

EVM User's Guide: TMP9R01EVM

TMP9R01 Evaluation Module



Description

The TMP9R01EVM is designed to provide a quick setup to evaluate the TMP9R01SEP device and gain familiarity with the device down to the bit-by-bit register level. In addition to testing the device for common functionality, the EVM also allows testing under radiation specifically for Signal Event Lookahead (SEL) Testing. The EVM allows users to evaluate the performance of the TMP9R01 digital temperature sensor under space conditions.

Get Started

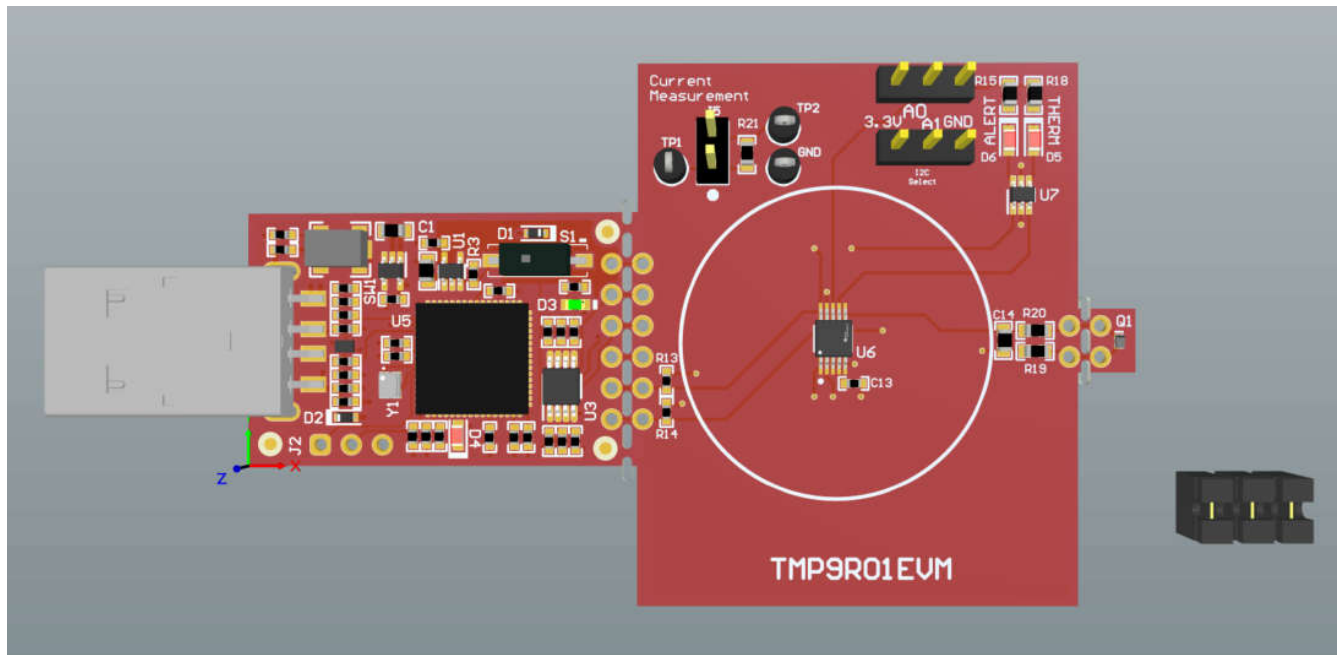
1. Order the [TMP9R01EVM](#) on ti.com
2. Connect the EVM to a computer
3. Open GUI link on the [TMP9R01EVM](#) product page
4. Open latest version on GUI on [dev.ti.com](#)
5. Install the TI Cloud Agent Setup plug-in

Features

- Straightforward application to check temperature functionality of TMP9R01SEP
- Easy to use cloud-based GUI is available on the web or can be downloaded for offline use
- Breakable TMP9R01 sensor board for flexibility in location on measurement for both local and remote
- Ready to go SEL board for radiation testing
- Access to data logging, adjusting the I2C frequency, and modifying data in registers
- Software powered by GUI Composer runs in a browser on Windows®, Mac®, and Linux® operating systems

Applications

- Spacecraft FPGA, ADCs, DACs, and ASIC temperature monitoring
- Spacecraft housekeeping and telemetry



TMP9R01EVM

1 Evaluation Module Overview

1.1 Introduction

The EVM comes in a USB stick form factor, with an onboard MSP430F5528 microcontroller that interfaces with both the host computer and the TMP9R01 device. The module is designed with perforations between the sensor and host controller on the EVM board. The perforation allows the user flexibility in evaluation:

- The user can connect the TMP9R01 to the user's system or host.
- The user can connect the EVM host and software to the user's system with TMP9R01 devices.
- Small individual boards allow the user to place sensors in the user's system.
- Hole spacing is compatible with common 0.1" prototyping breadboards.

This user's guide describes the characteristics, operation, and use of the TMP9R01 Evaluation Module (EVM). A complete schematic diagram, printed-circuit board layouts, and bill of materials are included in this document. This user's guide details through the steps to operate the TMP9R01 evaluation module.

1.2 Kit Contents

The contents of the EVM kit are listed in [Table 1-1](#). Contact the nearest Texas Instruments Product Information Center for missing components. TI highly recommends checking the TI website at <https://www.ti.com> for the latest revision.

Table 1-1. Kit Contents

Item	Quantity
TMP9R01EVM	1
USB Extension Cable	1

1.3 Specification

The absolute maximum thermal conditions of each section of the EVM are listed in [Table 1-2](#). The main two sections are the controller section and the sensor breakable section. These limits must be considered when evaluating the performance of the device at extreme temperatures. In this case, if the setup conditions exceed the controller absolute maximum thermal specifications, then the sensor breakable section must be detached so that only the sensor (and not the MCU) is evaluated at these temperatures.

Table 1-2. TMP9R01EVM Temperature Limits

BOARD SECTION	CONDITIONS	TEMPERATURE RANGE
Controller board	Recommended operating free-air temperature, T_A	-40°C to 85°C
	Absolute maximum junction temperature, $T_{J(MAX)}$	95°C
TMP9R01 breakable board	Recommended operating free-air temperature, T_A	-55°C to 150°C

1.4 Device Information

The TMP9R01 is radiation hardened, high-accuracy, low-power remote temperature sensor monitor with a built-in local temperature sensor. The remote junctions are typically low-cost, discrete, NPN or PNP transistors or substrate thermal transistors that can be integrated parts of microprocessors, microcontrollers, or field-programmable gate arrays (FPGAs). Temperature is represented as a 12-bit digital code for both the local and remote sensors, providing a resolution of 0.0625C. The two-wire serial interface accepts the SMBus communication protocol with up to nine different pin-programmable addresses. Some of the parameters of interest in the TMP9R01 to consider when using this EVM is shown in [Table 1-3](#).

