MCP9601 Thermocouple IC Evaluation Board User's Guide

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MCP9601 THERMOCOUPLE IC EVALUATION BOARD USER'S GUIDE

Table of Contents

Preface 5
Introduction 5
Document Layout 5
Conventions Used in This Guide 6
Recommended Reading 7
The Microchip Website 7
Customer Support 7
Revision History 7

Chapter 1. Product Overview
1.1 Introduction 9
1.2 What is the MCP9601 Device? 9
1.3 What is the MCP9601 Thermocouple IC Evaluation Board? 9
1.4 What the MCP9601 Thermocouple IC Evaluation Board Kit Contains 9

Chapter 2. Installation and Operation
2.1 Introduction 11
2.2 Required Tool 11
2.3 Getting Started 11
2.3.1 Hardware Setup 11
2.3.2 Hardware Operation 12
2.4 Microchip Thermal Management Software GUI 12
2.5 Configuring the MCP9601 15
2.5.1 MCP9600 vs. MCP9601 Additional Features 15
2.5.2 How to Check for Open Circuit and Short Circuit Conditions 16
2.6 Data Acquisition 16

Appendix A. Schematic and Layouts
A.1 Introduction 19
A.2 Schematic 1 20
A.3 Schematic 2 21
A.4 Board – Top Silk 22
A.5 Board – Top Copper and Silk 22
A.6 Board – Top Copper 23
A.7 Board – Bottom Copper 23
A.8 Board – Bottom Copper and Silk 24
A.9 Board – Bottom Silk 24

Appendix B. Bill of Materials (BOM) 25
Worldwide Sales and Service 27

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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 website (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 "DSXXXXXXXXA", where "XXXXXXXX" 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® 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 MCP9601 Thermocouple IC Evaluation Board. Items discussed in this chapter include:

- Document Layout
- Conventions Used in This Guide
- Recommended Reading
- The Microchip Website
- Customer Support
- Revision History

DOCUMENT LAYOUT

This document describes how to use the MCP9601 Thermocouple IC Evaluation Board as a development tool. The document is organized as follows:

- **Chapter 1. "Product Overview"** – This chapter includes important information about the MCP9601 Thermocouple IC Evaluation Board.
- **Chapter 2. "Installation and Operation"** – This chapter includes a detailed description of each function of the evaluation board and instructions on how to begin using the board.
- **Appendix A. "Schematic and Layouts"** – Shows the schematic and layout diagrams for MCP9601 Thermocouple IC Evaluation Board.
- **Appendix B. "Bill of Materials (BOM)"** – Lists the parts used to build the MCP9601 Thermocouple IC Evaluation Board.

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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) { ... }`

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RECOMMENDED READING

This user's guide describes how to use the MCP9601 Thermocouple IC Evaluation Board. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources:

- **MCP960X/L0X/RL0X Data Sheet –** ***"Thermocouple EMF to Temperature Converter, ±1.5°C Maximum Accuracy"*** **(DS20005426)**

This data sheet provides detailed information regarding the MCP9601 device:

- **PIC18F2455/2550/4455/4550 Data Sheet –** ***"28/40/44-Pin, High-Performance, Enhanced Flash, USB Microcontrollers with nanoWatt Technology"*** **(DS39632)**

This data sheet provides detailed information regarding the PIC18F2455/2550/4455/4550 devices.

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- **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

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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 website at:
http://www.microchip.com/support.

REVISION HISTORY

Revision A (January 2022)

NOTES:

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Chapter 1. Product Overview

1.1 INTRODUCTION

This chapter provides an overview of the MCP9601 Thermocouple IC Evaluation Board and covers the following topics:

- What is the MCP9601 Device?
- What is the MCP9601 Thermocouple IC Evaluation Board?
- What the MCP9601 Thermocouple IC Evaluation Board Kit Contains

1.2 WHAT IS THE MCP9601 DEVICE?

The MCP9601 is a Thermocouple Electromotive Force (EMF) to temperature converter. This device converts thermocouple EMF to degree Celsius with integrated Cold-Junction compensation. MCP9601 corrects the thermocouple nonlinear error characteristics of eight thermocouple types and outputs ±1.5°C accurate temperature data for the selected thermocouple. The correction coefficients are derived from the National Institute of Standards and Technology (NIST) ITS-90 Thermocouple Database.

1.3 WHAT IS THE MCP9601 THERMOCOUPLE IC EVALUATION BOARD?

The MCP9601 Thermocouple IC Evaluation Board is used to evaluate MCP9601 Thermocouple EMF voltage to degree Celsius converter. Users can easily evaluate all device features using a Type K thermocouple. The device also supports Types J, T, N, E, B, S and R thermocouples. Each of these types can be evaluated by replacing the Type K thermocouple connector with the corresponding connectors.

In addition, the MCP9601 Thermocouple IC Evaluation Board connects to a PC via a USB interface. Temperature can be data-logged using the Microchip Thermal Management Software Graphical User Interface (GUI).

1.4 WHAT THE MCP9601 THERMOCOUPLE IC EVALUATION BOARD KIT CONTAINS

The MCP9601 Thermocouple IC Evaluation Board package includes:

- MCP9601 Thermocouple IC Evaluation Board (ADM00665)
- Type K Thermocouple
- Mini USB Cable
- Important Information Sheet

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Chapter 2. Installation and Operation

2.1 INTRODUCTION

The MCP9601 Thermocouple IC Evaluation Board enables users to easily evaluate all user-programmable features such as thermocouple selection, temperature alert limit settings, temperature resolutions and Power mode.

Items discussed in this chapter include:

- Required Tool
- Getting Started
- Microchip Thermal Management Software GUI
- Configuring the MCP9601
- Data Acquisition

2.2 REQUIRED TOOL

The evaluation board software requires Windows® 7 or later, with a USB connection.

2.3 GETTING STARTED

This section describes how to power up and interface with the MCP9601 Thermocouple IC Evaluation Board.

2.3.1 Hardware Setup

1. The MCP9601 Thermocouple IC Evaluation Board has a mini USB connector. The USB connection is needed for power and data acquisition.

