

EVM User's Guide: ISOTMP35BEVM

ISOTMP35 Evaluation Module



Description

ISOTMP35 is the industry's first isolated temperature sensor IC, and provides an analog output voltage proportional to Centigrade temperature with a 10 mV/°C positive slope gain. This user's guide details through the steps to operate the ISOTMP35BEVM evaluation module, designed to evaluate the isolated temperature sensor. ISOTMP35BEVM also features a detachable breakable ISOTMP35 temperature sensor board portion and a screw hole for easy attachment to a high-voltage bus bar or power MOSFET.

Get Started

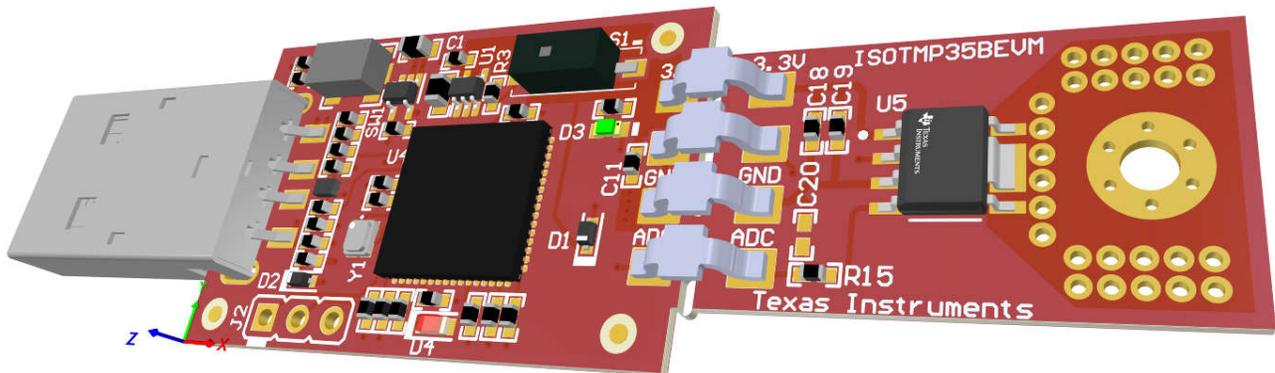
1. [Order ISOTMP35BEVM](#) evaluation module
2. Connect EVM to computer
3. Go to the [ISOTMP35 Gallery page](#) on dev.ti.com to either download the GUI or run on the web
4. Detach breakable sensor PCB section (optional)
5. Refer to [ISOTMP35 data sheet](#) for IC details
6. Visit our E2E forums for support or [questions](#)

Features

- Easy to use cloud-based [GUI](#) is available on the web or can be downloaded for offline use
- ISOTMP35 isolated temp sensor IC with electrically isolated thermal connection
- Breakable ISOTMP35 sensor board
- Back side copper plane with screw hole allows HV bus bar connection and good thermal conductivity
- Data logging using MCU integrated ADC

Applications

- [EV charging infrastructure](#)
 - AC charging (pile) station
 - DC fast charging station
 - DC wallbox charger
 - DC fast charging power module
- [Solar Energy](#)
 - String inverter
- [Hybrid, electric & powertrain systems](#)
 - HEV/EV on-board charger (OBC)
 - HEV/EV DC/DC converter
 - HEV/EV inverter & motor control
- [Energy storage systems](#)
 - Power conversion system (PCS)
- [Rack & server power](#)



ISOTMP35BEVM

1 Evaluation Module Overview

1.1 Introduction

The EVM uses a MSP430F5528 microcontroller along with a USB interface to enable the user to datalog results and interface with the ISOTMP35 analog output. The EVM is separated into two sections, the microcontroller section, and the sensor section. The sensor section can be separated from the microcontroller section. Then, the sensor side of the EVM must be reconnected to the microcontroller side to operate the ISOTMP35 in a high temperature or high voltage environment. The EVM has a bottom-side copper plate that can be glued or screwed onto a high voltage heat source for easy user evaluation.

This user's guide describes the characteristics, operation, and use of the ISOTMP35 Evaluation Module (EVM). A complete schematic diagram, printed-circuit board layouts, and bill of materials are included in this document.

1.2 Kit Contents

Table 1-1 details the contents of the EVM kit. 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. EVM Kit Contents

Item	Quantity
ISOTMP35BEVM	1

1.3 Specification

The controller side and the sensor breakout side of the EVM have different temperature limits, as shown in Table 1-2. The MSP430 limits the controller side temperature limits. The sensor breakout side temperature is limited by the ISOTMP35.

Table 1-2. ISOTMP35BEVM 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
ISOTMP35 breakout board	Recommended operating free-air temperature, T_A	-40°C to 150°C
	Absolute maximum junction temperature, $T_{J(MAX)}$	-60°C to 155°C

1.4 Device Information

ISOTMP35 is an isolated, linear analog output, temperature sensor designed to be connected directly to a high voltage heat source. The analog output is proportional to the ambient temperature, with a slope of +10mV/°C over the full sensor temperature range. A quick snapshot of key device specifications is shown in Table 1-3.

Table 1-3. ISOTMP35 Specifications

DEVICE SPECIFICATION	VALUE
Operating temperature range	-40°C to 150°C
Temperature accuracy (0°C to 70°C)	±1.0°C
Temperature accuracy (-40°C to 150°C)	±2.0°C
Maximum output current	500uA
Maximum capacitive load	1000 pF
Supply voltage range	2.3 V to 5.5 V

1.5 General Texas Instruments High Voltage Evaluation (TI HV EVM) User Safety Guidelines



Always follow TI's setup and application instructions, including use of all interface components within their recommended electrical rated voltage and power limits. Always use electrical safety precautions to help make sure your personal safety and those working around you. Contact TI's Product Information Center <http://ti.com/support> for further information.

