

# User's Guide

## REF35 Evaluation Module

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### ABSTRACT

The REF35 Evaluation Module (EVM) is an ultra low-power precision voltage reference evaluation module that demonstrates the [REF35](#) integrated circuit from Texas Instruments.

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### Trademarks

All trademarks are the property of their respective owners.

## 1 Overview

The REF35EVM is a voltage reference evaluation module that demonstrates the REF35 integrated circuit from Texas Instruments (TI).

The REF35 is an ultra-low power voltage reference with maximum 10 ppm/C temperature drift. The REF35 is used primarily as a voltage reference for low power data converters.

The REF35 is operable from  $V_{REF} + V_{DO}$  to 6 V. The REF35 uses only 1.4  $\mu\text{A}$  of current in active mode. This device comes with an enable pin that allows the device to be set in shutdown mode. The REF35 consumes only 0.1  $\mu\text{A}$  of current under the shutdown condition. REF35 is available for a wide range of applications such as flow transmitters, blood glucose monitors, servo drive control modules, power quality analyzers, fault indicators, oscilloscopes and process analytics.

The REF35EVM features a user selectable-wide VIN input which uses a [TPS7B8150](#) linear regulator, allowing the user to widen the input range to 40 V if desired. The VIN header is connectable to an external power supply to provide power. All of the REF35 input and output pins are accessible for external connection via test headers.

### 1.1 REF35EVM Features

- Includes: REF35125QDBVR
- Footprints for resistors and capacitors
- Multiple outputs for voltage measurements

KEY PARAMETERS	PARAMETER	PARAMETER LIMITS
Supply Voltage (VREF):	IN_VREF	0 V – 6 V
Supply Voltage (VLDO)	IN_LDO	0 V to 40 V
Enable Pin	EN	0 V to IN_VREF
Fixed Output Voltage:	VREF	1.25 V (REF35125QDBVR)
Output Current:	IOUT	-5 mA to 10 mA

#### CAUTION

Applying voltages above the limitations given in this table can cause permanent damage to your hardware.

## 1.2 REF35EVM Schematic

The schematic for the REF35EVM is illustrated in Figure 1-1.

