EVM User's Guide: TPS482H85EVM

TPS482H85-Q1 Evaluation Module

Description

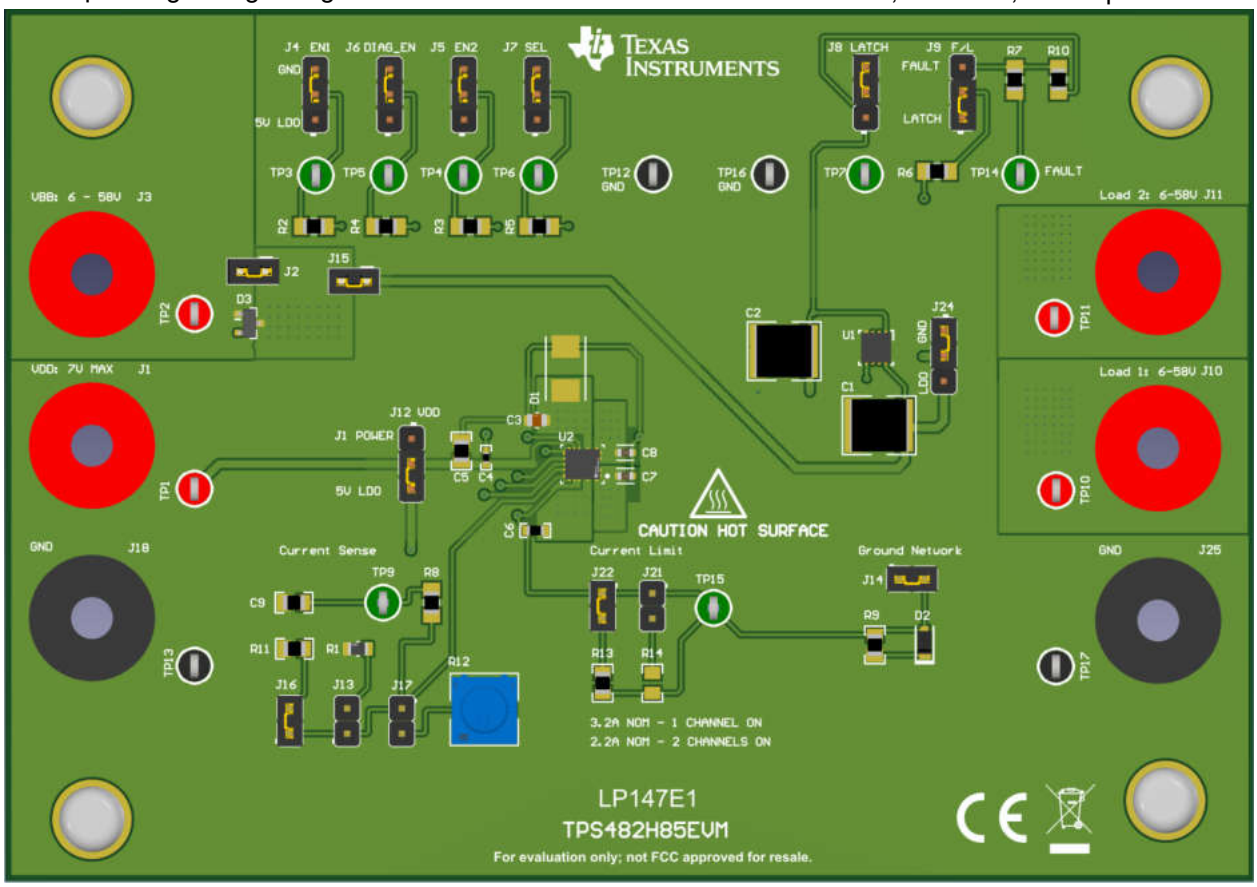
The TPS482H85EVM is a hardware evaluation module (EVM) used to enable hardware engineers to evaluate the full performance and functionality of the TPS482H85-Q1 automotive high side switch. This evaluation board provides a seamless way to connect a power supply to the inputs of the TPS482H85-Q1, connect a load to the output channels, and switch on and off the device using the control pins of the chip itself. The device integrates protection features such as thermal shut down, output clamp, and current limit.

