TPS61170EVM-280

This user's guide describes the characteristics, operation, and use of the TPS61170EVM-280 evaluation module (EVM). This EVM contains the Texas Instruments TPS61170 high-efficiency boost converter that is configured to provide a regulated 24-V output voltage from an input voltage ranging from 9 V to 18 V. The user's guide includes a schematic diagram, bill of materials and test data.

Contents

List of Figures

List of Tables

1 Introduction

This section contains background information for the TPS61170EVM-280 evaluation module.

1.1 Background

This TPS61170EVM-280 steps up 9-V to 18-V input voltages to a 24-V output. The goal of the EVM is to facilitate evaluation of the TPS61170 power supply solution. The EVM uses the TPS61170 adjustable output boost converter, external Schottky diode, input and output capacitors, inductor, and the appropriate feedback and compensation components to provide 24 V.

1.2 Performance Specification Summary

Table 1 provides a summary of the TPS61170EVM 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
V_{IN}		9		18	V
V_{OUT} (1)	V_{IN} = 9 V, I_{OUT} < 250 mA	23.1	24	24.9	V
	V_{IN} = 18 V , I_{OUT} < 550 mA				

(1) Minimum and maximum values include 1% resistor tolerance as well as IC feedback reference voltage tolerance.

1.3 Modifications

Because the primary goal of the EVM is to demonstrate the small size of the TPS61170 power supply solution, capacitors and inductors with small footprints were chosen. These capacitors and inductors were carefully selected to maximize efficiency and minimize ripple while minimizing overall solution size. Changing components could improve or degrade EVM performance.

The TPS61170 integrated circuit (IC) has a maximum input voltage of 18 V and can boost its input voltage up to 37 V. Changes to this EVM's operating input and output voltage range likely requires changing one or more of the following components: Schottky diode, input or output capacitors, inductor, feedback resistors, or error amplifier compensation components. Consult the data sheet and/or design tools for assistance in selecting these components for your application.

NOTE: When modifying the REV A version of this PCB, it is strongly recommended that you heat the PCB on a hot plate before using a soldering iron to remove/replace components, especially the input capacitor and inductor. Otherwise, the expansion when soldering and contraction when cooling of the wide traces/places connecting these components to the IC pins can damage the IC. For further explanation and guidance, see the TI application report *QFN/SON PCB Attachment* {SLUA271}.

2 Setup and Test Results

This section describes how to properly connect, set up, and use the TPS61170EVM.

2.1 Input/Output Connections

The connection points are described in the following paragraphs.

2.1.1 J1-VIN

This header is the positive connection to the input power supply. Twist the leads to the input supply, and keep them as short as possible.

2.1.2 J2-GND

This header is the return connection to the input power supply.

2.1.3 J3-VOUT

This header is the positive output for the device.

2.1.4 J4-GND

This header is the return connection for the load.

2.1.5 J5-USB-TO-GPIO Connector

This connector is for the 10-pin ribbon cable that connects the EVM to the USB-TO-GPIO interface box. It is only used when the software is used to perform dimming.

2.1.6 JP1-ON/CTRL

Installing this jumper ties the CTRL pin to V_{IN}, thereby turning on the device. Removing the jumper allows the internal pulldown resistor to pull CTRL to ground, thereby disabling the device.

2.2 Hardware Requirements

This EVM requires an external power supply capable of providing 9 V to 18 V at 1.5 A.

To change the default feedback (FB) value from 1.229 V, thereby dynamically changing the regulated output voltage, the user can apply either a pulse width modulation (PWM) or digital control signal to the CTRL pin. Both signals change the feedback voltage at the IC's FB pin. A function generator capable of driving the CTRL pin with 1.2-V to 18-V amplitude and a 5-kHz to 100-kHz PWM signal is required for PWM-controlled modulation of the FB voltage. The user also can change the FB voltage using a digital control signal. The EVM kit includes a personal computer (PC) software compact disk (CD) and USB-TO-GPIO interface box which, when installed on a PC and connected to the EVM, allows the user to communicate with the EVM via a GUI interface. The minimum PC requirements are:

- Windows™ 2000 or Windows™ XP operating system
- USB port
- Minimum of 30 MB of free hard disk space (100 MB recommended)
- Minimum of 256 MB of RAM

2.3 Hardware Setup

After connecting the power supply between J1 and J2, turning on the power supply, and installing JP1, the EVM will regulate the output voltage to the value per Table 1. Additional input capacitance may be required in order to mitigate the inductive voltage droop that may occur during a load transient event.

In order to change the output voltage via a PWM signal, remove the jumper on JP1 and the 10-pin ribbon cable from J5, if installed, and perform the following steps in any sequence:

- Connect the power supply between J1 and J2 and turn on the power supply.
- Connect the appropriately configured function generator to the CTRL side of JP1.
- Adjust the duty cycle of the 5kHz-100kHz PWM signal from the function generator to produce the desired feedback voltage. The PWM signal's duty cycle is directly proportional to the regulated output voltage, i.e., $V_{FB} = D_{CTRL} * 1.229V$.

In order to change the output voltage by sending the digital control signal via a PC running the TPS6116x Controller software and USB-TO-GPIO interface box, remove the jumper or the function generator on JP1, and perform the following steps in any sequence:

- Connect one end of the USB-TO-GPIO box to the PC using the USB cable and the other end to J5 of the TPS61161EVM using the supplied 10-pin ribbon cable per Figure 1. The connectors on the ribbon cable are keyed to prevent incorrect installation,
- Connect the power supply between J1 and J2, and turn on the power supply.
- Run the software as explained in the next section.

