TPL5000EVM User's Guide

1 Introduction

The Texas Instruments TPL5000EVM evaluation module (EVM) allows a designer to configure the delay timers of the TPL5000 and measure its very low current consumption. Moreover, the TPL5000EVM is ready to be connected to the Launchpads of MSP430, Stellaris and C2000, in order to test its watchdog, timer cycling, and power cycling features.
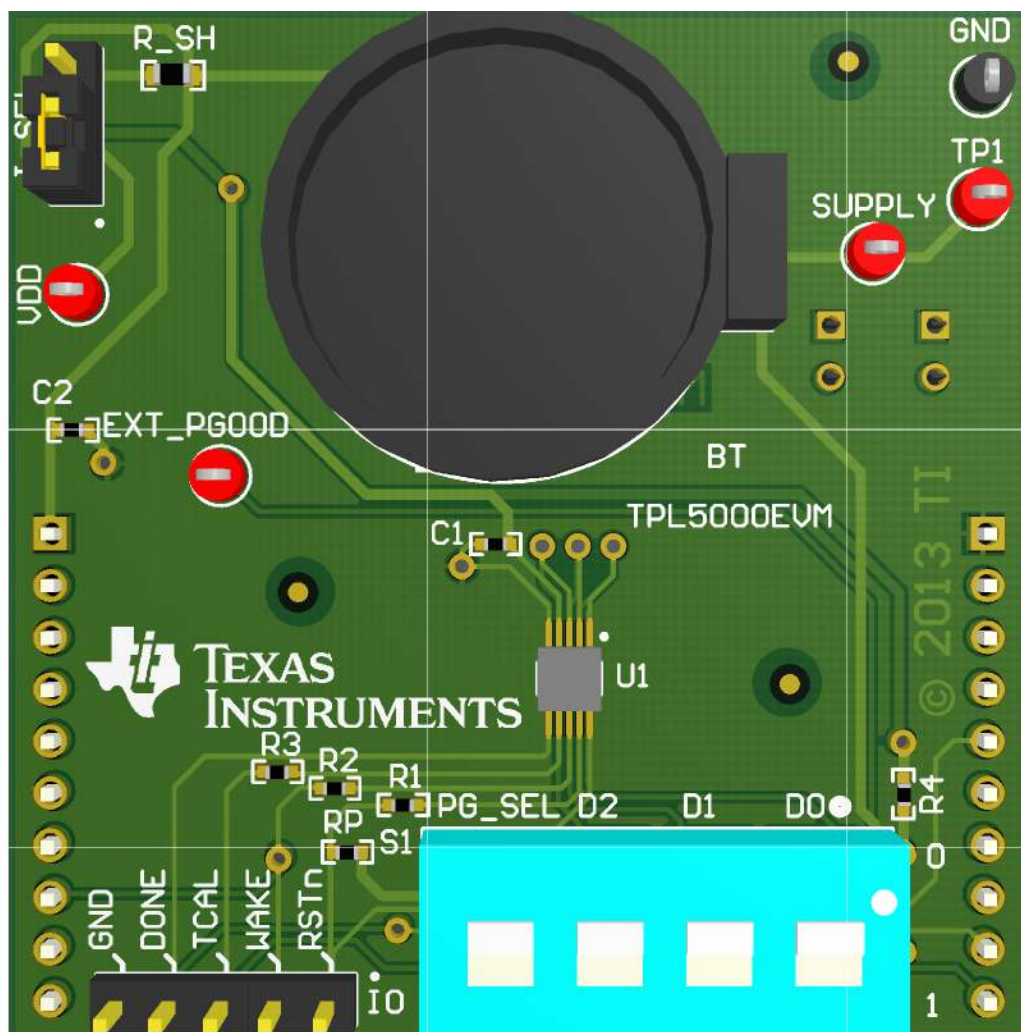

Figure 1. The LMP91010 Evaluation Board

2 Setup

This section describes how to properly connect, set up and use the TPL5000EVM.

