

Comparison and Selection of PC Card Power Controllers

Heping Dai
PMP Systems Power

ABSTRACT

With so many PC Card power controller options available from Texas Instruments, it may be somewhat difficult for designers to select a particular device. This report summarizes all of the similarities and differences, such as features and options, between all of these PC Card power controllers to help eliminate any potential confusion. With the help of this report, the designer can select an exact controller for a specific application.

Contents

1	Introduction	2
2	Single-Slot PC Card Power Controllers	3
2.1	TPS2211 and TPS2211A	3
2.2	TPS2212	3
2.3	TPS2221	4
3	Dual-Slot PC Card Power Controllers	4
3.1	TPS2201 and TPS2205	6
3.2	TPS2202 and TPS2202A	6
3.3	TPS2206 and TPS2206A	6
3.4	TPS2214, TPS2216, TPS2214A, and TPS2216A	6
3.5	TPS2223, TPS2224, and TPS2226	7
3.6	TPS2223A, TPS2224A, and TPS2226A	7
3.7	TPS2228	7
4	Typical PC Card Application	7
5	Other Applications for PC Card Power Controllers	8
6	References of the Data Sheets	9

List of Figures

1	Family Tree of All PC Card Power Controllers From Texas Instruments	2
2	Typical Dual-Slot PC Card Application Diagram	8

List of Tables

1	Comparison of Single-Slot PC Card Power Controllers	3
2	Comparison of Dual-Slot PC Card Power Controllers	5

1 Introduction

As the leading silicon manufacturer of the PC card power controllers, Texas Instruments provides various power controllers with different features to meet the different needs of our customers. These devices are ideal power managers to power PC cards, Smart cards, or multimedia cards. The goal is to give customers greater flexibility in design, minimize the components count, and reduce cost.

A family tree that includes all of the PC card power controllers from Texas Instruments is shown in Figure 1.

