TPIC8101 Evaluation Module

This user's guide describes the characteristics, operation, and use of the TPIC8101 Evaluation Module (EVM). This EVM helps designers evaluate the operation and performance of the TPIC8101 dual-channel knock sensor interface IC. A complete circuit description, schematic diagram, and bill of materials are also included.

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1 Introduction

The Texas Instruments TPIC8101EVM evaluation module set helps designers evaluate the operation and performance of the TPIC8101 dual-channel knock sensor interface IC. The EVM set contains one TI communication board (TIger), one IC EVM board and TPIC8101 IC (see Table 1).

Table 1. Device and Package Configurations

Converter	IC	Package
U1	TPIC8101DWG4	DW-20

2 Setup

This section describes the setup of EVM, including EVM hardware and GUI operation.

2.1 EVM Hardware Connections

The TI communication board should be connected to the IC EVM board via a 30-pin connector in the shipment box. Connect them if they are not connected yet, as shown in Figure 1.

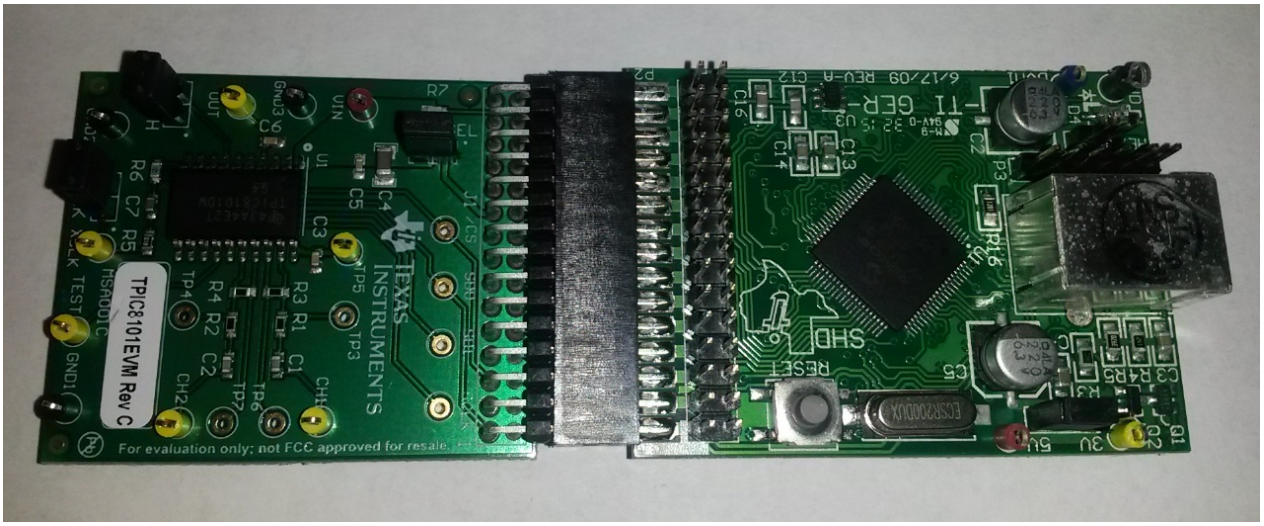

Figure 1. TIGER Communication Board (Left) and IC EVM Board (Right)

Table 2 and Table 3 show the various jumpers and test points on the TPIC8101 EVM. Note that not all of the test points are installed.

Table 2. TPIC8101 EVM Jumpers

Jumper Designator	Jumper Label	Description
JP1	VDD_SEL	**Installed** (default): When the USB is connected, the TI communication board supplies the 5-V VDD rail.
		Uninstalled: The 5-V rail must be supplied externally to the VIN test point.
JP2	CLK_SEL	**Installed** (default): When USB is connected, the TI communication board supplies a clock signal to the TPIC8101. The GUI can adjust the frequency.
		Uninstalled: The clock must be supplied externally to the XCLK test point.
JP3	INT/H	**Installed** (default): When the USB is connected, the TI communication board supplies the INT/H square wave signal at the period specified in the GUI.
		Uninstalled: The INT/H signal must be supplied externally to the INT/H jumper pin 2.