Table 1-3. Device Specifications

Device Specification	Value
Operating temperature range	-55°C to 125°C
Max temperature local accuracy	2C
Max temperature remote accuracy	1.5C
Operating supply range	1.7V to 3.6V

2 Hardware

2.1 Overview

The EVM is divided into two sections: the controller section and the breakable sensor section. The breakable sensor section can be detached to use the sensor in the following scenarios:

- Using the controller section with the sensor section connected by soldered wires and connectors to evaluate the sensor far from the controller and PC at extreme temperatures or other conditions.
- Using the sensor section with the user's system by interfacing through I2C with the TMP9R01.
- Using the controller section with TMP9R01 sensors in the user's system.

The EVM sections and some components that must be identified by the user to understand the purpose and use are highlighted in [Figure 2-1](#). The components are further explained in detail in the sections below.

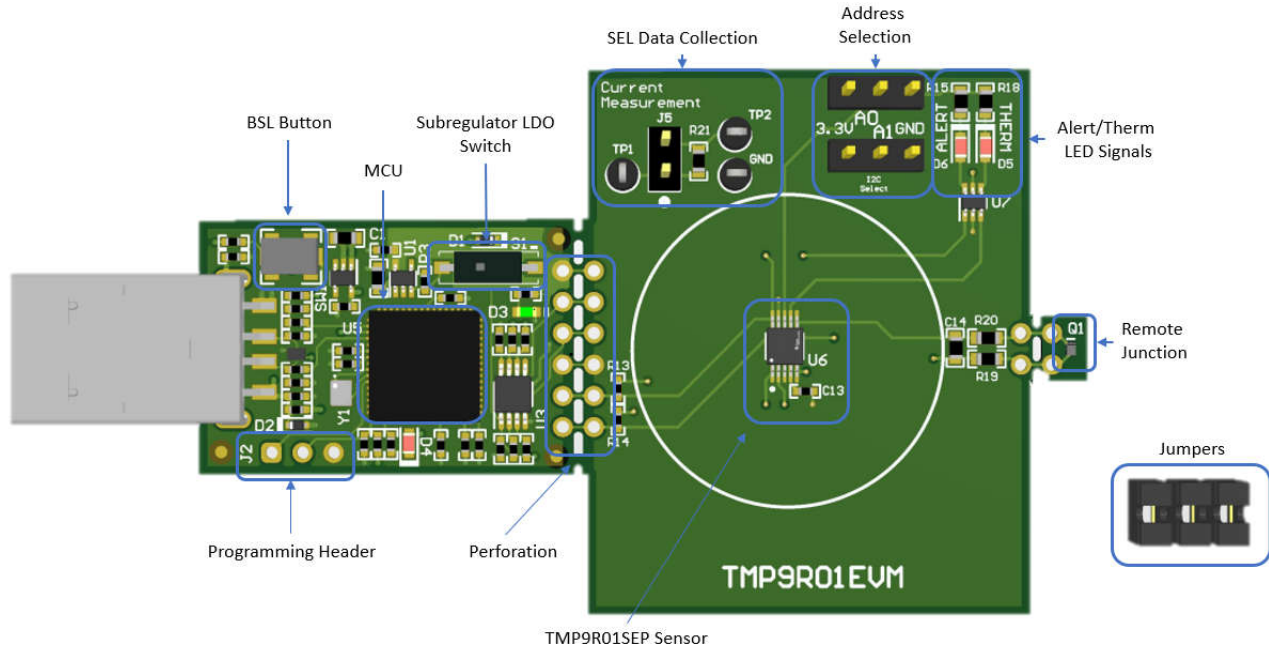


Figure 2-1. TMP9R01EVM Board Sections

2.2 Perforations and Connectivity

The perforation between the USB controller and TMP9R01 sensor is labeled on both sides for pin connections. Once the sensor section is detached from the controller section, the user can interface with the sensor section in two different ways:

- Soldering wires or 0.1" header connectors: With this approach, the user has access to all pins of the device.

Note

When interfacing with other controller boards, TI recommends to verify that pullup resistors and protection circuitry are present on any controller board for safe and proper functionality.

2.3 Status LEDs (D3, D5, D6) and Subregulator

The switch S1 enables and disables the onboard 3.3V regulator: U5. When the subregulator is enabled, the green LED D3 illuminates. The subregulator must be enabled for normal operation of TMP9R01EVM as the subregulator supplies power to the device and pullup voltage of the communication lines.

The red LED D4 is the MSP430F5528 status LED. The different modes of operation are displayed by the LED status and are shown in [Table 2-1](#).

Table 2-1. LED Status

D4 LED Status	MSP430F5528 Mode of Operation
Off	EVM is connected to EVM GUI
Blicking in burst of 4 blinks	EVM is plugged into PC, not connected to EVM GUI
Steady blinking	Connected to USB power

Two additional LEDs are presented on the EVM. The D5 LED can indicate a THERM fault and turns on when the device detects a THERM fault and brings the pin LOW. D6 does the same function but for the ALERT/THERM2 pin. Both these LEDs are red.

2.4 Programming Header

The TMP9R01EVM comes pre-loaded with firmware that is necessary for the correct operation of the USB interface and PC GUI software. The unpopulated header, J2, is provided for Spy-Bi-Wire access to the MSP430F5528. TI does not recommend that users access this header or reprogram the device.

2.5 BSL Button

The TMP9R01EVM features push-button SW1 for entering USB BSL mode. This can be used for firmware updates. To enter USB BSL mode, connect the EVM to a PC USB port while holding down SW1.

2.6 Remote BJT - Q1

Q1 is a MMBT3904LP NPN BJT. This is used as the remote temperature sensor on the EVM. The MMBT3904LP typically has an N-factor of about 1.0042. The TMP9R01 assumes an N-Factor of 1.008, which can cause a temperature error in the remote temperature reading. The GUI automatically sets the N-Factor correction register to 1.0042 to compensate for this. If the device is reset, then the device sets the N-Factor correction register back to the default value or 1.008 and a temperature error can be seen. If a remote temperature error is seen, then use the N-Factor correction feature to adjust the temperature reading. The MMBT3904LP can also be broken off to allow the engineer to connect a different temperature remote to the device.

2.7 Address Jumpers

J3 and J4 are used for setting the I2C address of the TMP9R01. J3 is used to set the A0 pin, and J4 is used to set the A1 pin.