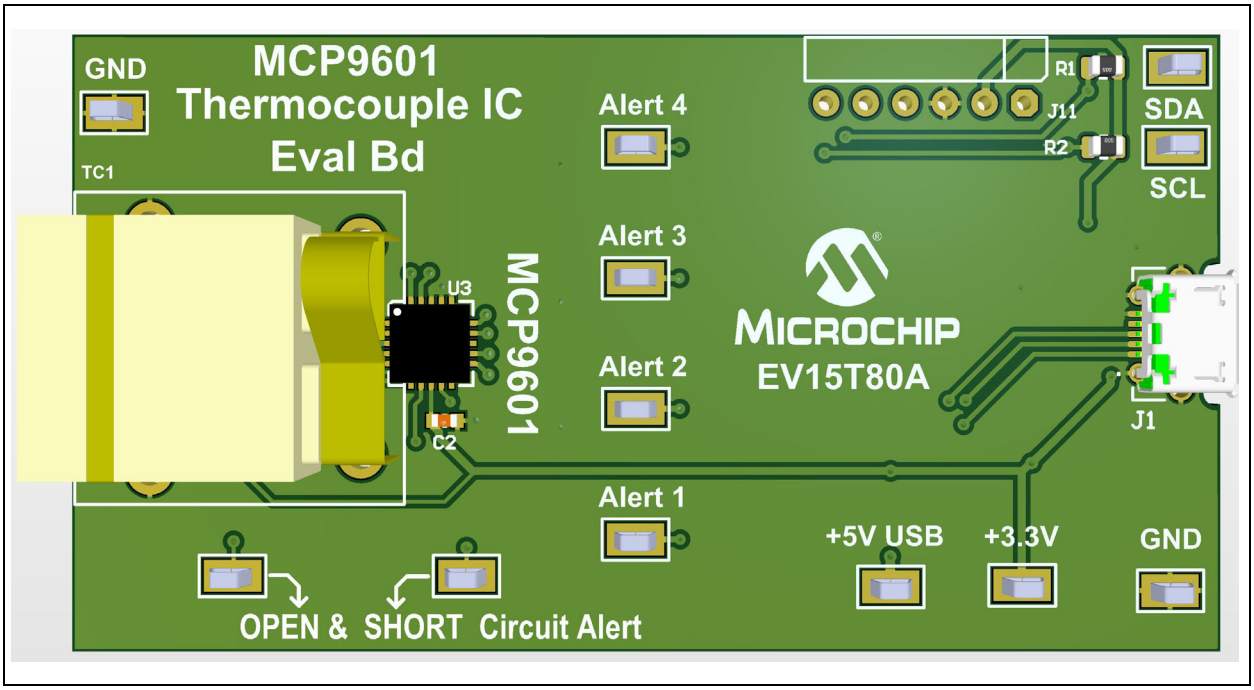

FIGURE 2-1: *MCP9601 Thermocouple IC Evaluation Board.*

2.3.2 Hardware Operation

The MCP9601 Thermocouple IC Evaluation Board is fully powered from a PC USB 5V source. Once power is applied and the USB is successfully enumerated, the PIC® microcontroller is ready to receive commands from GUI MCP9601 settings or transfer temperature data.

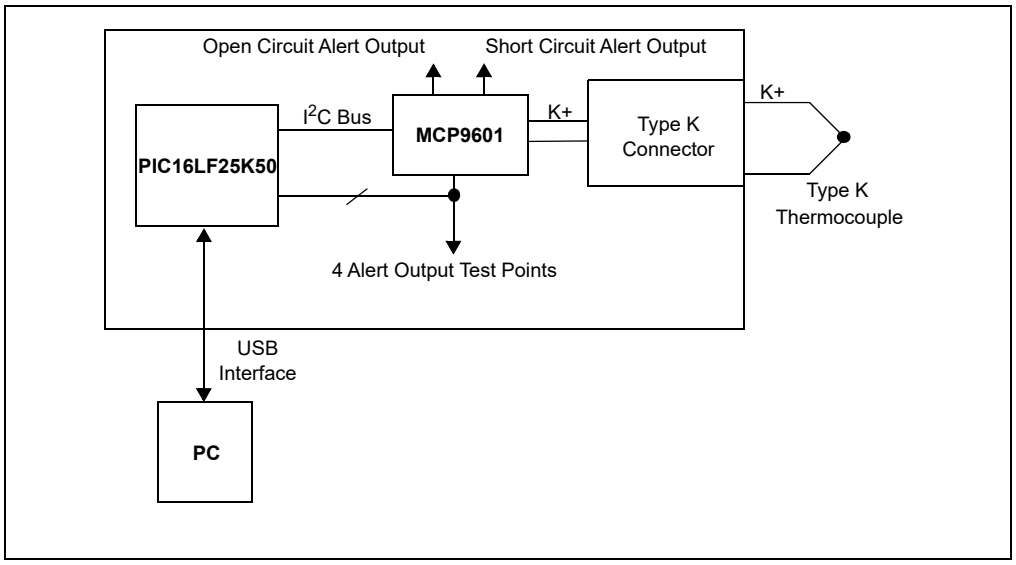

FIGURE 2-2: *Functional Block Diagram.*

The block diagram (Figure 2-2) shows that the thermocouple connector is directly connected to the MCP9601. The four Alert outputs are connected to test points for external connections. Additionally, these outputs are also connected to the microcontroller I/O pins so that the Alert Output statuses can be detected in software.

2.4 MICROCHIP THERMAL MANAGEMENT SOFTWARE GUI

The Microchip Thermal Management Graphical User Interface allows users to evaluate the MCP9601 for temperature-sensing applications. This software tool can be downloaded and installed from the evaluation board product page. The software requires the 'Microsoft.NET Framework' package. If this framework package is not installed on the computer, then the software will automatically download and install it. After the installation is successfully completed, the hardware is required to start the graphical user interface.

Once the hardware is connected, the software recognizes the device ID and displays the corresponding GUI for the evaluation board. Disconnecting the USB will close the GUI. This tool enables the user to evaluate the sensor features and perform temperature data logging.

Figure 2-3 shows the data acquisition interface with a plot of the thermocouple Hot-Junction and Cold-Junction temperature data. The Y1 axis is the Hot-Junction temperature and the Y2 axis is the Cold-Junction temperature. This data can also be exported by right-clicking the plot and following the export options.

