TPS63010EVM-235

This user's guide describes the characteristics, operation, and use of the TPS63010EVM evaluation module (EVM). This EVM is designed to help the user easily evaluate and test the operation and functionality of the TPS63010 single-inductor, buck-boost converter. This document includes setup instructions for the hardware, a schematic diagram, a bill of materials, and printed-circuit board (PCB) layout drawings for the EVM.

Contents

List of Figures

List of Tables

1 Introduction

The Texas Instruments TPS63010 is a high-efficiency, single-inductor, buck-boost converter in a 20-pin, WCSP package. Both fixed and adjustable output voltage units are available.

1.1 Background

The TPS63010EVM-235 uses the TPS63010 adjustable version and is set to 3.3-V output. The EVM operates with full-rated performance with an input voltage between 2 V and 5.5 V. However, the input voltage at start up must be at least 2.2 V. Once the TPS63010 has started switching, the input voltage can be reduced to 2 V.

1.2 Performance Specification

Table 1 provides a summary of the TPS63010EVM-235 performance specifications. All specifications are given for an ambient temperature of 25°C.

Table 1. Performance Specification Summary

Specification	Test Conditions	Min	Typ	Max	Unit
Input voltage	Iout = 500 mA	2	3.6	5.5	V
Output voltage	Iout = 0 mA to 500 mA	3.25	3.3	3.40	V
Output current	3.6 V in	0	500	1200	mA
Operating frequency			2400		kHz
Maximum efficiency	4.2 V in at 300-mA load		94.2%		
Output ripple	3.6 V in at 500-mA load		25		mV

1.3 Modifications

The PCB for this EVM is designed to accommodate both the fixed and adjustable versions of this integrated circuit (IC). If the fixed version is installed, R1 is replaced with a 0-Ω resistor and R2 is open.

1.3.1 Adjustable Output IC U1 Operation

U1 is configured for evaluation of the adjustable output version. This unit is configured for 3.3 V. Resistors R1 and R2 are used to set the output voltage between 1.2 V and 5.5 V. See the data sheet (SLVS653) for recommended values.

1.3.2 Fixed Output Operation

U1 can be replaced with the fixed version for evaluation. If U1 is replaced, R1 needs to be replaced with a 0-Ω resistor, and the R2 position needs to be open.

2 Setup and Results

This section describes how to properly use the TPS63010EVM-235.

2.1 Input/Output Connector and Header Descriptions

2.1.1 J1 – VIN

J1-1 is the positive sense (+S) for the positive input connection from the input supply for U1. J1-2 is the positive voltage connection (VIN) from the input supply to U1. J1-1 and J1-2 are electrically common.

2.1.2 J2 – GND

J1-1 is the return voltage connection (GND) from the input supply to U1. J2-2 is the negative sense (-S) for the return voltage connection from the input supply for U1. J2-1, J2-2, J4-1 and J4-2 are electrically common.

2.1.3 J3 – VOUT

J3-1 is the positive sense (+S) for the positive output connection to the load. J1-2 is the positive output connection (VOUT). J3-1 and J3-2 are electrically common.

2.1.4 J4 – GND

J4-1 is the return output connection (GND). J4-2 is the positive sense (-S) for the return output connection to the load. J2-1, J2-2, J4-1 and J4-2 are electrically common.

2.1.5 JP1 – EN

Enable function control jumper. JP1-1 (EN) is connected to Vin. JP1-2 (EN) is connected to U1-A4. J1-3 (DIS) is connected to ground. Shorting jumper JP1 between the JP1-1 (EN) and center pin JP1-2 (EN) turns on the unit. Shorting the jumper JP1 between the JP1-3 (DIS) and center pin JP1-2 (EN) turns on the unit off.

2.1.6 JP2 –PS

Power Save mode control jumper. JP2-1 (DIS) is connected to Vin. JP2-2 (PS) is connected to U1-C4. J2-3 (EN) is connected to ground. Shorting jumper JP2 between the JP2-1 (DIS) and center pin JP2-2 (PS) turns Power Save mode off. Shorting the jumper JP1 between the JP2-3 (EN) and center pin JP2-2 (PS) turns Power Save mode on.

