54ABT16500

54ABT16500 18-Bit Universal Bus Transceivers with TRI-STATE Outputs

Literature Number: SNOS052A

National Semiconductor

July 1998

54ABT16500
18-Bit Universal Bus Transceivers with TRI-STATE® Outputs

General Description

These 18-bit universal bus transceivers combine D-type latches and D-type flip-flops to allow data flow in transparent, latched, and clocked modes.

Data flow in each direction is controlled by output-enable (OEAB and $\overline{\text{OEBA}}$), latch-enable (LEAB and LEBA), and clock ($\overline{\text{CLKAB}}$ and $\overline{\text{CLKBA}}$) inputs. For A-to-B data flow, the device operates in the transparent mode when LEAB is high. When LEAB is low, the A data is latched if $\overline{\text{CLKAB}}$ is held at a high or low logic level. If LEAB is low, the A bus data is stored in the latch/flip-flop on the high-to-low transition of $\overline{\text{CLKAB}}$. Output-enable OEAB is active-high. When OEAB is high, the outputs are active. When OEAB is low, the outputs are in the high-impedance state.

Data flow for B to A is similar to that of A to B but uses $\overline{\text{OEBA}}$, LEBA, and $\overline{\text{CLKBA}}$. The output enables are complementary (OEAB is active high and $\overline{\text{OEBA}}$ is active low).

To ensure the high-impedance state during power up or power down, OE should be tied to GND through a pulldown resistor; the minimum value of the resistor is determined by the current-sourcing capability of the driver.

Features

- Combines D-Type latches and D-Type flip-flops for operation in transparent, latched, or clocked mode
- Flow-through architecture optimizes PCB layout
- Guaranteed latch-up protection
- High impedance glitch free bus loading during entire power up and power down cycle
- Non-destructive hot insertion capability
- Standard Microcircuit Drawing (SMD) 5962-9687001

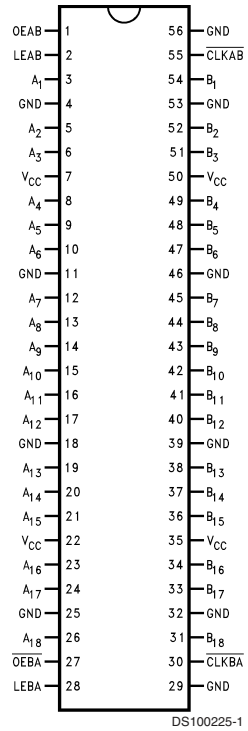
Ordering Code

Military	Package Number	Package Description
54ABT16500W-QML	WA56A	56-Lead Cerpack

TRI-STATE® is a registered trademark of National Semiconductor Corporation.

Connection Diagram

Pin Assignment for Cerpack



DS100225-1

Function Table (Note 1)

