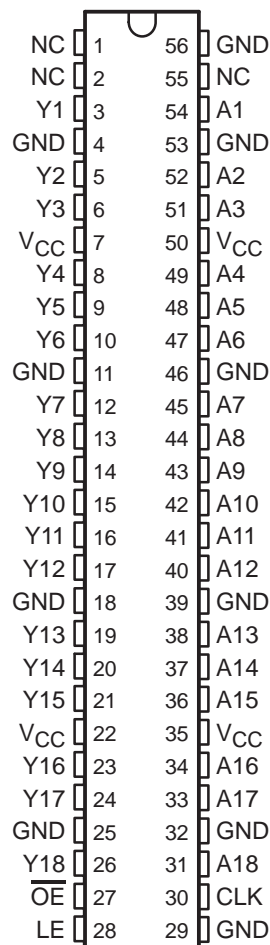


SN54LVTH16835, SN74LVTH16835 3.3-V ABT 18-BIT UNIVERSAL BUS DRIVERS WITH 3-STATE OUTPUTS

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- **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 Pin Configuration Minimizes 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 Using 25-mil Center-to-Center Spacings**

SN54LVTH16835 . . . WD PACKAGE
SN74LVTH16835 . . . DGG OR DL PACKAGE
(TOP VIEW)



NC – No internal connection

description

The 'LVTH16835 devices are 18-bit universal bus drivers 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.

Data flow from A to Y is controlled by the output-enable (\overline{OE}) input. These devices operate in the transparent mode when the latch-enable (LE) input is high. The A data is latched if the clock (CLK) input is held at a high or low logic level. If LE is low, the A data is stored in the latch/flip-flop on the low-to-high transition of the clock. When \overline{OE} is high, the outputs are in the high-impedance state.

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{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.



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SN54LVTH16835, SN74LVTH16835

3.3-V ABT 18-BIT UNIVERSAL BUS DRIVERS

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 SN54LVTH16835 is characterized for operation over the full military temperature range of -55°C to 125°C . The SN74LVTH16835 is characterized for operation from -40°C to 85°C .

FUNCTION TABLE

INPUTS				OUTPUT
$\overline{\text{OE}}$	LE	CLK	A	Y
H	X	X	X	Z
L	H	X	L	L
L	H	X	H	H
L	L	↑	L	L
L	L	↑	H	H
L	L	H	X	Y_0^{\dagger}
L	L	L	X	Y_0^{\ddagger}

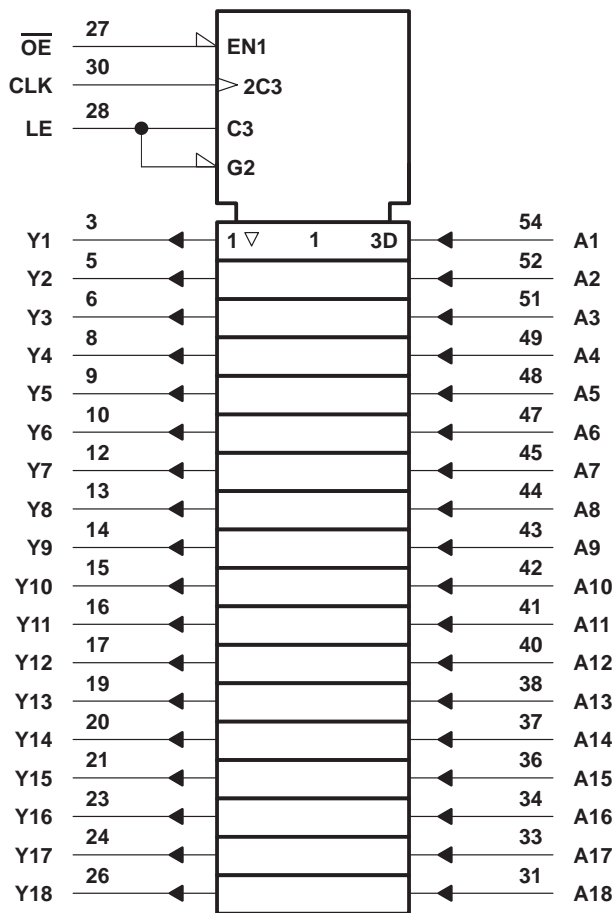
† Output level before the indicated steady-state input conditions were established, provided that CLK is high before LE goes low

‡ Output level before the indicated steady-state input conditions were established

