

bq24083 1-A, Single-Cell Li-Ion and Li-Polymer Charge Management IC EVM

1 Introduction

This user's guide describes the bq24083 evaluation module (EVM). The EVM provides a convenient method for evaluating the performance of a charge management solution for portable applications. A complete designed and tested charger is presented. The charger is designed to deliver up to 1 A of continuous charge current for single-cell Li-ion or Li-polymer applications using a dc power supply. The charger is programmed from the factory to deliver 0.7 A of charging current.

1.1 Background

The bq24083 is a highly integrated and flexible Li-ion linear charge and system power management device targeted at space-limited charger applications. The bq24083 integrated circuit (IC) offers an integrated power FET and current sensor, high-accuracy current and voltage regulation, charge status, and charge termination in a single monolithic device. An external resistor sets the magnitude of the charge current. The bq24083 charges the battery in three phases: conditioning, constant current, and constant voltage. The constant voltage can be programmed to 4.2 V without pullup on VBSEL and 4.1 V with a pullup (JMP5). Charge is terminated based on minimum current. An internal charge timer provides a backup safety for charge termination. The bq24083 automatically restarts the charge if the battery voltage falls below an internal threshold. The bq24083 automatically enters sleep mode when the input is removed.

1.2 Performance Specification Summary

Table 1. Performance Specification Summary

SPECIFICATION	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Input dc voltage, $V_{I(DC)}$		$V_{(REG)} + 0.5$	5	6.5	V
Battery charge current, $I_{O(CHG)}$			0.7	1	A
Power dissipation				1.5	W

2 Test Summary

This section shows the test setups used and the tests performed in evaluating the EVM. See the bq24083 data sheet ([SLUS848](#)) for complete details regarding the operation and specifications.

2.1 Test Setup

The bq24083EVM board requires a regulated 5-Vdc, 1-A power source to provide input power and a single-cell Li-ion or Li-polymer battery pack.

The test setup connections and jumper setting selections are configured for a stand-alone evaluation but can be changed to interface with external hardware such as a microcontroller.

Table 2. I/O and Jumper Connections

JACK	CONNECTION
J1-DC+	Power supply positive connection, preset to 5 Vdc, 1-A current limit.
J1-DC-	Power supply return connection, ground
J2-BAT+	Positive battery pack terminal
J2-BAT-	Negative battery pack terminal, BAT- is common with DC-
JMP1-STAT1	JMP1-2 STAT1 signal. Place shunt on JMP1 for LED, indication.
JMP2-STAT2	JMP2-2 STAT2 signal. Place shunt on JMP2 for LED indication.
JMP3- $\overline{\text{PG}}$	JMP3-2 $\overline{\text{PG}}$ signal. Place shunt on JMP3 for LED indication.
JMP4- $\overline{\text{CE}}$	Charge Enable-active low. Place shunt on JMP4 to pull $\overline{\text{CE}}$ Hi. Remove shunt for $\overline{\text{CE}}$ = Low
JMP5-VBSEL	JMP5-2 VBSEL signal. Place shunt on JMP5 to change output regulation from 4.2 V to 4.1 V.

2.2 Test Procedures

Set up the evaluation board as previously described by making the necessary I/O connections and jumper selections. Prior to test and evaluation, it is important to verify that the maximum power dissipation on the device is not exceeded: $P_{\text{MAX}} = 1.5 \text{ W}$.

$$P_{\text{MAX}} = (V_{(\text{DC}+)} - V_{(\text{BAT}+)}) \times I_{(\text{CHG})} \quad (1)$$

1. Turn on the power supply, which is preset to 5 Vdc, and 1 A for the current limit setting.
2. The bq24083 enters preconditioning mode if the battery is below the $V_{(\text{LOWV})}$ threshold. In this mode, the bq24083 precharges the battery with a low current, typically

$$\frac{I_{\text{O(CHG)}}}{10} = \frac{0.7 \text{ A}}{10} = 70 \text{ mA} \quad (2)$$

until the battery voltage reaches the $V_{(\text{LOWV})}$ threshold or until the precharge timer expires. If the timer expires, then the charge current is terminated and the bq24083 enters fault mode. Both LEDs turn off when in fault mode. Toggling input power or battery replacement resets fault mode. Note that the several fault conditions that can occur are described in the data sheet ([SLUS848](#)).

