LMP91000EVM User's Guide

CONTENTS

LIST OF FIGURES

LIST OF TABLES

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 Fooptprint

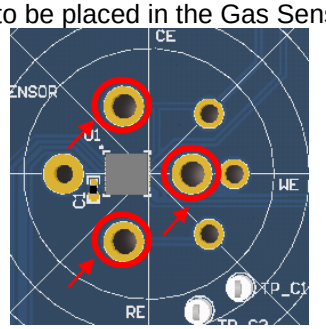

Figure 1: Gas sensor's footprint

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.

3-lead gas sensor *2-lead gas sensor*

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.

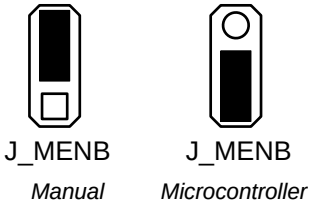

Figure 3: J_MENB Jumper Settings

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.

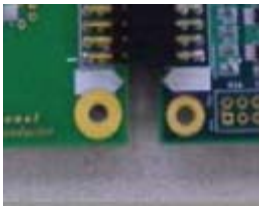

Figure 4: Connection of the LMP91000EVM to SPIO4 board

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.

.

3. Board Layout

Figure 5, Figure 6 and Figure 7 show the board layout for the LMP91000EVM.
The EVM offers footprint for

- External JFET (Q1) to short RE and WE pin,
- Resistor (R3) and capacitor (C2) to apply external RTIA gain and filter