2.8 Current Measurement - SEL Measurement

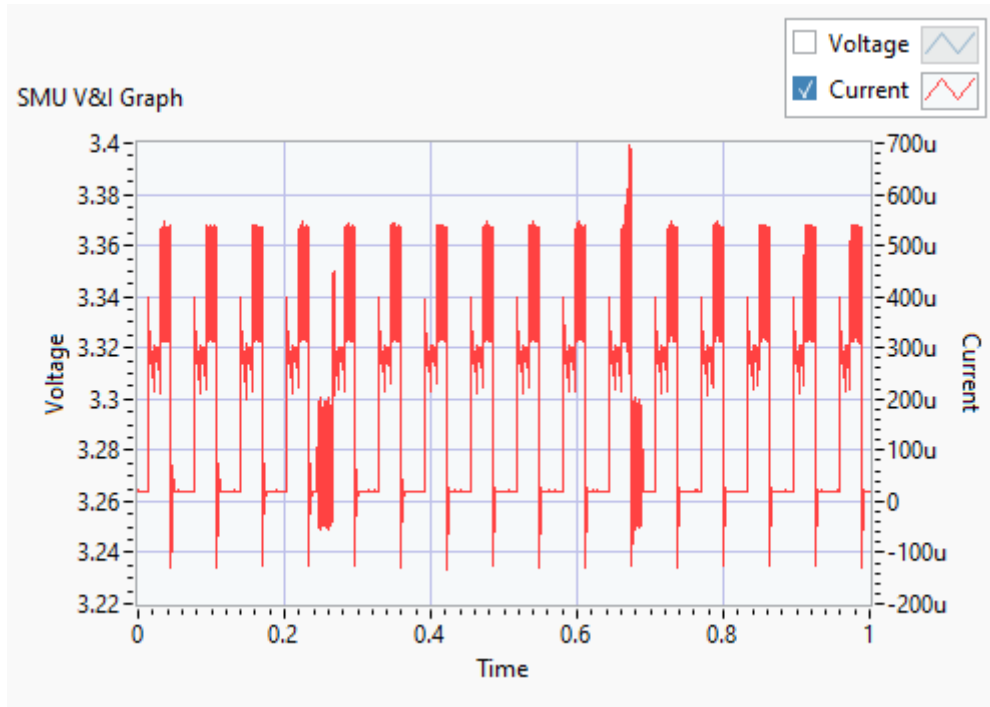
This EVM provides two approaches in measuring the total quiescent current of the TMP9R01 device. Within this section of the EVM, there is a jumper and three test points: TP1, TP2, and GND.

Option 1: Measure the current through the resistor with known voltage measurements of TP1 and TP2. The jumper is in parallel with a resistor. To take advantage of this option, users need to remove the jumper and repopulate the resistor R21 with a value of your choice.

Option 2: Using a SMU to supply voltage and measure current through TP2 and GND. To take advantage of this option, remove R21 resistor, switch off the USB power through the Subregulator switch and supply TP1 and TP2 with the same voltage within the range of 1.7V to 3.6V.

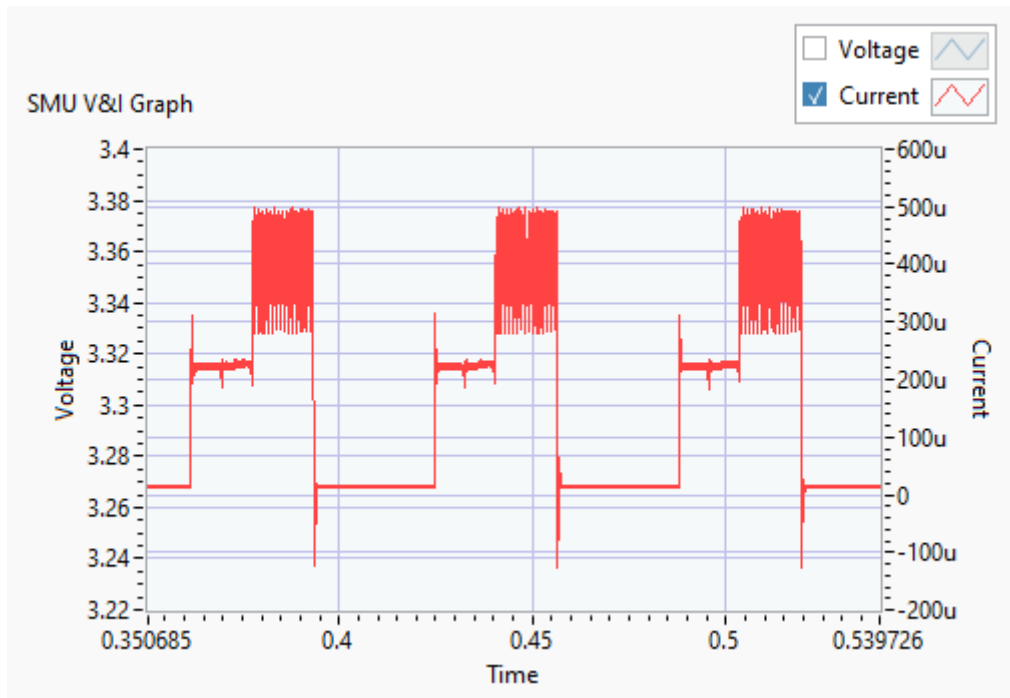
When measuring current through this device, the following images show what to expect for the current output. There are different current ranges for what mode the device is in. Shutdown mode consumes the least amount of power vs active conversion mode consumes the most amount of power.

		TYP (μA)	MAX (μA)
Iq	Active conversion, local sensor	240	375
	Active conversion, remote sensor	400	600
	Standby mode (between conversions)	15	35
	Shutdown mode, serial bus inactive	3	8
	Shutdown mode, serial bus active, fs = 400kHz	90	
	Shutdown mode, serial bus active, fs = 2.17MHz	350	



A. VDD is at 5.5V.

Figure 2-2. Expected Total Quiescent Current with Communication



A. VDD is at 3.3V.

Figure 2-3. Expected Total Quiescent Current without Communication

3 Software

3.1 Software Installation

The PC GUI Software for TMP9R01EVM runs on TI's GUI Composer framework. The software is available as a live version, which runs in a browser, and is available as a download for offline use. The software is compatible with Windows, Mac, or Linux operating systems.