Features

- Standalone operation with standard bench equipment
- Wide operating voltage range: 6V to 58V
- Potentiometer for SNS resistor, allowing for easy configuration of external resistance values
- Improve system level reliability through adjustable current limiting
- Accurate current sensing
- Integrated inductive discharge clamp >58V
- Functional safety capable
- Operating junction temperature, –40 to 125°C
- Input control, 1.8V, 3.3V, and 5V logic compatible
- Integrated fault sense voltage scaling for ADC protection
- Open-load detection in off-state
- Thermal shutdown/swing detection
- 12-pin QFN package

Applications

- General resistive, inductive, and capacitive loads



3D View - Top

1 Evaluation Module Overview

1.1 Introduction

The TPS482H85EVM contains everything needed to test and assess the TPS482H85-Q1 before designing into part of a greater application power system. The evaluation module is designed to either be used as a standalone board with an attached voltage supply and output load. A wide range of application features such as current sensing, programmable current limiting, and transient suppression are enabled and visible through use of this evaluation module. Place the module on a non-conductive surface before operation.

CAUTION

Hot surface. Contact can cause burns. Do not touch!

1.2 Kit Contents

Each evaluation module kit contains the following items:

- 1x TPS482H85EVM
- 1x EVM Disclaimer Read Me

1.3 Specification

The Texas Instruments' TPS482H85EVM is an evaluation module that is used to demonstrate and showcase all of the features of the underlying TPS482H85-Q1 automotive high side switch. An onboard 5V LDO is included on the EVM to simplify controlling signals to the TPS482H85-Q1 and easily assert and deassertion logic signals by the use of a set of external hardware jumpers.

Features of the TPS482H85EVM include:

- Current sense options with selectable resistors
- Depopulated pads for custom configuration for ILIM
- Onboard 5V LDO, allowing for control signals to be manipulated by set of jumpers
- Four-layer board layout and copper area for thermal performance
- Optional footprint for input TVS diode to extend transient protection of the device

1.4 Device Information

TPS482H85-Q1: This device is the device under evaluation by using this EVM. TPS482H85-Q1 is a dual channel smart high-side switch designed to meet the requirements of 24V automotive battery systems. The 85mΩ RON minimizes device power dissipation driving a wide range of output load currents and the 58V DC tolerance improves system robustness.

These features improve system robustness during fault events such as short circuit. TPS482H85-Q1 implements an adjustable current limiting circuit that improves the reliability of the system by reducing inrush current when driving large capacitive loads and minimizing overload current. To drive high inrush current loads such as lamps or fast charging capacitive loads, TPS482H85-Q1 implements an inrush current time period with a higher level of allowed current. The device also provides an accurate load current sense that allows for improved load diagnostics such as overload and open-load detection enabling better predictive maintenance.

TPS482H85-Q1 is available in a small 12-pin, 3.5mm × 3mm QFN package minimizing the PCB footprint.

This EVM board comes populated with the B version of the TPS482H85-Q1 device and so the J9 F/L jumper connection needs to be put on the LATCH option (configured by default). If you would like to evaluate version A of the chip, it will need to be ordered separately and replaced/soldered with U2 on the board.

TPS7A1650A: This LDO is used to provide an onboard 5V rail for easy use of the EVM out of the box.

2 Hardware

2.1 Connections and Test Points

Most connectors and test points are labeled with their functional names on the silk screen of the PCB and the actual component names are omitted to avoid clutter on the silk screen of the EVM. Likewise, jumpers are labeled to be self explanatory. The following tables contain a description of each test point and purpose.

Note, that by default the TPS482H85EVM comes configured for standalone operation.

Table 2-1. Connections and Test Points

Connector or Test Point	Description
J3/TP2	VBB input (supply).
J1/TP1	VDD input (supply).
J10/TP10 J11/TP11	VOUT1/2 output.
J18, J25, TP12, TP13, TP16, TP17	Ground connection (system ground).
TP5	Test point for diagnostics on the TPS482H85-Q1.
TP3/TP4	Test points for the EN1/2 pins for the TPS482H85-Q1.
TP6	Test point for the SEL pin for the TPS482H85-Q1.
TP7	Test point for latch functionality for the TPS482H85-Q1.
TP14	Open-drain fault test point for the TPS482H85-Q1.
TP15	Current limit test point for the TPS482H85-Q1.
TP9	Current sense test point for the current sense output of the TPS482H85-Q1.