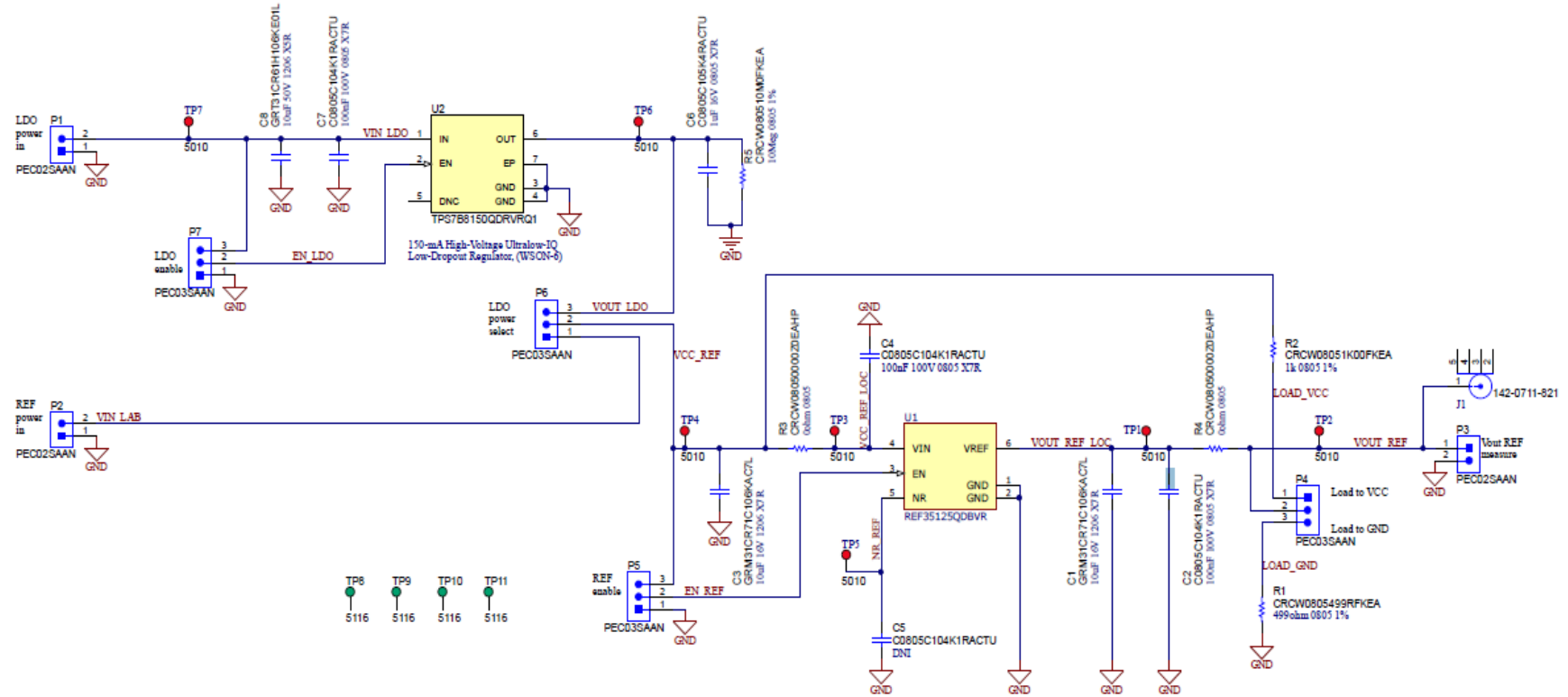


Figure 1-1. REF35EVM Schematic

### 1.3 REF35EVM Bill of Materials

**Table 1-1. REF35EVM BOM**

DESIGNATOR	QTY	VALUE	DESCRIPTION	PACKAGE	PART NUMBER	MANUFACTURER
!PCB	1		Printed Circuit Board		LP053	
C1, C3	2	10 uF	CAP, CERM, 10 uF, 16 V, ± 10%, X7R, 1206	1206	GRM31CR71C106KAC7L	Murata Electronics
C2, C4, C5, C7	4	0.1 uF	CAP, CERM, 0.1 uF, 100 V, ± 10%, X7R, 0805	0805	C0805C104K1RACTU	KEMET
C6	1	1 uF	CAP, CERM, 1 uF, 16 V, ± 10%, X7R, 0805	0805	C0805C105K4RACTU	KEMET
C8	1	10 uF	CAP, CERM, 10 uF, 50 V, ± 10%, X5R, AEC-Q200 Grade 1, 1206	1206	GRT31CR61H106KE01L	Murata Electronics
J1	1	50 Ω	SMA JACK 50 Ω EDGE MNT, SMT	SMT	142-0711-821	Cinch Connectivity Solutions Johnson
P1, P2, P3	3	100mil	Header, 100mil, 2x1, Tin, TH	TH	PEC02SAAN	Sullins Connector Solutions
P4, P5, P6, P7	4	100mil	Header, 100mil, 3x1, Tin, TH	TH	PEC03SAAN	Sullins Connector Solutions
R1	1	499 Ω	RES, 499, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	CRCW0805499RFKEA	Vishay Dale
R2	1	1k	RES, 1.00 k, 1%, 0.125W, AEC-Q200 Grade 0, 0805	0805	CRCW08051K00FKEA	Vishay Dale
R3, R4	2	0	RES, 0, 5%, 0.333 W, AEC-Q200 Grade 0, 0805	0805	CRCW08050000Z0EAHP	Vishay Dale
R5	1	10M	RES, 10.0 M, 1%, 0.125 W, 0805	0805	CRCW080510M0FKEA	Vishay Dale
TP1, TP2, TP3, TP4, TP5, TP6, TP7	7		Test Point, Multipurpose, Red, TH	Keystone _5010	5010	Keystone Technologies
TP8, TP9, TP10, TP11	4		Test Point, Miniature, Green, TH	Keystone _5116	5116	Keystone Technologies
U1	1		Ultra Low-Power, High-Precision Voltage Reference, SOT23-6	SOT23-6	REF35125QDBVR	Texas Instruments
U2	1		150-mA High-Voltage Ultralow-IQ Low-Dropout Regulator, DRV0006A (WSO-6)	WSO-6	TPS7B8150QDRVRQ1	Texas Instruments

## 1.4 REF35EVM Board

The PCB layout for the REF35EVM is illustrated in Figure 1-2 and Figure 1-3.