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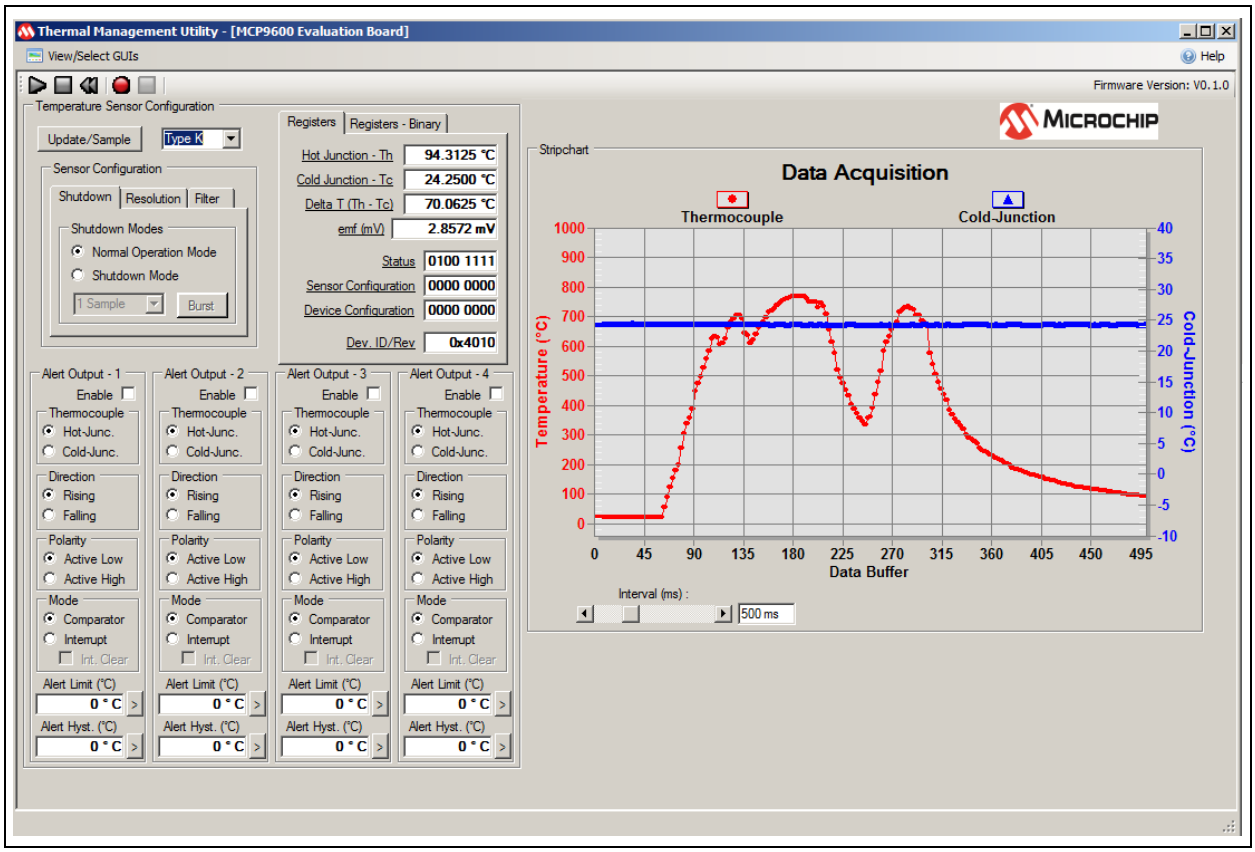

FIGURE 2-3: *Data Acquisition Interface.*

Use the Thermal Management Software Graphical User Interface (GUI) for temperature data logging or to evaluate the sensor board features. If the hardware is properly connected, the software will recognize the hardware, otherwise, the software will show the 'Hardware Not Detected' message box, as indicated in Figure 2-4.

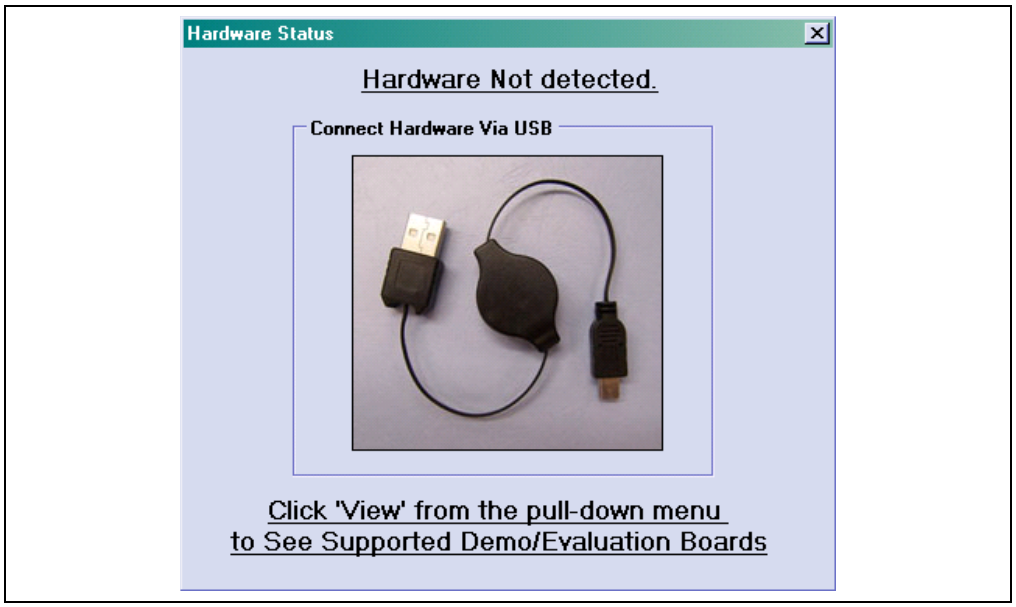

FIGURE 2-4: *Hardware Not Detected Message Box.*

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2.5 CONFIGURING THE MCP9601

Figure 2-5 shows the user interface for various sensor options. Once these options are selected, the software programs the device and refreshes the GUI from the device. Therefore the GUI displays the updated device settings.

