TMP102EVM Evaluation Board and Software Tutorial

This user's guide describes the characteristics, operation, and use of the TMP102EVM evaluation board. It discusses how to set up and configure the software and hardware and reviews various aspects of the program operation. Throughout this document, the terms *evaluation board*, *evaluation module*, and *EVM* are synonymous with the TMP102EVM. This user's guide also includes information regarding operating procedures and input/output connections, an electrical schematic, printed circuit board (PCB) layout drawings, and a parts list for the EVM.

Contents

1 Overview 2
2 TMP102EVM Hardware Setup 4
3 TMP102EVM Hardware 6
4 TMP102EVM Software 9
5 TMP102EVM Software Overview 11
6 TMP102 Documentation 18

List of Figures

1 Hardware Included with TMP102EVM Kit 3
2 TMP102EVM Hardware Setup 4
3 TMP102EVM Board Block Diagram 5
4 SM-USB-DIG Platform Block Diagram 6
5 Connecting SM-USB-DIG Platform 7
6 Confirmation of SM-USB-DIG Platform Driver Installation 7
7 10-Pin Ribbon Cable Extender 8
8 TMP102EVM Software Installation 9
9 TMP102EVM License Agreements 10
10 TMP102EVM Software Interface 11
11 TMP102EVM Software: Communication Error with the SM-USB-DIG Platform 11
12 TMP102 Reading from Registers 12
13 TMP102 Writing to Registers 13
14 Reading the Temperature Gauge 14
15 Configuring the Polarity 14
16 Active and Shutdown Mode 15
17 Extended Mode and Normal Mode 15
18 Comparator/Interrupt Mode 16
19 Conversion Rate 16
20 Setting the Fault Queue 16
21 Alert Config Box 17
22 Register Tab 17
23 TMP102EVM Board Schematic 18

24 TMP102EVM PCB Top Layer (Component Side) 19
25 TMP102EVM PCB Bottom Layer 19

List of Tables

1 TMP102EVM Kit Contents 3
2 Related Documentation 4
3 Signal Definition of H1 on TMP102EVM Board 5
4 Bill of Materials 20

1 Overview

The TMP102 is a digital output temperature sensor capable of reading temperatures to 12 bits of resolution. The TMP102 uses a two-wire I^{2}C™ and SMBus™ interface that allows up to four devices on one bus. The TMP102 is ideal for extended temperature measurement, and is also specified to operate between –40°C and +125°C. The TMP102EVM is a platform for evaluating the performance of the TMP102 under various signal, reference, and supply conditions.

This document gives a general overview of the TMP102EVM and provides a general description of the features and functions to be considered while using this evaluation module.

1.1 TMP102EVM Kit Contents

Table 1 summarizes the contents of the TMP102EVM kit. Figure 1 shows all of the included hardware. Contact the Texas Instruments Product Information Center nearest you if any component is missing. It is highly recommended that you also check the TMP102 product folder on the TI web site at www.ti.com to verify that you have the latest versions of the related software.

Table 1. TMP102EVM Kit Contents

Item	Quantity
TMP102EVM PCB Test Board	1
SM-USB-DIG Platform PCB	1
USB Extender Cable	1
10-pin Connector Ribbon Cable	1
User's Guide CD-ROM	1

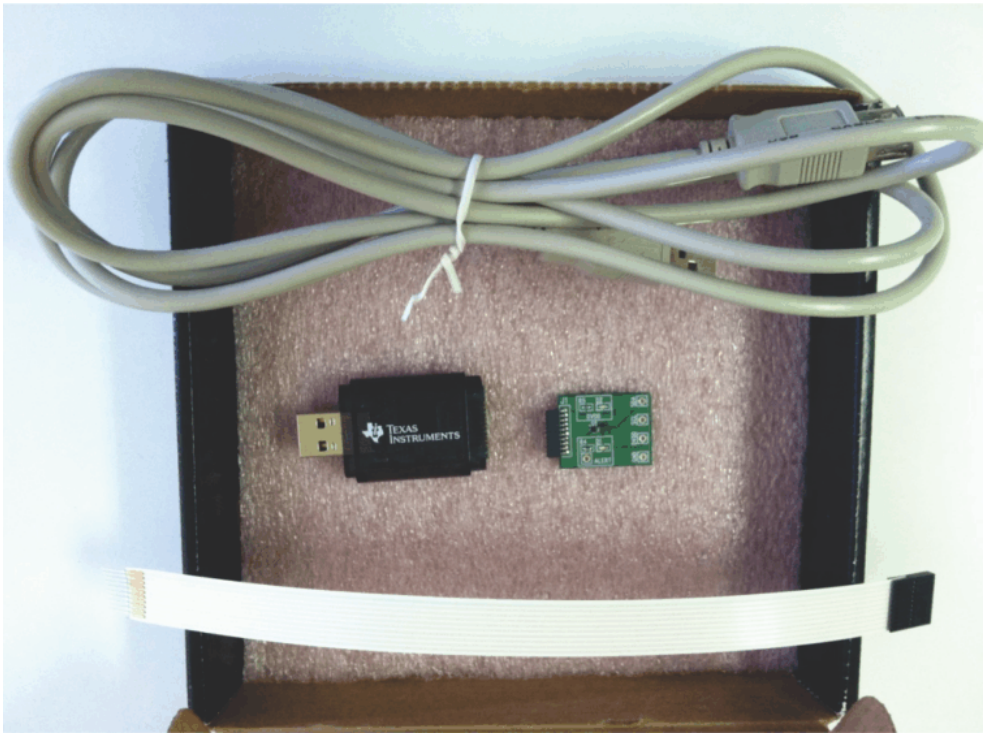

Figure 1. Hardware Included with TMP102EVM Kit

1.2 Related Documentation from Texas Instruments

The following documents provide information regarding Texas Instruments' integrated circuits used in the assembly of the TMP102EVM. This user's guide is available from the TI web site under literature number ***SBOU114***. Any letter appended to the literature number corresponds to the document revision that is current at the time of the writing of this document. Newer revisions may be available from the TI web site, or call the Texas Instruments' Literature Response Center at (800) 477-8924 or the Product Information Center at (972) 644-5580. When ordering, identify the document by both title and literature number.

Table 2. Related Documentation

Document	Literature Number
TMP102 Product Data Sheet	SBOS397B
SM-USB-DIG Platform User Guide	SBOU098

2 TMP102EVM Hardware Setup

Figure 2 shows the overall system setup for the TMP102EVM. The PC runs software that communicates with the SM-USB-DIG platform. The SM-USB-DIG platform generates the digital signals used to communicate with the TMP102 test board. The SM-USB-DIG and TMP102EVM are easily connectable through a 10-pin, board-to-board connector that should be attached to the SM-USB-DIG platform and the TMP102EVM PCBs. Once these two boards are connected, simply plug the USB device from the SM-USB-DIG into the computer as shown in Figure 2.