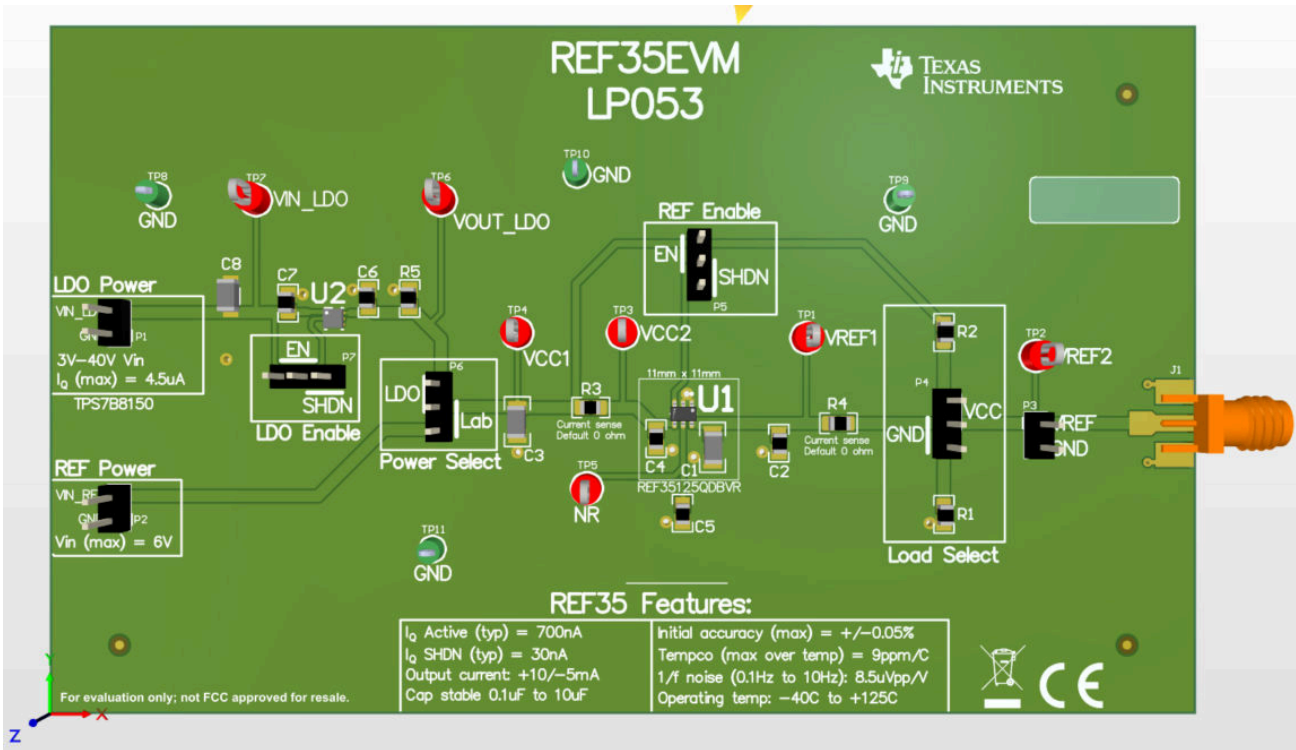


Figure 1-2. REF35EVM Board Top

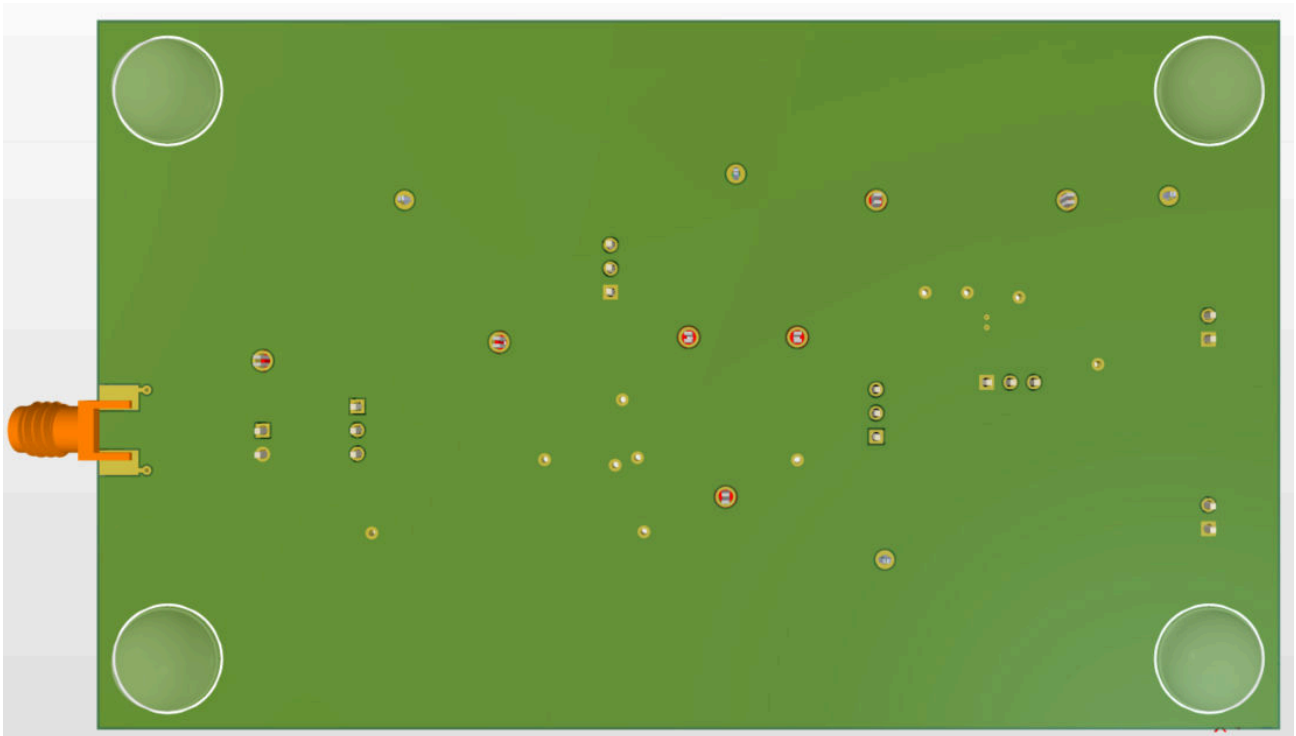


Figure 1-3. REF35EVM Board Bottom

## 2 Quick Setup Guide

This section describes the setup to quickly check the functionality of the REF35EVM.

### 2.1 Electrostatic Discharge Warning

Many of the components on the REF35EVM are susceptible to damage by electrostatic discharge (ESD). Customers are advised to observe proper ESD handling precautions when unpacking and handling the EVM, including the use of a grounded wrist strap at an approved ESD workstation.

#### CAUTION

Failure to observe ESD handling procedures may result in damage to EVM components.

### 2.2 Power Supply Setup and Functional Test

Normal operation:

If directly connecting the REF35 to the lab supply, a 5-V power supply capable of 50 mA of current is required (to handle load transients). Set the *Power Select* jumpers to *Lab*. The REF35 consumes 1.4  $\mu$ A of current during normal operating and has a maximum 10 mA of output current for maintaining regulated voltage. During start-up, the REF35 can momentarily consume  $I_{SC}$  to charge the output capacitors.

Connect the positive power supply lead to the VIN\_REF pin on the REF Power header pin on the left side of the board. Connect the negative power supply lead to the GND pin on the REF Power header pin.

If powering the REF35 through the on-EVM LDO, a 5-V (up to the LDO max voltage, 40 V) power supply capable of 50 mA of current is required. Set the *Power Select* jumpers to LDO.

Connect the positive power supply lead to the VIN\_REF pin on the REF Power header pin on the left side of the board. Connect the negative power supply lead to the GND pin on the REF Power header pin.

This EVM features selectable loads, where the loads are pulled to GND or VCC.

Connect a voltmeter to the VREF pin on the right side of the board. Connect the negative voltmeter terminal to GND. An SMA cable can also be used to measure the same output.

#### Note

Test points TP8, TP9, TP10, and TP11 are not soldered to the ground plane. The user can connect TP8, TP9, TP10, and TP11 to an external source ground if desired. Additionally, SMA connector J1 is not soldered to the ground plane.

The output voltage of the REF35125QDBVR is 1.25 V.