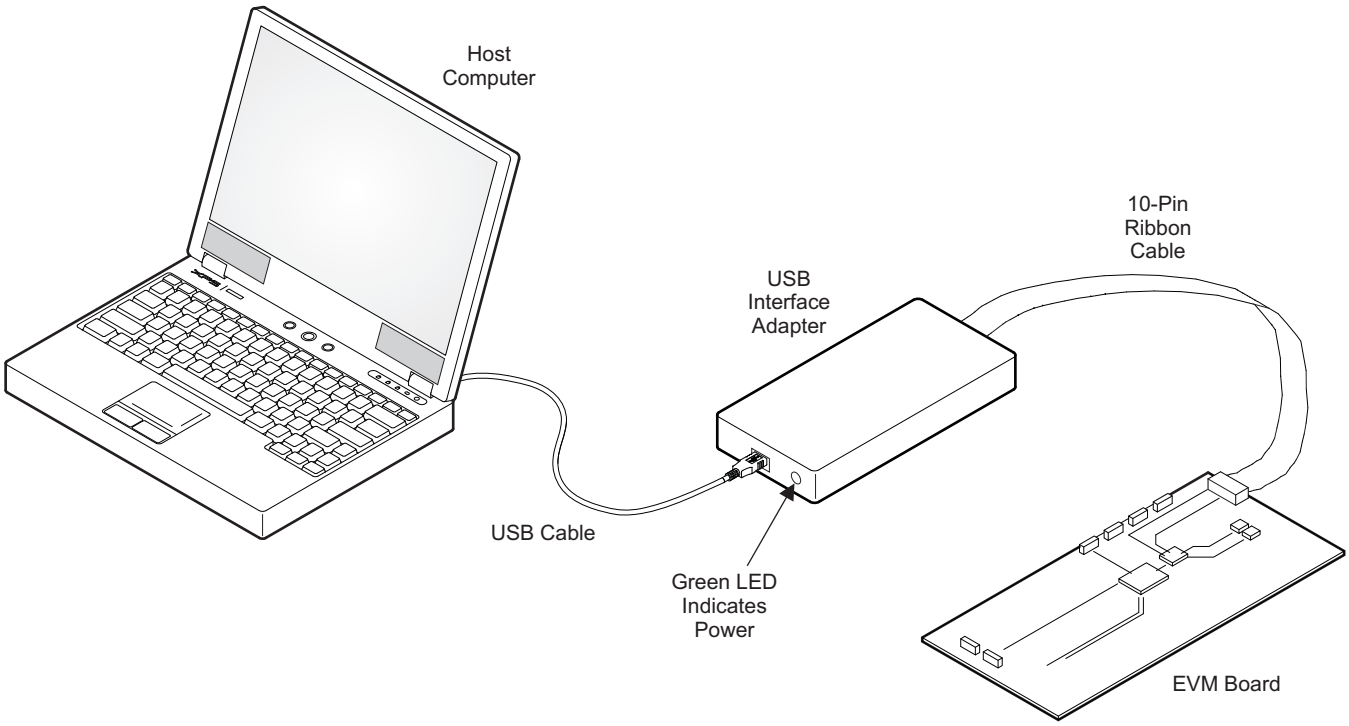

Figure 1. USB Interface Adapter Quick Connection Diagram

2.4 Software Installation and Operation

If installing from a CD, insert the CD and run Setup.exe; follow all the prompts to install the software.

If installing from the TI Web site, go to the URL, http://focus.ti.com/docs/toolsw/folders/print/tps6116xevm-sw.html .

NOTE: This installation page is best viewed with Microsoft™ Internet Explorer browser (It may not work correctly with other browsers).

Click on the install button; your PC gives you a security warning and asks if you want to install this application. Select Install to proceed. If a pre-release or Beta version is currently installed on your PC, you must uninstall this version of the software before installing the final version from either the CD or the TI Web site.

With both types of installation, the software attempts to install the Microsoft Dot Net Framework 2.0 (if it is not already installed) This framework is required for the software to run.

Immediately following installation, the software automatically runs.

To run the software after installation, go to

Start → all programs → Texas Instruments, Inc. → TPS6116x Controller EVM Software.

At start-up, the software first checks the firmware version of the USB-TO-GPIO adapter box. If an incorrect firmware version is installed, the software automatically searches on the Internet (if connected) for updates. If a new update is available, the software notifies the user of the update, and downloads and installs the software. Note that after the firmware is updated, the user must disconnect and then reconnect the USB cable between the adapter and PC, as instructed during the install process. The host PC software also automatically searches on the Internet (if connected) for updates. If a new update is available, the software notifies the user of the update and downloads and installs it.

NOTE: VeriSign™ Code Signing is used to prevent any malicious code from changing this application. If at any time in the future the binaries are modified, the code will no longer attempt to run.

The TPS61170 IC has a 5-bit register that stores the feedback voltage to which the error amplifier regulates the FB pin. Using the EasyScale™ protocol, the user can program a separate digital IC to generate a signal that changes this register to one of 32 discrete settings, thereby changing the FB voltage and subsequent regulated output voltage. The software provides a GUI interface which allows the user to change the bits directly or by a drop-down box. After changing the bits, the Write button must be pressed. See a screen shot of the software in Figure 2 In order to exit EasyScale™ mode, the IC needs to be shutdown by pulling the CTRL low for 2.5ms and restarted.

