

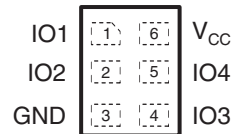
## FEATURES

- ESD Protection Exceeds JESD
  - $\pm 15$ -kV Human-Body Model (HBM)
  - $\pm 8$ -kV IEC 61000-4-2 Contact Discharge
  - $\pm 12$ -kV IEC 61000-4-2 Air-Gap Discharge
- Low 1.6-pF Input Capacitance
- 0.9-V to 5.5-V Supply Voltage Range
- 4-Channel Device
- Space-Saving SON (DRY) Package

## APPLICATIONS

- USB
- Ethernet
- FireWire
- Video
- Cell Phones
- SVGA Video Connections
- Glucose Meters

DRY PACKAGE  
(TOP VIEW)



## DESCRIPTION/ORDERING INFORMATION

The TPD4E004 is a low-capacitance  $\pm 15$ -kV ESD-protection diode array designed to protect sensitive electronics attached to communication lines. Each channel consists of a pair of diodes that steers ESD current pulses to  $V_{CC}$  or GND. The TPD4E004 protects against ESD pulses up to  $\pm 15$ -kV Human-Body Model (HBM),  $\pm 8$ -kV Contact Discharge, and  $\pm 12$ -kV Air-Gap Discharge, as specified in IEC 61000-4-2. This device has a 1.6-pF capacitance per channel, making it ideal for use in high-speed data IO interfaces.

The TPD4E004 is a quad-ESD structure designed for USB, ethernet, and other high-speed applications.

The TPD4E004 is available in the DRY package and is specified for  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$  operation.

## ORDERING INFORMATION

$T_A$	PACKAGE <sup>(1)(2)</sup>	ORDERABLE PART NUMBER	TOP-SIDE MARKING
$-40^{\circ}\text{C}$ to $85^{\circ}\text{C}$	SON – DRY (1.0 mm $\times$ 1.45 mm, Pitch = 0.5 mm, Height = 0.55 mm)	Reel of 5000 TPD4E004DRYR	2P

(1) Package drawings, thermal data, and symbolization are available at [www.ti.com/packaging](http://www.ti.com/packaging).

(2) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at [www.ti.com](http://www.ti.com).

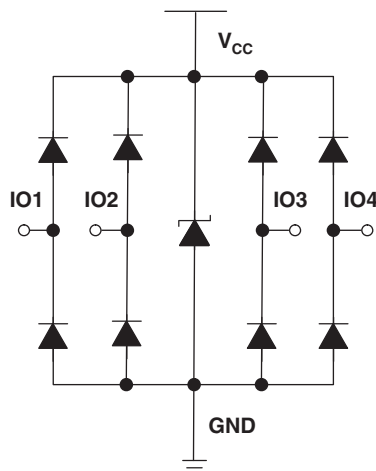


Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

All trademarks are the property of their respective owners.

# TPD4E004 4-CHANNEL ESD-PROTECTION ARRAY FOR HIGH-SPEED DATA INTERFACES

SLVS729A—FEBRUARY 2008—REVISED FEBRUARY 2008



## PIN DESCRIPTION

TERMINAL		DESCRIPTION
NAME	NO.	
GND	3	Ground
IOx	1,2,4,5	ESD-protected channel
V <sub>CC</sub>	6	Power-supply input

## ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

over operating free-air temperature range (unless otherwise noted)

		MIN	MAX	UNIT
V <sub>CC</sub>	Supply voltage range	-0.3	5.5	V
V <sub>IO</sub>	Input/output voltage range	-0.3	V <sub>CC</sub> + 0.3	V
T <sub>stg</sub>	Storage temperature range	-65	150	°C
T <sub>J</sub>	Junction temperature		150	°C
Bump temperature (soldering)	Infrared (15 s)		220	°C
	Vapor phase (60 s)		215	
Lead temperature (soldering, 10 s)			300	°C

- (1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum-rated conditions for extended periods may affect device reliability.