2.1   INPUT/OUTPUT CONNECTORS AND JUMPER DESCRIPTION

I_SEL   selects the current consumption measurement method: Open, current consumption measured with DMM connected between TP1 and VDD test points. 3-2 shorted, current consumption = Voltage drop on R_SH divided by R_SH 1-2 R_SH bypass

IO   5-pin header connector to bring out RSTn, WAKE, TCAL, DONE and GND signals.

S1   4 SPDT positions to set the D0, D1, D2 logic values and the source of the PGOOD signal (refer to Table 1)

Table 1. S1 Description

Description	Slider position	Value
PG_SEL	Top	0
	Bottom	1 or External PGOOD
D2	Top	0
	Bottom	1
D1	Top	0
	Bottom	1
D0	Top	0
	Bottom	1

In case the PGOOD is provided by an external power supply, set PG_SEL=1, Remove the REPG resistor and connect a power supply to the EXT_PGOOD test point.

VCC   2- pin female connector to plug the TPL5000EVM into MSP430 launchpad.

RST   2- pin female connector to plug the TPL5000EVM into MSP430 launchpad.

J1_10   10-pin female connector to plug the TPL5000EVM into MSP430 launchpad.

J11_20   10-pin female connector to plug the TPL5000EVM into MSP430 launchpad.

SUPPLY   test point to connect external supply voltage in alternative to the coin cell battery.

VDD   test point to monitor VDD pin of TPL5000.

TP1   test point to monitor the external supply voltage or coin cell battery voltage.

EXT_PGOOD   test point to connect external voltage supply for PGOOD signal.

GND   test point of the ground, connect here the GND of the power supplies.

BT   coin cell 2032 battery holder.

2.2   EVALUATION BOARD CONFIGURATION

The evaluation board can work standalone or plugged into the MSP430 launchpad; the following steps apply to both usages:

• Set the desired delay, configuring S1 (from position 2 to 4).

• Set the POWER GOOD source, configuring S1 (position 1). If you set the external source, connect the voltage source between the EXT_PGOOD and GND test points; do not turn on this voltage source. Refer to the data sheet regarding the allowable voltage range. This can be found on the MSP430 LaunchPad Wiki (MSP430 LaunchPad (MSP-EXP430G2) Wiki)

• Configure I_SEL as explained in Section 2.1.

• Plug the evaluation board in to the launchpad according to Table 2.

2.2.1   EVM Plugged into MSP430 Launchpad

• Load the code present in Section 5 of this User's Guide, into the MSP430 of the launchpad. Refer to the MSP430 launchpad documentation (MSP430 LaunchPad (MSP-EXP430G2) Wiki) for more details.

• Remove the jumpers VCC and RST of J3 header of the launchpad.

- Set the desired delay, configuring S1 (from position 2 to 4).
- Set the POWER GOOD source configuring S1 (position 1), if you set external source connect the voltage source between the EXT_PGOOD and GND test points; do not turn on this voltage source. Refer to the data sheet regarding the allowable voltage range. This can be found on the MSP430 LaunchPad Wiki (MSP430 LaunchPad (MSP-EXP430G2) Wiki).
- Configure I_SEL as explained in Section 2.1.
- Plug the evaluation board into the launchpad according to Table 2.

Table 2. TPL5000EVM to Launchpad Connection

TPL5000EVM	MSP430 Launchpad
J1_10	J1
J11_20	J2
VCC	VCC of J3
RST	RST of J3

- Insert a 2032 coin cell battery in the battery holder (BT), or alternatively connect a voltage source between the SUPPLY and GND test points. **DO NOT CONNECT THE COIN CELL BATTERY AND THE VOLTAGE SOURCE TO SUPPLY THE EVALUATION BOARD AT SAME TIME**.
- Power on the voltage sources connected to the EVM.

