importing the Plot Data

The data on each plot window may be stored in a semicolon-separated text file. To save the data, follow the steps:

- 1. Stop the plotting by selecting <u>Control > Stop</u> from the plot window, or <u>Control ></u> <u>Plots > Stop All Plots</u> from the Chip Manager main window.
- 2. Select *File > Export* from the plot window to save the data.

To review saved data, select *File > Import* from an open plot window and then select the file name to open.

**Note:** Importing a saved data file into a plot window with a different data type is not allowed by the Chip Manager application. In this case, a warning message will display. It is recommended to choose a file name that best describes the data type when exporting the plot data.

NOTES:



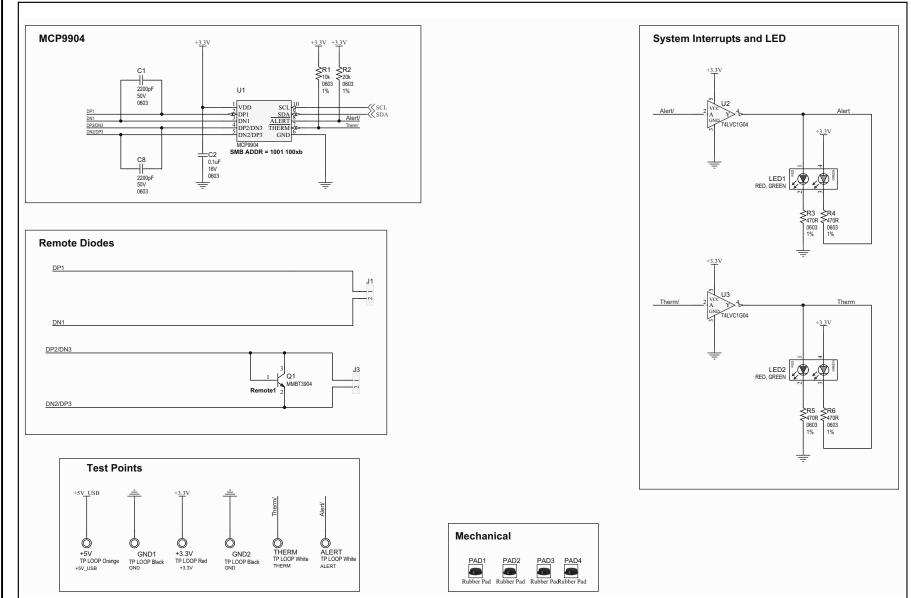
### **Appendix A. Schematic and Layouts**

#### A.1 INTRODUCTION

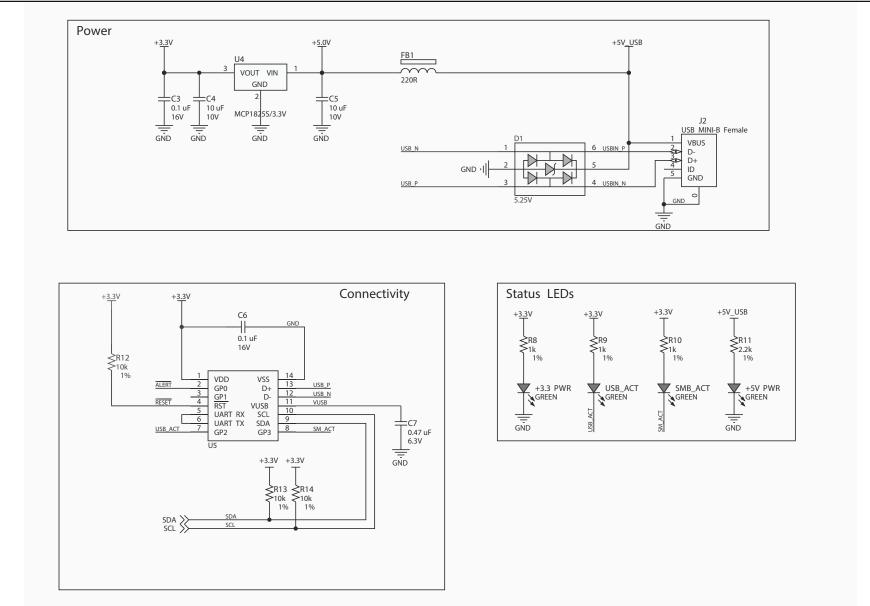
This appendix contains the following schematics and layouts for the MCP9904 Temperature Sensor Evaluation Board:

- · Board MCP9904 and Interface Schematic
- Board USB-to-SMBus Bridge Schematic
- Board Top Silk
- Board Top Copper and Silk
- Board Top Copper
- Board Bottom Copper
- Board Bottom Copper and Silk
- Board Bottom Silk

