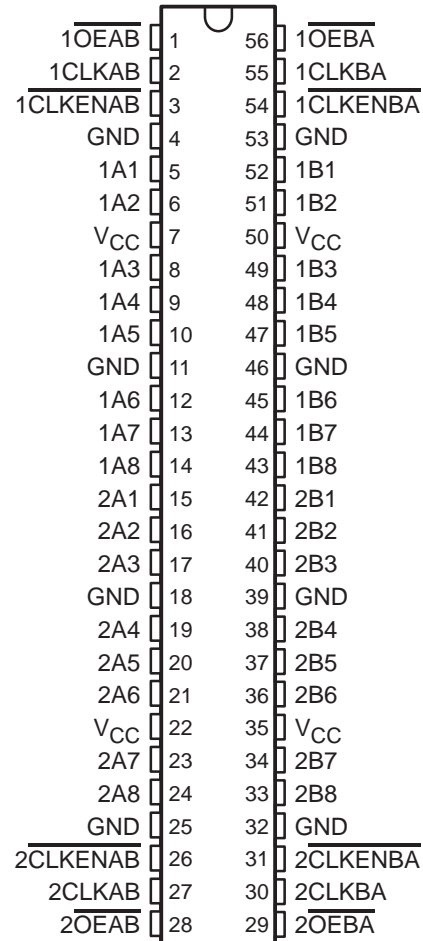


# SN54LVTH16952, SN74LVTH16952 3.3-V ABT 16-BIT REGISTERED TRANSCEIVERS WITH 3-STATE OUTPUTS

SCBS697G – JULY 1997 – REVISED APRIL 2000

- **Members of the Texas Instruments Widebus™ Family**
- **State-of-the-Art Advanced BiCMOS Technology (ABT) Design for 3.3-V Operation and Low Static-Power Dissipation**
- **Support Mixed-Mode Signal Operation (5-V Input and Output Voltages With 3.3-V  $V_{CC}$ )**
- **Support Unregulated Battery Operation Down to 2.7 V**
- **Typical  $V_{OLP}$  (Output Ground Bounce) <0.8 V at  $V_{CC} = 3.3$  V,  $T_A = 25^\circ\text{C}$**
- **$I_{off}$  and Power-Up 3-State Support Hot Insertion**
- **Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors**
- **Distributed  $V_{CC}$  and GND Pins Minimize High-Speed Switching Noise**
- **Flow-Through Architecture Optimizes PCB Layout**
- **Latch-Up Performance Exceeds 500 mA Per JESD 17**
- **ESD Protection Exceeds 2000 V Per MIL-STD-883, Method 3015; Exceeds 200 V Using Machine Model ( $C = 200$  pF,  $R = 0$ )**
- **Package Options Include Plastic Shrink Small-Outline (DL) and Thin Shrink Small-Outline (DGG) Packages and 380-mil Fine-Pitch Ceramic Flat (WD) Package**

SN54LVTH16952 . . . WD PACKAGE  
SN74LVTH16952 . . . DGG OR DL PACKAGE  
(TOP VIEW)



## description

The 'LVTH16952 devices are 16-bit registered transceivers designed for low-voltage (3.3-V)  $V_{CC}$  operation, but with the capability to provide a TTL interface to a 5-V system environment.

These devices can be used as two 8-bit transceivers or one 16-bit transceiver. Data on the A or B bus is stored in the registers on the low-to-high transition of the clock (CLKAB or CLKBA) input, provided that the clock-enable ( $\overline{\text{CLKENAB}}$  or  $\overline{\text{CLKENBA}}$ ) input is low. Taking the output-enable ( $\overline{\text{OEAB}}$  or  $\overline{\text{OEBA}}$ ) input low accesses the data on either port.

Active bus-hold circuitry is provided to hold unused or floating data inputs at a valid logic level.

When  $V_{CC}$  is between 0 and 1.5 V, the devices are in the high-impedance state during power up or power down. However, to ensure the high-impedance state above 1.5 V,  $\overline{\text{OE}}$  should be tied to  $V_{CC}$  through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.



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**

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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.