2.2 Jumper Information

Table 2-2. Jumper Configurations

Jumper	Function, Setting
J21, J22	These jumpers are used to select the ILIM resistor for the device. *R13* selects 34.8k and *R14* selects an solder down pad where any allowed resistor can be populated by the end user.
J13, J16, J17	These jumpers are used to select the current sense resistor. R11 selects 1k, R1 selects 500, and R12 enables the physical "SNS" potentiometer.
J24	Enables and disables the onboard 5-V LDO.
J9	Latch (version B)/fault (version A) connection depending on chip version.
J6	Connects the TPS482H85-Q1's DIAG_EN signal to either the LDO's 5-V signal or ground.
J7	Connects the TPS482H85-Q1's SEL signal to either the LDO's 5-V signal or ground.
J4/J5	Connects the TPS482H85-Q1's EN1/2 signals to either the LDO's 5-V signal or ground.
J8	Connects the TPS482H85-Q1's LATCH signal to either the LDO's 5-V signal or ground.
J14	Bypasses the resistor and diode ground network and connects IC ground to system ground.
J12	Connects the TPS482H85-Q1's VDD pin to either the LDO's 5-V supply or J1 input supply.
J2	Bypasses the input blocking diode (recommended for reverse polarity protection).
J15	Connects/disconnects the LDO from the TPS482H85-Q1. Disconnect when testing voltage transients greater than 60V.

2.3 Current Limit and Current Sense Configuration

The current limit resistor connected to the ILIM pin configures the current limit of the TPS482H85-Q1 device. Based off the limit of this resistor, the allowed current that passes through the high side switch can be controlled. The TPS482H85EVM provides two ways of configuring the effective value of the resistance on the ILIM pin:

- Connecting *J21* to use a soldered down pad, *R14*

- Connecting *J22* for R13 - 34.8kOhms

See the Section 2.2 for details on how to configure each one of these jumpers.

For the current sense resistance connected to the SNS pin, the *SNS Pot Enable* jumper controls the source. If this jumper is populated, then the *SNS* potentiometer is used to increase and decrease the resistance connected to the SNS pin. If this jumper is not populated, then one of the other jumpers must be used to provide the necessary resistance value. The output of the SNS pin of TPS482H85-Q1 is an analog current that is a representation of the load current going through the switch. The purpose of the sense resistor is to convert this current into a voltage so that an ADC can convert into a value for a microcontroller to use. For the TPS482H85EVM, the voltage across the sense resistor can either be read externally through the SNS test point.

2.4 Transient Protection

There are several footprints and populated components used to mitigate transient power events such as ESD, surges, and inductive load turn-offs. The TPS482H85EVM provides solder on pads to populate a TVS diode on VBB (D1) to protect against upstream power events (currently not populated). These protection mechanisms are provided in addition to the integrated transient mitigation features of the TPS482H85-Q1. Refer to the TPS482H85-Q1 data sheet for more information about the internal protections that the device provides.

For voltage transients greater than 60V, disconnect the LDO from the TPS482H85-Q1 by removing the shunt connector from the J15 header to prevent damage to the LDO. Supply power to the TPS482H85-Q1's signals with separate power supplies using the test points for the respective signals.

