EVM User's Guide: TPSI31XXQ1EVM

TPSI31xx-Q1 Evaluation Module

Description

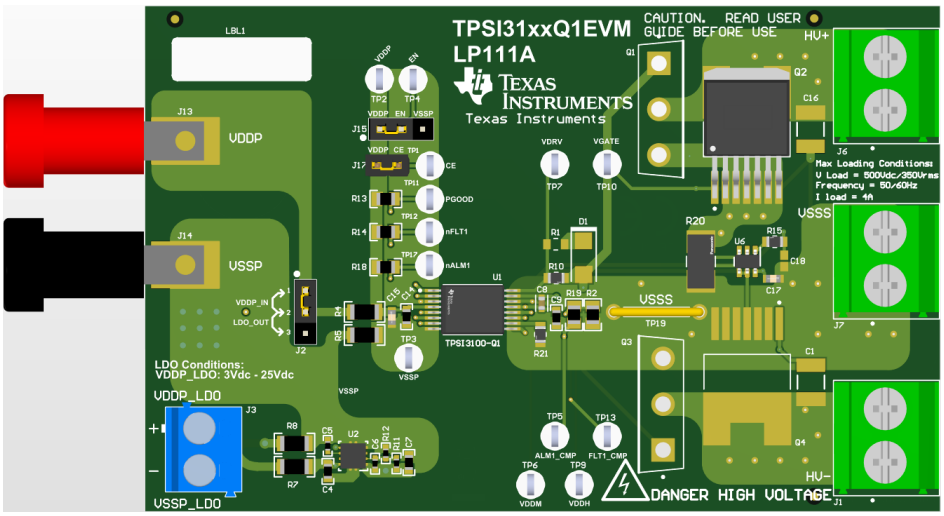
TPSI31xx-Q1 evaluation module (EVM) helps designers evaluate the operation and performance of the TPSI31xx-Q1 device family. The board features the TPSI3100-Q1, an isolated switch driver with integrated 15.8-V gate supply and fault/alarm indicators. The TPSI3100-Q1 is a 5-kVRMS reinforced isolated switch driver with 1.5-A peak source current and 3-A peak sink current. The device is able to generate a regulated secondary 15.8-V power supply, which allows for a wide selection of power switches such as MOSFETs, SiC MOSFETs, and IGBTs. The EVM features a current sense amplifier (INA181) and is intended for overcurrent protection with two-level detection (5-A alarm, 10-A fault). The EVM also includes an N-Channel 750-V 44-A silicon carbide (SiC) MOSFET in a TO-263-7L package. The board contains multiple test points to monitor TPSI3100-Q1 functionality. In addition, the EVM contains an adjustable 5-V LDO to support battery powering.

Features

- Overcurrent protection with 2-level detection (5-A alarm, 10-A fault)
- Current sense amplifier (INA181-Q1) for precise load detection
- Ultralow-noise LDO (5-V to 20-V input) for powering the circuit if adjustable power supply is unavailable
- Drives external power transistors, including placeholders for common through-hole and surface-mount footprints
- No isolated secondary supply required
- 5-kVRMS reinforced isolation
- 15.8-V gate drive with 1.5-A peak source current and 3-A peak sink current
- Up to 25-mW, 5-V supply for external auxiliary circuitry
- Dual isolated high-speed comparators with integrated voltage reference +/-1.5%
- Open-drain outputs for fault and alarm indicators

Applications

- Solid State Relay (SSR)
- Hybrid, electric, and powertrain systems
- Building automation
- Factory automation and control



PCB View

1 Evaluation Module Overview

1.1 Introduction

The TPSI31xx-Q1 is a fully integrated isolated switch driver that, when combined with an external power switch, forms a complete isolated solid state relay design. The TPSI31xx-Q1 can support driving single power switch, dual back-to-back, parallel power switches for a variety of AC or DC applications. The TPSI31xx-Q1 integrates a communication back-channel that transfers various status information from the secondary side to the primary side via open-drain outputs, PGOOD (Power Good), FLT1 (Fault 1), and ALM1 (Alarm 1). The TPSI31xx-Q1 integrated isolation protection is extremely robust with much higher reliability, lower power consumption, and increased temperature ranges than those found using traditional mechanical relays and optocouplers.

This user's guide provides connectors, test point descriptions, schematic, bill of materials, and board layout of the EVM.