2.2.1.1   *SOFTWARE OF THE MSP430*

Once loaded into the MSP430 of the launchpad, the code in Section 5 of this User's Guide performs the following features:

- At power on, the red LED present on the Launchpad is turned ON.
- As soon as the MSP430 receives a RESET signal from the TPL5000, the red LED blinks.
- As soon as the MSP430 receives a WAKE signal from the TPL5000, the green LED blinks.
- The S2 button of the Launchpad acts as a toggle button; the first push of the button does not allow the MSP430 to send the DONE signal to the TPL5000, a second push of the button allows the MSP430 to send the DONE signal.

2.2.2   EVM Standalone

- Connect your micro controller to the IO header, in order to manage the I/O signal of the DUT.
- Insert a 2032 coin cell battery in the battery holder (BT), or alternatively connect a voltage source between the **SUPPLY and GND test points. DO NOT CONNECT THE COIN CELL BATTERY AND THE VOLTAGE SOURCE TO SUPPLY THE EVALUATION BOARD AT SAME TIME**.
- Power on the voltage sources connected to the EVM.
- DO NOT LEAVE DONE PIN (4th pin of IO header) FLOATING. If supervisor feature is not needed, connect DONE pin to GND.

3   Supply Current Measurement

The TPL5000EVM offers 2 ways to measure the current consumption of the DUT. First, disconnect the TPL5000 from the launchpad or your micro controller, in order to not load the digital output pins of the DUT.

3.1   *DIRECT MEASUREMENT*

- Leave the I_SEL 3-pin header open.
- DO NOT LEAVE DIGITAL INPUT PINS FLOATING; for instance:
    - Short the DONE pin (4th pin of IO header) to GND
    - Set PGOOD =1 (see Table 1)
- Connect a Digital Multi Meter, configured as the current meter (able to measure nA), between TP1 and

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VDD test points.
- Read the current consumption on the DMM.

3.2 INDIRECT MEASUREMENT

- Short pin 2 and 3 of I_SEL.
- DO NOT LEAVE DIGITAL INPUT PINS FLOATING; for instance:
  – Short the DONE pin (4th pin of IO header) to GND
  – Set PGOOD =1 (see Table 1)
- Connect a Digital Multi Meter, configured as a voltage meter, between TP1 and VDD test points.
- Read the voltage drop on the R_SH on the DMM.
- The current consumption is simply the voltage drop on R_SH, divided by 1Mohm.

4   Bill of Materials (BOM)

Table 3. Bill of Material TPL5000EVM

DESIGNATOR	DESCRIPTION	PART NUMBER	MANUFACTURER	QUANTITY
BT	HOLDER COINCELL 2032 RETAINRCLIP	BS-7	Memory Protection Devices	1
C1, C2	CAP CER 0.1UF 6.3V 10% X5R 0402	C1005X5R0J104K050BA	TDK	2
EXT_PGOOD, SUPPLY, TP1, VDD	TEST POINT PC MINI .040	5000	Keystone	4
GND	TEST POINT PC MINI .040	5001	Keystone	1
IO	CONN HEADER 5POS .100	TSW-105-07-G-S	Samtec, Inc.	1
I_SEL	CONN HEADER 3POS .100	TSW-103-07-G-S	Samtec, Inc.	1
J1_10, J11_20	Connector, Receptacle, 100mil, 10x1, Gold plated, TH	SSW-110-01-G-S	Samtec, Inc.	2
R1, R2, R3	RES 1.0K OHM 1/16W 5% 0402 SMD	CRCW04021K00JNED	Vishay-Dale	3
R4	RES 49.9K OHM 1/16W 1% 0402 SMD	CRCW040249K9FKED	Vishay-Dale	1
REPG	RES 0.0 OHM 1/16W JUMP 0402 SMD	CRCW04020000Z0ED	Vishay-Dale	1
RP	RES 100K OHM 1/16W 5% 0402 SMD	CRCW0402100KJNED	Vishay-Dale	1
RST, VCC	CONN RECEPT 2POS .100 VERT DUAL	5-534206-1	TE Connectivity	2
R_SH	RES 1.00M OHM 1/10W 1% 0603 SMD	CRCW06031M00FKEA	Vishay-Dale	1
S1	SWITCH SPDT GOLD	206-124	CTS Electrocomponents	1
SH-J1	SHUNT JUMPER .1	969102-0000-DA	3M	1
U1	Nano Power Programmable Timer and Supervisor	TPL5000DGS	Texas Instruments	1