Save all warnings and instructions for future reference.

WARNING

Failure to follow warnings and instructions can result in personal injury, property damage or death due to electrical shock and burn hazards.

The term TI HV EVM refers to an electronic device typically provided as an open framed, unenclosed printed circuit board assembly. It is *intended strictly for use in development laboratory environments, solely for qualified professional users having training, expertise and knowledge of electrical safety risks in development and application of high voltage electrical circuits. Any other use and/or application are strictly prohibited by Texas Instruments.* If you are not suitably qualified, you should immediately stop from further use of the HV EVM.

1. Work Area Safety

- a. Keep work area clean and orderly.
- b. Qualified observers must be present anytime circuits are energized.
- c. Effective barriers and signage must be present in the area where the TI HV EVM and the interface electronics are energized, indicating operation of accessible high voltages can be present, for the purpose of protecting inadvertent access.
- d. All interface circuits, power supplies, evaluation modules, instruments, meters, scopes and other related apparatus used in a development environment exceeding 50Vrms/75VDC must be electrically located within a protected Emergency Power Off EPO protected power strip.
- e. Use stable and nonconductive work surface.
- f. Use adequately insulated clamps and wires to attach measurement probes and instruments. No freehand testing whenever possible.

2. Electrical Safety

As a precautionary measure, it is always a good engineering practice to assume that the entire EVM can have fully accessible and active high voltages.

- a. De-energize the TI HV EVM and all the inputs, outputs and electrical loads before performing any electrical or other diagnostic measurements. Revalidate that TI HV EVM power has been safely de-energized.
- b. With the EVM confirmed de-energized, proceed with required electrical circuit configurations, wiring, measurement equipment connection, and other application needs, while still assuming the EVM circuit and measuring instruments are electrically live.
- c. After EVM readiness is complete, energize the EVM as intended.

WARNING

While the EVM is energized, never touch the EVM or the electrical circuits, as the electrical circuits can be at high voltages capable of causing electrical shock hazard.

3. Personal Safety

- a. Wear personal protective equipment (for example, latex gloves or safety glasses with side shields) or protect EVM in an adequate lucent plastic box with interlocks to protect from accidental touch.

Limitation for safe use:

EVMs are not to be used as all or part of a production unit.

2 Hardware

2.1 Overview

Figure 2-1 and Figure 2-2 show the top side and bottom side of the ISOTMP35BEVM. Figure 2-3 shows a block diagram representation of the EVM for simplicity.