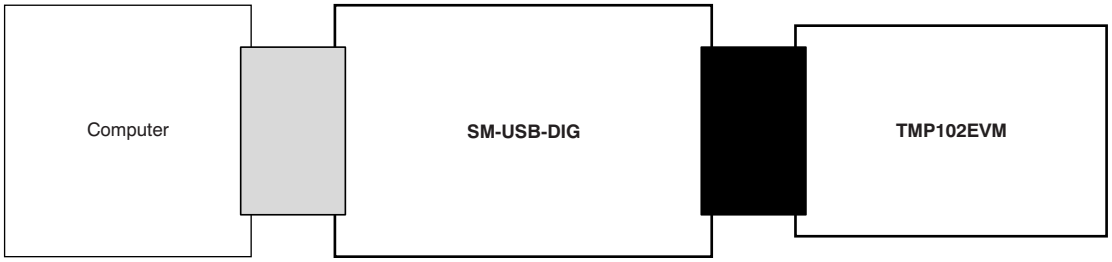

Figure 2. TMP102EVM Hardware Setup

2.1 Theory of Operation for TMP102 Hardware

The TMP102EVM only requires the two-wire I^2C lines (SDA and SCLK) and V_{DUT}/GND to supply a constant 3.3 V and power return, as shown in Figure 3. The TMP102EVM also has test points to monitor these signal lines and ground, in case users may want to use their own signals or verify successful I^2C communications.

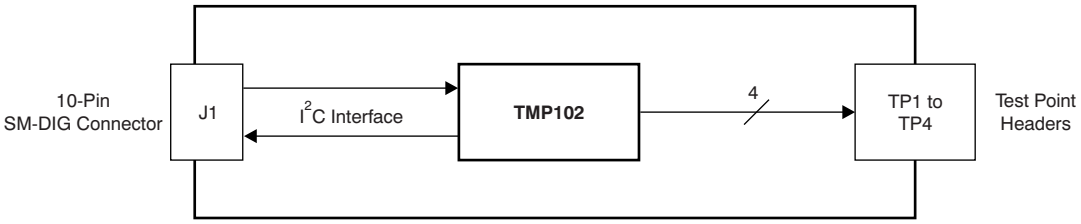

Figure 3. TMP102EVM Board Block Diagram

2.2 Signal Definitions of H1 (10-Pin Male Connector Socket)

Table 3 shows the pinout for the 10-pin connector socket used to communicate between the TMP102EVM and the SM-USB-DIG. It should be noted that the TMP102EVM uses only the necessary I^2C communication lines (pins 1 and 3) and the V_{DUT} and GND (pins 6 and 8, respectively) to issue commands to the TMP102 sensors.

Table 3. Signal Definition of H1 on TMP102EVM Board

Pin on U1	Signal	Description
1	I2C_SCL	I^2C Clock Signal (SCL)
2	CTRL/MEAS4	GPIO: Control Output or Measure Input
3	I2C_SDA1	I^2C Data Signal (SDA)
4	CTRL/MEAS5	GPIO: Control Output or Measure Input
5	SPI_DOUT1	SPI Data Output (MOSI)
6	V_{DUT}	Switchable DUT Power Supply: +3.3 V, +5 V, Hi-Z (Disconnected)(1)
7	SPI_CLK	SPI Clock Signal (SCLK)
8	GND	Power Return (GND)
9	SPI_CS1	SPI Chip Select Signal ($\overline{CS}$)
10	SPI_DIN1	SPI Data Input (MISO)

(1) When V_{DUT} is Hi-Z, all digital I/O are Hi-Z as well.

2.2.1 Theory of Operation for SM-USB-DIG Platform

Figure 4 shows the block diagram for the SM-USB-DIG platform. This platform is a general-purpose data acquisition system that is used on several different Texas Instruments evaluation modules. The details of its operation are included in a separate document, SBOU098 (available for download at www.ti.com). The block diagram shown in Figure 4 gives a brief overview of the platform. The primary control device on the SM-USB-DIG platform is the TUSB3210.

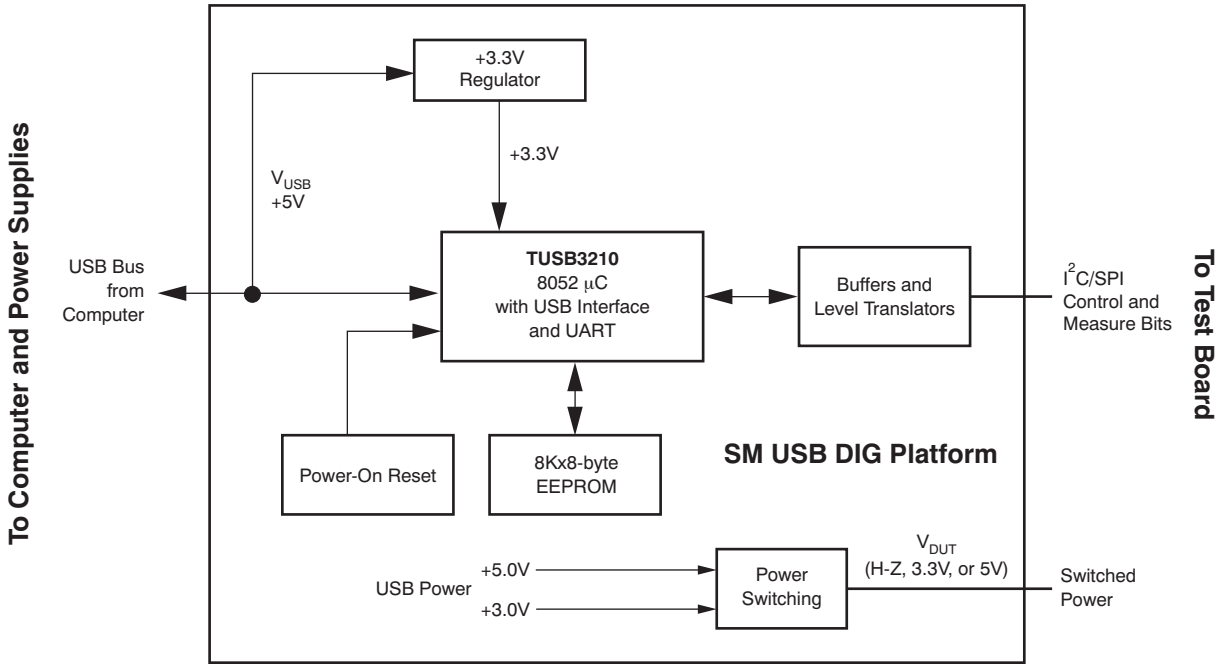

Figure 4. SM-USB-DIG Platform Block Diagram

3 TMP102EVM Hardware

The TMP102EVM hardware overview involves connecting the two PCBs of the EVM together, connecting the USB cable, applying power, and setting the jumpers. This section presents the details of this procedure.

3.1 Electrostatic Discharge Warning

CAUTION

Many of the components on the TMP102EVM are susceptible to damage by electrostatic discharge (ESD). Customers are advised to observe proper ESD handling precautions when unpacking and handling the EVM, including the use of a grounded wrist strap at an approved ESD workstation.

3.2 Typical Hardware Connections

To connect the TMP102 test board and the SM-USB-DIG Platform together, gently slide the male and female ends of the 10-pin connectors together. Make sure that the two connectors are completely pushed together; loose connections may cause intermittent operation.

3.3 Connecting the USB Cable to the DIG

Figure 5 shows the typical response to connecting the SM-USB-DIG Platform board to a PC USB port for the first time. Typically, the computer responds with a *Found New Hardware, USB Device* pop-up dialog. The pop-up window then changes to *Found New Hardware, USB Human Interface Device*. This pop-up indicates that the device is ready to be used. The SM-USB-DIG Platform uses the human interface device drivers that are part of the Microsoft® Windows® operating system.