3 Hardware Design Files

3.1 Schematic

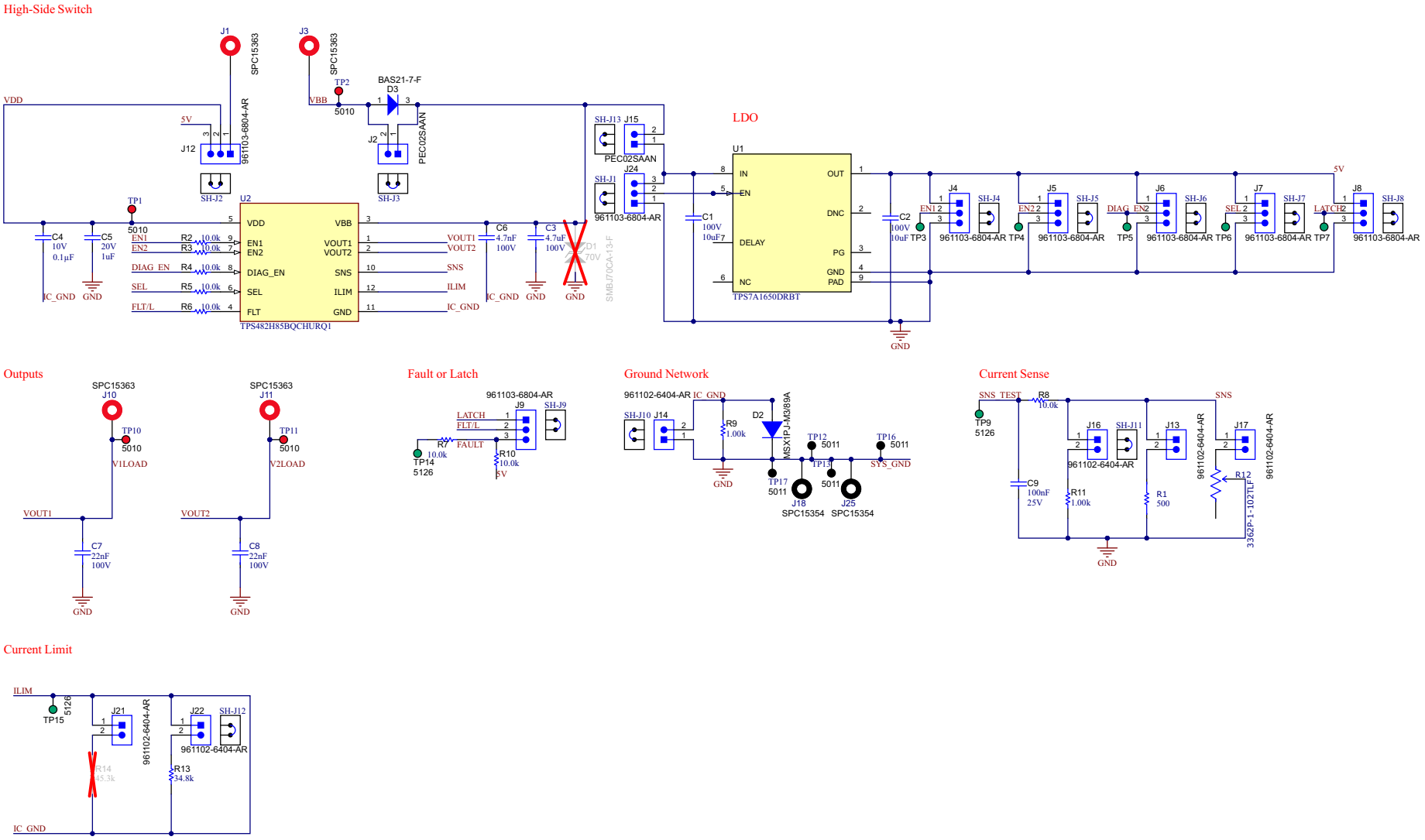


Figure 3-1. TPS482H85EVM Schematic

