EVM User's Guide: TPSI3050Q1EVM TPSI3050-Q1

TPSI3050Q1EVM Automotive Reinforced Isolated Switch Driver with Integrated 10-V Gate Supply EVM User's Guide

ABSTRACT

TPSI3050Q1EVM EVM (Evaluation Module) helps designers evaluate the operation and performance of the isolated switch driver, TPSI3050-Q1. This user's guide provides the connectors, test point descriptions, operational modes, schematic, bill of materials, and board layout of the EVM. The TPSI3050-Q1 is a 5-kV_{RMS} 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 power supply of 10 V. This regulated power supply allows for a wide selection of MOSFETs or SCRs. The EVM includes two back-to-back 650-V and 42-A NMOS with D2PAK package for easy testing and footprint for one SCR with a TO247-3 package. The inputs and outputs connections to the board are terminal blocks, which allow for easy wired connections. The EVM is rated for a load up to 500-V_{DC}/350-V_{RMS} and 4 A. The board contains multiple test points to monitor the TPSI3050-Q1 functionality. In addition, the EVM contains a 3.3-V LDO to supply VDDP from a battery to the input of the TPSI3050-Q1 with an output of 3.3 V. The EVM allows the user to test multiple applications, such as AC/DC Solid State Relay (SSR), battery management, and precharge circuits.

	**Caution**	**Do not leave EVM powered when unattended**
	**Caution**	**Read the user's guide before use**
	**Caution**	**Caution hot surface Contact can cause burns Do not touch!**
	**Danger**	**Do not use EVM to test Isolation above V_{IOWM} = 1414-V_{DC} High voltage**

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General Texas Instruments High Voltage Evaluation (TI HV EVM) User Safety Guidelines

Always follow TI's set-up and application instructions, including use of all interface components within their recommended electrical rated voltage and power limits. Always use electrical safety precautions to help ensure your personal safety and those working around you. Contact TI's Product Information Center http://ti.com/customer support for further information.

Save all warnings and instructions for future reference.

WARNING

Failure to follow warnings and instructions may result in personal injury, property damage or death due to electrical shock and burn hazards.

The term TI HV EVM refers to an electronic device typically provided as an open framed, unenclosed printed circuit board assembly. It is *intended strictly for use in development laboratory environments, solely for qualified professional users having training, expertise and knowledge of electrical safety risks in development and application of high voltage electrical circuits. Any other use and/or application are strictly prohibited by Texas Instruments.* If you are not suitably qualified, you should immediately stop from further use of the HV EVM.

1. Work Area Safety:
   a. Keep work area clean and orderly.
   b. Qualified observer(s) must be present anytime circuits are energized.
   c. Effective barriers and signage must be present in the area where the TI HV EVM and its interface electronics are energized, indicating operation of accessible high voltages may be present, for the purpose of protecting inadvertent access.
   d. All interface circuits, power supplies, evaluation modules, instruments, meters, scopes, and other related apparatus used in a development environment exceeding 50Vrms/75VDC must be electrically located within a protected Emergency Power Off EPO protected power strip.
   e. Use stable and non-conductive work surface.
   f. Use adequately insulated clamps and wires to attach measurement probes and instruments. No freehand testing whenever possible.
2. Electrical Safety:
   a. As a precautionary measure, it is always good engineering practice to assume that the entire EVM may have fully accessible and active high voltages.
   b. De-energize the TI HV EVM and all its inputs, outputs and electrical loads before performing any electrical or other diagnostic measurements. Revalidate that TI HV EVM power has been safely de-energized.
   c. With the EVM confirmed de-energized, proceed with required electrical circuit configurations, wiring, measurement equipment hook-ups and other application needs, while still assuming the EVM circuit and measuring instruments are electrically live.
   d. Once EVM readiness is complete, energize the EVM as intended.

WARNING

While the EVM is energized, never touch the EVM or its electrical circuits, as they could be at high voltages capable of causing electrical shock hazard.

3. Personal Safety
   a. Wear personal protective equipment e.g. latex gloves or safety glasses with side shields or protect EVM in an adequate lucent plastic box with interlocks from accidental touch.

Limitation for safe use:

EVMs are not to be used as all or part of a production unit.

1 Introduction

The TPSI3050-Q1 is a fully integrated isolated switch driver, that when combined with an external power switch, forms a complete isolated solid state relay solution. The TPSI3050-Q1 is designed for automotive and industrial applications such as battery management systems, EV/HEV on-board chargers, replacing mechanical relays with SSR, DC link pre-charging, and more. The TPSI3050-Q1 seamlessly replaces relays without need for a secondary side supply while leveraging unique isolation technology integrated in a compact SOIC package. The TPSI3050-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.