5   Source Code of MSP430 Present in the Launchpad

```
#include   <msp430g2553.h>

volatile unsigned int DONE=1;

void main(void)
{
  WDTCTL = WDTPW + WDTHOLD + WDTNMI + WDTNMIES;   // WDT off NMI hi/lo
```

```
    P1DIR |= BIT0;                                  // Set P1.0 to output direction RED LED
    P1DIR |= BIT6;                                  // Set P1.6 to output direction GREEN LED
    P1DIR &= ~BIT3;                                  // Set P1.3 S2 button to input
    P2DIR &= ~BIT0;                                  // Set P2.0 (WAKE) to input
    P2DIR |= BIT4;                                  // Set P2.4 (Done) to output direction

    P1OUT |= BIT0;                                  // RED LED ON
    __delay_cycles(25000);                          // delay 25ms
    P1OUT &= ~BIT0;                                 // Clear P1.0 RED LED Off

    //BUTTON S2 configuration
    P1REN |= BIT3;                                  // Pull-up resistor enabled
    P1IE  |= BIT3;                                  // P1.3 interrupt enabled
    P1IES |= BIT3;                                  // P1.3 Hi/Lo edge
    P1IFG &= ~BIT3;                                 // P1.3 IFG cleared

    // WAKE signal
    P2IE  |= BIT0;                                  // P2.0 interrupt enabled
    P2IES &= ~BIT0;                                 // P2.0 Lo/Hi edge
    P2IFG &= ~BIT0;                                 // P2.0 IFG cleared

    // DONE signal
    P2OUT |= BIT4;                                  // Done High
    __delay_cycles(100);                            // delay 100u
    P2OUT &= ~BIT4;                                 // Done Low

    IE1 |= NMIIE;                                   // Enable NMI

    _BIS_SR(LPM4_bits + GIE);                       // Enter LPM4 with Interrupt enabled
}

#pragma vector=NMI_VECTOR
__interrupt void nmi_ (void)
{
  P1OUT |= BIT0;                          // P1.0 Red Led On
  __delay_cycles(200000);                // delay 200ms
  P1OUT &= ~BIT0;                        // P1.0 Red Led Off

  if (DONE==1)
    {
      P2OUT |= BIT4;                     // Done On
      __delay_cycles(100);               // delay 100us