# SN54LVTH16952, SN74LVTH16952

## 3.3-V ABT 16-BIT REGISTERED TRANSCEIVERS

### WITH 3-STATE OUTPUTS

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#### description (continued)

These devices are fully specified for hot-insertion applications using  $I_{off}$  and power-up 3-state. The  $I_{off}$  circuitry disables the outputs, preventing damaging current backflow through the devices when they are powered down. The power-up 3-state circuitry places the outputs in the high-impedance state during power up and power down, which prevents driver conflict.

The SN54LVTH16952 is characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The SN74LVTH16952 is characterized for operation from  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .

FUNCTION TABLE†

INPUTS				OUTPUT B
$\overline{\text{CLKENAB}}$	CLKAB	$\overline{\text{OEAB}}$	A	
H	X	L	X	$B_0^{\ddagger}$
X	L	L	X	$B_0^{\ddagger}$
L	↑	L	L	L
L	↑	L	H	H
X	X	H	X	Z

† A-to-B data flow is shown; B-to-A data flow is similar, but uses  $\overline{\text{CLKENBA}}$ ,  $\text{CLKBA}$ , and  $\overline{\text{OEBA}}$ .

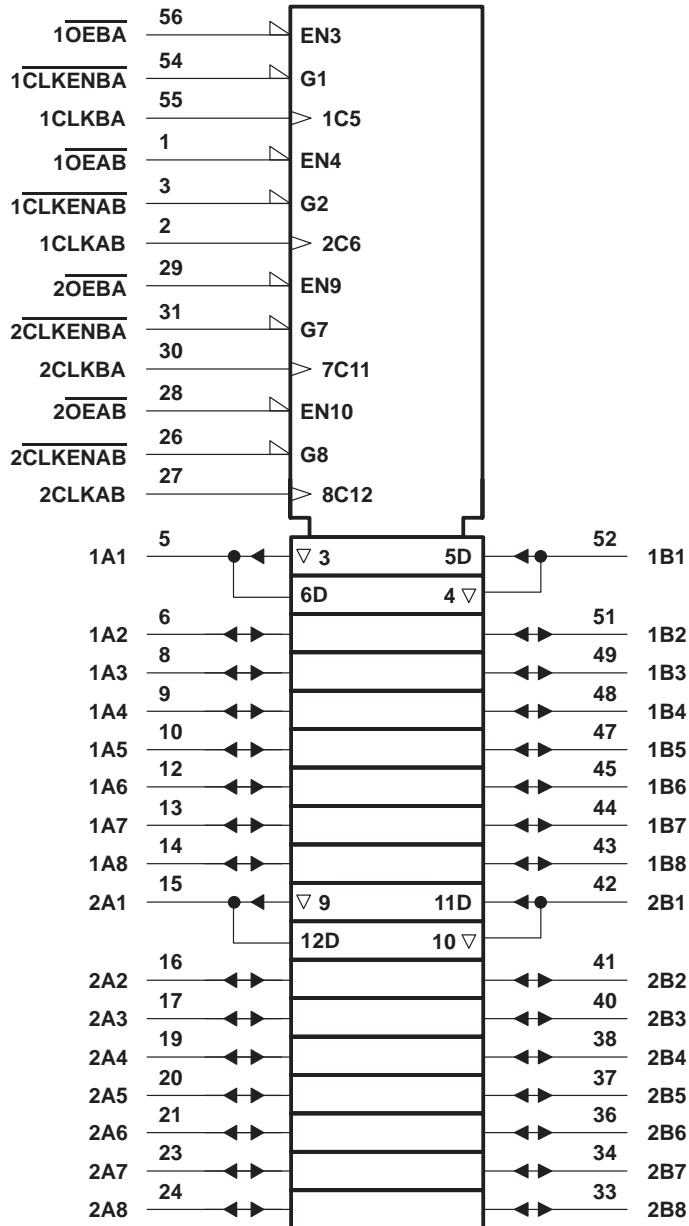
‡ Level of B before the indicated steady-state input conditions were established



SN54LVTH16952, SN74LVTH16952  
 3.3-V ABT 16-BIT REGISTERED TRANSCIEVERS  
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logic symbol†