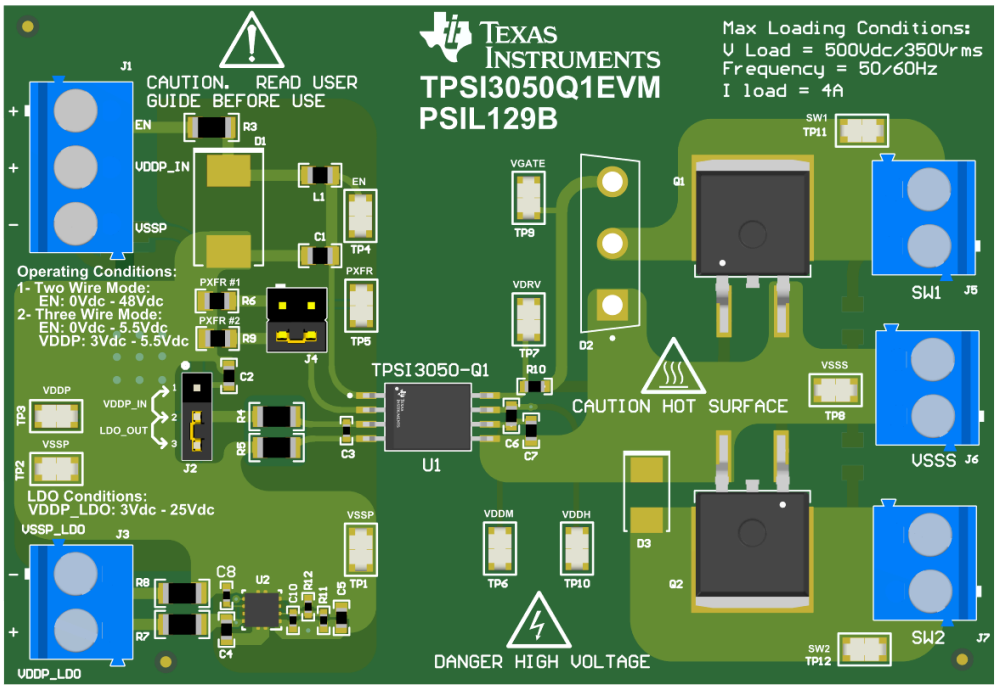

Figure 1-1. PCB View

1.1 Features

- No isolated secondary supply required
- Drives external power transistors or SCRs
- 5-kV_{RMS} reinforced isolation
- 10-V gate drive with 1.5-A peak source current and 3-A peak sink current
- Up to 50-mW supply for external auxiliary circuitry
- Supports AC or DC switching
- Supports two-wire or three-wire modes
- Seven levels of power transfer, resistor selectable

1.2 Applications

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

1.3 Description

TPSI3050Q1EVM allows users to easily switch between the two operational modes for evaluation. The EVM is designed with the flexibility to add Common Mode Chokes to minimize EMI. Figure 1-2 shows the functional block diagram for the isolated switch. The TPSI3050-Q1 is able to generate a floating secondary supply of 10-V with a 1.5-A peak source current and 3-A peak sink current. In addition, TPSI3050-Q1 supports two operation modes: two-wire and three-wire mode. In two-wire mode, the EN pin provides the power on the primary side. Use three-wire mode for applications that require higher levels of power transfer and the fastest enable and disable switch times the TPSI3050-Q1 can offer.

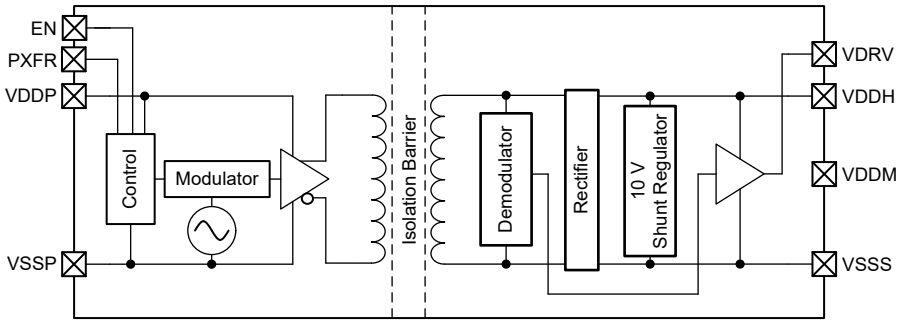

Figure 1-2. TPSI3050-Q1 Functional Block Diagram

Table 1-1. Device Information

PART NUMBER	PACKAGE(1)	BODY SIZE (NOM)	FUNCTIONALITY
TPSI3050-Q1	SOIC 8 pin (DWZ)	7.50 mm × 5.85 mm	Standard Enable
TPSI3050S-Q1	SOIC 8 pin (DWZ)	7.50 mm × 5.85 mm	Available in three-wire mode only, the TPSI3050S features a one-shot enable for the switch control. This feature is useful for driving SCRs that typically require only one pulse of current to trigger.

(1) For all available packages, see the orderable addendum at the end of the data sheet.

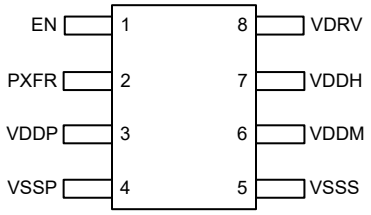

Figure 1-3. TPSI3050-Q1, TPSI3050S-Q1 DWZ Package 8-Pin SOIC Top View

2 Connection Descriptions

Table 2-1 shows the functionality of the test points, connectors, and terminal block.Table 2-2 shows the pin functions.

Table 2-1. Test Points and Jumpers

Name	Description
J2	VDDP power select input
J4	Power transfer select
TP1, TP2	VSSP test point
TP3	VDDP signal test point
TP4	EN signal test point
TP5	PXFR signal test point
TP6	VDDM signal test point
TP7	VDRV signal test point
TP8	VSSS signal test point
TP9	VGATE signal test point
TP10	VDDH signal test point
TP11	SW1 signal test point
TP12	SW2 signal test point

Table 2-2. Pin Functions

Pin Name	Description
EN	Active high driver enable
PXFR	Power transfer may be adjusted by selecting one of seven power level settings using an external resistor from the PXFR pin to VSSP.
VDDP	Power supply for primary side
VSSP	Ground supply for primary side
VSSS	Ground supply for secondary side
VDDM	Generated mid supply
VDDH	Generated high supply
VDRV	Active high driver output

3 Operating Modes

3.1 Two-Wire Mode

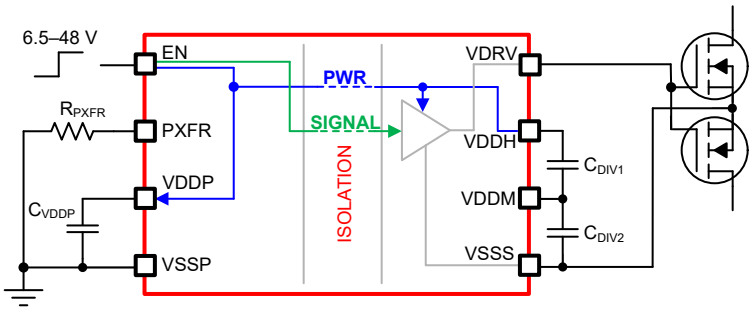

Figure 3-1. Two-Wire Mode Simplified Schematic

In two-wire mode, the TPSI3050-Q1 can be controlled using two pins, EN and VSSP. When EN is greater or equal to 6.5 V, power is drive to the device. When the EN voltage is high, power gets delivered into the secondary side of the device. When EN is low, then power transfer into the secondary side stops and the MOSFETs or SCRs turns off.