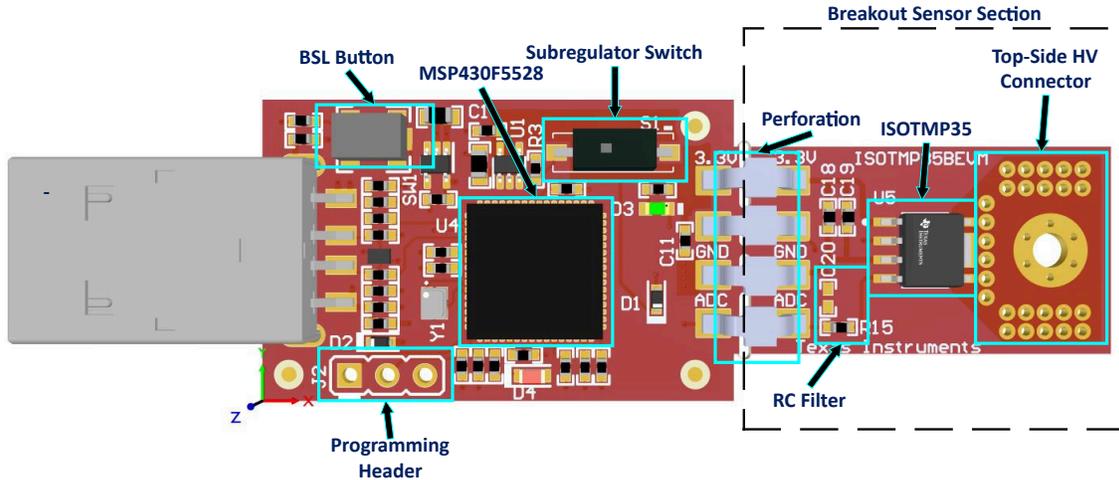


Figure 2-1. ISOTMP35BEVM Board Top Side

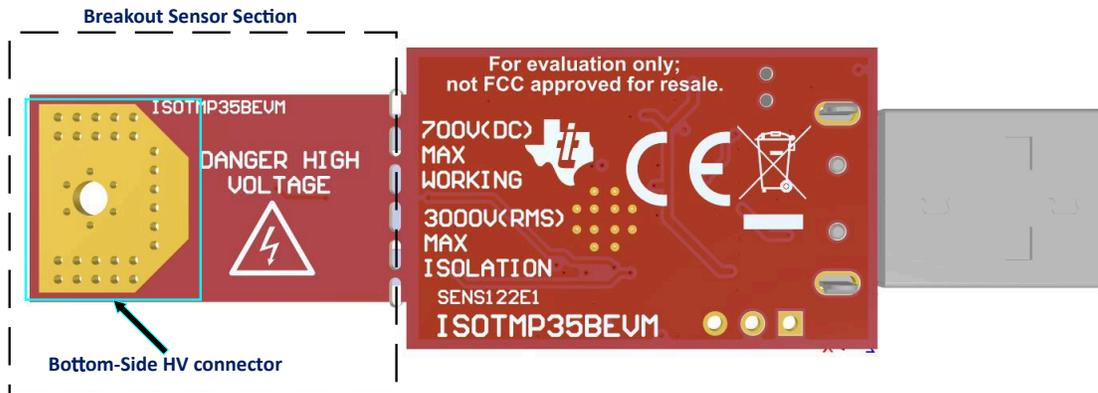


Figure 2-2. ISOTMP35BEVM Board Bottom Side

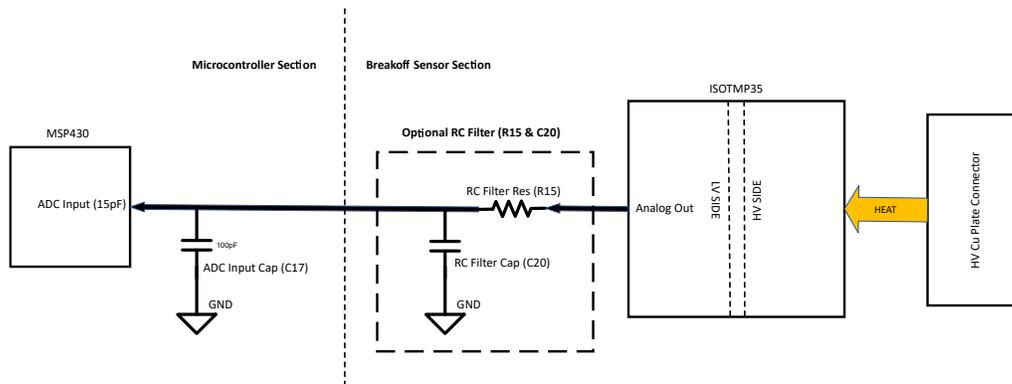


Figure 2-3. ISOTMP35BEVM Board Block Diagram

2.2 High Voltage Connection Setup Guide

2.2.1 Detaching the Sensor

The ISOTMP35BEVM functions with or without the sensor breakout board. However, to evaluate the ISOTMP35 in high voltage high temperature applications, the sensor breakout board must be detached to disconnect the breakout sensor board. To detach the sensor board and reconnect correctly, follow these recommendations:

- De-solder bridge connectors from pads on both side.
- Break off the sensor board from the controller board along the perforations.
- Reconnect sensor board and controller board with wires soldered to labeled pads. The signals traveling across these wires are low voltage, however the wires themselves must be rated to handle high-voltage levels.

Depending on the application, the sensor board can be connected in such a way that the wires connecting the EVM cross over other high voltage signals or components. If low voltage rated wires are used in that case, then the wires and EVM can be damaged if the wires and EVM come into physical contact with a high voltage signal.

The user can also choose the voltage on the sensor breakout board 3.3 V & GND pads. The ISOTMP35 can accept any supply voltage from 2.3 V to 5.5 V.

2.2.2 Attaching Sensor Section to High Voltage Heat Source

Once the user has reconnected the sensor breakout board, the user can attach the EVM to a high-voltage heat source using the bottom-side copper plate. This plate can be attached directly to a heat source, such as a heat-sink from a high-power MOSFET or a high-voltage bus bar, using glue or screws.

- For best thermal conductivity, do not place an insulator between the high-voltage heat source and the EVM bottom copper plate. Direct metal-to-metal contact is recommended.
- To decrease the ISOTMP35 response time, apply a thin layer of thermal conductive paste between the connector and the high-voltage heat source.
- Dissimilar metals in contact can increase the thermal resistance, to minimize this effect use thermal conductive paste.
- If screwing the EVM bottom copper connector on a high-power MOSFET, then TI recommends to minimize connection distance to the MOSFET.
- When screwing on the EVM to any high-voltage heat source, note that the FR4 expands and contracts with temperature. FR4 is a forgiving dielectric in terms of thermal expansion, but the user must periodically check that the screwing remains fastened when safe to do so.
- When gluing the EVM copper pad to a high voltage heat source, use as little glue as possible to make sure the connection is secure, excess glue increases the thermal resistance, therefore increasing response time. Once again, thermal conductive paste between the two different metals helps to reduce the metal-to-metal thermal resistance.

2.3 Perforations

There are perforations between the USB controller and the ISOTMP35 sensor, these exist so that after the bridge connectors between the pads are desoldered, the two sides of the EVM can be broken apart easily.

2.4 Status LEDs & Subregulator

The ISOTMP35BEVM includes LEDs to indicate the board status; the green LED D3 illuminates when voltage is supplied to the 3.3V net. The 3.3V net is connected directly to pin 1 of the ISOTMP35. U1 is the onboard regulator which supplied the 3.3V net, and is enabled and disabled by switch S1. For normal operation of the EVM, S1 must be enabled. When S1 is disabled, the green LED D3 turns off.

The red LED D4 is the MSP430F5528 status LED. [Table 2-1](#) shows what the different modes of operation mean.