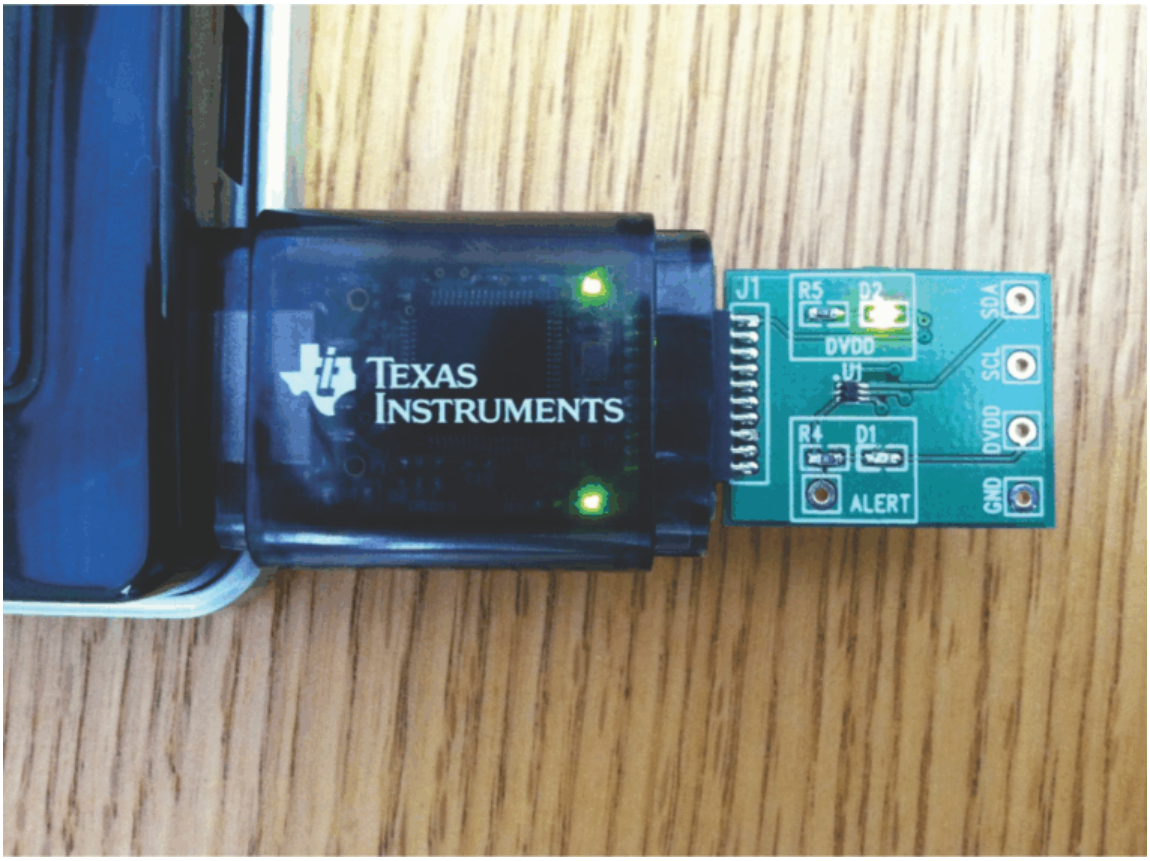

Figure 5. Connecting SM-USB-DIG Platform

In some cases, the Windows *Add Hardware Wizard* appears. If this prompt pops up, allow the system device manager to install the human interface drivers by clicking **Yes** when requested to install drivers. Windows confirms installation of the drivers with the message shown in Figure 6.

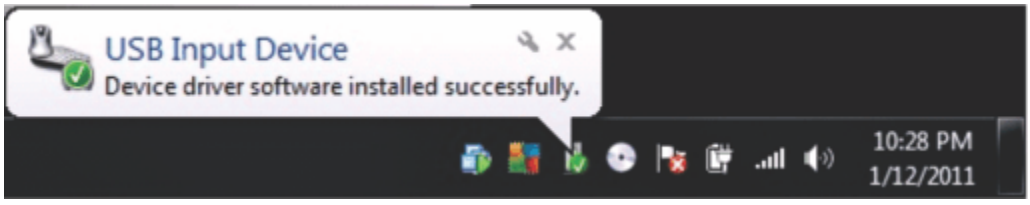

Figure 6. Confirmation of SM-USB-DIG Platform Driver Installation

3.4 TMP102EVM Features

This section describes some of the hardware features present on the TMP102EVM test board.

3.4.1 I²C Test Points

I²C test points are included on the TMP102 test board for user convenience. These test points can be used to monitor the two-wire lines of the I²C interface or to run the TMP102 test board externally without the use of the SM-USB-DIG.

3.4.2 10-Pin Connector Ribbon Extender (Optional)

The TMP102EVM kit ships with an optional ribbon cable for extending the connection between the SM-USB-DIG and the PCB. This extension cable can be useful if high temperature tests must be run on the test board, because the SM-USB-DIG is not rated for high temperatures. To connect the ribbon cable, attach the cable to the EVM and SM-USB-DIG as shown in Figure 7.