To configure the EVM for two-wire mode, the following changes must be made:

1. Remove J2-Header. Leave VDDP floating with Cin to VSSP.
2. Supply the EN voltage using the terminal block J1.

Figure 3-2 provides a visual representation of how to configure the board for the two-wire mode:

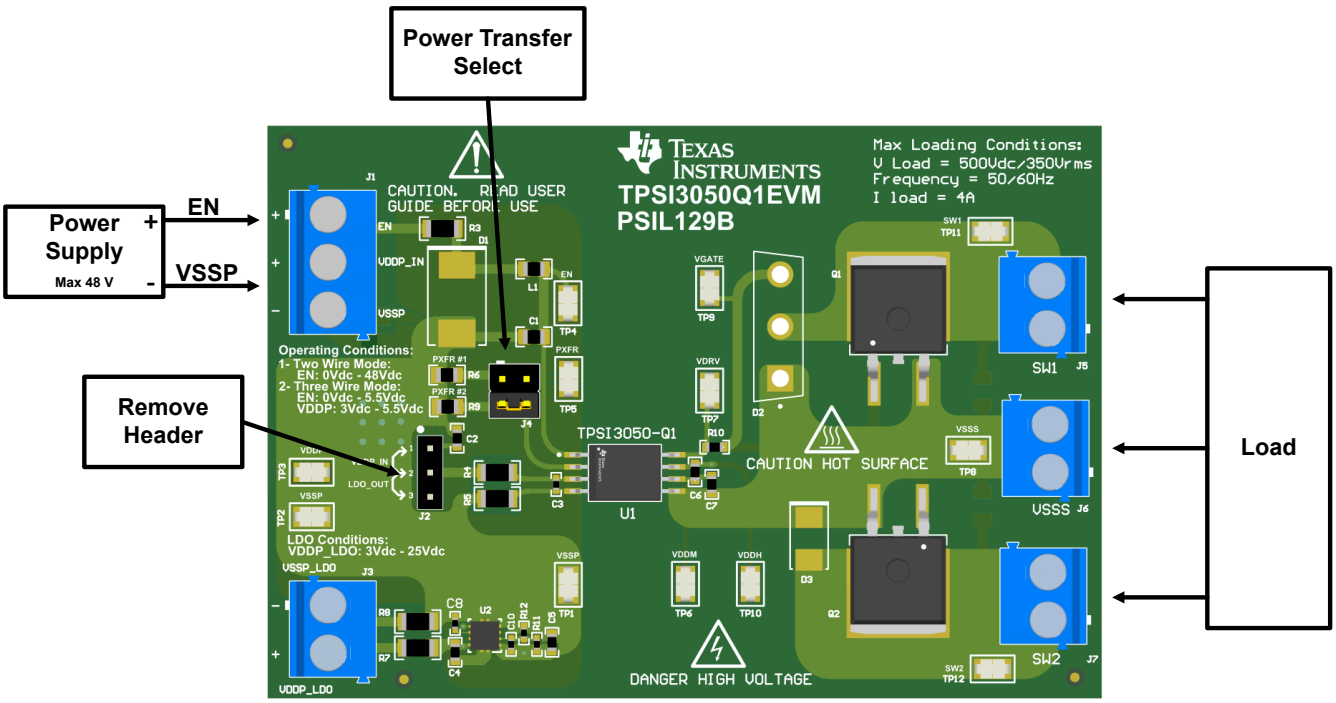

Figure 3-2. Two-Wire Mode Setup

Table 3-1. Power Selection for Two-Wire Mode

J4-Header	I_{EN}
PXFR #1 (7.32 kΩ)	1.9 mA
PXFR #2 (20 kΩ)	6. 8 mA

Measurements

Figure 3-3 shows the powering up delay from EN rising to VDDM and VDDP rising using the highest power transfer PXFR #2 (20 kΩ) in two-wire mode. The power up delay is directly related to the power transfer selection and to the capacitors from VDDH to VDDM and VDDM to VSSS. The delay from EN to VDDM is 1.222 ms and the delay from EN to VDDH is 1.322 ms. Figure 3-3 shows the delay from EN rising to VDRV rising using the highest power transfer PXFR #2 (20 kΩ) in two-wire mode. The delay from EN to VDRV is 2.689 ms. Figure 3-5 shows the delay from EN falling to VDRV falling. The delay is 2.441 us.