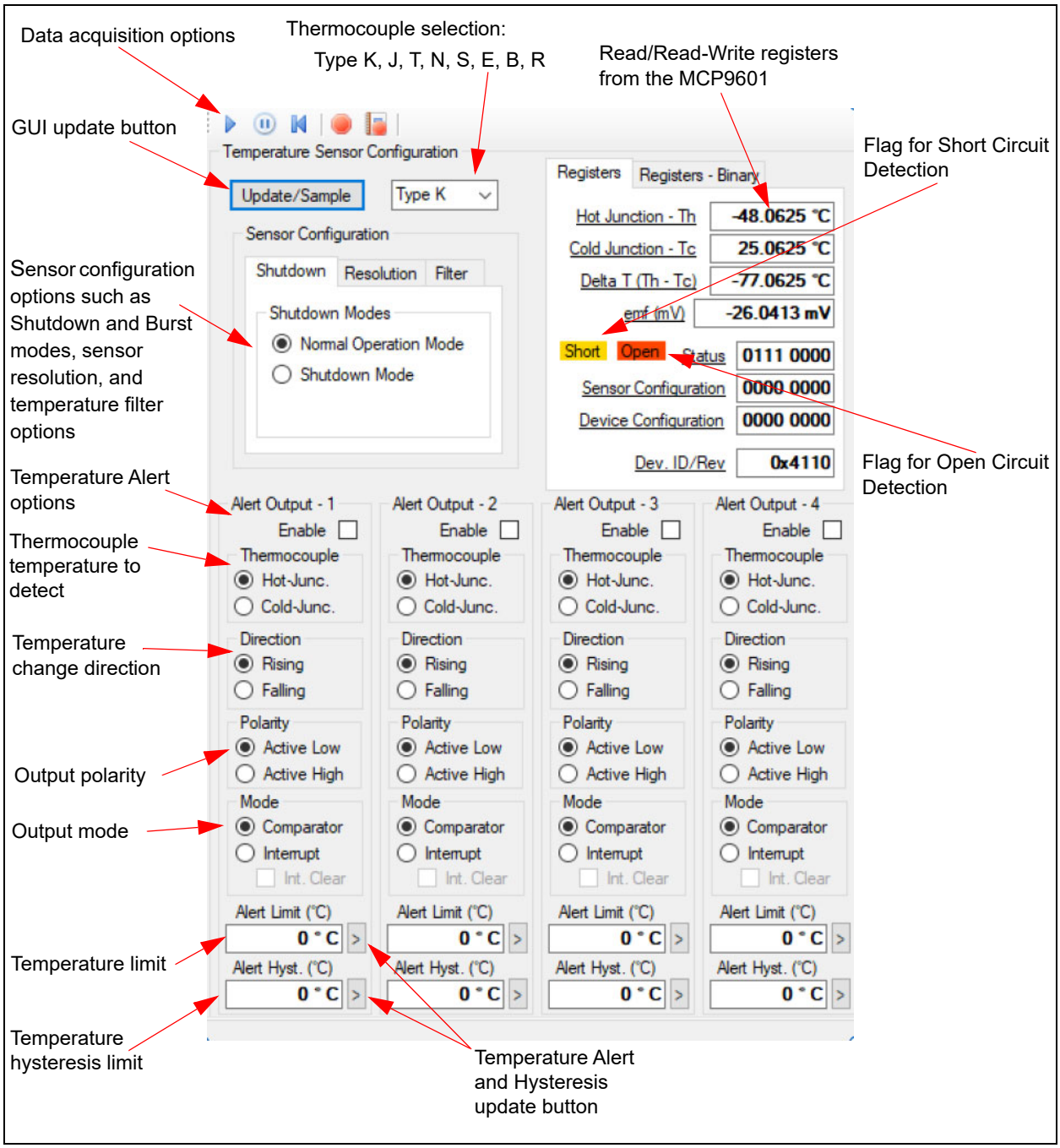

FIGURE 2-5: *Sensor Configuration Options.*

2.5.1 MCP9600 vs. MCP9601 Additional Features

The MCP9601 family integrates an open circuit and short circuit detection mechanism. When open/short circuit is detected, the device asserts an Alert signal using the SC Alert and OC Alert pins. There are test points for these pins on the MCP9601 evaluation board, which can be used to detect open circuit and short circuit conditions.

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Additionally, the status register bits 4 and 5 are also set when the open circuit and short circuit conditions are true. However, the MCP9600 family supports only open circuit detection which can only be read by the host controller from the status register. The MCP9600 does not integrate the alert output pin for open circuit detection.

2.5.2 How to Check for Open Circuit and Short Circuit Conditions

The GUI shows the open circuit and short circuit flags using a yellow and red colored texts as shown in Figure 2-5. These features can be validated by simply disconnecting the thermocouple header from the board for open circuit detection, or by shorting the thermocouple wire to the system ground or power source (V_{SS} or V_{DD} test points on the evaluation board).

2.6 DATA ACQUISITION

The black "Play", "Stop", and "Reset" icons (Figure 2-6) can be used to perform continuous data acquisitions. The red "Record" icon enables the user to data log to an external file. The logging interval can be adjusted using the Interval scroll bar from 100 ms to 30s, as shown in Figure 2-3.

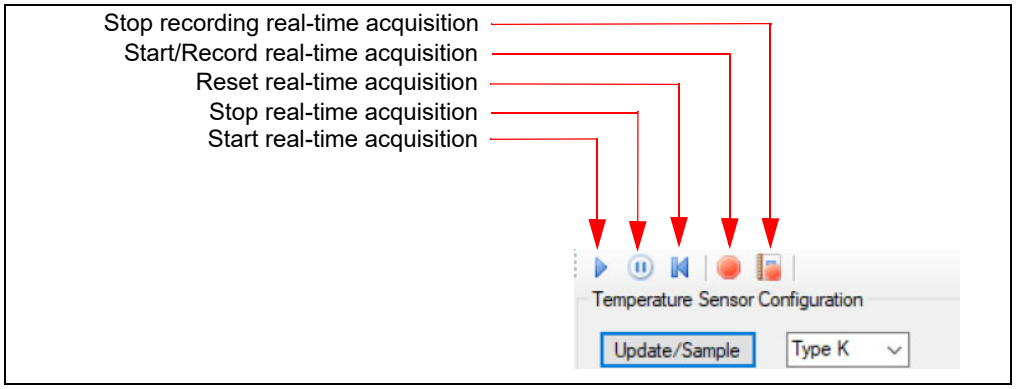

FIGURE 2-6: *Real-Time Acquisition.*

The data acquisition display chart (Figure 2-3) can be customized. The customizing options (Figure 2-7) can be selected by either double-clicking or right-clicking the chart (Figure 2-3). The displayed data can also be exported.

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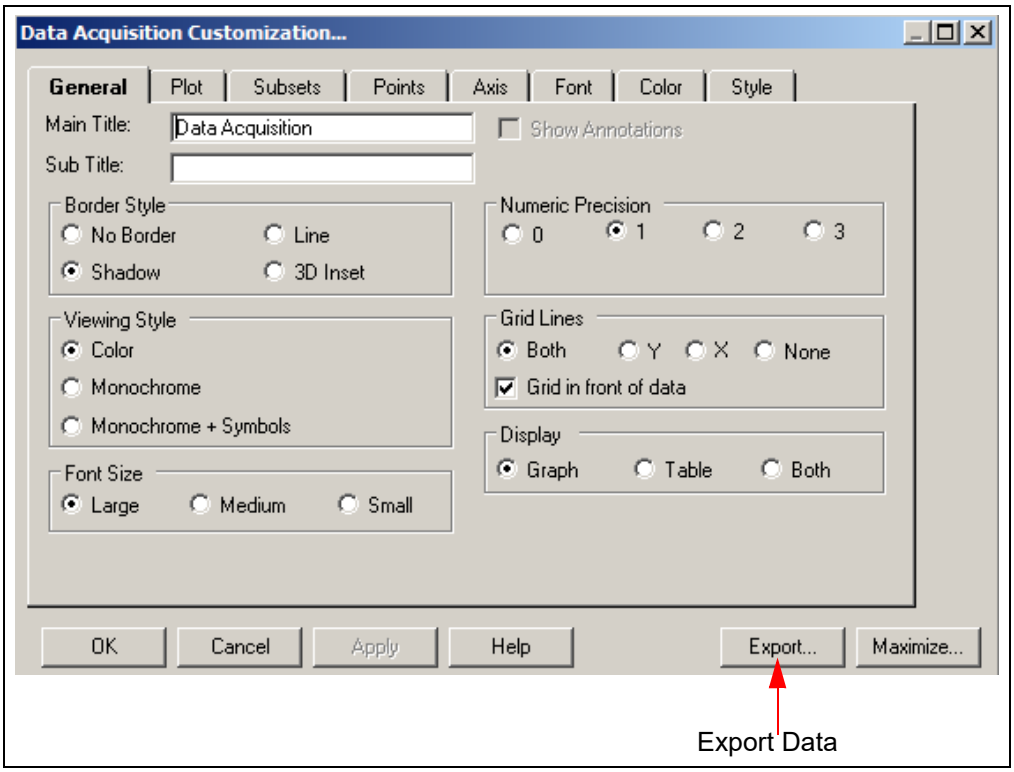

FIGURE 2-7: *Chart Setup Options.*

NOTES:

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Appendix A. Schematic and Layouts