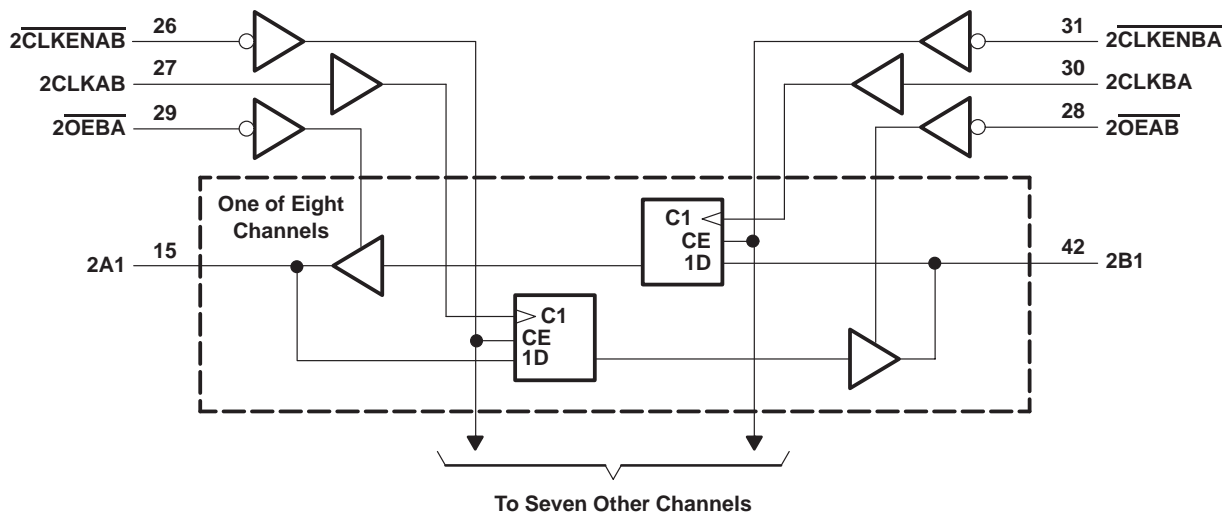
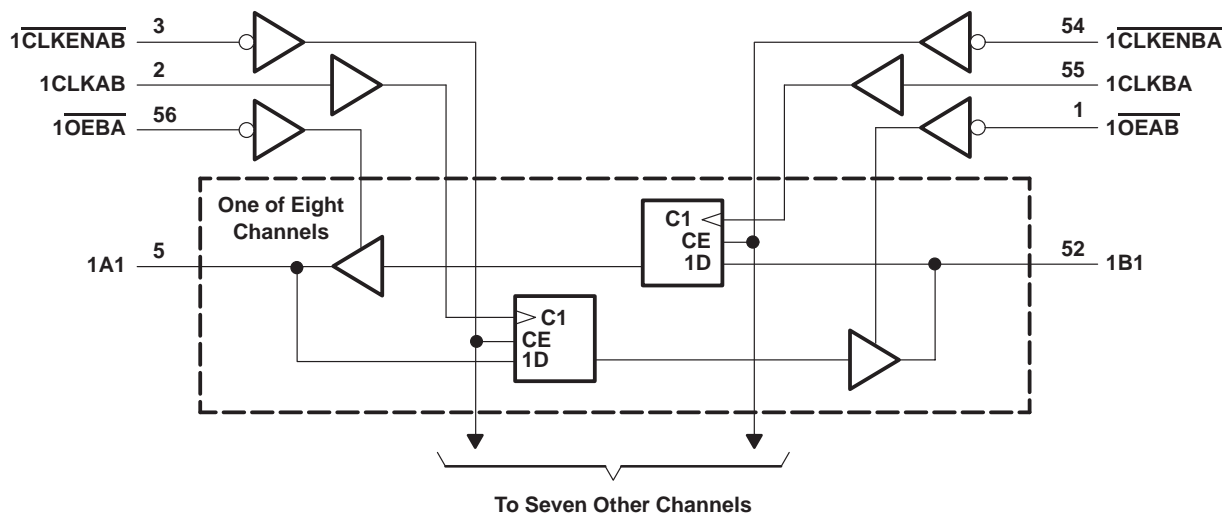
† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

# SN54LVTH16952, SN74LVTH16952

## 3.3-V ABT 16-BIT REGISTERED TRANSCIEVERS WITH 3-STATE OUTPUTS

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### logic diagram (positive logic)