Table 2-1. D4 LED Status

D4 LED STATUS	MEANING
Off	EVM is connected to EVM GUI
Blinking in 4 blink burst	EVM is plugged into PC, not connected to EVM GUI
Steady blinking	Connected to USB power

2.5 Programming Header

The ISOTMP35BEVM comes pre-loaded with firmware necessary for correct operation. Header J2 is provided for Spy-Bi-Wire access to the MSP430F5528, but TI does not recommend that users access this header or reprogram the device.

2.6 Pushbutton Switch

Switch SW1 is used for entering USB BSL mode; this can be used for firmware updates. To enter BSL mode, connect the EVM to a PC USB port while holding down SW1.

2.7 RC Filter

On the sensor breakout board, R15 and C20 can be used for an optional RC circuit to filter the voltage output of the ISOTMP35. R15 is already installed on the board, but is a 0 Ohm jumper so acts as a short. C20 is not installed by default. The user can desolder R15, solder on a different resistor in the place of R15, and solder on a capacitor for C20 to create an RC filter.

The user must be aware to not use a capacitor value greater than 885 pF for C20. The ISOTMP35 has a maximum capacitive load of 1000 pF, however C17 on the controller portion of the EVM is a 100 pF cap that is loaded onto the output voltage line. C17 prevents the voltage from dropping on the microcontroller ADC input, so C17 must not be removed. The ADC pin of the MSP430F5528 has 15 pF of capacitive loading as well.

A typical value that helps reduce noise in most cases and minimize ADC sampling error is 680 pF. Adding any resistor in place of R15 increases the output settling time, so the user must not exceed 100K Ohms if adding a resistor. An output impedance 10K Ohms is enough to avoid instability on the ISOTMP35 output. A resistor between 10K Ohms to 100K Ohms is acceptable.

In [Table 2-2](#), three resistor and capacitor values for an RC circuit on the ISOTMP35 analog output pin are provided, and the settling time and cutoff frequencies are calculated from that to help the user choose the right resistor and capacitor combination for their application.

- 115 pF is shown because this is the capacitance already loading the ISOTMP35 analog output (100 pF from C17, 15 pF from ADC pin of microcontroller) if the user does not add any capacitor to C20.
- 795 pF is shown because this takes the 115 pF already loaded and adds an additional 680 pF load which is recommended above.
- 1000 pF is shown because this is the maximum capacitive load that can be put onto the ISOTMP35 analog output.

Table 2-2. ISOTMP35 Settling Time & Cutoff Frequencies With Different RC Combinations

Settling Time (us) & Cutoff Frequency (KHz)	Settling Time (5*RC Time Constant)			Cutoff Frequency ($f_c = 1/(2\pi RC)$)		
	115 pF	795 pF	1000 pF	115 pF	795 pF	1000 pF
1K Ohms	0.575 us	3.975 us	5 us	1384 KHz	200.3 KHz	159.2 KHz
10K Ohms	5.75 us	39.75 us	50 us	138.4 KHz	20.03 KHz	15.92 KHz
100K Ohms	57.5 us	397.5 us	500 us	13.84 KHz	2.003 KHz	1.592 KHz

3 Software

The ISOTMP35BEVM software allows a user to read temperature from the ISOTMP35 by using the MSP430F5528. The analog output voltage is read by the microcontroller and converted to displayed temperature in software. Once the EVM hardware is connected to the GUI, temperature is sampled automatically once the user navigates to the *Data Capture* tab. The ISOTMP35BEVM GUI also contains a functional block diagram, key specs, and associated collateral for ISOTMP35.

3.1 Software Download

The PC GUI Software for ISOTMP35BEVM runs on TI's GUI Composer framework. The software is available as a live version that runs in a browser and as a download for offline use. The software is compatible with Microsoft® Windows®, Mac®, and Linux® operating systems.

3.1.1 Online Software

Access the online version by navigating to <https://dev.ti.com/gallery/info/THSApps/ISOTMP35BEVM>. The online software works with Google Chrome®, Firefox®, and Safari® browsers. Users can access the live GUI by following the link and clicking on the application icon within the gallery to launch the software. If prompted, install the TI Cloud Agent browser plug-in.

3.1.2 Offline Software

Fully offline version can be accessed by navigating to <https://dev.ti.com/gallery/info/THSApps/ISOTMP35BEVM> and downloading the application and runtime for Linux, Mac, or Microsoft Windows, and then following the on-screen installation instructions.