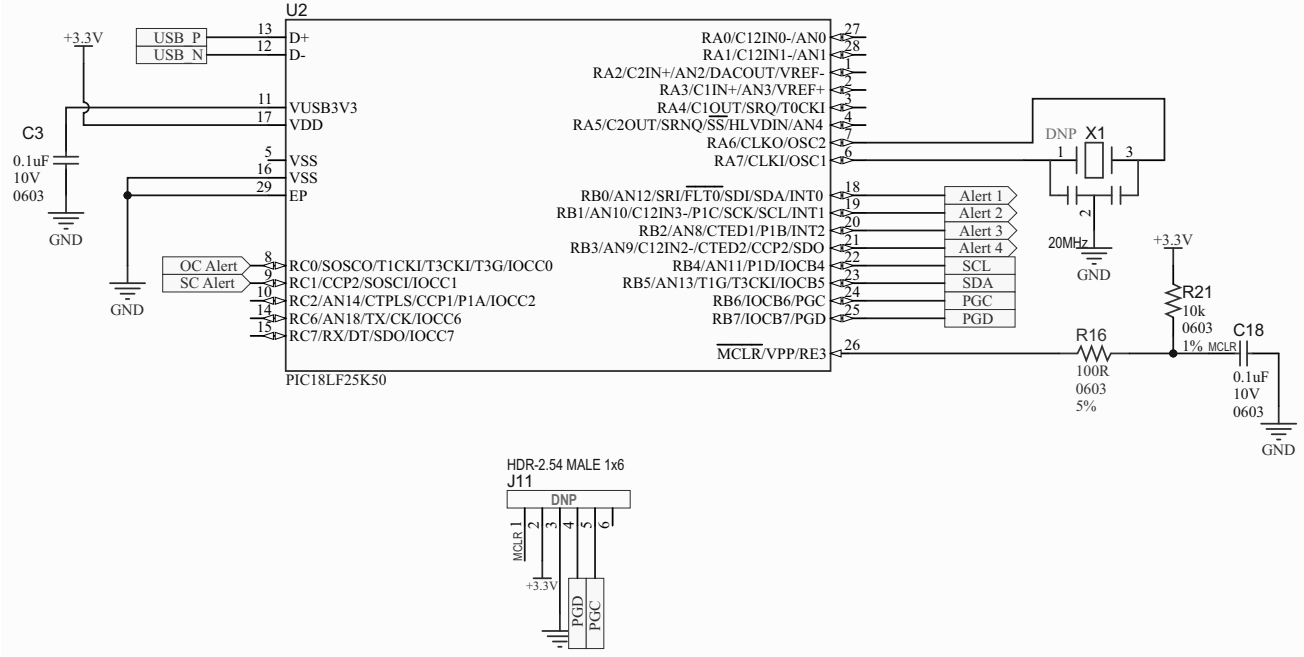
A.1 INTRODUCTION

This appendix contains the following schematics and layouts for the MCP9601 Thermocouple IC Evaluation Board:

- Schematic 1
- Schematic 2
- Board – Top Silk
- Board – Top Copper and Silk
- Board – Top Copper
- Board – Bottom Copper
- Board – Bottom Silk

A.2 SCHEMATIC 1

Connectivity



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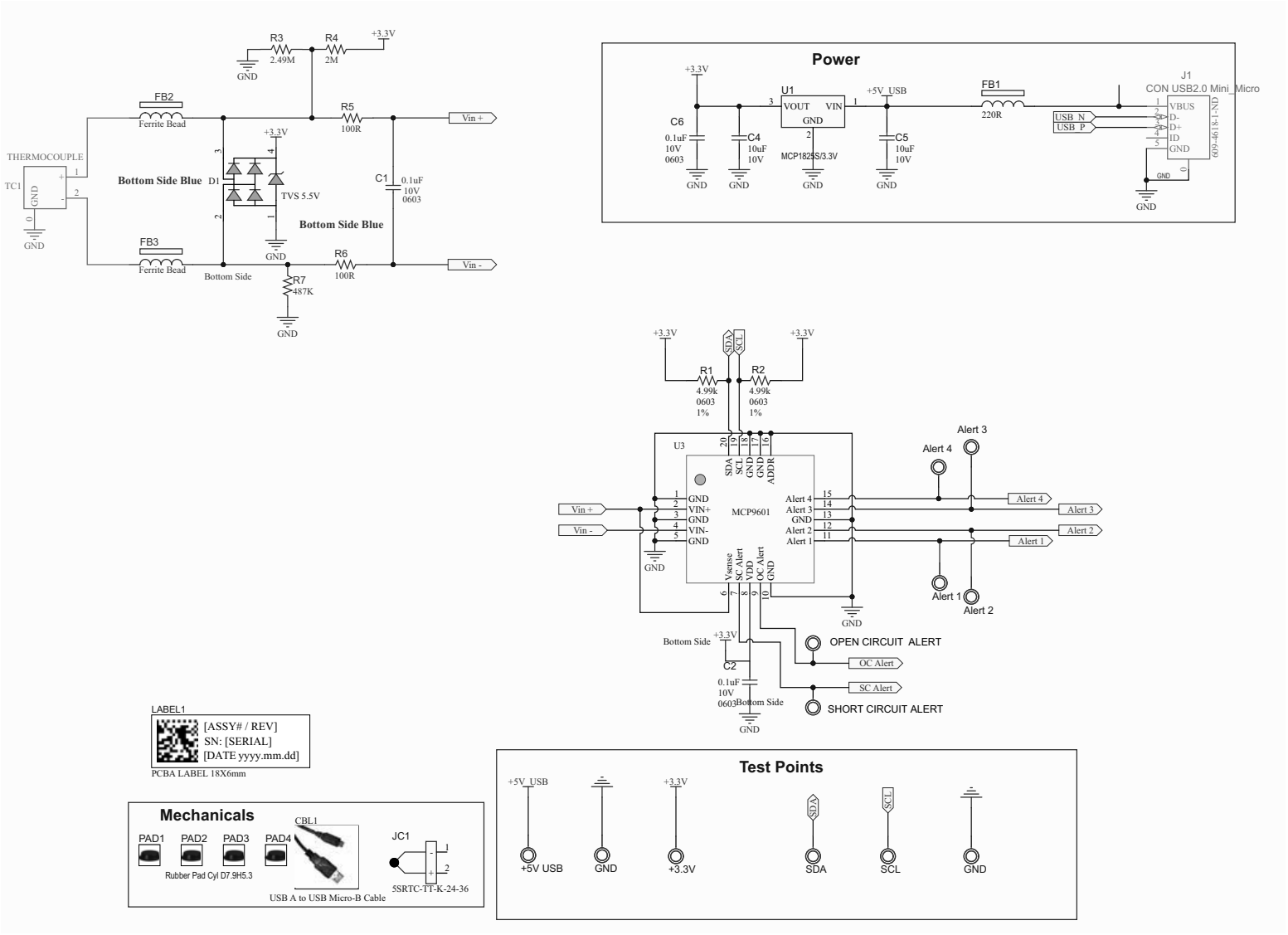
A.3 SCHEMATIC 2