# SN54LVTH16952, SN74LVTH16952 3.3-V ABT 16-BIT REGISTERED TRANSCEIVERS WITH 3-STATE OUTPUTS

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

Supply voltage range, $V_{CC}$ .....	–0.5 V to 4.6 V
Input voltage range, $V_I$ (see Note 1) .....	–0.5 V to 7 V
Voltage range applied to any output in the high-impedance or power-off state, $V_O$ (see Note 1) .....	–0.5 V to 7 V
Voltage range applied to any output in the high state, $V_O$ (see Note 1) .....	–0.5 V to $V_{CC} + 0.5$ V
Current into any output in the low state, $I_O$ : SN54LVTH16952 .....	96 mA
SN74LVTH16952 .....	128 mA
Current into any output in the high state, $I_O$ (see Note 2): SN54LVTH16952 .....	48 mA
SN74LVTH16952 .....	64 mA
Input clamp current, $I_{IK}$ ( $V_I < 0$ ) .....	–50 mA
Output clamp current, $I_{OK}$ ( $V_O < 0$ ) .....	–50 mA
Package thermal impedance, $\theta_{JA}$ (see Note 3): DGG package .....	64°C/W
DL package .....	56°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. This current flows only when the output is in the high state and  $V_O > V_{CC}$ .  
 3. The package thermal impedance is calculated in accordance with JESD 51.

## recommended operating conditions (see Note 4)

		SN54LVTH16952		SN74LVTH16952		UNIT
		MIN	MAX	MIN	MAX	
$V_{CC}$	Supply voltage	2.7	3.6	2.7	3.6	V
$V_{IH}$	High-level input voltage	2		2		V
$V_{IL}$	Low-level input voltage		0.8		0.8	V
$V_I$	Input voltage		5.5		5.5	V
$I_{OH}$	High-level output current		–24		–32	mA
$I_{OL}$	Low-level output current		48		64	mA
$\Delta t/\Delta v$	Input transition rise or fall rate	Outputs enabled			10	ns/V
$\Delta t/\Delta V_{CC}$	Power-up ramp rate	200		200		μs/V
$T_A$	Operating free-air temperature	–55	125	–40	85	°C

NOTE 4: 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.



**SN54LVTH16952, SN74LVTH16952**  
**3.3-V ABT 16-BIT REGISTERED TRANSCEIVERS**  
**WITH 3-STATE OUTPUTS**

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

PARAMETER	TEST CONDITIONS	SN54LVTH16952			SN74LVTH16952			UNIT	
		MIN	TYP†	MAX	MIN	TYP†	MAX		
V <sub>IK</sub>	V <sub>CC</sub> = 2.7 V, I <sub>I</sub> = -18 mA			-1.2			-1.2	V	
V <sub>OH</sub>	V <sub>CC</sub> = 2.7 V to 3.6 V, I <sub>OH</sub> = -100 μA	V <sub>CC</sub> -0.2			V <sub>CC</sub> -0.2			V	
	V <sub>CC</sub> = 2.7 V, I <sub>OH</sub> = -8 mA	2.4			2.4				
	V <sub>CC</sub> = 3 V	2			2				
V <sub>OL</sub>	V <sub>CC</sub> = 2.7 V	I <sub>OL</sub> = 100 μA		0.2			0.2	V	
		I <sub>OL</sub> = 24 mA		0.5			0.5		
	V <sub>CC</sub> = 3 V	I <sub>OL</sub> = 16 mA		0.4			0.4		
		I <sub>OL</sub> = 32 mA		0.5			0.5		
		I <sub>OL</sub> = 48 mA		0.55			0.55		
I <sub>I</sub>	Control inputs	V <sub>CC</sub> = 3.6 V, V <sub>I</sub> = V <sub>CC</sub> or GND		±1			±1	μA	
		V <sub>CC</sub> = 0 or 3.6 V, V <sub>I</sub> = 5.5 V		10			10		
	A or B ports‡	V <sub>CC</sub> = 3.6 V, V <sub>I</sub> = 5.5 V		20			20		
		V <sub>CC</sub> = 3.6 V, V <sub>I</sub> = V <sub>CC</sub>		1			1		
		V <sub>I</sub> = 0		-5			-5		
I <sub>off</sub>	V <sub>CC</sub> = 0, V <sub>I</sub> or V <sub>O</sub> = 0 to 4.5 V				±100			μA	
I <sub>I</sub> (hold)	A or B ports	V <sub>CC</sub> = 3 V, V <sub>I</sub> = 0.8 V		75			75	μA	
		V <sub>CC</sub> = 3 V, V <sub>I</sub> = 2 V		-75			-75		
	V <sub>CC</sub> = 3.6 V§, V <sub>I</sub> = 0 to 3.6 V					±500			
I <sub>OZPU</sub>	V <sub>CC</sub> = 0 to 1.5 V, V <sub>O</sub> = 0.5 V to 3 V, OE = don't care				±100			±100	μA
I <sub>OZPD</sub>	V <sub>CC</sub> = 1.5 V to 0, V <sub>O</sub> = 0.5 V to 3 V, OE = don't care				±100			±100	μA
I <sub>CC</sub>	V <sub>CC</sub> = 3.6 V, I <sub>O</sub> = 0, V <sub>I</sub> = V <sub>CC</sub> or GND	Outputs high		0.19			0.19	mA	
		Outputs low		5			5		
		Outputs disabled		0.19			0.19		
ΔI <sub>CC</sub> ¶	V <sub>CC</sub> = 3 V to 3.6 V, One input at V <sub>CC</sub> - 0.6 V, Other inputs at V <sub>CC</sub> or GND				0.2			0.2	mA
C <sub>i</sub>	V <sub>I</sub> = 3 V or 0				4			4	pF
C <sub>io</sub>	V <sub>O</sub> = 3 V or 0				10			10	pF