Table 3. TPIC8101 EVM Test Points

Jumper Designator	Jumper Label	Description
TP1	CH1	Channel 1 knock sensor input
TP2	CH2	Channel 2 knock sensor input
TP3	CH1N	Connects to CH1N pin of TPIC8101
TP4	CH2N	Connects to CH2N pin of TPIC8101
TP5	VREF	Connects to VREF, CH1P, and CH2P pins of TPIC8101
TP6	CH1FB	Connects to CH1FB pin of TPIC8101
TP7	CH2FB	Connects to CH2FB pin of TPIC8101
TP8	TEST	Connects to /TEST pin of TPIC8101
TP9	SCLK	SPI clock line
TP10	SDI	SPI slave data in line
TP11	SDO	SPI slave data out line
TP12	/CS	SPI chip select line
TP13	OUT	Analog output of the TPIC8101
TP14	XCLK	Clock input
TP15	VIN	Connects to VDD pin of TPIC8101. Can be used to externally supply 5V if TI communication board is not used.
GND1	GND1	Ground test point
GND2	GND2	Ground test point
GND3	GND3	Ground test point

2.2 TPIC8101 Quick-Start Guide

Use the following quick-start steps for the EVM:

1. Insert one end of a USB cable into the TIger communication board, the other end to the USB port in a PC.
2. Connect a 5-V voltage supply
   - 5 V is supplied by the TI communication board if the *VDD_SEL* jumper is connected (default setting).
   - 5 V is also supplied by connecting test point VDD with an external power supply and disconnecting the *VDD_SEL* jumper.
3. Connect the high-frequency oscillation input (for example, 8 MHz)
   - The high frequency oscillation signal is supplied by the TI communication board if the *CLK_SEL* jumper is connected (default setting).
   - The high frequency oscillation signal is also supplied by connecting test point XCLK with an external function generator, and disconnecting the *CLK_SEL* jumper.
4. Supply the integration window signal (for example, 5 ms)
   - The integration window signal is supplied by TI communication board if the *INT/H* jumper is connected (default setting).
   - The integration window signal is also supplied by removing the *INT/H* jumper and supplying the signal externally with a function generator to pin 2 of the *INT/H* terminal.
5. Connect the knock sensor output signal (for example, 10 KHz)
   - Knock sensor output signal is connected at test point *CH1* or *CH2* (for channel 1 and 2 correspondingly), from a knock sensor, or an external function generator.

2.3 GUI Operation

2.3.1 Software Package

Download the TPIC8101 EVM GUI from the TPIC8101 EVM tool folder. After installing, run the executable file **TPIC8101EVM.exe** to start the GUI.

Figure 2 illustrates the GUI. By default, the IC will be working on default SPI mode after power up, which happens after the USB cable is plugged into the PC. If the USB cable is consistently plugged into PC, the IC stays in either default SPI mode or advanced SPI mode, depending on the last operation. If the IC is in the advanced SPI mode, restart the IC to return to default SPI mode.

2.3.2 Operation in Default SPI Mode

The SPI is in the default mode on the power up sequence. In this case, the SDO directly equals the SDI (echo function). In this mode, five commands can be transmitted by the master controller (TI communication board) to configure the IC. Find setting details on page 13 of the datasheet (SLIS110).

In each setting, select a value from the combo boxes, and press the *Send SPI* button. The exact same SPI response should be read, if the IC works correctly.

- Set the prescaler and SDO status
- Select the channel
- Set the bandpass center frequency
- Set the gain
- Set the integration time constant
- Enter advanced SPI mode. Once the advanced mode is entered, there is no way to return to normal mode, unless the device is restarted.