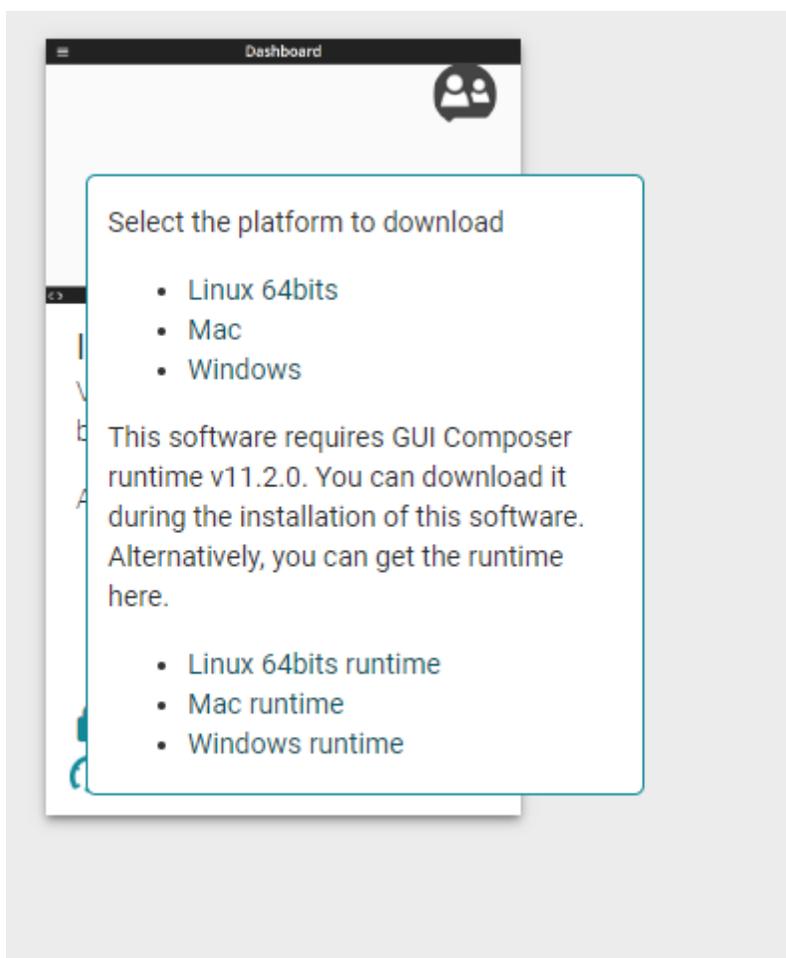


Figure 3-1. Download Pop-Up

3.2 Home Tab

When opening the GUI, the *Home* tab is displayed, see the figure below. From the home tab, device features such as a key specs and a functional block diagram can be seen when clicking the *Learn More* button. From the Home tab, there are shortcuts on the left bar and on the bottom to the *Data Capture* tab and the *Collateral* tab.

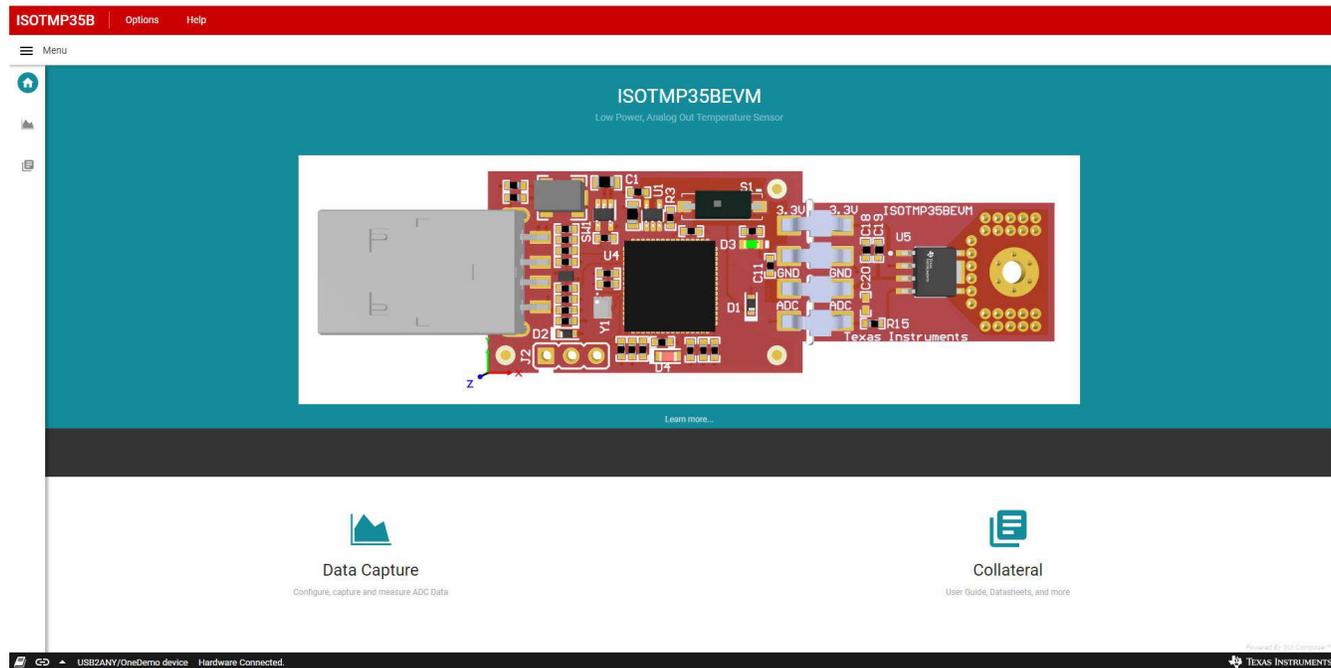


Figure 3-2. Home Tab

3.3 Data Capture Tab

The *Data Capture* tab automatically begins making temperature measurements. The data displays on a graph that scales with the temperature readings with recorded temperature on the y-axis, and measurement count on the x-axis. The default capture rate is 1 measurement per second. The drop-down menu allows the user to choose a different measurement rate, with the following options:

- Off
- As fast as possible
- Every 500 ms
- Every 1 s
- Every 5 s
- Every 10 s
- Every 60 s

The *SAVE START* and *SAVE STOP* buttons enable the user to log the EVM temperature results in a .csv file. When *SAVE START* is selected, the file begins downloading, and downloading ends when *SAVE STOP* is selected.



Figure 3-3. Data Capture Tab

3.4 Collateral Tab

The *Collateral* tab contains links to relevant sites and documentation for the EVM. This includes links to the EVM user's guide, the ISOTMP35 data sheet, the tool page on <http://www.ti.com>, any application notes, compliance documentation, and any other relevant literature.

