

# SN74LVTH16373-EP

## 3.3-V ABT 16-BIT TRANSPARENT D-TYPE LATCH WITH 3-STATE OUTPUTS

SCBS778A – NOVEMBER 2003 – REVISED MARCH 2004

- **Controlled Baseline**
  - One Assembly/Test Site, One Fabrication Site
- **Enhanced Diminishing Manufacturing Sources (DMS) Support**
- **Enhanced Product-Change Notification**
- **Qualification Pedigree†**
- **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,  $T_A = 25^\circ\text{C}$**
- **$I_{off}$  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 JESD 22**
  - 2000-V Human-Body Model (A114-A)
  - 200-V Machine Model (A115-A)

DGG OR DL PACKAGE  
(TOP VIEW)

1OE	1	48	1LE
1Q1	2	47	1D1
1Q2	3	46	1D2
GND	4	45	GND
1Q3	5	44	1D3
1Q4	6	43	1D4
$V_{CC}$	7	42	$V_{CC}$
1Q5	8	41	1D5
1Q6	9	40	1D6
GND	10	39	GND
1Q7	11	38	1D7
1Q8	12	37	1D8
2Q1	13	36	2D1
2Q2	14	35	2D2
GND	15	34	GND
2Q3	16	33	2D3
2Q4	17	32	2D4
$V_{CC}$	18	31	$V_{CC}$
2Q5	19	30	2D5
2Q6	20	29	2D6
GND	21	28	GND
2Q7	22	27	2D7
2Q8	23	26	2D8
2OE	24	25	2LE

† 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.

### description/ordering information

The SN74LVTH16373 is a 16-bit transparent D-type latch with 3-state outputs 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 is particularly suitable for implementing buffer registers, I/O ports, bidirectional bus drivers, and working registers.

This device can be used as two 8-bit latches or one 16-bit latch. When the latch-enable (LE) input is high, the Q outputs follow the data (D) inputs. When LE is taken low, the Q outputs are latched at the levels set up at the D inputs.



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### description/ordering information (continued)

A buffered output-enable ( $\overline{OE}$ ) input can be used to place the eight outputs in either a normal logic state (high or low logic levels) or a high-impedance state. In the high-impedance state, the outputs neither load nor drive the bus lines significantly. The high-impedance state and the increased drive provide the capability to drive bus lines without interface or pullup components.

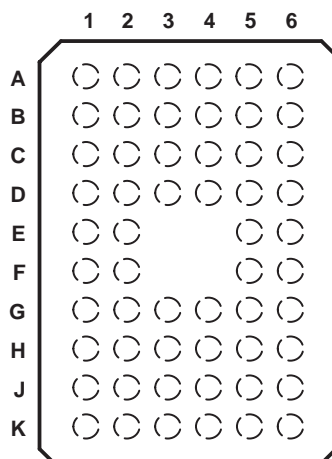
$\overline{OE}$  does not affect internal operations of the latch. Old data can be retained or new data can be entered while the outputs are in the high-impedance state.

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 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,  $\overline{OE}$  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.

GQL OR ZQL PACKAGE  
(TOP VIEW)



### terminal assignments

	1	2	3	4	5	6
A	$\overline{1OE}$	NC	NC	NC	NC	1LE
B	1Q2	1Q1	GND	GND	1D1	1D2
C	1Q4	1Q3	$V_{CC}$	$V_{CC}$	1D3	1D4
D	1Q6	1Q5	GND	GND	1D5	1D6
E	1Q8	1Q7			1D7	1D8
F	2Q1	2Q2			2D2	2D1
G	2Q3	2Q4	GND	GND	2D4	2D3
H	2Q5	2Q6	$V_{CC}$	$V_{CC}$	2D6	2D5
J	2Q7	2Q8	GND	GND	2D8	2D7
K	$\overline{2OE}$	NC	NC	NC	NC	2LE

NC – No internal connection

### ORDERING INFORMATION

$T_A$	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	SSOP – DL	Tape and reel	CLVTH16373IDLREP	LH16373EP
	TSSOP – DGG	Tape and reel	CLVTH16373IDGGREP	LH16373EP
	VFBGA – GQL	Tape and reel	CLVTH16373IGQLREP	LL373EP
	VFBGA – ZQL (Pb-free)		CLVTH16373IZQLREP	

† 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).