† All typical values are at V<sub>CC</sub> = 3.3 V, T<sub>A</sub> = 25°C.

‡ Unused pins at V<sub>CC</sub> or GND

§ This is the bus-hold maximum dynamic current. It is the minimum overdrive current required to switch the input from one state to another.

¶ This is the increase in supply current for each input that is at the specified TTL voltage level rather than V<sub>CC</sub> or GND.



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**3.3-V ABT 16-BIT REGISTERED TRANSCEIVERS**  
**WITH 3-STATE OUTPUTS**

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**timing requirements over recommended operating free-air temperature range (unless otherwise noted) (see Figure 1)**

			SN54LVTH16952				SN74LVTH16952				UNIT
			V <sub>CC</sub> = 3.3 V ± 0.3 V		V <sub>CC</sub> = 2.7 V		V <sub>CC</sub> = 3.3 V ± 0.3 V		V <sub>CC</sub> = 2.7 V		
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
f <sub>clock</sub>	Clock frequency		150		150		150		150		MHz
t <sub>w</sub>	Pulse duration		3.3		3.3		3.3		3.3		ns
t <sub>su</sub>	Setup time	A or B before CLK	2.6		3.3		1.7		2.5		ns
		$\overline{\text{CLKEN}}$ before CLK	2.2		2.8		2		2.8		
t <sub>h</sub>	Hold time	A or B after CLK	1		1		0.8		0		ns
		$\overline{\text{CLKEN}}$ after CLK	1.4		1.5		0.4		0		

**switching characteristics over recommended operating free-air temperature range, C<sub>L</sub> = 50 pF (unless otherwise noted) (see Figure 1)**

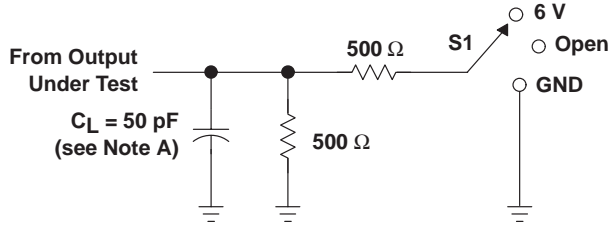
PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN54LVTH16952				SN74LVTH16952				UNIT	
			V <sub>CC</sub> = 3.3 V ± 0.3 V		V <sub>CC</sub> = 2.7 V		V <sub>CC</sub> = 3.3 V ± 0.3 V			V <sub>CC</sub> = 2.7 V		
			MIN	MAX	MIN	MAX	MIN	TYP†	MAX	MIN		MAX
f <sub>max</sub>			150		150		150			150		MHz
t <sub>PLH</sub>	CLKBA or CLKAB	A or B	1.6 5.7		7.4		1.3 2.7 4			4.4		ns
t <sub>PHL</sub>			1.7 6		7		1.3 2.7 4			4.4		
t <sub>PZH</sub>	$\overline{\text{OEBA}}$ or $\overline{\text{OEAB}}$	A or B	0.9 5		7.3		1 2.3 4			4.9		ns
t <sub>PZL</sub>			1.1 5.2		5.9		1 2.4 4			4.9		
t <sub>PHZ</sub>	$\overline{\text{OEBA}}$ or $\overline{\text{OEAB}}$	A or B	1.7 6.7		7.3		2.1 3.9 5.7			6.2		ns
t <sub>PLZ</sub>			1.1 5.8		6		2.1 3.5 5.1			5.3		

