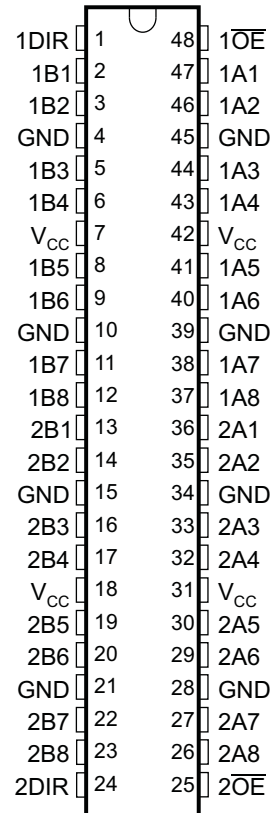


## FEATURES

- **Controlled Baseline**
  - One Assembly
  - One Test Site
  - One Fabrication Site
- **Enhanced Diminishing Manufacturing Sources (DMS) Support**
- **Enhanced Product-Change Notification**
- **Qualification Pedigree <sup>(1)</sup>**
- **Member 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**
- **Supports Mixed-Mode Signal Operation (5-V Input and Output Voltages With 3.3-V  $V_{CC}$ )**
- **Supports Unregulated Battery Operation Down to 2.7 V**
- **Typical  $V_{OLP}$  (Output Ground Bounce)  $<0.8$  V at  $V_{CC} = 3.3$  V,  $T_A = 25^\circ\text{C}$**
- **Distributed  $V_{CC}$  and GND Pins Minimize High-Speed Switching Noise**
- **Flow-Through Architecture Optimizes PCB Layout**
- **$I_{off}$  and Power-Up 3-State Support Hot Insertion**
- **Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors**
- **Latch-Up Performance Exceeds 500 mA Per JESD 17**
- **ESD Protection Exceeds JESD 22**
  - 2000-V Human-Body Model (A114-A)
  - 200-V Machine Model (A115-A)

(1) Component qualification in accordance with JEDEC and industry standards to ensure reliable operation over an extended temperature range. This includes, but is not limited to, Highly Accelerated Stress Test (HAST) or biased 85/85, temperature cycle, autoclave or unbiased HAST, electromigration, bond intermetallic life, and mold compound life. Such qualification testing should not be viewed as justifying use of this component beyond specified performance and environmental limits.

DGG, DGV, 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.

# SN74LVTH16245A-EP

## 3.3-V ABT 16-BIT BUS TRANSCEIVER

### WITH 3-STATE OUTPUTS

SCAS693G—APRIL 2003—REVISED OCTOBER 2006

## DESCRIPTION/ORDERING INFORMATION

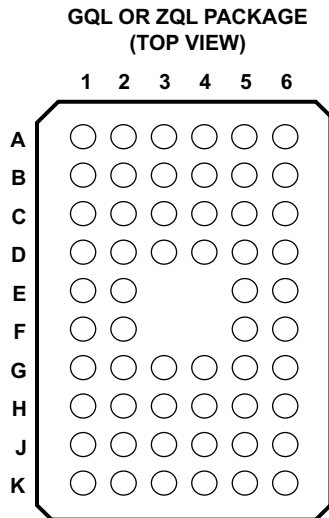
The SN74LVTH16245A is a 16-bit (dual-octal) noninverting 3-state transceiver designed for low-voltage (3.3-V)  $V_{CC}$  operation, but with the capability to provide a TTL interface to a 5-V system environment.

This device can be used as two 8-bit transceivers or one 16-bit transceiver. It allows 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 (OE) input can be used to disable the devices so that the buses effectively are isolated.

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.

When  $V_{CC}$  is between 0 V and 1.5 V, the device is in the high-impedance state during power up or power down. However, to ensure the high-impedance state above 1.5 V, 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.

This device is 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 device when it is 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.