3. Once the battery voltage is above the $V_{(\text{LOWV})}$ threshold, the battery enters fast-charge mode. This EVM is programmed for 0.7 A of fast-charging current.
4. Once the battery reaches voltage regulation (4.2 V or 4.1 V with JMP5 shunt applied), the current tapers down as the battery reaches its full capacity.
5. When the current reaches the taper termination threshold, the charge current terminates.
6. After termination, if the battery discharges down to the recharge threshold, the charger starts fast charging.
7. The procedure can be repeated with the JMP5 shunt applied for a regulation of 4.1 V.

2.3 Alternative Test Procedure

The alternative methods of testing the EVM without a battery include:

- Four Quadrant Power Supply (Sinks or Source Current)
- Large Capacitor
- Dynamic Load Board

The output of the battery charger delivers varying amounts of power depending on the output voltage and load impedance. For this reason, it is difficult to test the different charge phases without a battery (using just resistors). A load resistor is required to keep the output in precharge after power up. If increased in resistance to allow the output to enter constant current fast-charge, the output voltage would quickly transition through the constant current phase into voltage regulation and then terminate. Applying a load to pull the output into fast charge would discharge the output to precharge before the refresh deglitch allows a recharge. Therefore, it is necessary to use an active load or a small battery as a load (i.e., large capacitor) that can be charged and discharged fairly quickly for timely evaluations.

2.3.1 Four Quadrant Power Supply

A source meter that can sink or source current can easily be adjusted to test each mode.

2.3.2 Large Capacitor

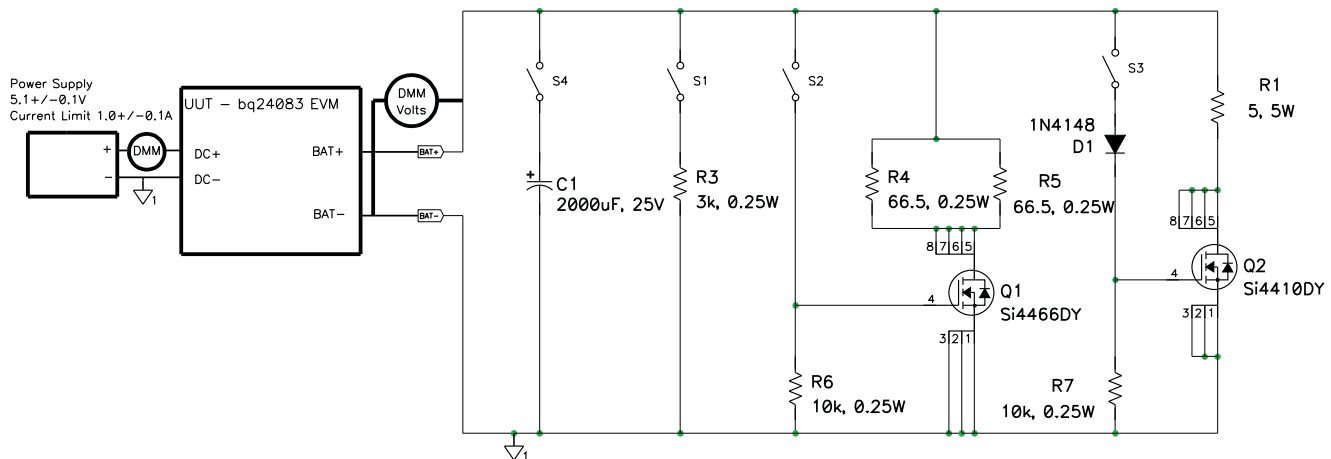
To briefly see each mode on an oscilloscope, connect a 1-mF capacitor in parallel with a 20-k Ω resistor, from the output to ground, to observe the power up, termination, and then cycling between voltage regulation and fast charge.

2.3.3 Dynamic Load Board

The loads are dynamic and automatically adjusted as a function of the output (battery) voltage. The sequence of the test procedure is important to remain in the desired mode. If altered, no damage occurs, but one might get different results than anticipated. The following test procedure applies more to verifying that the EVM was built correctly and does not test every feature. See the data sheet for an explanation of all the features.

