

SN54ABTE16245, SN74ABTE16245 16-BIT INCIDENT-WAVE SWITCHING BUS TRANSCEIVERS WITH 3-STATE OUTPUTS

SCBS226J – JULY 1993 – REVISED DECEMBER 2001

- Members of the Texas Instruments Widebus™ Family
- Support the VME64 ETL Specification
- Reduced, TTL-Compatible, Input Threshold Range
- High-Drive Outputs ($I_{OH} = -60$ mA, $I_{OL} = 90$ mA) Support 25- Ω Incident-Wave Switching
- V_{CCBIAS} Pin Minimizes Signal Distortion During Live Insertion
- Internal Pullup Resistor on \overline{OE} Keeps Outputs in High-Impedance State During Power Up or Power Down
- Distributed V_{CC} and GND Pins Minimize High-Speed Switching Noise
- Equivalent 25- Ω Series Damping Resistor on B Port
- Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors

description

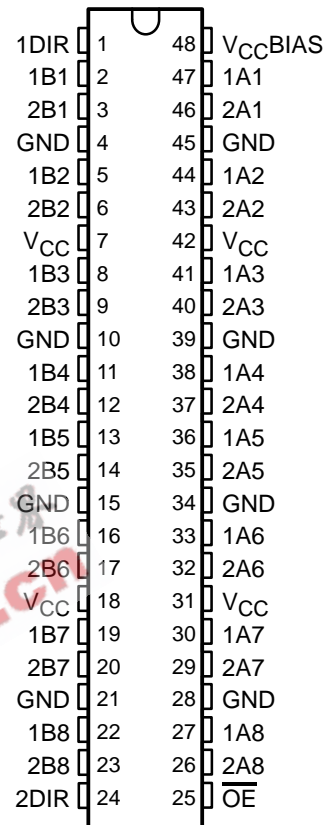
The 'ABTE16245 devices are 16-bit (dual-octal) noninverting 3-state transceivers designed for synchronous two-way communication between data buses. The control-function implementation minimizes external timing requirements. These devices can be used as two 8-bit transceivers or one 16-bit transceiver. They allow data transmission from the A bus to the B bus or from the B bus to the A bus, depending on the logic level at the direction-control (DIR) input. The output-enable (\overline{OE}) input can be used to disable the device so that the buses are effectively isolated. When \overline{OE} is low, the device is active.

The B port has an equivalent 25- Ω series output resistor to reduce ringing. Active bus-hold inputs also are on the B port to hold unused or floating inputs at a valid logic level.

The A port provides for the precharging of the outputs via V_{CCBIAS} , which establishes a voltage between 1.3 V and 1.7 V when V_{CC} is not connected.

Active bus-hold circuitry holds unused or undriven inputs at a valid logic state. Use of pullup or pulldown resistors with the bus-hold circuitry is not recommended.

SN54ABTE16245 . . . WD PACKAGE
SN74ABTE16245 . . . DGG OR DL PACKAGE
(TOP VIEW)



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.

Widebus is a trademark of Texas Instruments.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

 **TEXAS
INSTRUMENTS**

POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

Copyright © 2001, Texas Instruments Incorporated
On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

SN54ABTE16245, SN74ABTE16245 16-BIT INCIDENT-WAVE SWITCHING BUS TRANSCEIVERS WITH 3-STATE OUTPUTS

SCBS226J – JULY 1993 – REVISED DECEMBER 2001

ORDERING INFORMATION

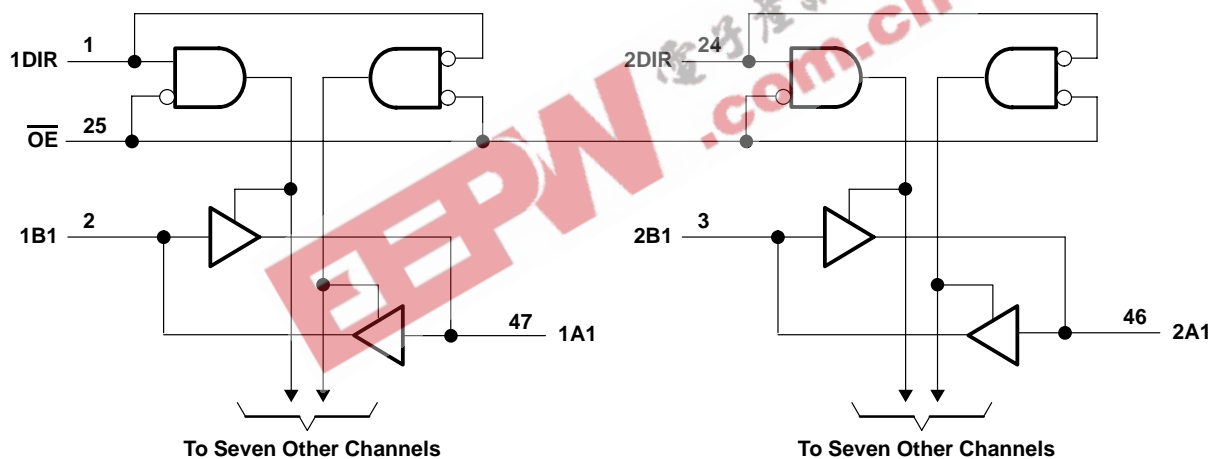
T _A	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	SSOP – DL	Tube	SN74ABTE16245DL	ABTE16245
		Tape and reel	SN74ABTE16245DLR	
	TSSOP – DGG	Tape and reel	SN74ABTE16245DGGR	ABTE16245
–55°C to 125°C	CFP – WD	Tube	SNJ54ABTE16245WD	SNJ54ABTE16245WD