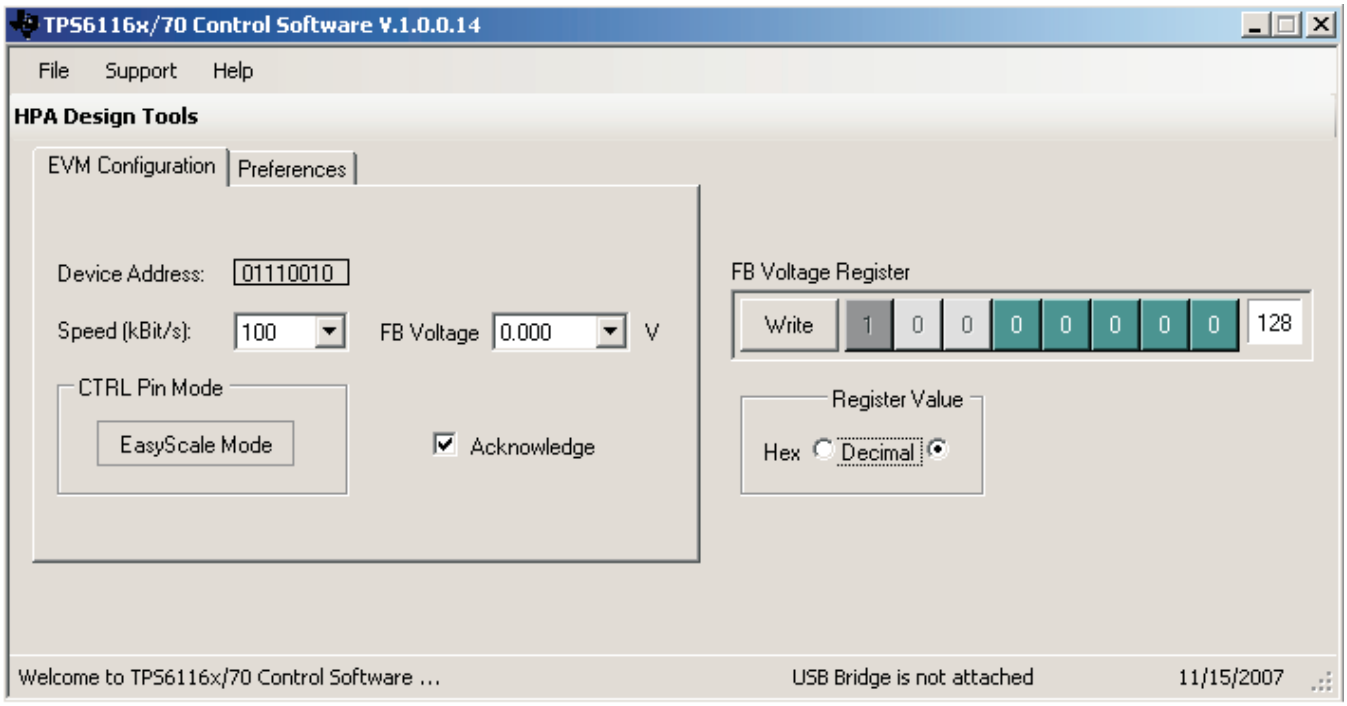

Figure 2. Screen Capture of TPS6116x/70 Controller Software GUI Interface

2.5 Test Results

Figure 3 shows the test results using this EVM.

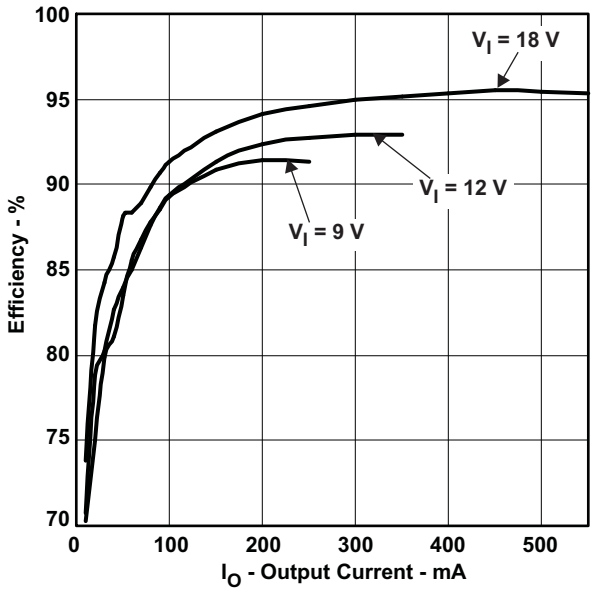

Figure 3. Efficiency With V_{IN} = 9 V, 12 V, and 18 V and the SD6030 22-µH Inductor