## ELECTRICAL CHARACTERISTICS

$V_{CC} = 0.9\text{ V to }5.5\text{ V}$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$  (unless otherwise noted)

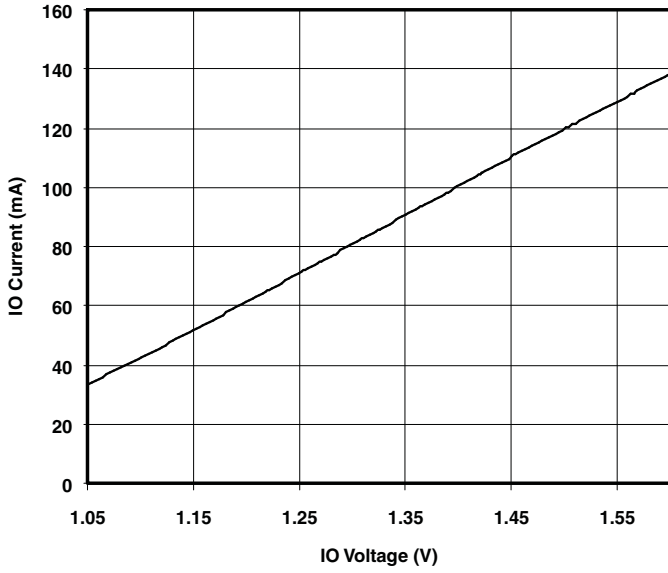
PARAMETER		TEST CONDITIONS	MIN	TYP <sup>(1)</sup>	MAX	UNIT
$V_{CC}$	Supply voltage		0.9		5.5	V
$I_{CC}$	Supply current				500	nA
$V_F$	Diode forward voltage	$I_F = 1\text{ mA}$		0.8		V
$I_l$	Channel leakage current			$\pm 1$		nA
$V_{BR}$	Break-down voltage	$I_l = 10\text{ }\mu\text{A}$	6		8	V
$C_{I/O}$	Channel input capacitance	$V_{CC} = 5\text{ V}$ , Bias of $V_{CC}/2$ , $f = 10\text{ MHz}$		1.6	2	pF

(1) Typical values are at  $V_{CC} = 5\text{ V}$  and  $T_A = 25^\circ\text{C}$ .

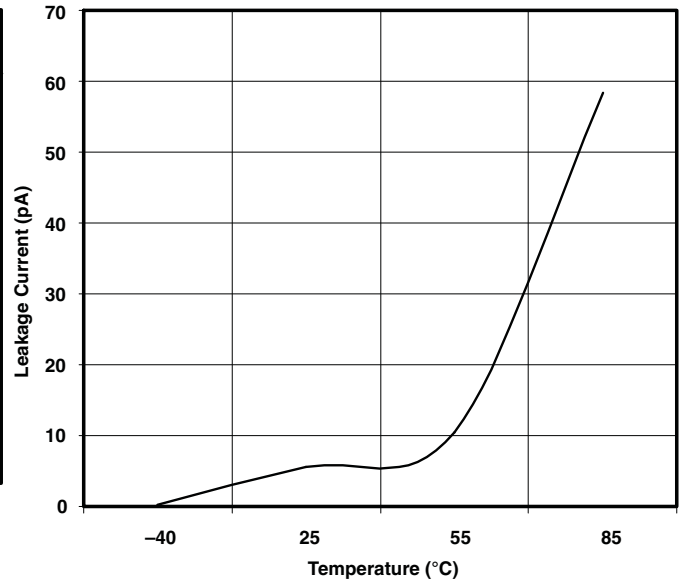
## ESD Protection

PARAMETER	TYP	UNIT
HBM	$\pm 15$	kV
IEC 61000-4-2 Contact Discharge	$\pm 8$	kV
IEC 61000-4-2 Air-Gap Discharge	$\pm 12$	kV