2.1.7 JP3–VSEL

Voltage Select mode control jumper. Used to set high or low voltage option when the EVM is configured for use with the TPS63011 or the TPS63012. JP3-1 (HI V) is connected to Vin. JP3-2 (VSEL) is connected to U1-D4. J3-3 (LO V) is connected to ground. Shorting jumper JP3 between the JP3-1 (HI V) and center pin JP3-2 (VSEL) selects the higher voltage option. Shorting the jumper JP3 between the JP3-3 (LO V) and center pin JP3-2 (VSEL) selects the lower voltage option. JP3 must be set to either position for operation with the TPS63010.

2.1.8 JP4 –SYNC

SYNC mode control and input jumper. JP4-1 (N/A) is connected to Vin. JP4-2 (SYNC) is connected to U1-B4. J4-3 (DIS) is connected to ground. Shorting jumper JP4 between the JP4-3 (DIS) and center pin JP4-2 (SYNC) disables external synchronization. Leave JP4 open to enable SYNC function control. JP4-2 center pin is SYNC input and is used to synchronize the unit with an external clock.

2.2 Setup

To operate the EVM, simply connect an input supply to the appropriate pins, connect a load to the appropriate pins. Maximum recommended load is dependent on input supply voltage. Typically, the TPS63010 is capable of 800 mA in boost mode (Vin > 2.4 V) and 1.2 A in buck mode (Vin ≥3.6). Input supply voltage of 2 V to 5.5 V is recommended. The TPS63010 requires a minimum input voltage of 2.2 V at power up. After the device is switching the input voltage can be lowered to 2 V.

2.3 Power Up

After being enabled, the device starts operating. The average current limit ramps up from an initial 400 mA following the output voltage increasing. At an output voltage of about 1.2 V, the current limit is at its nominal value. Output voltage is monitored during this time and must increase for switch current to increase. In the start-up waveform pictured, CH1 is EN, CH2 is Vout and CH3 is Iin.

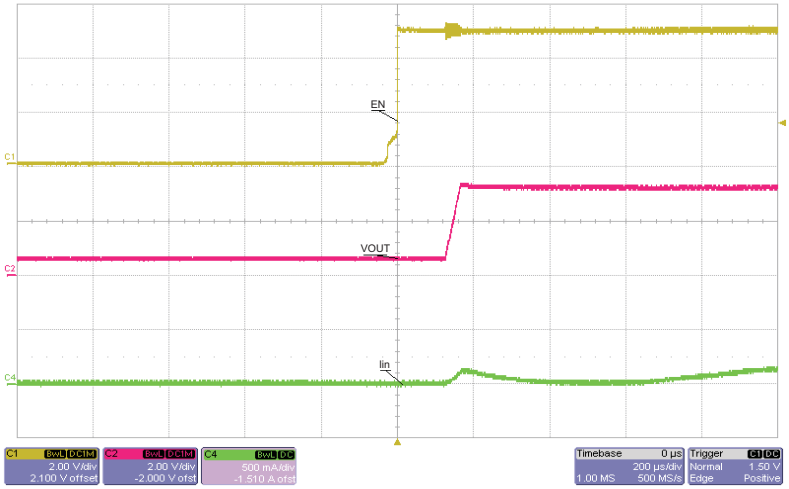

Figure 1. Turn ON Into Electronic Load

2.4 Output Ripple

Output ripple occurs at the switching frequency of 2.4 MHz, and with the recommended L and output C, is low. Amplitude of the ripple varies, depending on load current and input voltage. Ensure that the oscilloscope probe is connected as close as possible to the output capacitor, with a short ground lead, for accurate measurements. Resistance in trace and leads adds to output ripple, and ground lead length increases the amplitude of switching spikes. In the voltage ripple waveforms pictured, CH1 is L1 (U1-B1 and U1-B2), CH2 is Vout and CH3 is L2 (U1-D1 and U1-D2).