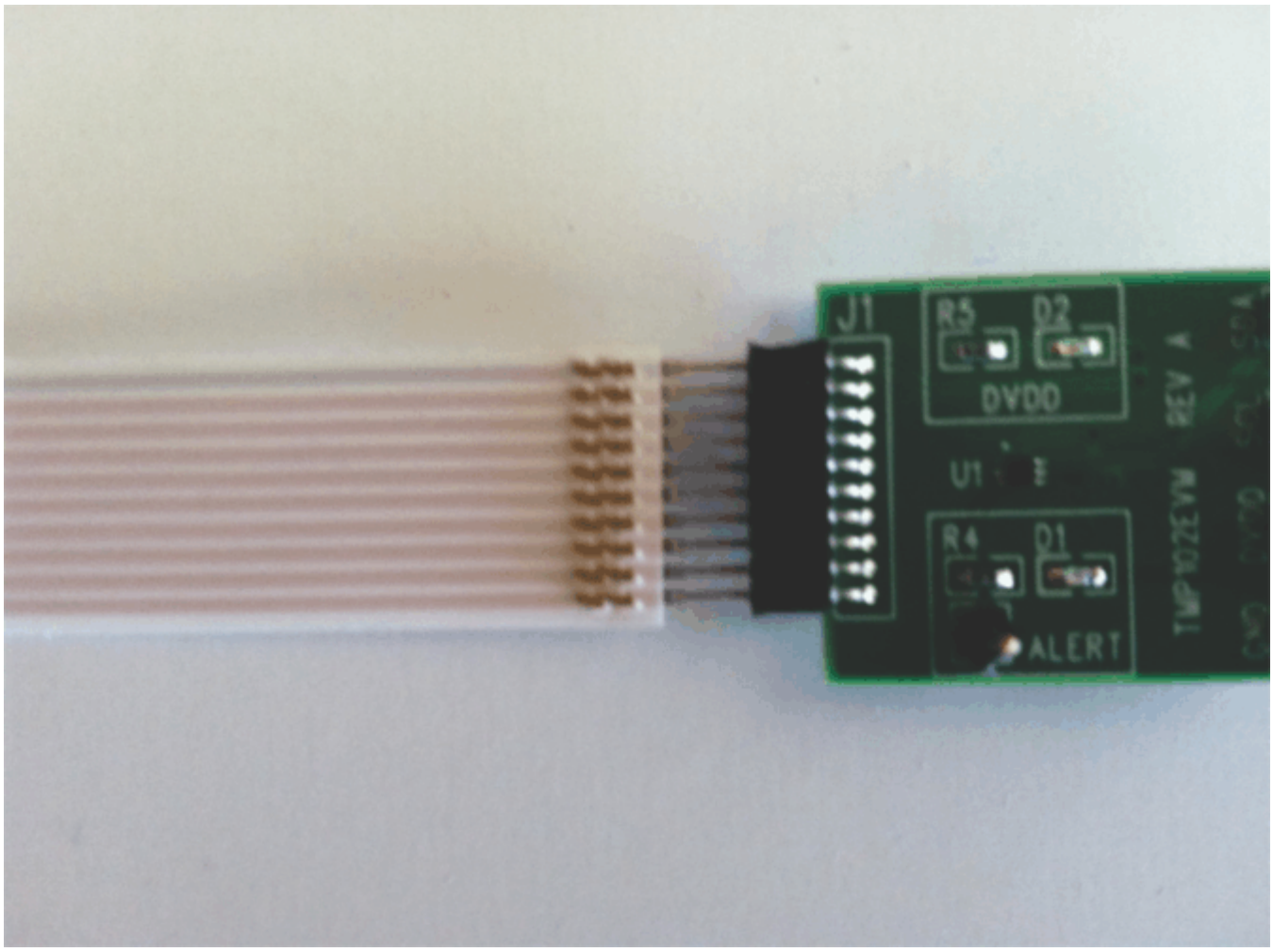

Figure 7. 10-Pin Ribbon Cable Extender

4 TMP102EVM Software

This section discusses how to install the TMP102EVM software.

4.1 Hardware Requirements

The TMP102EVM software has been tested on Microsoft Windows XP operating systems (OS) with United States and European regional settings. The software should also function on other Windows OS platforms.

4.2 Software Installation

The TMP102EVM software is included on the CD that is shipped with the EVM kit. It is also available through the TMP102EVM product folder on the TI website. To install the software to a computer, insert the disc into an available CD-ROM drive. Navigate to the drive contents and open the TMP102EVM software folder. Locate the compressed file (*TMP102EVM.zip*) and open it using WinZIP® or a similar file compression program; extract the TMP102EVM files into a specific TMP102EVM folder (for example, *C:\TMP102EVM*) on your hard drive.

Once the files are extracted, navigate to the TMP102EVM folder you created on the hard drive. Locate the *setup.exe* file and execute it to start the installation. The TMP102 software installer file then begins the installation process as shown in Figure 8.

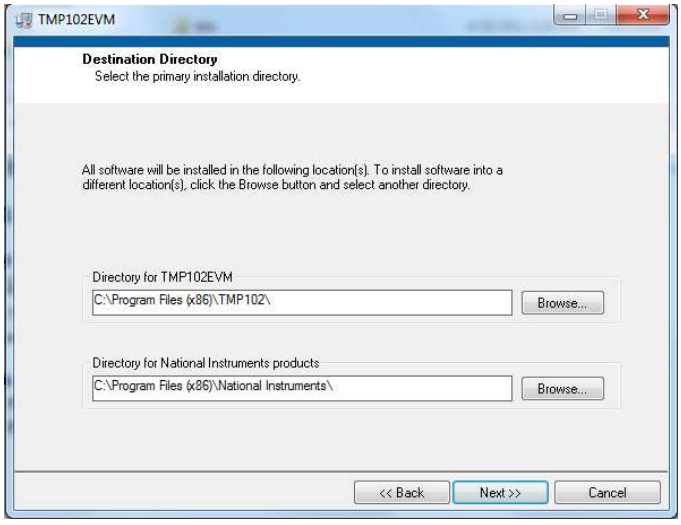

Figure 8. TMP102EVM Software Installation

After the installation process initializes, the user is given the choice of selecting the directory in which to install the program; the default location is *C:\Program Files\TMP102* and *C:\Program Files\National Instruments*. Following this option, two license agreements are presented that must be accepted, as shown in Figure 9. After accepting the Texas Instruments and National Instruments license agreements, the progress bar opens and shows the installation of the software. Once the installation process is completed, click **Finish**.

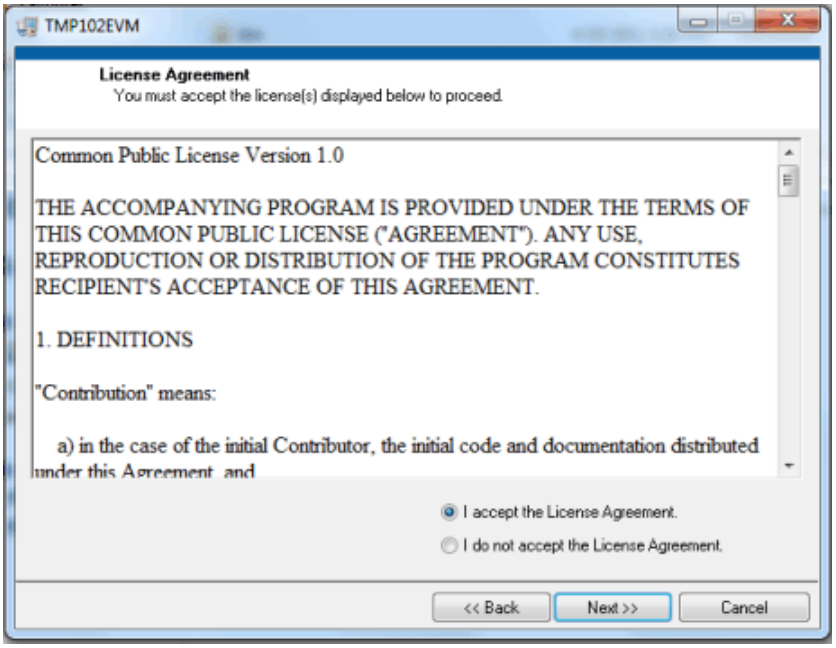

Figure 9. TMP102EVM License Agreements

5 TMP102EVM Software Overview

This section discusses how to use the TMP102EVM software.

5.1 Starting the TMP102EVM Software

The TMP102 software can be operated through the Windows *Start* menu. From Start, select *All Programs*; then select the *TMP102EVM* program.

Figure 10 illustrates how the software should appear if the TMP102EVM is functioning properly.

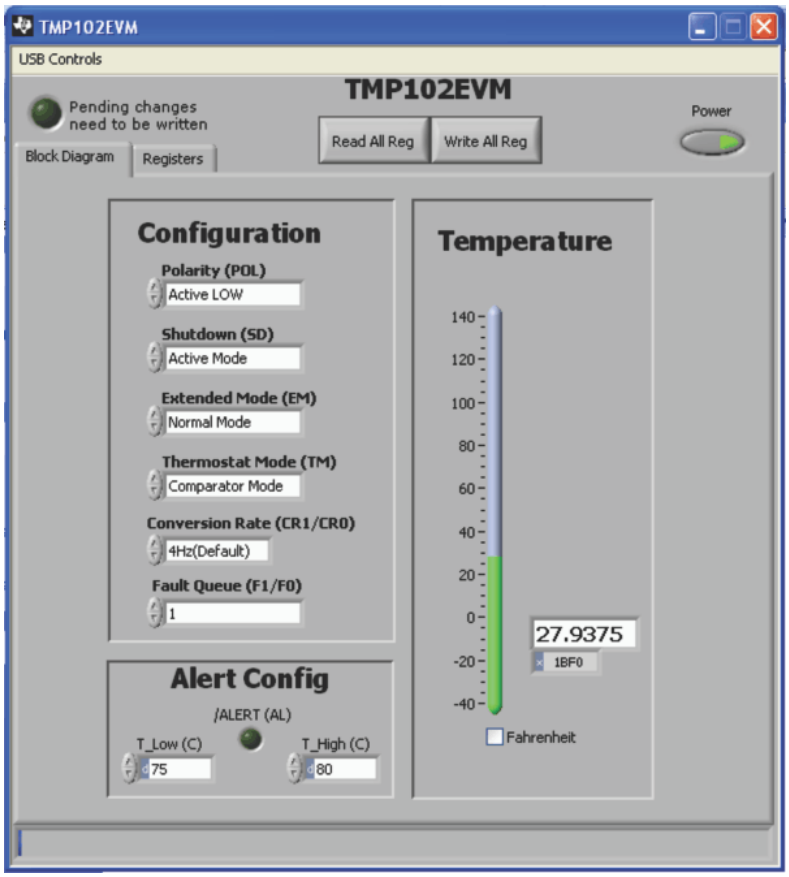

Figure 10. TMP102EVM Software Interface

Figure 11 shows an error message that is displayed if the PC cannot communicate with the SM-USB-DIG platform. If you receive this error message, first check to see that the USB extension cable is properly connected to both the PC USB port and to the SM-USB-DIG platform. Another possible source for this error is a problem with the PC USB Human Interface Device driver. Make sure that the device is recognized when the USB cable is plugged in; recognition is indicated by a Windows-generated confirmation sound.