2.3.3.1 Equipment

1. Power source: current-limited 5-V laboratory supply with its current limit set to 1 A \pm 0.1 A
2. Two Fluke 75 Multimeters, equivalent or better.
3. Oscilloscope – TDS220 or better
4. Load Test Board: PR694



2.3.3.2 Equipment Setup

1. Connect the load board to the BAT+ and BAT-. Set SW1 through SW4 in the ON (closed) position.
2. Connect a voltage meter to the BAT+/BAT- output to monitor the output voltage (range is 0-to-5 V).
3. Connect CH1 of scope to BAT+ and ground lead to BAT- (1 V/div and 200 ms/div).
4. Set the laboratory power supply for 5.1 V \pm 0.1 Vdc, 1-A \pm 0.1-A current limit and then turn off supply. Connect the source supply to a current meter and to J1, noting polarity (may use an internal source current meter if it has 5% or better accuracy).
5. Install shunt jumpers on the LED pins 1 and 2 of headers JMP1, JMP2, and JMP3.

2.3.3.3 Procedure

1. Ensure that the EQUIPMENT SETUP steps are followed {switches must be in the ON (closed) position, shunts installed, and power source set to 5.1 V \pm 0.1 Vdc}. Turn on the power source.
2. Verify output voltage, BAT+, charges up to between 2 V to 2.9 V and the red LED (D1), green LED (D2), and green LED (D3) are illuminated.
3. Open switch SW2 and then close switch SW2.

4. Verify that output voltage BAT+ settles between 3.2 V to 4 V.
5. Verify that the LED (D2) turns off.
6. Verify that the input current is between 0.65 A to 0.75 A.
7. Open switch SW3.
8. Verify that the input current is between 70 mA and 160 mA.
9. Verify the output voltage BAT+ is between 4.15 V dc and 4.25 Vdc.
10. Place shunt on JMP5 (4.1 V) and verify output voltage BAT+ is between 4 Vdc and 4.1 Vdc.
11. Place shunt on JMP4 (CHG DISABLE), and verify input current is less than 10 mA.
12. Remove JMP4 shunt (place on only one pin of JMP4 to keep from losing the shunt).
13. Open switch SW2.
14. Verify with a scope (250 ms/div, 1 V/div) that output BAT+ charges and discharges between the maximum limits of 3.3 V and 4.25 V with a period of between 600 ms to 1500 ms.
15. Verify that the LEDs flash between RED (D1) and GREEN (D2).
16. Close switches SW2 and SW3 (all switches should be closed now), and power down supply.
17. EVM is good if all tests have passed. Remove I/O connections.
18. If more EVMs are to be tested, loop back to 7.1 and continue until all units have been tested.

2.4 Ordering Information

Table 3. Ordering Information

EVM Part Number	Additional Devices	Chemistry	Pack Voltage	Capacity
bq24083EVM	None	Li-Ion / Li-Poly	2.5 V to 4.2 V	Any

3 Schematic

Figure 1 shows the schematic diagram for the bq24083EVM.