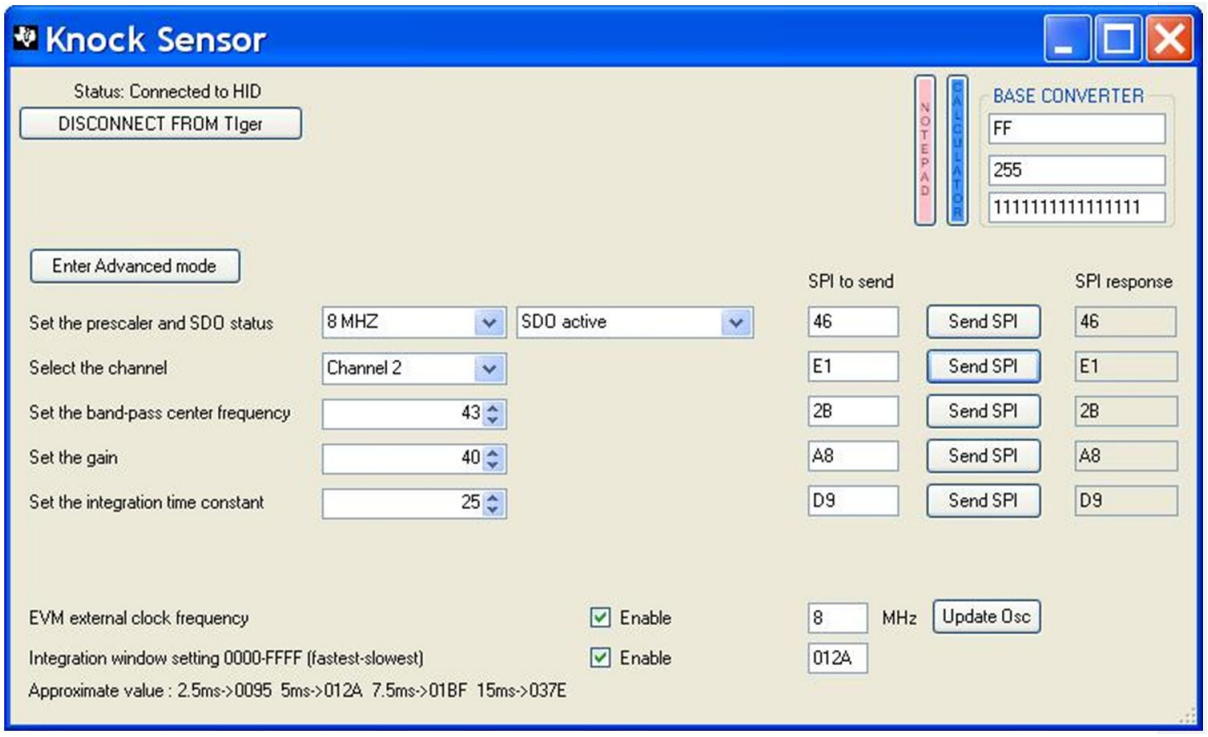

Figure 2. GUI : Default SPI Mode

2.3.3 Operation in Advanced SPI Mode

The advanced SPI mode has additional features to the default SPI mode. A control byte is written to the SDI and shifted with the MSB first. The response byte on the SDO is shifted out with MSB first. The response byte corresponds to the previous command. Therefore, the SDI shifts in a control byte n and shifts out a response command byte n − 1. Each control/response pair of commands requires two full 8-bit shift cycles to complete a transmission. The control bytes with the expected response are shown in page 14 of datasheet (SLIS110). In the advanced SPI mode, only a power-down condition resets the SPI mode to the default state on the subsequent power-up cycle.

