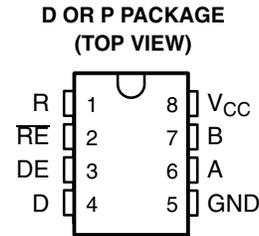


- **Bidirectional Transceiver**
- **Meets or Exceeds the Requirements of TIA/EIA-422-B, TIA/EIA-485-A, and ITU Recommendation V.11**
- **High-Speed Advanced Low-Power Schottky Circuitry**
- **Low Skew . . . 6 ns Max**
- **Designed for Multipoint Transmission on Long Bus Lines in Noisy Environments**
- **Low Supply-Current Requirements . . . 30 mA Max**
- **Wide Positive and Negative Input/Output Bus-Voltage Ranges**
- **Driver Output Capacity . . .  $\pm 60$  mA**
- **Thermal-Shutdown Protection**
- **Driver Positive and Negative Current Limiting**
- **Receiver Input Impedances . . . 12 k $\Omega$  Min**
- **Receiver Input Sensitivity . . .  $\pm 200$  mV Max**
- **Receiver Input Hysteresis . . . 120 mV Typ**
- **Fail Safe . . . High Receiver Output With Inputs Open**
- **Operates From a Single 5-V Supply**
- **Glitch-Free Power-Up and Power-Down Protection**
- **Interchangeable With National DS3695 and DS3695A**



## description

The TL3695 differential bus transceiver is designed for bidirectional data communication on multipoint bus-transmission lines. It is designed for balanced transmission lines and meets TIA/EIA-422-B, TIA/EIA-485-A, and ITU Recommendation V.11.

The TL3695 combines a 3-state differential line driver and a differential input line receiver, both of which operate from a single 5-V power supply. The driver and receiver have active-high and active-low enables, respectively, which can be externally connected together to function as a directional control. The driver differential outputs and the receiver differential inputs are connected internally to form a differential input/output (I/O) bus port that is designed to offer minimum loading to the bus when the driver is disabled or  $V_{CC} = 0$ . This port features wide positive and negative common-mode voltage ranges, making the device suitable for party line applications.

The TL3695 is characterized for operation from 0°C to 70°C.



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.

**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 © 1999, Texas Instruments Incorporated

# TL3695 DIFFERENTIAL BUS TRANSCEIVER

SLLS044D – NOVEMBER 1988 – REVISED DECEMBER 1999

## AVAILABLE OPTIONS

T <sub>A</sub>	PACKAGED DEVICES	
	SMALL OUTLINE (D)	PLASTIC DIP (P)
0°C to 70°C	TL3695D	TL3695P

The D package is available taped and reeled. Add the suffix R to device type (e.g., TL3695DR).

## Function Tables

### DRIVER

INPUT D	ENABLE DE	OUTPUTS	
		A	B
H	H	H	L
L	H	L	H
X	L	Z	Z

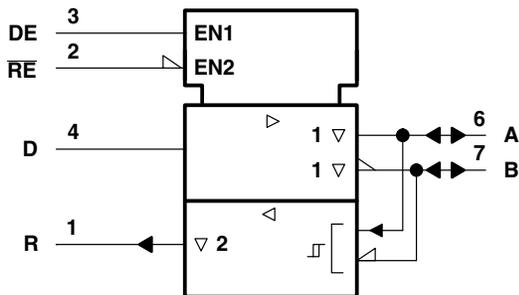
H = high level, L = low level, ? = indeterminate, X = irrelevant, Z = high impedance (off)

### RECEIVER

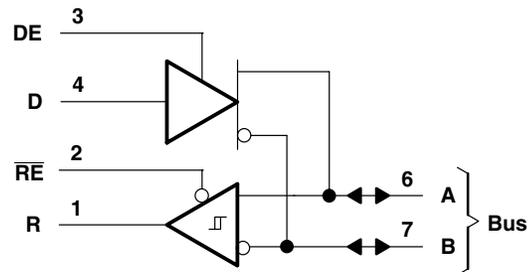
DIFFERENTIAL INPUTS A - B	ENABLE RE	OUTPUT R
$V_{ID} \geq 0.2 V$	L	H
$-0.2 V < V_{ID} < 0.2 V$	L	?
$V_{ID} \leq -0.2 V$	L	L
X	H	Z
Inputs open	L	H

H = high level, L = low level, ? = indeterminate, X = irrelevant, Z = high impedance (off)

### logic symbol†

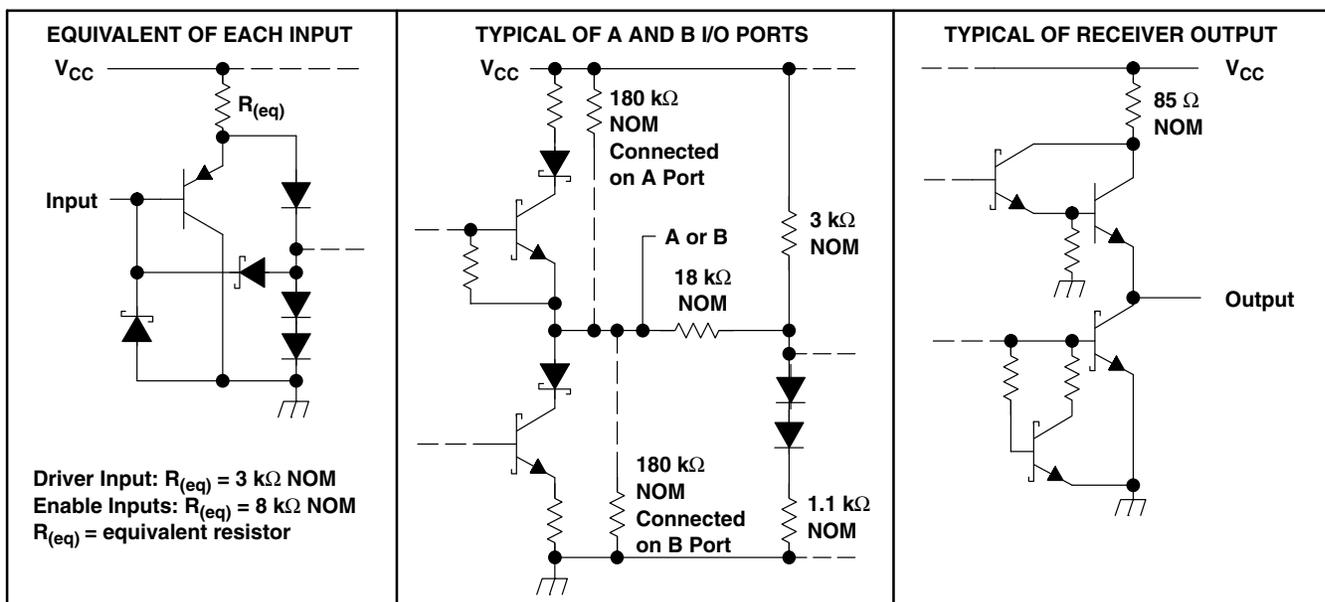


### logic diagram (positive logic)



† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

**schematic of inputs and outputs**



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

Supply voltage, $V_{CC}$ (see Note 1)	7 V
Voltage range at any bus terminal	-10 V to 15 V
Enable input voltage, $V_I$	5.5 V
Operating free-air temperature range, $T_A$	0°C to 70°C
Package thermal impedance, $\theta_{JA}$ (see Note 2):	
D package	97°C/W
PW package	85°C/W
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	260°C
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. All voltage values, except differential I/O bus voltage, are with respect to network ground terminal.  
2. The package thermal impedance is calculated in accordance with JESD 51.