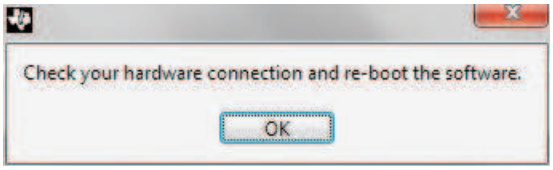

Figure 11. TMP102EVM Software: Communication Error with the SM-USB-DIG Platform

5.2 Using the TMP102Software

5.2.1 Reading from Registers

When first starting the TMP102EVM software, the user should confirm stable connections to the test board by toggling the **Read All Reg** button (shown in Figure 12). If all devices are communicating correctly, the user should be able to see temperature change over time in the TMP102 Temperature box.

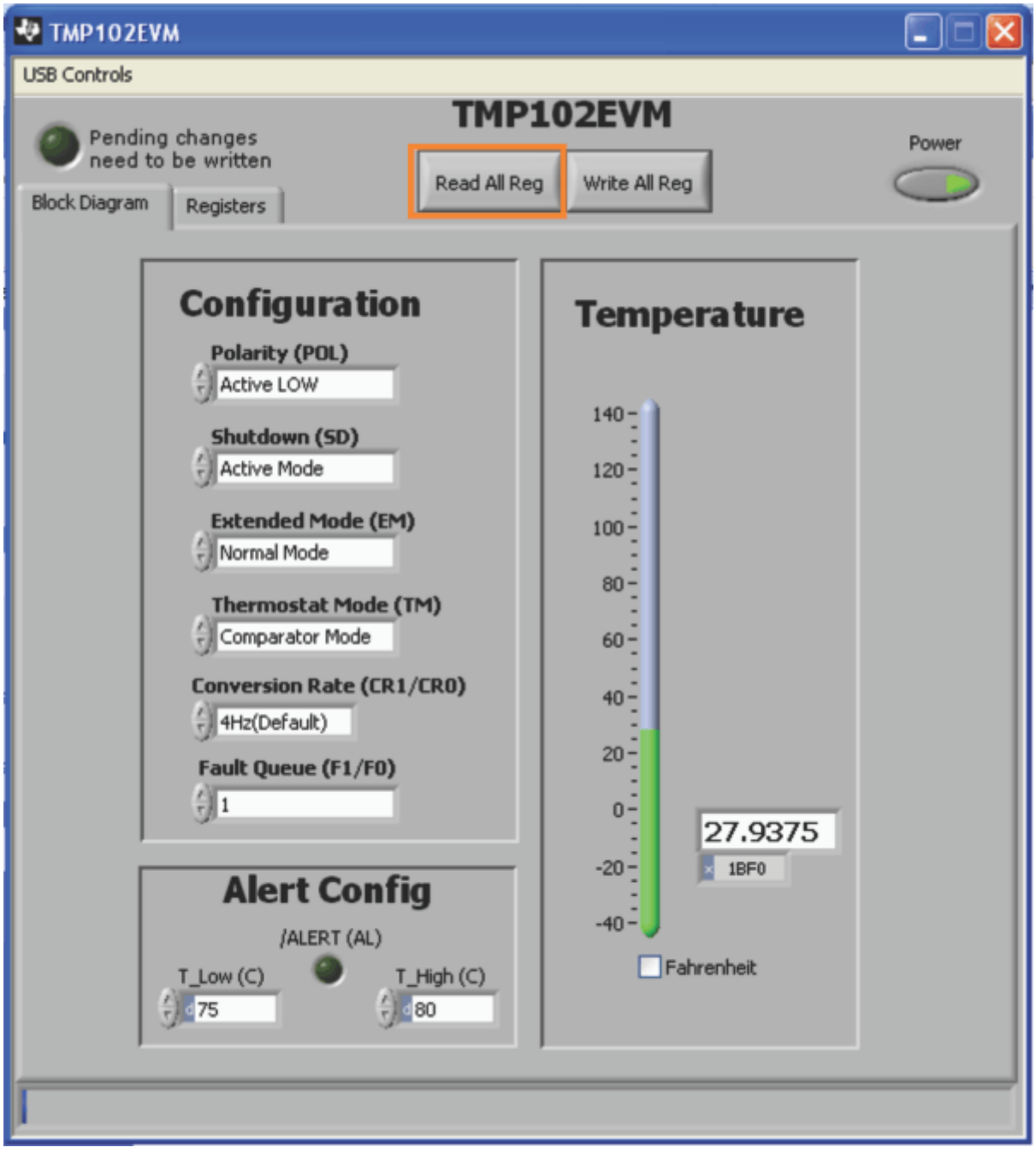

Figure 12. TMP102 Reading from Registers

5.2.2 Writing to Registers

The TMP102EVM software contains two different methods for writing data: *Write All Reg* and *Auto-Write Reg*. Writing the registers individually without Auto-write can be useful when adjusting large numbers of the configuration registers on the left side of the panel. The Auto-write feature automatically makes changes to the configuration register whenever one of the configuration settings on the left changes, as shown in Figure 13.

