TPS61093EVM-519 User's Guide

The TPS61093EVM is an evaluation board to assist in evaluting the TPS61093 IC as a boost or step-up power supply.

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1 Introduction

1.1 Description

The TPS61093 is a 1.2-MHz, fixed-frequency boost converter designed for high integration and high reliability. The IC integrates a 20-V power switch, input/output isolation switch, and power diode. When the output current exceeds the over load limit, the IC's isolation switch opens up to disconnect the output from the input. This protects the IC and the input supply. The isolation switch also disconnects the output from the input during shutdown to minimize leakage current. When the IC is shutdown, the output capacitor is discharged to a low voltage level by internal diodes. Other protection features include 1.1-A peak over-current protection (OCP) at each cycle, output over voltage protection (OVP), thermal shutdown, and under voltage lockout (UVLO).

With its 1.6-V minimum input voltage, the IC can be powered by two alkaline batteries, a single Li-ion battery, or 3.3-V and 5-V regulated supply. The output can be boosted up to 17-V. The TPS61093 is available in 2.5 mm $\times$ 2.5 mm SON package with thermal pad.

1.2 Applications

- Glucose Meter
- OLED Power Supply
- 3.3-V to 12-V, 5-V to 12-V Boost Converter

1.3 Features

- Input Range: 1.6-V to 6-V
- Integrated Power Diode and Isolation FET
- 20-V Internal Switch FET With 1.1-A Current
- Fixed 1.2-MHz Switching Frequency
- Over Load and Over Voltage Protection
- Programmable Soft Start-up
- Load Discharge Path After IC Shutdown

2 TPS61093EVM Electrical Performance Specifications

The specifications below are for TA = 25°C unless otherwise specified.

Table 1. TPS61093EVM Electrical and Performance Specifications

Parameter		Notes & Conditions	Min	Nom	Max	Units
INPUT CHARACTERISTICS						
V_{IN} at J1	Input Voltage		1.6		6	V
V_{IN_UVLO}	Input UVLO	V_{IN} falling		1.5	1.55	V
OUTPUT CHARACTERISTICS						
OUT at J7	Output Voltage	V_{IN} = 1.6 V, I_{OUT} < 25 mA	14.4	15.0	15.6	V
		V_{IN} = 6 V, I_{OUT} < 300 mA				
F_{SW}	Switching Frequency		1.0	1.2	1.4	MHz

3 Modifications

3.1 General

To aid user customization of the EVM, the board was designed with devices having 0603 or larger footprints. A real implementation likely occupies less total board space. Changing components can improve or degrade EVM performance. For example, adding a larger output capacitor reduces output voltage undershoot but lengthens response time after a load transient event. Due to the internal compensation, the inductor and output capacitor must remain within the datasheet limits in order for the boost converter to remain control loop stability.

3.2 Output Voltage

The TPS61093's output voltage is adjutable and is set by resistors R1 and R2. To change the output voltage, the user should consult the datasheet on how to properly size R1 and R2 and potentially C6.

3.3 Using VO instead of OUT

The TPS61093 has two output pins, OUT and VO. The EVM is designed to regulate the voltage on the OUT pin, with external loads being applied between J7 and J8. If the application requires slightly higher efficiency at heavy loads but does not need input-to-output isolation during shutdown or over load protection, the user can modify the EVM so that it regulates the voltage at the VO pin by

- moving the 0 ohm resistor from R4 to R3,
- replacing C2=0.1uF with a 1 uF or larger output capacitor and
- removing C4=1uF.

Once the above modifications are made, the user must only apply external loads between J4 and J6 in order for the converter to properly regulate the output voltage.