# TL3695

## DIFFERENTIAL BUS TRANSCEIVER

SLLS044D – NOVEMBER 1988 – REVISED DECEMBER 1999

### recommended operating conditions

		MIN	NOM	MAX	UNIT
Supply voltage, $V_{CC}$		4.75	5	5.25	V
Voltage at any bus terminal (separately or common mode), $V_I$ or $V_{IC}$		12			V
		-7			
High-level Input voltage, $V_{IH}$	D, DE, and RE	2			V
Low-level Input voltage, $V_{IL}$	D, DE, and RE	0.8			V
Differential input voltage, $V_{ID}$ (see Note 3)		$\pm 12$			V
High-level output current, $I_{OH}$	Driver	- 60			mA
	Receiver	- 400			$\mu$ A
Low-level output current, $I_{OL}$	Driver	60			mA
	Receiver	8			
Operating free-air temperature, $T_A$		0	70		$^{\circ}$ C

NOTE 3: Differential input/output bus voltage is measured at the noninverting terminal A with respect to the inverting terminal B.



### DRIVER SECTION

**electrical characteristics over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)**

PARAMETER		TEST CONDITIONS†		MIN	TYP‡	MAX	UNIT
$V_{IK}$	Input clamp voltage	$I_I = -18 \text{ mA}$				-1.5	V
$V_O$	Output voltage	$I_O = 0$		0		6	V
$ V_{OD1} $	Differential output voltage	$I_O = 0$		1.5		5	V
$ V_{OD2} $	Differential output voltage	$R_L = 100 \Omega$ ,	See Figure 1	$1/2 V_{OD1}$ or $2^{\S}$			V
		$R_L = 54 \Omega$ ,	See Figure 1	1.5	2.5	5	V
$V_{OD3}$	Differential output voltage	$V_{test} = -7 \text{ V to } 12 \text{ V}$ ,	See Figure 2	1.5		5	V
$\Delta  V_{OD} $	Change in magnitude of differential output voltage¶	$R_L = 54 \Omega$ , See Figure 1				$\pm 0.2$	V
$V_{OC}$	Common-mode output voltage					3	V
$\Delta  V_{OC} $	Change in magnitude of common-mode output voltage¶					$\pm 0.2$	V
$I_O$	Output current	Output disabled, See Note 4		$V_O = 12 \text{ V}$		1	mA
				$V_O = -7 \text{ V}$		-0.8	
$I_{IH}$	High-level input current	$V_I = 2.4 \text{ V}$				20	$\mu\text{A}$
$I_{IL}$	Low-level input current	$V_I = 0.4 \text{ V}$				-200	$\mu\text{A}$
$I_{OS}$	Short-circuit output current#	$V_O = -6 \text{ V}$				-250	mA
		$V_O = 0$				-150	
		$V_O = V_{CC}$				250	
		$V_O = 8 \text{ V}$				250	
$I_{CC}$	Supply current	No load		Outputs enabled	23	50	mA
				Outputs disabled	19	35	

† The power-off measurement in TIA/EIA-422-B applies to disabled outputs only and is not applied to combined inputs and outputs.

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

§ The minimum  $V_{OD2}$  with a 100- $\Omega$  load is either  $1/2 V_{OD1}$  or 2 V, whichever is greater.

¶  $\Delta |V_{OD}|$  and  $\Delta |V_{OC}|$  are the changes in magnitude of  $V_{OD}$  and  $V_{OC}$ , respectively, that occur when the input is changed from a high level to a low level.

# Duration of the short circuit should not exceed one second for this test.

NOTE 4: This applies for power on and power off. Refer to TIA/EIA-485-A for exact conditions. The TIA/EIA-422-B limit does not apply for a combined driver and receiver terminal.

**switching characteristics over recommended ranges of supply voltage and operating free-air temperature**

PARAMETER		TEST CONDITIONS			MIN	TYP‡	MAX	UNIT
$t_{d(OD)}$	Differential-output delay time	$C_{L1} = C_{L2} = 100 \text{ pF}$ , $R_L = 60 \Omega$ , See Figure 3				8	22	ns
	Skew ( $ t_{d(ODH)} - t_{d(ODL)} $ )					1	8	ns
$t_{t(OD)}$	Differential output transition time					8	18	ns
$t_{PZH}$	Output enable time to high level	$C_L = 100 \text{ pF}$ ,	$R_L = 500 \Omega$ ,	See Figure 4			50	ns
$t_{PZL}$	Output enable time to low level	$C_L = 100 \text{ pF}$ ,	$R_L = 500 \Omega$ ,	See Figure 5			50	ns
$t_{PHZ}$	Output disable time from high level	$C_L = 15 \text{ pF}$ ,	$R_L = 500 \Omega$ ,	See Figure 4		8	30	ns
$t_{PLZ}$	Output disable time from low level	$C_L = 15 \text{ pF}$ ,	$R_L = 500 \Omega$ ,	See Figure 5		8	30	ns

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

# TL3695 DIFFERENTIAL BUS TRANSCEIVER

SLLS044D – NOVEMBER 1988 – REVISED DECEMBER 1999

## SYMBOL EQUIVALENTS

DATA-SHEET PARAMETER	TIA/EIA-422-B	TIA/EIA-485-A
$V_O$	$V_{oa}, V_{ob}$	$V_{oa}, V_{ob}$
$ V_{OD1} $	$V_O$	$V_O$
$ V_{OD2} $	$V_t (R_L = 100 \Omega)$	$V_t (R_L = 54 \Omega)$
$ V_{OD3} $		$V_t$ (test termination measurement 2)
$V_{test}$		$V_{tst}$
$\Delta  V_{OD} $	$  V_t  -  \bar{V}_t  $	$  V_t  -  \bar{V}_t  $
$V_{OC}$	$ V_{os} $	$ V_{os} $
$\Delta  V_{OC} $	$ V_{os} - \bar{V}_{os} $	$ V_{os} - \bar{V}_{os} $
$I_{OS}$	$ I_{sa} ,  I_{sb} $	
$I_O$	$ I_{xa} ,  I_{xb} $	$I_{ia}, I_{ib}$

## RECEIVER SECTION

electrical characteristics over recommended ranges of common-mode input voltage, supply voltage, and operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP†	MAX	UNIT
$V_{IT+}$	Positive-going input threshold voltage	$V_O = 2.7 V,$	$I_O = -0.4 mA$			0.2	V
$V_{IT-}$	Negative-going input threshold voltage	$V_O = 0.5 V,$	$I_O = 8 mA$	-0.2‡			V
$V_{hys}$	Hysteresis voltage ( $V_{IT+} - V_{IT-}$ )	$V_{OC} = 0$			70		mV
$V_{IK}$	Enable-input clamp voltage	$I_I = -18 mA$				-1.5	V
$V_{OH}$	High-level output voltage	$V_{ID} = 200 mV$ or inputs open, $I_{OH} = -400 \mu A,$	See Figure 6	2.4			V
$V_{OL}$	Low-level output voltage	$V_{ID} = -200 mV,$ See Figure 6	$I_{OL} = 16 mA$			0.5	V
			$I_{OL} = 8 mA$			0.45	
$I_{OZ}$	High-impedance-state output current	$V_O = 0.4 V$ to $2.4 V$				$\pm 20$	$\mu A$
$I_I$	Line input current	Other input = 0, See Note 5	$V_I = 12 V$			1	mA
			$V_I = -7 V$			-0.8	
$I_{IH}$	High-level enable-input current	$V_{IH} = 2.7 V$				20	$\mu A$
$I_{IL}$	Low-level enable-input current	$V_{IL} = 0.4 V$				-100	$\mu A$
$r_I$	Input resistance			12			k $\Omega$
$I_{OS}$	Short-circuit output current§	$V_O = 0$		-15		-85	mA
$I_{CC}$	Supply current	No load	Outputs enabled		23	50	mA
			Outputs disabled		19	35	

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

‡ The algebraic convention, in which the less positive (more negative) limit is designated minimum, is used in this data sheet for common-mode input voltage and threshold voltage levels only.

§ Duration of the short circuit should not exceed one second for this test.