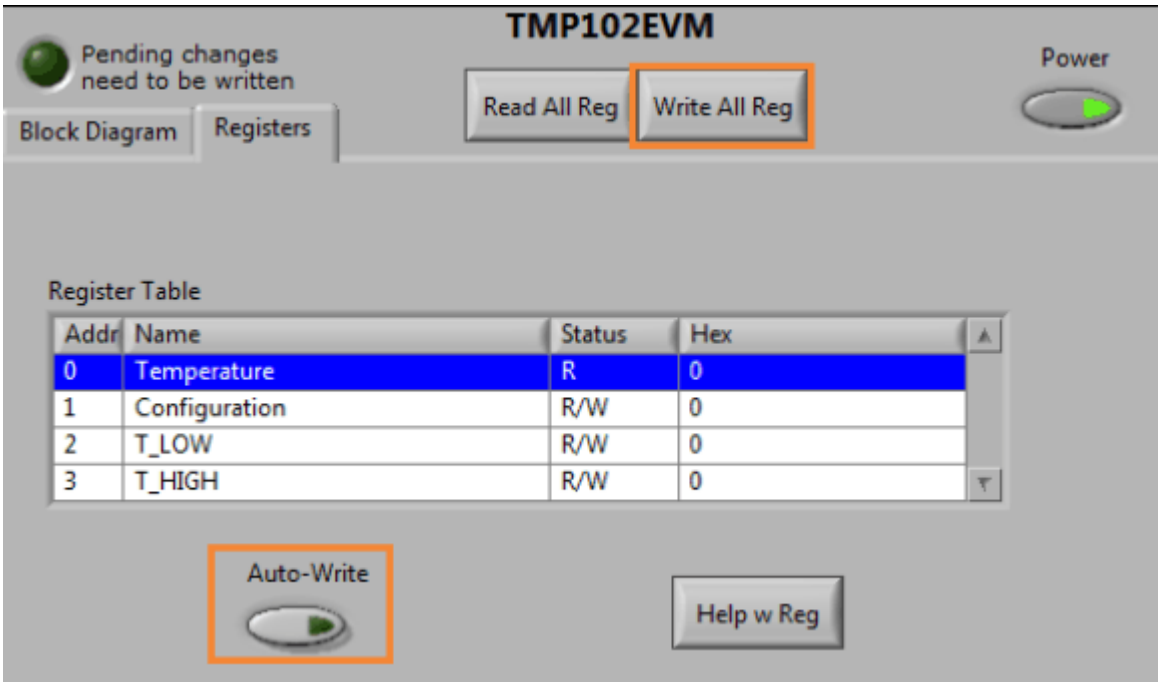

Figure 13. TMP102 Writing to Registers

5.2.3 Reading the Temperature Gauge

The Temperature box on the TMP102EVM software window displays the measured values of the TMP102 registers in a graphical format, as Figure 14 shows. This value can be toggled to either (degrees) Fahrenheit or Celsius by toggling the checkbox at the bottom of the window. It is important to note that changing to extended mode on the TMP102EVM software also changes the full-scale value of TMP102 thermometer.

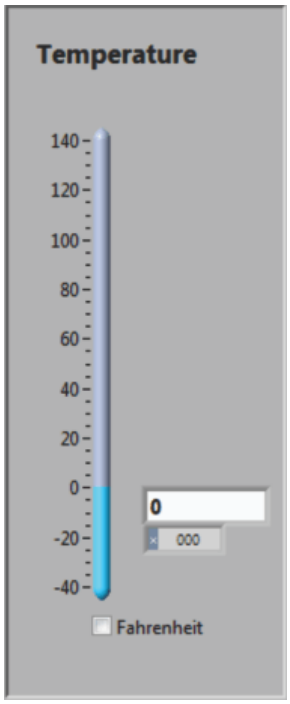

Figure 14. Reading the Temperature Gauge

5.2.4 Polarity (Alert Pin)

The polarity drop-down selection box in the Configuration section allows the user to toggle how the Alert pin behaves when it is triggered. When the polarity box is set to Active Low, as shown in Figure 15, the LED on the TMP102EVM board lights up when triggered and acts as a ground source. When the polarity box is set to Active High, the LED on the TMP102EVM board does not function, and the Alert pin on the TMP102 is set to DVDD when triggered.

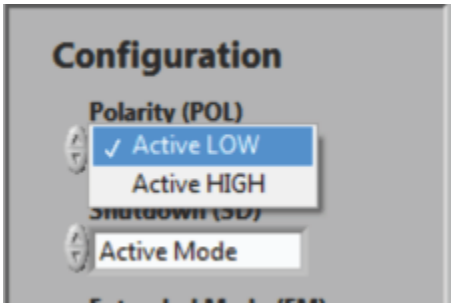

Figure 15. Configuring the Polarity

5.2.5 Shutdown Mode

The TMP102 has a built-in shutdown mode that allows the device to stop consuming power. The Shutdown mode selection box (illustrated in Figure 16) can also be used to clear the Alert pin when the Interrupt Mode (refer to Section 5.2.7) is selected. It is important to note that the TMP102 EVM cannot perform temperature conversions while in Shutdown mode.

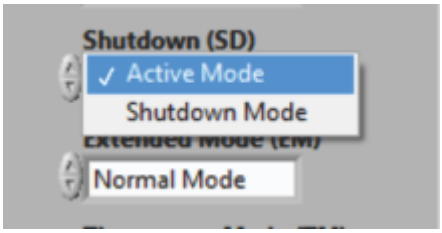

Figure 16. Active and Shutdown Mode

5.2.6 Extended Mode

The TMP102EVM has two modes for storing converted temperature data as shown in Figure 17: Extended Mode and Normal Mode. Normal mode gives the Temperature, T_{LOW}, and T_{HIGH} Registers 12 bits of accuracy. By changing to Extended Mode, the user increases to 13 bits of accuracy and adjusts the full-scale value of the three registers from 120°C to 150°C. It is important to note that adding an additional bit of accuracy also changes the current T_{HIGH} and T_{LOW} values; these values must then be reset to the user's original, intended values after adjusting the Extended Mode drop-down box.

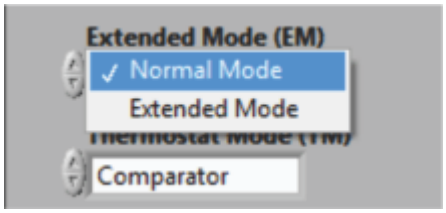

Figure 17. Extended Mode and Normal Mode

5.2.7 Thermostat Mode

Thermostat Mode, in the Configuration box, allows the user to designate how the TMP102 Alert pin behaves when the Temperature Register exceeds the T_{HIGH} Register. When the TMP102EVM software is in Comparator Mode, the Alert pin triggers if the temperature measured by the TMP102 exceeds the T_{HIGH} Register for the set amount of faults, described in the Fault Queue (see Section 5.2.9). Once the Alert pin has been triggered, it remains triggered until the temperature measured by the TMP102 falls below the T_{LOW} Register value for the set amount of faults.

When the TMP102EVM software is in Interrupt Mode, the Alert pin does not automatically clear after it falls below the T_{LOW} Register limit. Instead, the user must either select the **Read All Reg** button or put the device into Shutdown mode, described in Section 5.2.5. After the **Read All Reg** button is selected, or the device is put into Shutdown Mode, the Alert pin clears when the measured temperature drops down below the T_{LOW} Register. Figure 18 illustrates the Thermostat Mode dialog.

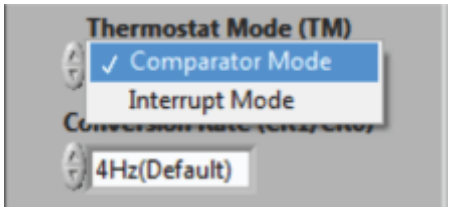

Figure 18. Comparator/Interrupt Mode

5.2.8 Conversion Rate

The Conversion Rate selection box (shown in Figure 19) allows the user to change how long each temperature conversion takes the TMP102 to perform. The user may want to select a slower conversion time, as shown in Figure 19, to make the TMP102 consume less power.

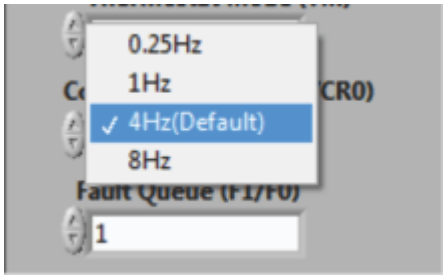

Figure 19. Conversion Rate

5.2.9 Fault Queue

The fault queue drop-down box allows the user to configure how many faults must be triggered before the Alert pin is activated, as shown in Figure 20. A fault is generated whenever the TMP102 T_{HIGH} Register is exceeded by the Temperature Register. This feature can be useful to prevent the TMP102 from triggering on temperature spikes that the user may not want to trigger with the Alert pin.