SN54LVTH16835, SN74LVTH16835
3.3-V ABT 18-BIT UNIVERSAL BUS DRIVERS
WITH 3-STATE OUTPUTS

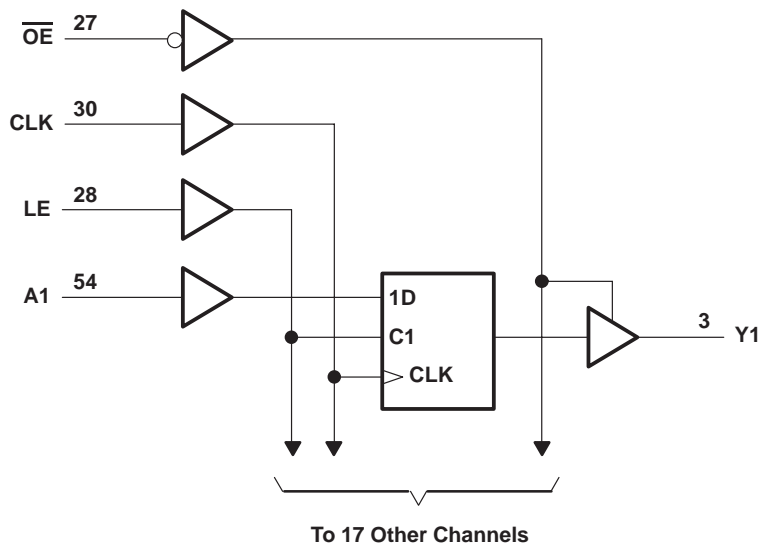
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logic symbol†



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

logic diagram (positive logic)



SN54LVTH16835, SN74LVTH16835

3.3-V ABT 18-BIT UNIVERSAL BUS DRIVERS

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 : SN54LVTH16835	96 mA
SN74LVTH16835	128 mA
Current into any output in the high state, I_O (see Note 2): SN54LVTH16835	48 mA
SN74LVTH16835	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, θ_{JA} (see Note 3): DGG package	81°C/W
DL package	74°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)

		SN54LVTH16835		SN74LVTH16835		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	μ s/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.

SN54LVTH16835, SN74LVTH16835
3.3-V ABT 18-BIT UNIVERSAL BUS DRIVERS
WITH 3-STATE OUTPUTS

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

PARAMETER		TEST CONDITIONS		SN54LVTH16835		SN74LVTH16835		UNIT	
				MIN	TYP†	MAX	MIN		TYP†
V_{IK}		$V_{CC} = 2.7\text{ V}$, $I_I = -18\text{ mA}$		-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	
		$V_{CC} = 2.7\text{ V}$, $I_{OH} = -8\text{ mA}$		2.4		2.4			
		$V_{CC} = 3\text{ V}$		2		2			
		$I_{OH} = -24\text{ mA}$							
				$I_{OH} = -32\text{ mA}$					
V_{OL}		$V_{CC} = 2.7\text{ V}$		$I_{OL} = 100\text{ }\mu\text{A}$		0.2		0.2	
				$I_{OL} = 24\text{ mA}$		0.5		0.5	
		$V_{CC} = 3\text{ V}$		$I_{OL} = 16\text{ mA}$		0.4		0.4	
				$I_{OL} = 32\text{ mA}$		0.5		0.5	
				$I_{OL} = 48\text{ mA}$		0.55			
				$I_{OL} = 64\text{ mA}$				0.55	
I_I		Control inputs $V_{CC} = 0\text{ or }3.6\text{ V}$, $V_I = 5.5\text{ V}$ $V_{CC} = 3.6\text{ V}$, $V_I = V_{CC}\text{ or GND}$		10		10		μA	
				A inputs $V_{CC} = 3.6\text{ V}$		± 1			± 1
$V_I = V_{CC}$		1				1			
$V_I = 5.5\text{ V}$		10				10			
				$V_I = 0$		-5		-5	
I_{off}		$V_{CC} = 0$, $V_I\text{ or }V_O = 0\text{ to }4.5\text{ V}$				± 100		μA	
$I_I(\text{hold})$		$V_{CC} = 3\text{ V}$		$V_I = 0.8\text{ V}$		75		μA	
				$V_I = 2\text{ V}$		-75			-75
		$V_{CC} = 3.6\text{ V}\ddagger$, $V_I = 0\text{ to }3.6\text{ V}$						± 500	
I_{OZH}		$V_{CC} = 3.6\text{ V}$, $V_O = 3\text{ V}$		5		5		μA	
I_{OZL}		$V_{CC} = 3.6\text{ V}$, $V_O = 0.5\text{ V}$		-5		-5		μA	
I_{OZPU}		$V_{CC} = 0\text{ to }1.5\text{ V}$, $V_O = 0.5\text{ V to }3\text{ V}$, $OE = \text{don't care}$		$\pm 100^*$		± 100		μA	
I_{OZPD}		$V_{CC} = 1.5\text{ V to }0$, $V_O = 0.5\text{ V to }3\text{ V}$, $OE = \text{don't care}$		$\pm 100^*$		± 100		μA	
I_{CC}		$V_{CC} = 3.6\text{ V}$, $I_O = 0$, $V_I = V_{CC}\text{ or GND}$		Outputs high		0.19		0.19	
				Outputs low		5		5	
				Outputs disabled		0.19		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		0.2		mA	
C_i		$V_I = 3\text{ V or }0$		3.5		3.5		pF	
C_o		$V_O = 3\text{ V or }0$		9		9		pF	

* On products compliant to MIL-PRF-38535, this parameter is not production tested.