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

FUNCTION TABLE
(each 8-bit section)

INPUTS		OPERATION
\overline{OE}	DIR	
L	L	A data to B bus
L	H	B data to A bus
H	X	Isolation

logic diagram (positive logic)



absolute maximum ratings over operating free-air temperature range (unless otherwise noted)‡

Supply voltage range, V _{CC} and V _{CCBIAS}	–0.5 V to 7 V
Input voltage range, V _I (except I/O ports) (see Note 1)	–0.5 V to 7 V
Voltage range applied to any output in the high state or power-off state, V _O	–0.5 V to 5.5 V
Current into any output in the low state, I _O	128 mA
Input clamp current, I _{IK} (V _I < 0)	–18 mA
Output clamp current, I _{OK} (V _O < 0)	–50 mA
Package thermal impedance, θ _{JA} (see Note 2): DGG package	70°C/W
DL package	63°C/W
Storage temperature range, T _{stg}	–65°C to 150°C

‡ 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 under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- NOTES: 1. The input and output negative-voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
2. The package thermal impedance is calculated in accordance with JESD 51-7.

SN54ABTE16245, SN74ABTE16245
16-BIT INCIDENT-WAVE SWITCHING BUS TRANSCEIVERS
WITH 3-STATE OUTPUTS

SCBS226J – JULY 1993 – REVISED DECEMBER 2001

recommended operating conditions (see Note 3)

		SN54ABTE16245			SN74ABTE16245			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC} , V_{CCBIAS}	Supply voltage	4.5	5	5.5	4.5	5	5.5	V
V_{IH}	High-level input voltage	\overline{OE}	2		2			V
		Except \overline{OE}	1.6		1.6			
V_{IL}	Low-level input voltage	\overline{OE}		0.8			0.8	V
		Except \overline{OE}		1.4			1.4	
V_I	Input voltage	0		V_{CC}	0		V_{CC}	V
I_{OH}	High-level output current	B bus		-12			-12	mA
		A bus		-24			-60	
I_{OL}	Low-level output current	B bus		12			12	mA
		A bus		64			90	
$\Delta t/\Delta v$	Input transition rise or fall rate			10			10	ns/V
T_A	Operating free-air temperature	-55		125	-40		85	°C

NOTE 3: All unused control inputs of the device must be held at V_{CC} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.