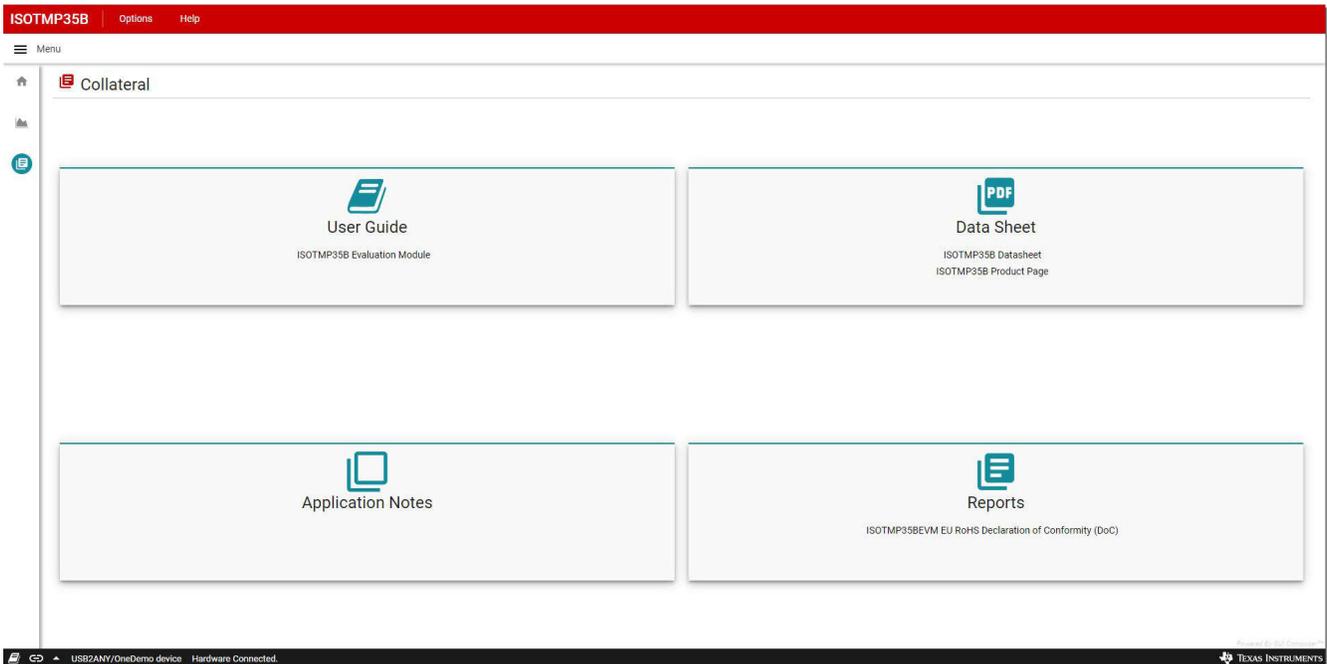


Figure 3-4. Collateral Tab

4 Hardware Design Files

4.1 ISOTMP35BEVM Schematic

Figure 4-1 shows the EVM schematic.