3.2 PCB Layouts

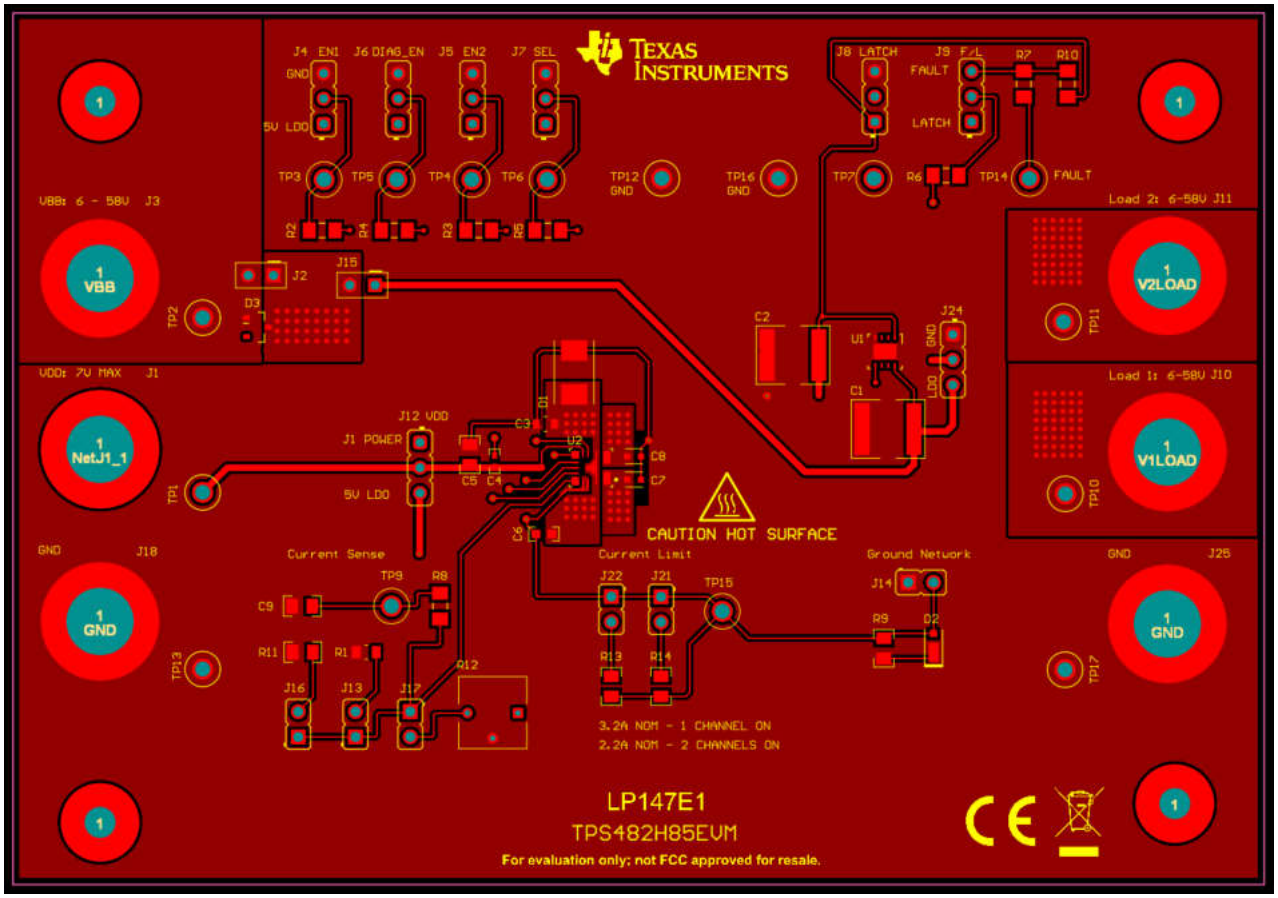


Figure 3-2. Top Layer

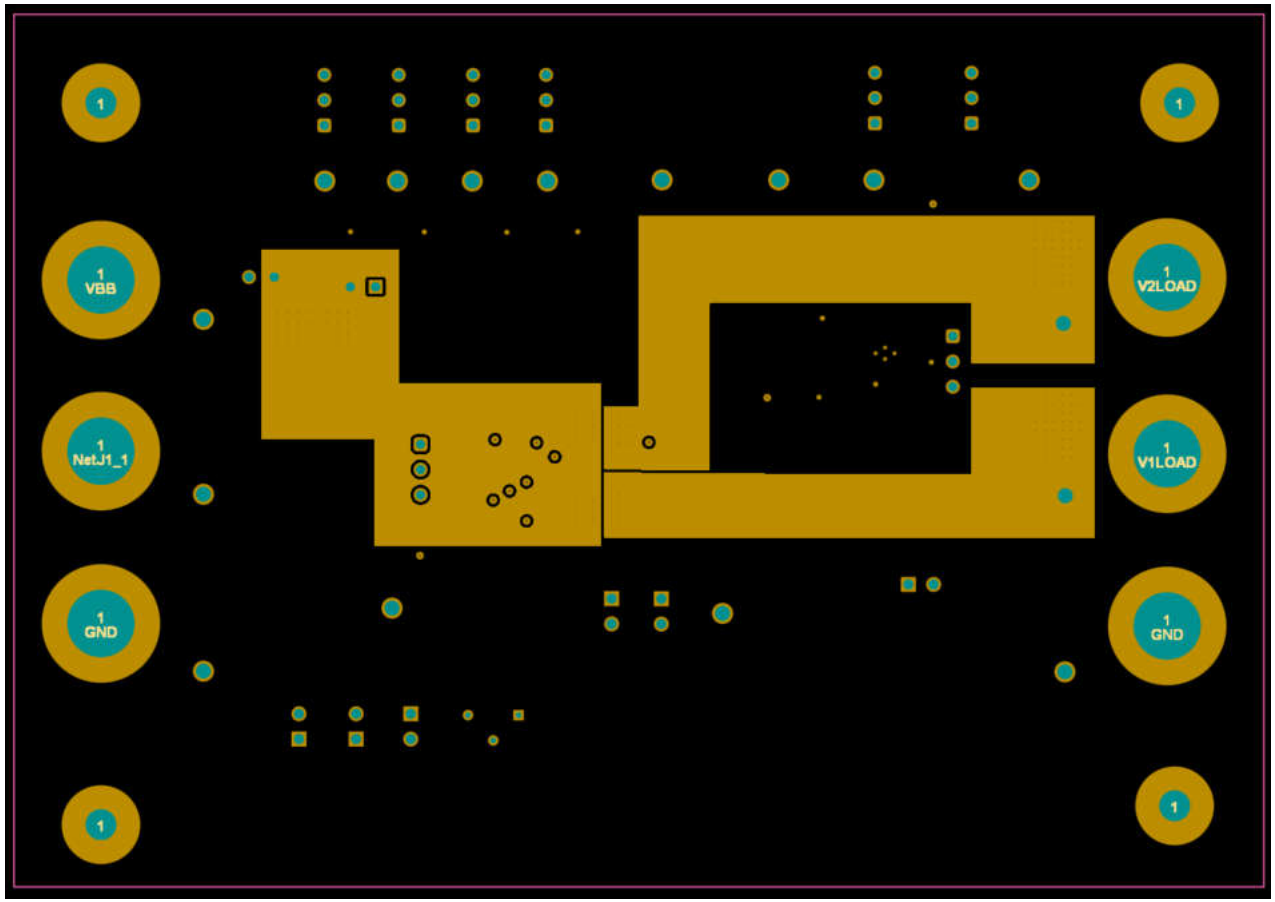