NOTE 5: This applies for power on and power off. Refer to TIA/EIA-485-A for exact conditions.



switching characteristics over recommended ranges of supply voltage and operating free-air temperature range,  $C_L = 15 \text{ pF}$

PARAMETER	TEST CONDITIONS	MIN	TYP†	MAX	UNIT
$t_{PLH}$ Propagation delay time, low- to high-level output	$V_{ID} = -1.5 \text{ V to } 1.5 \text{ V}$ , See Figure 7		14	37	ns
$t_{PHL}$ Propagation delay time, high- to low-level output			14	37	ns
$t_{PZH}$ Output enable time to high level	See Figure 8		7	20	ns
$t_{PZL}$ Output enable time to low level			7	20	ns
$t_{PHZ}$ Output disable time from high level	See Figure 8		7	16	ns
$t_{PLZ}$ Output disable time from low level			8	16	ns

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

PARAMETER MEASUREMENT INFORMATION

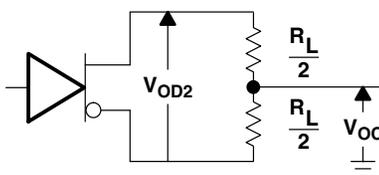


Figure 1. Driver  $V_{OD}$  and  $V_{OC}$

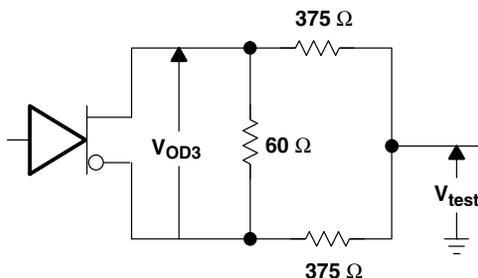
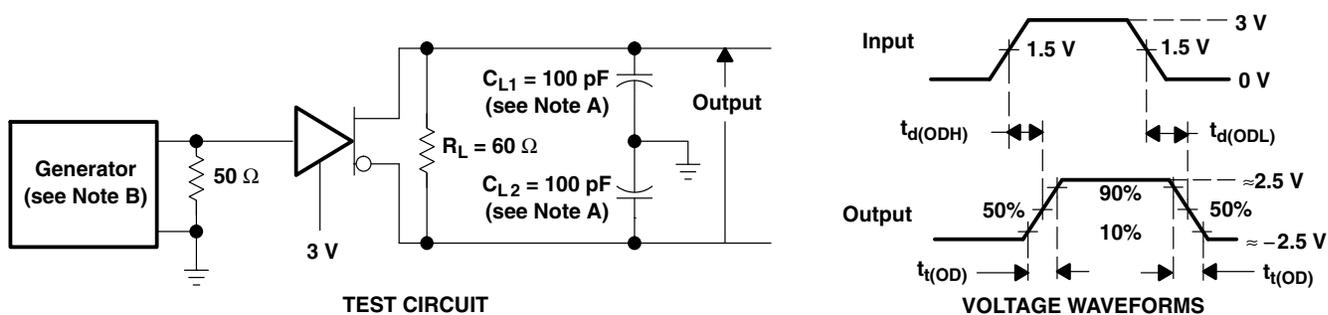


Figure 2. Driver  $V_{OD3}$



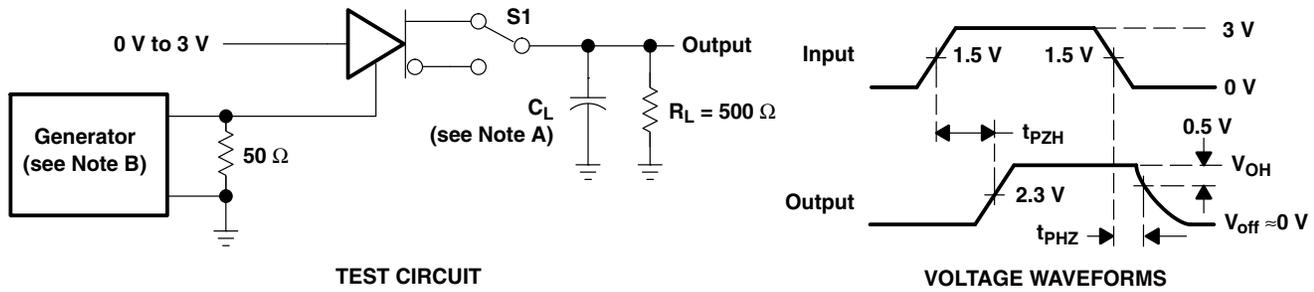
NOTES: A.  $C_L$  includes probe and jig capacitance.  
B. The input pulse is supplied by a generator having the following characteristics:  $PRR \leq 1 \text{ MHz}$ , 50% duty cycle,  $t_r \leq 6 \text{ ns}$ ,  $t_f \leq 6 \text{ ns}$ ,  $Z_O = 50 \Omega$ .

Figure 3. Driver Differential-Output Test Circuit and Voltage Waveforms

# TL3695 DIFFERENTIAL BUS TRANSCEIVER

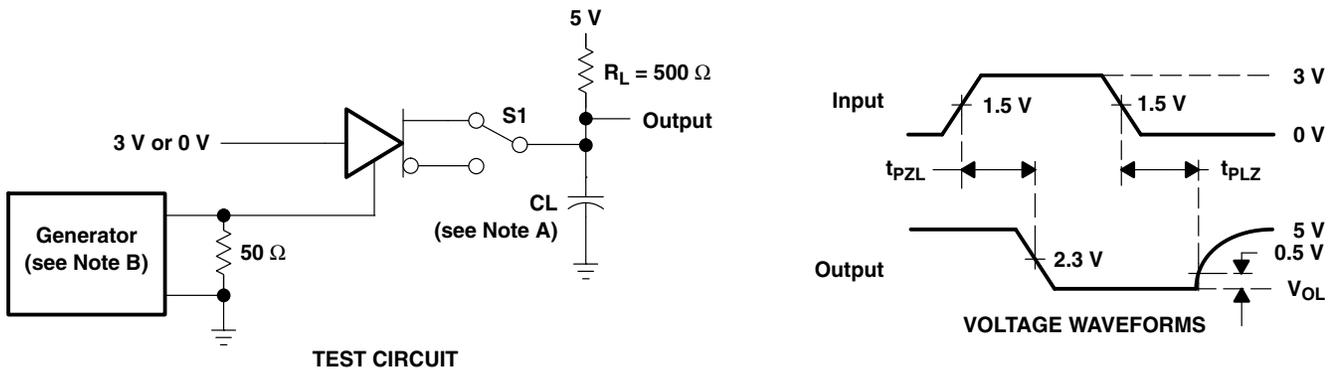
SLLS044D – NOVEMBER 1988 – REVISED DECEMBER 1999

## PARAMETER MEASUREMENT INFORMATION



- NOTES: A.  $C_L$  includes probe and jig capacitance.  
 B. The input pulse is supplied by a generator having the following characteristics:  $PRR \leq 1$  MHz, 50% duty cycle,  $t_r \leq 10$  ns,  $t_f \leq 10$  ns,  $Z_O = 50 \Omega$ .

Figure 4. Driver Test Circuit and Voltage Waveforms



- NOTES: A.  $C_L$  includes probe and jig capacitance.  
 B. The input pulse is supplied by a generator having the following characteristics:  $PRR \leq 1$  MHz, 50% duty cycle,  $t_r \leq 10$  ns,  $t_f \leq 10$  ns,  $Z_O = 50 \Omega$ .