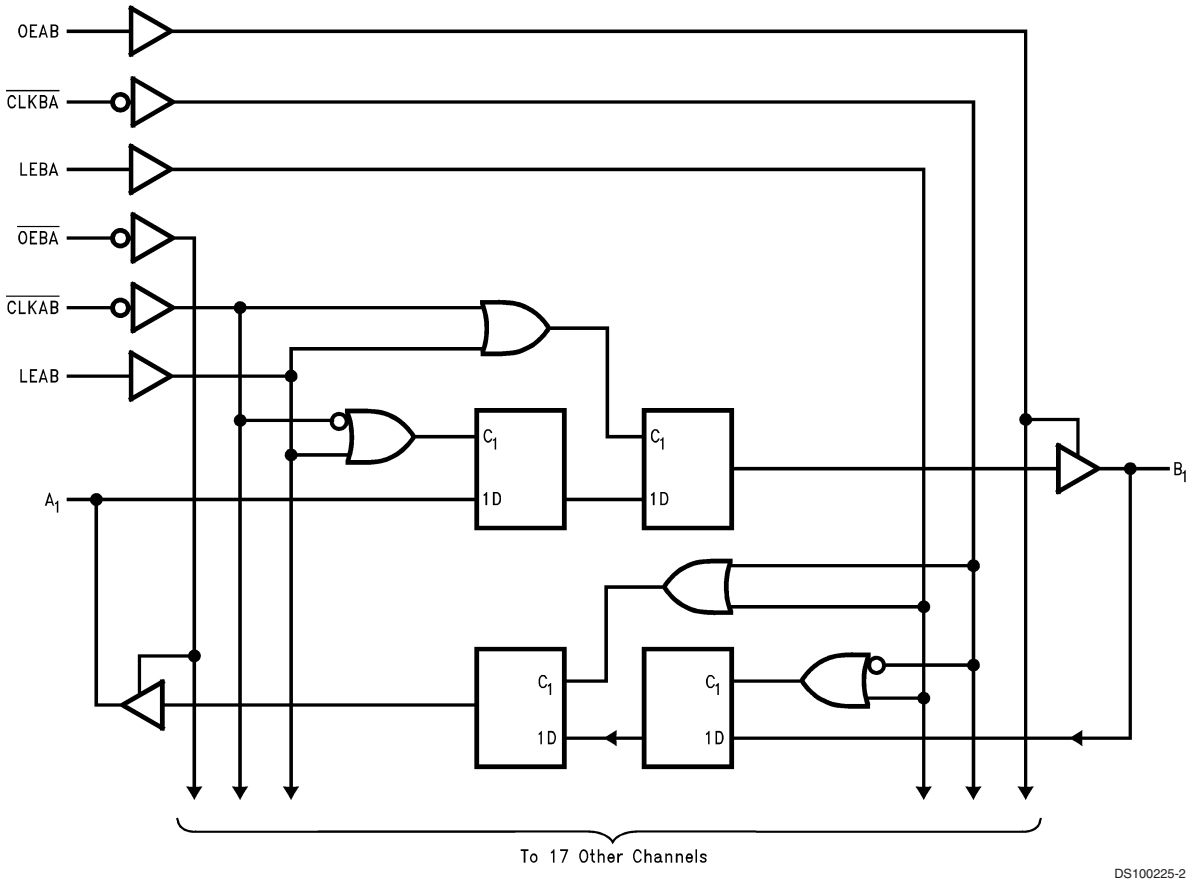
Inputs				Output
OEAB	**LEAB**	**$\overline{\text{CLKAB}}$**	**A**	**B**
L	X	X	X	Z
H	H	X	L	L
H	H	X	H	H
H	L	↓	L	L
H	L	↓	H	H
H	L	H	X	B_0 (Note 2)
H	L	L	X	B_0 (Note 3)

Note 1: A-to-B data flow is shown: B-to-A flow is similar but uses $\overline{\text{OEBA}}$, LEBA, and $\overline{\text{CLKBA}}$.

Note 2: Output level before the indicated steady-state input conditions were established.

Note 3: Output level before the indicated steady-state input conditions were established, provided that $\overline{\text{CLKAB}}$ was low before LEAB went low.

Logic Diagram



DS100225-2

Absolute Maximum Ratings (Note 4)

Storage Temperature	−65˚C to +150˚C
Ambient Temperature under Bias	−55˚C to +125˚C
Junction Temperature under Bias	
Ceramic	−55˚C to +175˚C
V_{CC} Pin Potential to	
Ground Pin	−0.5V to +7.0V
Input Voltage (Note 4)	−0.5V to +7.0V
Input Current (Note 4)	−30 mA to +5.0 mA
Voltage Applied to Any Output	
in the Disabled or	
Power-off State	−0.5V to 5.5V
in the HIGH State	−0.5V to V_{CC}
Current Applied to Output	
in LOW State (Max)	twice the rated I_{OL} (mA)
DC Latchup Source Current	−500 mA
Over Voltage Latchup (I/O)	10V

Recommended Operating Conditions

Free Air Ambient Temperature	
Military	−55˚C to +125˚C
Supply Voltage	
Military	+4.5V to +5.5V
Minimum Input Edge Rate	($\Delta V/\Delta t$)
Data Input	50 mV/ns
Enable Input	20 mV/ns

Note 4: Absolute maximum ratings are values beyond which the device may be damaged or have its useful life impaired. Functional operation under these conditions is not implied.