## TERMINAL ASSIGNMENTS<sup>(1)</sup>

	1	2	3	4	5	6
<b>A</b>	1DIR	NC	NC	NC	NC	1 $\overline{OE}$
<b>B</b>	1B2	1B1	GND	GND	1A1	1A2
<b>C</b>	1B4	1B3	$V_{CC}$	$V_{CC}$	1A3	1A4
<b>D</b>	1B6	1B5	GND	GND	1A5	1A6
<b>E</b>	1B8	1B7			1A7	1A8
<b>F</b>	2B1	2B2			12A2	2A1
<b>G</b>	2B3	2B4	GND	GND	2A4	2A3
<b>H</b>	2B5	2B6	$V_{CC}$	$V_{CC}$	2A6	2A5
<b>J</b>	2B7	2B8	GND	GND	2A8	2A7
<b>K</b>	2DIR	NC	NC	NC	NC	2 $\overline{OE}$

(1) NC – no internal connection

## ORDERING INFORMATION

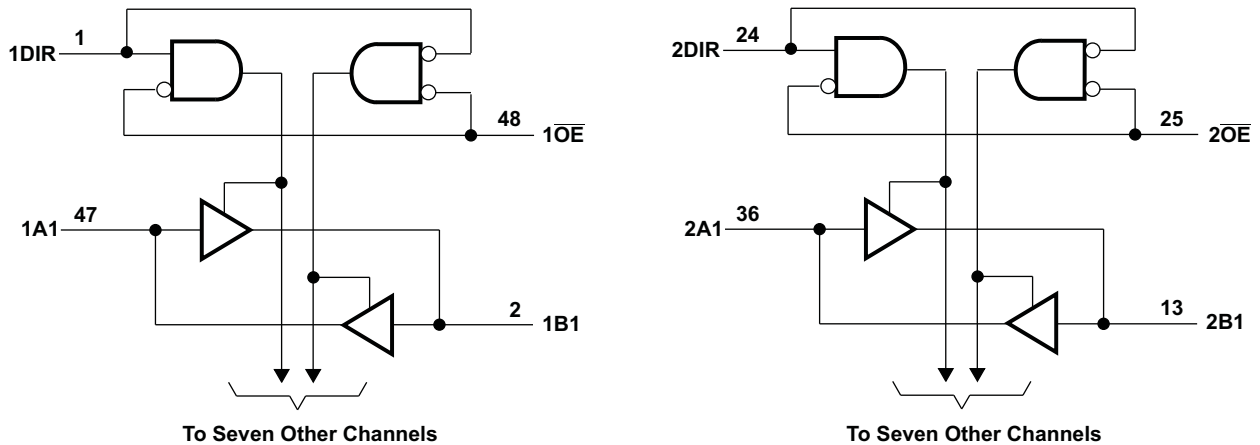
$T_A$	PACKAGE <sup>(1)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 125°C	SSOP – DL	Tape and reel	CLVTH16245AQDLREP	LH16245AEP
	TSSOP – DGG	Tape and reel	CLVTH16245AQDGGREP	LH16245AEP
–40°C to 85°C	TVSOP – DGV	Tape and reel	CLVTH16245AIDGVREP	LL245AEP
	VFBGA – GQL	Tape and reel	CLVTH16245AIGQLREP	LL245AEP
	VFBGA – ZQL (Pb-free)		CLVTH16245AIZQLREP	
–55°C to 125°C	SSOP – DL	Tape and reel	CLVTH16245AMDREP	LH16245AEP

(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).

FUNCTION TABLE  
(each 8-bit section)

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

LOGIC DIAGRAM (POSITIVE LOGIC)



### Absolute Maximum Ratings<sup>(1)</sup>

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

		MIN	MAX	UNIT
$V_{CC}$	Supply voltage range	-0.5	4.6	V
$V_I$	Input voltage range <sup>(2)</sup>	-0.5	7	V
$V_O$	Voltage range applied to any output in the high-impedance or power-off state <sup>(2)</sup>	-0.5	7	V
$V_O$	Voltage range applied to any output in the high state <sup>(2)</sup>	-0.5	$V_{CC} + 0.5$	V
$I_O$	Current into any output in the low state	SN74LVTH16245A(Q/M)	96	mA
		SN74LVTH16245AI	128	
$I_O$	Current into any output in the high state <sup>(3)</sup>	SN74LVTH16245A(Q/M)	48	mA
		SN74LVTH16245AI	64	
$I_{IK}$	Input clamp current	$V_I < 0$	-50	mA
$I_{OK}$	Output clamp current	$V_O < 0$	-50	mA
$\theta_{JA}$	Package thermal impedance <sup>(4)</sup>	DGG package	70	°C/W
		DGV package	58	
		DL package	63	
		GQL/ZQL package	42	
$T_{stg}$	Storage temperature range	-65	150	°C

- (1) 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.
- (2) The input and output negative-voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
- (3) This current flows only when the output is in the high state and  $V_O > V_{CC}$ .
- (4) The package thermal impedance is calculated in accordance with JESD 51-7.

