

# LMP91000EVM User's Guide

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## 1. Introduction

The Texas Instruments LMP91000EVM evaluation module (EVM) helps designers evaluate the operation and performance of the LMP91000 Sensor Analog Front End for Electrochemical sensor. The LMP91000EVM is part of the Sensor AFE eval platform

The EVM contains one LMP91000, (See Table 1).

**Table 1: Device and Package Configurations**

DEVICE	IC	PACKAGE
U1	LMP91000SD	LLP-14

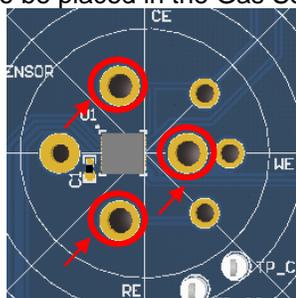
The LMP91000EVM is provided with a 16 bit ADC (ADC161S626) in order to capture the output of the LMP91000. ***The LMP91000EVM is not provided with any gas sensor. It supports 3-lead electrochemical cells and 2-lead galvanic cell in potentiostat configuration.***

## 2. Setup

This section describes the jumpers and connectors on the EVM as well and how to properly connect, set up and use the LMP91000EVM in the Sensor AFE eval platform.

## 2.1. Gas Sensor Connection

Both 3-lead and 2-lead gas sensor need to be placed in the Gas Sensor Footprint



**Figure 1: Gas sensor's footprint**

### 2.1.1. Not Biased Gas sensor

Even if the LMP91000 is provided with an internal switch to short the RE and WE pin that can be enabled when the device is in Deep sleep mode, it is possible to add an external JFET which makes the same feature when the gas sensor is left connected to the board and the LMP91000 is turned off.

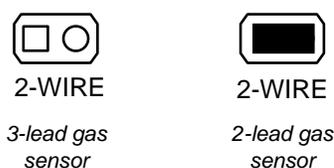
The JFET (Q1) should be a p-type FET. Recommended FETs are listed in the table below. The gate resistance R12 can be populated with a 1kohm resistor.

**Table 2: Recommended p-FETs for short circuiting RE and WE when LMP91000 is OFF**

DEVICE	IC	DESCRIPTION	MANUFACTURER	PACKAGE
Q1	PMBFJ177	P-channel Silicon Junction Field-effect Transistor	NXP SEMICONDUCTOR	SOT23
	SST177		VISHAY SILICONIX	
	MMBF177		Fairchild	

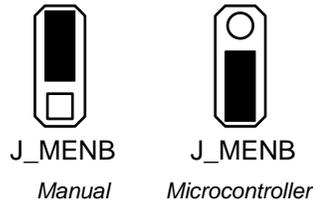
## 2.2. Jumpers Configuration

**2-WIRE** is the jumper which shorts CE and RE pin when a 2-lead gas sensor is connected to the LMP91000.



**Figure 2: 2-WIRE Jumper Settings**

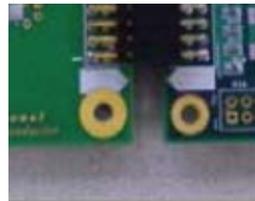
**J\_MENB** configures the Module Enable of the LMP91000 either manual or controlled by external microcontroller. In manual mode, the Module Enable of the LMP91000 is tied to GND. When the LMP91000EVM is connected to the SPIO4 board pin 1-2 need to be shorted.



**Figure 3: J\_MENB Jumper Settings**

### 2.3. Connection of the LMP91000EVM to SPIO4 Board

The SPIO4 board is a data capture board required when the LMP91000 is used in the Sensor AFE eval platform. The LMP91000EVM is connected to the SPIO4 board through the SPIO-GPSI16 connector. The white arrows present on both LMP91000EVM and SPIO4 board need to be aligned in order to guaranty the right connection.



**Figure 4: Connection of the LMP91000EVM to SPIO4 board**

### 2.4. LMP91000EVM as part of Sensor AFE eval platform

When the LMP91000EVM is part of the Sensor AFE eval platform it doesn't require any external power supply to properly work.

Before using the Sensor AFE eval platform make sure the following steps have been accomplished:

1. Install the Graphical User Interface of the LMP91000EVM
2. Connect the LMP91000EVM to the SPIO4 board
3. Connect the USB cable to SPIO-4 board
4. Connect the other end of the USB cable to an available USB port on the computer
5. Run the Graphical User Interface

The voltage at VDD pin of the LMP91000 (VDD test point) is 3.3V, the voltage at VREF pin of the LMP91000 (VREF test point) is 2.5V. The LMP91000EVM is ready to work.

### 2.5. LMP91000EVM In Standalone Operation (without ADC)

The LMP91000EVM can be used as a standalone board. In this case it requires the following voltages

#### 2.5.1. Jumper/s setting

**J\_MENB** - pin 2 and 3 shorted (manual mode), if on the I2C bus already exist a device with the same address of the LMP91000, leave pin1 and 2 shorted.