3.1.1 Live Software on dev.ti.com

The live software currently works on Chrome™, Firefox®, and Safari® browsers. Internet Explorer® is not supported. Users can access the live version through one of the following actions:

- Go to the TMP9R01EVM Product page on ti.com and click on the View button
- Go to dev.ti.com/gallery, log in with myTI account credentials, and search for TMP9R01EVM.
- Go to <https://dev.ti.com/gallery/info/THSApps/TMP9R01EVM/>.

Click the application icon within the gallery to launch the software. Agree to the prompts to install or update the TI Cloud Agent browser plug-in. The plug-in is necessary for connection to the USB hardware.

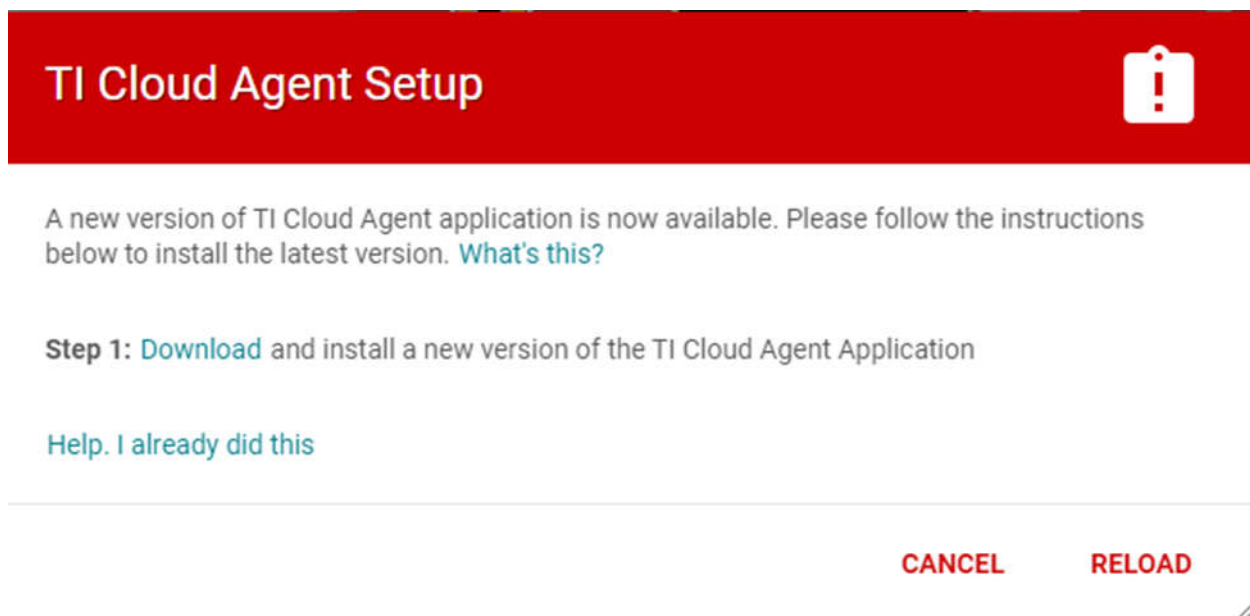



Figure 3-1. Plug-in Setup

3.1.2 Download from dev.ti.com

Users can access the latest version of the offline software by navigating to the live version as noted above. Look for the download icon  and download both the application and run time for the operating system as shown in Figure 3-2.

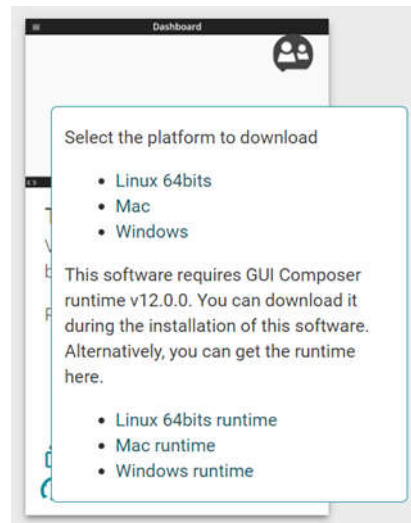


Figure 3-2. Download Pop-Up

3.2 Home Tab

The *Home* tab is shown at software launch. The icons on the bottom of this tab are shortcuts to the other functional tabs of the GUI, and correspond to the icons on the left side of the GUI.

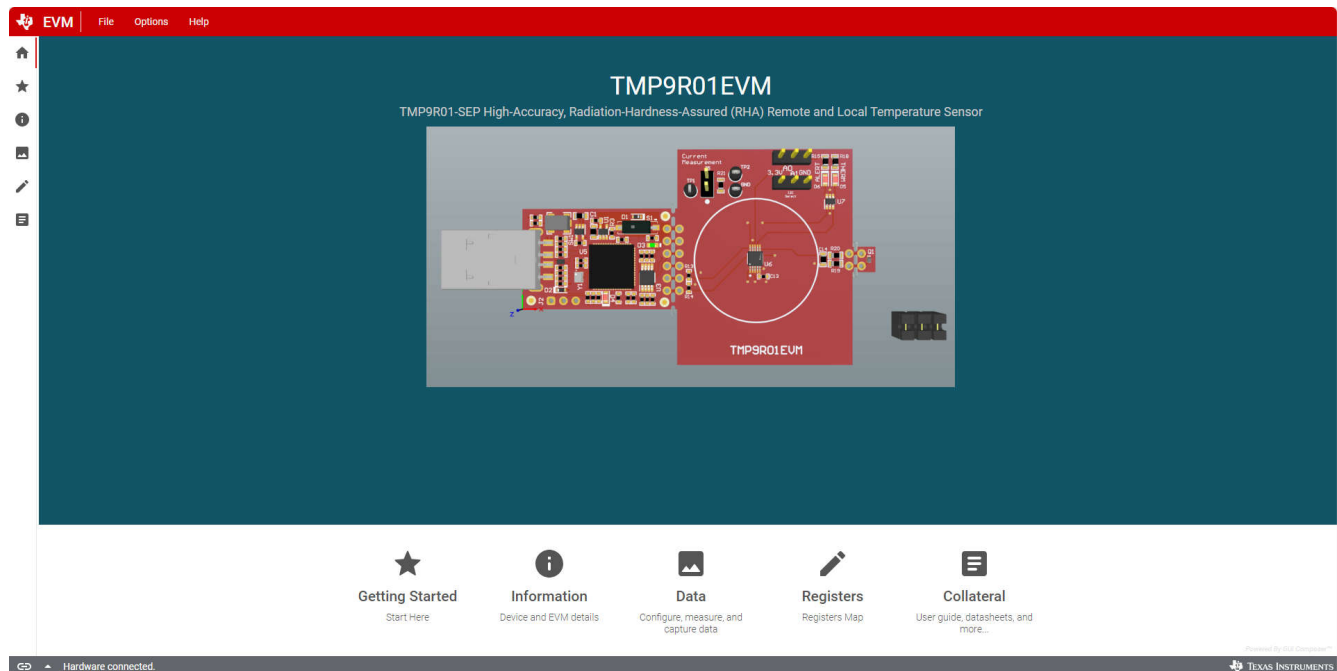


Figure 3-3. Home

3.3 Data Capture Tab

The *Data Capture* tab reports the temperature from the TMP9R01 device included on the TMP9R01EVM. Temperature data is polled and displayed by default. By default, the MCU polls the registers with a 100ms delay. The CONVERT TEMP command (0x44) is sent automatically while polling. The polling rate setting on the *Data Capture* tab is synchronized with the polling rate setting on the *Registers* tab. The following features of the Data Capture Tab include:

- Reading the current temperature measurement from the TMP9R01 displayed in the upper right corner.
- Polling Rate drop-down menu is used to disable polling or change the polling rate.
- The *Save Logging* and *Stop Logging* buttons can be used to capture Temperature data and save the data to a CSV format.

When capturing data, please remember the following:

- For the online version of the GUI, a download begins in the browser. This download is lost if the GUI is closed.
- For the offline version of the GUI, the file is appended as data is received. In this case, appended data is not lost if the GUI is closed.

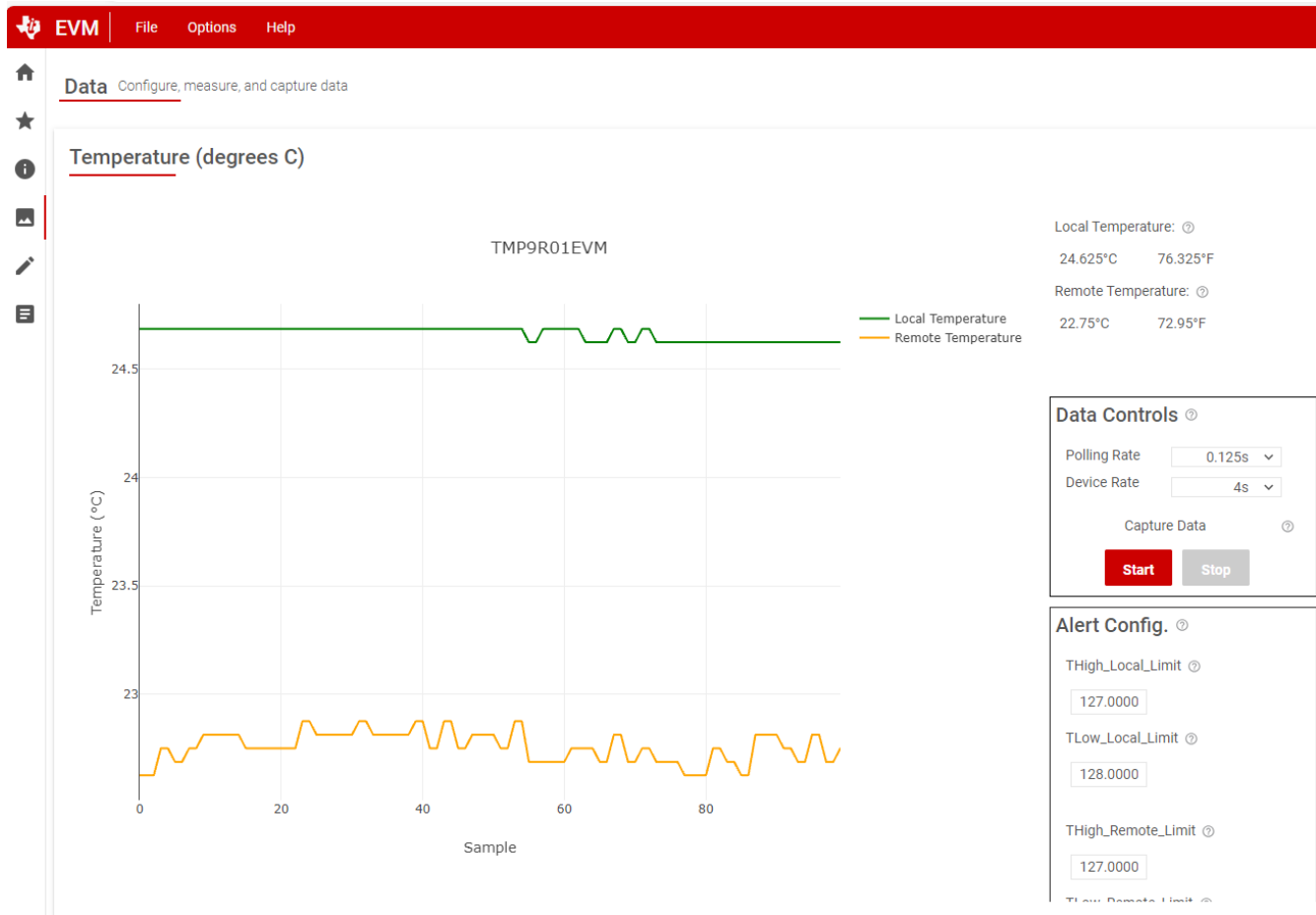


Figure 3-4. Data Capture

3.4 Registers Tab

The *Registers* tab interacts with the registers and the bits within the TMP9R01 device. For more information on each register/bit, hover over the register name and click on the question mark to see what each bit defines.

By default, the MCU polls the registers with a 100ms delay and the table shows the current status of the registers and updates the changes in the table every poll. By clicking on the bits in the table, the user has the availability to change the bit to a 1 or 0. The Write Register buttons are grayed and disabled when the button is set to Immediate. Immediate mode triggers a Write operation each time a register is modified. When Deferred mode is selected and the Write Register button is enabled, write operations are not performed unless the Write Register button is clicked.

When Deferred mode is selected, the user can take advantage of the following:

- Write button writes the bit changes in the selected register.
- Write All button is used to write all bit changes in all registers.

When auto read is turned off, the table no longer updates and the user can take advantage of the following:

- Read button reads the current status of the selected register.
- Read All button is used to fetch the current contents of all registers at once.

These settings give the user total control over bus activity, and enable individual transactions to be easily observed with an oscilloscope, logic analyzer, or bus-sniffing device.