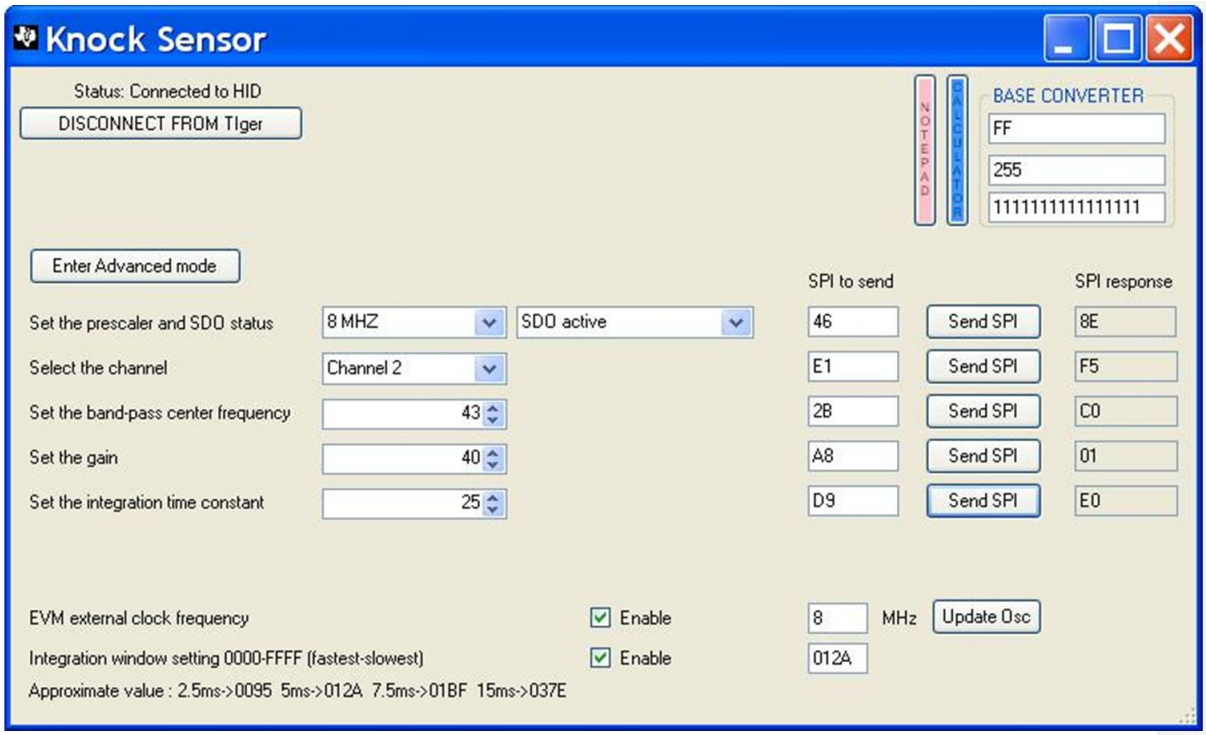

Figure 3. GUI : Advanced SPI Mode

2.3.4 Clock and Integration Window Settings

The TI communication board can generate 2 square wave forms, a high frequency one which could be used as an external clock frequency signal, such as 8 MHz; and a low frequency one which could be used as a integration window, such as 5 ms.

To use the external clock, check the *Enable* box and enter a desired frequency in the edit box. Press the *Update Osc* button once the settings have been updated.

To use the integration window, check the *Enable* box and enter a 4-digit hex number in the edit box. Hex 0000 is the fastest square waveform the TI communication board can produce, and hex FFFF corresponds to the slowest waveform. The waveform is generated by the GPIO of the micro controller, therefore the frequency is approximate. For example, hex 01C6 generates a 100-Hz square waveform, which could be used to serve as a 5 ms integration window. An approximate formula that can be used to calculate the hex value needed for a given time window is as follows:

$$HEX = \frac{t - 25\ \mu s}{22\ \mu s} \quad (1)$$

Sample waveforms of knock sensor output, integration window and IC analog output are shown in Figure 4.

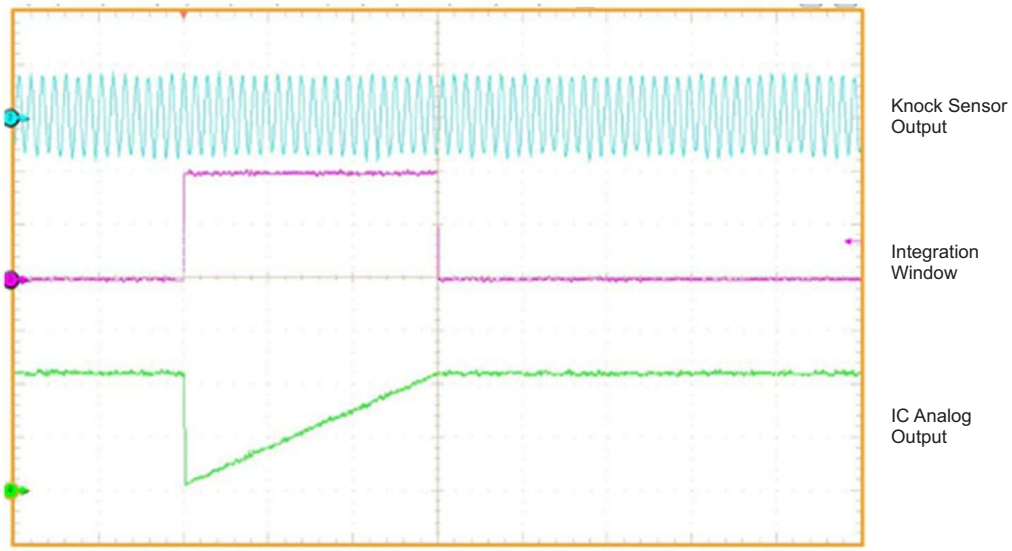

Figure 4. Sample Waveforms

3 Ranges and Typical Setup for Evaluation

Table 4 shows the acceptable ranges of values that can be entered for each variable in the GUI.