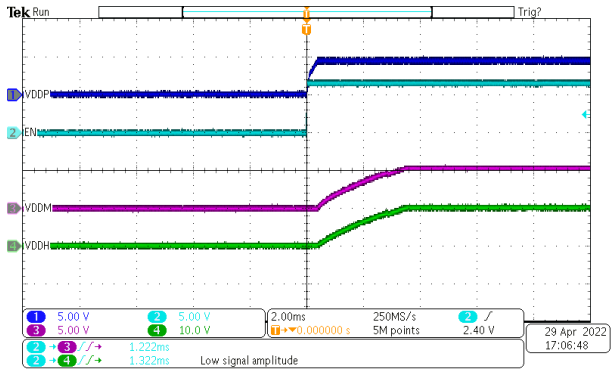

Figure 3-3. Two-Wire Mode Powering Up

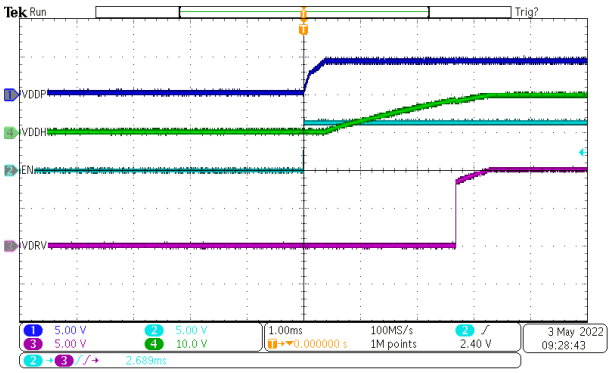

Figure 3-4. Two-Wire Mode Switching ON

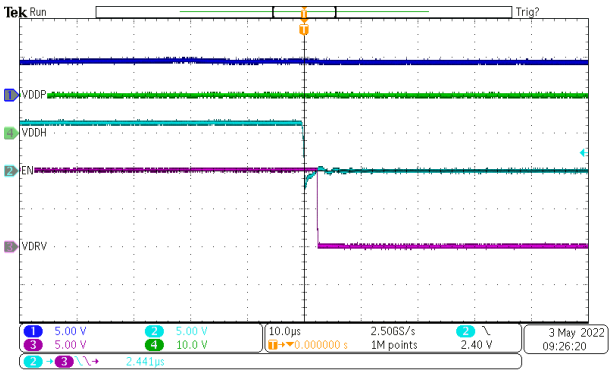

Figure 3-5. Two-Wire Mode Switching OFF

3.2 Three-Wire Mode

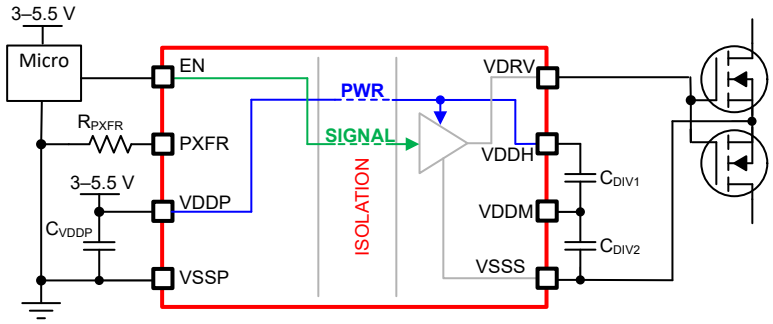

Figure 3-6. Three-Wire Mode Simplified Schematic

Use three-wire mode for applications that require higher levels of power transfer and the fastest enable and disable switch times the TPSI3050-Q1 can offer. In this mode, power transfers from the primary to secondary side independent of the enable pin state. Setting EN pin high or low asserts the V_{DRV} to drive the external power MOSFETs or SCRs.

To configure the EVM for three-wire mode, the following changes must be made:

1. J2 header allows to supply VDDP directly or indirectly through an LDO with a 5-V output.
   a. Supply VDDP directly: place J2 shunt between positions 1-2. This action allows the user to supply VDDP directly.

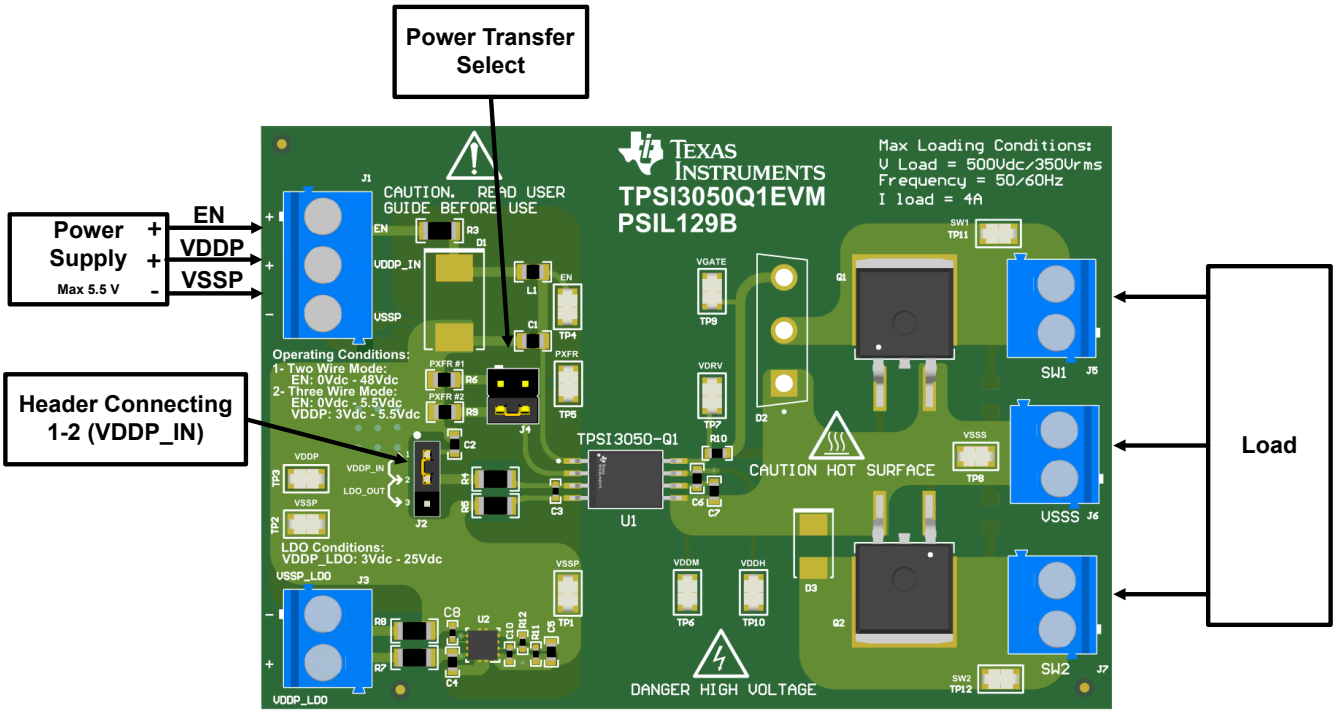

Figure 3-7. Three-Wire Mode VDDP Direct Supply

b. Supply VDDP through LDO: place the J2 shunt between positions 2-3. The user can supply VDDP indirectly through an LDO with a 5-V output.