Note 5: Either voltage limit or current limit is sufficient to protect inputs.

DC Electrical Characteristics

Symbol	Parameter		ABT16500 Min	ABT16500 Typ	ABT16500 Max	Units	V_{CC}	Conditions
V_{IH}	Input HIGH Voltage		2.0			V		Recognized HIGH Signal
V_{IL}	Input LOW Voltage				0.8	V		Recognized LOW Signal
V_{CD}	Input Clamp Diode Voltage				−1.2	V	Min	I_{IN} = −18 mA
V_{OH}	Output HIGH Voltage	54ABT	2.5			V	Min	I_{OH} = −3 mA
		54ABT	2.0			V	Min	I_{OH} = −24 mA
V_{OL}	Output LOW Voltage	54ABT			0.55	V	Min	I_{OL} = 48 mA
I_{IH}	Input HIGH Current				5	µA	Max	V_{IN} = 2.7V (Note 6)
					5			V_{IN} = V_{CC}
I_{BVI}	Input HIGH Current Breakdown Test				7	µA	Max	V_{IN} = 7.0V
I_{IL}	Input LOW Current				−5	µA	Max	V_{IN} = 0.5V (Note 6)
					−5			V_{IN} = 0.0V
V_{ID}	Input Leakage Test		4.75			V	0.0	I_{ID} = 1.9 µA All Other Pins Grounded
I_{IH} + I_{OZH}	Output Leakage Current				50	µA	0 – 5.5V	V_{OUT} = 2.7V; $\overline{OE}$, OE = 2.0V
I_{IL} + I_{OZL}	Output Leakage Current				−50	µA	0 – 5.5V	V_{OUT} = 0.5V; $\overline{OE}$, OE = 2.0V
I_{OS}	Output Short-Circuit Current		−100		−275	mA	Max	V_{OUT} = 0V
I_{CEX}	Output High Leakage Current				50	µA	Max	V_{OUT} = V_{CC}
I_{ZZ}	Bus Drainage Test				100	µA	0.0	V_{OUT} = 5.5V; All Others GND
I_{CCH}	Power Supply Current				1.0	mA	Max	All Outputs HIGH
I_{CCL}	Power Supply Current				68	µA	Max	An or Bn Outputs Low
I_{CCZ}	Power Supply Current				1.0	mA	Max	$\overline{OE}_n$ = V_{CC}, All Others at V_{CC} or GND
I_{CCT}	Additional I_{CC}/Input				2.5	mA	Max	V_I = V_{CC} − 2.1V All Others at V_{CC} or GND
I_{CCD}	Dynamic I_{CC} (Note 6)	No Load			0.23	mA/MHz	Max	Outputs Open Transparent Mode One Bit Toggling, 50% Duty Cycle

Note 6: Guaranteed, but not tested.

DC Electrical Characteristics

Symbol	Parameter	Min	Max	Units	V_{CC}	Conditions C_L = 50 pF; R_L = 500Ω
V_{OLP}	Quiet Output Maximum Dynamic V_{OL}		1.1	V	5.0	T_A = 25˚C (Note 7)

DC Electrical Characteristics (Continued)

Symbol	Parameter	Min	Max	Units	V_{CC}	Conditions C_L = 50 pF; R_L = 500Ω
V_{OLV}	Quiet Output Minimum Dynamic V_{OL}		-1.7	V	5.0	T_A = 25˚C (Note 7)

Note 7: Max number of outputs defined as (n). n – 1 data inputs are driven 0V to 3V. One output at LOW. Guaranteed, but not tested.