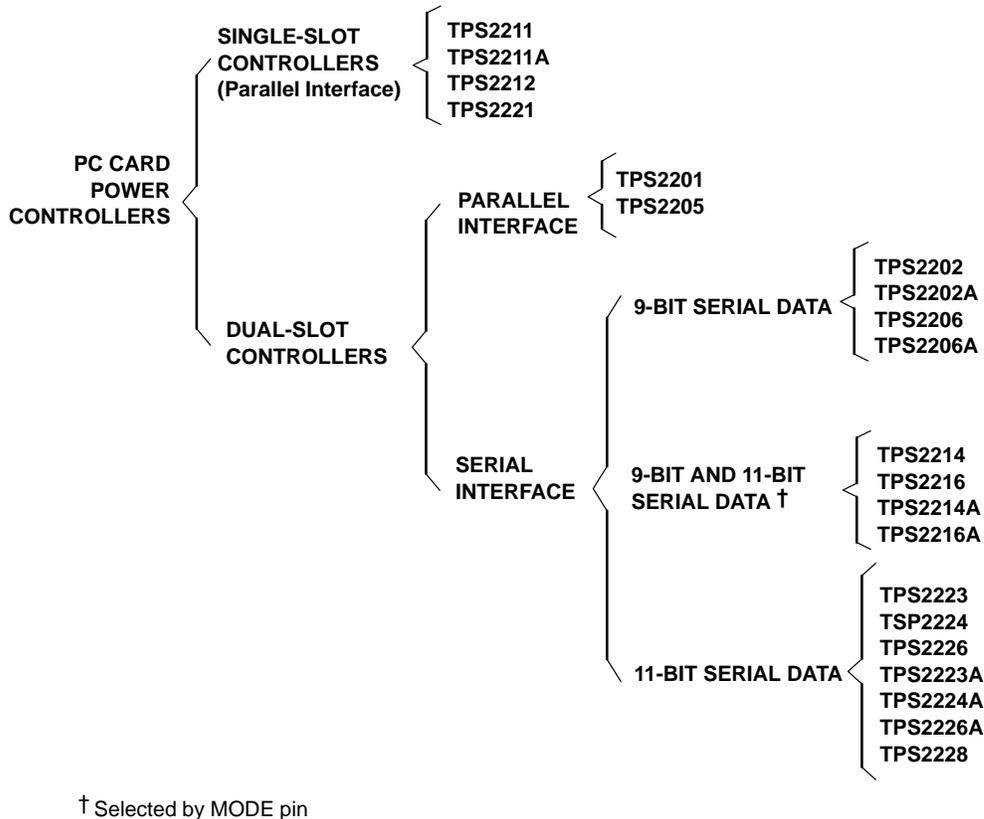


Figure 1. Family Tree of All PC Card Power Controllers From Texas Instruments

This report explains the differences among all of these controllers so that the selection of controllers is easy and clear for customers.

2 Single-Slot PC Card Power Controllers

All the single-slot controllers support a parallel interface only. These devices have three different supply inputs and two outputs. The main features of these devices are listed in Table 1.

Table 1. Comparison of Single-Slot PC Card Power Controllers

PART NO.	INPUT SUPPLY (V)	AV _{CC} or V _{CC}			AV _{PP} or V _{PP} or V _{PP} /V _{CORE}			PACKAGE
		OUTPUT VOLTAGE (V)	MAXIMUM DC CURRENT (A)	MAXIMUM R _{DS(on)} (mΩ)	OUTPUT VOLTAGE (V)	MAXIMUM DC CURRENT (A)	MAXIMUM R _{DS(on)} (Ω)	
TPS2211	12	5	1	90	12	0.15	1	SSOP16
	5	3.3	1	90	5	0.15	6	
	3.3				3.3	0.15	6	
TPS2211A	12	5	1	120	12	0.15	2	SSOP16 HTSSOP20
	5	3.3	1	120	5	0.15	6	
	3.3				3.3	0.15	6	
TPS2212	12	5	0.25	210	12	0.15	1	SSOP16
	5	3.3	0.25	210	5	0.15	6	
	3.3				3.3	0.15	6	
TPS2221	5	5	1	160	5	0.1	1.6	HTSSOP14
	3.3	3.3	1	120	3.3	0.5	0.325	
	1.8	3.3			1.8	0.5	0.12	

All the devices in Table 1 have an over-current reporting pin (\overline{OC}) and an active-low shutdown pin (\overline{SHDN} or $\overline{SHDN_RST}$).

2.1 TPS2211 and TPS2211A

The TPS2211 was the first single-slot PC Card power controller from Texas Instruments, and it is used in many applications in notebook PCs, set top boxes, and PDAs. The device uses a 4-pin parallel interface ($\overline{VCC0}$, $\overline{VCC1}$, $\overline{VPP0}$, and $\overline{VPP1}$) to control the switching from three input supplies (12 V, 5 V, and 3.3 V) to two outputs ($\overline{AV_{CC}}$ and $\overline{AV_{PP}}$). The 12-V supply can be disabled if not required by its load, and either the 5-V (if 5 V is present) or 3.3-V (if 5 V is not present) supply provide chip power for the whole device, which provides greater design flexibility. With more customers using the TPS2211, new demands are encountered, such as cost reduction and new packages. The TPS2211A uses the latest fabrication process from Texas Instruments and has the same functionality as the TPS2211 but costs less. The TPS2211A also adds a new package HTSSOP-20 (PowerPAD™) that minimizes temperature rise caused by power dissipation.

2.2 TPS2212

The TPS2212 has lower current ratings on the $\overline{AV_{CC}}$ switches and higher current ratings on the $\overline{AV_{PP}}$ switches than those of the TPS2211 and TPS2211A as shown in Table 1. The functionality of the TPS2212 is the same as the TPS2211 and the TPS2211A. The device is suitable for low-power PC card applications.

PowerPAD is a trademark of Texas Instruments.