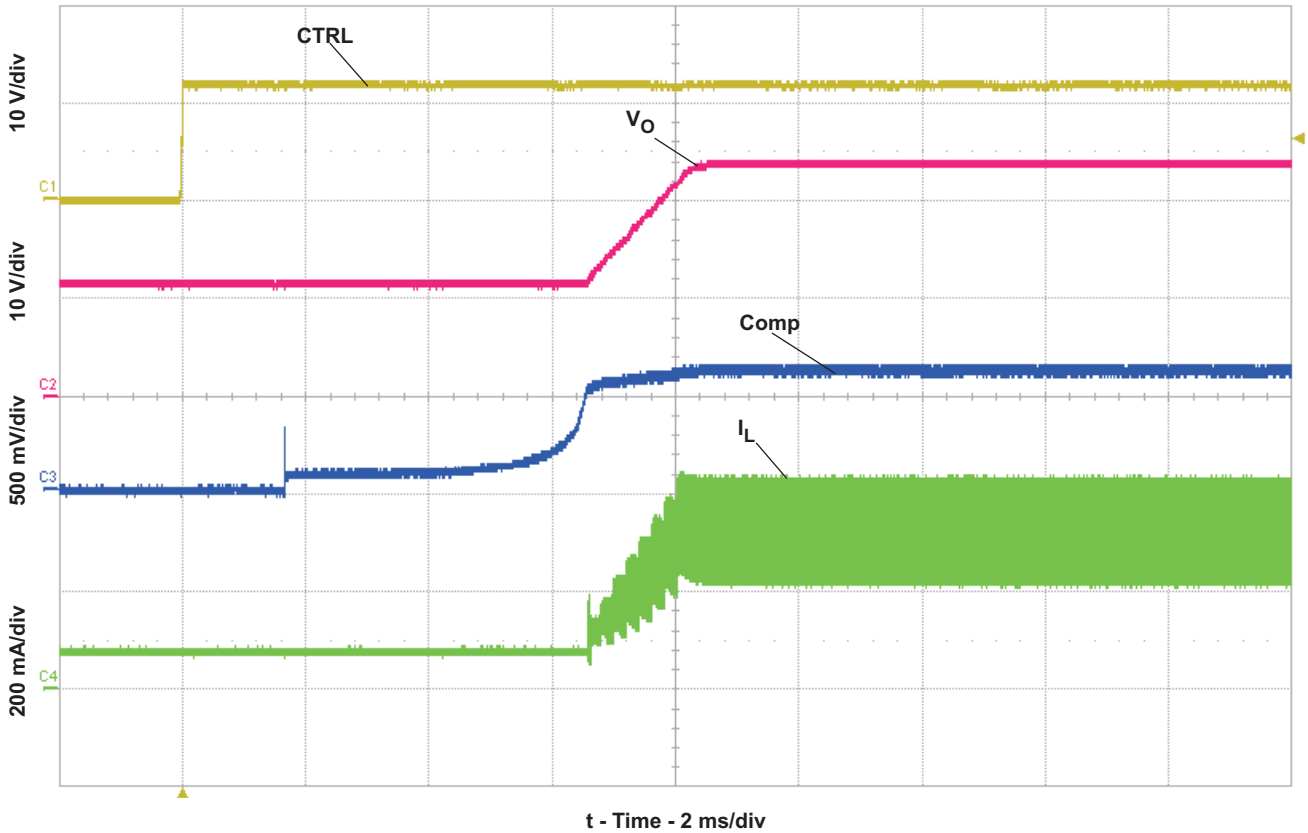

Figure 4. Start-Up With V_{IN} = 12 V and I_{OUT} = 200 mA

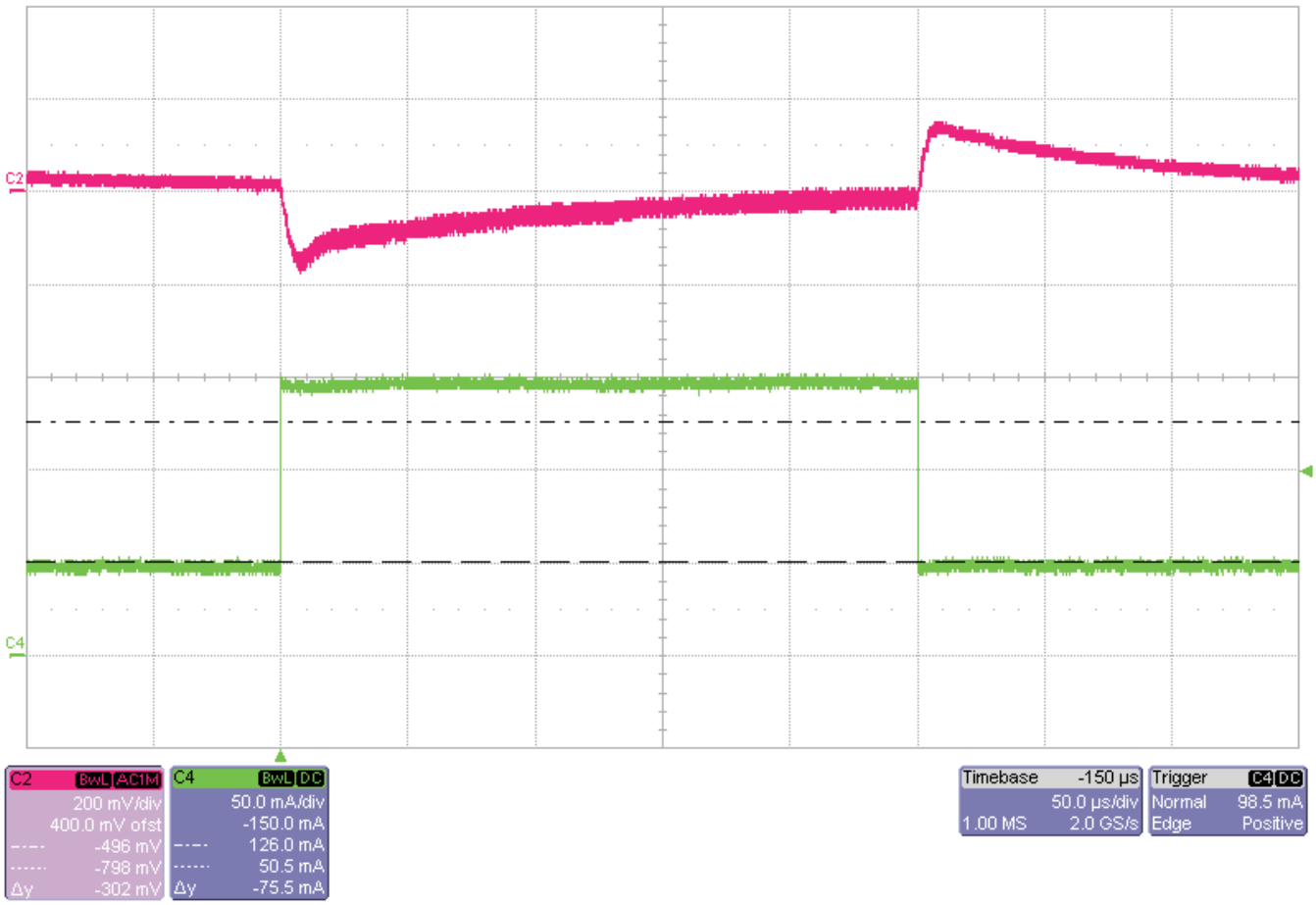

Figure 5. Load Transient Response From 50 mA to 150 mA With V_{IN} = 12 V

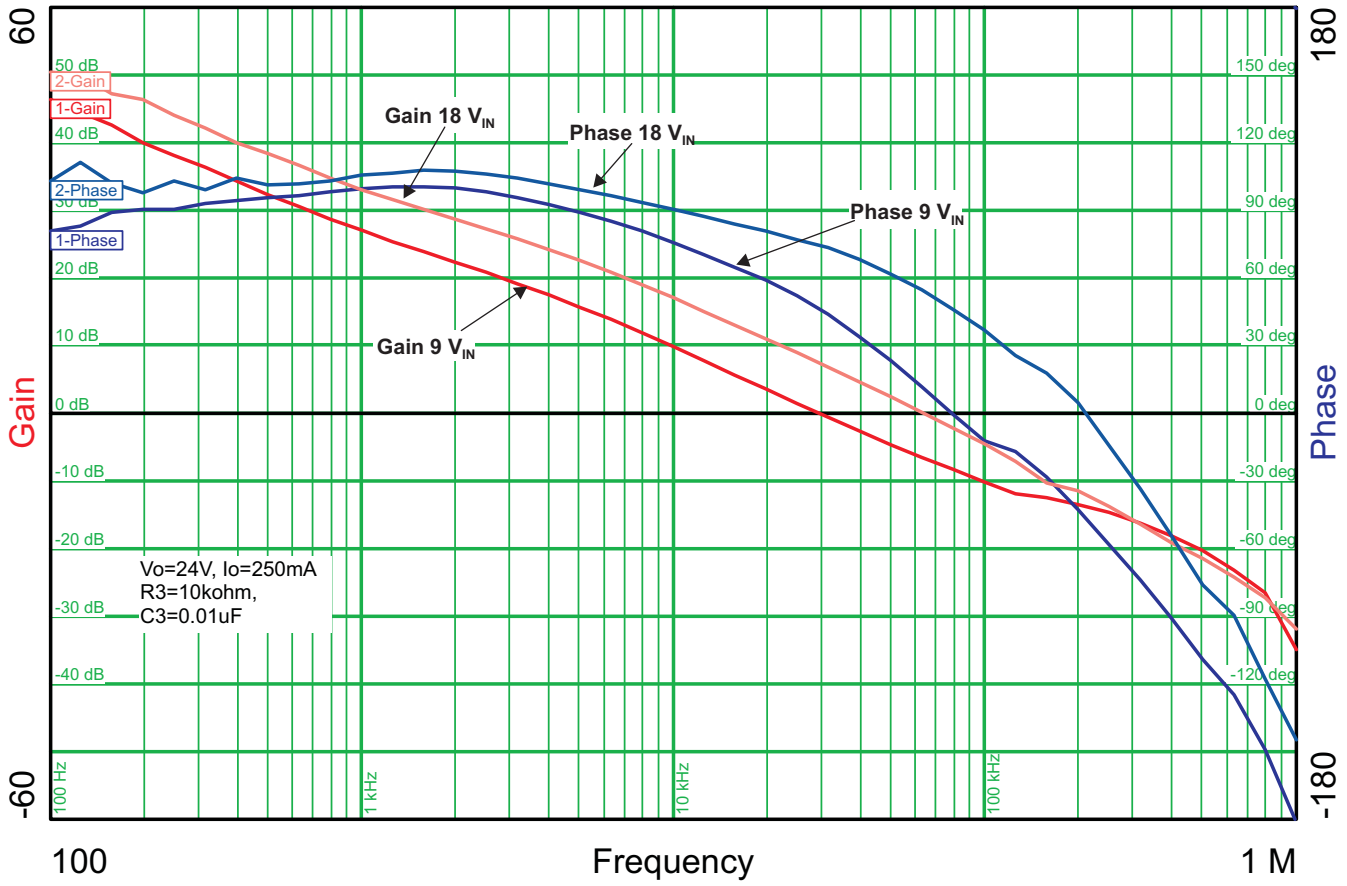

Figure 6. Loop Gain With I_{OUT} = 250 mA and V_{IN} = 9 V and 18 V