Figure 5. Driver Test Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION

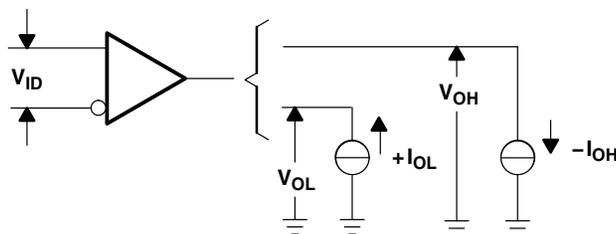
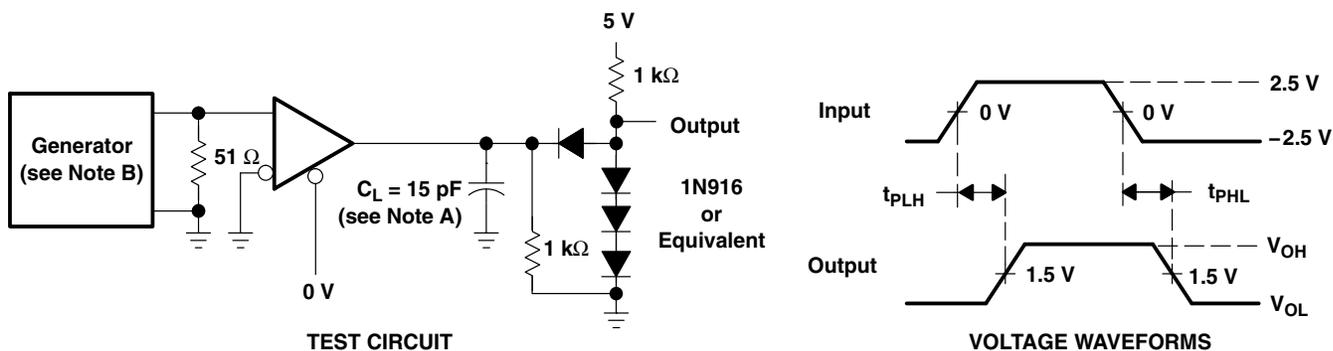


Figure 6. Receiver  $V_{OH}$  and  $V_{OL}$



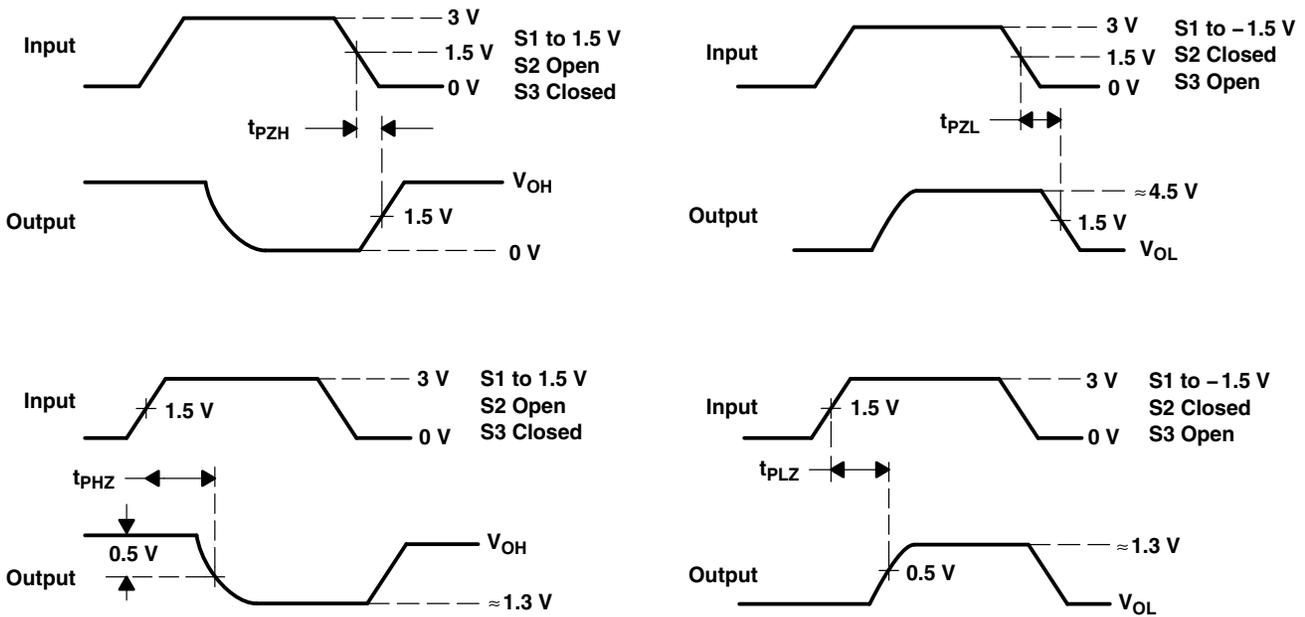
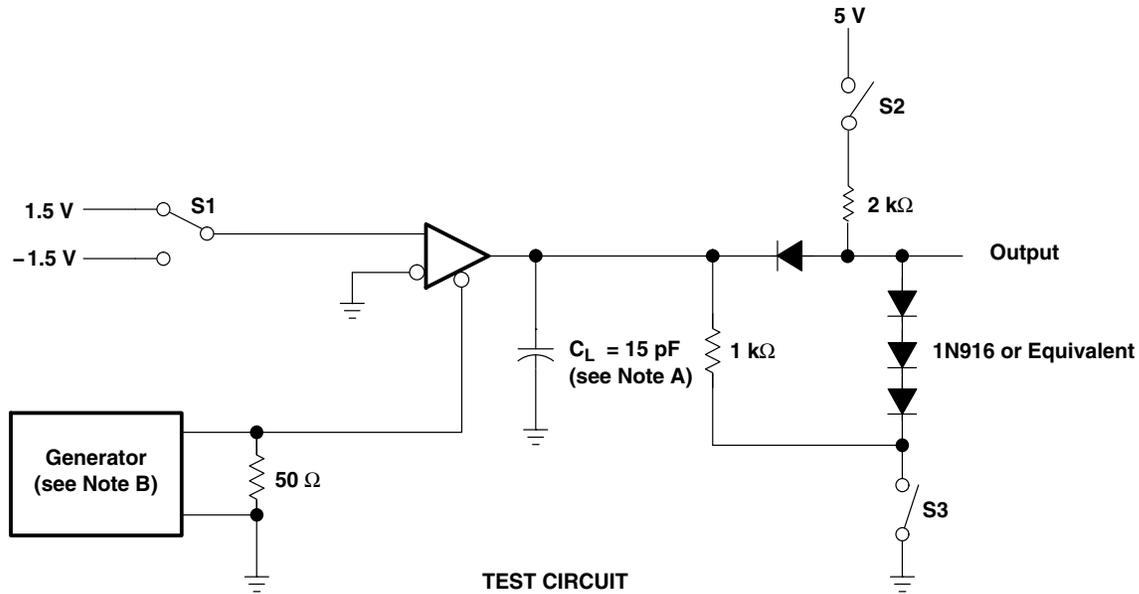
- NOTES: A.  $C_L$  includes probe and jig capacitance.  
 B. The input pulse is supplied by a generator having the following characteristics:  $PRR \leq 1$  MHz, 50% duty cycle,  $t_r \leq 10$  ns,  $t_f \leq 10$  ns,  $Z_O = 50 \Omega$ .

Figure 7. Receiver Test Circuit and Voltage Waveforms

# TL3695 DIFFERENTIAL BUS TRANSCEIVER

SLLS044D – NOVEMBER 1988 – REVISED DECEMBER 1999

## PARAMETER MEASUREMENT INFORMATION



- NOTES: A.  $C_L$  includes probe and jig capacitance.  
 B. The input pulse is supplied by a generator having the following characteristics: PRR  $\leq$  1 MHz, 50% duty cycle,  $t_r \leq$  10 ns,  $t_f \leq$  10 ns,  $Z_O = 50 \Omega$ .