AC Electrical Characteristics

Symbol	Parameter	54ABT T_A = –55˚C to +125˚C V_{CC} = 4.5V–5.5V C_L = 50 pF		Units	Fig. No.
		Min	Max		
f_{max}	Maximum Clock Frequency	150		MHz	
t_{PLH}	Propagation Delay	1.0	6.5	ns	*Figure 4*
t_{PHL}	A or B to B or A	1.0	7.0		
t_{PLH}	Propagation Delay	1.0	7.0	ns	*Figure 4*
t_{PHL}	LEAB or LEBA to B or A	1.0	7.8		
t_{PLH}	Propagation Delay	1.0	7.5	ns	*Figure 4*
t_{PHL}	$\overline{CLKAB}$ or $\overline{CLKBA}$ to B or A	1.0	8.0		
t_{PZH}	Propagation Delay	1.0	6.3	ns	*Figure 6*
t_{PZL}	OEAB or $\overline{OEBA}$ to B or A	1.0	6.5		
t_{PHZ}	Propagation Delay	1.0	7.2	ns	*Figure 6*
t_{PLZ}	OEAB or $\overline{OEBA}$ to B or A	1.0	6.8		

AC Operating Requirements

Symbol	Parameter	54ABT T_A = –55˚C to +125˚C V_{CC} = 4.5V–5.5V C_L = 50 pF		Units	Fig. No.
		Min	Max		
t_s(H)	Setup Time,	4.5		ns	*Figure 7*
t_s(L)	A to $\overline{CLKAB}$	4.5			
t_h(H)	Hold Time,	0		ns	*Figure 7*
t_h(L)	A to $\overline{CLKAB}$	0			
t_s(H)	Setup Time,	4.0		ns	*Figure 7*
t_s(L)	B to $\overline{CLKBA}$	4.0			
t_h(H)	Hold Time,	0		ns	*Figure 7*
t_h(L)	B to $\overline{CLKBA}$	0			
t_s(H)	Setup Time, A to LEAB	1.5		ns	*Figure 7*
t_s(L)	or B to LEBA, $\overline{CLK}$ High	1.5			
t_h(H)	Hold Time, A to LEAB	1.5		ns	*Figure 7*
t_h(L)	or B to LEBA, $\overline{CLK}$ High	1.5			
t_s(H)	Setup Time, A to LEAB	4.5		ns	*Figure 7*
t_s(L)	or B to LEBA, $\overline{CLK}$ Low	4.5			
t_h(H)	Hold Time, A to LEAB	1.5		ns	*Figure 7*
t_h(L)	or B to LEBA, $\overline{CLK}$ Low	1.5			
t_w(H)	Pulse Width,	3.3		ns	*Figure 5*
t_w(L)	LEAB or LEBA, High	3.3			

AC Operating Requirements (Continued)

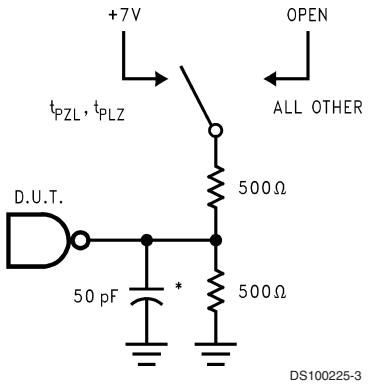
Symbol	Parameter	54ABT		Units	Fig. No.
		$T_A = -55^\circ C$ to $+125^\circ C$ $V_{CC} = 4.5V–5.5V$ $C_L = 50$ pF			
		Min	Max		
$t_w(H)$	Pulse Width, $\overline{CLKAB}$	3.3		ns	*Figure 5*
$t_w(L)$	or $\overline{CLKBA}$, High or Low	3.3			

Capacitance

Symbol	Parameter	Typ	Units	Conditions, $T_A = 25^\circ C$
C_{IN}	Input Capacitance	5.0	pF	$V_{CC} = 0.0V$
$C_{I/O}$ (Note 8)	Output Capacitance	11.0	pF	$V_{CC} = 5.0V$

Note 8: $C_{I/O}$ is measured at frequency f = 1 MHz per MIL-STD-883B, Method 3012.

