TPS65137A Evaluation Module

This user's guide describes the characteristics, operation, and use of the TPS65137A evaluation module (EVM). This EVM contains the Texas Instruments OLED display supply IC TPS65137A with a minimum switch current of 0.9 A on the boost converter, OUTP, and a minimum switch current of 1.1 A on the negative buck-boost converter, OUTN. The user's guide includes EVM specifications, the recommended test setup (hardware and software), the schematic diagram, the bill of materials, and the board layout.

Contents

List of Figures

List of Tables

1 Introduction

The Texas Instruments TPS65137A EVM uses a TPS65137A 200-mA, dual-output, AMOLED (Active Matrix Organic Light-Emitting Diode) display power regulator to provide both a positive and negative power rail. The goal of the EVM is to facilitate evaluation of the TPS65137A. The TPS65137A is designed to provide best-in-class picture quality for AMOLED displays requiring positive and negative voltage supply rails. With its wide input voltage range, the device is ideally suited for AMOLED displays, which are used in mobile phones or smart phones. With this device, the input voltage can be higher than the positive output voltage and still maintains accurate regulation of OUTP. Using the digital control pin (CTRL) allows adjustment of the negative output voltage in digital steps. The TPS65137A uses a novel technology enabling excellent line and load regulation with minimum output voltage ripple by using an LDO post regulator for OUTP. This is required in order to avoid disturbance of the AMOLED display due to input voltage transients occurring during transmit periods in mobile phones.

1.1 Requirements

The negative output voltage, OUTN, can be adapted through the CTRL one-wire interface to the individual needs of the application. All components and connectors for this voltage change are supplied in the EVM except for the host computer and the DC power supply. Software must be downloaded from the TI Web site at www.ti.com, if needed.

1.1.1 Power Supply

In order to operate this EVM, only a DC power supply capable of delivering between 2.3 V and 5.5 V at up to 1.5 A is necessary. The EVM is fully functional, except changing the negative output voltage, with just a power supply connected.

1.1.2 Host Computer

A computer with a USB port is required to operate this EVM. The TPS65137A software runs on the personal computer (PC) and communicates with the EVM via the PC's USB port.

PC Requirements:

- Windows™ XP operating system with Service Pack 2
- USB port
- Minimum of 280 MB of free hard disk space (610 MB recommended)
- Minimum of 512 MB of RAM

1.1.3 Software

Texas Instruments provides the software necessary to evaluate the TPS65137AEVM. Check the TPS65137A product folder on the TI Web site (www.ti.com) for updates to the software.

1.2 Application

Active Matrix OLED Power Supply

1.3 Features

- 2.3-V to 5.5-V input voltage range
- 1 % output voltage accuracy OUTP
- Excellent line transient regulation
- Low-noise operation
- 200-mA output current
- Fixed, 4.6-V positive output voltage
- Digitally programmable negative output voltage down to –5.2 V
- –4.9-V default value for OUTN
- Advanced Power-Save mode
- Short-circuit protection
- Thermal shutdown
- High-impedance output in shutdown
- Double-sided, two-active-layer PCB with all components on top side

2 TPS65137AEVM Electrical and Performance Specifications

Table 1. TPS65137AEVM Electrical and Performance Specifications

Parameter		Notes and Conditions	Min	Typ	Max	Unit
Input Characteristics						
V_{IN}	Input Voltage		2.3		5.5	V
I_{IN}	Input Current	V_{IN} = 3.5 V, I_{out} = 200 mA		680		mA
	No Load Input Current	V_{IN} = 3.5 V, I_{OUTP} = I_{OUTN} = 0 mA		0.6	2	mA
Output Characteristics						
V_{OUTP}	Positive Output Voltage	V_{IN} = 3.5 V, I_{OUTP} = 200 mA	4.5	4.6	4.7	V
	Line Regulation OUTP	V_{IN} = 2.7 V to 4.2 V, I_{OUTP} = 50 mA		3		mV
	Load Regulation OUTP	I_{OUTP} = 10 mA to 200 mA, PWM; V_{IN} = 3.5 V		2		mV
V_{OUTN}	Default Negative Output Voltage	V_{IN} = 3.5 V, I_{OUTN} = 200 mA	-4.8	-4.9	-5.0	V
	Line Regulation OUTN	V_{IN} = 2.7 V to 4.2 V, I_{OUT} = 50 mA		3		mV
	Load Regulation OUTN	I_{OUTN} = 10 mA to 200 mA, ; V_{IN} = 3.5 V		3		mV
$V_{OUTP(PP)}$	Output Voltage Ripple OUTP	V_{IN}= 3.5 V, I_{OUT}= 200 mA		5		mV_{PP}
$V_{OUTN(PP)}$	Output Voltage Ripple OUTN	V_{IN}= 3.5 V, I_{OUT}= 200 mA		40		mV_{PP}
System Characteristics						
f_{SW}	Switching Frequency			1.6		MHz
η_{pk}	Peak Efficiency	V_{IN} = 3.5 V		85%		

