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>
<thead>
<tr>
<th>DEVICE</th>
<th>IC</th>
<th>PACKAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>U1</td>
<td>LMP91000SD</td>
<td>LLP-14</td>
</tr>
</tbody>
</table>

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

![Gas Sensor Footprint](image)

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>
<thead>
<tr>
<th>DEVICE</th>
<th>IC</th>
<th>DESCRIPTION</th>
<th>MANUFACTURER</th>
<th>PACKAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>PMBFJ177</td>
<td>P-channel Silicon Junction Field-effect Transistor</td>
<td>NXP SEMICONDUCTOR</td>
<td>SOT23</td>
</tr>
<tr>
<td></td>
<td>SST177</td>
<td></td>
<td>VISHAY SILICONIX</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MMBF177</td>
<td></td>
<td>Fairchild</td>
<td></td>
</tr>
</tbody>
</table>

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

2.2. Jumper Configuration

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

![2-WIRE Jumpers](image)

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.
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.

![Connection of the LMP91000EVM to SPIO4 board](image)

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

<table>
<thead>
<tr>
<th>COUNT</th>
<th>REF DES</th>
<th>DESCRIPTION</th>
<th>SIZE</th>
<th>MFR</th>
<th>PART NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2-wire</td>
<td>Header, TH, 100mil, 1x2, Gold plated, 230 mil above insulator</td>
<td>0.100 x 2</td>
<td>Samtec Inc.</td>
<td>TSW-102-07-G-S</td>
</tr>
<tr>
<td>12</td>
<td>3V3, 5V, SCL, SDA, VDD, TP_C1, TP_C2, VOUT, CSB, DOUT, SCLK, VREF</td>
<td>Test Point, TH, Miniature, Red</td>
<td>40 mil</td>
<td>Keystone Electronics</td>
<td>5000</td>
</tr>
<tr>
<td>1</td>
<td>C1</td>
<td>CAP, CERM, 0.1uF, 10V, +/-10%, X5R</td>
<td>402</td>
<td>Murata</td>
<td>GRM155R61A104KA01D</td>
</tr>
<tr>
<td>5</td>
<td>C5, C9, C11, C13, C16</td>
<td>CAP, CERM, 0.1uF, 16V, +/-5%, X7R</td>
<td>603</td>
<td>AVX</td>
<td>0603YC104JAT2A</td>
</tr>
<tr>
<td>1</td>
<td>C6</td>
<td>CAP, CERM, 56pF, 50V, +/-5%, COG/NP0</td>
<td>603</td>
<td>AVX</td>
<td>06035A660JAT2A</td>
</tr>
<tr>
<td>1</td>
<td>C7</td>
<td>CAP, TANT, 100uF, 10V, +/-10%, 0.1 ohm</td>
<td>6032-28</td>
<td>AVX</td>
<td>TPSC107K010R0100</td>
</tr>
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<td>1</td>
<td>C8</td>
<td>CAP, CERM, 470pF, 50V, +/-5%, COG/NP0</td>
<td>603</td>
<td>AVX</td>
<td>06035A471JAT2A</td>
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<td>3</td>
<td>C10, C12, C14</td>
<td>CAP, TANT, 10uF, 16V, +/-10%, 0.45 ohm</td>
<td>6032-28</td>
<td>Vishay-Sprague</td>
<td>593D106X9016C2TE3</td>
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<tr>
<td>4</td>
<td>GND, GND2, GND3, GND4</td>
<td>Test Point, TH, Miniature, Black</td>
<td>40 mil</td>
<td>Keystone Electronics</td>
<td>5001</td>
</tr>
<tr>
<td>3</td>
<td>GAS_SENSOR</td>
<td>Gas sensor Hood</td>
<td>100mil</td>
<td>Cambion</td>
<td>450-3326-01-03-00</td>
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<tr>
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<td>BUMPON HEMISPHERE .44X.20 BLACK</td>
<td>3M</td>
<td>SJ-5003 (BLACK)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>J_MENB</td>
<td>Header, TH, 100mil, 1x3, Gold plated, 230 mil above insulator</td>
<td>0.100 x 3</td>
<td>Samtec Inc.</td>
<td>TSW-103-07-G-S</td>
</tr>
<tr>
<td>2</td>
<td>R4, R8</td>
<td>RES, 20.0 ohm, 1%, 0.1W</td>
<td>603</td>
<td>Yageo America</td>
<td>RC0603FR-0720RL</td>
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<tr>
<td>2</td>
<td>R6, R7</td>
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<td>805</td>
<td>Vishay-Dale</td>
<td>CRCW08050000Z0EA</td>
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<tr>
<td>1</td>
<td>R10</td>
<td>RES, 27.4 ohm, 1%, 0.1W</td>
<td>603</td>
<td>Vishay-Dale</td>
<td>CRCW060327R4FKEA</td>
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<tr>
<td>1</td>
<td>SPIO-GPSI16</td>
<td>SPIO-GPSI16 Header, 8-Pin, Dual row, Right Angle</td>
<td>0.100 x 8 dual row</td>
<td>Sullins Connector Solutions</td>
<td>PBC36DGAN</td>
</tr>
<tr>
<td>1</td>
<td>U1</td>
<td>LMP91000</td>
<td>LLP-14</td>
<td>Texas Instruments</td>
<td>LMP91000SD</td>
</tr>
<tr>
<td>1</td>
<td>U2</td>
<td>IC ADC 16BIT 50-250KSPS</td>
<td>MSOP-10</td>
<td>Texas Instruments</td>
<td>ADC161S626CIMM/NOPB</td>
</tr>
<tr>
<td>1</td>
<td>U3</td>
<td>Precision Micropower Low Dropout Voltage Reference</td>
<td>SOT-23</td>
<td>Texas Instruments</td>
<td>LM4120AIM5-2.5</td>
</tr>
<tr>
<td>1</td>
<td>U4</td>
<td>IC EEPROM 2KBIT 400KHZ</td>
<td>TSSOP-8</td>
<td>ON Semiconductor</td>
<td>CAT24C01WI-GT3</td>
</tr>
</tbody>
</table>
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- 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.

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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.

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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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http://www.tij.co.jp
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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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