**SN74LVTH16245A-EP**  
**3.3-V ABT 16-BIT BUS TRANSCEIVER**  
**WITH 3-STATE OUTPUTS**

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**Recommended Operating Conditions<sup>(1)</sup>**

		SN74LVTH16245AQ		SN74LVTH16245AI		SN74LVTH16245AM		UNIT
		MIN	MAX	MIN	MAX	MIN	MAX	
V <sub>CC</sub>	Supply voltage	2.7	3.6	2.7	3.6	2.7	3.6	V
V <sub>IH</sub>	High-level input voltage	2		2		2		V
V <sub>IL</sub>	Low-level input voltage		0.8		0.8		0.8	V
V <sub>I</sub>	Input voltage		5.5		5.5		5.5	V
I <sub>OH</sub>	High-level output current		–24		–32		–24	mA
I <sub>OL</sub>	Low-level output current		24		64		24	mA
Δt/Δv	Input transition rise or fall rate	Outputs enabled		10	10	10	10	ns/V
Δt/ΔV <sub>CC</sub>	Power-up ramp rate	200		200		200		μs/V
T <sub>A</sub>	Operating free-air temperature	–40	125	–40	85	–55	125	°C

(1) All unused control inputs of the device must be held at V<sub>CC</sub> or GND to ensure proper device operation. See the TI application report, *Implications of Slow or Floating CMOS Inputs* (SCBA004).

**Electrical Characteristics**

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

PARAMETER		TEST CONDITIONS	SN74LVTH16245AQ			SN74LVTH16245AI			SN74LVTH16245AM			UNIT		
			MIN	TYP <sup>(1)</sup>	MAX	MIN	TYP <sup>(1)</sup>	MAX	MIN	TYP <sup>(1)</sup>	MAX			
$V_{IK}$		$V_{CC} = 2.7\text{ V}$ , $I_I = -18\text{ mA}$	-1.2			-1.2			-1.2			V		
$V_{OH}$		$V_{CC} = 2.7\text{ V to } 3.6\text{ V}$ , $I_{OH} = -100\text{ }\mu\text{A}$	$V_{CC} - 0.2$			$V_{CC} - 0.2$			$V_{CC} - 0.2$			V		
		$V_{CC} = 2.7\text{ V}$ , $I_{OH} = -8\text{ mA}$	2.4			2.4			2.4					
		$V_{CC} = 3.3\text{ V}$	$I_{OH} = -24\text{ mA}$		2			$I_{OH} = -32\text{ mA}$		2				
$V_{OL}$		$V_{CC} = 2.7\text{ V}$	$I_{OL} = 100\text{ }\mu\text{A}$		0.2			$I_{OL} = 24\text{ mA}$		0.5			V	
			$I_{OL} = 24\text{ mA}$		0.5			$I_{OL} = 16\text{ mA}$		0.4				
		$V_{CC} = 3\text{ V}$	$I_{OL} = 16\text{ mA}$		0.4			$I_{OL} = 32\text{ mA}$		0.5				
			$I_{OL} = 32\text{ mA}$					$I_{OL} = 64\text{ mA}$		0.55				
			$I_{OL} = 64\text{ mA}$											
$I_I$		Control inputs	$V_{CC} = 3.6\text{ V}$ , $V_I = V_{CC}\text{ or GND}$		$\pm 1$			$\pm 1$		$\pm 1$			$\mu\text{A}$	
			$V_{CC} = 0\text{ or } 3.6\text{ V}$ , $V_I = 5.5\text{ V}$		10			10		10				
		A or B port <sup>(2)</sup>	$V_{CC} = 3.6\text{ V}$	$V_I = 5.5\text{ V}$		20			20		20			
				$V_I = V_{CC}$		5			1		5			
			$V_I = 0$		-5			-5		-5				
$I_{off}$		$V_{CC} = 0$ , $V_I\text{ or } V_O = 0\text{ to } 4.5\text{ V}$							$\pm 100$			$\mu\text{A}$		
$I_{I(\text{hold})}$ <sup>(3)</sup>		A or B port	$V_{CC} = 3\text{ V}$	$V_I = 0.8\text{ V}$		75			75		75			$\mu\text{A}$
				$V_I = 2\text{ V}$		-75			-75		-75			
		$V_{CC} = 3.6\text{ V}$ , $V_I = 0\text{ to } 3.6\text{ V}$								500 -750				
$I_{OZPU}$		$V_{CC} = 0\text{ to } 1.5\text{ V}$ , $V_O = 0.5\text{ V to } 3\text{ V}$ , $\overline{OE} = \text{don't care}$	$\pm 100$			$\pm 100$			$\pm 100$			$\mu\text{A}$		
$I_{OZPD}$		$V_{CC} = 1.5\text{ V to } 0$ , $V_O = 0.5\text{ V to } 3\text{ V}$ , $\overline{OE} = \text{don't care}$	$\pm 100$			$\pm 100$			$\pm 100$			$\mu\text{A}$		
$I_{CC}$		$V_{CC} = 3.6\text{ V}$ , $I_O = 0$ , $V_I = V_{CC}\text{ or GND}$	Outputs high		0.19			0.19		0.19			mA	
			Outputs low		5			5		5				
			Outputs disabled		0.19			0.19		0.19				
$\Delta I_{CC}$ <sup>(4)</sup>		$V_{CC} = 3\text{ V to } 3.6\text{ V}$ , One input at $V_{CC} - 0.6\text{ V}$ , Other inputs at $V_{CC}\text{ or GND}$	0.2			0.2			0.2			mA		
$C_i$		$V_I = 3\text{ V or } 0$	4			4			4			pF		
$C_{io}$		$V_O = 3\text{ V or } 0$	10			10			10			pF		