2.3 TPS2221

With Smart card and Multimedia cards becoming more popular, a lower voltage supply is demanded, and the TPS2221 is the result of this trend. The device supports 5-V, 3.3-V, and 1.8-V supplies, but no longer supports the 12-V supply input. In the TPS2221, a 3.3-V input is required for chip power, so this input must be present for proper operation of the device. Another major difference is the logic control. The control of the TPS2221 uses four digital logic inputs but has a different switching table from those of the TPS2211, TPS2211A, and TPS2212. This change provides more flexibility to the PCMCIA controller that generates the parallel interface data inputs. Refer to the data sheets of these devices for a more thorough explanation of the control logic differences.

Due to some confusion between pin names ($\overline{\text{SHDN_RST}}$ of the TPS2221 and $\overline{\text{SHDN}}$ of the other controllers), it is necessary to explain the difference between the functions of the shutdown and reset pins.

A shutdown pin, when activated (e.g., low voltage on $\overline{\text{SHDN}}$), causes all the internal switches from inputs to outputs to be turned off and no internal discharge paths on the outputs to be activated. In other words, the outputs are Hi-Z after shutdown. But when a reset pin is activated, all of the internal switches from inputs to outputs are turned off and the outputs are discharged to ground through internal discharge paths. Therefore the voltages on the outputs are forced to 0 V during a reset. For the devices with both a shutdown pin and a reset pin, such as the dual-slot controllers described in the next section, the shutdown function overwrites the reset function if both are activated. However, when both the shutdown pin and the reset pin go back to inactive states from active states simultaneously, the device resets all outputs to 0 V during the transaction before switching to the projected states set by control logic inputs (e.g., CLOCK, LATCH, and DATA for the TPS2206A).

The $\overline{\text{SHDN_RST}}$ pin of the TPS2221 actually has the same functionality as the $\overline{\text{SHDN}}$ pin of the other controllers. In other words, $\overline{\text{SHDN_RST}}$ is only a shutdown pin and not a reset pin as its name might suggest.

3 Dual-Slot PC Card Power Controllers

As shown in Figure 1, two kinds of interfaces exist in the dual-slot PC card power controllers: parallel and serial. For the serial interface devices, they can be divided into three categories based on the format of their DATA input: 9-bit only serial data, 11-bit only serial data, or both. The main features of these devices are listed in Table 2.

Table 2. Comparison of Dual-Slot PC Card Power Controllers

PART NO.	V _I (V)	xV _{CC}			xV _{PP} or xV _{PP} /V _{CORE}			SPECIAL PINS (see Note 1)					PACKAGE
		V _O (V)	MAX I _O (A)	MAX R _{DS(on)} (mΩ)	V _O (V)	MAX I _O (A)	MAX R _{DS(on)} (Ω)	RESET	RESET	SHDN	PWR_GOOD	MODE and STBY	
TPS2201	12 5 3.3	5 3.3	1 1	160 225	12 5 3.3	0.15 0.15 0.15	1 6 6	N	N	Y	Y	N	SSOP30
TPS2205	12 5 3.3	5 3.3	1 1	140 110	12 5 3.3	0.15 0.15 0.15	1 6 6	N	N	Y	N	N	SSOP30 TSSOP32
TPS2202	12 5 3.3	5 3.3	1 1	160 225	12 5 3.3	0.15 0.15 0.15	1 6 6	N	N	N	Y	N	SSOP30
TPS2202A	12 5 3.3	5 3.3	1 1	160 225	12 5 3.3	0.15 0.15 0.15	1 6 6	Y	Y	N	Y	N	SSOP30
TPS2206	12 5 3.3	5 3.3	1 1	140 110	12 5 3.3	0.15 0.15 0.15	1 6 6	Y	Y	N	N	N	SSOP30 TSSOP32
TPS2206A	12 5 3.3	5 3.3	1 1	160 140	12 5 3.3	0.1 0.1 0.1	3.4 1.3 1.3	N	Y	Y	N	N	SSOP30 TSSOP32
TPS2214	12 5 3.3	5 3.3	1 1	140 140	12 5 3.3	0.2 0.2 0.2	2.5 2.5 2.5	Y	Y	N	N	Y	SSOP24
TPS2214A	12 5 3.3	5 3.3	0.75 0.75	200 140	12 5 3.3	0.2 0.2 0.2	2.5 2.5 2.5	Y	Y	N	N	Y	SSOP24
TPS2216	12 5 3.3	5 3.3	1 1	140 140	12 5 3.3	0.2 0.2 0.2	2.5 2.5 2.5	Y	Y	N	N	Y	SSOP30 TSSOP32
TPS2216A	12 5 3.3	5 3.3	0.75 0.75	200 140	12 5 3.3	0.2 0.2 0.2	2.5 2.5 2.5	Y	Y	N	N	Y	SSOP30 TSSOP32
TPS2223	5 3.3	5 3.3	1 1	160 140	5 3.3	0.1 0.1	1.3 1.3	N	Y	Y	N	N	SSOP24 HTSSOP24
TPS2223A	5 3.3	5 3.3	1 1	160 140	5 3.3	0.1 0.1	1.3 1.3	N	Y	Y	N	N	SSOP24 HTSSOP24
TPS2224	12 5 3.3	5 3.3	1 1	160 140	12 5 3.3	0.1 0.1 0.1	3.4 1.3 1.3	N	Y	Y	N	N	SSOP24 HTSSOP24
TPS2224A	12 5 3.3	5 3.3	1 1	160 140	12 5 3.3	0.1 0.1 0.1	3.4 1.3 1.3	N	Y	Y	N	N	SSOP24 HTSSOP24
TPS2226	12 5 3.3	5 3.3	1 1	160 140	12 5 3.3	0.1 0.1 0.1	3.4 1.3 1.3	N	Y	Y	N	N	SSOP30
TPS2226A	12 5 3.3	5 3.3	1 1	160 140	12 5 3.3	0.1 0.1 0.1	3.4 1.3 1.3	N	Y	Y	N	N	SSOP30
TPS2228	5 3.3 1.8	5 3.3	1 1	160 120	5 3.3 1.8	0.1 0.5 0.5	1.6 0.325 0.12	N	Y	Y	N	N	SSOP30 HTSSOP20