† All typical values are at V<sub>CC</sub> = 3.3 V, T<sub>A</sub> = 25°C.

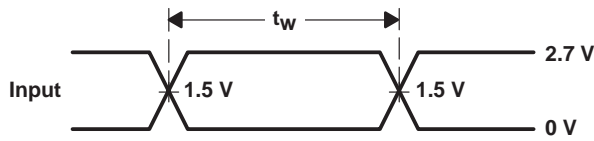
**SN54LVTH16952, SN74LVTH16952**  
**3.3-V ABT 16-BIT REGISTERED TRANSCEIVERS**  
**WITH 3-STATE OUTPUTS**

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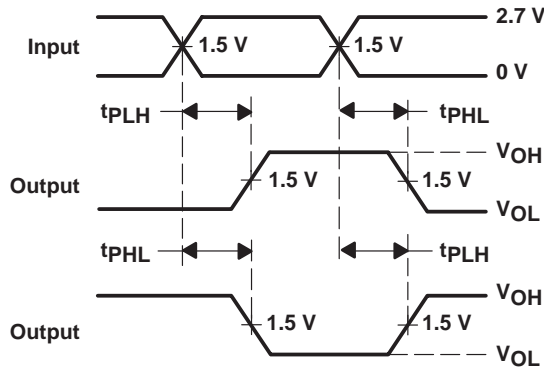
**PARAMETER MEASUREMENT INFORMATION**



**LOAD CIRCUIT**

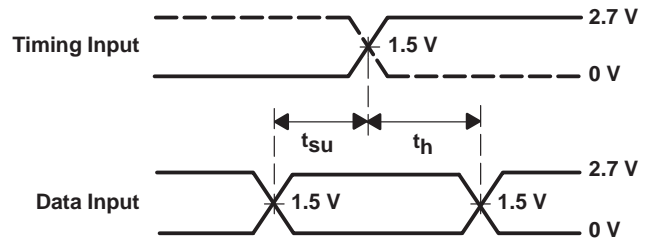


**VOLTAGE WAVEFORMS**  
**PULSE DURATION**

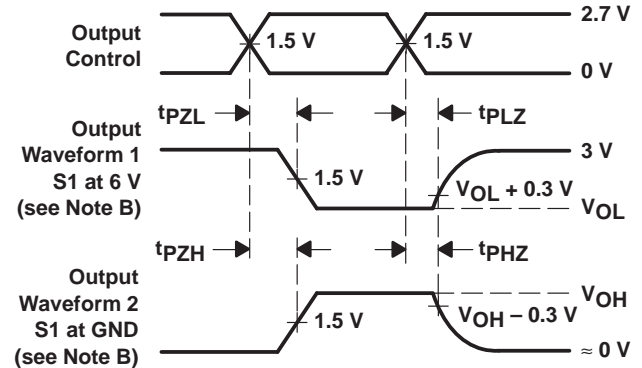


**VOLTAGE WAVEFORMS**  
**PROPAGATION DELAY TIMES**  
**INVERTING AND NONINVERTING OUTPUTS**

TEST	S1
$t_{PLH}/t_{PHL}$	Open
$t_{PLZ}/t_{PZL}$	6 V
$t_{PHZ}/t_{PZH}$	GND



**VOLTAGE WAVEFORMS**  
**SETUP AND HOLD TIMES**



**VOLTAGE WAVEFORMS**  
**ENABLE AND DISABLE TIMES**  
**LOW- AND HIGH-LEVEL ENABLING**

- NOTES: A.  $C_L$  includes probe and jig capacitance.  
 B. 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.  
 C. All input pulses are supplied by generators having the following characteristics:  $PRR \leq 10 \text{ MHz}$ ,  $Z_O = 50 \Omega$ ,  $t_r \leq 2.5 \text{ ns}$ ,  $t_f \leq 2.5 \text{ ns}$ .  
 D. The outputs are measured one at a time with one transition per measurement.