#### 2.5.2. Power supply

1. Remove R7 resistor
2. Connect a supply voltage (2.7V to 5.25V) between VDD test point and GND test point.

### **2.5.3. Voltage reference**

If the on board 2.5V voltage reference fits the requirements of the application, do not accomplish the following steps.

1. Remove R6 resistor
2. Connect a reference voltage (1.5V to VDD) between VREF test point and GND test point.

### **2.5.4. I2C bus**

The I2C bus requires two 10kohm pull-up resistors (R1, R2); the external microcontroller can be connected to the SPIO-GPSI16 connector according to the following pin out:

SCL	pin 12 of SPIO-GPSI16
SDA	pin 11 of SPIO-GPSI16
GND	pin 2 of SPIO-GPSI16

Refer to LMP91000's datasheet for further details on I2C commands and registers.

The footprints of the pull-up resistors (R1, R2) are on the bottom side of the eval board.

### **2.5.5. Other**

Remove the resistor R8 in order to disconnect the ADC's input from LMP91000's output.



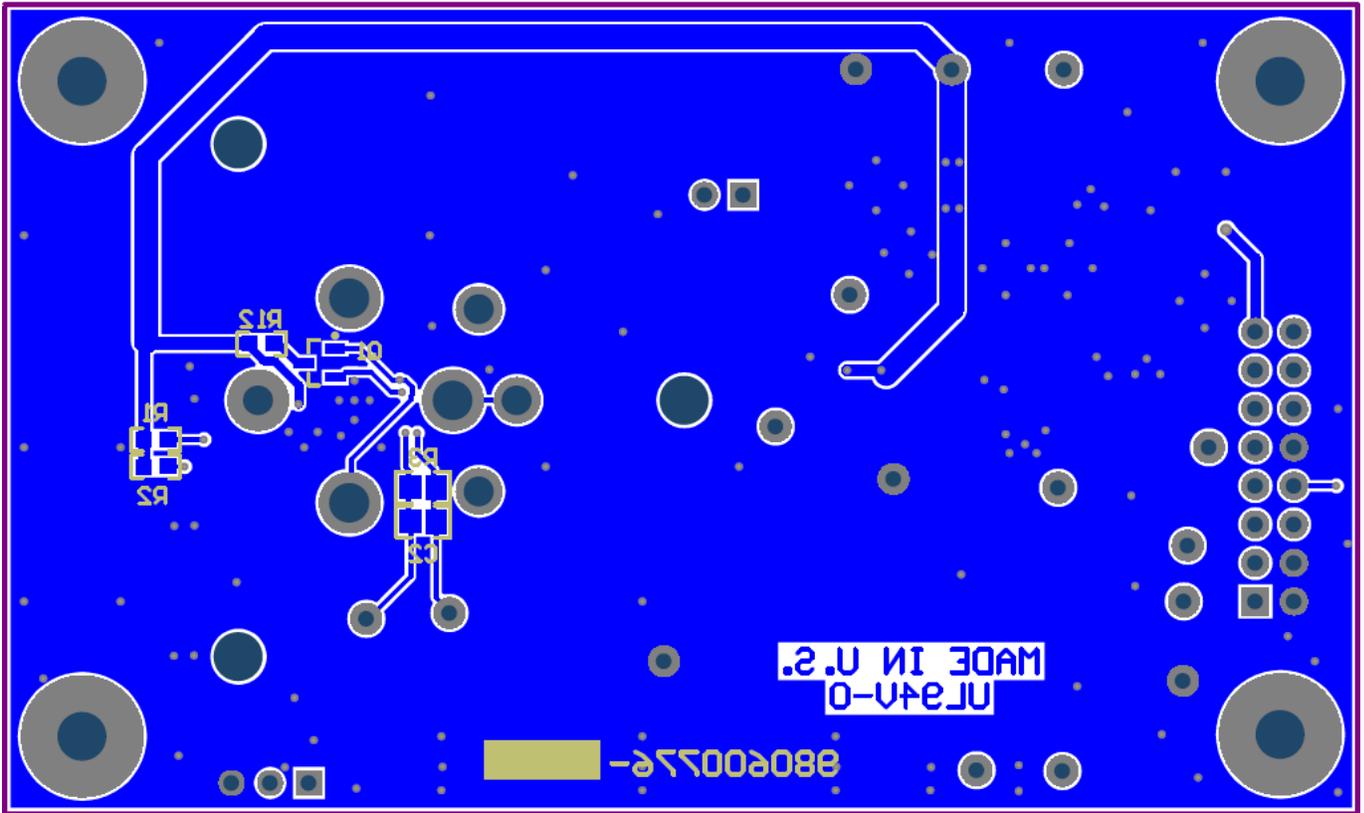
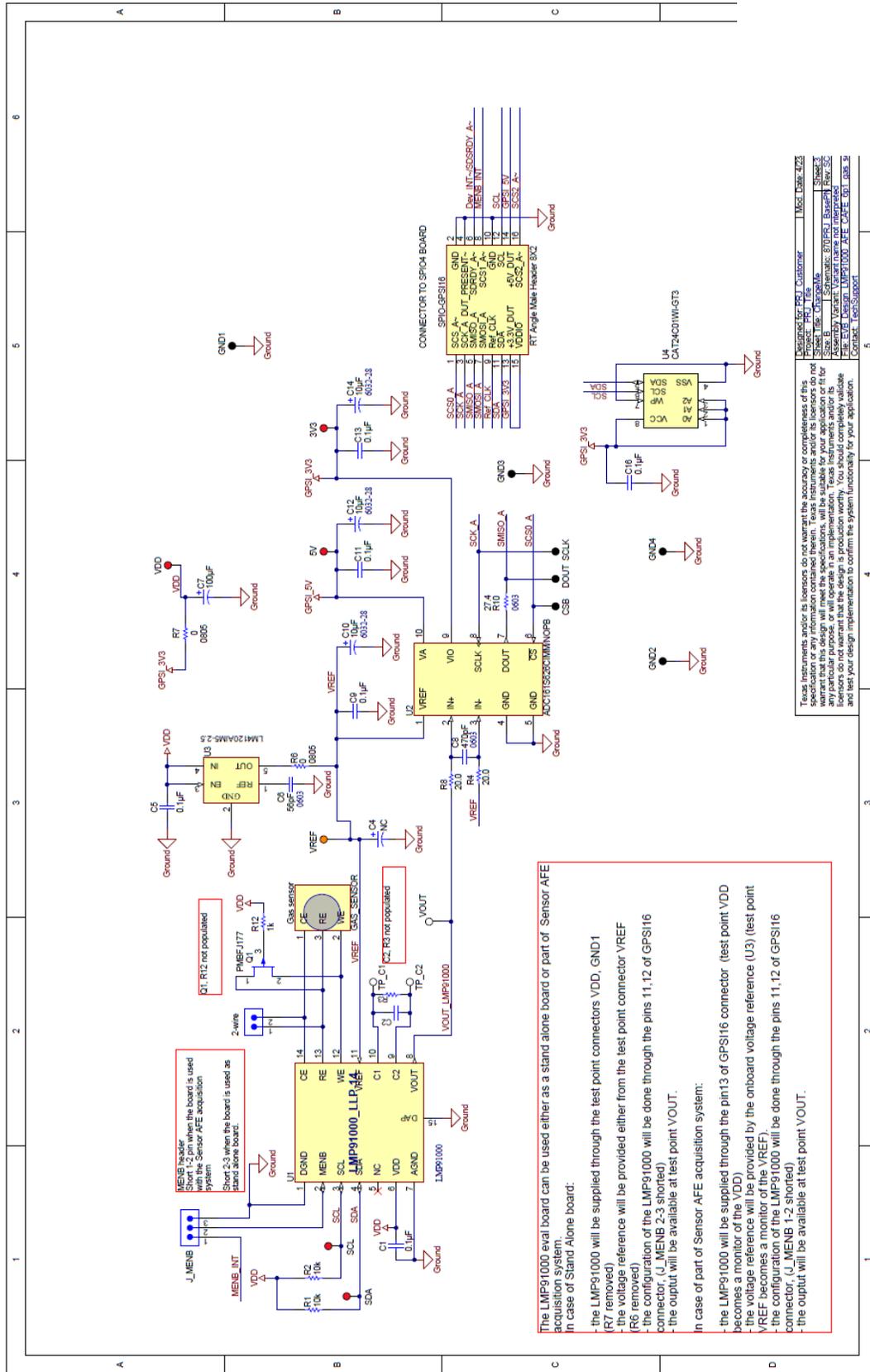


Figure 6: Bottom Layer Routing

4. Schematic



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 Designated for Part:   
 Sheet Title:   
 Sheet No.:   
 Size:   
 Rev:   
 Title:   
 Part Number:   
 Date:   
 Contact:   
 Mod. Date:   
 Sheet 3 of 3

The LMP91000 eval board can be used either as a stand alone board or part of Sensor AFE acquisition system. In case of Stand Alone board:

- the LMP91000 will be supplied through the test point connectors VDD, GND1
- the voltage reference will be provided either from the test point connector VREF (R6 removed)
- the configuration of the LMP91000 will be done through the pins 11,12 of GPS116 connector, (J\_MENB 2-3 shorted)
- the output will be available at test point VOUT.