† 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.

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SN54LVTH16835, SN74LVTH16835
3.3-V ABT 18-BIT UNIVERSAL BUS DRIVERS
WITH 3-STATE OUTPUTS

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

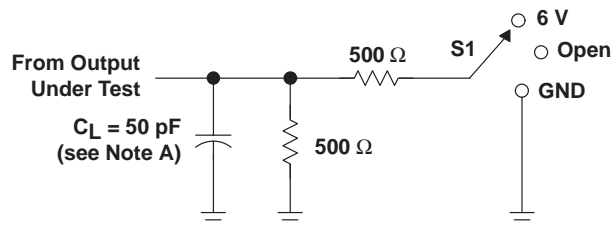
		SN54LVTH16835				SN74LVTH16835				UNIT		
		$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$		$V_{CC} = 2.7\text{ V}$		$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$		$V_{CC} = 2.7\text{ V}$				
		MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX			
f_{clock}	Clock frequency	150		150		150		150		MHz		
t_w	Pulse duration	LE high		3.3		3.3		3.3		ns		
		CLK high or low		3.3		3.3		3.3				
t_{su}	Setup time	Data before CLK \uparrow		2.2		2.5		2.1		2.4		
		Data before LE \downarrow	CLK high		2.5		1.7		2.3		1.5	
			CLK low		1.5		0.5		1.5		0.5	
t_h	Hold time	Data after CLK \uparrow		1		0		1		0		
		Data after LE \downarrow		0.8		0.8		0.8		0.8		

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN54LVTH16835				SN74LVTH16835				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 \dagger	MAX	MIN		MAX
f_{max}			150		150		150			150		MHz
t_{PLH}	A	Y	1.2	3.9	4.3		1.3	2.6	3.7	4		ns
t_{PHL}			1.2	3.9	4.3		1.3	2.4	3.7	4		
t_{PLH}	LE	Y	1.4	5.3	5.9		1.5	3.2	5.1	5.7		ns
t_{PHL}			1.4	5.3	5.9		1.5	3.3	5.1	5.7		
t_{PLH}	CLK	Y	1.4	5.3	5.9		1.5	3.5	5.1	5.7		ns
t_{PHL}			1.4	5.3	5.9		1.5	3.4	5.1	5.7		
t_{PZH}	$\overline{\text{OE}}$	Y	1.2	5	5.9		1.3	2.9	4.6	5.5		ns
t_{PZL}			1.2	5	5.9		1.3	3	4.6	5.5		
t_{PHZ}	$\overline{\text{OE}}$	Y	1.6	6	6.5		1.7	4.2	5.8	6.3		ns
t_{PLZ}			1.6	6	6.5		1.7	3.7	5.8	6.3		

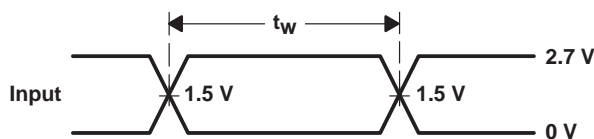
\dagger All typical values are at $V_{CC} = 3.3\text{ V}$, $T_A = 25^\circ\text{C}$.

PARAMETER MEASUREMENT INFORMATION

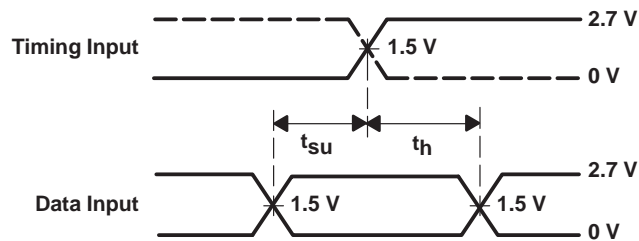


LOAD CIRCUIT

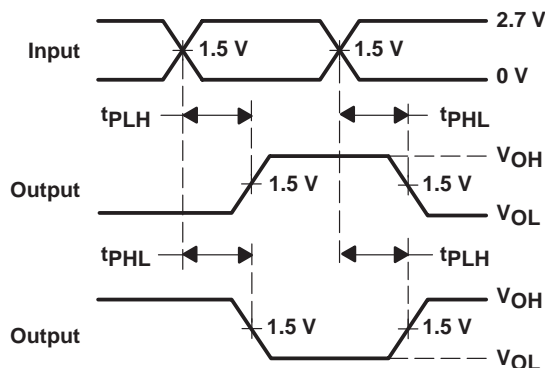
TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	6 V
t_{PHZ}/t_{PZH}	GND