1.2 Kit Contents

- TPSI31xx-Q1 evaluation module circuit

1.3 Specification

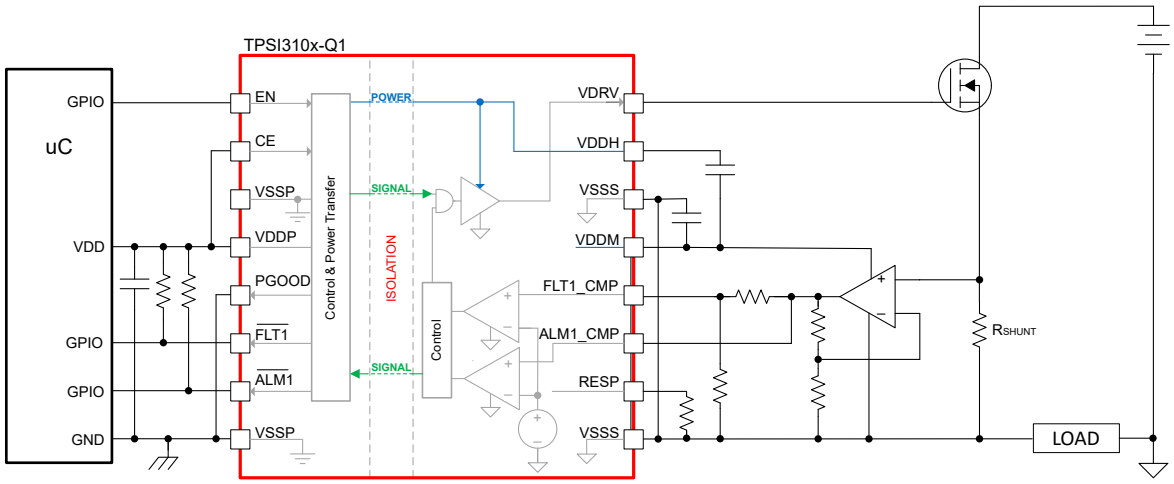


Figure 1-1. TPSI3100-Q1 Simplified Schematic

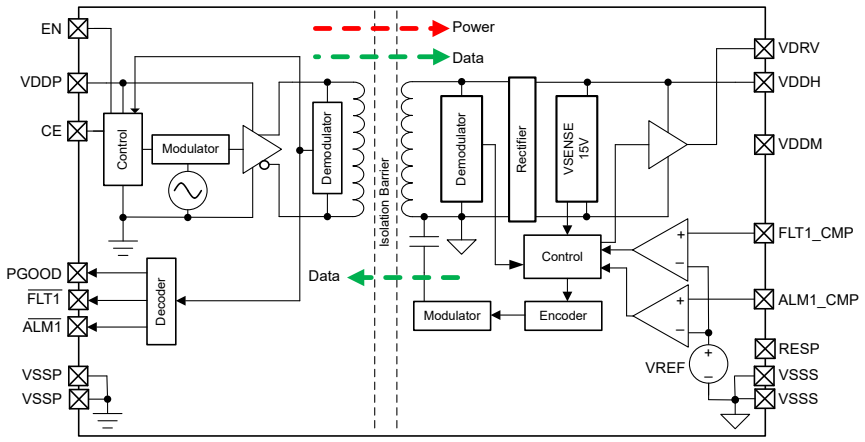


Figure 1-2. TPSI310x-Q1 Functional Block Diagram

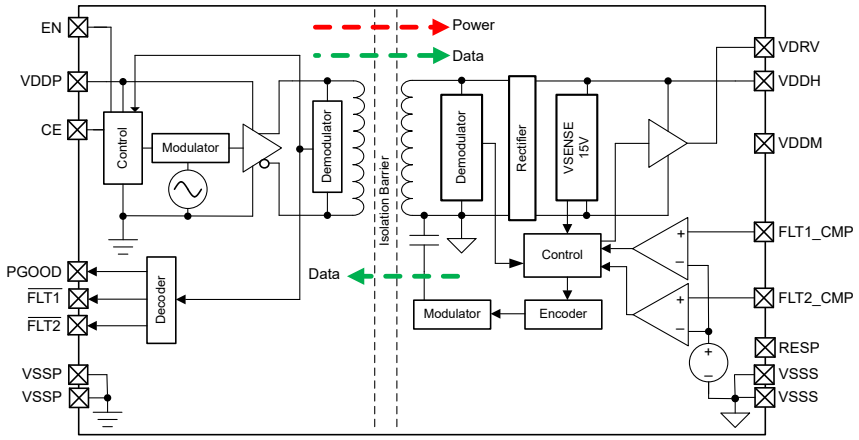


Figure 1-3. TPSI311x-Q1 Functional Block Diagram

1.4 Device Information

The TPSI31XXQ1EVM is an evaluation module (EVM) designed to demonstrate the performance and functionality of the TPSI31xx-Q1 family of devices in an overcurrent application with 2-level detection. This family includes the devices shown in the table below with differences in performance and function noted. The TPSI31XXQ1EVM also features a current sense amplifier (INA181-Q1) for accurate load detection and LDO (TPS7A4901) for flexible powering.

PART NUMBER	REF	COMPARATORS	LATCHED FAULT
TPSI3100-Q1	0.3 V	1 fault / 1 alarm	NO
TPSI3103-Q1	1.2 V		
TPSI3100L-Q1	0.3 V	1 latched fault / 1 alarm	YES
TPSI3103L-Q1	1.2 V		
TPSI3110-Q1	0.3 V	2 faults	NO
TPSI3113-Q1	1.2 V		
TPSI3110L-Q1	0.3 V	2 latched faults	YES