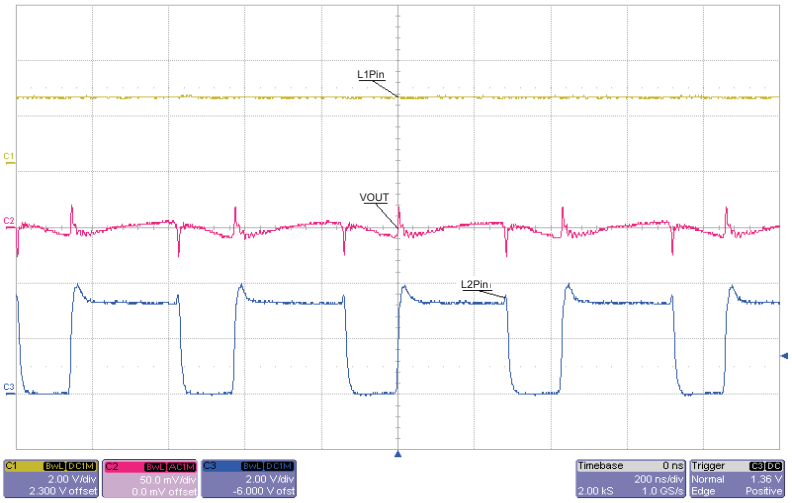

Figure 2. Output Ripple Vin 3 V

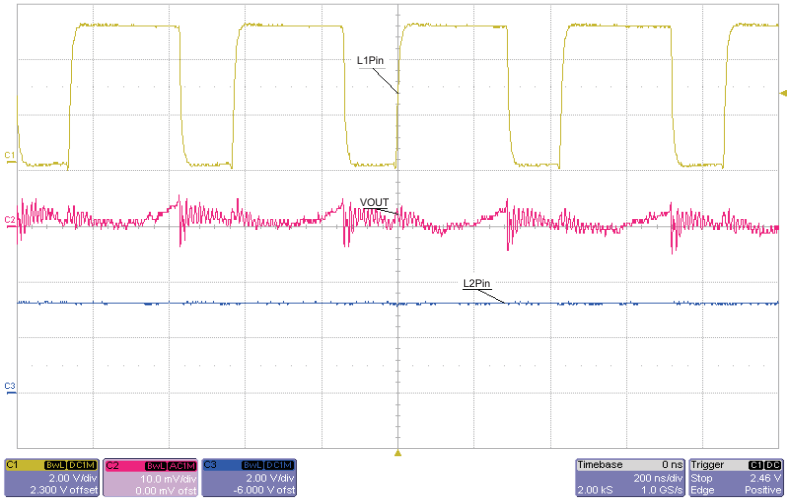

Figure 3. Output Ripple Vin 5 V

2.5 Efficiency

Efficiency is shown in the following graph. Peak efficiency occurs between 300- and 400-mA load currents.

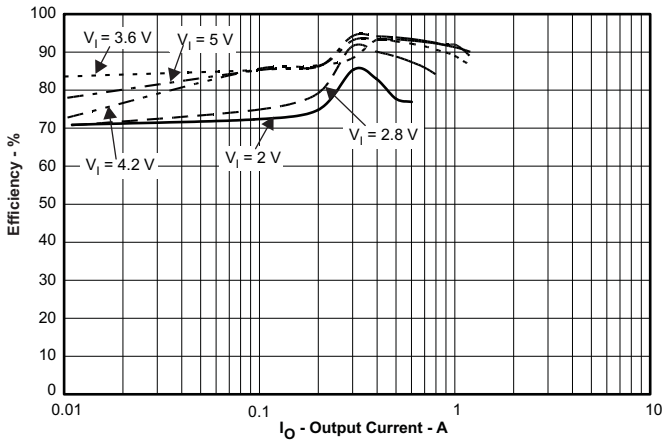

Figure 4. Efficiency Over Li-Ion Cell Range

2.6 Load Transients

Load transient response is well regulated. Additional output capacitance reduces voltage over- and undershoot.