**Figure 1. Load Circuit and Voltage Waveforms**

**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>	Samples (Requires Login)
5962-9684901QXA	ACTIVE	CFP	WD	56	1	TBD	Call TI	Call TI	
74LVTH16952DGGRE4	ACTIVE	TSSOP	DGG	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
74LVTH16952DGGRG4	ACTIVE	TSSOP	DGG	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
74LVTH16952DLRG4	ACTIVE	SSOP	DL	56	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
SN74LVTH16952DGGR	ACTIVE	TSSOP	DGG	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
SN74LVTH16952DL	ACTIVE	SSOP	DL	56	20	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
SN74LVTH16952DLG4	ACTIVE	SSOP	DL	56	20	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
SN74LVTH16952DLR	ACTIVE	SSOP	DL	56	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
SNJ54LVTH16952WD	ACTIVE	CFP	WD	56	1	TBD	A42	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.

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**OTHER QUALIFIED VERSIONS OF SN54LVTH16952, SN74LVTH16952 :**

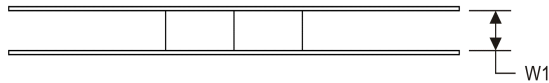
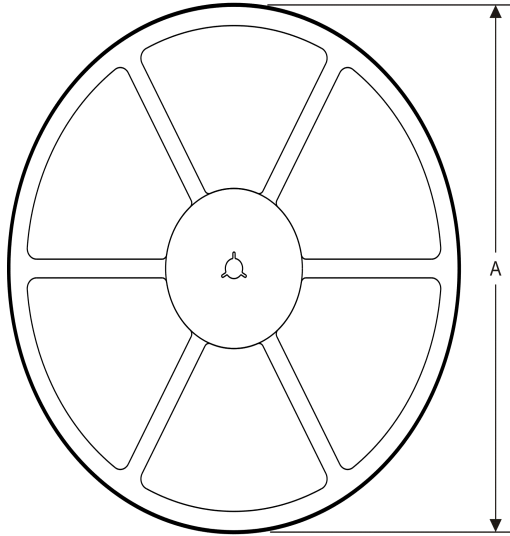
- Catalog: [SN74LVTH16952](#)
- Enhanced Product: [SN74LVTH16952-EP](#), [SN74LVTH16952-EP](#)
- Military: [SN54LVTH16952](#)

NOTE: Qualified Version Definitions:

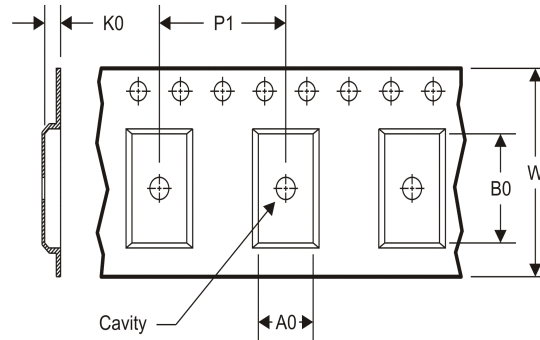
- Catalog - TI's standard catalog product
- Enhanced Product - Supports Defense, Aerospace and Medical Applications
- Military - QML certified for Military and Defense Applications

**TAPE AND REEL INFORMATION**

**REEL DIMENSIONS**



**TAPE DIMENSIONS**



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

**TAPE AND REEL INFORMATION**

\*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
SN74LVTH16952DGGR	TSSOP	DGG	56	2000	330.0	24.4	8.6	15.6	1.8	12.0	24.0	Q1
SN74LVTH16952DLR	SSOP	DL	56	1000	330.0	32.4	11.35	18.67	3.1	16.0	32.0	Q1