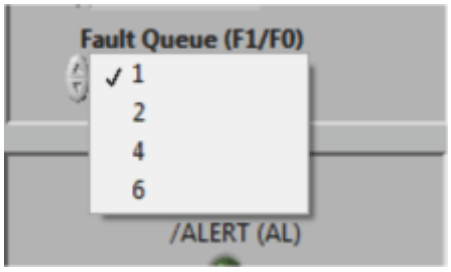

Figure 20. Setting the Fault Queue

5.2.10 Alert Configuration (T_{LOW} and T_{HIGH})

The Alert Config box has three objects that make up the main functionality of the TMP102 Alert pin, as Figure 21 shows: the Alert bit, T_{LOW} Register, and T_{HIGH} Register. The green LED within the Alert Config box lights up when the T_{HIGH} Register has been exceeded and the Alert pin has been activated. It is denoted as a $\overline{\text{Alert}}$ because of the default configuration. The Alert pin can also be switched to an active high, as shown in Section 5.2.4, if so desired by the user.

Figure 21. Alert Config Box

The T_{LOW} input box allows the user to set when the alert pin is cleared. When the measured value in the temperature register falls below the T_{LOW} threshold, the Alert pin clears, depending on which thermostat mode is selected. For more information on the behavior of the Thermostat mode, see Section 5.2.7.

The T_{HIGH} input box allows the user to set when the Alert pin is triggered. When the measured value in the temperature register exceeds the T_{HIGH} threshold, the Alert pin triggers until the temperature returns to a value below the T_{LOW} threshold, depending on the thermostat mode selected.

5.2.11 Registers Tab

The registers tab displays the individual register setting for the TMP102 sensors. For more information on the individual registers and the bit meanings, simply highlight the desired register and hit the **Help with Reg** button shown in Figure 22.

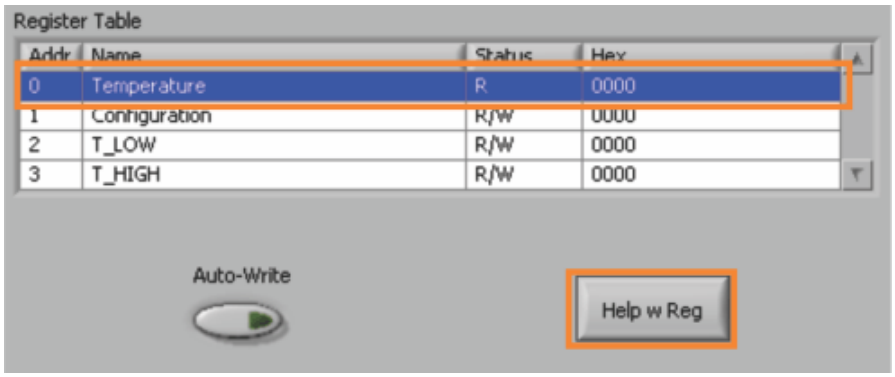

Figure 22. Register Tab

The Registers tab also includes the Dig_Bits table. The Dig_Bits table allows the user to monitor and change individual bits by highlighting the desired register and toggling the bit controls beneath it.

NOTE: Only the bits that can be written within a given register can be toggled.

6 TMP102 Documentation

This section contains the complete bill of materials and PCB layout for the TMP102EVM.

NOTE: These board layouts are not to scale. These image are intended to show how the board is laid out; they are not intended to be used for manufacturing TMP102EVM PCBs.

6.1 TMP102EVM Board Schematic

Figure 23 shows the schematic for the TMP102EVM board.

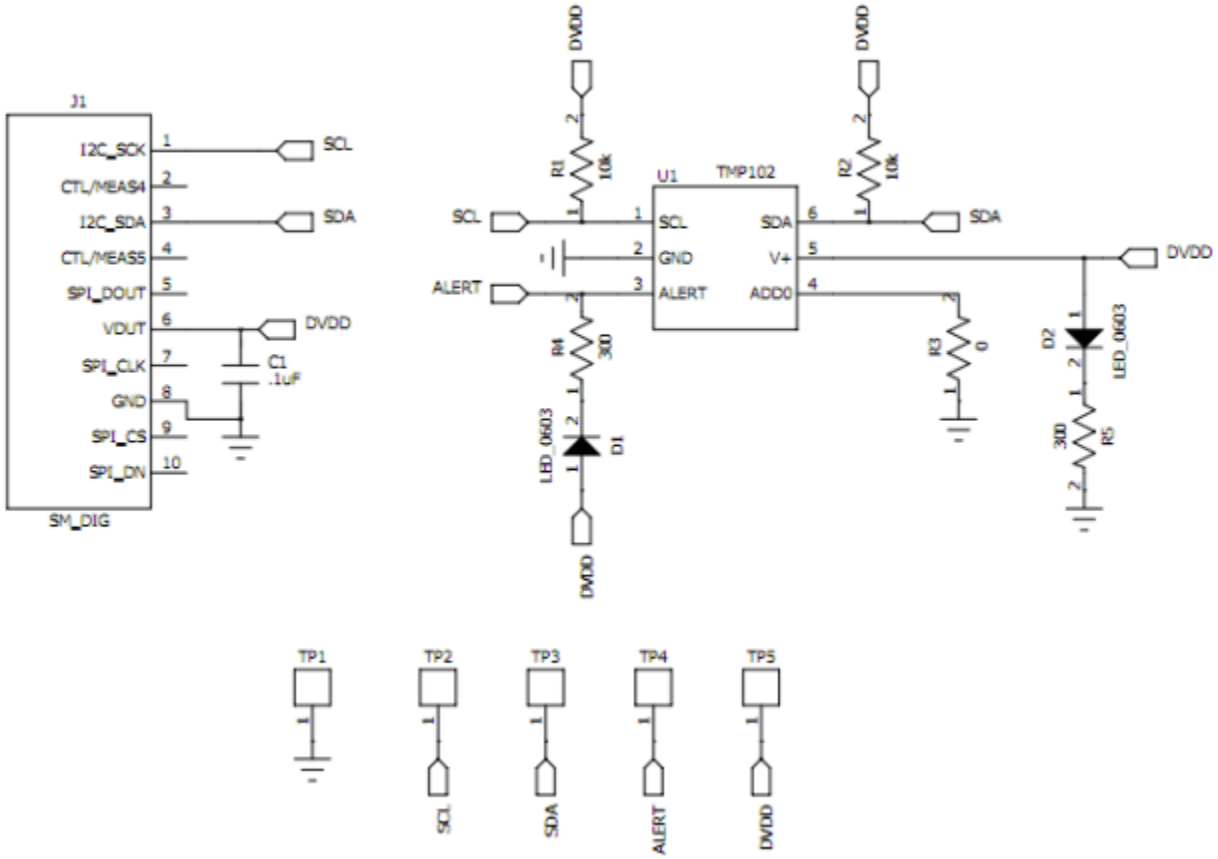

Figure 23. TMP102EVM Board Schematic

6.2 PCB Layout

Figure 24 and Figure 25 show the PCB layout of the TMP102EVM.