 NOTE 1: Each controller listed in this table has an overcurrent reporting pin \overline{OC} .

3.1 TPS2201 and TPS2205

As one of the earliest PC card power controllers, the TPS2201, provides a complete dual-slot card power controller with a simple parallel interface. Compared to the TPS2201, the TPS2205 has lower switch turnon resistance. The TPS2205 no longer supports a power-good reporting function that is not needed in PC card applications. Both the TPS2201 and the TPS2205 have a shutdown pin ($\overline{\text{SHDN}}$) but no reset pin. Therefore the reset function can only be performed through certain combinations of the parallel interface logic. Another notable difference between these two devices is that the TPS2201 has a designated supply pin V_{DD} for chip power but the TPS2205 uses 3.3-V (if a 5-V input is not present) or 5-V (if a 5-V input is present) as its bias supply. The TPS2201 is only available in a SSOP-30 package, and the TPS2205 is available in both SSOP30 and TSSOP32 packages.

3.2 TPS2202 and TPS2202A

Among all the serial-interfaced dual-slot controllers, the TPS2202 was the first to provide a complete integrated power solution for dual PC cards. It provides a power-good reporting pin but does not have a reset or shutdown pin. The A version of this device, the TPS2202A, adds two reset pins to the device, an active-low $\overline{\text{RESET}}$ pin and an active-high RESET pin. Both reset pins serve the same function. A reset is performed as long as one of the two reset pins is activated. Both the TPS2202 and the TPS2202A, like the TPS2201, have a V_{DD} input as their chip power source.

3.3 TPS2206 and TPS2206A

To meet the demands of some new applications, the TPS2206 has reduced switch turnon resistance and the power-good reporting pin is eliminated that is supported in the TPS2201 and the TPS2202A. The device is available in both SSOP30 and TSSOP32 packages. Like the TPS2205, the TPS2206 uses either the 5-V input or 3.3-V input as its bias power supply. Because of its simplicity and adequate parameters, the TPS2206 attracted much interest and soon became the most preferred PC card power controller before a newer version was released.