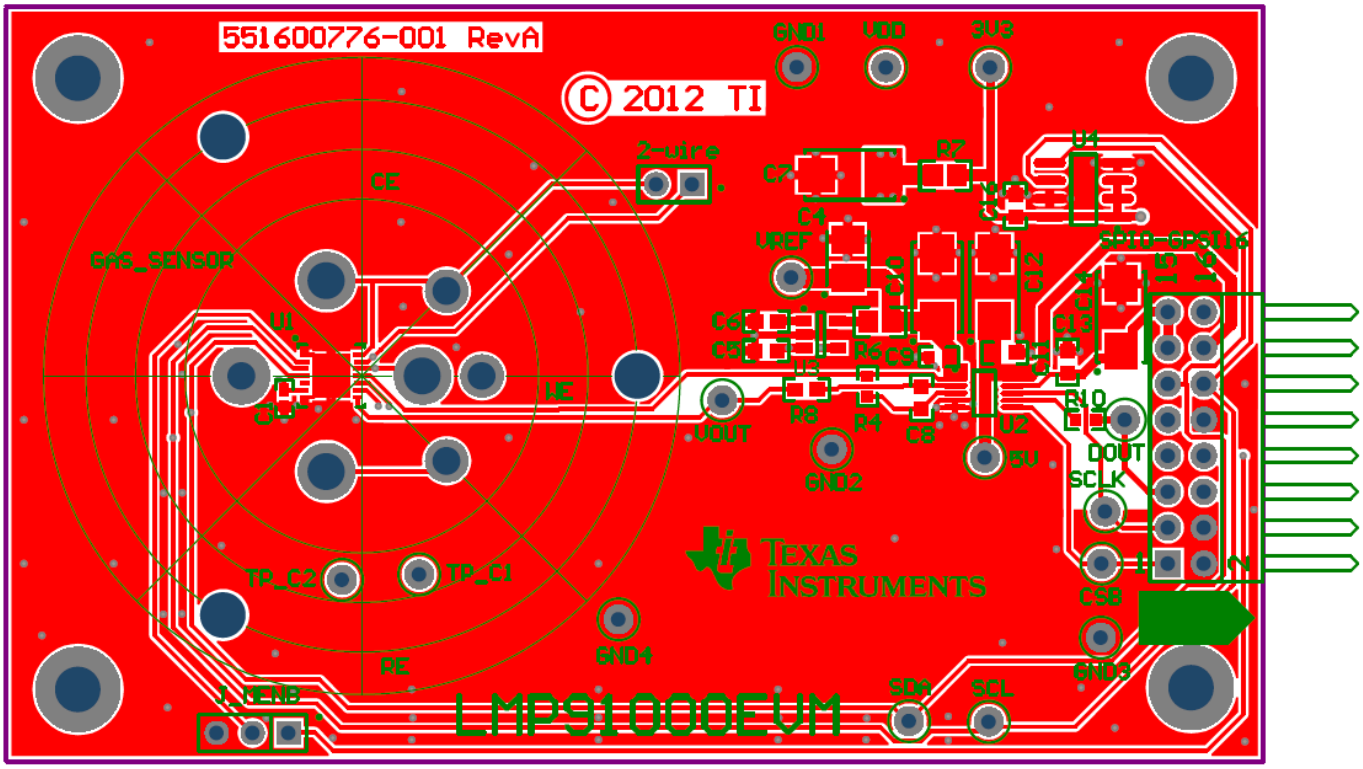

Figure 5: Top Layer Routing

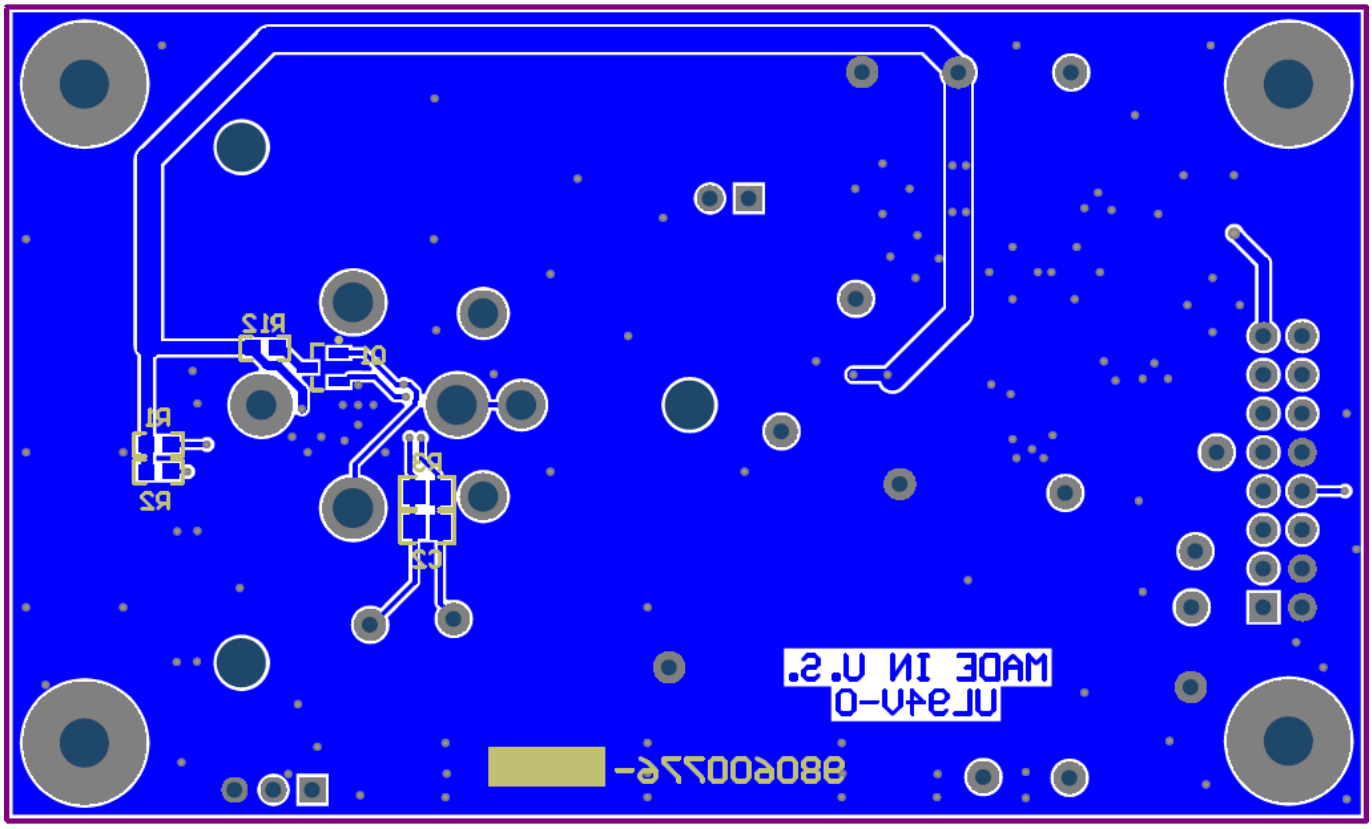

Figure 6: Bottom Layer Routing

4. Schematic

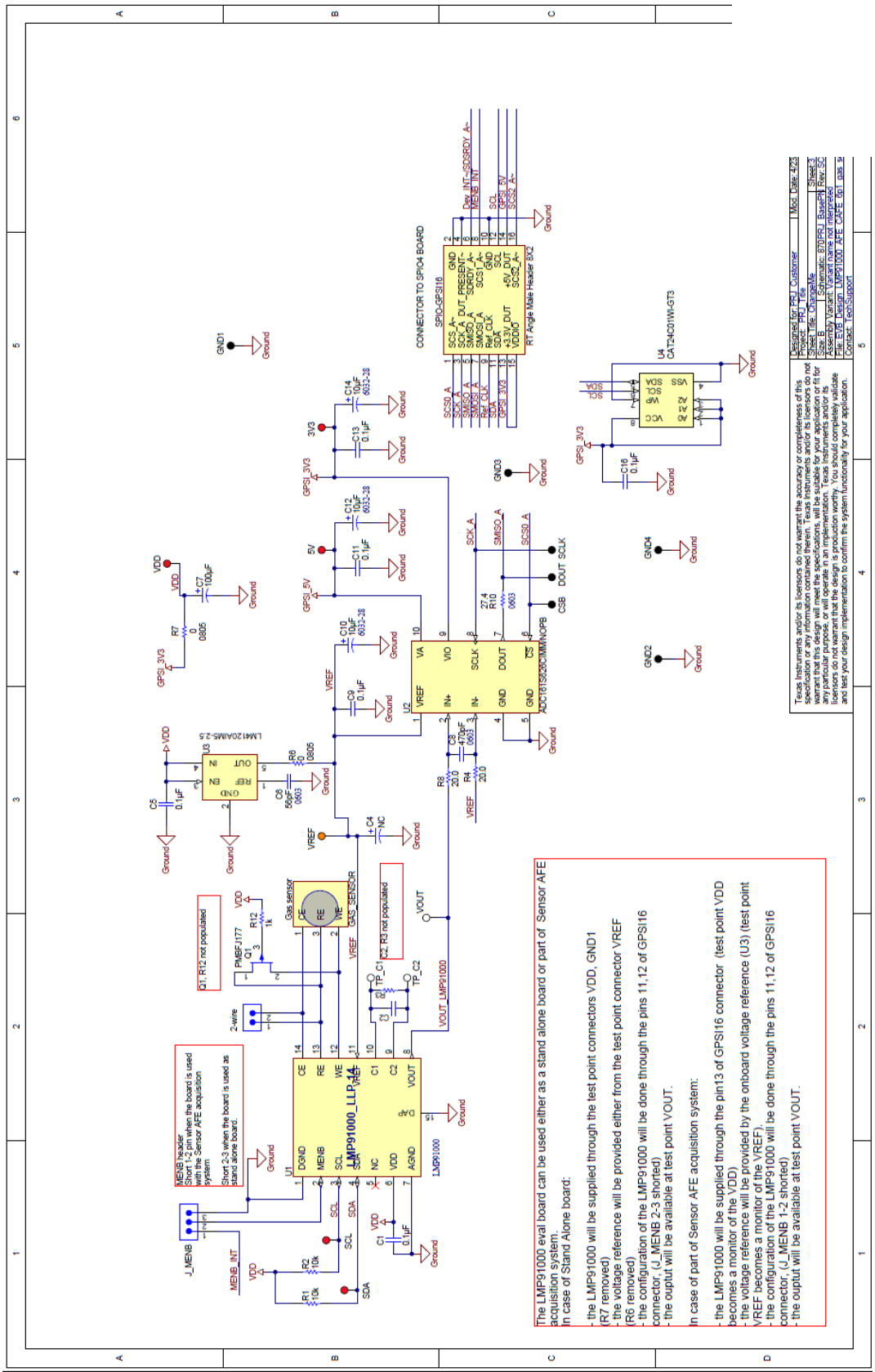

Figure 7: LMP91000EVM Schematic

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

EVALUATION BOARD/KIT/MODULE (EVM) ADDITIONAL TERMS

Texas Instruments (TI) provides the enclosed Evaluation Board/Kit/Module (EVM) under the following conditions:

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies TI from all claims arising from the handling or use of the goods.