4 Schematic

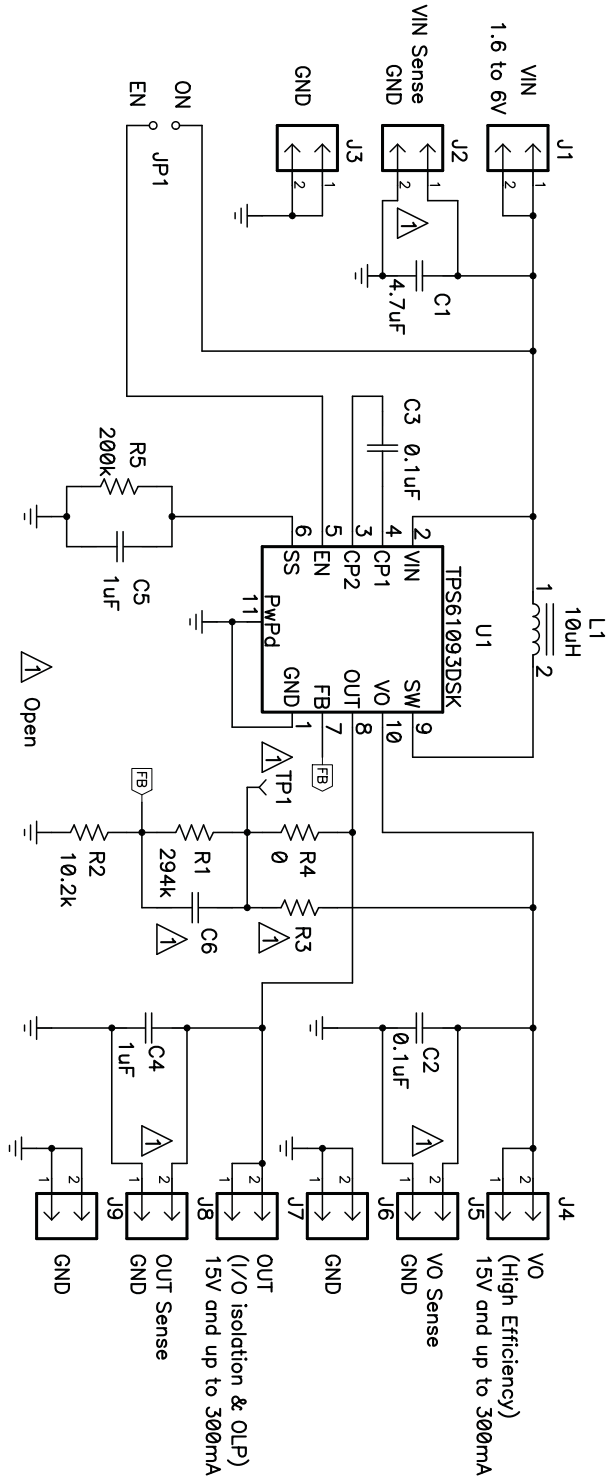

Figure 1. TPS61093 EVM Schematic

5 Connector and Test Point Descriptions

5.1 J1 –VIN

This header is the positive connection to the input power supply and is tied to the ICs VIN pin. The power supply must be connected between J1 and J3 (GND). The leads to the input supply should be twisted and kept as short as possible. The input voltage must be between 1.6-V and 6-V.

5.2 J2 – VIN and GND Kelvin Sense

Although not installed, this header provides Kelvin sense connections across the input capacitor C1.

5.3 J3 – GND

This header is the return connection to the input power supply and is tied to the ICs GND pin. The user must connect the power supply between J3 and J1 (VIN). The leads to the input supply should be twisted and kept as short as possible. The input voltage must be between 1.6-V and 6-V.

5.4 J4 – VO

This header connects to the pin that is the output of the non-synchronous boost converter before the input-to-output isolation switch. Unless the modifications in section 3.2 are made, this header should only be used for measuring the boost converter output voltage prior to the input-to-output isolation. If the modifications in section 3.2 are made, then the output voltage at this header is the regulated output voltage and the user can apply external loads between J4 and J6 (GND).

5.5 J5– VO and GND Kelvin Sense

Although not installed, this header provides Kelvin sense connections across the input capacitor C2.

5.6 J6 – GND

This header is connected to the IC's GND pin. If the modifications in section 3.2 are made to cause the voltage at J4 to be the regulated output voltage, then this header provides the return connection for an external load applied at J4.

5.7 J7– OUT

This header connects to the pin that is the output of the non-synchronous boost converter after the input-to-output isolation switch. Unless the modifications in section 3.2 are made, the output voltage at this header is the regulated output voltage and external loads can be applied between J7 and J9 (GND). If the modifications in section 3.2 are made, this header should not be used.

5.8 J8– OUT and GND Kelvin Sense

Although not installed, this header provides Kelvin sense connections across the input capacitor C4.

5.9 J9– GND

This header is connected to the IC's GND pin and provides the return connection for an external load applied at J7.