AC Loading



*Includes jig and probe capacitance.

FIGURE 1. Standard AC Test Load

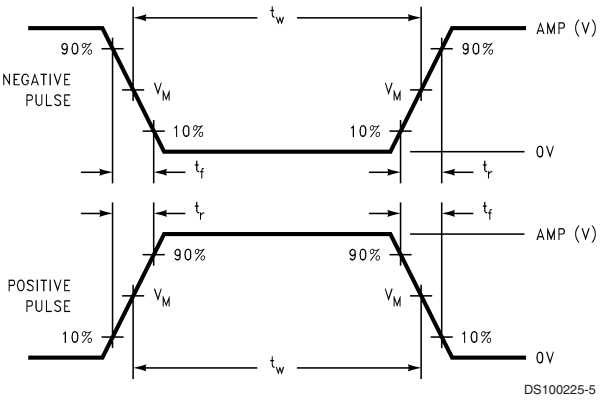


FIGURE 2. V_M = 1.5V

Input Pulse Requirements

Amplitude	Rep. Rate	t_w	t_r	t_f
3.0V	1 MHz	500 ns	2.5 ns	2.5 ns

FIGURE 3. Test Input Signal Requirements

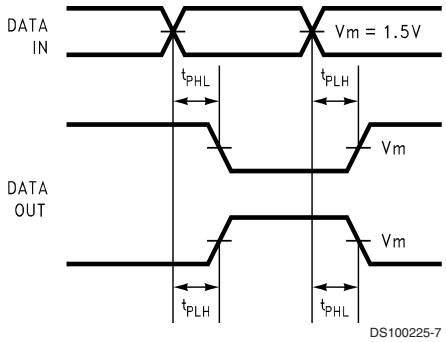


FIGURE 4. Propagation Delay Waveforms for Inverting and Non-Inverting Functions

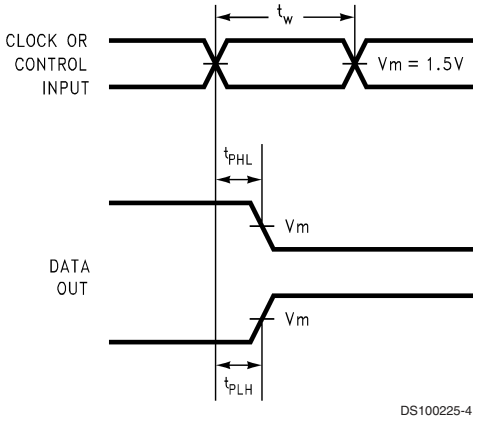


FIGURE 5. Propagation Delay, Pulse Width Waveforms

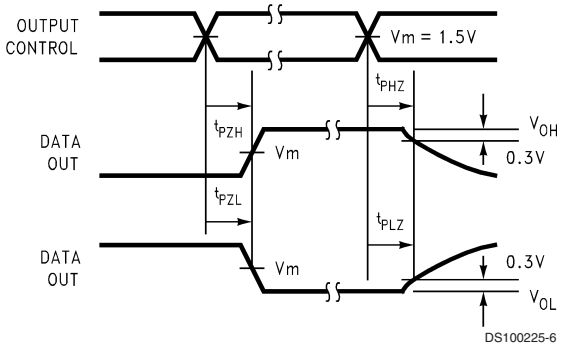


FIGURE 6. TRI-STATE Output HIGH and LOW Enable and Disable Times

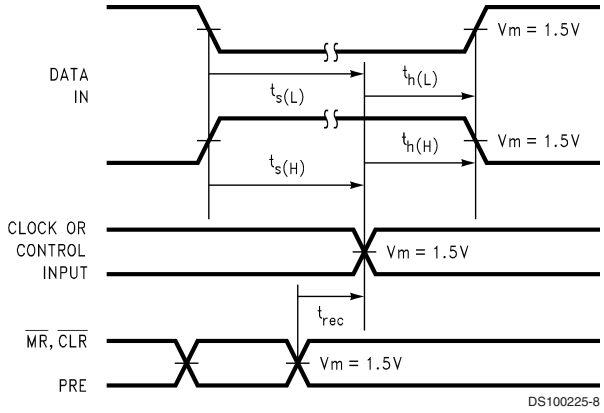
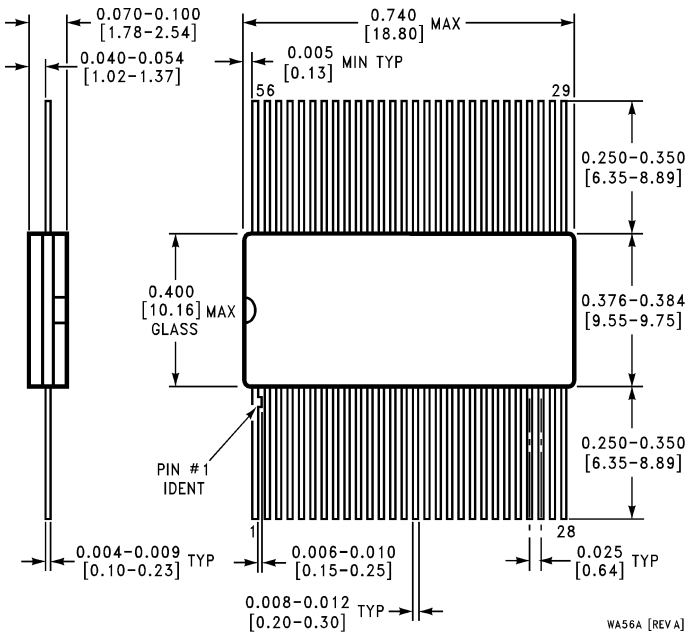


FIGURE 7. Setup Time, Hold Time and Recovery Time Waveforms

Physical Dimensions inches (millimeters) unless otherwise noted



56-Lead Cerpack
NS Package Number WA56A

LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT AND GENERAL COUNSEL OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

BANNED SUBSTANCE COMPLIANCE

National Semiconductor certifies that the products and packing materials meet the provisions of the Customer Products Stewardship Specification (CSP-9-111C2) and the Banned Substances and Materials of Interest Specification (CSP-9-111S2) and contain no "Banned Substances" as defined in CSP-9-111S2.

National Semiconductor
Americas Customer
Support Center