3 TPS65137AEVM Schematic

Figure 1is for reference only; see Table 2for specific values.

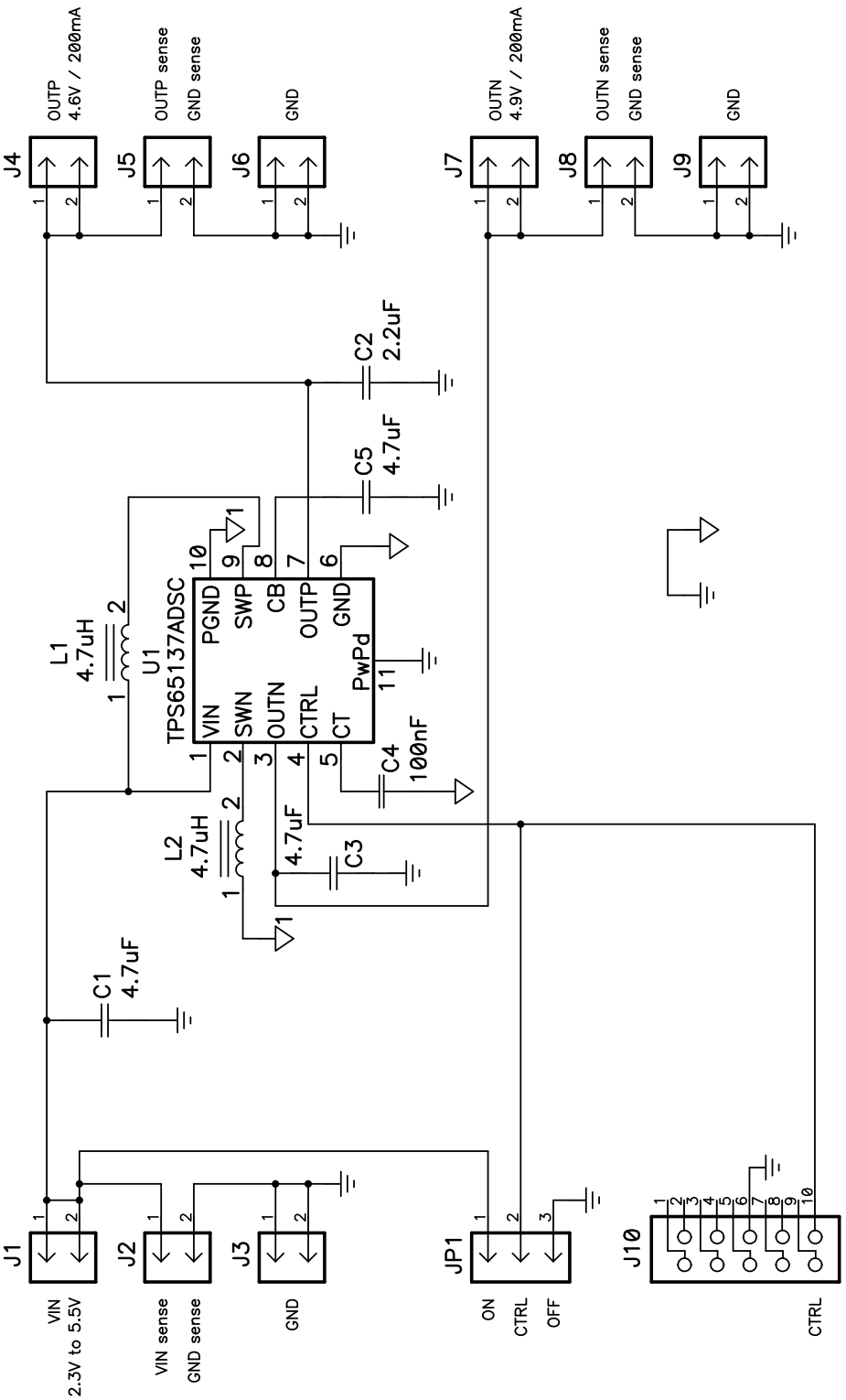

Figure 1. TPS65137AEVM Schematic

4 Connector and Test Point Descriptions

4.1 Input Connectors

4.1.1 J1 – VIN

This header is the positive connection to the input power supply. The power supply must be connected between J1 and J3 (GND). Twist the leads to the input supply, and keep them as short as possible. The input voltage has to be between 2.3 V and 5.5 V.

4.1.2 J2 – Input Sense Connector

This header is intended to measure the input voltage directly on the input capacitor. Therefore, a 4-wire power and sense supply can be connected. Twist the leads to the sensing connector.

4.1.3 J3 – GND

This header is the return connection to the input power supply. Connect the power supply between these pins and J1 (VIN). Twist the leads to the input supply, and keep them as short as possible. The input voltage must be between 2.3 V and 5.5 V.

4.2 Output Connectors

4.2.1 J4 – OUTP

This header is the positive connection of the output voltage of the boost converter. Connect the boost converter's load between J4 and J6 (GND).

4.2.2 J5 – OUTP Output Sense Connector

This header is intended to measure the output voltage of the boost converter directly on the output capacitors.

4.2.3 J6 – GND

This header is the return connection of the output voltage of the boost converter. Connect the boost converter's load between these pins and J4 (VOUT).

4.2.4 J7 – OUTN

This header is the negative connection of the output voltage of the boost converter. Connect the boost converter's load between J7 and J9 (GND).

4.2.5 J8 – OUTN Output Sense Connector

This header is intended to measure the output voltage of the boost converter directly on the output capacitors.

4.2.6 J9 – GND