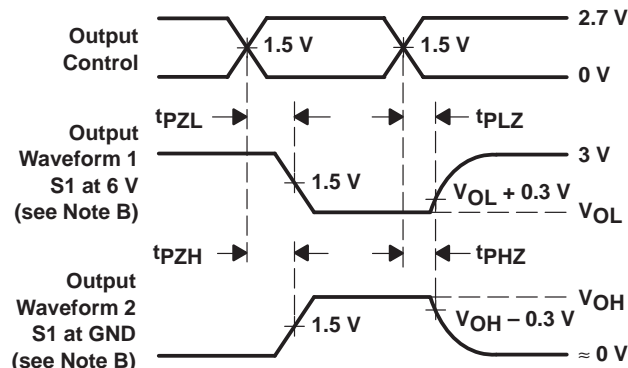
VOLTAGE WAVEFORMS
PULSE DURATION



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: $PRR \leq 10 \text{ MHz}$, $Z_O = 50 \Omega$, $t_r \leq 2.5 \text{ ns}$, $t_f \leq 2.5 \text{ ns}$.
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⁾
74LVTH16835DGGRE4	ACTIVE	TSSOP	DGG	56	2000	Pb-Free (RoHS)	CU NIPDAU	Level-1-250C-UNLIM
74LVTH16835DLRG4	ACTIVE	SSOP	DL	56	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LVTH16835DGGR	ACTIVE	TSSOP	DGG	56	2000	Pb-Free (RoHS)	CU NIPDAU	Level-1-250C-UNLIM
SN74LVTH16835DL	ACTIVE	SSOP	DL	56	20	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LVTH16835DLG4	ACTIVE	SSOP	DL	56	20	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LVTH16835DLR	ACTIVE	SSOP	DL	56	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

⁽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.

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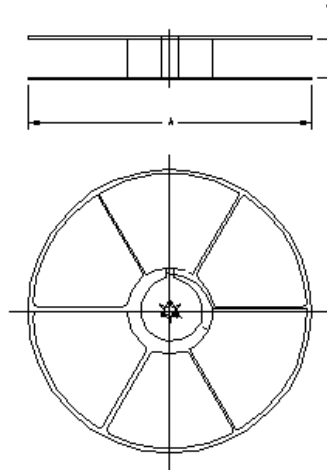
Carrier tape design is defined largely by the component length, width, and thickness.

A_o = Dimension designed to accommodate the component width.
B_o = Dimension designed to accommodate the component length.
K_o = Dimension designed to accommodate the component thickness.
W = Overall width of the carrier tape.
P = Pitch between successive cavity centers.



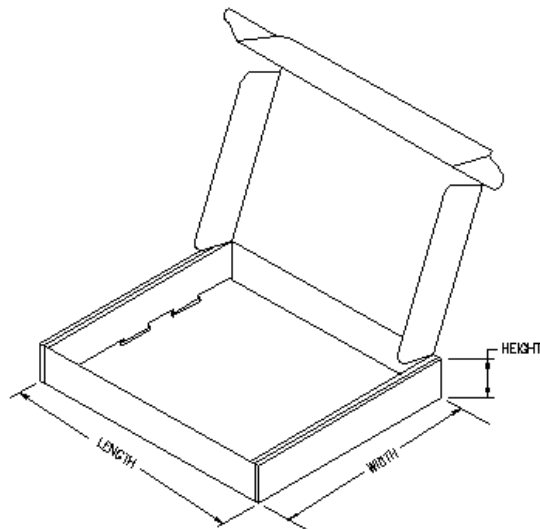
TAPE AND REEL INFORMATION

Device	Package	Pins	Site	Reel Diameter (mm)	Reel Width (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
SN74LVTH16835DGGR	DGG	56	MLA	330	24	8.6	15.8	1.8	12	24	Q1
SN74LVTH16835DLR	DL	56	MLA	330	32	11.35	18.67	3.1	16	32	Q1



TAPE AND REEL BOX INFORMATION

Device	Package	Pins	Site	Length (mm)	Width (mm)	Height (mm)
SN74LVTH16835DGGR	DGG	56	MLA	333.2	333.2	31.75
SN74LVTH16835DLR	DL	56	MLA	346.0	346.0	49.0



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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