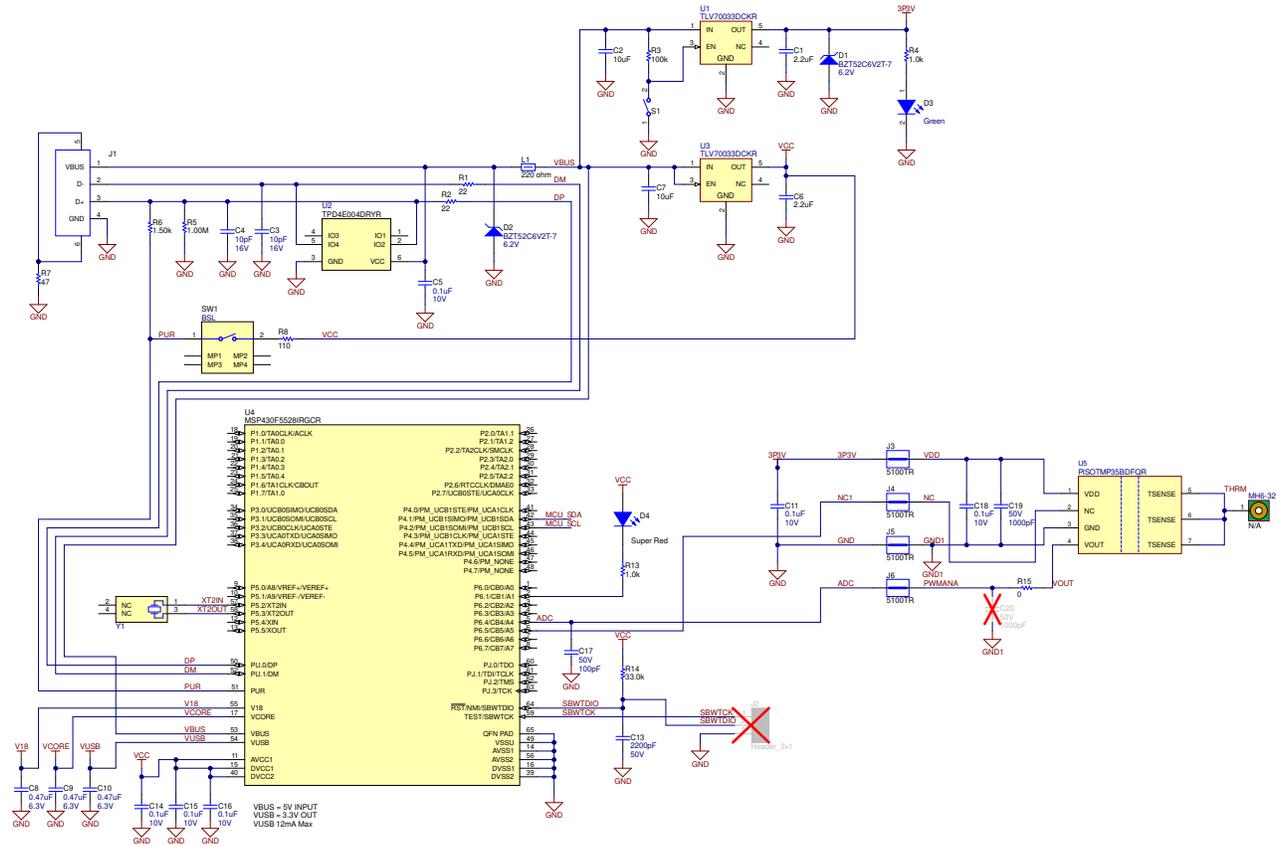


Figure 4-1. ISOTMP35BEVM Schematic

4.2 PCB Layout

Figure 4-2 and Figure 4-3 show the EVM PCB layout images.

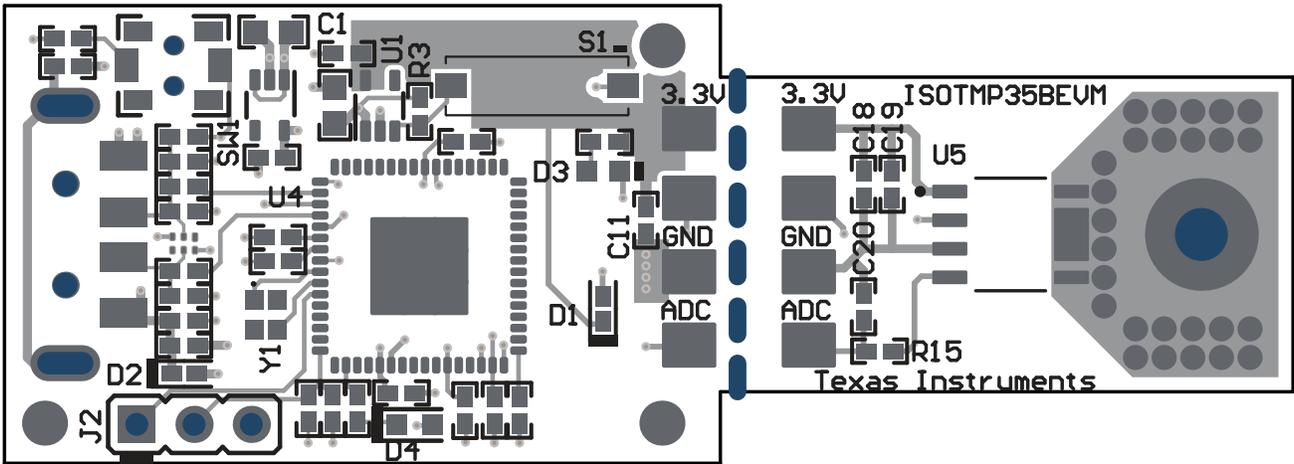


Figure 4-2. Top View

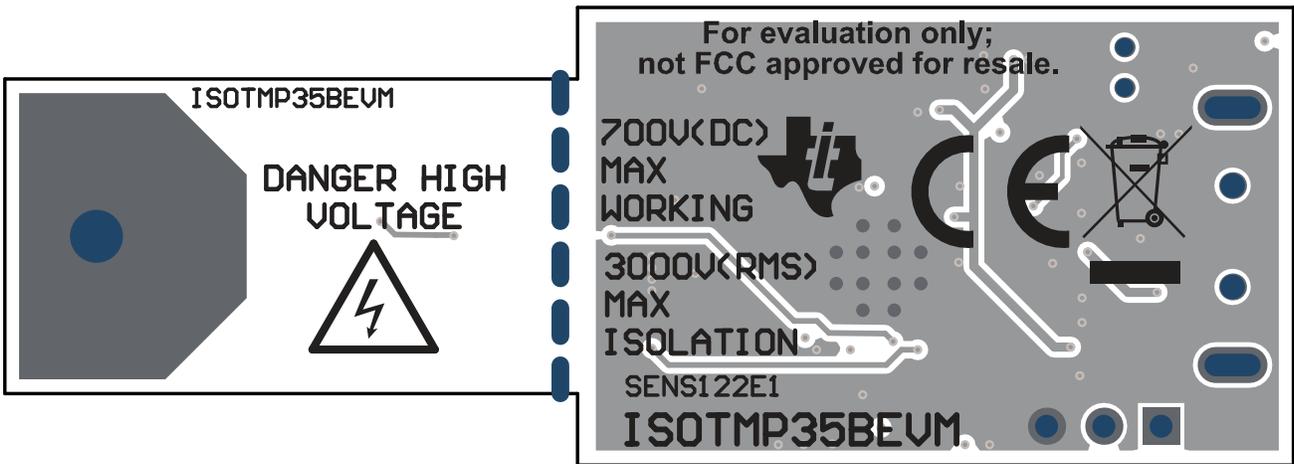


Figure 4-3. Bottom View

4.3 Bill of Materials

Table 4-1 shows the EVM bill of materials.