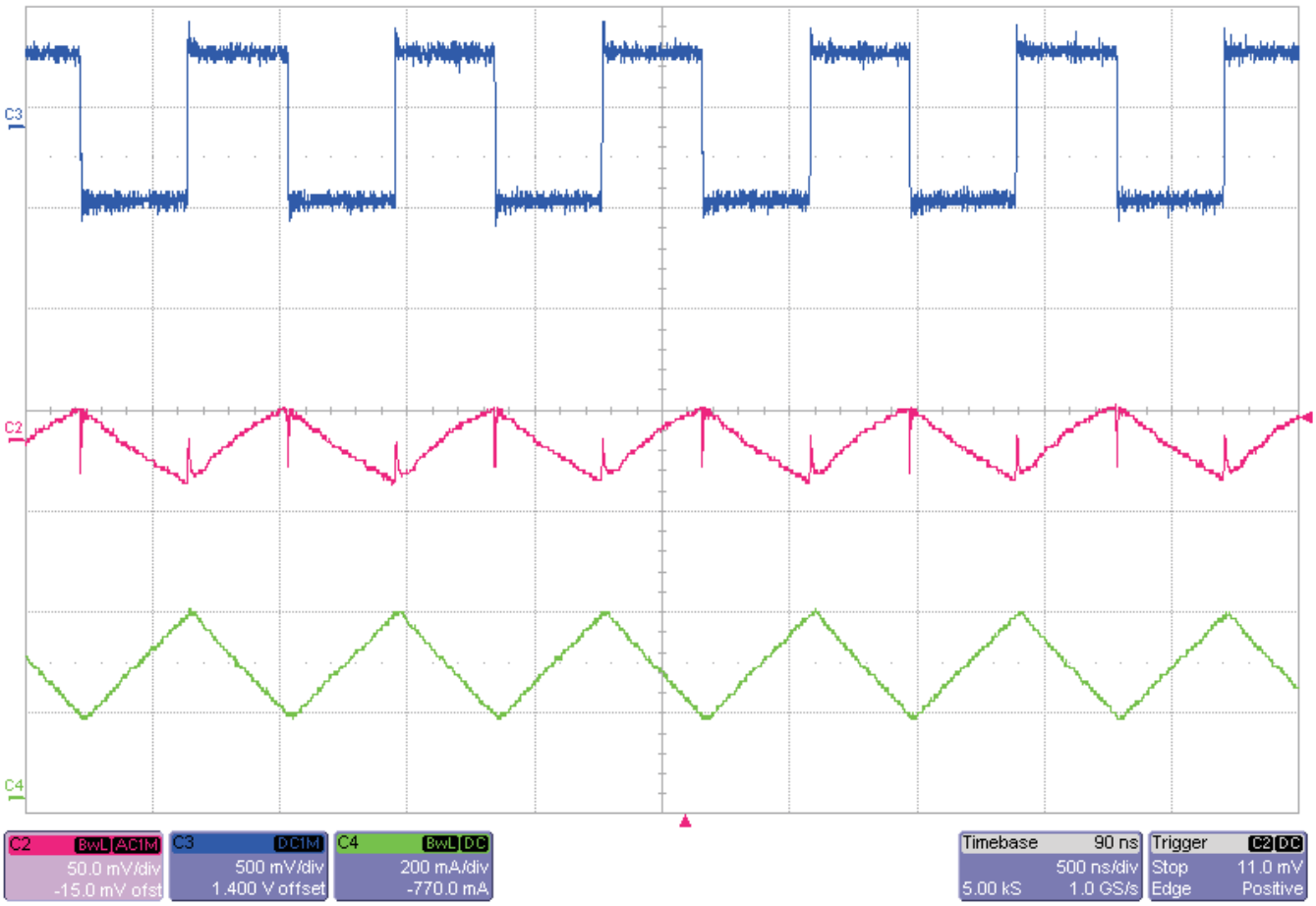

Figure 7. PWM Operation at 200 mA With V_{IN} = 12 V

3 Board Layout

This section provides the TPS61170EVM board layout and illustrations.

3.1 Layout

Board layout is critical for all switch-mode power supplies. Figure 8 and Figure 10 show the board layout for the HPA280 printed-circuit board. The switching nodes with high-frequency noise are isolated from the noise-sensitive feedback circuitry. Careful attention has been given to the routing of high-frequency current loops. See the data sheet for further layout guidelines.