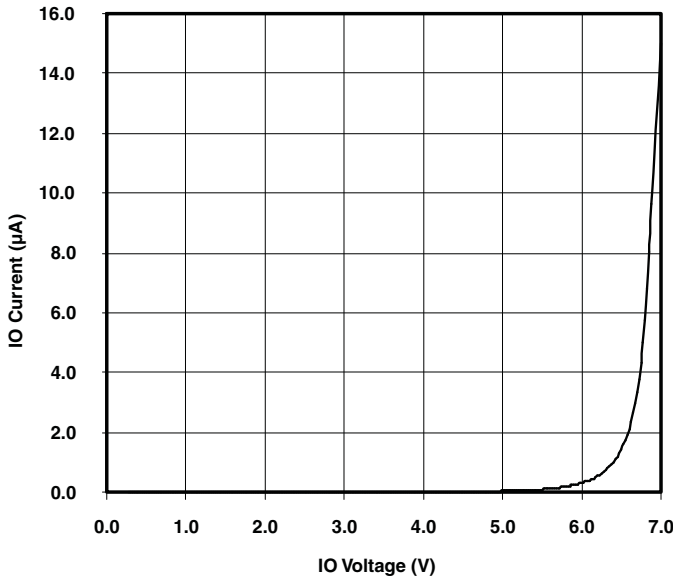
**TYPICAL OPERATING CHARACTERISTICS**



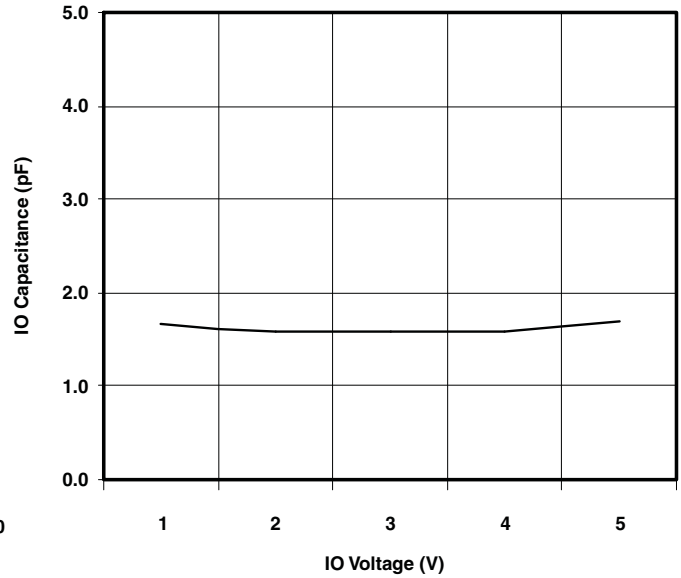
**Figure 1. Forward Diode Voltage (Upper Clamp Diode)**  
( $V_{CC} = 0$  V, DC Sweep Across the IO Pin)



**Figure 2. Leakage Current vs Temperature ( $V_{IO} = 2.5$  V)**



**Figure 3. Reverse Diode Curve Current IO to GND**  
( $V_{CC} = \text{Open}$ )



**Figure 4. IO Capacitance vs Input Voltage**  
( $V_{CC} = 5$  V)

TYPICAL OPERATING CHARACTERISTICS (continued)

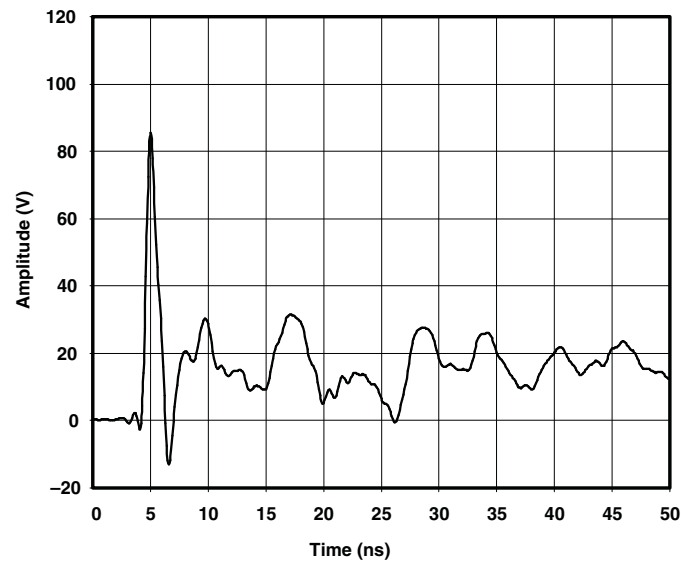
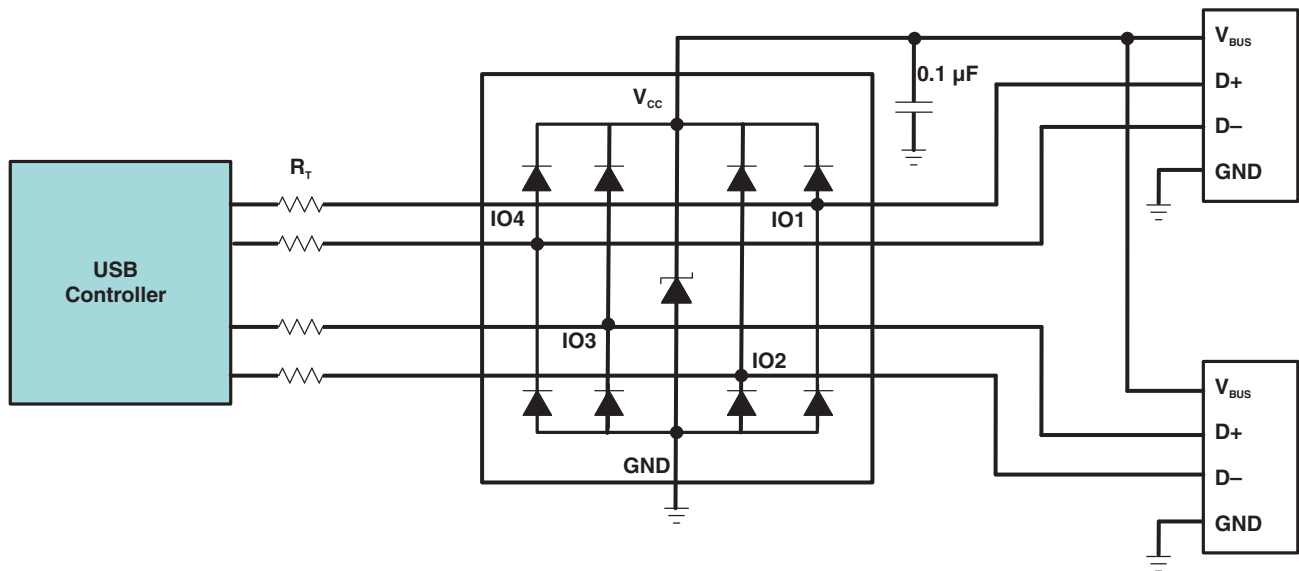