Table 4. Ranged for GUI Variables

Variable	Decimal Range	SPI Command Range	Number of Options
Set the prescaler and SDO status:	Drop-down menu	0x40–0x51	18
Select the channel:	Drop-down menu	0xE0–0xE1	2
Set the band-pass center frequency:	0 through 63	0x00–0x3F	64
Set the gain:	0 through 63	0x80–0xBF	64
Set the integration time constant:	0 through 31	0xC0–0xDF	32
EVM external clock frequency	4, 5, 6, 8, 10, 12, 16, 20, 24	Not Applicable	9
Integration window setting	Not Applicable	0x0000–0xFFFF	65536

Typical test set-up:

- External signal to CH1 or CH2: 300 mV peak to peak, 7.2-kHz signal to Channel 1
- EVM external clock frequency: 6 MHz
- Bandpass center frequency: 7.27 KHz (42nd gain setting (0x22), SPI 0x2A)
- Gain: .381 (34th gain setting (0x22), SPI 0xA2)
- Integration time constant: 106 µs (10th code, SPI 0xCA)
- Integration window setting: 0x0110

Refer to Figure 5 to see how to input these settings into the GUI.

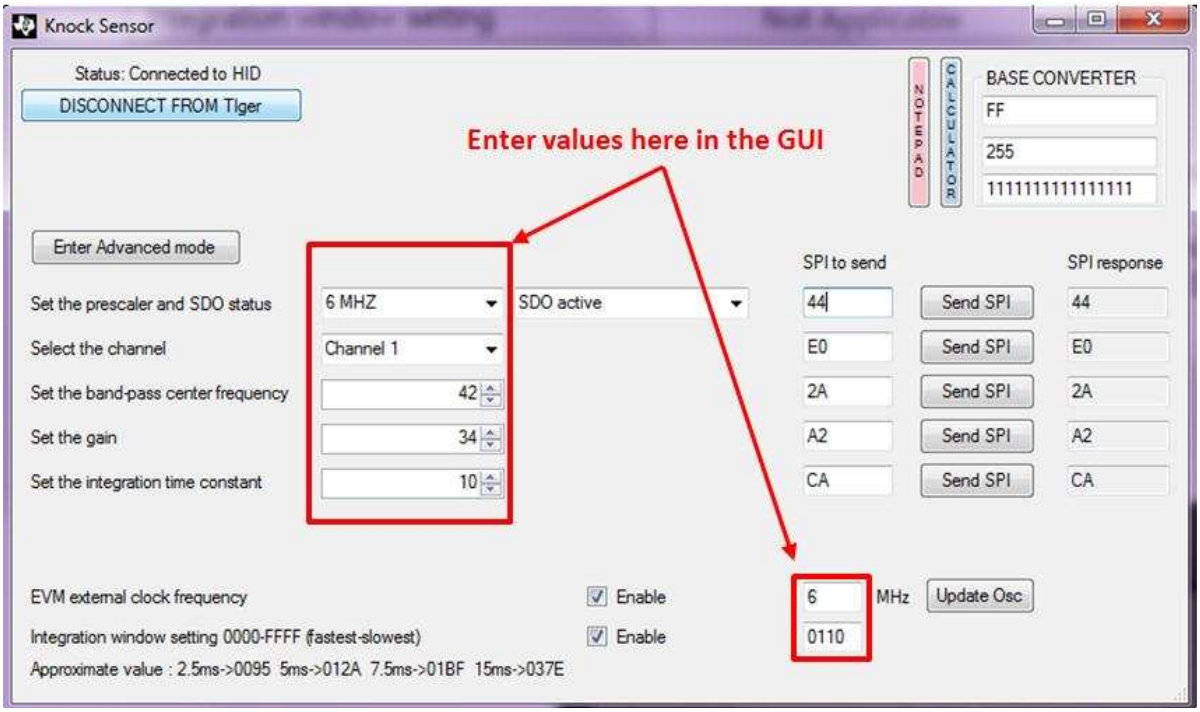

Figure 5. GUI Inputs

This set-up results in the following:

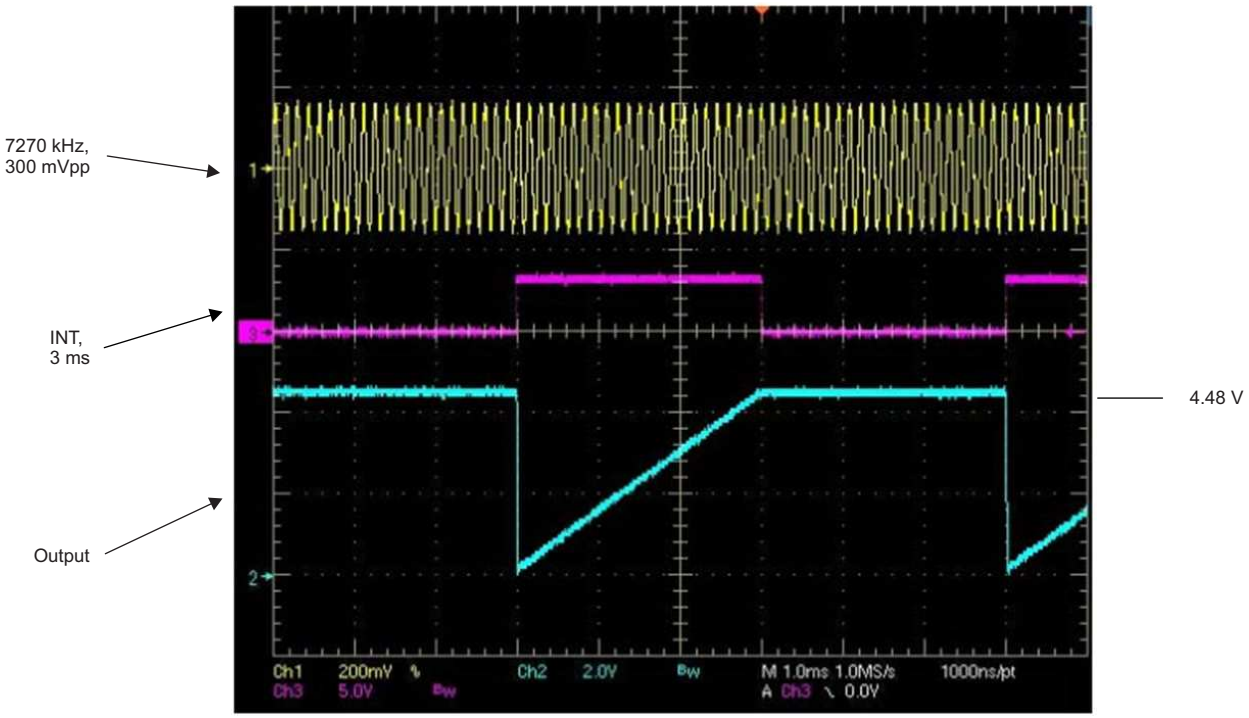

Figure 6. Typical EVM Waveforms

4 Board Layout

Figure 7 and Figure 8 show the board layout for the TPIC8101EVM PCB. The board layout and the PCB for TIGER communication board are not provided.