5.10 JP1– EN

Pin one of this jumper connects to the IC's EN pin. When its shunt is installed, this jumper ties the EN pin to VIN thereby turning on the boost converter. The isolation switch also turns on and connects pins VO (J4) and OUT (J7). Removing the shunt from this jumper allows its internal pull down resistor to pull it to ground thereby disabling the converter and disconnecting VO (J4) and OUT (J7).

5.11 TP1 – Test Point

This test point can be used to measure the small signal control loop gain and phase with a Venable or similar gain phase analyzer. The user must replace the 0-ohm resistor in R3 or R4 with a 49.9-100 ohm resistor before attaching a gain/phase analyzer between the output voltage and TP1.

6 Test Setup and Results

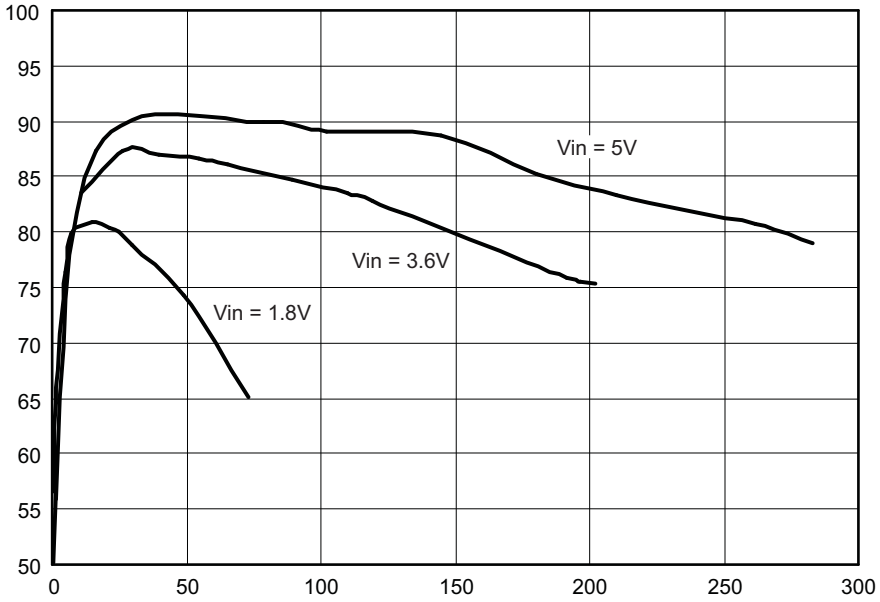

Figure 2. Efficiency at OUT

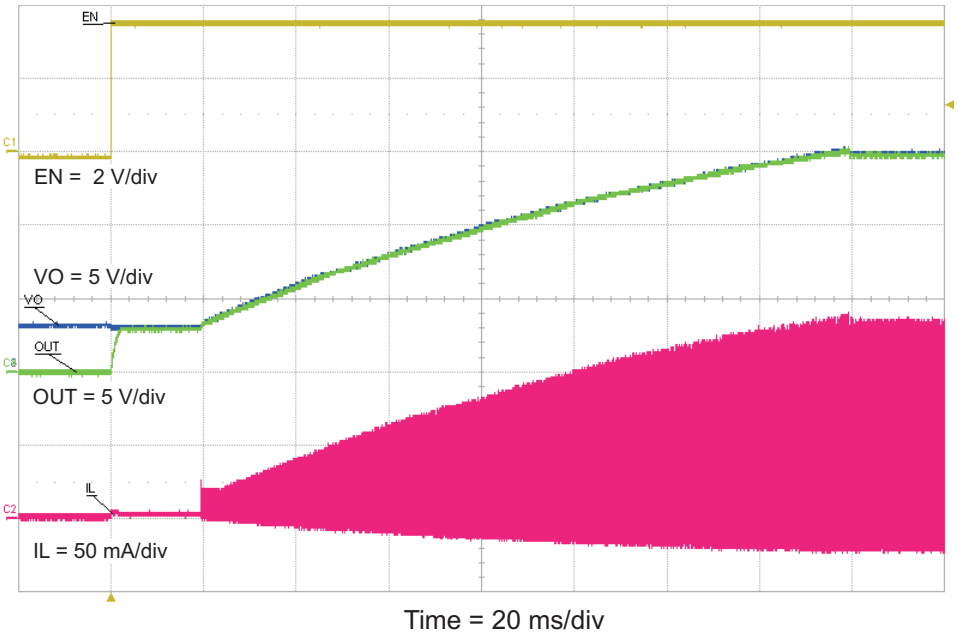

Figure 3. Startup with V_{IN} = 3.6V and R_{LOAD} = 1500 Ω

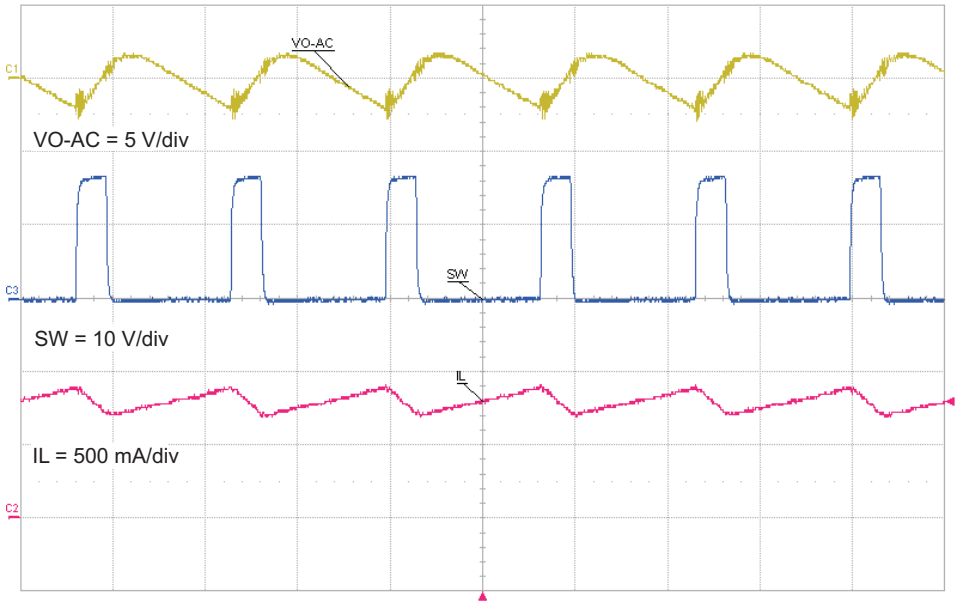

Figure 4. Operation with V_{IN} = 3.6V and I_{OUT} = 200mA

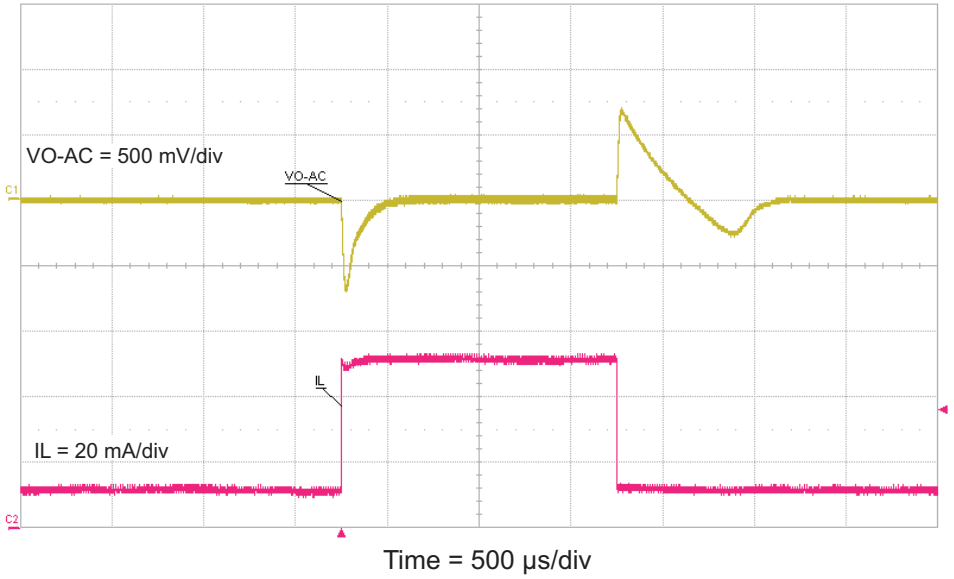

Figure 5. Load Transient with V_{IN} = 2.5V and I_{OUT} from 10mA to 50mA

7 EVM Assembly Drawings and Layout

Figure 6 through Figure 8 show the design of HPA519, the TPS61093EVM's printed circuit board. The EVM has been designed using a 2-Layer, 1oz copper-clad, 2 inch x 2 inch circuit board.