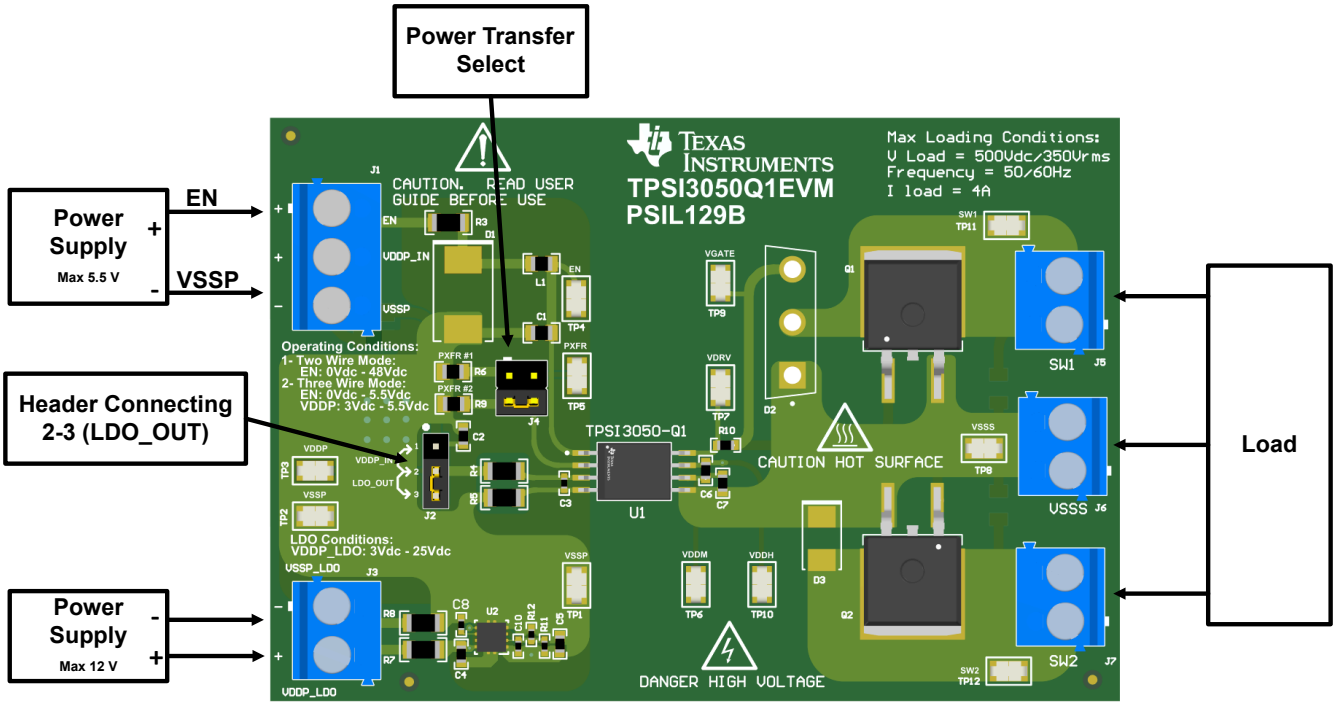

Figure 3-8. Three-Wire Mode VDDP Supply Through 5-V LDO

2. Supply the EN voltage using the terminal block J2.

Table 3-2. Power Selection for Three-Wire Mode

J4-Header	Power Converter Duty Cycle (Three-Wire Mode, Nominal)
PXFR #1 (7.32 kΩ)	13.3%
PXFR #2 (20 kΩ)	93.3%

Measurements

Figure 3-10 shows the powering up delay from VDDP rising to VDDM and VDDP rising using the highest power transfer PXFR #2 (20 kΩ) in three-wire mode. The power up delay is directly related to the power transfer selection and to the capacitors from VDDH to VDDM and VDDM to VSSS. The delay from VDDP to VDDM is 330.5 us and the delay from VDDP to VDDH is 357.6 us. Figure 3-3 shows the delay from EN rising to VDRV rising using the highest power transfer PXFR #2 (20 kΩ) in three-wire mode. The delay from EN to VDRV is 3.145 us. Figure 3-11 shows the delay from EN falling to VDRV falling. The delay is 2.461 us.

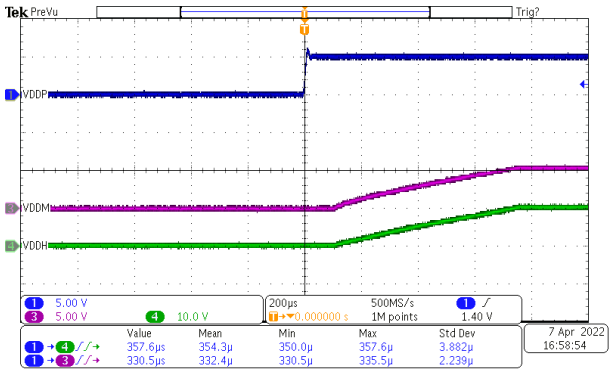

Figure 3-9. Three-Wire Mode Powering Up

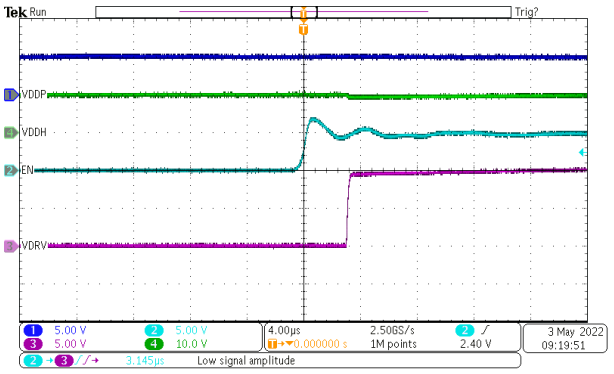

Figure 3-10. Three-Wire Mode Switching ON

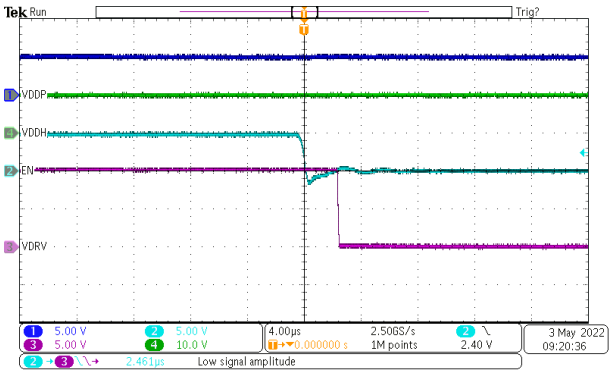

Figure 3-11. Three-Wire Mode Switching OFF

4 Load Configurations

This EVM is designed to support different load configurations to maximize flexibility to the user.