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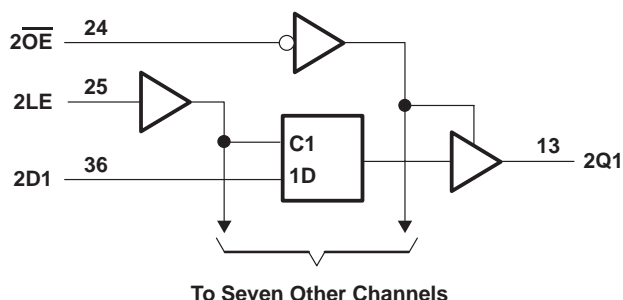
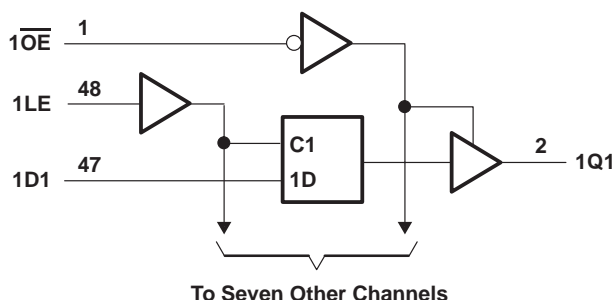
## 3.3-V ABT 16-BIT TRANSPARENT D-TYPE LATCH WITH 3-STATE OUTPUTS

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FUNCTION TABLE  
(each 8-bit section)

INPUTS			OUTPUT Q
$\overline{OE}$	LE	D	
L	H	H	H
L	H	L	L
L	L	X	$Q_0$
H	X	X	Z

### logic diagram (positive logic)



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

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, $I_O$	128 mA
Current into any output in the high state, $I_O$	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	70°C/W
DL package	63°C/W
GQL/ZQL package	42°C/W
Storage temperature range, $T_{stg}$	–65°C to 150°C

<sup>†</sup> 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 51-7.

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## 3.3-V ABT 16-BIT TRANSPARENT D-TYPE LATCH

### WITH 3-STATE OUTPUTS

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#### recommended operating conditions (see Note 4)

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

NOTE 4: All unused control inputs of the device must be held at V<sub>CC</sub> or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