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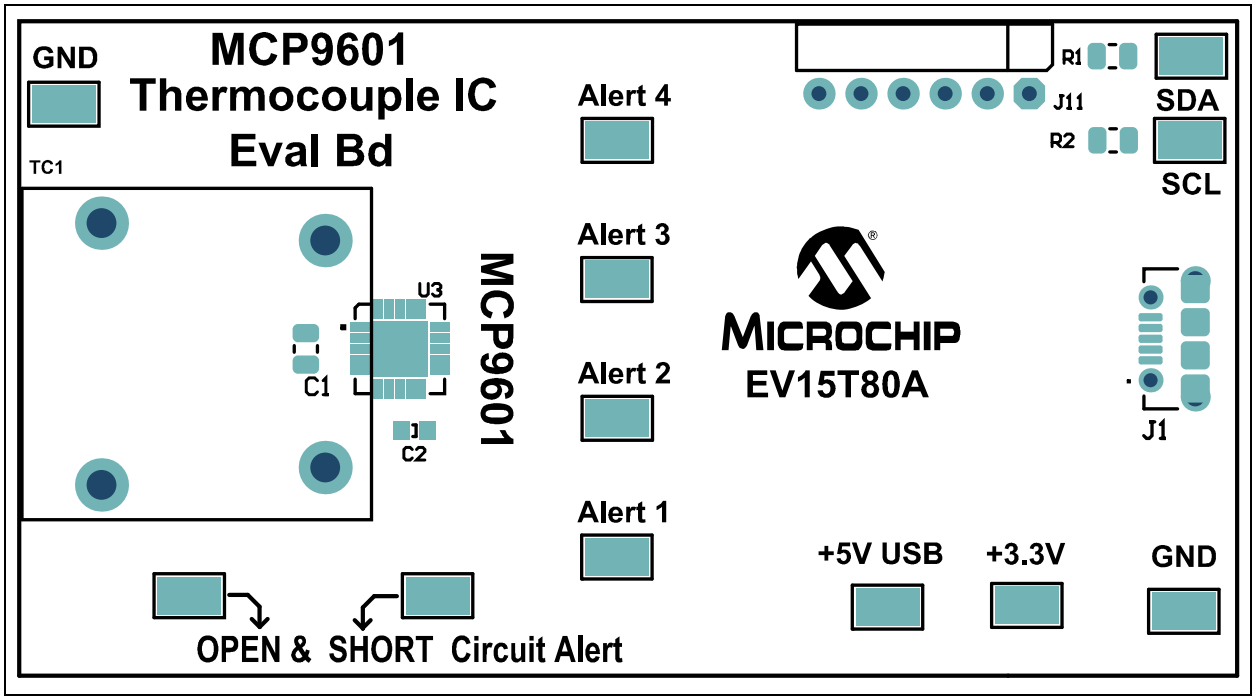
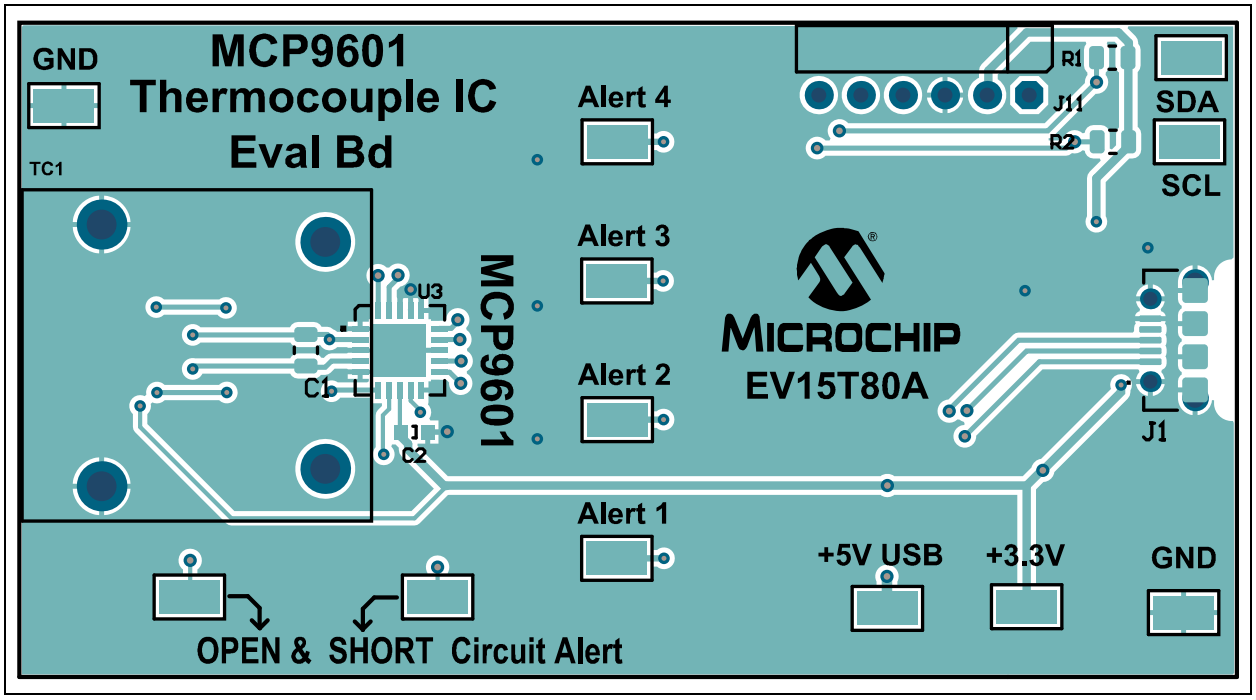
A.4 BOARD – TOP SILK