1. MOSFET configurations:
   a. Figure 4-1 shows an application using two back-to-back common source MOSFETs. By connecting the load between terminals SW1-SW2, the user can load the EVM with an AC or a DC load. By using two back-to-back FETs, the body diodes are able to stand off both positive and negative voltages. In addition, an RC snubber can be added for damping the switching oscillations in presence of a highly inductive load.

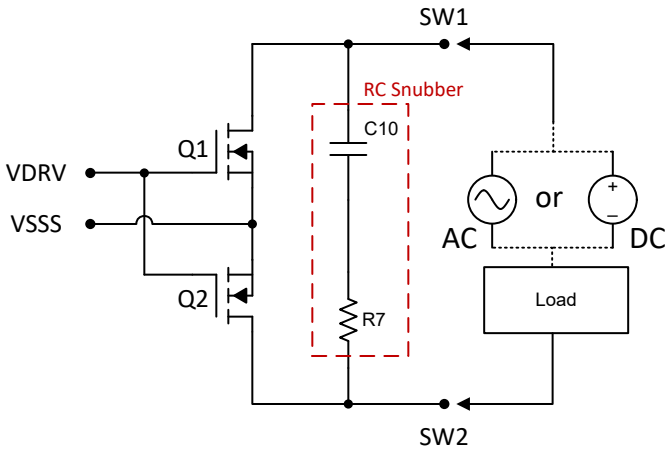

Figure 4-1. AC/DC Load

b. Figure 4-2 shows an application using two parallel common source MOSFETs. This action allows the users to achieve lower RDSON. Because one MOSFET cannot block reverse current when off, the recommended load for this configuration is a DC load.

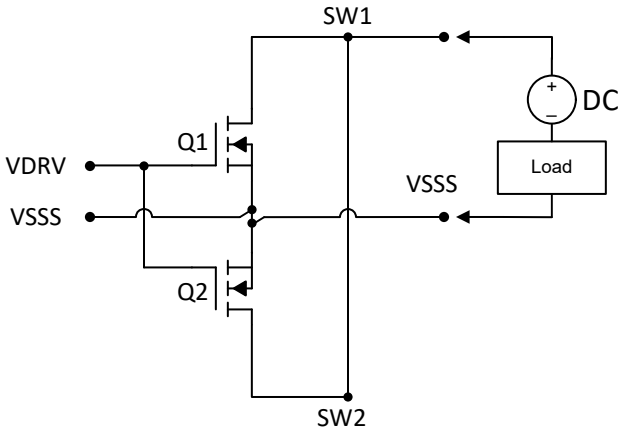

Figure 4-2. DC Load

c. Figure 4-3 shows a possible load configuration using one MOSFET (Q1) while leaving (Q2) unpopulated. This configuration allows the addition of an RC snubber for when a highly inductive load is connected by shorting terminal SW2 to VSSS terminal.

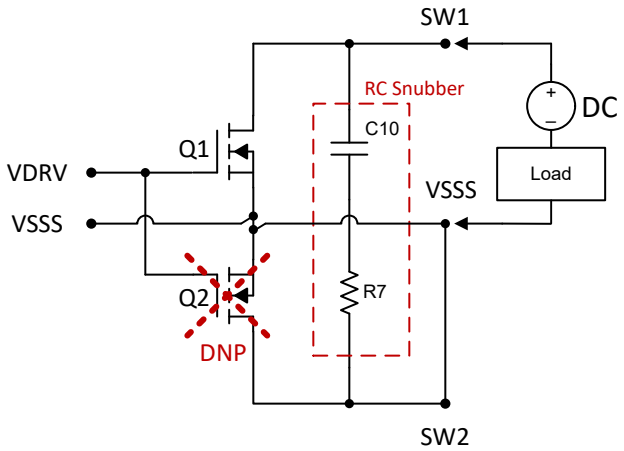

Figure 4-3. DC Load With RC Snubber

2. SCR configuration:
   a. Figure 4-4 shows a possible load configuration using an SCR. For this case, TI recommends to use the TPSI3050S-Q1, which allows for a one-shot operation to trigger enable with a pulse to drive an SCR. This action can be useful because a short duration of power can trigger most SCRs.

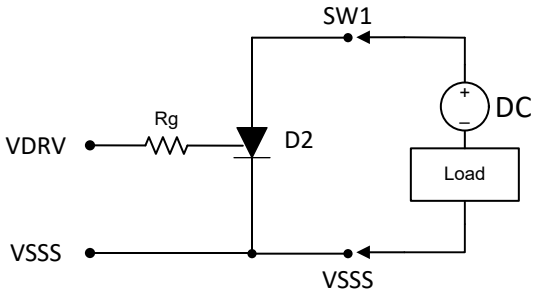

Figure 4-4. SCR for a DC Load

3. MOSFET or SCR for highly inductive loads:
   a. Figure 4-5 shows a possible load configuration for a highly inductive load. The setup can be accomplished using a Q1 (MOSFET) or D2 (SCR) for S1 (switching component). This setup has footprints to add D3, which can be used as a clamping diode to provide a connection to ground when S1 switches off the inductive load.