With a new fabrication process and additional design efforts, an A version of TPS2206, the TPS2206A, became available, which cost less than the TPS2206. Another major change from the TPS2206 to the TPS2206A is that an active-low shutdown pin ($\overline{\text{SHDN}}$) was added to the TPS2206A, providing a shutdown function directly from a single pin. The active-high reset pin (RESET) is no longer supported in the TPS2206A because the active-low reset pin ($\overline{\text{RESET}}$) provides the same function. Unlike the TPS2206, the TPS2206A only uses the 3.3-V input as the chip power supply.

3.4 TPS2214, TPS2216, TPS2214A, and TPS2216A

All of the previous serial controllers discussed integrate a 9-bit serial data interface that controls V_{PP} outputs depending on V_{CC} switching status. However, some new PCMCIA controllers with an 11-bit serial data interface emerged in the last few years which provide independent switching between V_{PP} and V_{CC} switches. To meet this new requirement, the TPS2214 and the TPS2216 were designed. They support both 9-bit serial data and 11-bit serial data, selected by a special MODE pin. Another special pin in the TPS2214 and the TPS2216, named $\overline{\text{STBY}}$, is provided to select the current rating and the on-resistance of the power switches. With $\overline{\text{STBY}}$, these devices can be used for normal PC card loads when $\overline{\text{STBY}}$ is high or can be used to power low-power loads when $\overline{\text{STBY}}$ is set low. The only difference between the TPS2214 and the TPS2216 is the package as listed in Table 2.

The TPS2214 was the first 24-pin dual-slot PC card power controller. For cost reduction reasons, the TPS2214A and the TPS2216A used the latest fabrication process and some newer design techniques to achieve the same functionality of the TPS2214 and the TPS2216. The on-resistance of the xV_{CC} switches had some changes from the non-A versions to A versions, but not much. The current ratings on the xV_{CC} switches were reduced to 0.75 A from 1 A to limit the voltage drop and power dissipation, but they still meet PCMCIA power requirements. The chip power of these four devices is supplied from either a 5-V or 3.3-V input, similar to the TPS2206.

3.5 TPS2223, TPS2224, and TPS2226

With more PCMCIA controllers using 11-bit serial data interfaces, an 11-bit only serial data interfaced power controller, the TPS2226, was designed. This device is pin compatible with the TPS2206A and has almost the same parameters as the TPS2206A. The major difference between them is that the TPS2226 has an integrated 11-bit serial data interface instead of the 9-bit data interface in the TPS2206A. The TPS2226 is available in both 30-pin SSOP and 32-pin TSSOP packages. The TPS2223 and the TPS2224 are the 24-pin versions of the TPS2226, both of which are available in 24-pin SSOP and 24-pin HTSSOP packages. The only difference between the TPS2223 and the TPS2224 is that the TPS2223 does not have a 12-V input so it does not support 12-V switching. The chip power for the TPS2223, TPS2224, and TPS2226 is only supplied from their 3.3-V inputs.

3.6 TPS2223A, TPS2224A, and TPS2226A

While the TPS2223, TPS2224, and TPS2226 meet all power requirements for PC card applications, they were found to not respond fast enough during a short circuit created by the removal of some Smart cards. Some Smart cards have a close-loop metal trace around the edge of the cards. When the cards are removed with power applied, the power connection may short to ground. This may cause the input supplies to droop and generate a system reset if the drop is big enough. To solve this issue, faster current limiting is required to limit the total power flow during the short-circuit period. To meet this demand, a faster current-limiting version of the TPS2223, TPS2224, and TPS2226 were released to the market. They are the TPS2223A, TPS2224A, and TPS2226A. These devices have the same pin configurations, packages, functions, and parameters as their non-A counterparts. The only difference is that the current-limiting response is faster for the A version devices than the non-A versions.

3.7 TPS2228

Another 11-bit serial data interfaced power controller is the TPS2228. The device supports 5-V, 3.3-V, and 1.8-V power switching and uses the 3.3-V input as the chip power supply. Like the TPS2221, this device supports both PC card and Smart card or Multimedia card applications. The TPS2228 is available in both 30-pin SSOP and 20-pin HTSSOP packages.