This header is the return connection of the output voltage of the boost converter. Connect the boost converter's load between these pins and J4 (VOUT).

4.3 Additional Jumper and Connector

4.3.1 JP1 – Enable

This is the enable pin for both converters. Placing a jumper across pins 2 and 3 shorts the EN pin to GND (off), thereby disabling the device. Placing a jumper across pins 1 and 2 shorts the EN pin to VIN (on), thereby enabling the converter.

4.3.2 J10 – CTRL

This is the interface connector for the CTRL interface. Connect the 10-pin ribbon cable between this connector and the I/O connector of the USB interface adapter.

5 Test Setup

5.1 EVM Operation

The user must connect an input power supply set between 2.3 V and 5.5 V between headers J1 and J3 in order for the EVM to operate. The absolute maximum input voltage is 7 V.

The user can connect a load resistance between the positive and negative output voltage, J4 and J7, or the two output voltages and GND, J4 and J6, and J7 and J9.

5.2 Software Setup To Change Negative Output Voltage

The software is not needed for testing the standard operation of the TPS65137AEVM, but if changing the negative output voltage is necessary, the software has to be installed, and the USB interface adapter used with a host computer.

For the newest software version, go to the TPS65137A product folder on the TI Web site (http://focus.ti.com/docs/prod/folders/print/tps65137.html), download the software (zipped file), unpack it, and execute the setup.exe file. This installs the newest software version on your PC. It is recommended to remove older versions before installing the newest one.

5.3 Hardware Setup

Figure 2 details the connection of the power supply, the load, and the host computer. The host computer is just required if a voltage change on the negative rail is needed. The connection of the load is just an example; the load(s) can also be connected between J4 and J6 and/or J7 and J9.