In case of part of Sensor AFE acquisition system:

- the LMP91000 will be supplied through the pin13 of GPS116 connector (test point VDD becomes a monitor of the VDD)
- the voltage reference will be provided by the onboard voltage reference (U3) (test point VREF becomes a monitor of the VREF).
- the configuration of the LMP91000 will be done through the pins 11,12 of GPS116 connector, (J\_MENB 1-2 shorted)
- the output will be available at test point VOUT.

Figure 7: LMP91000EVM Schematic

**Table 3: LMP91000EVM Bill of Materials**

COUNT	REF DES	DESCRIPTION	SIZE	MFR	PART NUMBER
1	2-wire	Header, TH, 100mil, 1x2, Gold plated, 230 mil above insulator	0.100 x 2	Samtec Inc.	TSW-102-07-G-S
12	3V3, 5V, SCL, SDA, VDD, TP_C1, TP_C2, VOUT, CSB, DOUT, SCLK, VREF	Test Point, TH, Miniature, Red	40 mil	Keystone Electronics	5000
1	C1	CAP, CERM, 0.1uF, 10V, +/-10%, X5R	402	MuRata	GRM155R61A104KA01D
5	C5, C9, C11, C13, C16	CAP, CERM, 0.1uF, 16V, +/-5%, X7R	603	AVX	0603YC104JAT2A
1	C6	CAP, CERM, 56pF, 50V, +/-5%, C0G/NP0	603	AVX	06035A560JAT2A
1	C7	CAP, TANT, 100uF, 10V, +/-10%, 0.1 ohm	6032-28	AVX	TPSC107K010R0100
1	C8	CAP, CERM, 470pF, 50V, +/-5%, C0G/NP0	603	AVX	06035A471JAT2A
3	C10, C12, C14	CAP, TANT, 10uF, 16V, +/-10%, 0.45 ohm	6032-28	Vishay-Sprague	593D106X9016C2TE3
4	GND1, GND2, GND3, GND4,	Test Point, TH, Miniature, Black	40 mil	Keystone Electronics	5001
3	GAS_SENSOR	Gas sensor Hood	100mil	Cambion	450-3326-01-03-00
4	H1, H2, H3, H4	BUMPON HEMISPHERE .44X.20 BLACK		3M	SJ-5003 (BLACK)
1	J_MENB	Header, TH, 100mil, 1x3, Gold plated, 230 mil above insulator	0.100 x 3	Samtec Inc.	TSW-103-07-G-S
2	R4, R8	RES, 20.0 ohm, 1%, 0.1W	603	Yageo America	RC0603FR-0720RL
2	R6, R7	RES, 0 ohm, 5%, 0.125W	805	Vishay-Dale	CRCW08050000Z0EA
1	R10	RES, 27.4 ohm, 1%, 0.1W	603	Vishay-Dale	CRCW060327R4FKEA
1	SPIO-GPSI16	SPIO-GPSI16 Header, 8-Pin, Dual row, Right Angle	0.100 x 8 dual row	Sullins Connector Solutions	PBC36DGAN
1	U1	LMP91000	LLP-14	Texas Instruments	LMP91000SD
1	U2	IC ADC 16BIT 50-250KSPS	MSOP-10	Texas Instruments	ADC161S626CIMM/NOPB
1	U3	Precision Micropower Low Dropout Voltage Reference	SOT-23	Texas Instruments	LM4120AIM5-2.5
1	U4	IC EEPROM 2KBIT 400KHZ	TSSOP-8	ON Semiconductor	CAT24C01WI-GT3



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For EVMs **not** subject to the above rules, this evaluation board/kit/module 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 or ICES-003 rules, which are designed to provide reasonable protection against radio frequency interference. Operation of the equipment 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.

### General Statement for EVMs including a radio

User Power/Frequency Use Obligations: This radio is intended for development/professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability of this EVM and its development application(s) must comply with local laws governing radio spectrum allocation and power limits for this evaluation module. It is the user's sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this is strictly prohibited and unauthorized by Texas Instruments unless user has obtained appropriate experimental/development licenses from local regulatory authorities, which is responsibility of user including its acceptable authorization.

## **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**

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**

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.

## **For EVMs annotated as IC – INDUSTRY CANADA Compliant**

This Class A or B digital apparatus complies with Canadian ICES-003.

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### **Concerning EVMs including radio transmitters**

This device complies with Industry Canada licence-exempt RSS standard(s). 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.

### **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.

~

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Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

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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.

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(2) Use this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or

(3) Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product.

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# EVALUATION BOARD/KIT/MODULE (EVM)

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2. You have full and exclusive responsibility to assure the safety and compliance of your products with all such laws and other applicable regulatory requirements, and also to assure the safety of any activities to be conducted by you and/or your employees, affiliates, contractors or designees, using the EVM. Further, you are responsible to assure 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.
3. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.
4. You will take care of proper disposal and recycling of the EVM's electronic components and packing materials.

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