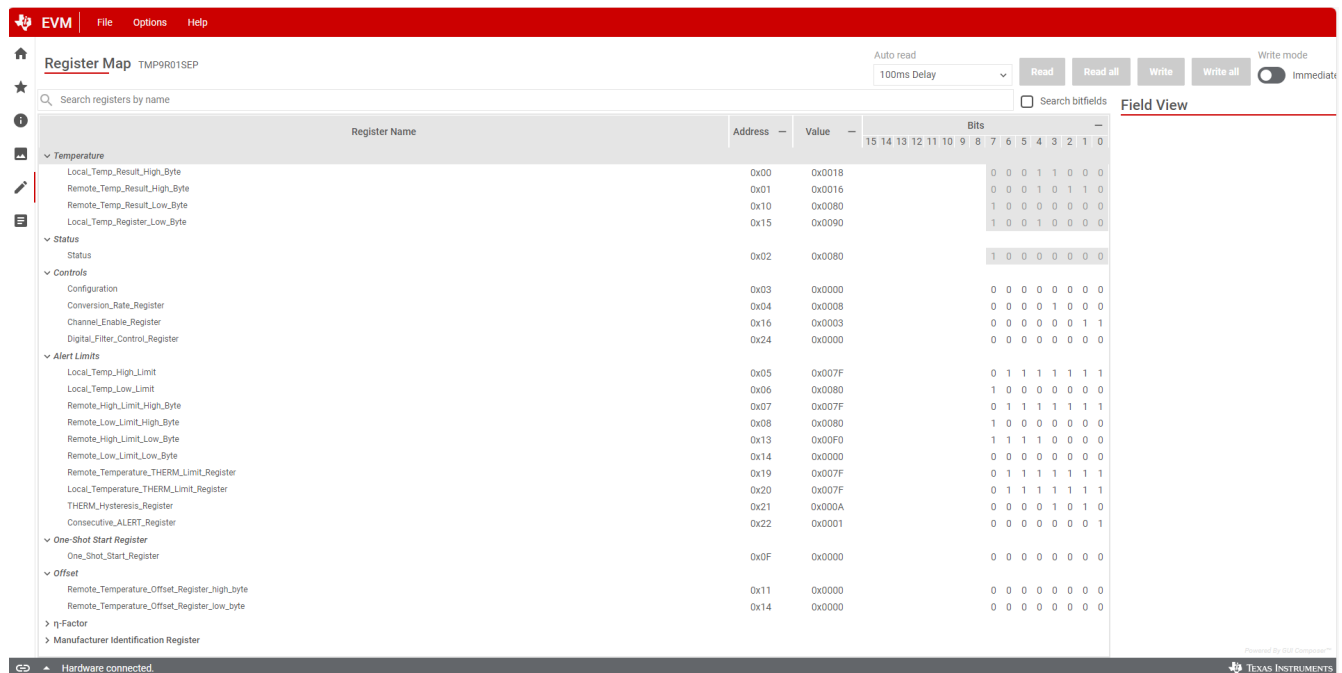


Figure 3-5. Registers

4 Hardware Design Files

4.1 Schematic

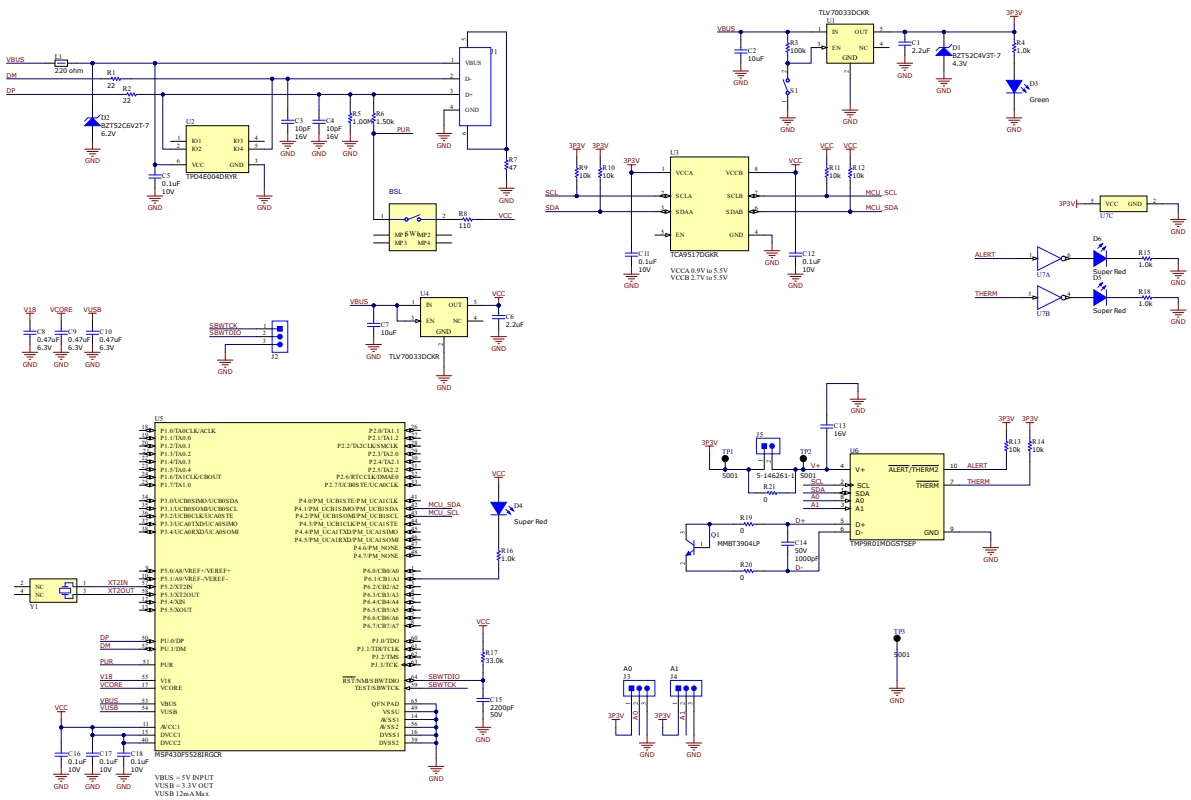


Figure 4-1. Schematic

4.2 PCB Layout

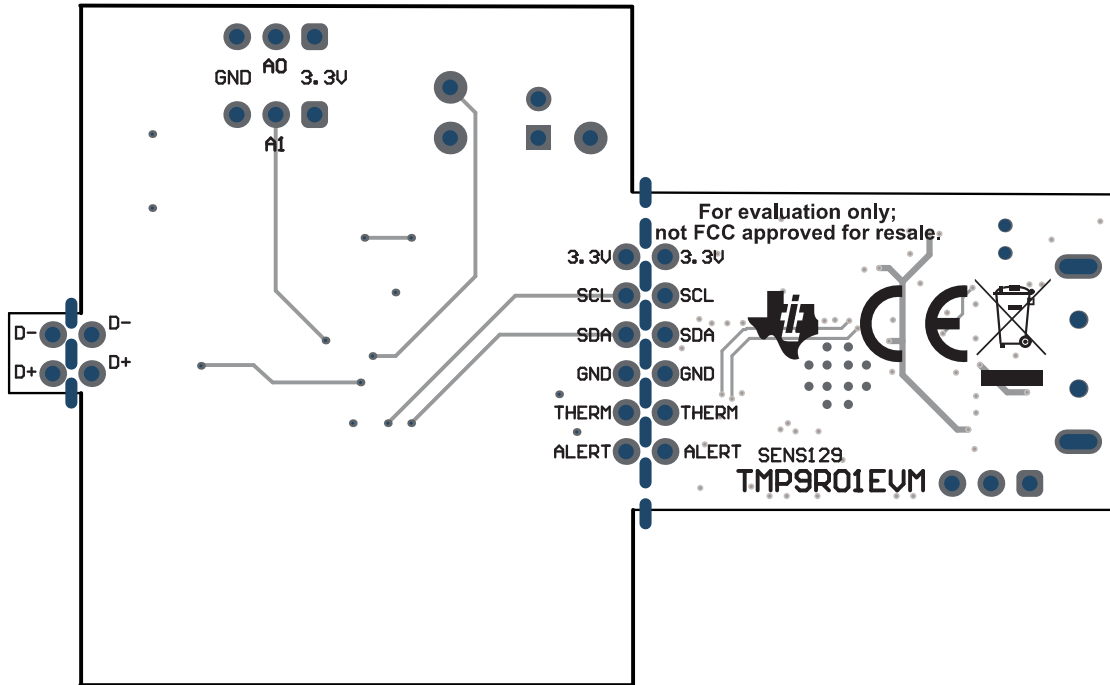


Figure 4-2. PCB (Top View)

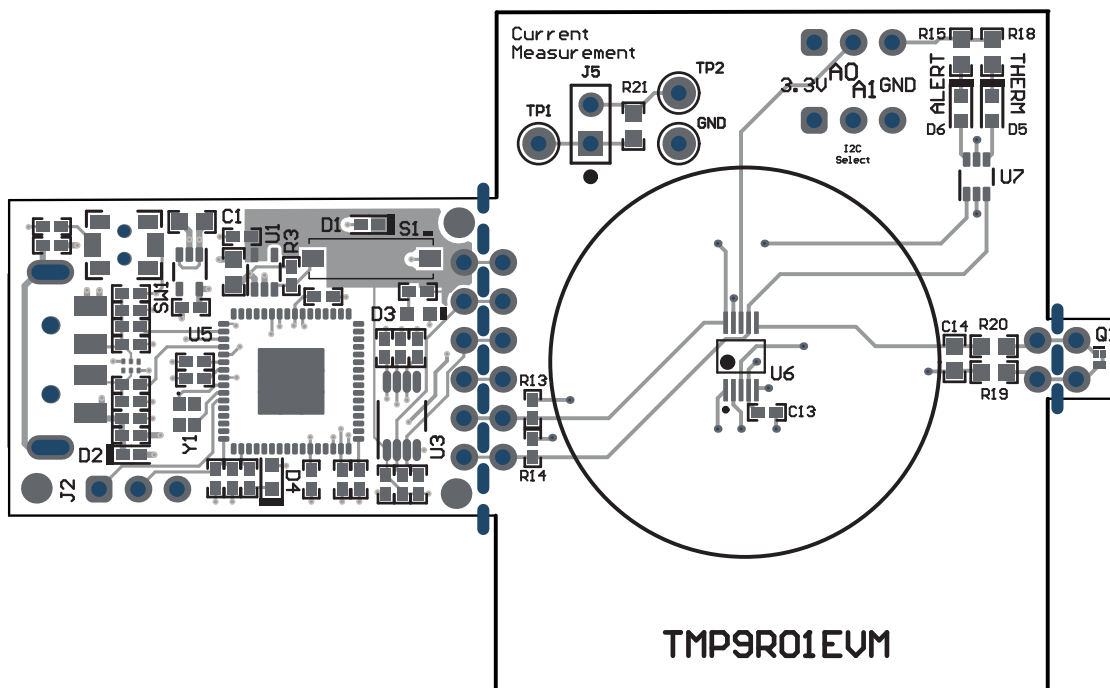


Figure 4-3. PCB (Bottom View)

4.3 Bill of Materials

The bill of materials for TMP9R01EVM is listed in [Table 4-1](#).

Table 4-1. Bill of Materials

Designator	Quantity	Value	Description	Part Number	Package Reference	Manufacturer
!PCB1	1		Printed Circuit Board	SENS129		Any
C1, C6	2	2.2uF	CAP, CERM, 2.2uF, 16V, +/- 10%, X5R, 0402	GRM155R61C225KE11D	0402	MuRata
C2, C7	2	10uF	CAP, CERM, 10uF, 10V, +/- 20%, X5R, 0603	C1608X5R1A106M080AC	0603	TDK
C3, C4	2	10pF	CAP, CERM, 10pF, 16V, +/- 10%, C0G, 0402	C0402C100K4GACTU	0402	Kemet
C5, C11, C12, C16, C17, C18	6	0.1uF	CAP, CERM, 0.1uF, 10V, +/- 10%, X5R, 0402	LMK105BJ104KV-F	0402	Taiyo Yuden
C8, C9, C10	3	0.47uF	CAP, CERM, 0.47uF, 6.3V, +/- 10%, X7R, 0402	JMK105B7474KVHF	0402	Taiyo Yuden
C13	1	0.1uF	CAP, CERM, 0.1uF, 16V, +/- 10%, X7R, 0402	ATC530L104KT16T	0402	AT Ceramics
C14	1	1000pF	CAP, CERM, 1000pF, 50V, +/- 5%, C0G/NP0, 0603	C0603C102J5GACTU	0603	Kemet
C15	1	2200pF	CAP, CERM, 2200pF, 50V, +/- 5%, X7R, 0402	CL05B222JB5NNNC	0402	Samsung Electro-Mechanics