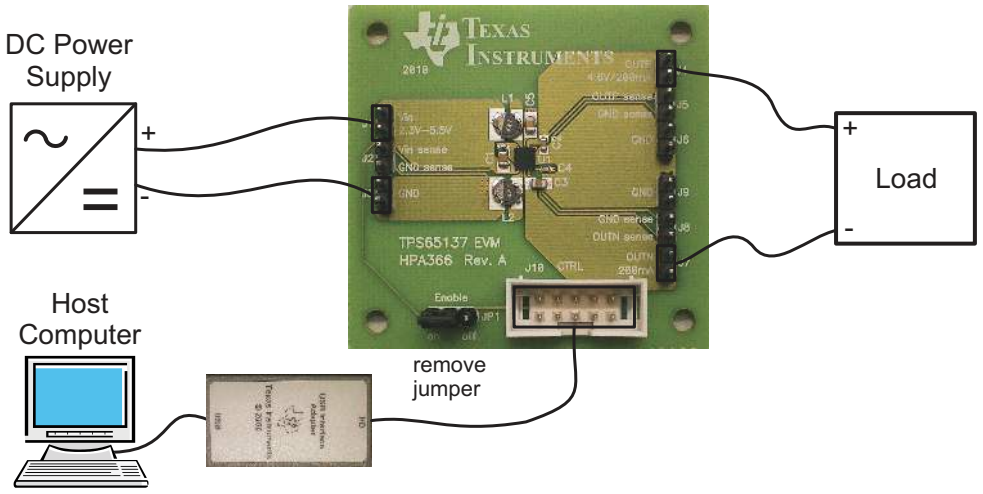

Figure 2. Connection of the Board and Host Computer

5.4 Software Operation

After the installation of the software, an icon with the name TPS65137 EVM appears on the desktop of the host computer. If it does not, browse the program files in the Start menu for the software. The default location is Program Files/Texas Instruments/TPS65137 EVM.

After connecting the USB interface adapter to the host computer, the software can be started. Most likely, at the first startup, the system asks to update the adapter's firmware. After confirmation of this update, the software window shown in Figure 3 appears.