Should this evaluation board/kit not meet the specifications indicated in the User's Guide, the board/ kit may be returned within 30 days from the date of delivery for a full refund. THE FOREGOING LIMITED WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

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

No license is granted under any patent right or other intellectual property right of TI covering or relating to any machine, process, or combination in which such TI products or services might be or are used. TI currently deals with a variety of customers for products, and therefore our arrangement with the user is not exclusive. TI assumes no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein.

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

REGULATORY COMPLIANCE INFORMATION

As noted in the EVM User's Guide and/or EVM itself, this EVM and/or accompanying hardware may or may not be subject to the Federal Communications Commission (FCC) and Industry Canada (IC) rules.

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.

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

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.
~

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada.

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.

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.

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.

Important Notice for Users of this Product in Japan】

This development kit is NOT certified as Confirming to Technical Regulations of Radio Law of Japan!

If you use this product in Japan, you are required by Radio Law of Japan to follow the instructions below with respect to this product:

(1) Use this product 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 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.

Also, please do not transfer this product, unless you give the same notice above to the transferee.

Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

Texas Instruments Japan Limited
(address) 24-1, Nishi-Shinjuku 6 chome, Shinjukku-ku, Tokyo, Japan

http://www.tij.co.jp

【ご使用にあたっての注意】

本開発キットは技術基準適合証明を受けておりません。

本製品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２４番１号
西新宿三井ビル
http://www.tij.co.jp

EVALUATION BOARD/KIT/MODULE (EVM)

WARNINGS, RESTRICTIONS AND DISCLAIMERS

For Feasibility Evaluation Only, in Laboratory/Development Environments. Unless otherwise indicated, this EVM is not a finished electrical equipment and not intended for consumer use. It is intended solely for use for preliminary feasibility evaluation in laboratory/development environments by technically qualified electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems and subsystems. It should not be used as all or part of a finished end product.

Your Sole Responsibility and Risk. You acknowledge, represent and agree that:

1. You have unique knowledge concerning Federal, State and local regulatory requirements (including but not limited to Food and Drug Administration regulations, if applicable) which relate to your products and which relate to your use (and/or that of your employees, affiliates, contractors or designees) of the EVM for evaluation, testing and other purposes.

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.

Certain Instructions. It is important to operate this EVM within TI’s recommended specifications and environmental considerations per the user guidelines. Exceeding the specified EVM ratings (including but not limited to input and output voltage, current, power, and environmental ranges) may cause property damage, personal injury or death. If there are questions concerning these ratings please 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 result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, some circuit components may have case temperatures greater than 60^{o}C as long as the input and output are maintained at a normal ambient operating temperature. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during normal operation, please be aware that these devices may be very warm to the touch. As with all electronic evaluation tools, only qualified personnel knowledgeable in electronic measurement and diagnostics normally found in development environments should use these EVMs.

Agreement to Defend, Indemnify and Hold Harmless. You agree to 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 use of the EVM that is not in accordance with the terms of the agreement. This obligation shall apply whether Claims arise under law of tort or contract or any other legal theory, and even if the EVM fails to perform as described or expected.

Safety-Critical or Life-Critical Applications. If you intend to evaluate the components for possible use in safety critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, such as devices which are classified as FDA Class III or similar classification, then you must specifically notify TI of such intent and enter into a separate Assurance and Indemnity Agreement.

IMPORTANT NOTICE

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

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

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

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI. Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices.

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

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

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

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

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

Products		**Applications**	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DSP	dsp.ti.com	Broadband	www.ti.com/broadband
Interface	interface.ti.com	Digital Control	www.ti.com/digitalcontrol
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
RFID	www.ti-rfid.com	Telephony	www.ti.com/telephony
Low Power Wireless	www.ti.com/lpw	Video & Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless

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