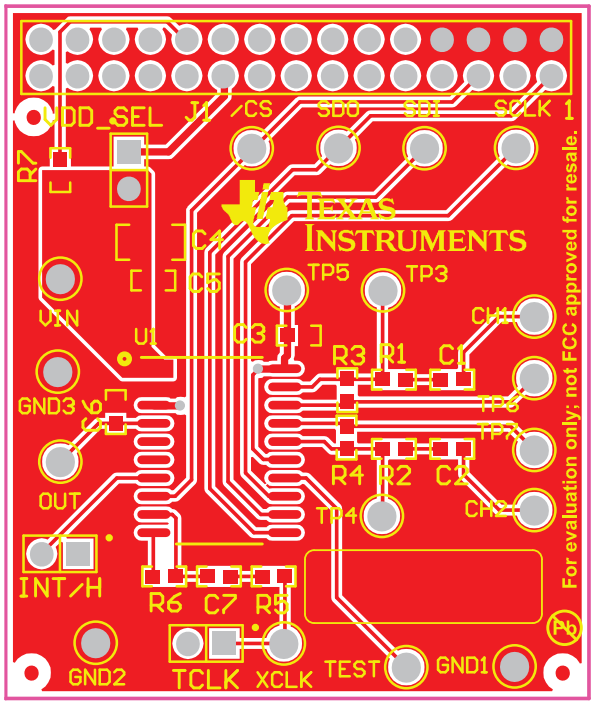

Figure 7. Top Assembly Layer

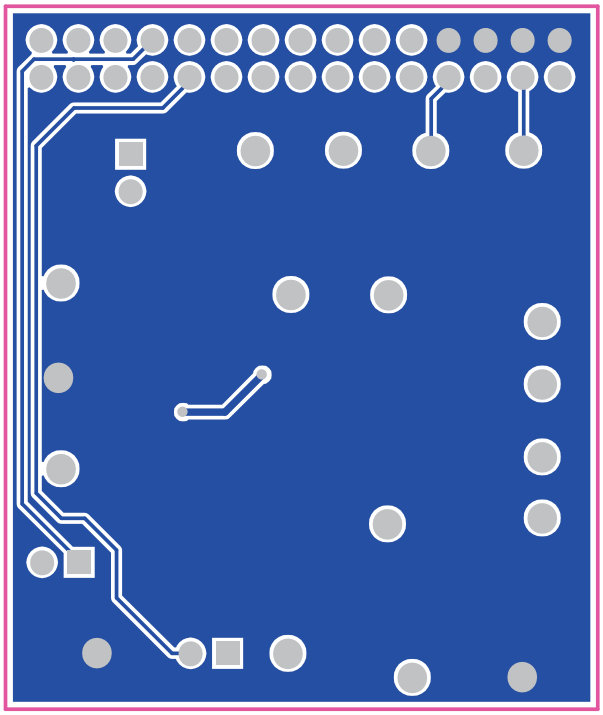

Figure 8. Bottom Layer Routing

5 Schematic

Figure 9 illustrates the TPIC8101EVM schematic.