TPSI3113L-Q1	1.2 V		

2 Hardware

2.1 Additional Images

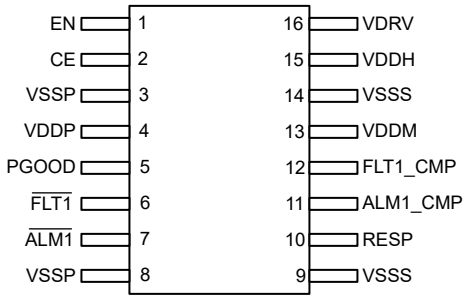


Figure 2-1. TPSI310x-Q1 DVX Package 16-Pin SSOP Top View

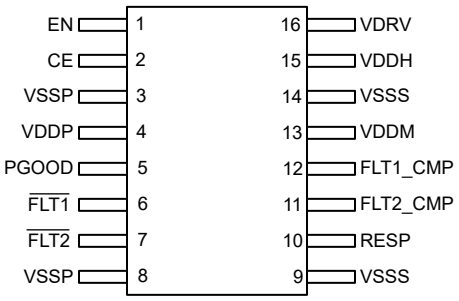


Figure 2-2. TPSI311x-Q1 DVX Package 16-Pin SSOP Top View

2.2 Header Information

Name	Description
J13	VDDP supply input for primary side, banana jack
J14	Ground supply input for primary side, screw terminal
J3	Input into LDO, screw terminal
J6	HV+ secondary load, screw terminal
J7	VSSS secondary load, screw terminal
J1	HV- secondary load, screw terminal

2.3 Jumper Information

Name	Description
J2	VDDP power select input
J15	EN select, ties to VDDP or VSSP
J17	CE select, ties to VDDP

2.4 Test Points

Name	Description
TP2	VDDP signal test point
TP4	EN signal test point
TP1	CE signal test point
TP11	PGOOD signal test point
TP12	nFLT1 signal test point
TP17	nALM1 signal test point
TP3	VSSP signal test point
TP7	VDRV signal test point
TP10	VGATE signal test point
TP6	VDDM signal test point
TP5	ALM1_CMP signal test point
TP9	VDDH signal test point
TP14	FLT1_CMP signal test point