D1	1	4.3V	Diode, Zener, 4.3V, 300mW, SOD-523	BZT52C4V3T-7	SOD-523	Diodes Inc.
D2	1	6.2V	Diode, Zener, 6.2V, 300mW, SOD-523	BZT52C6V2T-7	SOD-523	Diodes Inc.
D3	1	Green	LED, Green, SMD	SML-LX0603GW-TR	LED, GREEN, 0603	Lumex
D4, D5, D6	3	Super Red	LED, Super Red, SMD	150060SS75000	LED_0603	Wurth Elektronik
J1	1		Connector, Plug, USB Type A, R/A, Top Mount SMT	48037-1000	USB Type A right angle	Molex
J3, J4	2		Header, 100mil, 3x1, Gold, TH	TSW-103-07-G-S	3x1 Header	Samtec
J5	1		Header, 100mil, 2x1, Gold, TH	5-146261-1	Header, 2x1, 100mil	TE Connectivity
L1	1	220 ohm	Ferrite Bead, 220 ohm at 100MHz, 0.45A, 0402	BLM15AG221SN1D	0402	MuRata
Q1	1	40V	Transistor, NPN, 40V, 0.2A, 3-UFDNF	MMBT3904LP	3-UFDNF	Diodes Inc.
R1, R2	2	22	RES, 22, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	ERJ-2GEJ220X	0402	Panasonic
R3	1	100k	RES, 100 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	ERJ-2GEJ104X	0402	Panasonic
R4, R16	2	1.0k	RES, 1.0 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	ERJ-2GEJ102X	0402	Panasonic
R5	1	1.00Meg	RES, 1.00M, 1%, 0.063W, AEC-Q200 Grade 0, 0402	RMCF0402FT1M00	0402	Stackpole Electronics Inc
R6	1	1.50k	RES, 1.50 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	RMCF0402FT1K50	0402	Stackpole Electronics Inc
R7	1	47	RES, 47, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	ERJ-2GEJ470X	0402	Panasonic