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**WITH 3-STATE OUTPUTS**

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

PARAMETER		TEST CONDITIONS	MIN	TYP†	MAX	UNIT
$V_{IK}$		$V_{CC} = 2.7\text{ V}$ , $I_I = -18\text{ mA}$			-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
		$V_{CC} = 2.7\text{ V}$ , $I_{OH} = -8\text{ mA}$	2.4			
		$V_{CC} = 3\text{ V}$ , $I_{OH} = -32\text{ mA}$	2			
$V_{OL}$	$V_{CC} = 2.7\text{ V}$	$I_{OL} = 100\text{ }\mu\text{A}$			0.2	V
		$I_{OL} = 24\text{ mA}$			0.5	
	$V_{CC} = 3\text{ V}$	$I_{OL} = 16\text{ mA}$			0.4	
		$I_{OL} = 32\text{ mA}$			0.5	
		$I_{OL} = 64\text{ mA}$			0.55	
$I_I$		$V_{CC} = 0\text{ or } 3.6\text{ V}$ , $V_I = 5.5\text{ V}$			10	$\mu\text{A}$
	Control inputs	$V_{CC} = 3.6\text{ V}$ , $V_I = V_{CC}\text{ or GND}$			$\pm 1$	
	Data inputs	$V_{CC} = 3.6\text{ V}$ , $V_I = V_{CC}$			1	
		$V_{CC} = 3.6\text{ V}$ , $V_I = 0$			-5	
$I_{off}$		$V_{CC} = 0$ , $V_I\text{ or } V_O = 0\text{ to } 4.5\text{ V}$			$\pm 100$	$\mu\text{A}$
$I_{I(hold)}$	Data inputs	$V_{CC} = 3\text{ V}$ , $V_I = 0.8\text{ V}$	75			$\mu\text{A}$
		$V_{CC} = 3\text{ V}$ , $V_I = 2\text{ V}$	-75			
		$V_{CC} = 3.6\text{ V}^\ddagger$ , $V_I = 0\text{ to } 3.6\text{ V}$			$\pm 500$	
$I_{OZH}$		$V_{CC} = 3.6\text{ V}$ , $V_O = 3\text{ V}$			5	$\mu\text{A}$
$I_{OZL}$		$V_{CC} = 3.6\text{ V}$ , $V_O = 0.5\text{ V}$			-5	$\mu\text{A}$
$I_{OZPU}$		$V_{CC} = 0\text{ to } 1.5\text{ V}$ , $V_O = 0.5\text{ V to } 3\text{ V}$ , $\overline{OE} = \text{don't care}$			$\pm 100$	$\mu\text{A}$
$I_{OZPD}$		$V_{CC} = 1.5\text{ V to } 0$ , $V_O = 0.5\text{ V to } 3\text{ V}$ , $\overline{OE} = \text{don't care}$			$\pm 100$	$\mu\text{A}$
$I_{CC}$	$V_{CC} = 3.6\text{ V}$ , $I_O = 0$ , $V_I = V_{CC}\text{ or GND}$	Outputs high			0.19	mA
		Outputs low			5	
		Outputs disabled			0.19	
$\Delta I_{CC}^\S$		$V_{CC} = 3\text{ V to } 3.6\text{ V}$ , One input at $V_{CC} - 0.6\text{ V}$ , Other inputs at $V_{CC}\text{ or GND}$			0.2	mA
$C_i$		$V_I = 3\text{ V or } 0$			3	pF
$C_o$		$V_O = 3\text{ V or } 0$			9	pF

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

‡ 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  $V_{CC}$  or GND.

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

		$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$		$V_{CC} = 2.7\text{ V}$		UNIT
		MIN	MAX	MIN	MAX	
$t_w$	Pulse duration, LE high	3		3		ns
$t_{su}$	Setup time, data before LE↓	1		0.6		ns
$t_h$	Hold time, data after LE↓	1		1.1		ns

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switching characteristics over recommended operating free-air temperature range,  $C_L = 50$  pF  
(unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CC} = 3.3\text{ V}$ $\pm 0.3\text{ V}$			$V_{CC} = 2.7\text{ V}$		UNIT
			MIN	TYP†	MAX	MIN	MAX	
t <sub>PLH</sub>	D	Q	1.5	2.7	3.8	4.2	4	ns
t <sub>PHL</sub>			1.5	2.5	3.6	4		
t <sub>PLH</sub>	LE	Q	2.1	3	4.3	4.8	4	ns
t <sub>PHL</sub>			2.1	2.9	4	4		
t <sub>PZH</sub>	$\overline{OE}$	Q	1.5	2.8	4.3	5.1	4.7	ns
t <sub>PZL</sub>			1.5	2.8	4.3	4.7		
t <sub>PHZ</sub>	$\overline{OE}$	Q	2.4	3.5	5	5.4	4.8	ns
t <sub>PLZ</sub>			2	3.2	4.7	4.8		
t <sub>sk(o)</sub>					0.5			ns

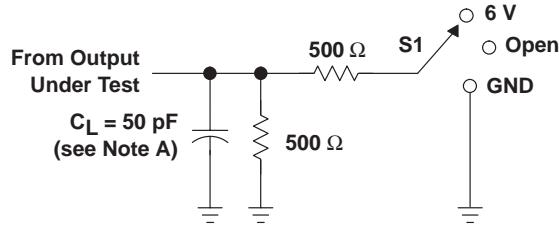
† All typical values are at  $V_{CC} = 3.3\text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