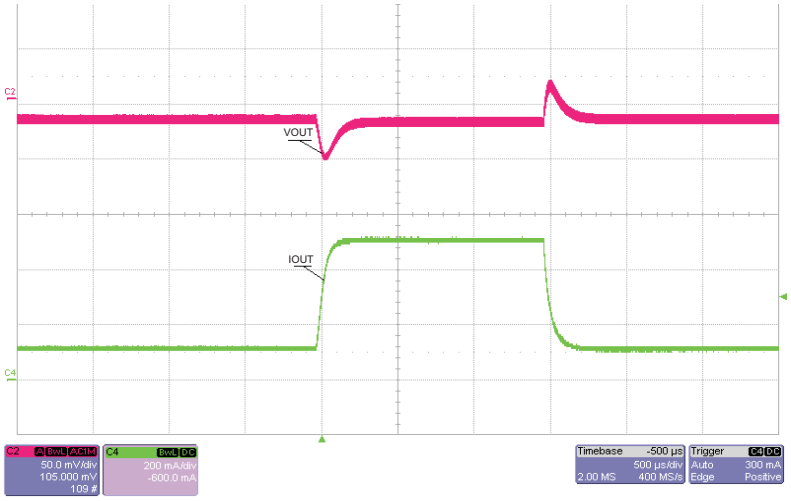

Figure 5. Load Step 100 mA to 500 mA

2.7 Closed Loop Response

The closed loop response for the TPS63010 EVM is shown for Vin = 5 V and Iout = 500 mA.

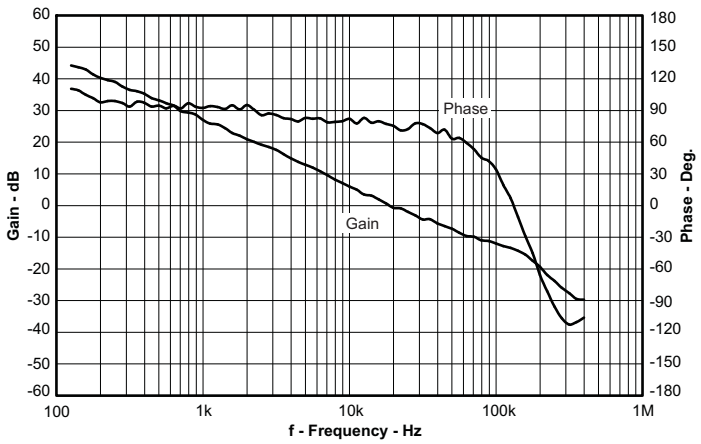

Figure 6. Closed Loop Response

3 Board Layout

This section provides the TPS63010EVM-235 board layout and illustrations.

3.1 Layout

Figure 7 through Figure 9 show the board layout for the TPS63010EVM-235 PCB.