Figure 3-3. Power Layer

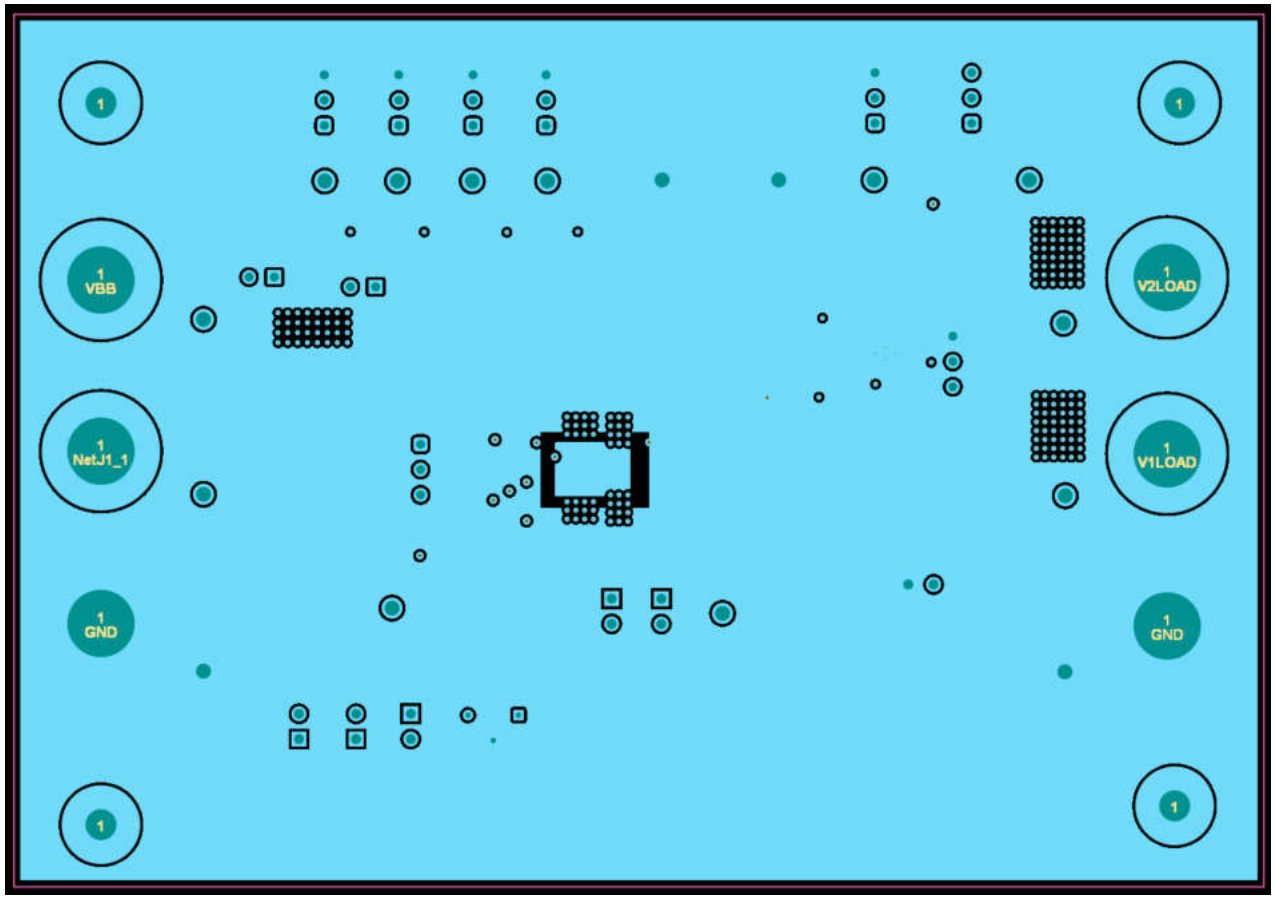


Figure 3-4. Ground Layer