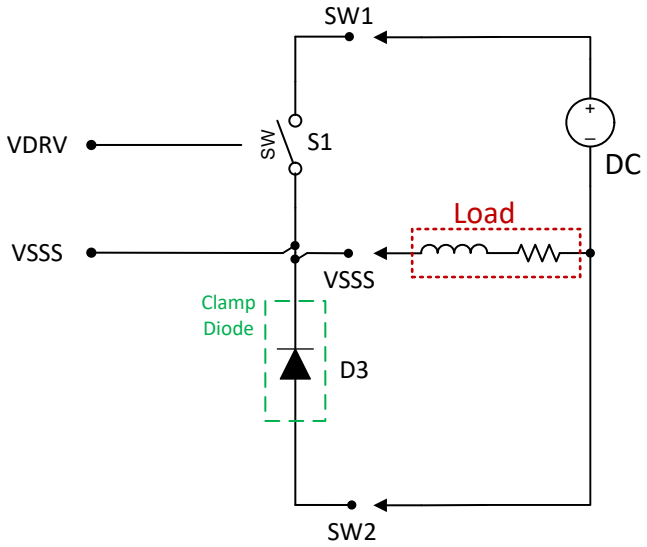

Figure 4-5. RL Load

5 Schematic

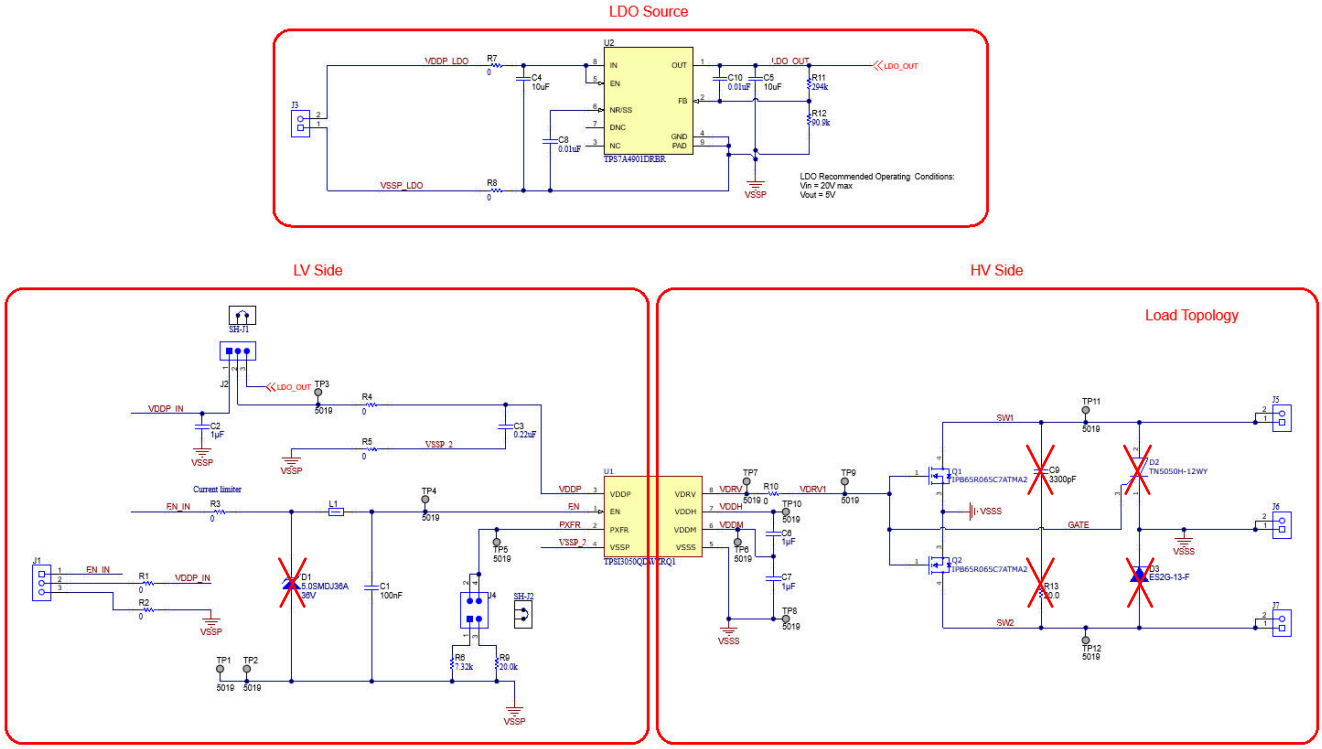

Figure 5-1. PSIL129 Schematic

6 Layout

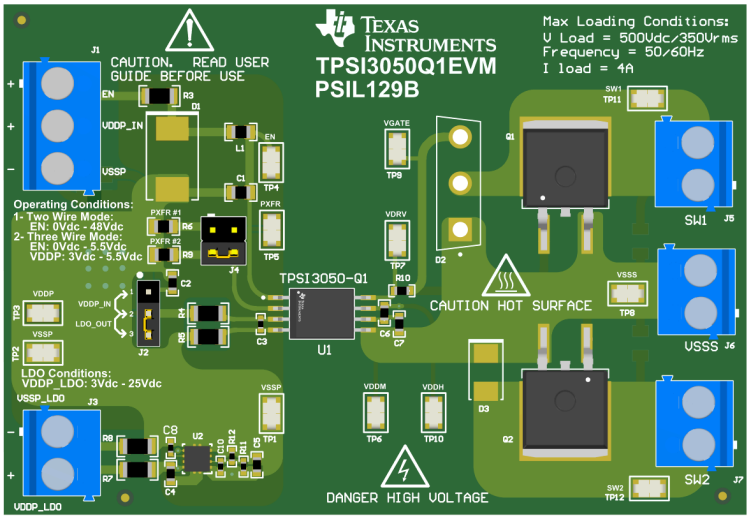

Figure 6-1. 3D View

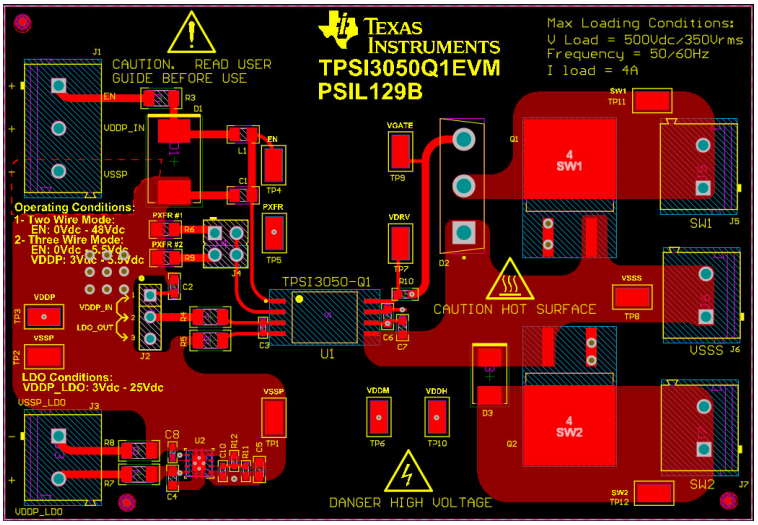

Figure 6-2. PCB Top Layer

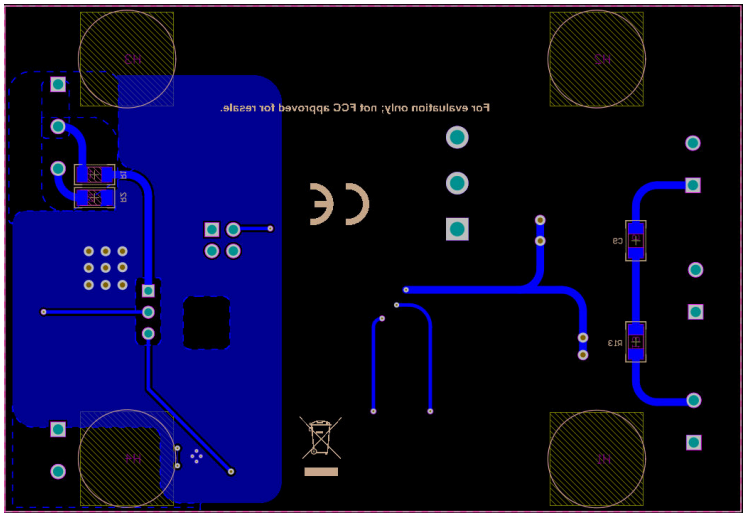

Figure 6-3. PCB Bottom Layer

7 Bill of Materials

Table 7-1. Bill Of Materials

Designator	Quantity	Description	PartNumber	Manufacturer
C1	1	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0805	GCM21BR71H104KA37K	MuRata
C2	1	CAP, CERM, 1 uF, 25 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0603	GCM188R71E105KA64D	MuRata
C3	1	CAP, CERM, 0.22 uF, 16 V, +/- 10%, X7R, 0402	GRM155R71C224KA12D	MuRata
C4, C5	2	CAP, CERM, 10 uF, 25 V, +/- 20%, X5R, 0603	GRT188R61E106ME13D	MuRata
C6, C7	2	CAP, CERM, 1 uF, 50 V, +/- 10%, X7R, 0603	UMK107AB7105KA-T	Taiyo Yuden

Table 7-1. Bill Of Materials (continued)

Designator	Quantity	Description	PartNumber	Manufacturer
C8, C10	2	CAP, CERM, 0.01 uF, 25 V, +/- 10%, X7R, 0402	GRM155R71E103KA01D	MuRata
H1, H2, H3, H4	4	Bumpon, Hemisphere, 0.44 X 0.20, Clear	SJ-5303 (CLEAR)	3M
J1	1	Terminal Block, 5 mm, 3x1, Tin, TH	691 101 710 003	Wurth Elektronik
J2	1	Header, 100mil, 3x1, Tin, TH	PEC03SAAN	Sullins Connector Solutions
J3, J5, J6, J7	4	Terminal Block, 5 mm, 2x1, Tin, TH	691 101 710 002	Wurth Elektronik
J4	1	Header, 2.54mm, 2x2, Gold, TH	PBC02DAAN	Sullins Connector Solutions
L1	1	Ferrite Bead, 2200 ohm @ 100 MHz, 0.2 A, 0805	742792094	Wurth Elektronik
Q1, Q2	2	MOSFET N-Channel 650V 33A (Tc) 171W (Tc) Surface Mount PG-TO263-3	IPB65R065C7ATMA2	Infineon
R1, R2, R3, R4, R5	5	RES, 0, 5%, 0.25 W, AEC-Q200 Grade 0, 1206	CRCW12060000Z0EA	Vishay-Dale
R6	1	RES, 7.32 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	ERJ-6ENF7321V	Panasonic
R7, R8	2	RES, 0, 5%, 0.25 W, AEC-Q200 Grade 0, 1206	ERJ-8GEY0R00V	Panasonic
R9	1	RES, 20.0 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	ERJ-6ENF2002V	Panasonic