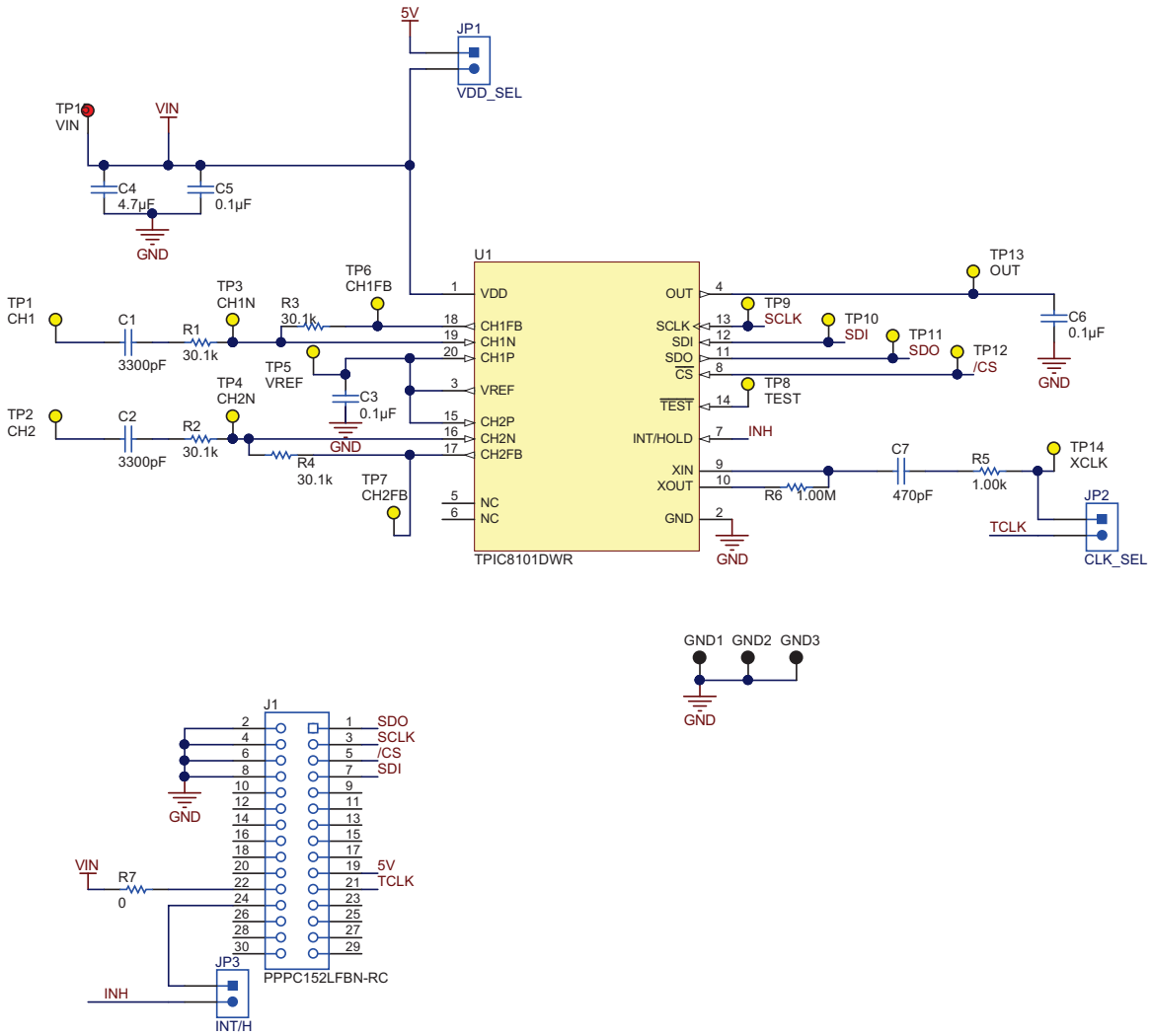

Figure 9. EVM Schematic

6 TPIC8101EVM Bill of Materials

Table 5 lists the TPIC8101EVM bill of materials.

Table 5. TPIC8101EVM Bill of Materials

Designator	Description	Manufacturer	Part Number	Qty
PCB	Printed Circuit Board	Any	MSA001	1
PCB2	Printed Circuit Board Assembly	Any	TI-GER PCB	1
C1, C2	CAP, CERM, 3300 pF, 50 V, +/- 5%, C0G/NP0, 0603	TDK	C1608C0G1H332J	2
C3, C5, C6	CAP, CERM, 0.1 µF, 25 V, +/- 5%, X7R, 0603	AVX	06033C104JAT2A	3
C4	CAP, CERM, 4.7 µF, 25 V, +/- 10%, X5R, 1206	AVX	12063D475KAT2A	1
C7	CAP, CERM, 470 pF, 50 V, +/- 5%, C0G/NP0, 0603	AVX	06035A471JAT2A	1
FID1, FID2, FID3	Fiducial mark. There is nothing to buy or mount.	N/A	N/A	3
GND1, GND2, GND3	Test Point, Miniature, Black, TH	Keystone	5001	3
J1	R/A Header, 100mil, 15x2, Gold, TH	Sullins Connector Solutions	PBC15DBAN	1
JP1, JP2, JP3	Header, 100mil, 2x1, Gold, TH	Samtec	TSW-102-07-G-S	3
LBL1	Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	Brady	THT-14-423-10	1
R1, R2, R3, R4	RES, 30.1 k, 0.1%, 0.1 W, 0603	Susumu Co Ltd	RG1608P-3012-B-T5	4
R5	RES, 1.00 k, 1%, 0.1 W, 0603	Panasonic	ERJ-3EKF1001V	1
R6	RES, 1.00 M, 1%, 0.1 W, 0603	Vishay-Dale	CRCW06031M00FKEA	1
R7	RES, 0, 5%, 0.1 W, 0603	Panasonic	ERJ-3GEY0R00V	1
TP1, TP2, TP5, TP8, TP13, TP14	Test Point, Miniature, Yellow, TH	Keystone	5004	6
TP15	Test Point, Miniature, Red, TH	Keystone	5000	1
U1	Knock Sensor Interface, DW0020A	Texas Instruments	TPIC8101DWR	1

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      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.

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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*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-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.

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.

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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

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If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required by Radio Law of Japan to follow the instructions below with respect to EVMs:

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.

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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.

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