Shutdown mode: Move the jumper pin from EN to SHDN to place the part in shutdown mode. The REF35 is in active mode if the jumper pin is either in EN or not present.

### 3 Layout

Figure 3-1 and Figure 3-2 show the top and bottom layers and Figure 3-3 shows the top solder mask of the EVM.

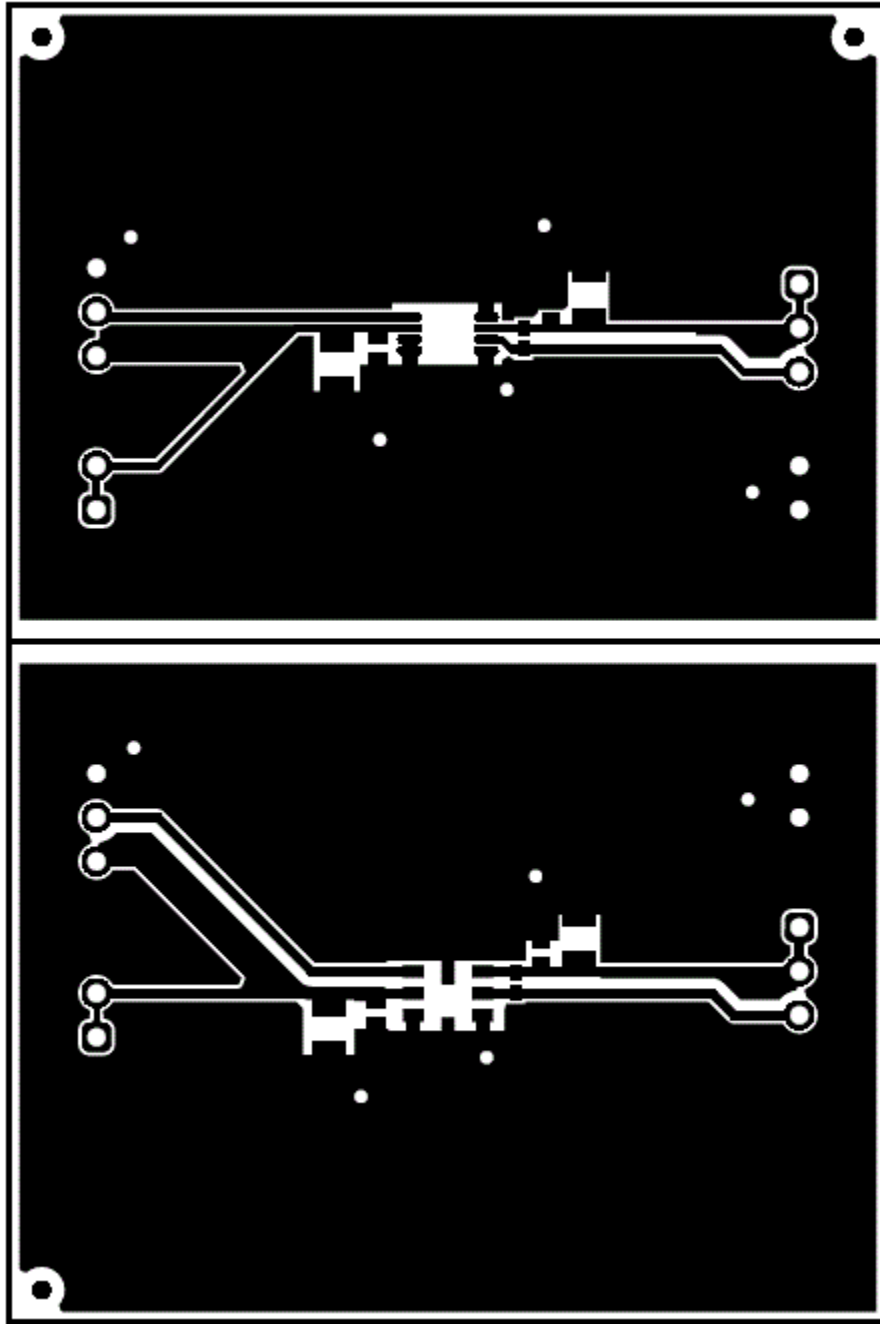


Figure 3-1. Top Layer

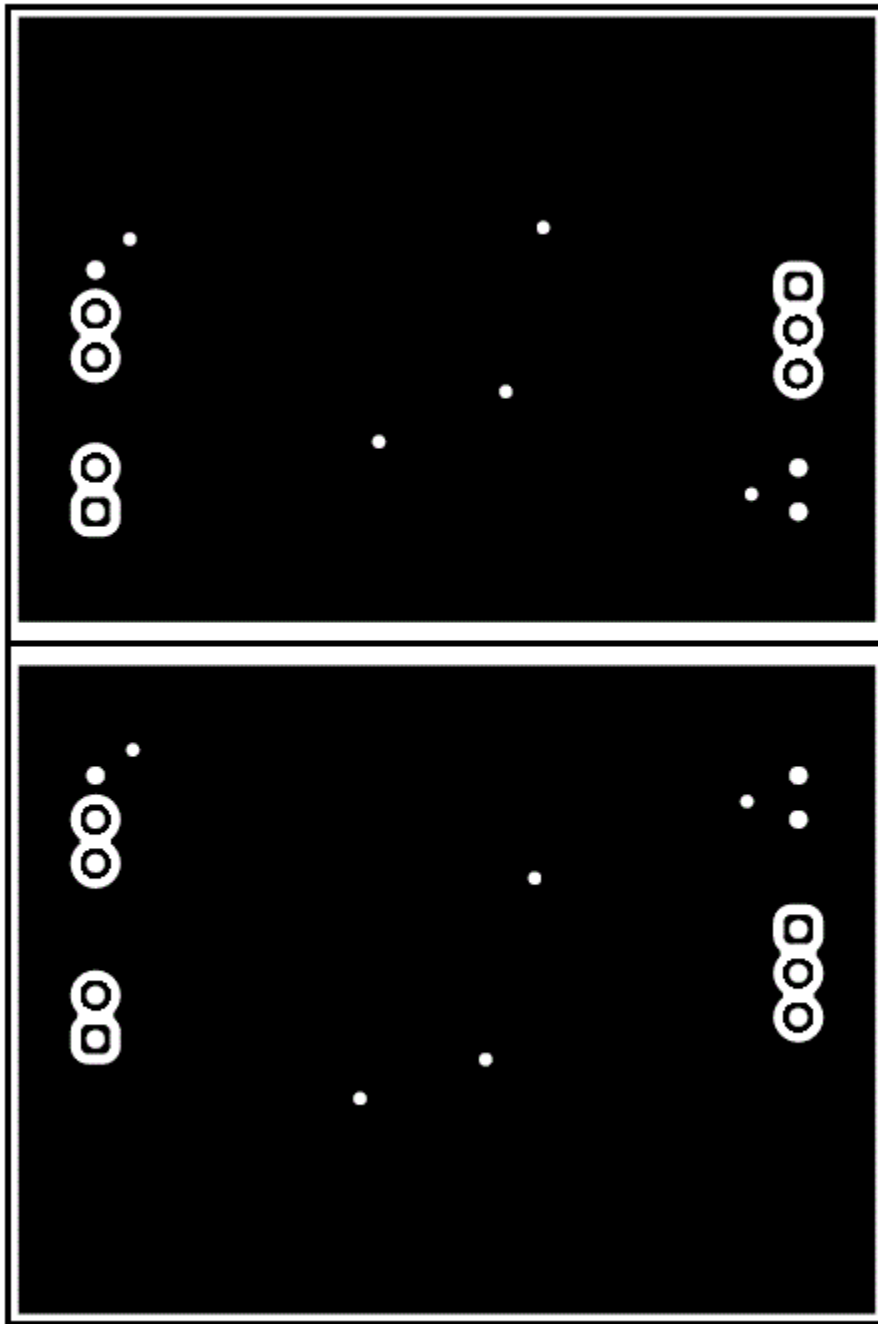


Figure 3-2. Bottom Layer



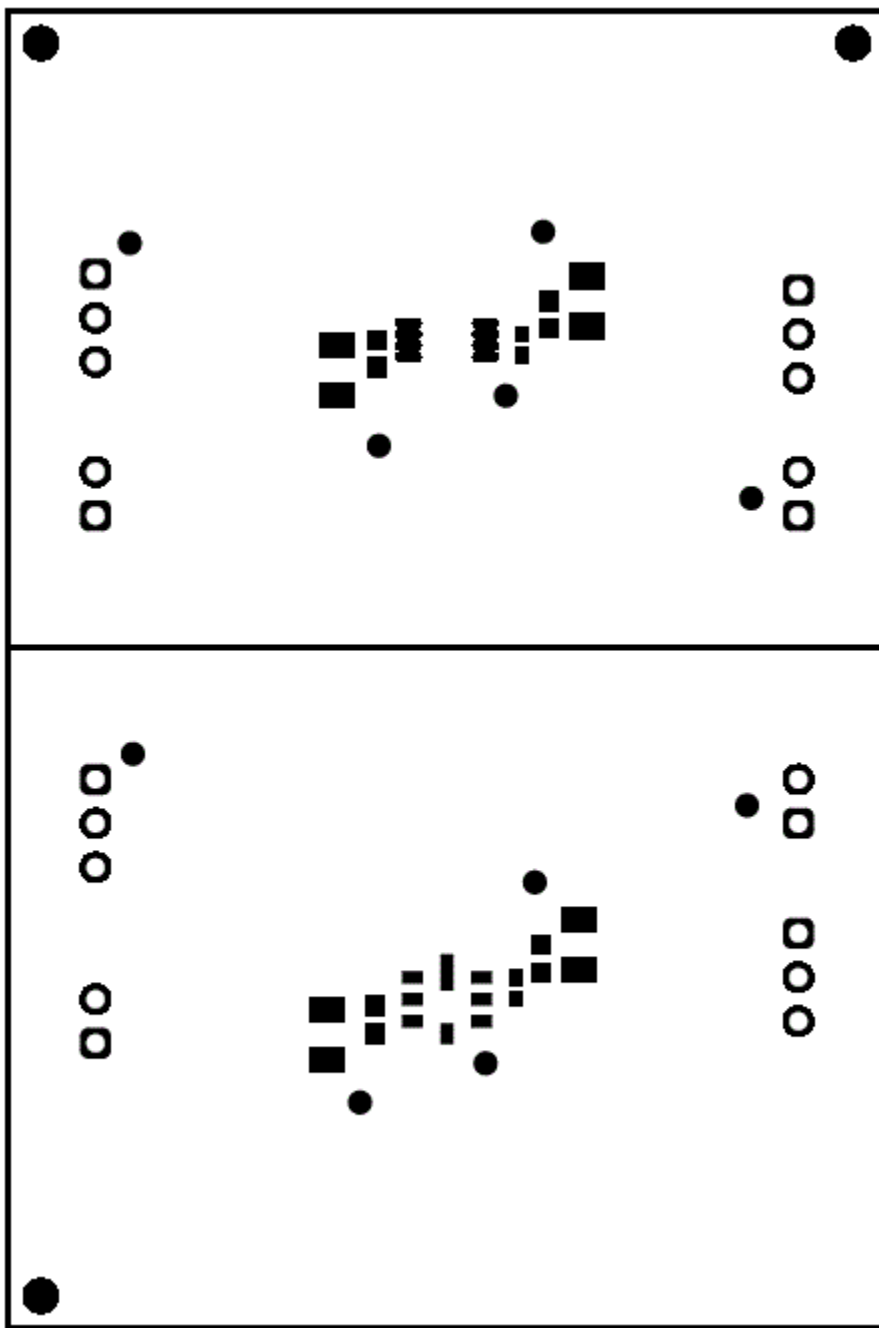


Figure 3-3. Top Solder Mask

## 4 Revision History

<b>Changes from Revision * (January 2022) to Revision A (November 2023)</b>	<b>Page</b>
• Updated the numbering format for tables, figures, and cross-references throughout the document.....	1
• Added a note and information about output voltage and shutdown mode.....	6

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## 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.
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2. *Limited Warranty and Related Remedies/Disclaimers:*
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  - 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.

### **WARNING**

**Evaluation Kits 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 shall operate the Evaluation Kit within TI's recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI's recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI's instructions for electrical ratings of interface circuits such as input, output and electrical loads.**

**NOTE:**

**EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGRADATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.**

### 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 or RSS-247

#### **Concerning EVMs Including Radio Transmitters:**

This device complies with Industry Canada license-exempt RSSs. 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/lstds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/lstds/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。

<https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html>

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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#### 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:*
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      - 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.
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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.

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