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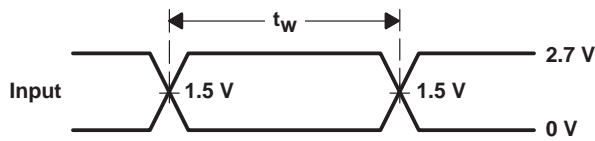
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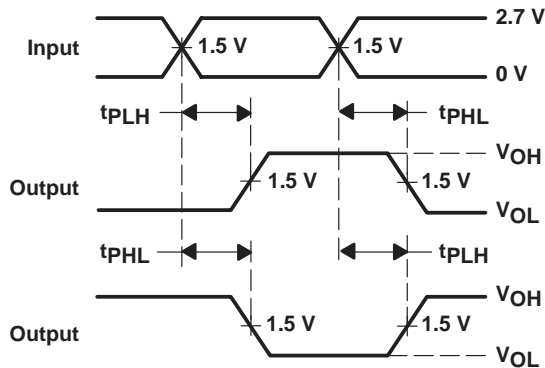
### PARAMETER MEASUREMENT INFORMATION



LOAD CIRCUIT

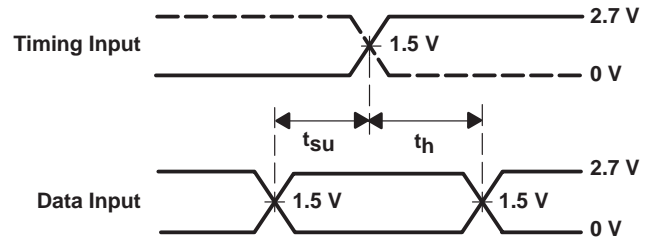


VOLTAGE WAVEFORMS  
PULSE DURATION

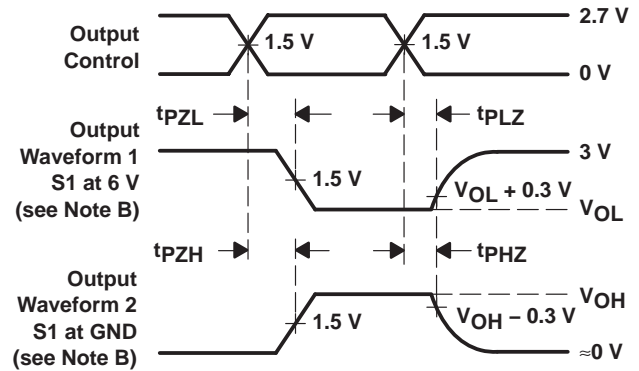


VOLTAGE WAVEFORMS  
PROPAGATION DELAY TIMES  
INVERTING AND NONINVERTING OUTPUTS

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 (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
CLVTH16373IDGGREP	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LH16373EP	<a href="#">Samples</a>
CLVTH16373IDLREP	ACTIVE	SSOP	DL	48	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LH16373EP	<a href="#">Samples</a>
CLVTH16373IZQLREP	ACTIVE	BGA MICROSTAR JUNIOR	ZQL	56	1000	Pb-Free (RoHS)	SNAGCU	Level-1-260C-UNLIM	-40 to 85	LL373EP	<a href="#">Samples</a>
V62/04712-01XE	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LH16373EP	<a href="#">Samples</a>
V62/04712-01YE	ACTIVE	SSOP	DL	48	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LH16373EP	<a href="#">Samples</a>
V62/04712-01ZA	ACTIVE	BGA MICROSTAR JUNIOR	GQL	56		TBD	Call TI	Call TI	-40 to 85		<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.

**OBSOLETE:** 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) Only one of markings shown within the brackets will appear on the physical device.



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- Catalog: [SN74LVTH16373](#)
- Military: [SN54LVTH16373](#)

**NOTE:** Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Military - QML certified for Military and Defense Applications

**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
CLVTH16373IDGGREP	TSSOP	DGG	48	2000	330.0	24.4	8.6	15.8	1.8	12.0	24.0	Q1
CLVTH16373IDLREP	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)
CLVTH16373IDGGREP	TSSOP	DGG	48	2000	367.0	367.0	45.0
CLVTH16373IDLREP	SSOP	DL	48	1000	367.0	367.0	55.0

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