R10	1	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	ERJ-3GEY0R00V	Panasonic
R11	1	RES, 294 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0402	ERJ-2RKF2943X	Panasonic
R12	1	RES, 90.9 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0402	ERJ-2RKF9092X	Panasonic
SH-J1, SH-J2	2	Shunt, 100mil, Gold plated, Black	SNT-100-BK-G	Samtec
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12	12	Test Point, Miniature, SMT	5019	Keystone
U1	1	Automotive Reinforced Isolated Switch Driver With Integrated 10-V Gate Supply	TPSI3050QDWZRQ1	Texas Instruments
U2	1	Vin 3V to 36V, 150mA, Ultra-Low-Noise, High-PSRR Low-Dropout (LDO) Linear Regulator, DRB0008A (VSON-8)	TPS7A4901DRBR	Texas Instruments

8 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision B (May 2022) to Revision C (August 2022)	Page
• Updated *Operating Modes* section	7
• Updated *Schematic* section	14
• Updated *Layout* section	14
• Updated *Bill of Materials* section	15

Changes from Revision A (December 2021) to Revision B (May 2022)	Page
• Changed DUTY pin to PXFR pin throughout the document	5
• Updated all images	5
• Added the *Section General Texas Instruments High Voltage Evaluation (TI HV EVM) User Safety Guidelines*	5
• Updated the *Features* section	5
• Updated the *Applications* section	6
• Added measurements for two-wire mode	7
• Added measurements for three-wire mode	9

Changes from Revision * (October 2021) to Revision A (December 2021)	Page
• Updated the document title	1

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.

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。
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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1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明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.

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8. *Limitations on Damages and Liability:*

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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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