SN54ABTE16245, SN74ABTE16245 16-BIT INCIDENT-WAVE SWITCHING BUS TRANSCEIVERS WITH 3-STATE OUTPUTS

SCBS226J – JULY 1993 – REVISED DECEMBER 2001

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

PARAMETER	TEST CONDITIONS	SN54ABTE16245			SN74ABTE16245			UNIT
		MIN	TYP†	MAX	MIN	TYP†	MAX	
V_{IK}	$V_{CC} = 4.5\text{ V}$, $I_I = -18\text{ mA}$			-1.2			-1.2	V
V_{OH}	B port	$V_{CC} = 5.5\text{ V}$, $I_{OH} = -100\text{ }\mu\text{A}$		$V_{CC}-0.2$			$V_{CC}-0.2$	
		$V_{CC} = 4.5\text{ V}$	$I_{OH} = -1\text{ mA}$	2.4		2.4		
			$I_{OH} = -12\text{ mA}$	2		2		
	A port	$V_{CC} = 5.5\text{ V}$, $I_{OH} = -1\text{ mA}$		4.5			4.5	
		$V_{CC} = 4.5\text{ V}$	$I_{OH} = -32\text{ mA}$	2.4		2.4		
			$I_{OH} = -64\text{ mA}$			2		
V_{OL}	B port	$V_{CC} = 4.5\text{ V}$	$I_{OL} = 1\text{ mA}$		0.4		0.4	
			$I_{OL} = 12\text{ mA}$				0.8	
	A port	$V_{CC} = 4.5\text{ V}$	$I_{OL} = 64\text{ mA}$		0.55		0.55	
			$I_{OL} = 90\text{ mA}$				0.9	
$I_{I(\text{hold})}$	B port	$V_{CC} = 4.5\text{ V}$	$V_I = 0.8\text{ V}$	100		100		
			$V_I = 2\text{ V}$	-100		-100		
		$V_{CC} = 5.5\text{ V}$, $V_I = 0\text{ to }5.5\text{ V}$			± 500		± 500	
I_I	Control inputs	$V_{CC} = 5.5\text{ V}$, $V_I = V_{CC}\text{ or GND}$			± 1		± 1	
	A or B ports				± 20		± 20	
I_{OZH}^{\ddagger}	A port	$V_{CC} = 5.5\text{ V}$, $V_O = 2.7\text{ V}$			10		10	
I_{OZL}^{\ddagger}	A port	$V_{CC} = 5.5\text{ V}$, $V_O = 0.5\text{ V}$			-10		-10	
I_O	A port	$V_{CC} = 5.5\text{ V}$, $V_O = 2.5\text{ V}$		-50	-120	-180	-50	-180
	B port			-25	-52	-90	-25	-90
I_{off}		$V_{CC} = 0$, $V_I\text{ or }V_O \leq 4.5\text{ V}$, $V_{CCBIAS} = 0$			± 100		± 100	
I_{CC}	A or B ports	$V_{CC} = 5.5\text{ V}$, $I_O = 0$, $V_I = V_{CC}\text{ or GND}$	Outputs high	28	36		28	36
			Outputs low	38	48		38	48
			Outputs disabled	20	32		20	32
I_{CCD}	A or B ports	$V_{CC} = 5\text{ V}$, $C_L = 50\text{ pF}$	\overline{OE} high	0.02			0.02	
			\overline{OE} low	0.33			0.33	
C_i	Control inputs	$V_I = 2.5\text{ V or }0.5\text{ V}$			10		2.5	4
C_{io}	I/O ports	$V_O = 2.5\text{ V or }0.5\text{ V}$			13		4.5	8

† All typical values are at $V_{CC} = 5\text{ V}$, $T_A = 25^\circ\text{C}$.

‡ The parameters I_{OZH} and I_{OZL} include the input leakage current.

SN54ABTE16245, SN74ABTE16245 16-BIT INCIDENT-WAVE SWITCHING BUS TRANSCEIVERS WITH 3-STATE OUTPUTS

SCBS226J – JULY 1993 – REVISED DECEMBER 2001

live-insertion specifications over recommended operating free-air temperature range

PARAMETER	TEST CONDITIONS		SN54ABTE16245			SN74ABTE16245			UNIT		
			MIN	TYP†	MAX	MIN	TYP†	MAX			
I _{CC} (V _{CC} BIAS)	V _{CC} = 0 to 4.5 V, V _{CC} BIAS = 4.5 V to 5.5 V, I _O (DC) = 0		250	700		250	700		μA		
	V _{CC} = 4.5 V to 5.5 V‡, V _{CC} BIAS = 4.5 V to 5.5 V, I _O (DC) = 0			20			20				
V _O	A port	V _{CC} = 0	V _{CC} BIAS = 4.5 V to 5.5 V		1.1	1.5	1.9	1.1	1.5	1.9	V
			V _{CC} BIAS = 4.75 V to 5.25 V		1.3	1.5	1.7	1.3	1.5	1.7	
I _O	A port	V _{CC} = 0, V _{CC} BIAS = 4.5 V	V _O = 0		-20		-100	-20		-100	μA
			V _O = 3 V		20		100	20		100	μA

† All typical values are at V_{CC} = 5 V, T_A = 25°C.

‡ V_{CC} – 0.5 V < V_{CC}BIAS

switching characteristics over recommended ranges of supply voltage and operating free-air temperature, C_L = 50 pF (unless otherwise noted) (see Figure 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V _{CC} = 5 V, T _A = 25°C			SN54ABTE16245		SN74ABTE16245		UNIT
			MIN	TYP	MAX	MIN	MAX	MIN	MAX	
t _{PLH}	A	B	1.5	3.3	4.2	1.5	5.4	1.5	5.2	ns
t _{PHL}			1.5	3.8	4.6	1.5	5.4	1.5	5.2	
t _{PLH}	B	A	1.5	3	3.8	1.5	4.7	1.5	4.5	ns
t _{PHL}			1.5	3.1	4	1.5	4.7	1.5	4.5	
t _{PZH}	OE	A	2	3.9	5.3	2	6.4	2	6.2	ns
t _{PZL}			2	4.4	5.9	2	7	2	6.8	
t _{PZH}	OE	B	2	4.5	6	2	7.3	2	7.1	ns
t _{PZL}			2	5	6.4	2	7.5	2	7.3	
t _{PHZ}	OE	A	2	4.9	5.9	2	7	2	6.7	ns
t _{PLZ}			2	3.7	4.6	2	5.4	2	5.1	
t _{PHZ}	OE	B	2	5.2	6.2	2	7.2	2	7	ns
t _{PLZ}			2	4	5	2	5.8	2	5.5	