3 Hardware Design Files

3.1 Schematics

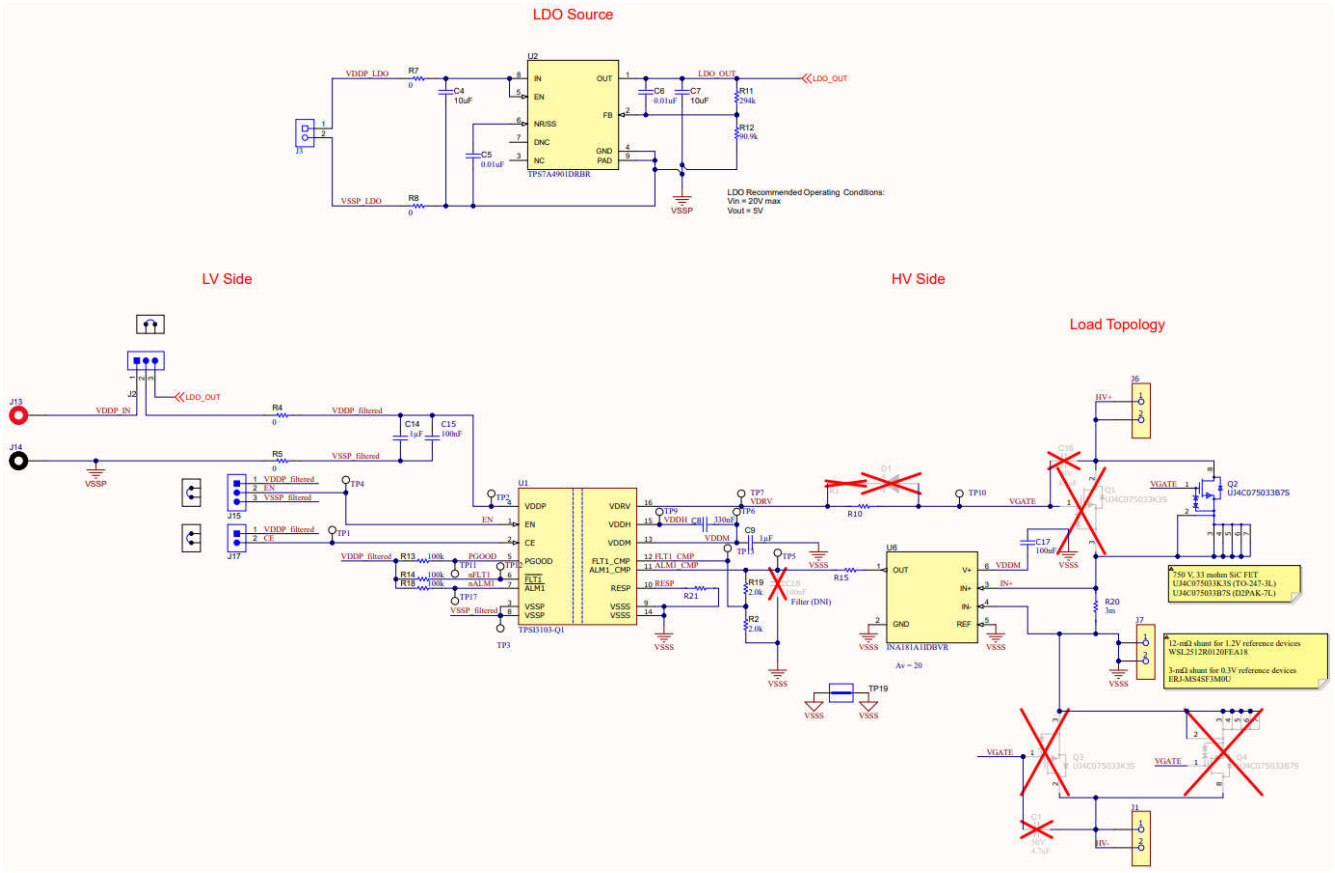


Figure 3-1. TPSI31XXQ1EVM Schematic

3.2 PCB Layouts

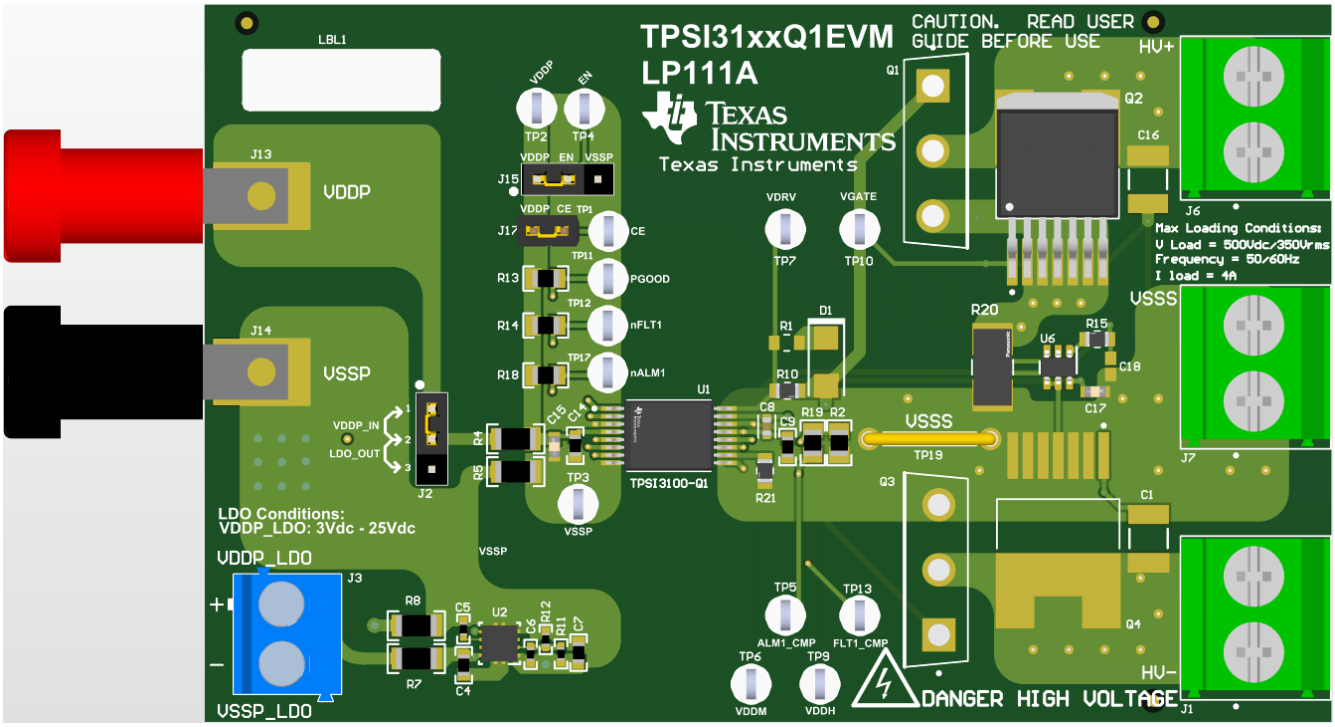


Figure 3-2. 3D View

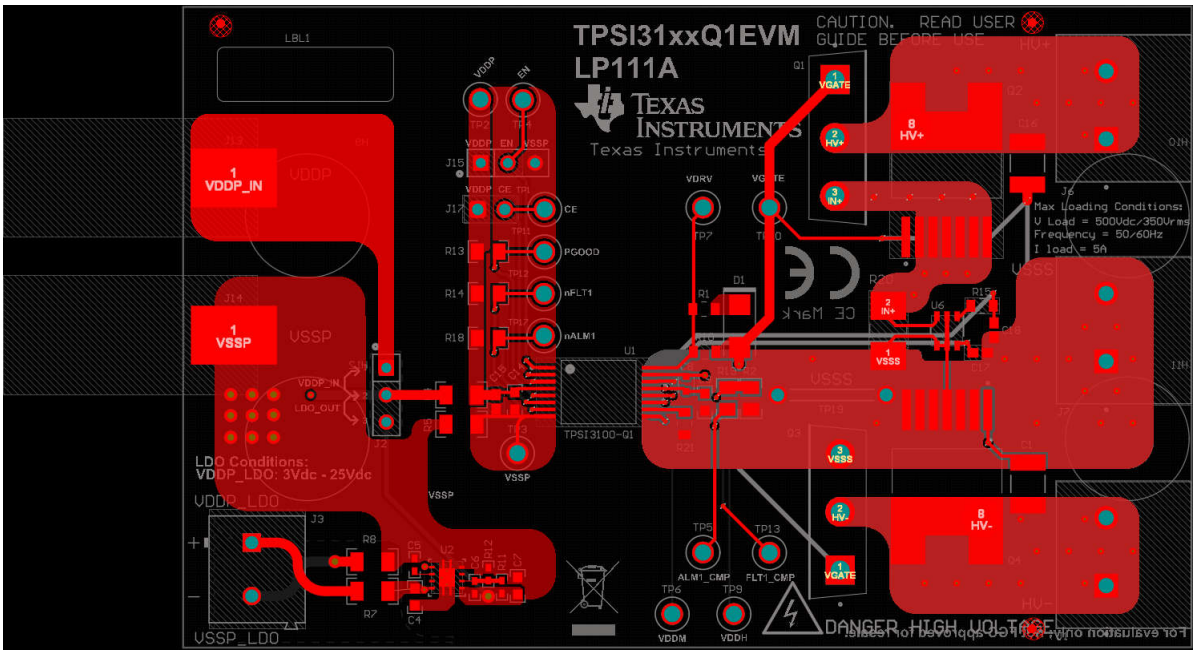


Figure 3-3. PCB Top Layer

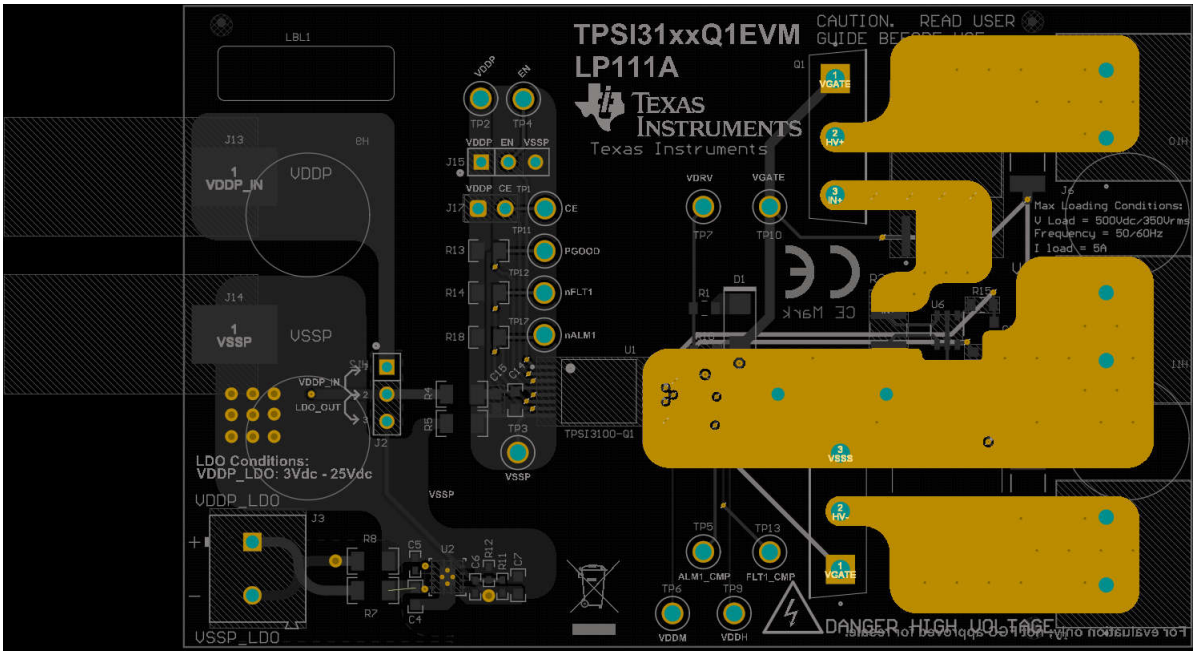


Figure 3-4. PCB Internal Layer 1

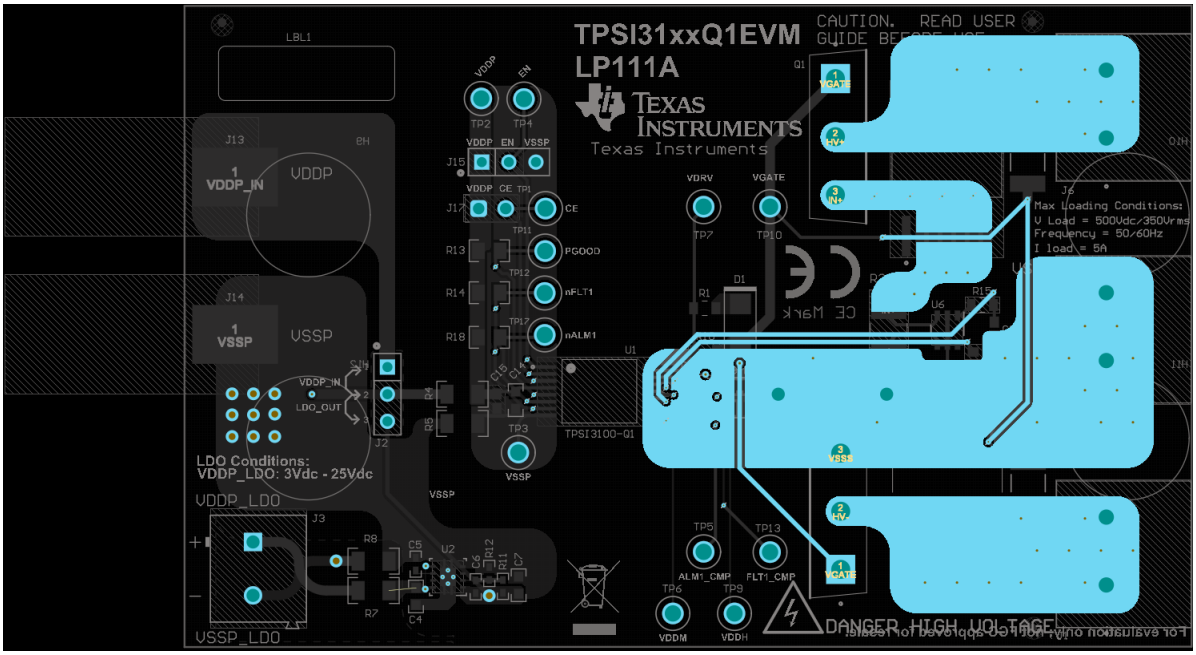


Figure 3-5. PCB Internal Layer 2

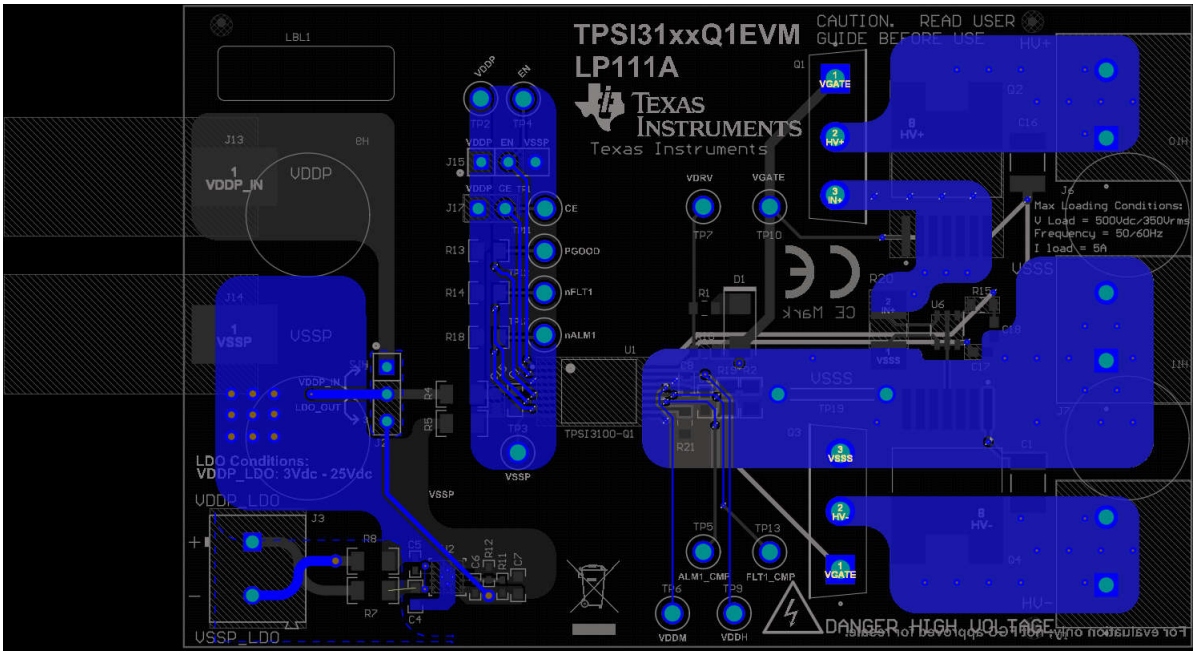


Figure 3-6. PCB Bottom Layer

3.3 Bill of Materials (BOM)

Table 3-1. Bill of Materials

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
!PCB	1		Printed Circuit Board		LP-111	Any
C4, C7	2	10uF	CAP, CERM, 10 uF, 25 V, +/- 20%, X5R, 0603	0603	GRT188R61E106ME13D	MuRata
C5, C6	2	0.01uF	CAP, CERM, 0.01 uF, 25 V, +/- 10%, X7R, 0402	0402	GRM155R71E103KA01D	MuRata
C8	1	330 nF	Cap Ceramic 330 nF 25 V X7R 10% Pad SMD 0603 +125°C Automotive T/R	0603	CGA3E3X7R1E334K080AB	TDK