Figure 5. IEC ESD Clamping Waveforms +8-kV Contact

**APPLICATION INFORMATION**



**Detailed Description**

When placed near the connector, the TPD4E004 ESD solution offers little or no signal distortion during normal operation due to low I/O capacitance and ultra-low leakage current specifications. The TPD4E004 ensures that the core circuitry is protected and the system is functioning properly in the event of an ESD strike. For proper operation, the following layout/design guidelines should be followed:

1. Place the TPD4E004 solution close to the connector. This allows the TPD4E004 to take away the energy associated with ESD strike before it reaches the internal circuitry of the system board.
2. Place a 0.1-µF capacitor very close to the V<sub>CC</sub> pin. This limits any momentary voltage surge at the IO pin during the ESD strike event.
3. Make sure that there is enough metallization for the V<sub>CC</sub> and GND loop. During normal operation, the TPD4E004 consumes nA leakage current. But during the ESD event, V<sub>CC</sub> and GND may see 15 µA to 30 µA of current, depending on the ESD level. Sufficient current path enables safe discharge of all the energy associated with the ESD strike.
4. Leave the unused IO pins floating.
5. The V<sub>CC</sub> pin can be connected in two different ways:
  - a. If the V<sub>CC</sub> pin is connected to the system power supply (a 0.1-µF capacitor at V<sub>CC</sub> is recommended for ESD bypass), the TPD4E004 works as a transient voltage suppressor for any signal swing above V<sub>CC</sub> + V<sub>d</sub>.
  - b. If the V<sub>CC</sub> pin is not connected to system power supply (a 0.1-µF capacitor is still recommended at the V<sub>CC</sub> pin for ESD bypass), the TPD4E004 can tolerate higher signal swing in the range up to V<sub>BR</sub>. Note that initially the bypass capacitor is charged by the signals through clamp diode.

**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
TPD4E004DRYR	ACTIVE	SON	DRY	6	5000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TPD4E004DRYRG4	ACTIVE	SON	DRY	6	5000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBsolete:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

**Important Information and Disclaimer:**The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**TAPE AND REEL INFORMATION**