SN54ABTE16245, SN74ABTE16245 16-BIT INCIDENT-WAVE SWITCHING BUS TRANSCEIVERS WITH 3-STATE OUTPUTS

SCBS226J – JULY 1993 – REVISED DECEMBER 2001

extended switching characteristics over recommended ranges of supply voltage and operating free-air temperature, $C_L = 50$ pF (unless otherwise noted) (see Figure 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD	$V_{CC} = 5$ V, $T_A = 25^\circ$ C			SN54ABTE16245		SN74ABTE16245		UNIT
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
t_{PLH}	B	A	$R_X = 13 \Omega$	1.5	3.2	4	1.5	5	1.5	4.8	ns
t_{PHL}				1.5	3.8	4.7	1.5	5.8	1.5	5.6	
t_{PLH}	B	A	$R_X = 26 \Omega$	1.5	3.1	4	1.5	4.8	1.5	4.6	ns
t_{PHL}				1.5	3.5	4.4	1.5	5.2	1.5	4.9	
t_{PLH}	B	A	$R_X = 56 \Omega$	1.5	3	3.8	1.5	4.7	1.5	4.5	ns
t_{PHL}				1.5	3.3	4.2	1.5	5.1	1.5	4.7	
$t_{sk(p)}$	B	A	$R_X = \text{Open}$		0.1	0.6		2		2	ns
	A	B	$R_X = \text{Open}$		0.4	0.8		2		2	
	B	A	$R_X = 26 \Omega$		0.3	0.8		2		2	
$t_{sk(o)}$	B	A	$R_X = \text{Open}$		0.3	0.7		1.3		1.3	ns
	A	B	$R_X = \text{Open}$		0.7	1.1		1.3		1.3	
	B	A	$R_X = 26 \Omega$		0.5	1		1.3		1.3	
t_t^\dagger	B	A	$R_X = 26 \Omega$	0.5	0.8	1.5	0.5	1.5	0.5	1.5	ns
t_t^\ddagger	A	B	$R_X = \text{Open}$	3.5	5.5	7.3	3.5	8.1	3.5	7.9	ns

$^\dagger t_t$ is measured between 1 V and 2 V of the output waveform.

$^\ddagger t_t$ is measured between 10% and 90% of the output waveform.

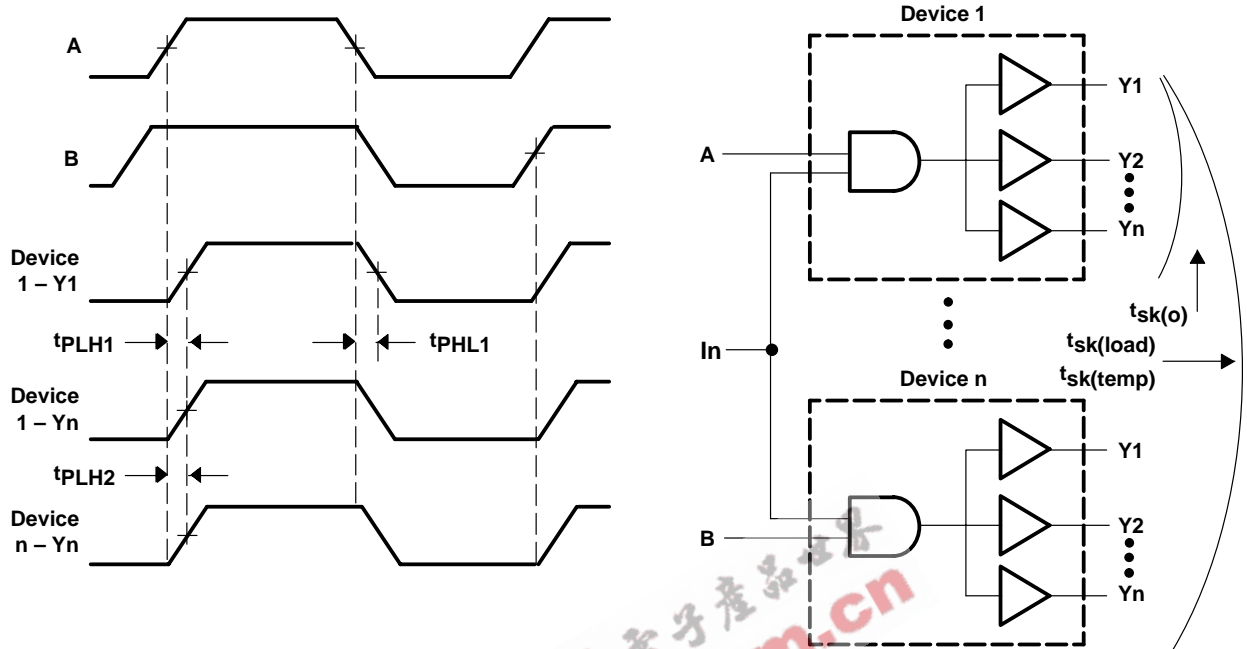
extended output characteristics over recommended ranges of supply voltage and operating free-air temperature, $C_L = 50$ pF (see Figures 1 and 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	LOAD	SN54ABTE16245		SN74ABTE16245		UNIT
					MIN	MAX	MIN	MAX	
$t_{sk(temp)}$	A	B	$V_{CC} = \text{constant},$ $\Delta T_A = 20^\circ$ C			3		2.5	ns
	B	A		$R_X = 56 \Omega$		4.5		4	
$t_{sk(load)}$	B	B	$V_{CC} = \text{constant},$ Temperature = constant	$R_X = 13, 26,$ or 56Ω		4.5		4	ns