**TAPE AND REEL BOX DIMENSIONS**

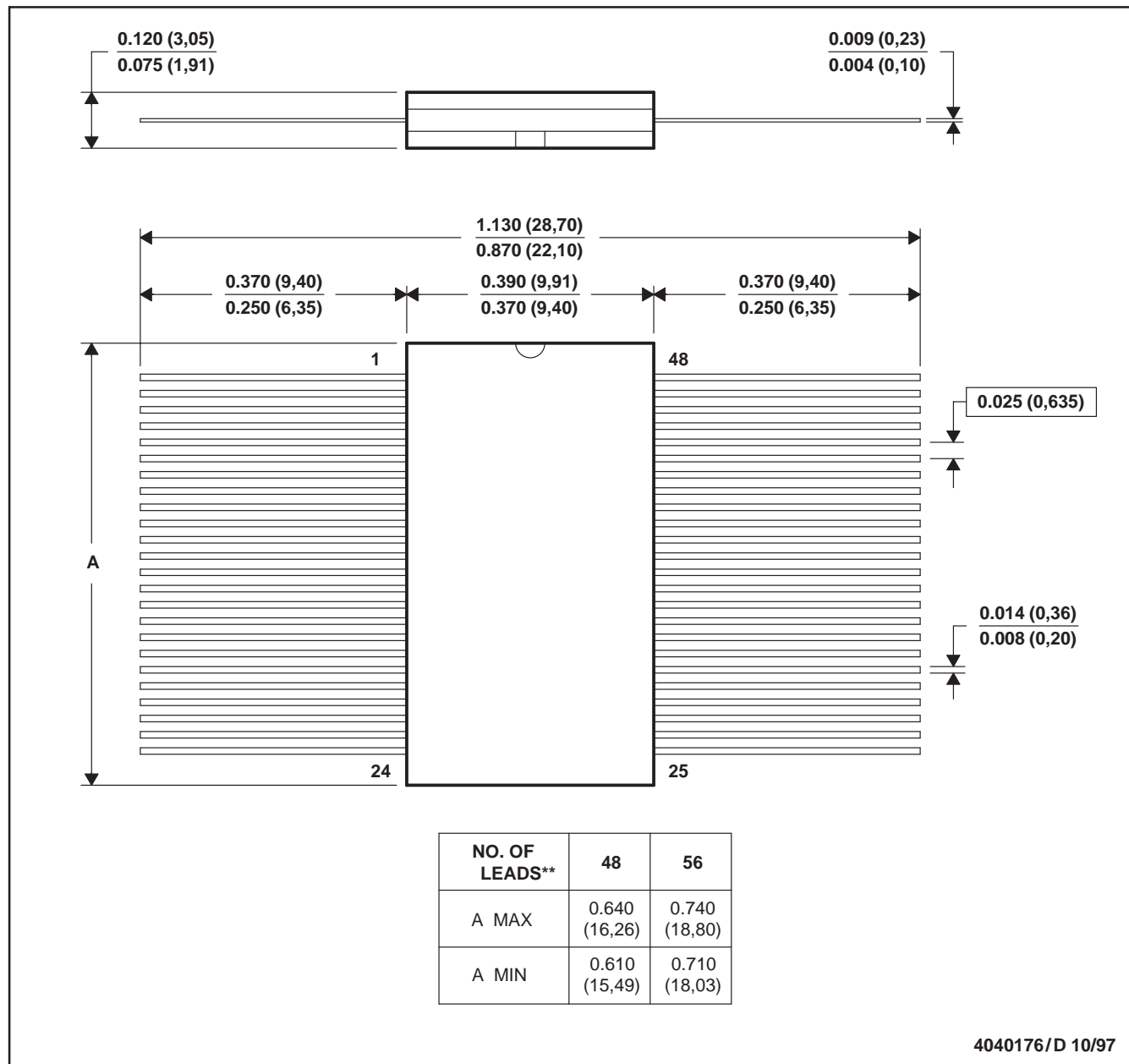

\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74LVTH16952DGGR	TSSOP	DGG	56	2000	367.0	367.0	45.0
SN74LVTH16952DLR	SSOP	DL	56	1000	367.0	367.0	55.0

WD (R-GDFP-F\*\*)

CERAMIC DUAL FLATPACK

48 LEADS SHOWN



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

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

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

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