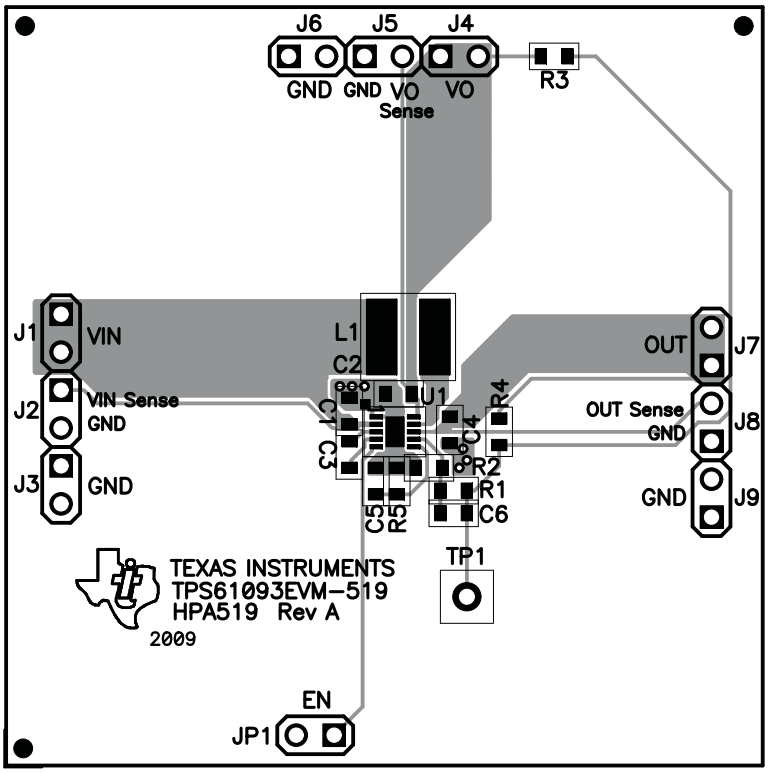

Figure 6. TPS61093EVM Top and Silkscreen (Viewed from Top)