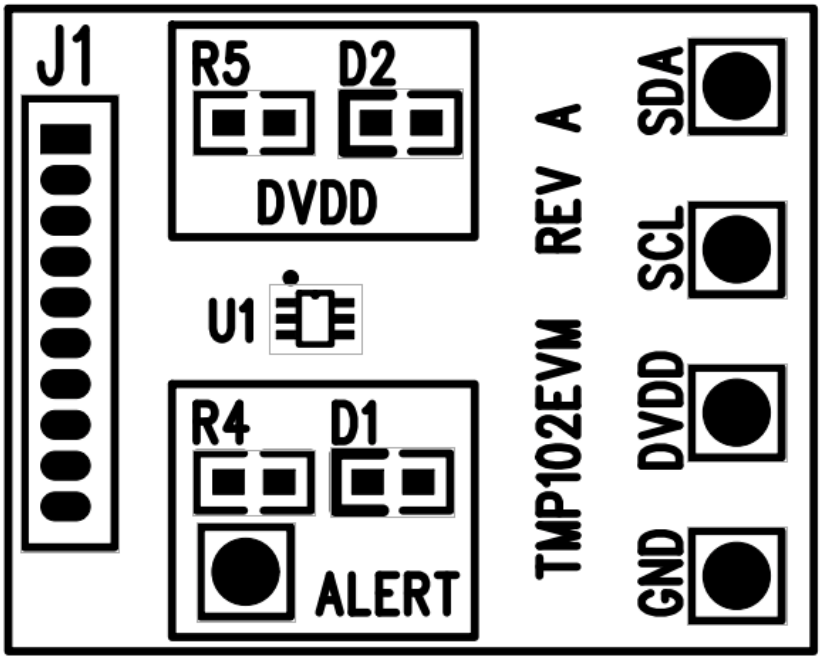

Figure 24. TMP102EVM PCB Top Layer (Component Side)

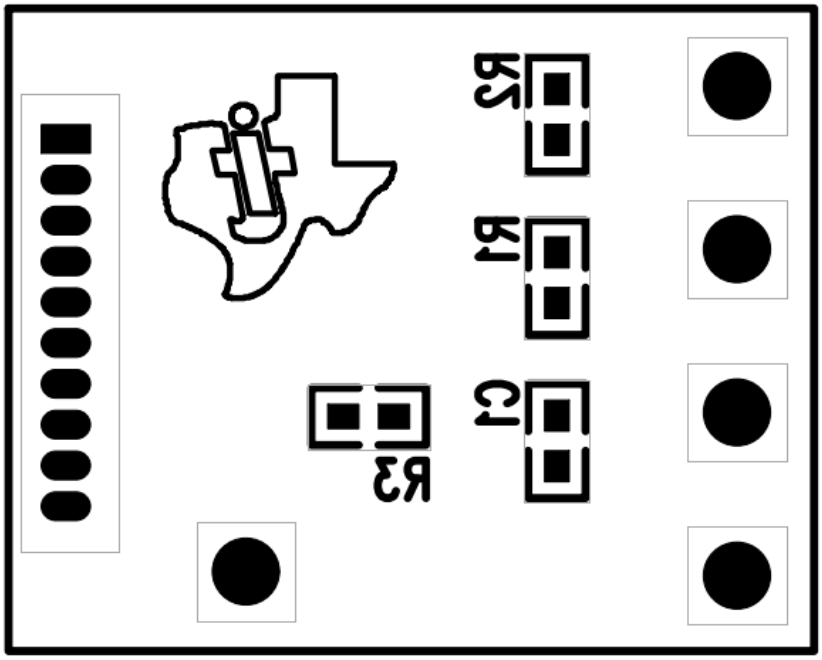

Figure 25. TMP102EVM PCB Bottom Layer

6.3 Bill of Materials

Table 4 lists the bill of materials for the TMP102EVM.

Table 4. Bill of Materials

Item No.	Qty	Value	Ref Des	Description	Vendor/Mfr	Part Number
1	2	10 kΩ	R1, R2	Resistor, 10 kΩ 1/10W 5% 0603 SMD	Stackpole Electronics	RMCF0603JT10K0
2	1	300 Ω	R4, R5	Resistor, 300 Ω 1/10W 5% 0603 SMD	Panasonic	ERJ-3GEYJ301V
3	1	0 Ω	R3	Resistor, 0.0 Ω 1/10W 0603 SMD	Stackpole Electronics	RMCF0603ZT0R00
4	1	0.1 µF	C1	Capacitor, Ceramic, 0.10-µF 25-V Y5V 0603	TDK Corporation	C1608Y5V1E104Z
5	2	2 V, 5 mA	D1, D2	LED Green Wide Angle 0603 SMD	Panasonic	LNJ3W0C83RA
6	1	—	U1	TMP102	Texas Instruments	
7	1	Jumper TP cut to size (See Note 3xx)	Jumpers, All	Connector, Header 50-Pos .100-in. SGL Gold	Samtec	TSW-150-07-G-S
8	1	Super MiniDIG connector Socket (See Note 2xx)	J1	Connector, Socket 50-Pin .050 R/A Sngl	Mill-Max Manufacturing	851-43-050-20- 001000

Evaluation Board/Kit Important Notice

Texas Instruments (TI) provides the enclosed product(s) under the following conditions:

This evaluation board/kit is intended for use for **ENGINEERING DEVELOPMENT, DEMONSTRATION, OR EVALUATION PURPOSES ONLY** and is not considered by TI to be a finished end-product fit for general consumer use. Persons handling the product(s) must have electronics training and observe good engineering practice standards. As such, the goods being provided are not intended to be complete in terms of required design-, marketing-, and/or manufacturing-related protective considerations, including product safety and environmental measures typically found in end products that incorporate such semiconductor components or circuit boards. This evaluation board/kit does not fall within the scope of the European Union directives regarding electromagnetic compatibility, restricted substances (RoHS), recycling (WEEE), FCC, CE or UL, and therefore may not meet the technical requirements of these directives or other related directives.

Should this evaluation board/kit not meet the specifications indicated in the User's Guide, the board/kit may be returned within 30 days from the date of delivery for a full refund. THE FOREGOING WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies TI from all claims arising from the handling or use of the goods. Due to the open construction of the product, it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge.

EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

TI currently deals with a variety of customers for products, and therefore our arrangement with the user **is not exclusive.**

TI assumes **no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein.**

Please read the User's Guide and, specifically, the Warnings and Restrictions notice in the User's Guide prior to handling the product. This notice contains important safety information about temperatures and voltages. For additional information on TI's environmental and/or safety programs, please contact the TI application engineer or visit www.ti.com/esh.

No license is granted under any patent right or other intellectual property right of TI covering or relating to any machine, process, or combination in which such TI products or services might be or are used.

FCC Warning

This evaluation board/kit is intended for use for **ENGINEERING DEVELOPMENT, DEMONSTRATION, OR EVALUATION PURPOSES ONLY** and is not considered by TI to be a finished end-product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment in other environments may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

EVM Warnings and Restrictions

It is important to operate this EVM within the input voltage range of 1.4 V to 3.6 V and the output voltage range of 1.4 V to 3.6 V .

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative.

During normal operation, some circuit components may have case temperatures greater than +25°C. The EVM is designed to operate properly with certain components above +25°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		**Applications**	
Audio	www.ti.com/audio	Communications and Telecom	www.ti.com/communications
Amplifiers	amplifier.ti.com	Computers and Peripherals	www.ti.com/computers
Data Converters	dataconverter.ti.com	Consumer Electronics	www.ti.com/consumer-apps
DLP® Products	www.dlp.com	Energy and Lighting	www.ti.com/energy
DSP	dsp.ti.com	Industrial	www.ti.com/industrial
Clocks and Timers	www.ti.com/clocks	Medical	www.ti.com/medical
Interface	interface.ti.com	Security	www.ti.com/security
Logic	logic.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Power Mgmt	power.ti.com	Transportation and Automotive	www.ti.com/automotive
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Mobile Processors	www.ti.com/omap		
Wireless Connctivity	www.ti.com/wirelessconnectivity		
	TI E2E Community Home Page		e2e.ti.com

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265