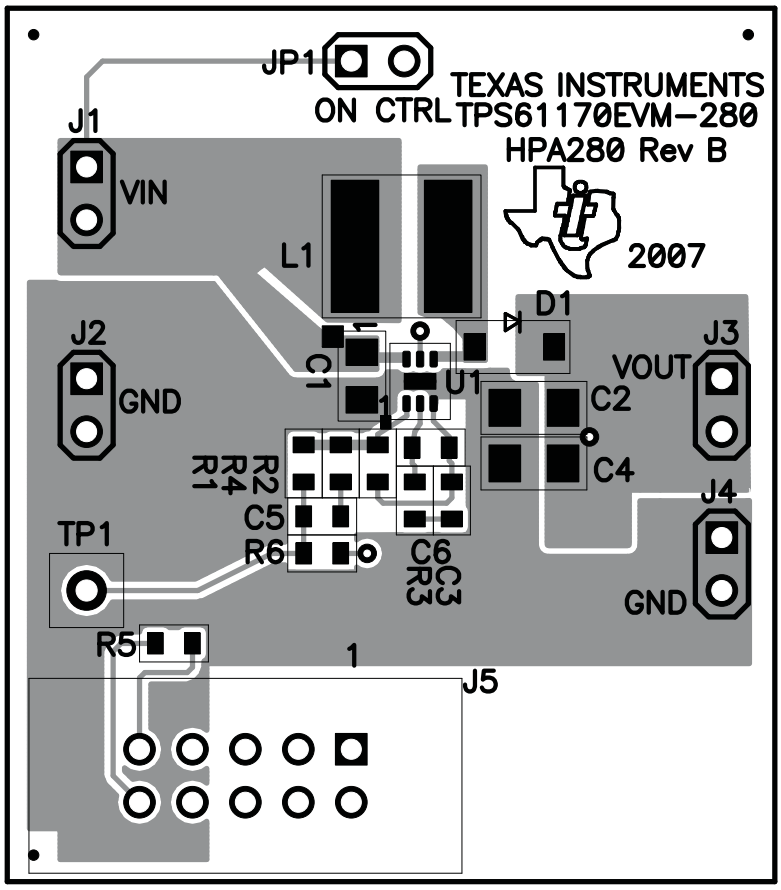

Figure 8. Top Assembly Layer

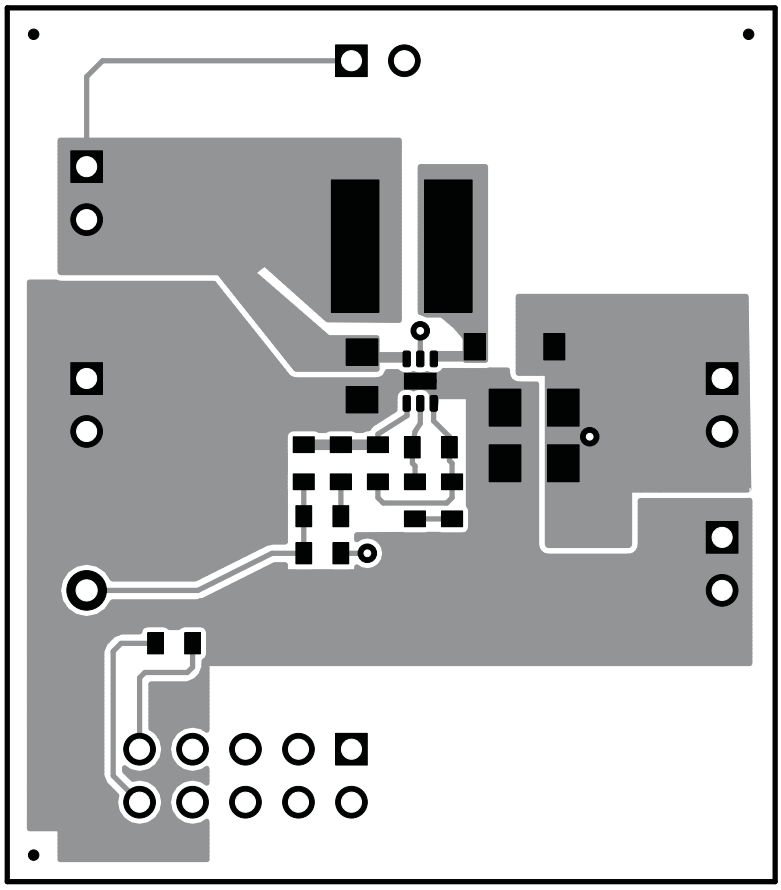

Figure 9. Top-Side Layer

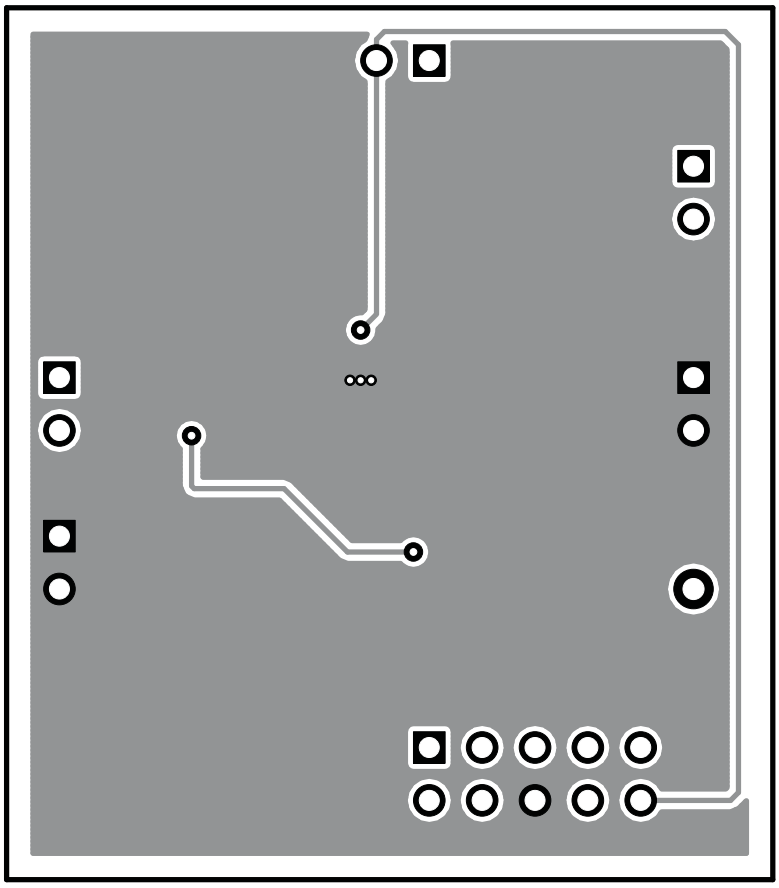

Figure 10. Bottom-Side Layer

4 Bill of Materials and Schematic

This section provides the TPS61170EVM-280 bill of materials and schematic.