Table 4-1. ISOTMP35BEVM BOM

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
!PCB1	1		Printed Circuit Board		SENS122	Any
C1, C6	2	2.2uF	CAP, CERM, 2.2 uF, 16 V, +/- 10%, X5R, 0402	0402	GRM155R61C225KE11D	MuRata
C2, C7	2	10uF	CAP, CERM, 10 uF, 10 V, +/- 20%, X5R, 0603	0603	C1608X5R1A106M080AC	TDK
C3, C4	2	10 pF	CAP, CERM, 10 pF, 16 V,+/- 10%, C0G, 0402	0402	C0402C100K4GACTU	Kemet
C5, C11, C14, C15, C16, C18	6	0.1uF	CAP, CERM, 0.1 uF, 10 V,+/- 10%, X5R, 0402	0402	LMK105BJ104KV-F	Taiyo Yuden
C8, C9, C10	3	0.47uF	CAP, CERM, 0.47 uF, 6.3 V, +/- 10%, X7R, 0402	0402	JMK105B7474KVHF	Taiyo Yuden
C13	1	2200 pF	CAP, CERM, 2200 pF, 50 V, +/- 5%, X7R, 0402	0402	CL05B222JB5NNNC	Samsung Electro-Mechanics
C17	1	100 pF	CAP, CERM, 100 pF, 50 V, +/- 5%, C0G/NP0, 0402	0402	GRM1555C1H101JA01D	MuRata
C19	1	1000 pF	CAP, CERM, 1000 pF, 50 V, +/- 5%, C0G/NP0, 0402	0402	C1005NP01H102J050BA	TDK
D1, D2	2	6.2V	Diode, Zener, 6.2 V, 300 mW, SOD-523	SOD-523	BZT52C6V2T-7	Diodes Inc.
D3	1	Green	LED, Green, SMD	LED, GREEN, 0603	SML-LX0603GW-TR	Lumex
D4	1	Super Red	LED, Super Red, SMD	LED_0603	150060SS75000	Würth Elektronik
J1	1		Connector, Plug, USB Type A, R/A, Top Mount SMT	USB Tyoe A right angle	48037-1000	Molex
J3, J4, J5, J6	4		Jumper, 5.31mm, 2 Position, Silver, SMT	Jumper, 5.31mm, 2 Position, SMT	5100TR	Keystone
L1	1	220 ohm	Ferrite Bead, 220 ohm @ 100 MHz, 0.45 A, 0402	0402	BLM15AG221SN1D	MuRata
R1, R2	2	22	RES, 22, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	ERJ-2GEJ220X	Panasonic
R3	1	100k	RES, 100 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	ERJ-2GEJ104X	Panasonic
R4, R13	2	1.0k	RES, 1.0 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	ERJ-2GEJ102X	Panasonic
R5	1	1.00Meg	RES, 1.00 M, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	RMCF0402FT1M00	Stackpole Electronics Inc
R6	1	1.50k	RES, 1.50 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	RMCF0402FT1K50	Stackpole Electronics Inc
R7	1	47	RES, 47, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	ERJ-2GEJ470X	Panasonic

Table 4-1. ISOTMP35BEVM BOM (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
R8	1	110	RES, 110, 1%, 0.1 W, AEC-Q200 Grade 0, 0402RES, 33.0 k, 1%, 0.063 W, 0402	0402	ERJ-2RKF1100X	Panasonic
R14	1	33.0k	RES, 33.0 k, 1%, 0.063 W, 0402	0402	RC0402FR-0733KL	Yageo America
R15	1	0	RES, 0, 0%, 0.2 W, AEC-Q200 Grade 0, 0402	0402	CRCW04020000Z0EDHP	Vishay-Dale
S1	1		Switch, Slide, SPST, Top Slide, SMT		Switch, Single Top Slide, 2.5x8x2.5mm	Copal Electronics
SW1	1		Switch, SPST-NO, Off-Mom, 0.05A, 12VDC, SMD		3.9x2.9mm	C&K Components
U1, U3	2		Single Output LDO, 200 mA, Fixed 3.3 V Output, 2 to 5.5 V Input, with Low IQ, 5-pin SC70 (DCK), -40 to 125 degC, Green (RoHS & no Sb/Br)		DCK0005A	Texas Instruments
U2	1		4-Channel ESD Protection Array for High-Speed Data Interfaces, DRY0006A (USON-6)		DRY0006A	Texas Instruments
U4	1		16-Bit Ultra-Low-Power Microcontroller, 128KB Flash, 8KB RAM, USB, 12Bit ADC, 2 USCIs, 32Bit HW MPY, RGC0064B (VQFN-64)		RGC0064B	Texas Instruments
U5	1		PISOTMP35BDFQR		SOIC7	Texas Instruments
Y1	1		Crystal, 24 MHz, SMD		2x1.6mm	MuRata

5 Additional Information

Trademarks

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

Mac® and Safari® are registered trademarks of Apple Inc.

Linux® is a registered trademark of Linus Torvalds.

Chrome® is a registered trademark of Google LLC.

Firefox® is a registered trademark of Mozilla Foundation.

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.

-
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.

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.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2023, Texas Instruments Incorporated

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to [TI's Terms of Sale](#) or other applicable terms available either on [ti.com](https://www.ti.com) or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2023, Texas Instruments Incorporated