C9, C14	2	1uF	CAP, CERM, 1 uF, 25 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0603	0603	GCM188R71E105KA64D	MuRata
C15, C17	2		CAP CER 0.1UF 50 V X7R 0603	0603	C0603R104K5RAC	Kemet
H9, H10, H11, H12	4		Bumpon, Hemisphere, 0.44 X 0.20, Clear	Transparent Bumpon	SJ-5303 (CLEAR)	3M
J1, J6, J7	3			CONN_TERM_BLOCK2	6.91251E+11	Wurth Electronics
J2, J15	2		Header, 100mil, 3x1, Tin, TH	Header, 3 PIN, 100mil, Tin	PEC03SAAN	Sullins Connector Solutions
J3	1		Terminal Block, 5 mm, 2x1, Tin, TH	Terminal Block, 5 mm, 2x1, TH	691 101 710 002	Wurth Elektronik
J13	1		Banana Jack Insul Nylon Red, TH	Banana Jack Insul Nylon Red, TH	108-0902-001	Cinch Connectivity
J14	1		Banana Jack Insul Nylon Black, TH	Banana Jack Insul Nylon Black, TH	108-0903-001	Cinch Connectivity
J17	1		Header, 2.54 mm, 2x1, Gold, TH	Header, 2.54mm, 2x1, TH	61300211121	Wurth Elektronik