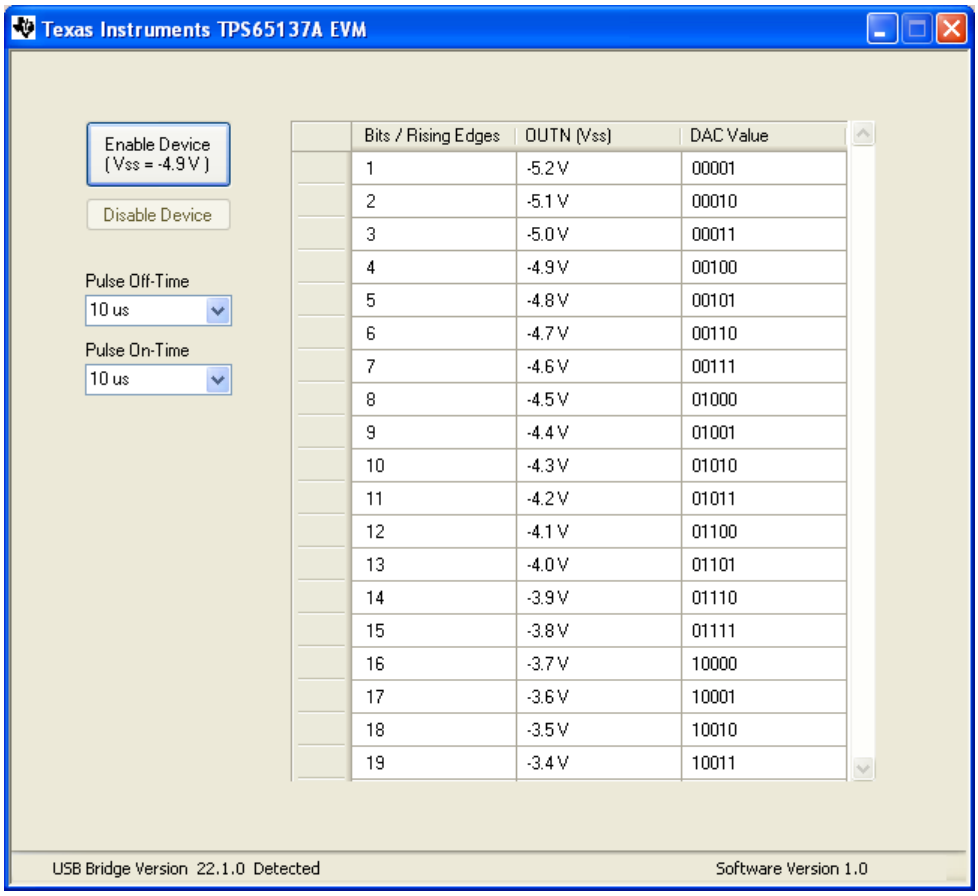

Figure 3. TPS65137A Software Window

Remove the jumper from the enable connector, JP1, to enable control of the EVM via the TPS65137A software. On the left top corner is the 'Enable Device' button that turns the TPS65137A on with the default -4.9 V on OUTN. After this button is pressed, it grays out and the 'Disable Device' button becomes active. With the drop-down menus, the selections 'Pulse Off-Time' and 'Pulse On-Time' can be used to change the pulse width of the controlling signal between 4 µs and 24 µs to test the different pulse widths possible with this interface. For more details on the interface, see the TPS65137A data sheet.

On the right side, the list of possible output voltages is displayed. By clicking on one of the output voltages, the software sends the necessary amount of rising edges to change the DAC value in the TPS65137A, which finally changes the voltage on the negative rail, OUTN. Whenever the part is disabled and enabled again, it starts with the default negative output voltage of -4.9 V.

6 TPS65137AEVM Assembly Drawings and Layout

Figure 4 through Figure 6 show the design of the TPS65137AEVM printed-circuit board (PCB). The EVM has been designed using a two-layer, 35-µm (1 oz), copper-clad circuit board. All components are on the top side, and all active traces on the top and bottom layers allow the user to easily view, probe, and evaluate the TPS65137A control IC in a practical, double-sided application. Moving components to both sides of the PCB or using additional internal layers can offer additional size reduction for space-constrained systems.