Table 4-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Part Number	Package Reference	Manufacturer
R8	1	110	RES, 110, 1%, 0.1 W, AEC-Q200 Grade 0, 0402	ERJ-2RKF1100X	0402	Panasonic
R9, R10, R11, R12, R13, R14	6	10k	RES, 10 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	ERJ-2GEJ103X	0402	Panasonic
R15, R18	2	1.0k	RES, 1.0 k, 5%, 0.1 W, 0603	RC0603JR-071KL	0603	Yageo
R17	1	33.0k	RES, 33.0 k, 1%, 0.063 W, 0402	RC0402FR-0733KL	0402	Yageo America
R19, R20, R21	3	0	RES, 0, 0%, 0.25 W, AEC-Q200 Grade 0, 0603	RCS06030000Z0EA	0603	Vishay-Dale
S1	1		Switch, Slide, SPST, Top Slide, SMT	CHS-01TB	Switch, Single Top Slide, 2.5x8x2.5mm	Copal Electronics
SH-J1, SH-J2, SH-J3	3		Single Operation 2.54mm Pitch Open Top Jumper Socket	M7582-05	Single Operation 2.54mm Pitch Open Top Jumper Socket	Harwin
SW1	1		Switch, SPST-NO, Off-Mom, 0.05A, 12VDC, SMD	PTS820 J20M SMTR LFS	3.9x2.9mm	C&K Components
TP1, TP2, TP3	3		Test Point, Miniature, Black, TH	5001	Black Miniature Testpoint	Keystone Electronics
U1, U4	2		Single Output LDO, 200mA, Fixed 3.3V Output, 2 to 5.5V Input, with Low IQ, 5-pin SC70 (DCK), -40 to 125 degC, Green (RoHS & no Sb/Br)	TLV70033DCKR	DCK0005A	Texas Instruments
U2	1		4-Channel ESD Protection Array for High-Speed Data Interfaces, DRY0006A (USON-6)	TPD4E004DRYR	DRY0006A	Texas Instruments
U3	1		Level-Shifting I2C Bus Repeater, DGK0008A (VSSOP-8)	TCA9517DGKR	DGK0008A	Texas Instruments
U5	1		16-Bit Ultra-Low-Power Microcontroller, 128KB Flash, 8KB RAM, USB, 12Bit ADC, 2 USCIs, 32Bit HW MPY, RGC0064B (VQFN-64)	MSP430F5528IRGCR	RGC0064B	Texas Instruments
U6	1		High-Accuracy, Radiation-Hardness-Assured (RHA) Remote and Local Temperature Sensor	TMP9R01MDGSTSEP	VSSOP10	Texas Instruments
U7	1		Dual Inverter, DCK0006A (SOT-SC70-6)	SN74LVC2G04DCKR	DCK0006A	Texas Instruments
Y1	1		Crystal, 24MHz, SMD	XRCGB24M000F2P00R0	2x1.6mm	MuRata
J2	3		Header, 100mil, 3x1, Gold, TH	TSW-103-07-G-S	3x1 Header	Samtec

5 Additional Information

5.1 Trademarks

Chrome™ is a trademark of Google LLC.

Windows® and Internet Explorer® are registered trademarks of Microsoft Corporation.

Mac® is a registered trademark of Apple Inc..

Linux® is a registered trademark of Linus Torvalds.

Firefox® is a registered trademark of Mozilla Foundation.

Safari® is a registered trademark of Apple Inc.

All trademarks are the property of their respective owners.

STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.
 - 1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM ("Software") shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software
 - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
2. *Limited Warranty and Related Remedies/Disclaimers:*
 - 2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
 - 2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.
 - 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

WARNING

Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.

User shall operate the Evaluation Kit within TI's recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI's recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI's instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGRADATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 Regulatory Notices:

3.1 United States

3.1.1 Notice applicable to EVMs not FCC-Approved:

FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

3.1.2 For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:

CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

3.2 Canada

3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

3.3 Japan

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。

<https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html>

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。技術適合証明を受けていないものご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。日本テキサス・イ

ンスツルメンツ株式会社

東京都新宿区西新宿 6 丁目 2 4 番 1 号

西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_02.page

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。 <https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html>

3.4 European Union

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):*

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

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4. *EVM Use Restrictions and Warnings:*
 - 4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.
 - 4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.
 - 4.3 *Safety-Related Warnings and Restrictions:*
 - 4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user 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, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.
 - 4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.
 - 4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.
 5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.
 6. *Disclaimers:*
 - 6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.
 - 6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.
 7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL DEFEND, INDEMNIFY AND HOLD TI, ITS LICENSORS AND THEIR REPRESENTATIVES HARMLESS FROM AND AGAINST ANY AND ALL CLAIMS, DAMAGES, LOSSES, EXPENSES, COSTS AND LIABILITIES (COLLECTIVELY, "CLAIMS") ARISING OUT OF OR IN CONNECTION WITH ANY HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.
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8. *Limitations on Damages and Liability:*

8.1 *General Limitations.* IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS , REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMNITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

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