SN54ABTE16245, SN74ABTE16245
16-BIT INCIDENT-WAVE SWITCHING BUS TRANSCEIVERS
WITH 3-STATE OUTPUTS

SCBS226J – JULY 1993 – REVISED DECEMBER 2001

PARAMETER MEASUREMENT INFORMATION



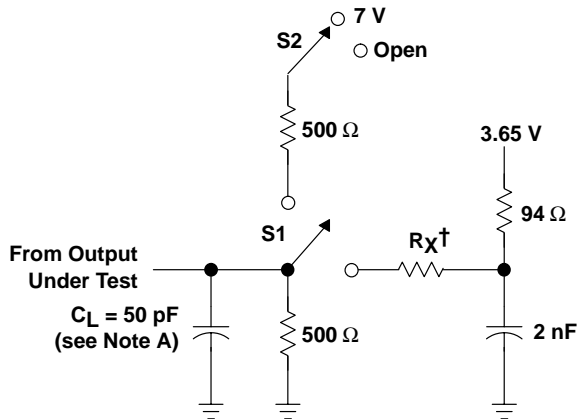
- NOTES: A. Pulse skew, $t_{sk(p)}$, is defined as the difference in propagation-delay times t_{PLH1} and t_{PHL1} on the same terminal at identical operating conditions.
- B. Output skew, $t_{sk(o)}$, is defined as the difference in propagation delay of any two outputs of the same device switching in the same direction (e.g., $|t_{PLH1} - t_{PLH2}|$).
- C. Temperature skew, $t_{sk(temp)}$, is the output skew of two devices, both having the same value of $V_{CC} \pm 1\%$ and with package temperature differences of 20°C .
- D. Load skew, $t_{sk(load)}$, is measured with R_X in Figure 2 at $13\ \Omega$ for one unit and $56\ \Omega$ for the other unit.

Figure 1. Voltage Waveforms for Extended Characteristics

SN54ABTE16245, SN74ABTE16245 16-BIT INCIDENT-WAVE SWITCHING BUS TRANSCEIVERS WITH 3-STATE OUTPUTS

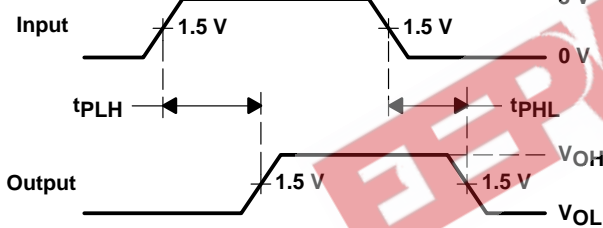
SCBS226J – JULY 1993 – REVISED DECEMBER 2001

PARAMETER MEASUREMENT INFORMATION

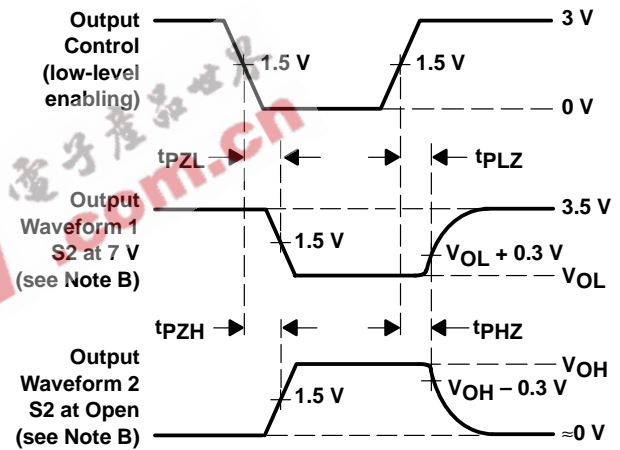


† $R_X = 13, 26, \text{ or } 56 \Omega$

LOAD CIRCUIT FOR OUTPUTS



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

SWITCHING TABLE LOADS	S1	S2
t_{PLH}/t_{PHL} (A and B port)	Up	Open
t_{PLZ}/t_{PZL}	Up	7 V
t_{PHZ}/t_{PZH}	Up	Open