      P2OUT &= ~BIT4;                    // Done Off
    }
  IFG1 &= ~NMIIFG;                       // Re-clear NMI flag in case bounce
  IE1 |= NMIIE;                          // Enable NMI
}

// Port 2 interrupt service routine
#pragma vector=PORT2_VECTOR
__interrupt void Port_2(void)
{
    P1OUT |= BIT6;                       // P1.6 Red Green On
    __delay_cycles(200000);              // delay 200ms
    P1OUT &= ~BIT6;                      // P1.6 Red Green Off

  if (DONE==1)
  {
      P2OUT |= BIT4;                     // Done On
      __delay_cycles(100);               // delay 100us
      P2OUT &= ~BIT4;                    // Done Off
  }
  P2IES &= ~BIT0;                        // P1.4 Lo/Hi edge
  P2IFG &= ~BIT0;                        // P1.4 IFG cleared
}
```
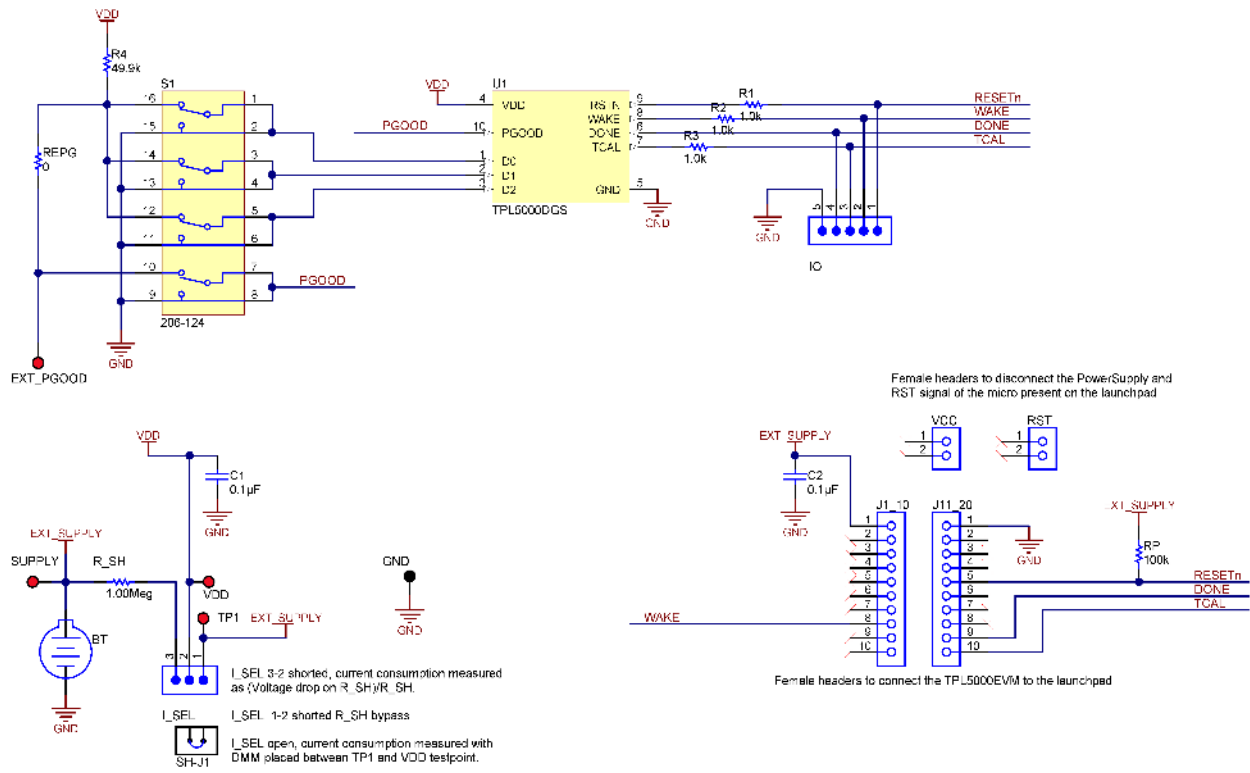
```
// Port 1 interrupt service routine
#pragma vector=PORT1_VECTOR
__interrupt void Port_1(void)
{
    if (DONE == 1)                              // enabled/disabled and viceverasa DONE signal
          {
                DONE = 0;
          }