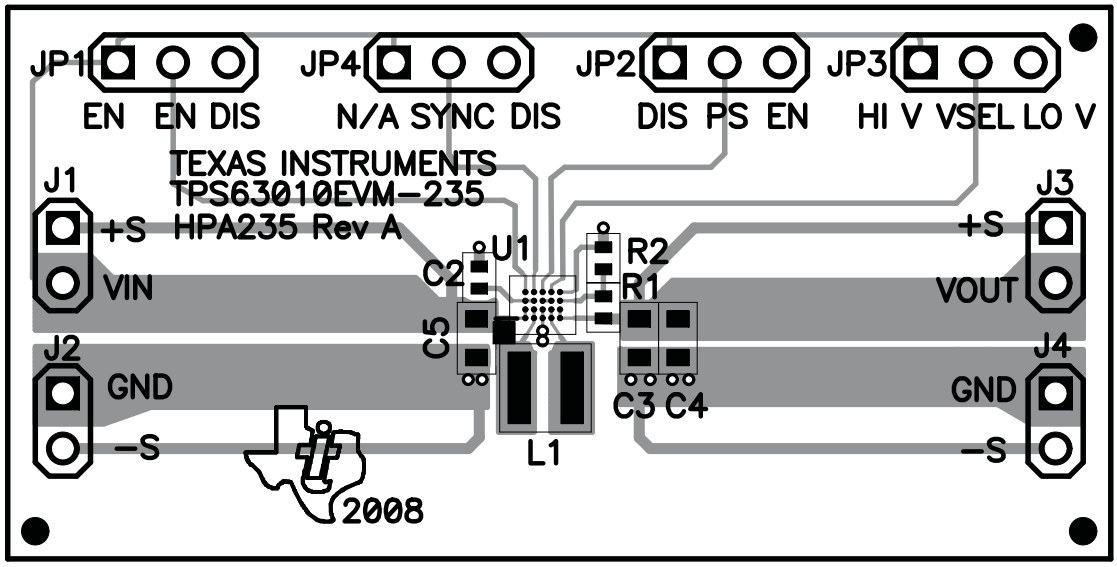

Figure 7. Assembly Layer

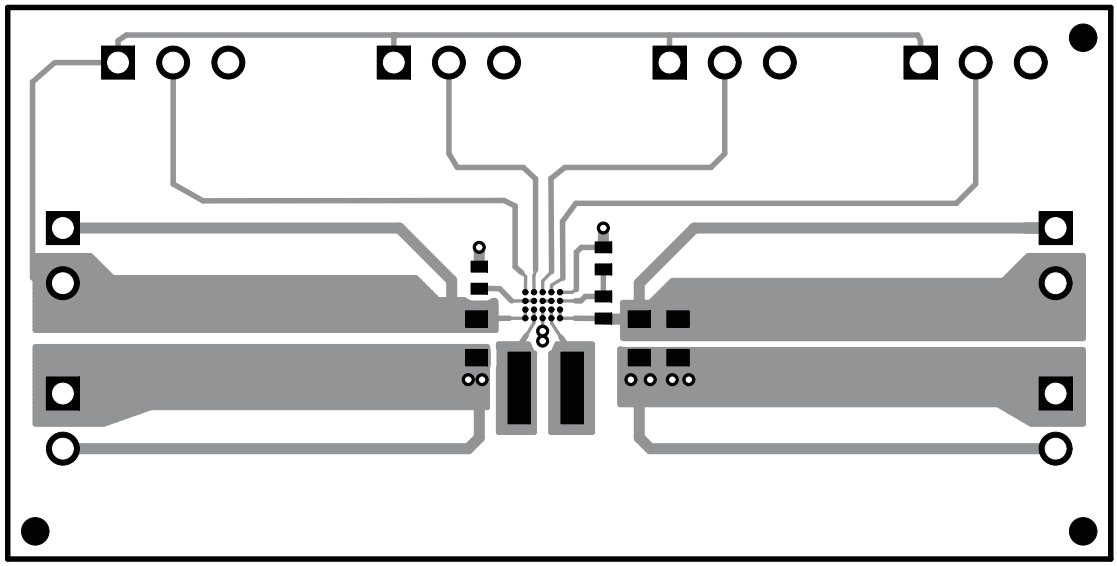

Figure 8. Top Layer Routing

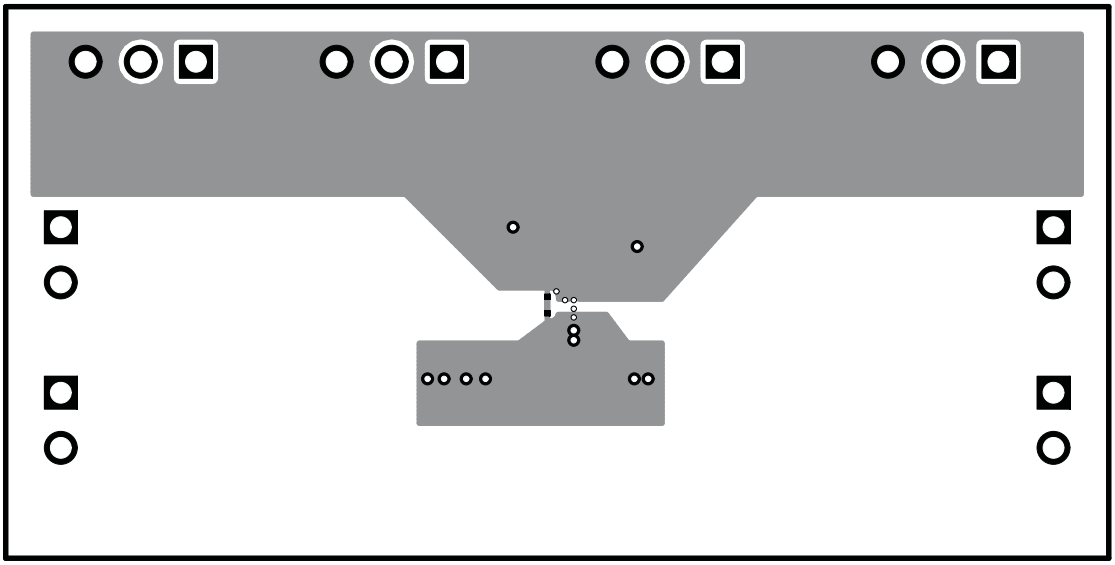

Figure 9. Bottom Layer Routing

4 Schematic and Bill of Materials

This section provides the TPS63010EVM-235 schematic and bill of materials.