EXTENDED SWITCHING TABLE LOADS	S1	S2
$t_{PLH}/t_{PHL}/t_{sk}$ (A port)	Down	X
$t_{PLH}/t_{PHL}/t_{sk}$ (B port)	Up	Open
t_t (A port) (see Note E)	Down	X
t_t (B port) (see Note F)	Up	Open

- NOTES:
- C_L includes probe and jig capacitance.
 - Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
 - All input pulses are supplied by generators having the following characteristics: $PRR \leq 10 \text{ MHz}$, $Z_O = 50 \Omega$, $t_r \leq 2.5 \text{ ns}$, $t_f \leq 2.5 \text{ ns}$.
 - The outputs are measured one at a time with one transition per measurement.
 - t_t is measured between 1 V and 2 V of the output waveform.
 - t_t is measured between 10% and 90% of the output waveform.

Figure 2. Load Circuit and Voltage Waveforms

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
5962-9677501QXA	ACTIVE	CFP	WD	48	1	TBD	A42 SNPB	N / A for Pkg Type
74ABTE16245DGGRE4	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
74ABTE16245DLRG4	ACTIVE	SSOP	DL	48	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74ABTE16245DGGR	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74ABTE16245DL	ACTIVE	SSOP	DL	48	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74ABTE16245DLG4	ACTIVE	SSOP	DL	48	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74ABTE16245DLR	ACTIVE	SSOP	DL	48	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SNJ54ABTE16245WD	ACTIVE	CFP	WD	48	1	TBD	A42 SNPB	N / A for Pkg Type

⁽¹⁾ 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.

OBSELETE: TI has discontinued the production of the device.

⁽²⁾ 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)

⁽³⁾ 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.