A.5 BOARD – TOP COPPER AND SILK



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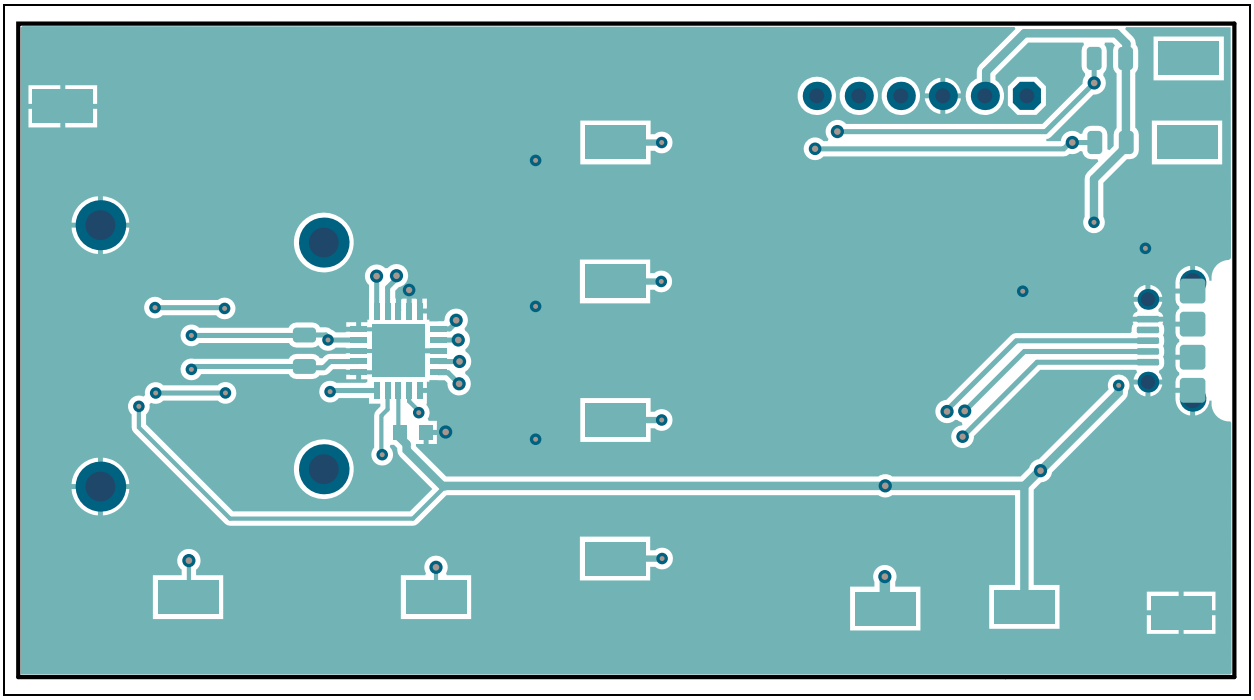
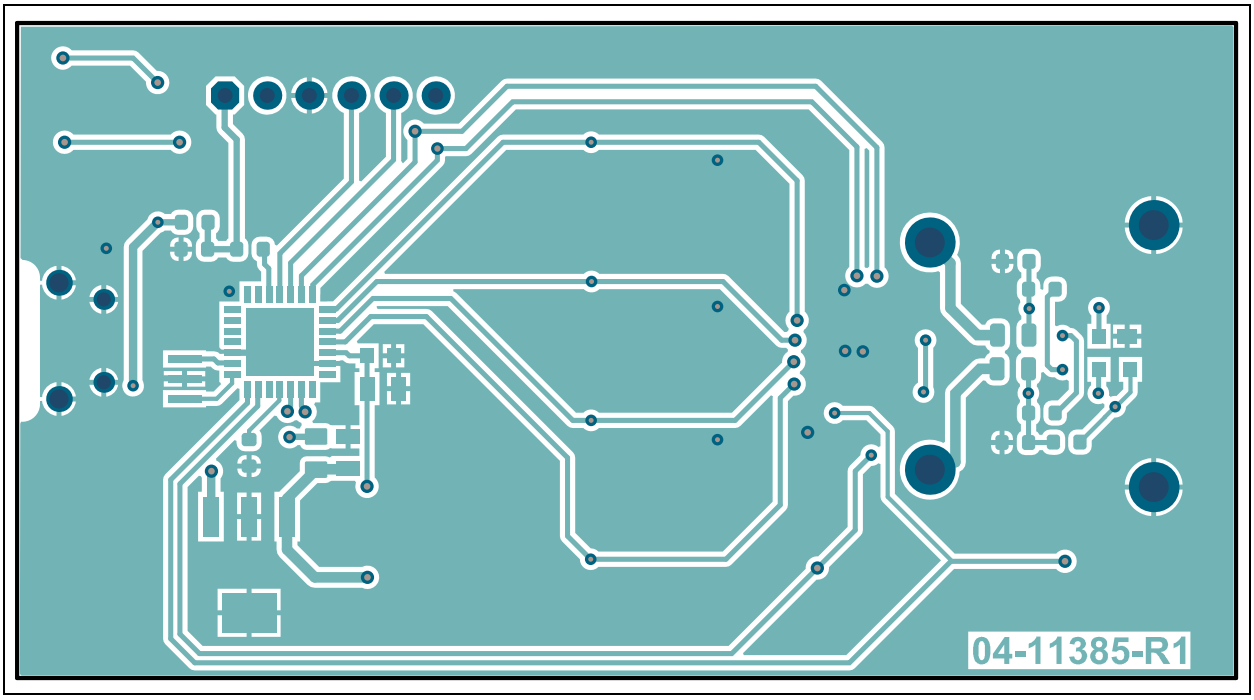
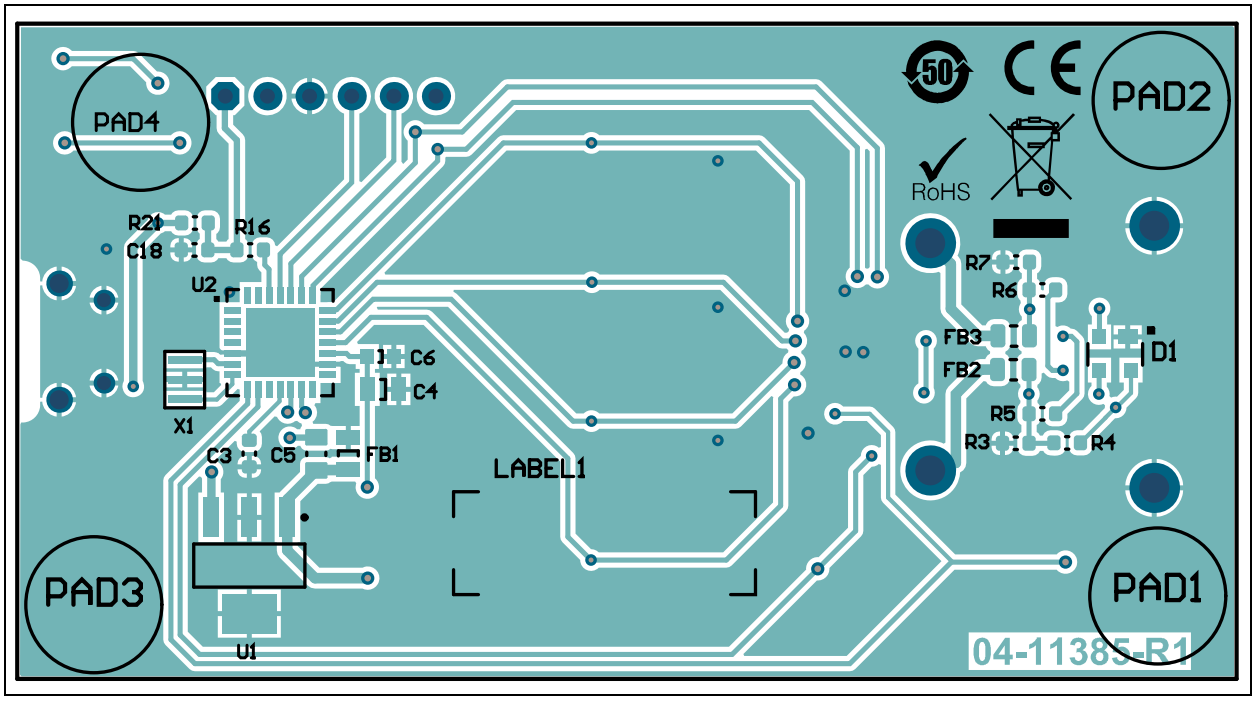
A.6 BOARD –TOP COPPER