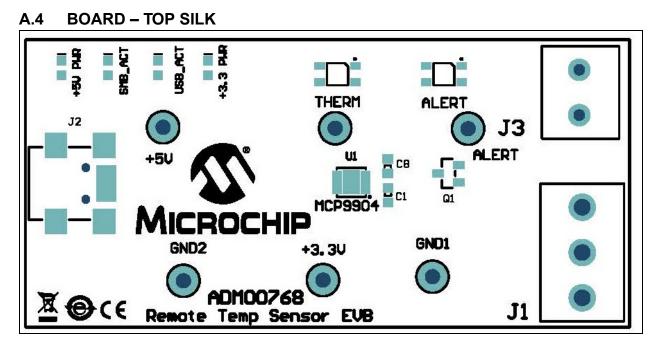
#### A.2 BOARD – MCP9904 AND INTERFACE SCHEMATIC



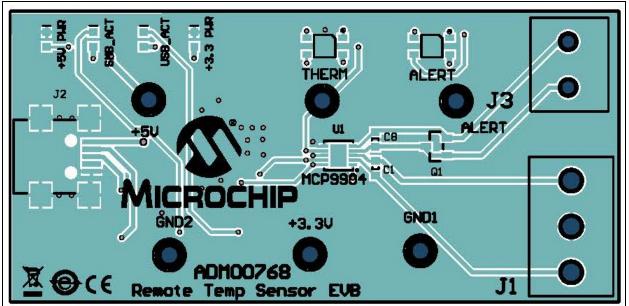
### A.3 BOARD – USB-TO-SMBUS BRIDGE SCHEMATIC



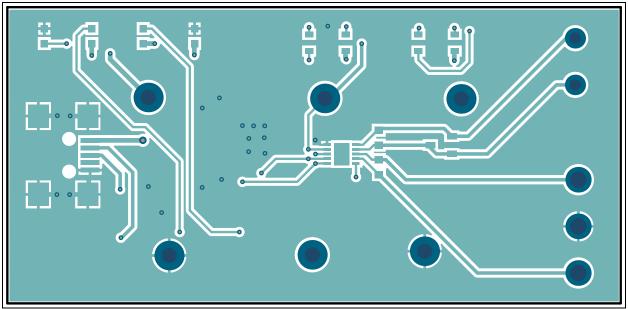
### MCP9904 Temperature Sensor Evaluation Board User's Guide