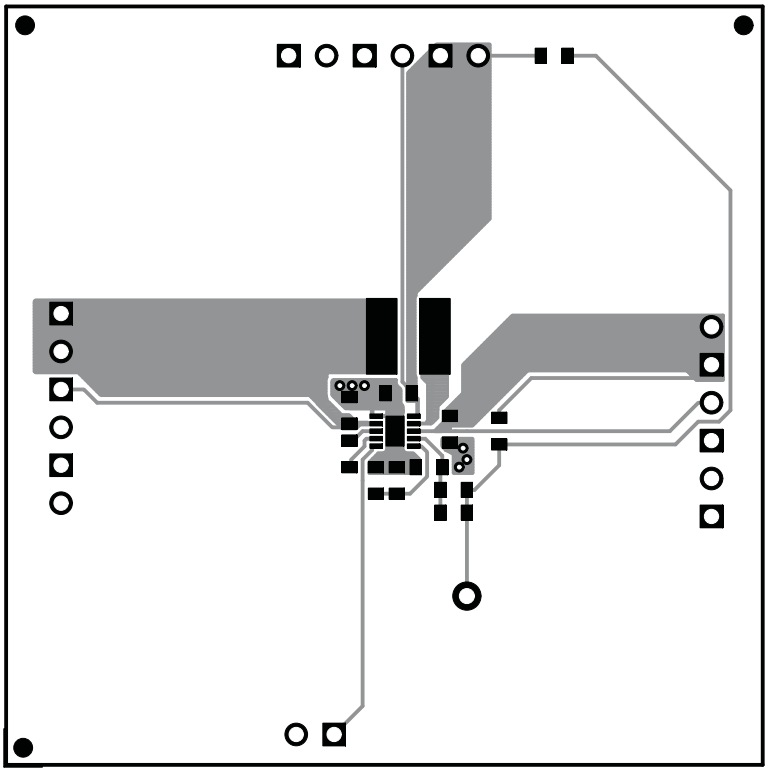

Figure 7. TPS61093EVM Top Copper

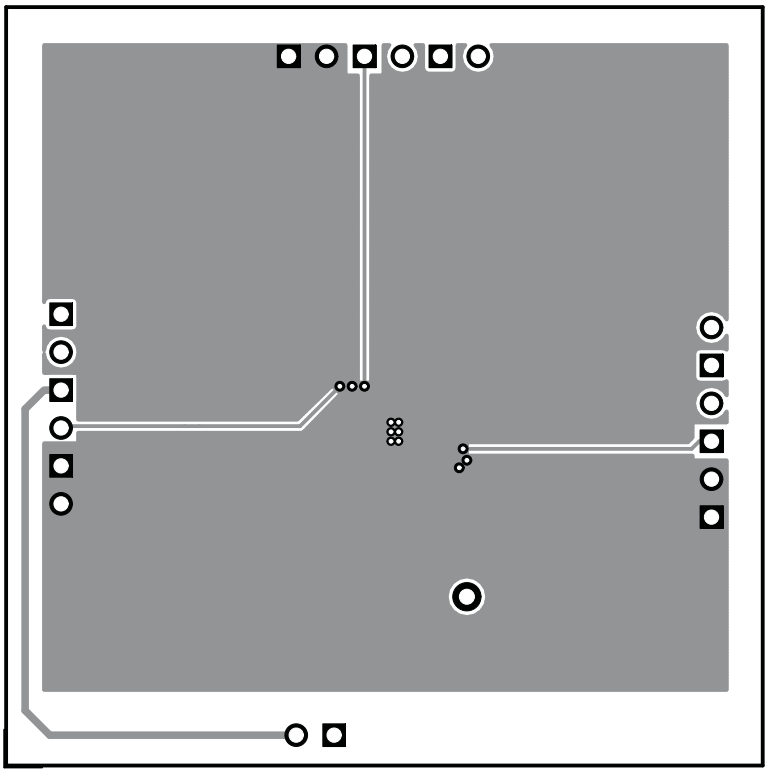

Figure 8. TPS61093 EVM Bottom Layer

8 Bill of Materials

Table 2 lists the EVM components as configured according to the schematic shown in Figure 1.

Table 2. TPS61093EVM Bill of Materials

Count	RefDes	Value	Description	Size	Part Number	MFR
1	C1	4.7µF	Capacitor, Ceramic, 6.3V, X5R, 20%	0603	Std	Std
1	C2	0.1µF	Capacitor, Ceramic, 25V, X5R, 20%	0603	Std	Std
1	C3	0.1µF	Capacitor, Ceramic, 6.3V, X5R, 20%	0603	Std	Std
1	C4	1µF	Capacitor, Ceramic, 25V, X5R, 20%	0603	Std	Std
1	C5	1µF	Capacitor, Ceramic, 6.3V, X5R, 20%	0603	Std	Std
0	C6	Open	Capacitor, Ceramic, 6.3V, X5R, 20%	0603	Std	Std
0	J2, J5, J8	Open	Header, Male 2-pin, 100mil spacing	0.100 inch x 2	PEC02SAAN	Sullins
6	J1, J3, J4, J6, J7, J9	PEC02SAAN	Header, Male 2-pin, 100mil spacing,	0.100 inch x 2	PEC02SAAN	Sullins
1	JP1	PEC02SAAN	Header, 2-pin, 100mil spacing Inductor,	0.100 inch x 2	PEC02SAAN	Sullins
1	L1	10uH	SMT, 1.4A, 127 milliohm	0.189 x 0.189 inch	LPS5030-103ML	Coilcraft
1	R1	294k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R2	10.2k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	R3	Open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R4	0	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R5	200k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	TP1	Open	Test Point, Red, Thru Hole Color Keyed	0.100 x 0.100 inch	5000	Keystone
1	U1	TPS61093DSK	IC, Low Input Boost Converter with Integrated Power Diode and Isolation	QFN	TPS61093DSK	TI
1	—		Shunt, 100-mil, Black	0.100	929950-00	3M
1			PCB	2.0"x 2.0"x 0.062"	HPA519	Any

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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

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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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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.

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6. *Disclaimers:*

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Last updated 10/2025