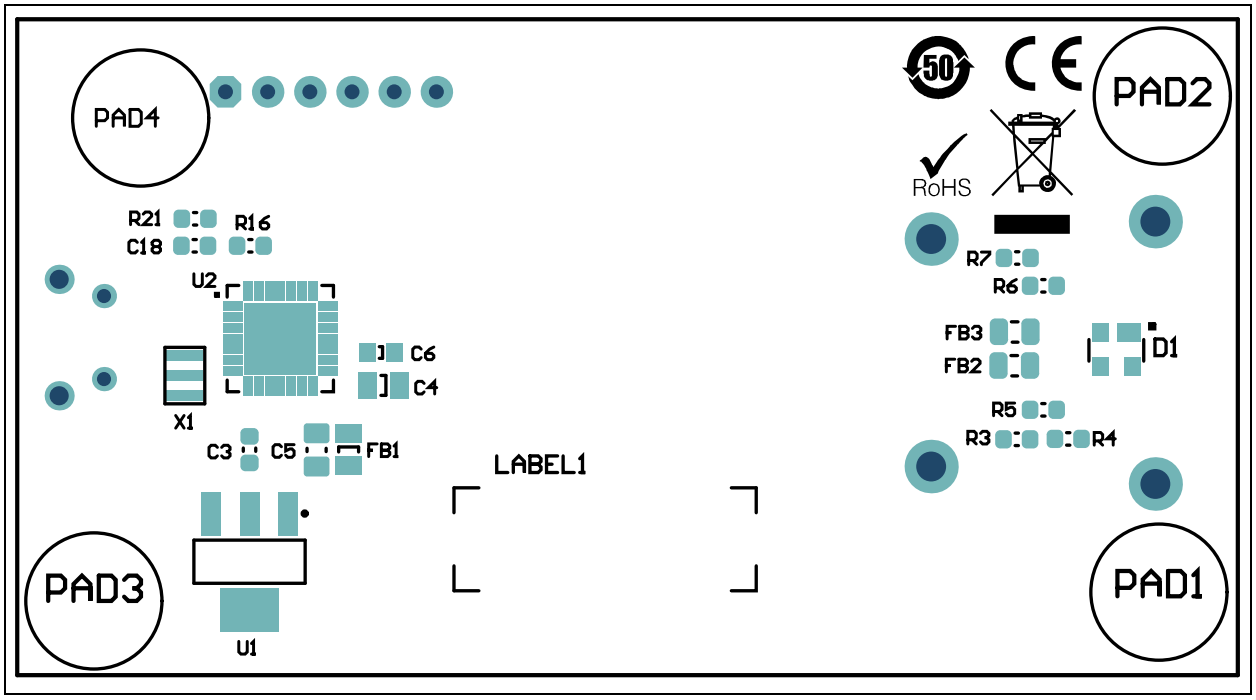
A.7 BOARD – BOTTOM COPPER



A.8 BOARD – BOTTOM COPPER AND SILK



A.9 BOARD – BOTTOM SILK



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Appendix B. Bill of Materials (BOM)

TABLE B-1: BILL OF MATERIALS (BOM)

Qty.	Reference	Description	Manufacturer	Part Number
12	+3.3V, +5V USB, Alert 1, Alert 2, Alert 3, Alert 4, GND, SCL, SDA, TP1, TP2	Connector, TP, loop, silver, 0.38, SMD	Keystone® Electronics Corp.	5018
5	C1, C2, C3, C6, C18	Capacitor, ceramic, 0.1 µF, 10V, 10%, X7R, SMD, 0603	KEMET	C0603C104K8RACTU
2	C4, C5	Capacitor, ceramic, 10 µF, 10V, 10%, X5R, SMD, 0805	Taiyo Yuden Co., Ltd.	LMK212BJ106KD-T
1	D1	TVS, diode, 5.5V, SOT143B	Nexperia	PRTR5V0U2X,215
1	FB1	Ferrite, 2A, 220R, SMD, 0805	Murata Electronics®	BLM21PG221SN1D
2	FB2, FB3	Ferrite, 800 mA, 0.15R, SMD, 0805	Laird Technologies®	LI0805H151R-10
1	J1	Connector, USB, 2.0 MICRO-B, female, TH/SMD, R/A	Amphenol Corporation	10118194-0001LF
1	J11	Connector, header-2.54, male, 1x6, gold, 6.10MH, TH R/A – **DO NOT POPULATE**	3M	961106-5604-AR
1	LABEL1	Label, PCBA, 18x6mm, Datamatrix, Assy# / Rev / Serial / Date	Logimark AB	505462
4	PAD1, PAD2, PAD3, PAD4	Mechanical, hardware, rubber pad, Cylindrical, D7.9, H5.3, black	3M	SJ61A11
1	PCB	MCP9601 Thermocouple IC Evaluation Board – Printed Circuit Board	—	04-11385-R2
2	R1, R2	Resistor, TKF, 4.99k, 1%, 1/10W, SMD, 0603	Panasonic® – ECG	ERJ-3EKF4991V
1	R3	Resistor, SMD, 2.49M, Ohm, 1%, 1/10W, 0603	Yageo Corporation	RC0603FR-072M49L
1	R4	Resistor, TKF, 2M, 5%, 1/10W, SMD, 0603	Panasonic – ECG	ERJ-3GEYJ205V
3	R5, R6, R16	Resistor, TKF, 100R, 5%, 1/10W, SMD, 0603	Vishay/Dale	CRCW0603100RJNEA
1	R7	Resistor, SMD, 487K, Ohm, 1%, 1/10W, 0603	Panasonic – ECG	ERJ-3EKF4873V
1	R21	Resistor, TF, 10k, 1%, 1/16W, SMD, 0603	TE Connectivity, Ltd.	CPF0603F10KC1
1	TC1	Mechanical, hardware, adapter, Thermocoupler, TH, R/A	Omega® Engineering Inc.	PCC-SMP-K-100
1	U1	Microchip, Analog, LDO, 3.3V, MCP1825ST-3302E/DB, SOT-223-3	Microchip Technology Inc.	**MCP1825ST-3302E/DB**

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

Qty.	Reference	Description	Manufacturer	Part Number
1	U2	Microchip, MCU 8-Bit, 48 MHz 32 kB, 2kB, PIC18LF25K50-I/ML, QFN-28	Microchip Technology Inc.	**PIC18LF25K50-I/ML**
1	U3	MCP9601 Thermocouple EMF to Temperature Converter	Microchip Technology Inc.	**MCP9601-I/MX MQFN-20**
1	X1	Resonator, 20 MHz, 0.1%, SMD CSTCE-V13L – **DO NOT POPULATE**	Murata Electronics	CSTCE20M0V13L99-R0

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.

TABLE B-2: BILL OF MATERIALS – MECHANICAL PARTS

Qty.	Reference	Description	Manufacturer	Part Number
1	CBL1	Mechanical, hardware, cable, USB, male, A TO USB, Male, Micro-B, 0.91M	Qualtek Electronics Corporation	3025030-03
1	JC1	Sensor, temperature, 5SRTC-TT-K-24-36, Subminiature Connector	Omega Engineering Inc.	5SRTC-TT-K-24-36

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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