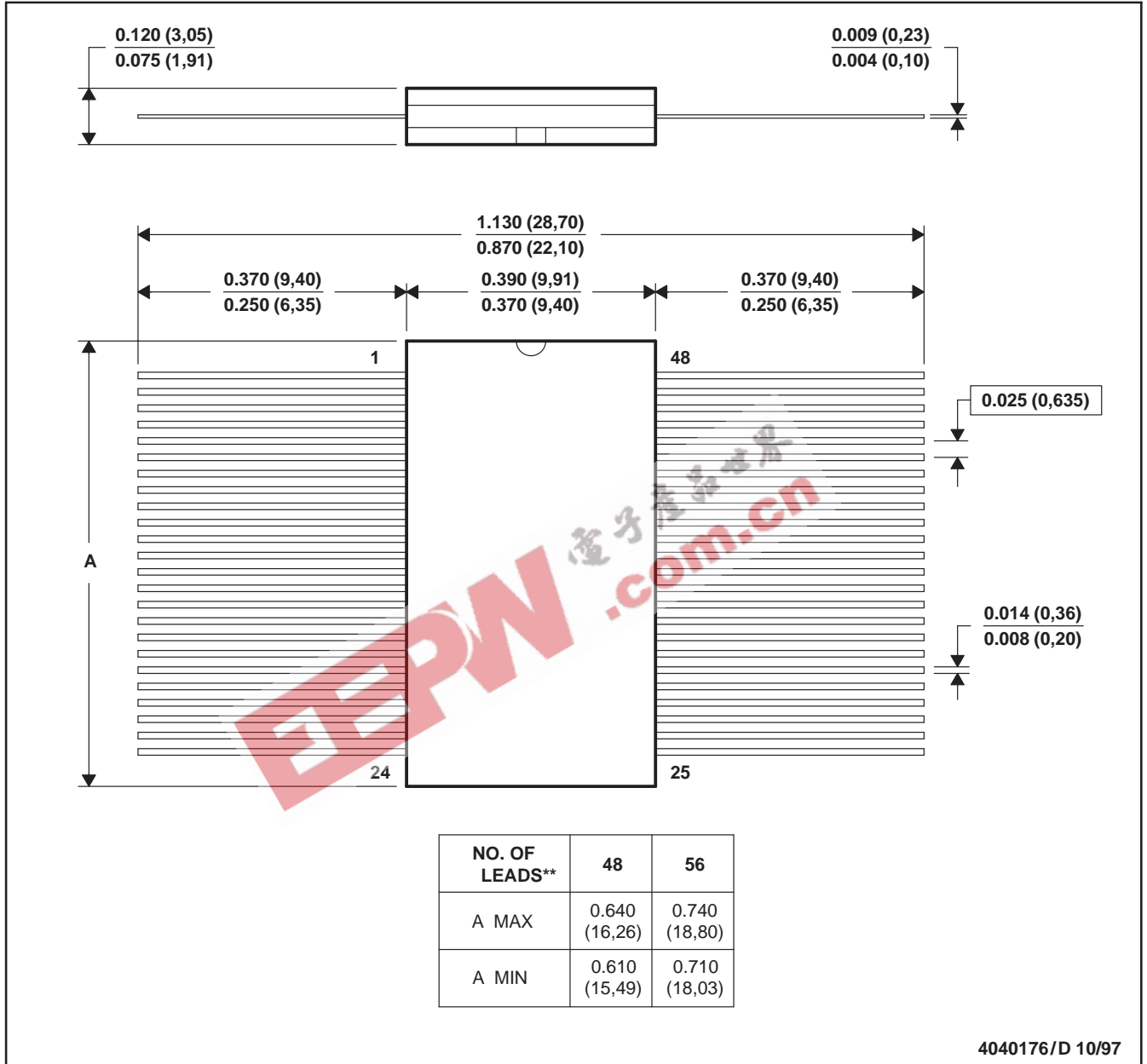
MECHANICAL DATA

MCFP010B – JANUARY 1995 – REVISED NOVEMBER 1997

WD (R-GDFP-F**)

CERAMIC DUAL FLATPACK

48 LEADS SHOWN



- NOTES:
- All linear dimensions are in inches (millimeters).
 - This drawing is subject to change without notice.
 - This package can be hermetically sealed with a ceramic lid using glass frit.
 - Index point is provided on cap for terminal identification only
 - Falls within MIL STD 1835: GDFP1-F48 and JEDEC MO-146AA
GDFP1-F56 and JEDEC MO-146AB

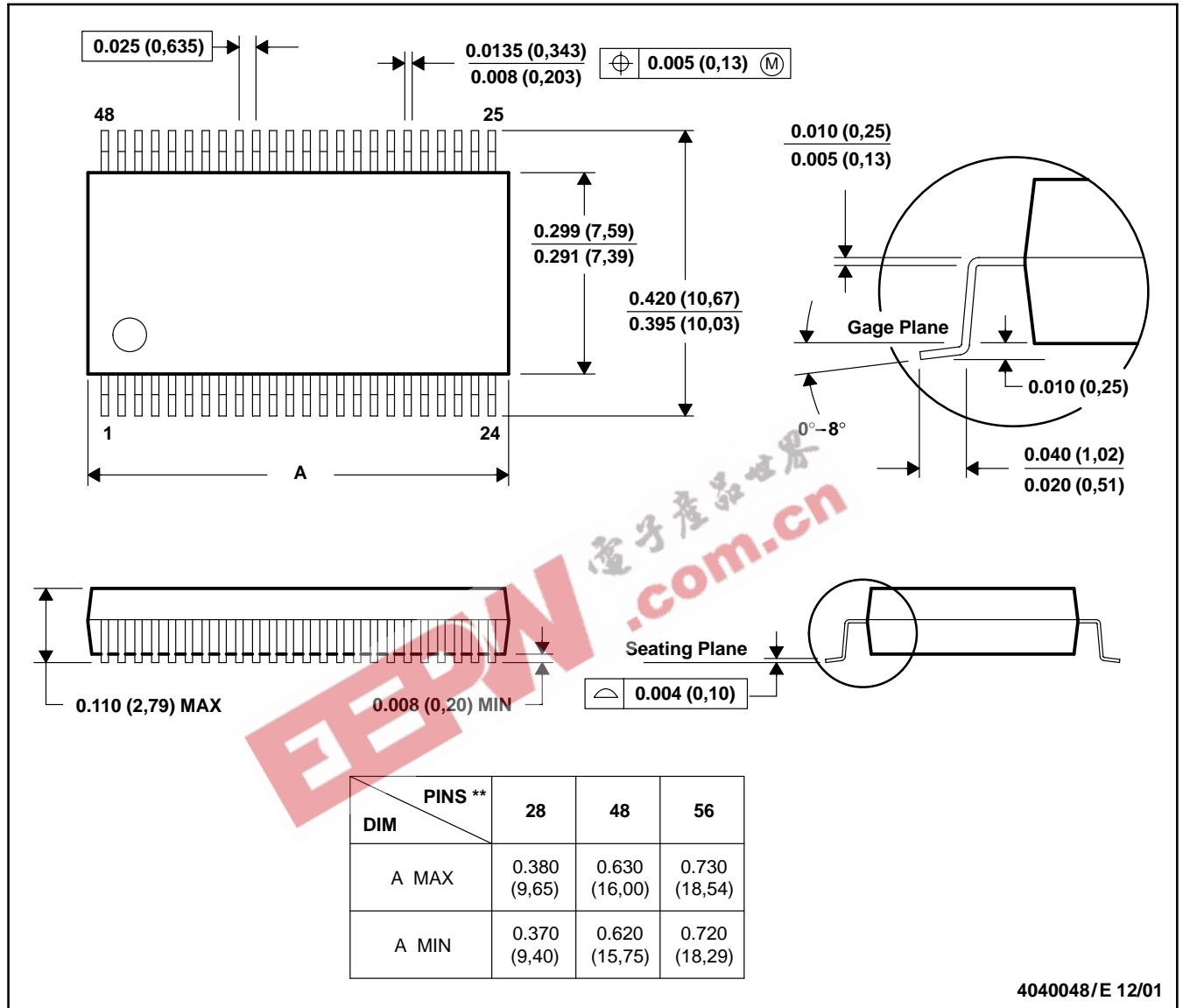
MECHANICAL DATA

MSS0001C – JANUARY 1995 – REVISED DECEMBER 2001

DL (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

48 PINS SHOWN



- NOTES: A. All linear dimensions are in inches (millimeters).
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
 D. Falls within JEDEC MO-118