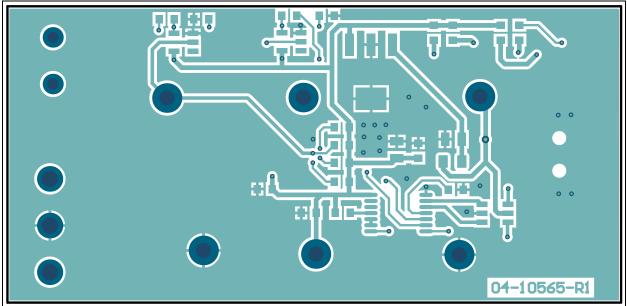
A.5 BOARD – TOP COPPER AND SILK



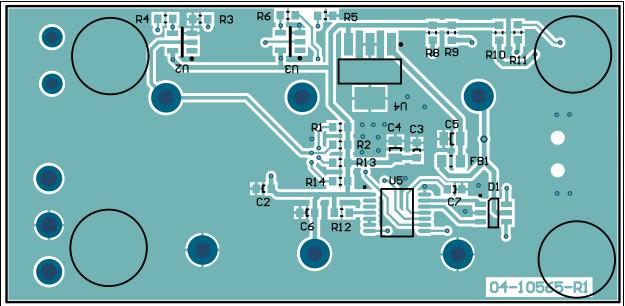
A.6 BOARD – TOP COPPER



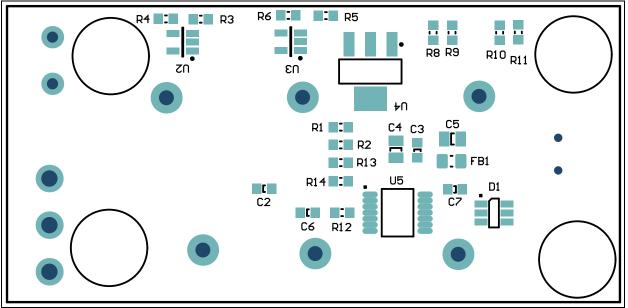
A.7 BOARD – BOTTOM COPPER



#### A.8 BOARD – BOTTOM COPPER AND SILK



#### A.9 BOARD – BOTTOM SILK





### Appendix B. Bill of Materials (BOM)

TABLE	B-1: BILL O	F MATERIALS (BOM)	1	1
Qty.	Reference	Description	Manufacturer	Part Number
4	+3.3 PWR, +5V PWR, SMB_ACT, USB_ACT	Diode LED green 2.2V 25 mA 15 mcd Clear SMD 0603	Kingbright Corp.	APT1608SGC
1	+3.3V	Conn. TP Loop Red TH	Keystone Electronics Corp.	5010
1	+5V	Conn. TP Loop Orange TH	Keystone Electronics Corp.	5013
2	ALERT, THERM	Conn. TP Loop White TH	Keystone Electronics Corp.	5012
2	C1, C8	Cap. ceramic 2200 pF 50V 10% X7R SMD 0603	KEMET®	C0603C222K5RACTU
3	C2, C3, C6	Cap. ceramic 0.1 µF 16V 10% X7R SMD 0603	NIC Components Corp.	NMC0603X7R104K16TRPF
2	C4, C5	Cap. ceramic 10 µF 10V 10% X5R SMD 0805	Taiyo Yuden Co., Ltd.	LMK212BJ106KD-T
1	C7	Cap. ceramic 0.47 µF 6.3V 10% X5R SMD 0603	Murata Electronics <sup>®</sup>	GRM188R60J474KA01D
1	D1	Diode TVSARR USBLC6-2SC6 5.25V SMD SOT-23-6	STMicroelectronics	USBLC6-2SC6
1	FB1	Ferrite 2A 220R SMD 0805	Murata Electronics	BLM21PG221SN1D
2	GND1, GND2	Conn. TP Loop Black TH	Keystone Electronics Corp.	5011
1	J1	Conn. Term Block 5 mm 3POS GRN	PHOENIX CONTACT	1792876
1	J2	Conn. USB MINI-B female SMD R/A	Hirose Electric Co., Ltd.	UX60-MB-5ST
1	J3	Conn. term Block 5 mm 2POS GRN	PHOENIX CONTACT	1792863
2	LED1, LED2	Diode LED bi red, green 2V, 2.2V, 30 mA, 25 mA 4-SMD	Lumex <sup>®</sup> Inc.	SSL-LXA3025IGC-TR
4	PAD1, PAD2, PAD3, PAD4	Mech. HW rubber pad cylindrical D7.9 H5.3 black	3M	SJ61A11
1	PCB	MCP9904 Temperature Sensor Evaluation Board – Printed Circuit Board	Microchip Technology Inc.	04-10565
1	Q1	Trans. BJT NPN MMBT3904 40V 200 mA 310 mW SOT-23-3	Diodes <sup>®</sup> Incorporated	MMBT3904-7
1	R1	Res. TKF 10 kΩ 1% 1/10W SMD 0603	NIC Components Corp.	NRC06F1002TRF

The components listed in this Bill of Materials are representative of the PCB assembly. The Note: released BOM used in manufacturing uses all RoHS-compliant components.

Qty.	Reference	Description	Manufacturer	Part Number
1	R2	Res. TKF 20 kΩ 1% 1/10W SMD 0603	Yageo Corporation	9C06031A2002FKHFT
4	R3, R4, R5, R6	Res. TKF 470R 1% 1/10W SMD 0603	Yageo Corporation	RC0603FR-07470RL
3	R8, R9, R10	Res. TKF 1 kΩ 1% 1/10W SMD 0603	Panasonic <sup>®</sup> – ECG	ERJ-3EKF1001V
1	R11	Res. TKF 2.2 kΩ 1% 1/10W SMD 0603	Panasonic – ECG	ERJ-3EKF2201V
3	R12, R13, R14	Res. TF 10 kΩ 1% 1/8W SMD 0603	Vishay Intertechnology, Inc.	MCT06030C1002FP500
1	U1	Microchip Analog Temperature Sensor -40°C to +125°C MCP9904T-1E/RW DFN-10	Microchip Technology Inc.	MCP9904T-1E/9Q
2	U2, U3	IC LOGIC 74LVC1G04 SOT-23-5	Texas Instruments	SN74LVC1G04DBVR
1	U4	MCHP ANALOG LDO 3.3V MCP1825ST-3302E/DB SOT-223-3	Microchip Technology Inc.	MCP1825S-3302E/DB
1	U5	USB-to-I <sup>2</sup> C/UART SMBus Protocol Converter with GPIO	Microchip Technology Inc.	MCP2221-I/ST

TABLE B-1:	BILL OF MATERIALS (BOM) (CONTINUED)
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**Note:** The components listed in this Bill of Materials are representative of the PCB assembly. The released BOM used in manufacturing uses all RoHS-compliant components.



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