4.1 Schematic

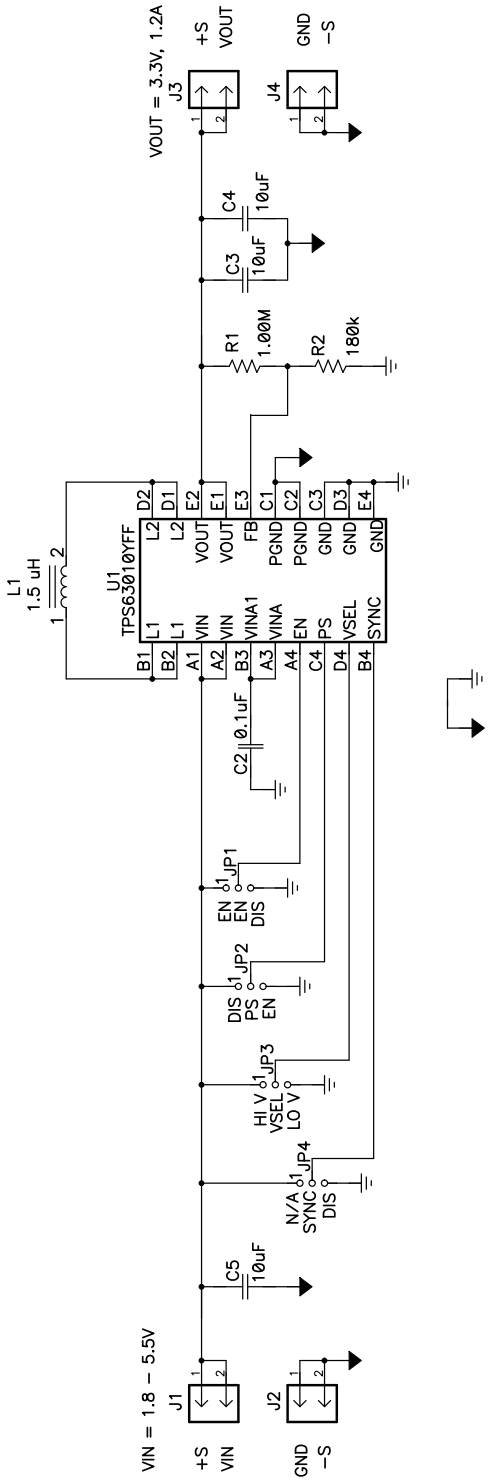

Figure 10. TPS63010EVM-235 Schematic

4.2 Bill of Materials

Table 2. TPS63010EVM-235 Bill of Materials

Count	RefDes	Value	Description	Size	Part Number	MFR
1	C2	0.1 µF	Capacitor, Ceramic, 16V, X7R, 10%	0402	GRM155R71C104KA88D	Murata
3	C3–C5	10 µF	Capacitor, Ceramic, 6.3V, X5R, 20%	0603	ECJ-1VB0J106M	Panasonic
4	J1–J4	PTC36SAAN	Header, 2-pin, 100mil spacing, (36-pin strip)	0.100 inch x 2	PTC36SAAN	Sullins
4	JP1–JP4	PTC36SAAN	Header, 3-pin, 100mil spacing, (36-pin strip)	0.100 inch x 3	PTC36SAAN	Sullins
1	L1	1.5 µH	Inductor, SMT, 2.1A, 100milliohm	0.118 x 0.118 inch	LPS3015-152ML	Coilcraft
1	R1	1.00 M	Resistor, Chip, 1/16W, 1%	0402	Std	Std
1	R2	180k	Resistor, Chip, 1/16W, 1%	0402	Std	Std
1	U1	TPS63010YFF	IC, High Efficient Single Inductor Buck-Boost Converter	WCSP	TPS63010YFF	TI
1	—		PCB, 2 In x 1 In x 0.062 In		HPA235A	Any
4	—		Shunt, 100-mil, Black	0.1	929950-00	3m

Notes: 1. These assemblies are ESD sensitive, ESD precautions shall be observed.
2. These assemblies must be clean and free from flux and all contaminants. Use of no clean flux is not acceptable.
3. These assemblies must comply with workmanship standards IPC-A-610 Class 2.
4. Ref designators marked with an asterisk ('**') cannot be substituted.
All other components can be substituted with equivalent MFG's components.
5. **Maximum 30 grams placement pressure on WCSP parts.**

4.3 Related Documentation From Texas Instruments

TPS63010 data sheet (SLVS653)

4.4 If You Need Assistance

Contact your local TI sales representative.

EVALUATION BOARD/KIT IMPORTANT NOTICE

Texas Instruments (TI) provides the enclosed product(s) under the following conditions:

This evaluation board/kit is intended for use for **ENGINEERING DEVELOPMENT, DEMONSTRATION, OR EVALUATION PURPOSES ONLY** and is not considered by TI to be a finished end-product fit for general consumer use. Persons handling the product(s) must have electronics training and observe good engineering practice standards. As such, the goods being provided are not intended to be complete in terms of required design-, marketing-, and/or manufacturing-related protective considerations, including product safety and environmental measures typically found in end products that incorporate such semiconductor components or circuit boards. This evaluation board/kit does not fall within the scope of the European Union directives regarding electromagnetic compatibility, restricted substances (RoHS), recycling (WEEE), FCC, CE or UL, and therefore may not meet the technical requirements of these directives or other related directives.