 (1) All typical values are at  $V_{CC} = 3.3\text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

 (2) Unused pins at  $V_{CC}$  or GND

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

 (4) This is the increase in supply current for each input that is at the specified TTL voltage level, rather than  $V_{CC}$  or GND.

# SN74LVTH16245A-EP

## 3.3-V ABT 16-BIT BUS TRANSCEIVER WITH 3-STATE OUTPUTS

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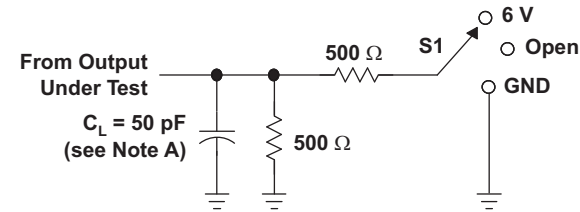
### Switching Characteristics

over operating free-air temperature range,  $C_L = 50$  pF (unless otherwise noted) (see [Figure 1](#))

PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN74LVTH16245AQ SN74LVTH16245AM				SN74LVTH16245AI				UNIT	
			$V_{CC} = 3.3\text{ V}$ $\pm 0.3\text{ V}$		$V_{CC} = 2.7\text{ V}$		$V_{CC} = 3.3\text{ V}$ $\pm 0.3\text{ V}$			$V_{CC} = 2.7\text{ V}$		
			MIN	MAX	MIN	MAX	MIN	TYP <sup>(1)</sup>	MAX	MIN		MAX
$t_{PLH}$	A or B	B or A	0.5	4.5	4.6		1.5	2.3	3.3	3.7		ns
$t_{PHL}$			0.5	4.4	3.9		1.3	2.1	3.3	3.5		
$t_{PZH}$	$\overline{OE}$	A or B	0.5	6.5	6.6		1.5	2.8	4.5	5.3		ns
$t_{PZL}$			0.5	5.4	6.2		1.6	2.9	4.6	5.2		
$t_{PHZ}$	$\overline{OE}$	A or B	1	6.8	7		2.3	3.7	5.1	5.5		ns
$t_{PLZ}$			1	6.2	6.3		2.2	3.5	5.1	5.4		
$t_{sk(o)}$								0.5		0.5	ns	

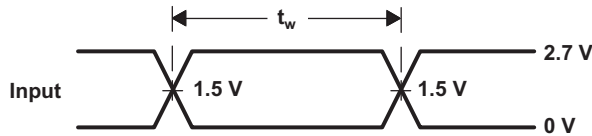
(1) All typical values are at  $V_{CC} = 3.3\text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

PARAMETER MEASUREMENT INFORMATION

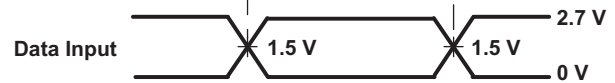
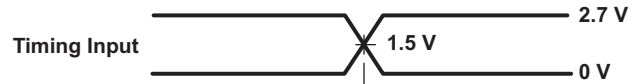