**Figure 8. Receiver Test Circuit and Voltage Waveforms**

TYPICAL CHARACTERISTICS†

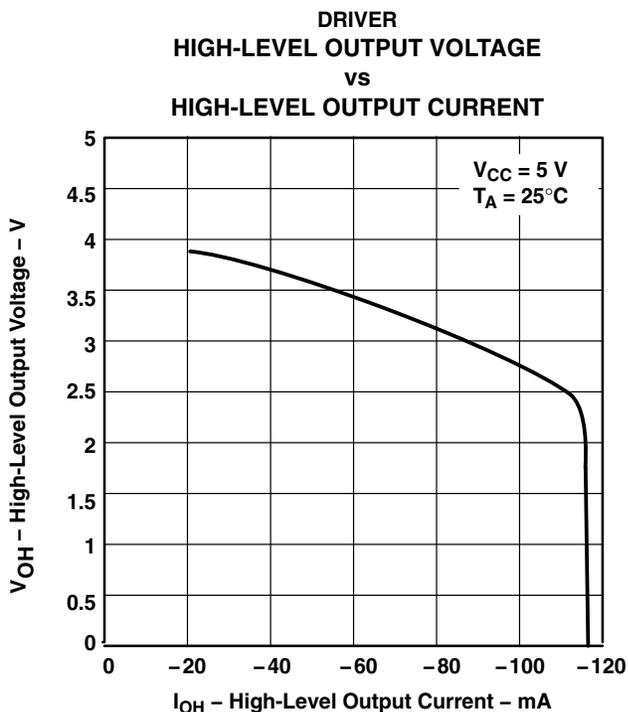


Figure 9

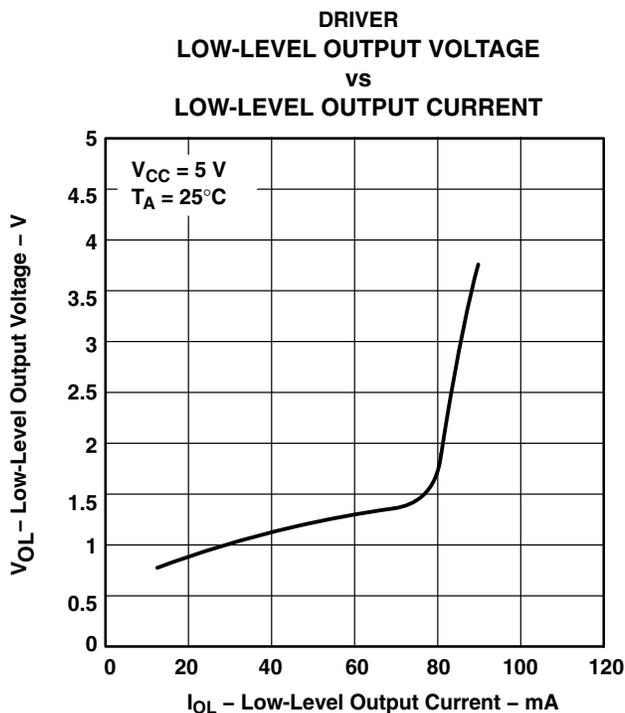


Figure 10

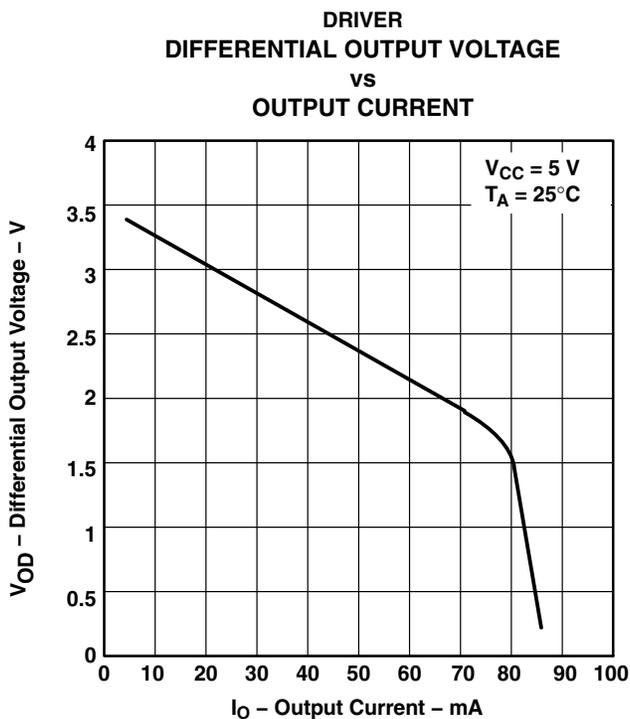


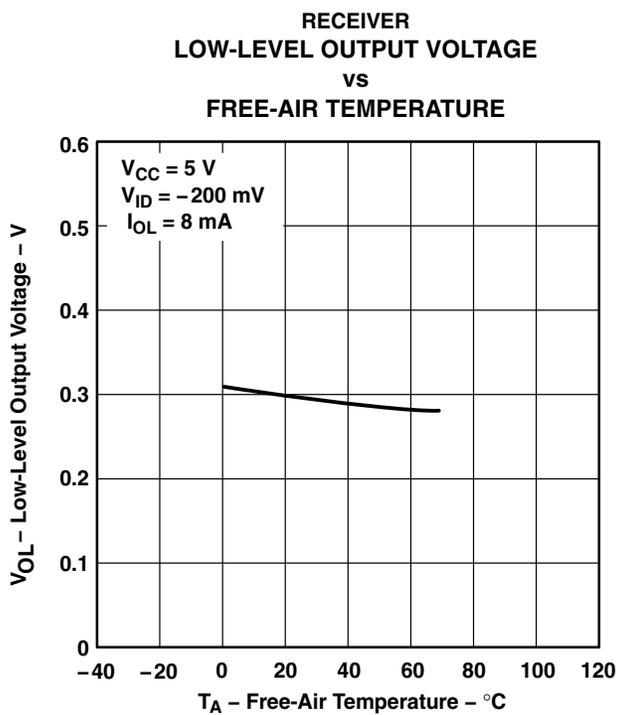
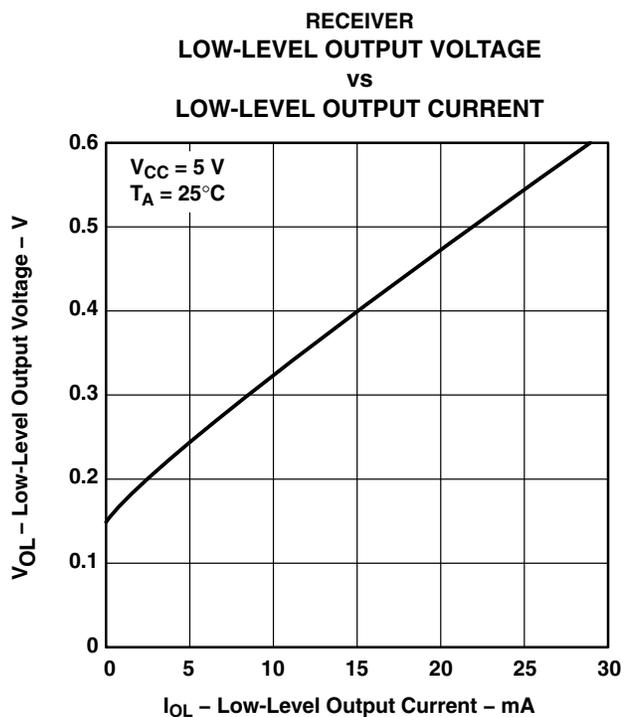
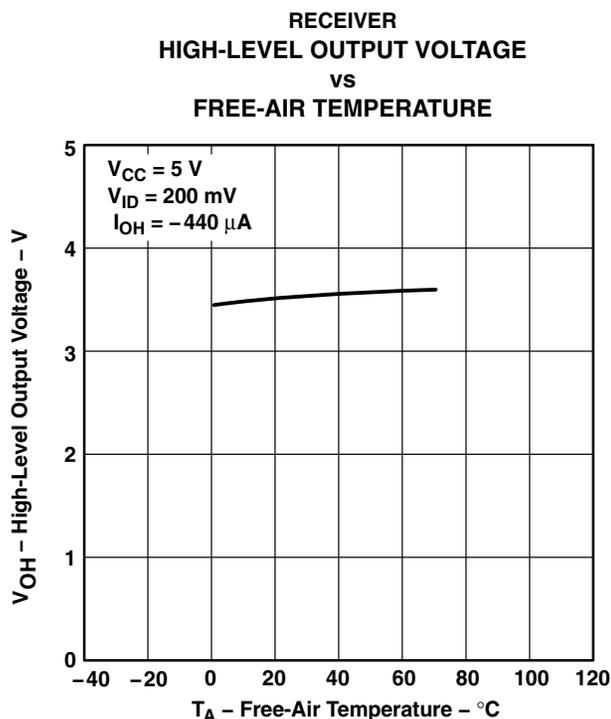
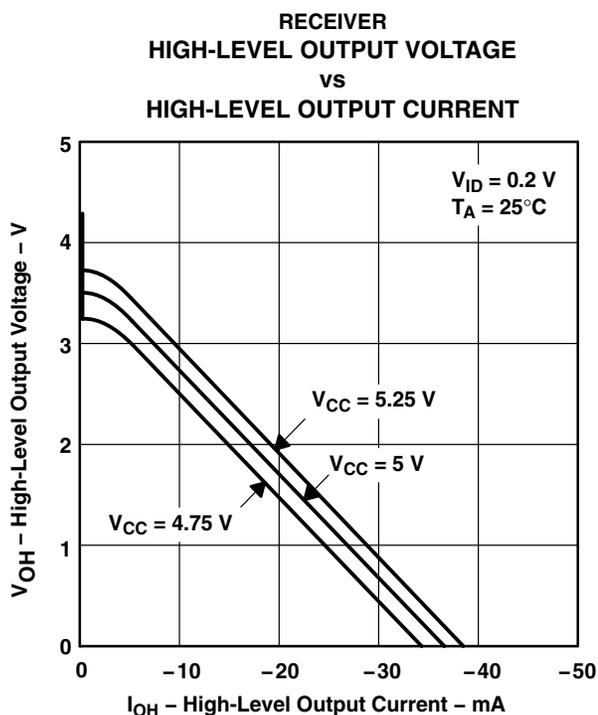
Figure 11

† Operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied.

# TL3695 DIFFERENTIAL BUS TRANSCEIVER

SLLS044D – NOVEMBER 1988 – REVISED DECEMBER 1999

## TYPICAL CHARACTERISTICS†



† Operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied.

TYPICAL CHARACTERISTICS†

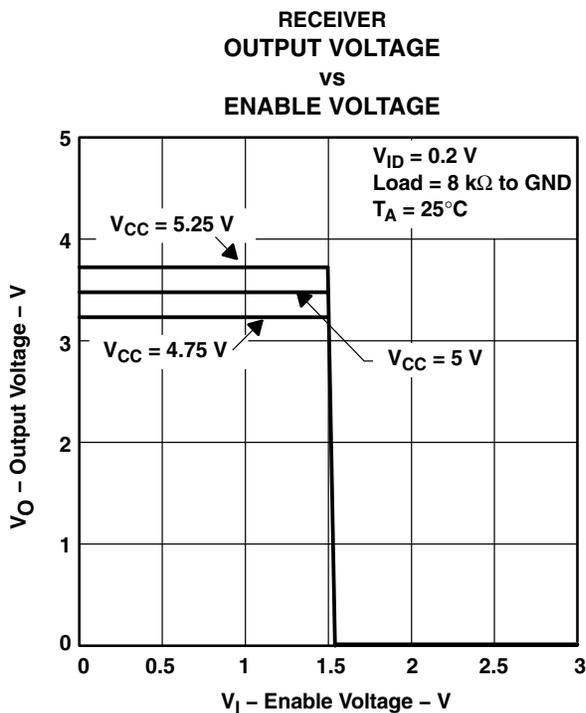


Figure 16

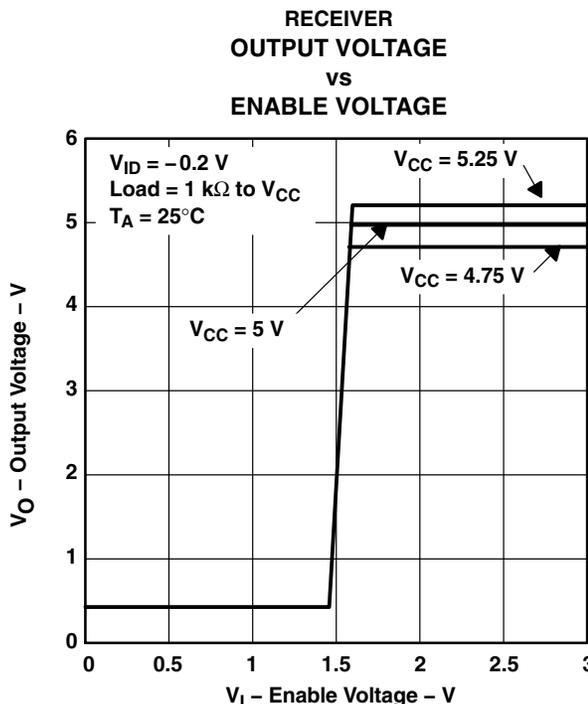
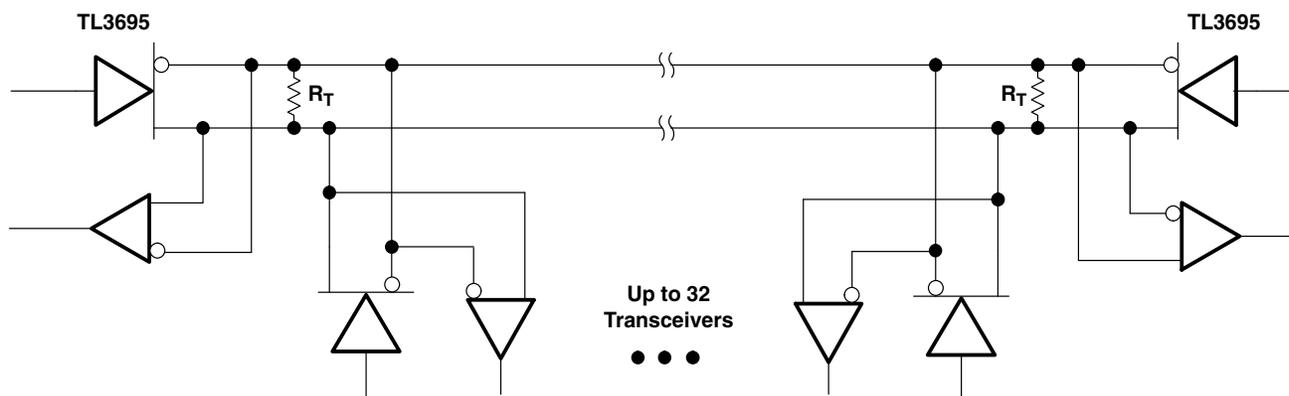


Figure 17

† Operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied.

APPLICATION INFORMATION



NOTE A: The line should be terminated at both ends in its characteristic impedance ( $R_T = Z_0$ ). Stub lengths off the main line should be kept as short as possible.

Figure 18. Typical Application Circuit

**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>
TL3695D	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL3695DE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL3695DG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL3695DR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL3695DRE4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL3695DRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TL3695P	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TL3695PE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type

<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.