**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TPD4E004DRYR	SON	DRY	6	5000	179.0	8.4	1.2	1.65	0.7	4.0	8.0	Q1



**TAPE AND REEL BOX DIMENSIONS**

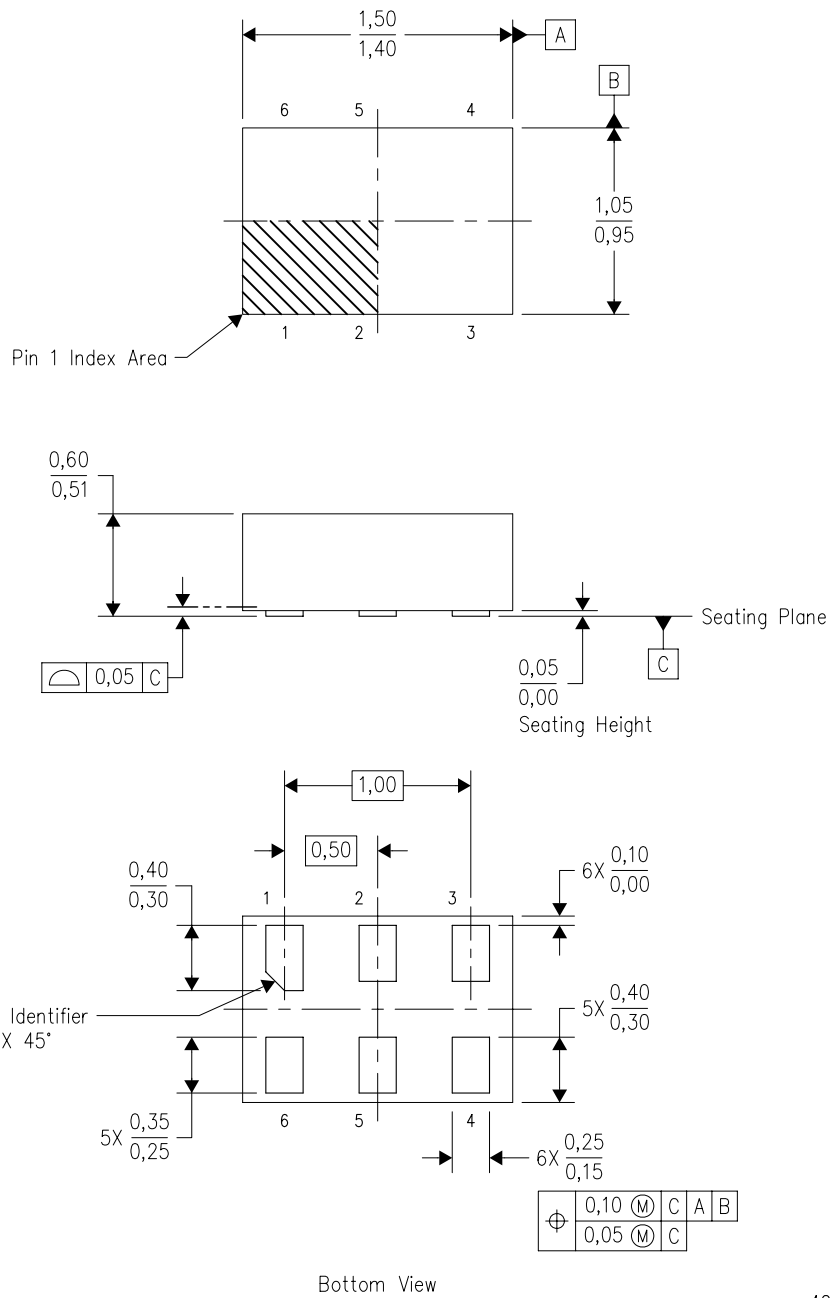


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPD4E004DRYR	SON	DRY	6	5000	220.0	205.0	50.0

DRY (R-PDSO-N6)

PLASTIC SMALL OUTLINE



4207181/B 12/2007

- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
  - B. This drawing is subject to change without notice.
  - C. SON (Small Outline No-Lead) package configuration.
  - D. This package complies to JEDEC MO-287 variation UFAD.

## 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	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
RF/IF and ZigBee® Solutions	<a href="http://www.ti.com/lprf">www.ti.com/lprf</a>

### Applications

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Automotive	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Broadband	<a href="http://www.ti.com/broadband">www.ti.com/broadband</a>
Digital Control	<a href="http://www.ti.com/digitalcontrol">www.ti.com/digitalcontrol</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Military	<a href="http://www.ti.com/military">www.ti.com/military</a>
Optical Networking	<a href="http://www.ti.com/opticalnetwork">www.ti.com/opticalnetwork</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Telephony	<a href="http://www.ti.com/telephony">www.ti.com/telephony</a>
Video & Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>
Wireless	<a href="http://www.ti.com/wireless">www.ti.com/wireless</a>

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