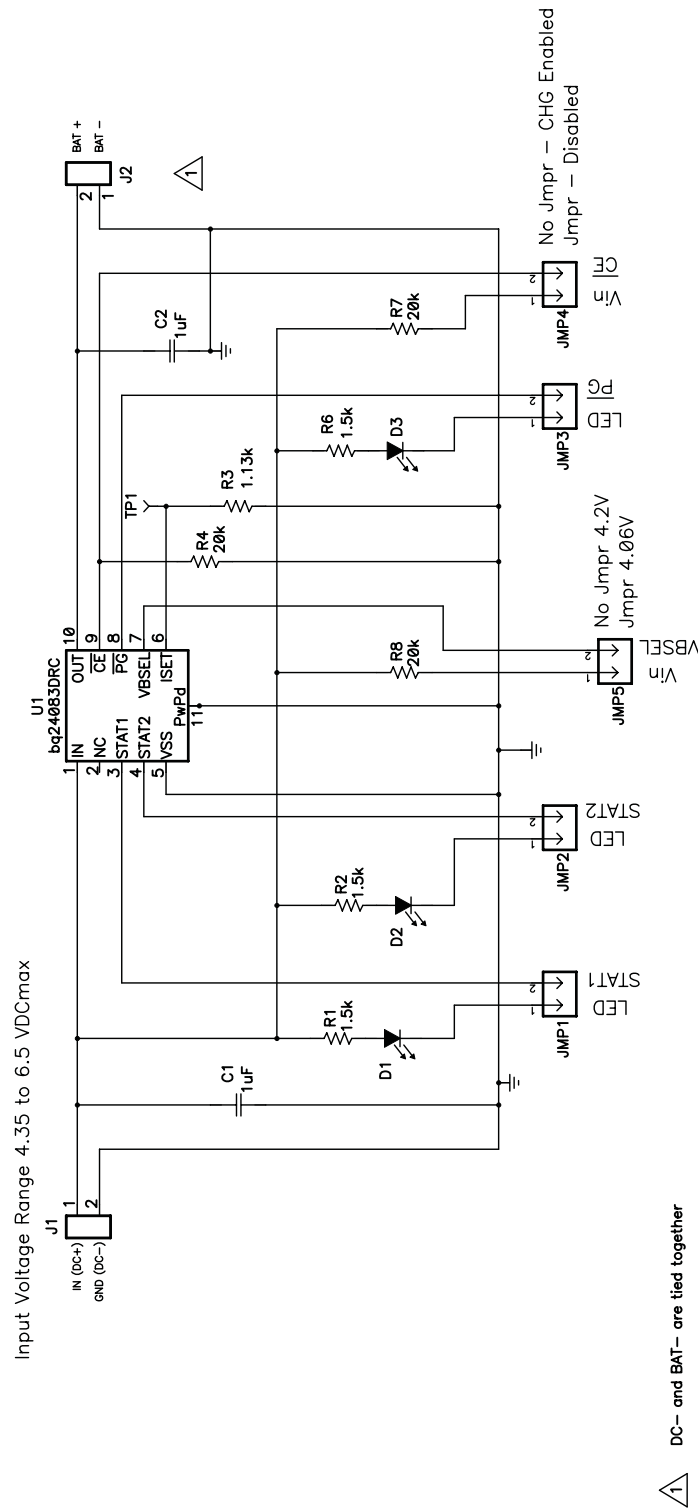


Figure 1. Schematic Diagram

4 Physical Layouts

Figure 2 and Figure 3 show the top layer and bottom layer of the EVM, respectively. Figure 3 shows the top assembly view.