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady
Q2	1		N-Channel 750 V, 33 mohm, PG-TO263-7	TO-263-7	UJ4C075033B7S	Qorvo
R2, R19	2	2.0k	RES, 2.0 k, 5%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	CRCW08052K00JNEA	Vishay-Dale
R4, R5, R7, R8	4	0	RES, 0, 5%, 0.25 W, AEC-Q200 Grade 0, 1206	1206	ERJ-8GEY0R00V	Panasonic
R10, R15, R21	3	0	RES SMD 0 OHM JUMPER 1/8W 0805	0805	RC0805FR-070RL	Yageo
R11	1	294k	RES, 294 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	ERJ-2RKF2943X	Panasonic

Table 3-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
R12	1	90.9k	RES, 90.9 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	ERJ-2RKF9092X	Panasonic
R13, R14, R18	3	100k	RES, 100 k, 5%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	ERJ-6GEYJ104V	Panasonic
R20	1	3 m	3 mOhms ±1% 3W Chip Resistor 2512 (6432 Metric) Automotive AEC-Q200, Current Sense, Moisture Resistant Metal Element	2512	ERJ-MS4SF3M0U	Panasonic
SH-J1, SH-J2, SH-J3	3	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP9, TP10, TP11, TP12, TP13, TP17	13		Test Point, White, Through Hole, RoHS, Bulk	5012	5012	Keystone
TP19	1		1 mm Uninsulated Shorting Plug, 10.16mm spacing, TH	Shorting Plug, 10.16mm spacing, TH	D3082-05	Harwin
U1	1		Automotive Reinforced Isolated Switch Driver with Integrated 15-V Gate Supply and Fault/ Alarm Indicators	SSOP16	TPSI3100-Q1	Texas Instruments
U2	1		Vin 3 V to 36 V, 150 mA, Ultra-Low-Noise, High-PSRR Low-Dropout (LDO) Linear Regulator, DRB0008A (VSON-8)	DRB0008A	TPS7A4901DRBR	Texas Instruments
U6	1		Bidirectional, Low- and High-Side Measurement, Multichannel, Voltage Output, Current-Sense Amplifier, DBV0006A (SOT-6)	DBV0006A	INA181A1IDBVR	Texas Instruments
C1, C16	0	4.7uF	CAP, CERM, 4.7 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1,		CGA8M3X7R1H475K200KB	TDK
C18	0		CAP CER 0.1UF 50 V X7R 0603	0603	C0603R104K5RAC	Kemet
D1	0	50 V	Diode, Ultrafast, 50 V, 1 A, SMA	SMA	ES1A-13-F	Diodes Inc.
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A
Q1, Q3	0		N-Channel 750 V 28 A (Tc) 155W (Tc) Through Hole TO-247-3	TO-247-3L	UJ4C075060K3S	UnitedSiC
Q4	0		N-Channel 750 V, 33 mohm, PG-TO263-7	TO-263-7	UJ4C075033B7S	Qorvo
R1	0	0	RES SMD 0 OHM JUMPER 1/8W 0805	0805	RC0805FR-070RL	Yageo

4 Additional Information

4.1 Trademarks

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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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   2.2 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 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.

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西新宿三井ビル

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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