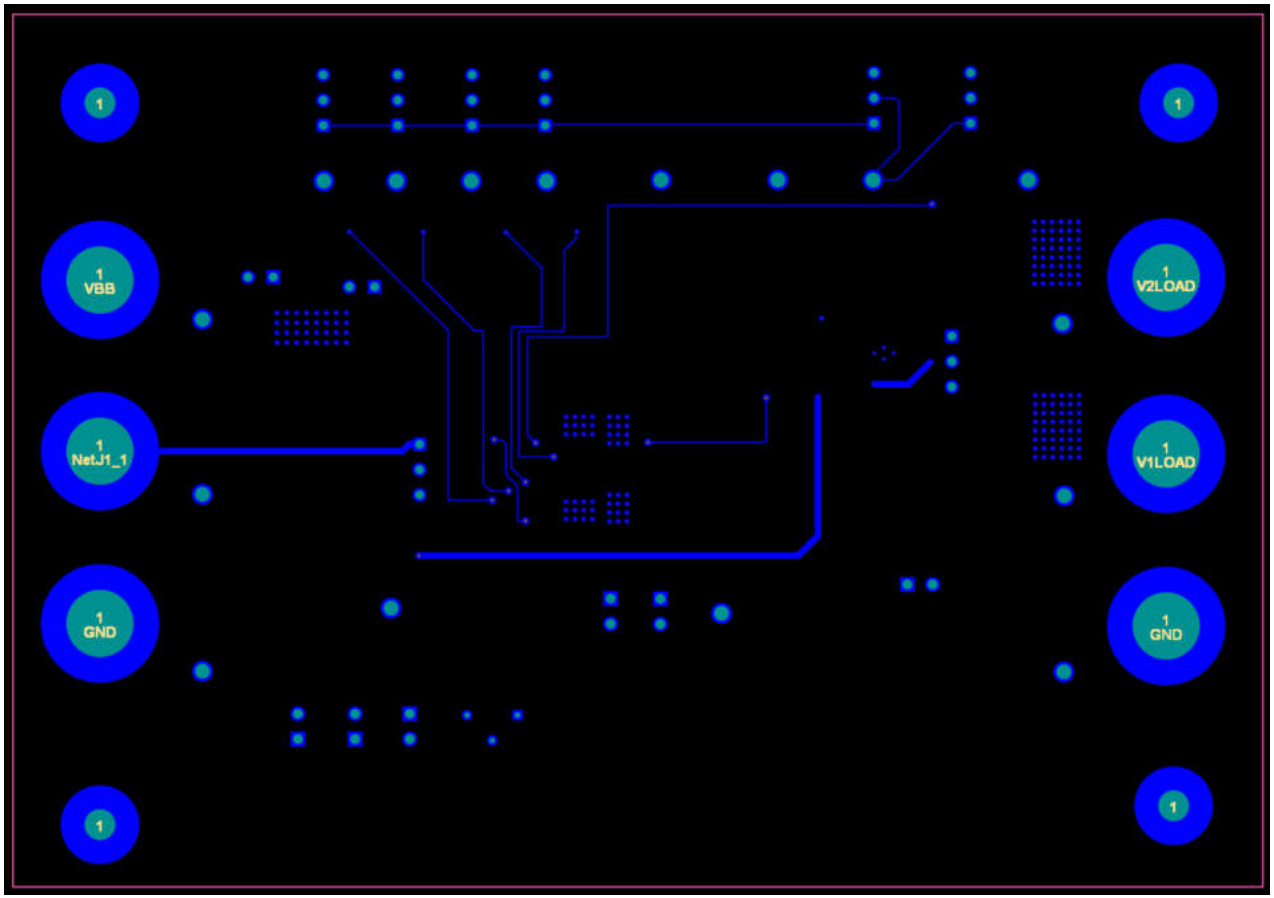


Figure 3-5. Bottom Layer

3.3 Bill Of Materials (BOM)

Table 3-1 lists the bill of materials.