4 Typical PC Card Application

Using the TPS2206A as an example, a typical application diagram for dual-slot PC cards is shown in Figure 2.

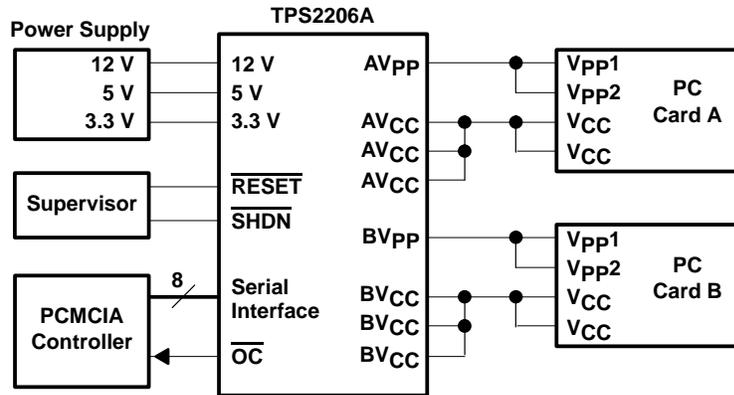


Figure 2. Typical Dual-Slot PC Card Application Diagram

The serial interface includes the CLOCK, LATCH, and DATA lines which are the same for all serial-interfaced PC card power controllers. The diagram also applies to single-slot controllers and dual-slot parallel-interfaced controllers with modification of the control interface.

5 Other Applications for PC Card Power Controllers

Although PC card power controllers are designed for PC card applications, due to the similarity between PC cards, Smart cards, and Multimedia cards, these controllers can also be used to power Smart cards and Multimedia cards as well. The TPS2228 and TPS2221 support 1.8-V power switching and meet the low-voltage requirements of many Smart cards and Multimedia cards. They are designed to be used in PC card, Smart card, or Multimedia card applications.

6 References of the Data Sheets

<http://www-s.ti.com/sc/ds/tps2211.pdf> Literature number: SLVS156E
<http://www-s.ti.com/sc/ds/tps2211a.pdf> Literature number: SLVS282A
<http://www-s.ti.com/sc/ds/tps2212.pdf> Literature number: SLVS193A
<http://www-s.ti.com/sc/ds/tps2221.pdf> Literature number: SLVS419A
<http://www-s.ti.com/sc/ds/tps2201.pdf> Literature number: SLVS094C
<http://www-s.ti.com/sc/ds/tps2205.pdf> Literature number: SLVS128E
<http://www-s.ti.com/sc/ds/tps2202.pdf> Literature number: SLVS103B
<http://www-s.ti.com/sc/ds/tps2202a.pdf> Literature number: SLVS123B
<http://www-s.ti.com/sc/ds/tps2206.pdf> Literature number: SLVS138D
<http://www-s.ti.com/sc/ds/tps2206a.pdf> Literature number: SLVS449A
<http://www-s.ti.com/sc/ds/tps2214.pdf> Literature number: SLVS206B
<http://www-s.ti.com/sc/ds/tps2216.pdf> Literature number: SLVS179D
<http://www-s.ti.com/sc/ds/tps2214a.pdf> Literature number: SLVS267B
<http://www-s.ti.com/sc/ds/tps2216a.pdf> Literature number: SLVS267B
<http://www-s.ti.com/sc/ds/tps2223.pdf> Literature number: SLVS317
<http://www-s.ti.com/sc/ds/tps2224.pdf> Literature number: SLVS317
<http://www-s.ti.com/sc/ds/tps2226.pdf> Literature number: SLVS317
<http://www-s.ti.com/sc/ds/tps2223a.pdf> Literature number: SLVS428
<http://www-s.ti.com/sc/ds/tps2224a.pdf> Literature number: SLVS428
<http://www-s.ti.com/sc/ds/tps2226a.pdf> Literature number: SLVS428
<http://www-s.ti.com/sc/ds/tps2228.pdf> Literature number: SLVS419A

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 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.

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.

Mailing Address:

Texas Instruments
Post Office Box 655303
Dallas, Texas 75265