LOAD CIRCUIT

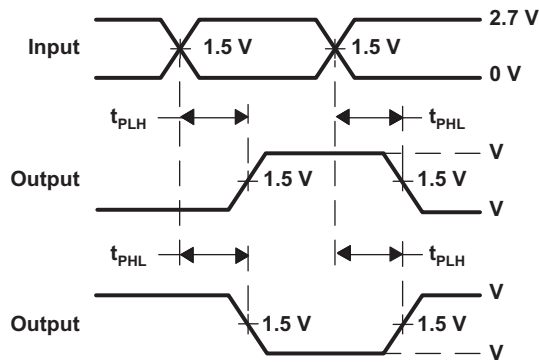
TEST	S1
$t_{PLH}/t_{PHL}$	Open
$t_{PLZ}/t_{PZL}$	6 V
$t_{PHZ}/t_{PZH}$	GND



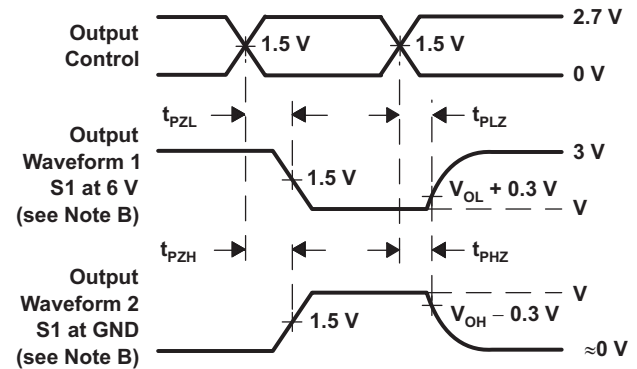
VOLTAGE WAVEFORMS  
PULSE DURATION



VOLTAGE WAVEFORMS  
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS  
PROPAGATION DELAY TIMES  
INVERTING AND NONINVERTING OUTPUTS



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 MHz,  $Z_O = 59 \Omega$ ,  $t_r \leq 2.5 \text{ ns}$ ,  $t_f \leq 2.5 \text{ ns}$ .  
 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 (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
8V16245AMDLREPG4	ACTIVE	SSOP	DL	48	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	LVTH16245AEP	<a href="#">Samples</a>
CLVTH16245AMDLREP	ACTIVE	SSOP	DL	48	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	LVTH16245AEP	<a href="#">Samples</a>
CLVTH16245AQDGGREP	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	LH16245AEP	<a href="#">Samples</a>
CLVTH16245AQDLREP	ACTIVE	SSOP	DL	48	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	LH16245AEP	<a href="#">Samples</a>
V62/04602-01XE	ACTIVE	SSOP	DL	48	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	LH16245AEP	<a href="#">Samples</a>
V62/04602-01YE	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	LH16245AEP	<a href="#">Samples</a>
V62/04602-02UA	ACTIVE	BGA MICROSTAR JUNIOR	GQL	56		TBD	Call TI	Call TI	-40 to 85		<a href="#">Samples</a>
V62/04602-03XE	ACTIVE	SSOP	DL	48	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	LVTH16245AEP	<a href="#">Samples</a>

(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.



(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

**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.

**OTHER QUALIFIED VERSIONS OF SN74LVTH16245A-EP :**

- Catalog: [SN74LVTH16245A](#)
- Automotive: [SN74LVTH16245A-Q1](#)
- Military: [SN54LVTH16245A](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects
- Military - QML certified for Military and Defense Applications

**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
CLVTH16245AMDREP	SSOP	DL	48	1000	330.0	32.4	11.35	16.2	3.1	16.0	32.0	Q1
CLVTH16245AQDGGREP	TSSOP	DGG	48	2000	330.0	24.4	8.6	15.8	1.8	12.0	24.0	Q1
CLVTH16245AQDLREP	SSOP	DL	48	1000	330.0	32.4	11.35	16.2	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)
CLVTH16245AMDLREP	SSOP	DL	48	1000	367.0	367.0	55.0
CLVTH16245AQDGGREP	TSSOP	DGG	48	2000	367.0	367.0	45.0
CLVTH16245AQLREP	SSOP	DL	48	1000	367.0	367.0	55.0

# MECHANICAL DATA

DL (R-PDSO-G48)

PLASTIC SMALL-OUTLINE PACKAGE



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

PowerPAD is a trademark of Texas Instruments.

GQL (R-PBGA-N56)

PLASTIC BALL GRID ARRAY



- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
  - B. This drawing is subject to change without notice.
  - C. Falls within JEDEC MO-285 variation BA-2.
  - D. This package is tin-lead (SnPb). Refer to the 56 ZQL package (drawing 4204437) for lead-free.

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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