Email: new.feedback@nsc.com
Tel: 1-800-272-9959

www.national.com

National Semiconductor
Europe Customer Support Center
Fax: +49 (0) 180-530 85 86
Email: europe.support@nsc.com
Deutsch Tel: +49 (0) 69 9508 6208
English Tel: +44 (0) 870 24 0 2171
Français Tel: +33 (0) 1 41 91 8790

National Semiconductor
Asia Pacific Customer
Support Center
Email: ap.support@nsc.com

National Semiconductor
Japan Customer Support Center
Fax: 81-3-5639-7507
Email: jpn.feedback@nsc.com
Tel: 81-3-5639-7560

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**	
Audio	www.ti.com/audio	Communications and Telecom	www.ti.com/communications
Amplifiers	amplifier.ti.com	Computers and Peripherals	www.ti.com/computers
Data Converters	dataconverter.ti.com	Consumer Electronics	www.ti.com/consumer-apps
DLP® Products	www.dlp.com	Energy and Lighting	www.ti.com/energy
DSP	dsp.ti.com	Industrial	www.ti.com/industrial
Clocks and Timers	www.ti.com/clocks	Medical	www.ti.com/medical
Interface	interface.ti.com	Security	www.ti.com/security
Logic	logic.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Power Mgmt	power.ti.com	Transportation and Automotive	www.ti.com/automotive
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Mobile Processors	www.ti.com/omap		
Wireless Connectivity	www.ti.com/wirelessconnectivity		
	TI E2E Community Home Page		e2e.ti.com

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