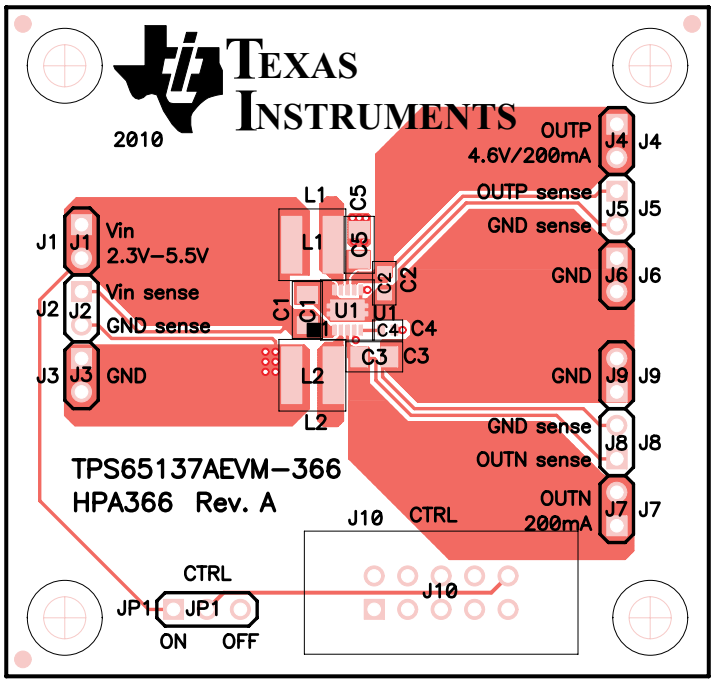

Figure 4. TPS65137AEVM Component Placement, Viewed From Top

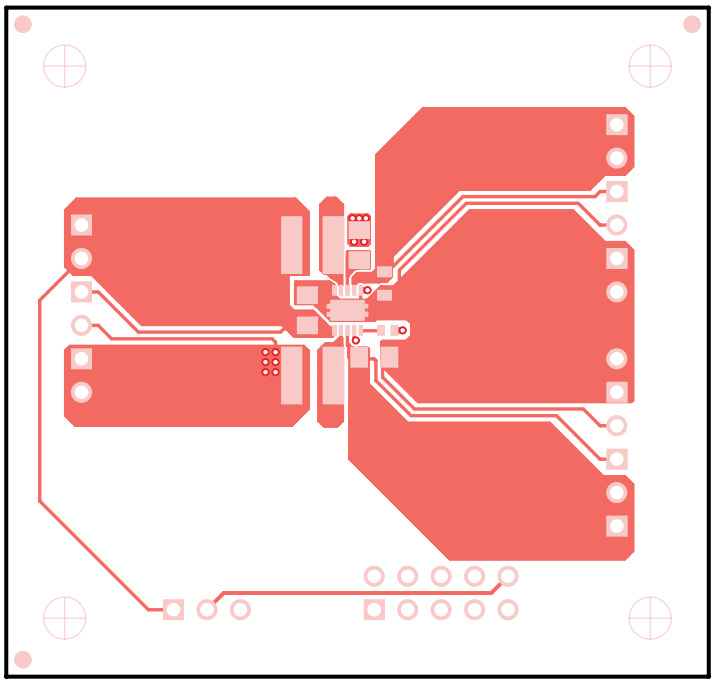

Figure 5. TPS65137AEVM Top Copper, Viewed From Top

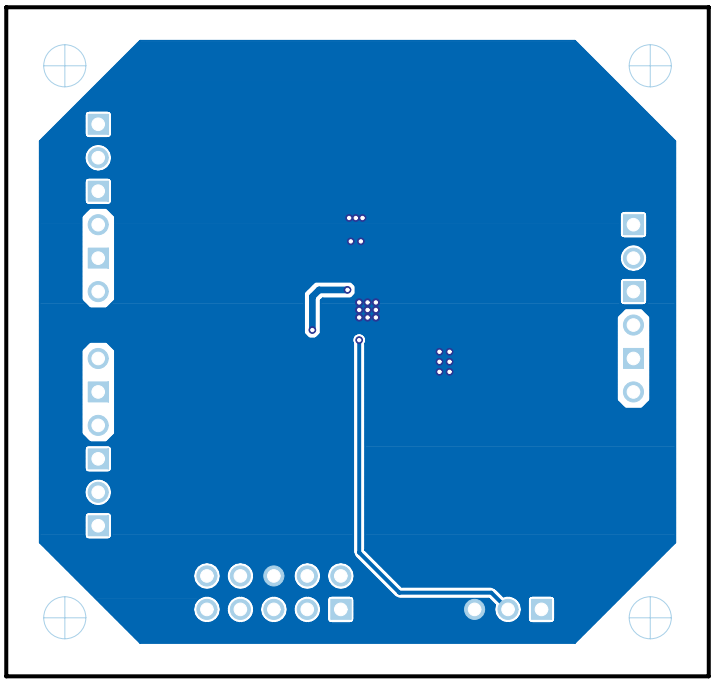

Figure 6. TPS65137AEVM Bottom Copper, Viewed From Bottom

7 List of Materials

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

Table 2. TPS65137AEVM Bill of Materials

Count	RefDes	Value	Description	Size	Part Number	MFR
3	C1, C3, C5	4.7 µF	Capacitor, Ceramic, 16V, X5R, 10%	0805	GRM21BR61C475KA88	Murata
1	C2	2.2 µF	Capacitor, Ceramic, 10V, X5R, 10%	0603	GRM188R61A225KE34	Murata
1	C4	100 nF	Capacitor, Ceramic, 10V, X7R, 10%	0402	Std	Std
2	L1, L2	4.7 µH	Inductor, SMT, 1.1A, 160milliohm	0.153 x 0.153 inch	VLF4012AT-4R7M1R1	Coilcraft
1	U1	TPS65137ADSC	IC, Triple output AMOLED Display Power Supply	QFN-10	TPS65137ADSC	TI

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 2.3 V to 5.5 V and various output voltages between 4.6 V and -5.2 V.

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 85°C. The EVM is designed to operate properly with certain components above 125°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
DLP® Products	www.dlp.com	Communications and Telecom	www.ti.com/communications
DSP	dsp.ti.com	Computers and Peripherals	www.ti.com/computers
Clocks and Timers	www.ti.com/clocks	Consumer Electronics	www.ti.com/consumer-apps
Interface	interface.ti.com	Energy	www.ti.com/energy
Logic	logic.ti.com	Industrial	www.ti.com/industrial
Power Mgmt	power.ti.com	Medical	www.ti.com/medical
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
RFID	www.ti-rfid.com	Space, Avionics & Defense	www.ti.com/space-avionics-defense
RF/IF and ZigBee® Solutions	www.ti.com/lprf	Video and Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless-apps

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