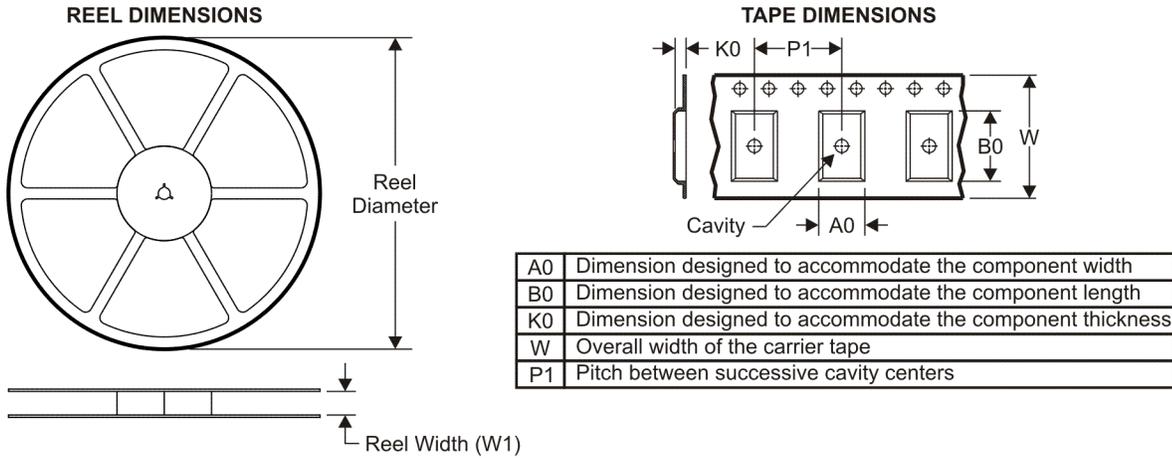
**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

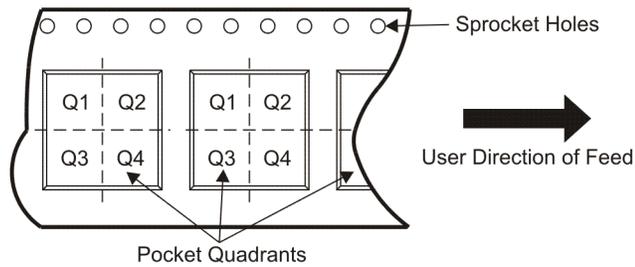
**Important Information and Disclaimer:**The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. 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**



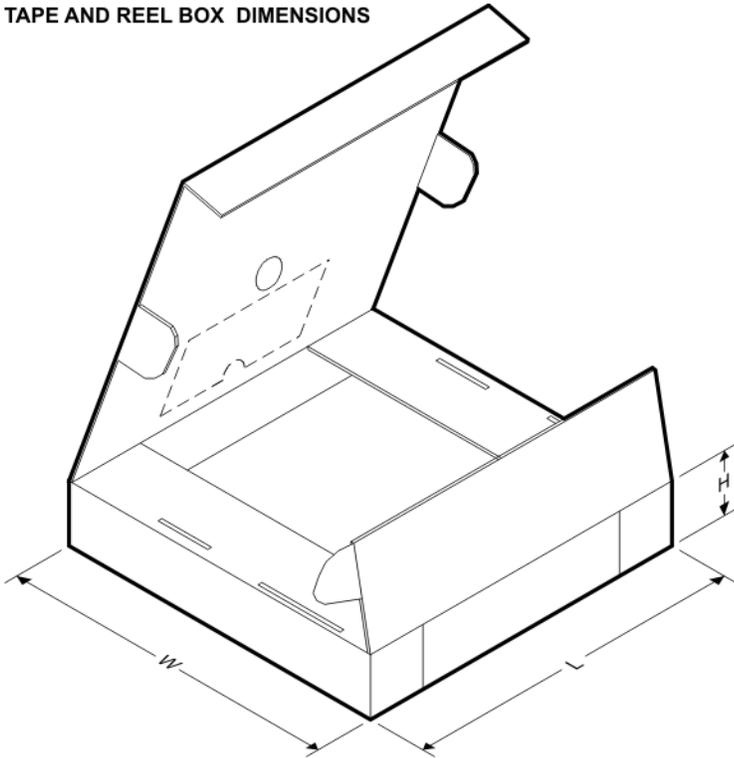
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**



\*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
TL3695DR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1

**TAPE AND REEL BOX DIMENSIONS**

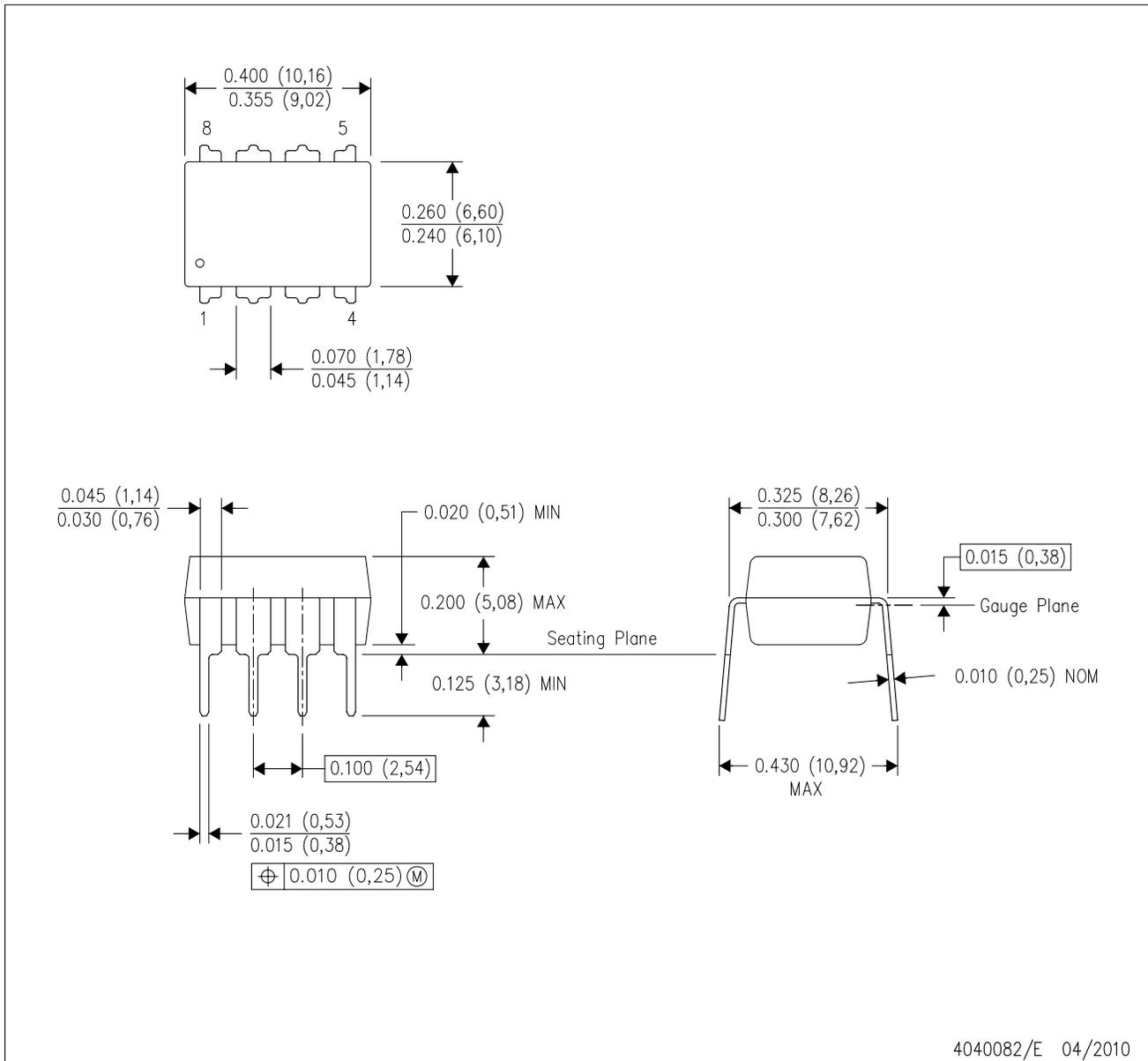


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TL3695DR	SOIC	D	8	2500	340.5	338.1	20.6

P (R-PDIP-T8)