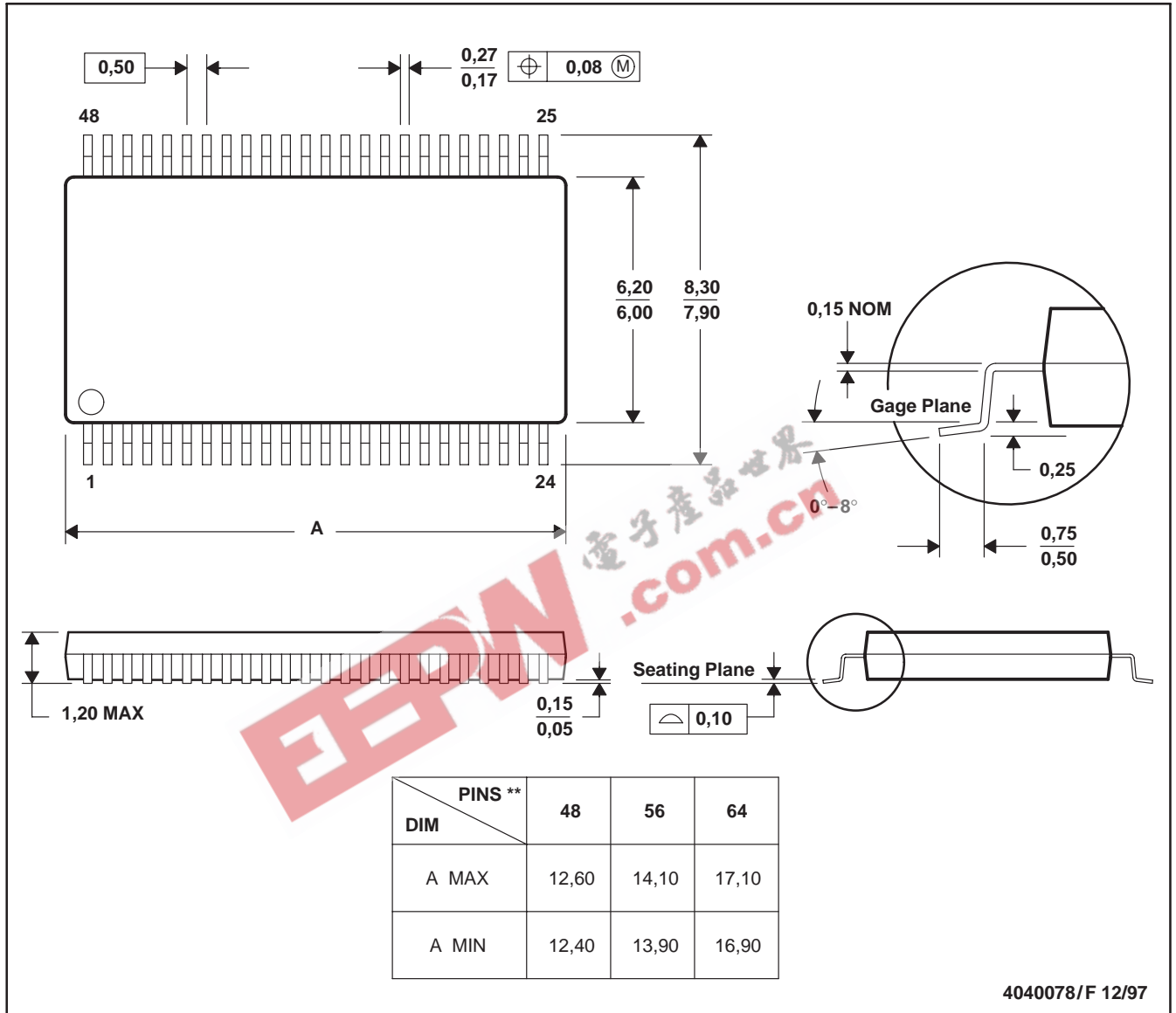
MECHANICAL DATA

MTSS003D – JANUARY 1995 – REVISED JANUARY 1998

DGG (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

48 PINS SHOWN



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold protrusion not to exceed 0,15.
 - D. Falls within JEDEC MO-153

4040078/F 12/97

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.

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
DSP	dsp.ti.com	Broadband	www.ti.com/broadband
Interface	interface.ti.com	Digital Control	www.ti.com/digitalcontrol
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
Low Power Wireless	www.ti.com/lpw	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