Table 3-1. Bill Of Materials

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
C1, C2	2	10uF	CAP, CERM, 10 uF, 100 V, +/- 10%, X7S,	2220	C5750X7S2A106K230KB	TDK
C3	1	4.7µF	4.7 µF ±10% 100V Ceramic Capacitor X5R 0805 (2012 Metric)	0805	C2012X5R2A475K125AC	TDK
C4	1	0.1uF	CAP, CERM, 0.1 µF, 10 V,+/- 10%, X7R, 0402	0402	C0402C104K8RACTU	Kemet
C5	1	1uF	CAP, CERM, 1 uF, 20 V, +/- 10%, X5R, 0805	0805	TMK212BJ105KG-T	Taiyo Yuden
C6	1	4700pF	CAP, CERM, 4700 pF, 100 V,+/- 10%, X7R, AEC-Q200 Grade 1, 0603	0603	GCM188R72A472KA37D	MuRata
C7, C8	2	22nF	0.022 µF ±10% 100V Ceramic Capacitor X8R 0603 (1608 Metric)	0603	CGA3E3X8R2A223K080AB	TDK
C9	1	0.1uF	CAP, CERM, 0.1 µF, 25 V,+/- 10%, X7R, 0805	0805	SR0805X7R104K1NT95(F)#M123A	Presidio Components
D2	1	600V	Diode, Standard Recovery Rectifier, 600 V, 1 A, MicroSMP	MicroSMP	MSX1PJ-M3/89A	Vishay-Semiconductor
D3	1	200V	Diode, Switching, 200 V, 0.2 A, SOT-23	SOT-23	BAS21-7-F	Diodes Inc.
H1, H2, H3, H4	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply
H5, H6, H7, H8	4		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone
J1, J3, J10, J11	4		BANANA JACK, SOLDER LUG, RED, TH	Red Insulated Banana Jack	SPC15363	Tenma
J2, J15	2		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions
J4, J5, J6, J7, J8, J9, J12, J24	8		Header, 2.54mm, 3x1, Gold, TH	Header, 2.54mm, 3x1, TH	961103-6804-AR	3M
J13, J14, J16, J17, J21, J22	6		Header, 2.54mm, 2x1, TH	Header, 2.54mm, 2x1, TH	961102-6404-AR	3M

Table 3-1. Bill Of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
J18, J25	2		BANANA JACK, SOLDER LUG, BLACK, TH	Black Insulated Banana Jack	SPC15354	Tenma
R1	1	500	Precision Thin Film Chip Resistor 0805 Size 500 Ohm 0.01% 0.125 W 5 ppm/°C 2-Pin SMD T/R	0805	RNCF0805TKY500R	Stackpole Electronics
R2, R3, R4, R5, R6, R7, R8, R10	8	10.0k	RES, 10.0 k, 0.02%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	RG2012V-103-P-T1	Susumu Co Ltd
R9, R11	2	1.00k	RES, 1.00 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	ERJ-6ENF1001V	Panasonic
R12	1	1k	1 kOhms 0.5W, 1/2W PC Pins Through Hole Trimmer Potentiometer Cermet 1 Turn Top Finger Adjustment	PTH_POT_6MM6_6MM99	3362P-1-102TLF	Bourns
R13	1	34.8k	RES, 34.8 k, 0.1%, 0.125 W, 0805	0805	RT0805BRD0734K8L	Yageo America
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8, SH-J9, SH-J10, SH-J11, SH-J12, SH-J13	13	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec
TP1, TP2, TP10, TP11	4		Test Point, Multipurpose, Red, TH	Red Multipurpose Testpoint	5010	Keystone Electronics
TP3, TP4, TP5, TP6, TP7, TP9, TP14, TP15	8		Test Point, Multipurpose, Green, TH	Green Multipurpose Testpoint	5126	Keystone Electronics
TP12, TP13, TP16, TP17	4		Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	5011	Keystone Electronics
U1	1		60V, 5uA Iq, 100mA Low-Dropout (LDO) Voltage Regulator With Enable and Power Good, DRB0008B (VSON-8)	DRB0008B	TPS7A1650DRBT	Texas Instruments
U2	1		48-V, 85-mΩ Dual-Channel Smart High-Side Switch	VQFN-HR12	TPS482H85BQCHURQ1	Texas Instruments
D1	0	70V	Diode, TVS, Bi, 70 V, SMB	SMB	SMBJ70CA-13-F	Diodes Inc.
R14	0	45.3k	RES, 45.3 k, 1%, 0.125 W, 0805	0805	ERJ-6ENF4532V	Panasonic

4 Additional Information

Trademarks

All trademarks are the property of their respective owners.

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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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   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*:

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   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 DEGREDATION 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/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。

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.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。 技術適合証明を受けていないもの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。

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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html

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.

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