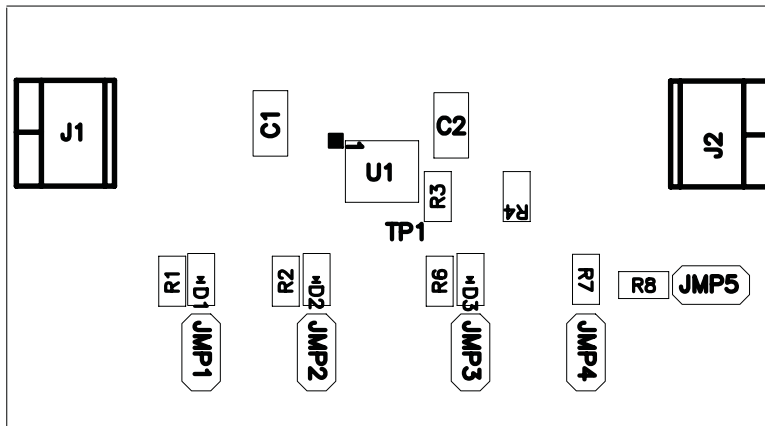


Figure 2. bq24083EVM Top Assembly Layer

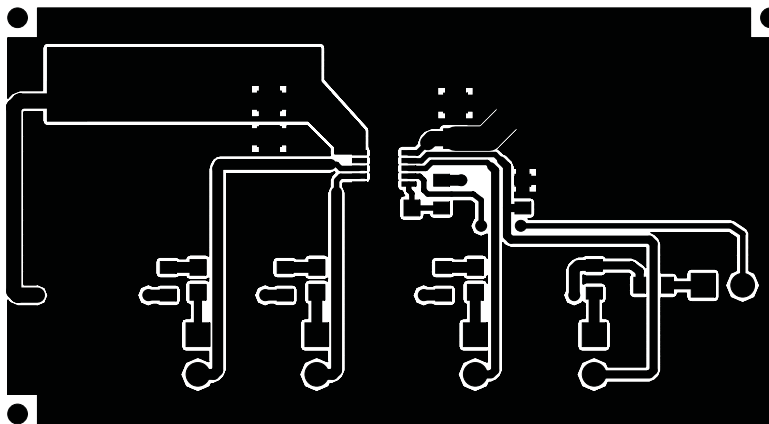


Figure 3. bq24083EVM Top Copper Layer

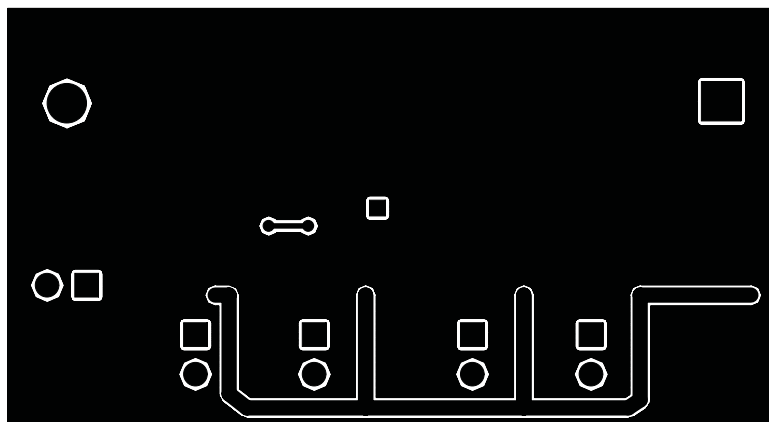


Figure 4. bq24083EVM Bottom Copper Layer

5 Bill of Materials

Table 4 lists the materials required for the bq24083EVM.

Table 4. bq24083EVM BOM

COUNT	REF DES	VALUE	DESCRIPTION	SIZE	PART NUMBER	MFR
2	C1, C2	1 μ F	Capacitor, Ceramic, 16V, X5R, 10%	0805	Std	Std
1	D1	LTST-C190CKT	Diode, LED, Red, 2.1-V, 20-mA, 20-mcd	0603	LTST-C190CKT	Lite On
2	D2, D3	LTST-C190CKT	Diode, LED, Green, 2.1-V, 20-mA, 6-mcd	0603	LTST-C190CKT	Lite On
2	J1, J2**	ED555/2DS	Terminal Block, 2-pin, 6-A, 3,5 mm	0.27 x 0.25 INCH	ED555/2DS	OST
5	JMP1–JMP5	PTC36SAAN	Header, 2-pin, 100-mil spacing, (36-pin strip)	0.100 x 2	PTC36SAAN	Sullins
3	R1, R2, R6	1.5 k	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
1	R3	1.13 k	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
3	R4, R7, R8	20 k	Resistor, Chip, 1/16-W, 1%	0603	Std	Std
1	U1	bq24083DRC	IC, Stand-alone linear charger	DRC10	bq24083DRC	TI
1	—		PCB, 2 In x 1 In x 0.31 In		HPA344	Any
5	Shunt ⁽⁵⁾ ⁽⁶⁾		Shunt, 100-mil, black	0.1	929950-00	3M

Notes: 1. Shunts are placed on pins 1 and 2 for jumpers JMP1, JMP2, and JMP3.

2. For JMP4 and JMP5 place shunt on just one pin (do no short pins 1 and 2 with shunt)

6 References

bq24083, 1-A Single-Chip, Li-Ion and Li-Pol Charger IC data sheet ([SLUS848](#)).

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 VREG + 0.5 V to 5.2 V and the output voltage range of 0 V to 4.2 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 70C. The EVM is designed to operate properly with certain components above 70C 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
Copyright 2008, Texas Instruments Incorporated

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

Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
RF/IF and ZigBee® Solutions	www.ti.com/lprf

Applications

Audio	www.ti.com/audio
Automotive	www.ti.com/automotive
Broadband	www.ti.com/broadband
Digital Control	www.ti.com/digitalcontrol
Medical	www.ti.com/medical
Military	www.ti.com/military
Optical Networking	www.ti.com/opticalnetwork
Security	www.ti.com/security
Telephony	www.ti.com/telephony
Video & Imaging	www.ti.com/video
Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2008, Texas Instruments Incorporated