  else
  {
          DONE = 1;
  }
  P1IFG &= ~BIT3;                               // P1.3 IFG cleared
  P1IES |= BIT3;                                // P1.3 Hi/Lo edge
}
```
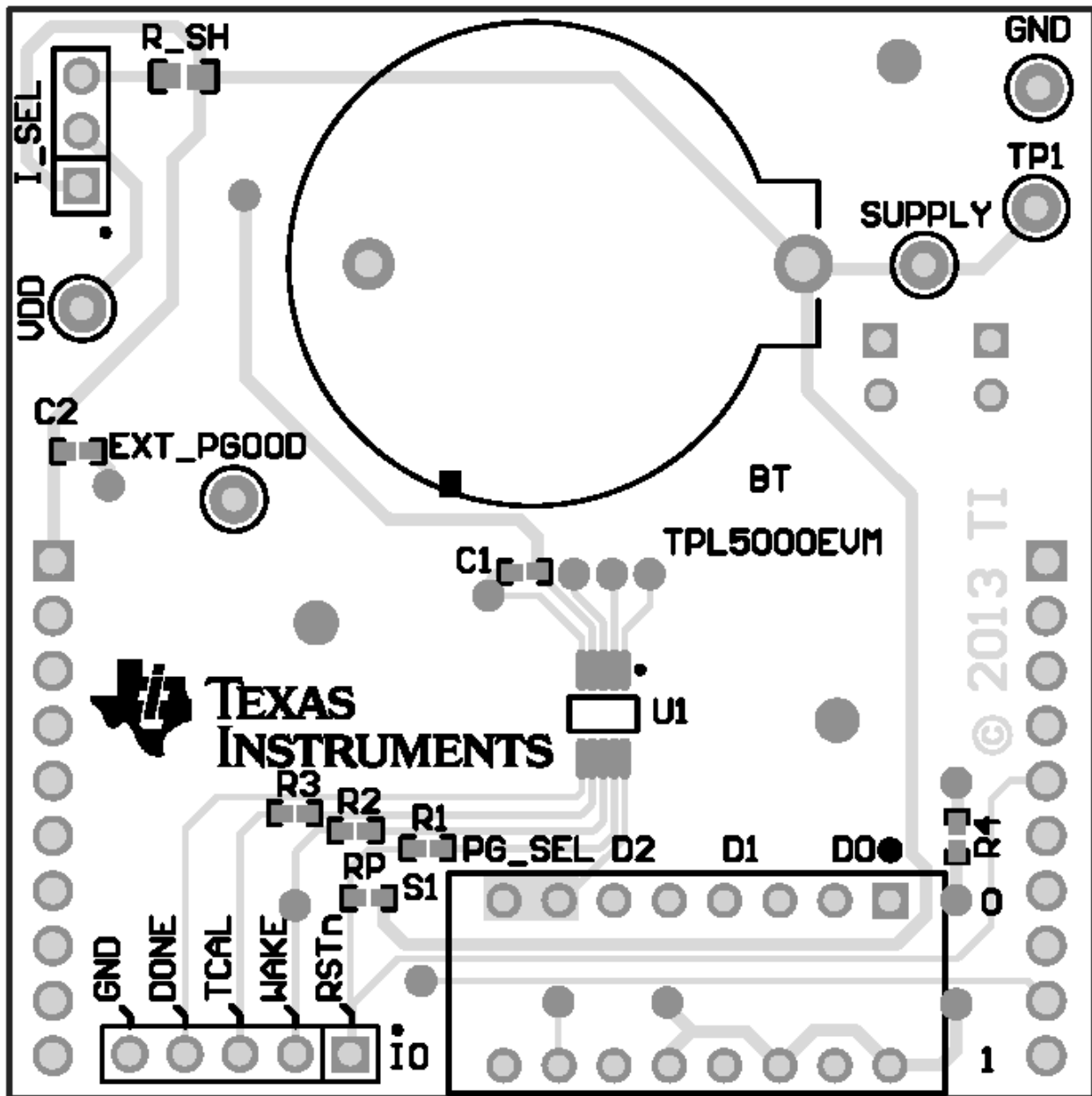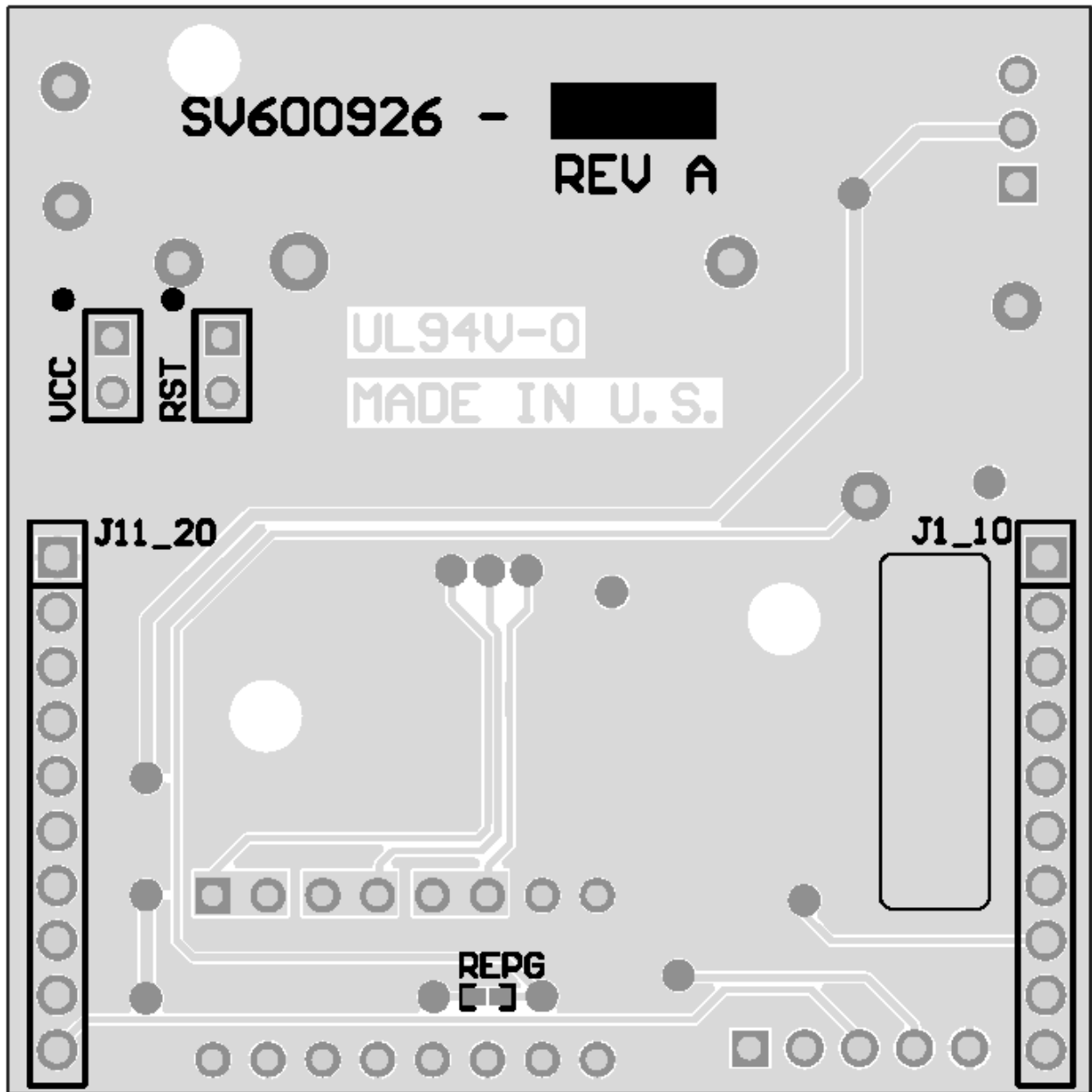
Appendix A Schematic

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Appendix B Layout

Figure 2. Layout
Top Layer
Silkscreen

Figure 3. Layout
Bottom Layer
Silkscreen

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.

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*

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.

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/lsds/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。 http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

 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.

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2. 実験局の免許を取得後ご使用いただく。
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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, INDEMITY 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.