4.1 Bill of Materials

Table 2. HPA280A Bill of Materials

Count	RefDes	Value	Description	Size	Part Number	MFR
1	--		PCB, 1.65 In × 1.45 In × 0.062 In		HPA280	Any
1	C1	4.7uF	Capacitor, Ceramic, 25V, X5R, 10%	0805	TMK212BJ475KG-T	Taiyo Yuden
2	C2, C4	2.2uF	Capacitor, Ceramic, 50V, X7R, 10%	1206	GRM31CR71H225KA88L	Murata
1	C3	0.01uF	Capacitor, Ceramic, 25V, X5R, 10%	0603	GRM188R71E103KA01D	Murata
2	C5, C6	Open	Capacitor, Ceramic	0603		
1	D1	MBR0530T1G	Diode, Schottky, 0.5A, 30V	SOD-123	MBR0530T1G	On Semi
4	J1–J4	PTC36SAAN	Header, 2 pin, 100mil spacing, (36-pin strip)	0.100 inch × 2	PTC36SAAN	Sullins
1	J5	2510-6002UB	Connector, Male Straight 2 × 5 pin, 100 mil spacing, 4 Wall	0.338 × 0.788 inch	2510-6002UB	3M
1	JP1	PTC36SAAN	Header, 2 pin, 100mil spacing, (36-pin strip)	0.100 inch × 2	PTC36SAAN	Sullins
1	L1	22uH	Inductor, SMT, 0.9-A, 122-mΩ	0.236 sq inch	SD6030-220-R	Cooper
1	R1	196k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	R2, R3	10.5k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R4	Open	Resistor, Chip, 1/16W, 1%	0603		
1	R5	1.82k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R6	49.9	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	TP1	5000	Test Point, Red, Thru Hole Color Keyed	0.100 × 0.100 inch	5000	Keystone
1	U1	TPS61170DRV	IC,1.2 MHz/1A PWM	SON-6	TPS61170DRV	TI
1	–		Shunt, 100 mil, Black	0.1	929950-00	

4.2 Schematic

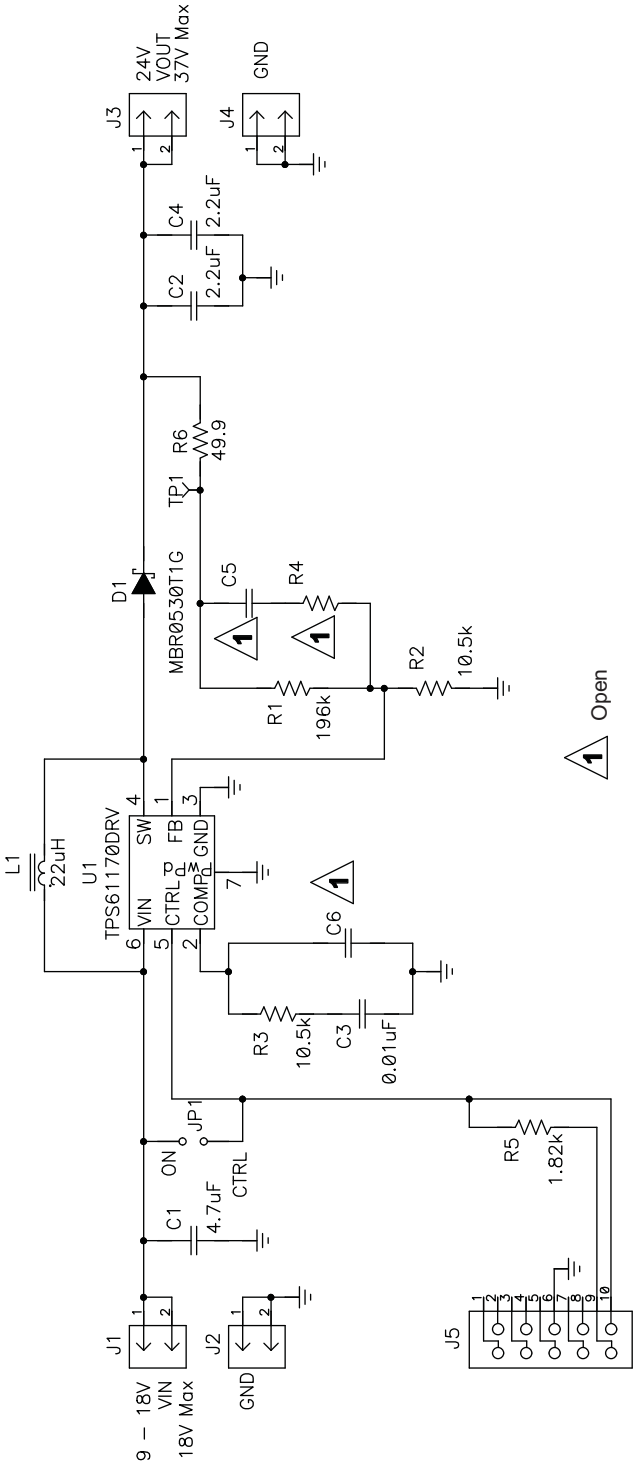

Figure 11. TPS61170EVM-280 Schematic

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 V to 18 V and the output voltage range of up to 39 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 125° C. The EVM is designed to operate properly with certain components above 85° 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	Broadband	www.ti.com/broadband
DSP	dsp.ti.com	Digital Control	www.ti.com/digitalcontrol
Clocks and Timers	www.ti.com/clocks	Medical	www.ti.com/medical
Interface	interface.ti.com	Military	www.ti.com/military
Logic	logic.ti.com	Optical Networking	www.ti.com/opticalnetwork
Power Mgmt	power.ti.com	Security	www.ti.com/security
Microcontrollers	microcontroller.ti.com	Telephony	www.ti.com/telephony
RFID	www.ti-rfid.com	Video & Imaging	www.ti.com/video
RF/IF and ZigBee® Solutions	www.ti.com/lprf	Wireless	www.ti.com/wireless

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