Should this evaluation board/kit not meet the specifications indicated in the User's Guide, the board/kit may be returned within 30 days from the date of delivery for a full refund. THE FOREGOING WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies TI from all claims arising from the handling or use of the goods. Due to the open construction of the product, it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge.

EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

TI currently deals with a variety of customers for products, and therefore our arrangement with the user **is not exclusive.**

TI assumes **no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein.**

Please read the User's Guide and, specifically, the Warnings and Restrictions notice in the User's Guide prior to handling the product. This notice contains important safety information about temperatures and voltages. For additional information on TI's environmental and/or safety programs, please contact the TI application engineer or visit www.ti.com/esh.

No license is granted under any patent right or other intellectual property right of TI covering or relating to any machine, process, or combination in which such TI products or services might be or are used.

FCC Warning

This evaluation board/kit is intended for use for **ENGINEERING DEVELOPMENT, DEMONSTRATION, OR EVALUATION PURPOSES ONLY** and is not considered by TI to be a finished end-product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment in other environments may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage range of 3.6 V to 5.5 V and the output voltage range of 1000 mA.

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's 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, some circuit components may have case temperatures greater than 50 C. The EVM is designed to operate properly with certain components above 50 C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		**Applications**	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DSP	dsp.ti.com	Broadband	www.ti.com/broadband
Clocks and Timers	www.ti.com/clocks	Digital Control	www.ti.com/digitalcontrol
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
RFID	www.ti-rfid.com	Telephony	www.ti.com/telephony
RF/IF and ZigBee® Solutions	www.ti.com/lprf	Video & Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265