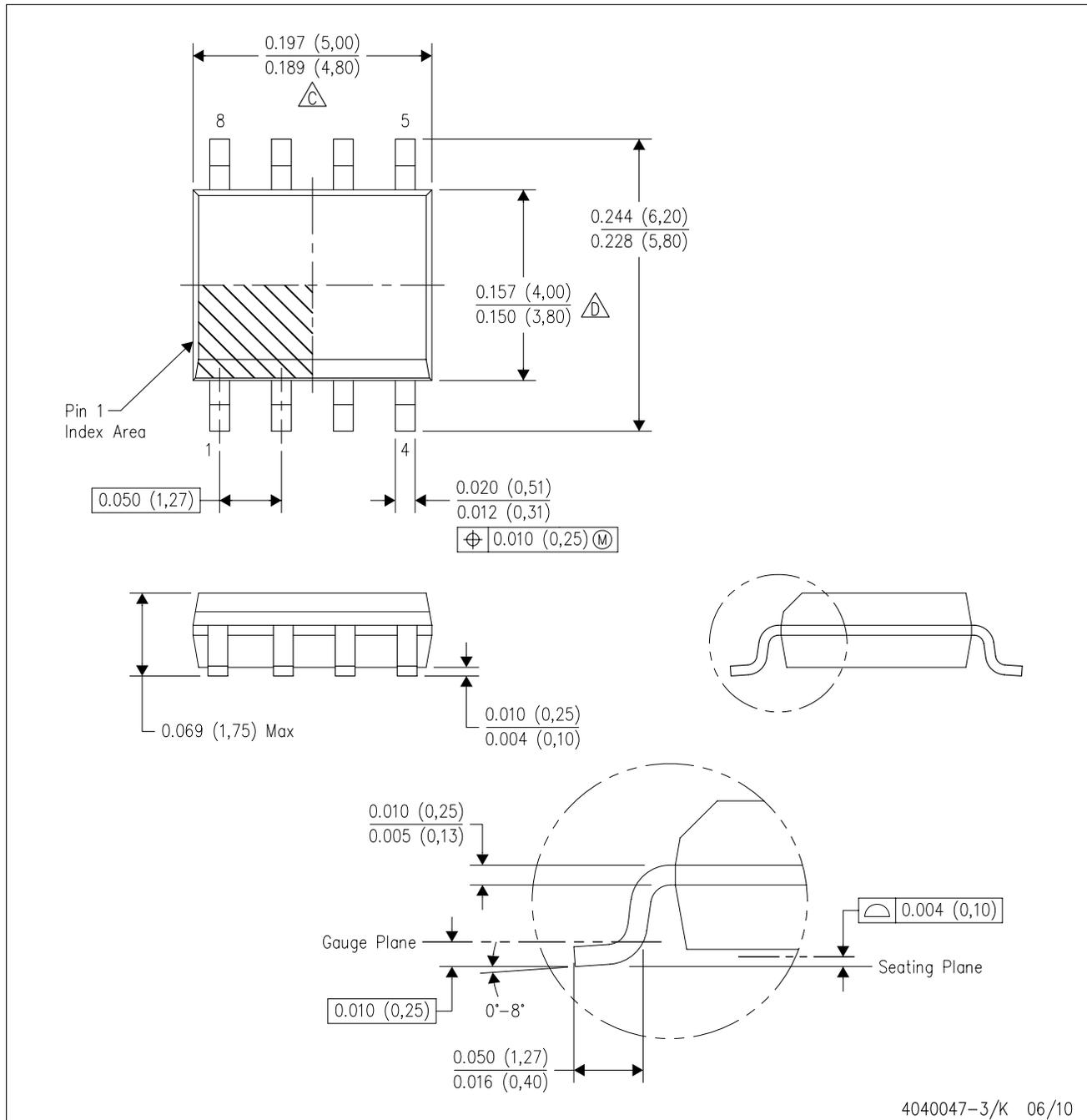
PLASTIC DUAL-IN-LINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Falls within JEDEC MS-001 variation BA.

D (R-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE

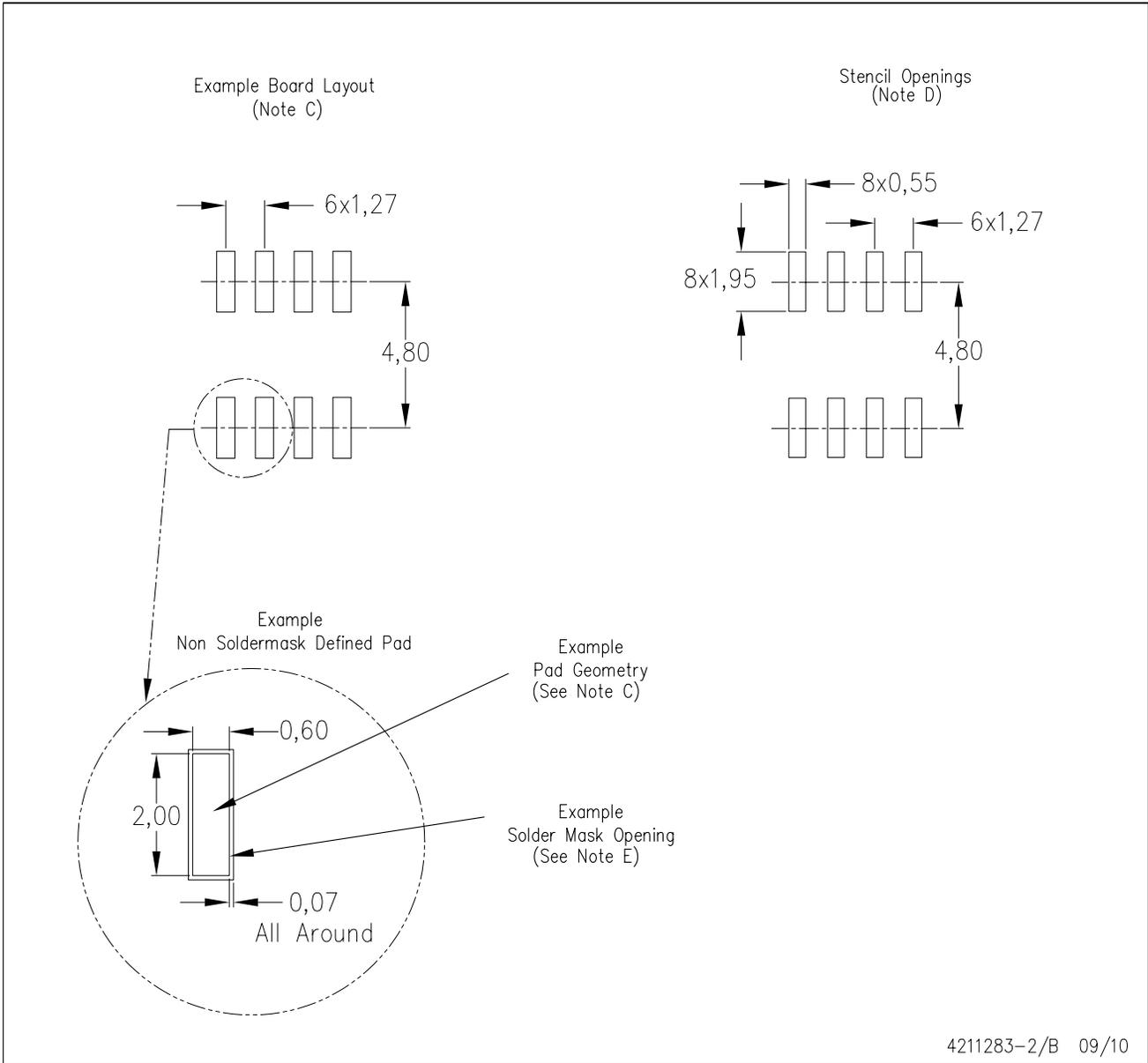


4040047-3/K 06/10

- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  -  Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 (0,15) per end.
  -  Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
  - E. Reference JEDEC MS-012 variation AA.

D (R-PDSO-G8)

PLASTIC SMALL OUTLINE



- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Publication IPC-7351 is recommended for alternate designs.
  - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
  - Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

## 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:

<b>Products</b>		<b>Applications</b>	
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>	Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>	Automotive	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>	Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>	Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>	Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>	Energy	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>	Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>	Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>	Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>	Space, Avionics & Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
RF/IF and ZigBee® Solutions	<a href="http://www.ti.com/lprf">www.ti.com/lprf</a>	Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>
		Wireless	<a href="http://www.ti.com/wireless-apps">www.ti.com/wireless-apps</a>

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2010, Texas Instruments Incorporated