

SN74LVTH16835-EP 3.3-V ABT 18-BIT UNIVERSAL BUS DRIVER WITH 3-STATE OUTPUTS

SCBS788 – NOVEMBER 2003

- **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 2000 V Per MIL-STD-883, Method 3015; Exceeds 200 V Using Machine Model ($C = 200$ pF, $R = 0$)**
- **Thin Shrink Small-Outline (DGG) Package**

DGG PACKAGE
(TOP VIEW)

NC	1	56	GND
NC	2	55	NC
Y1	3	54	A1
GND	4	53	GND
Y2	5	52	A2
Y3	6	51	A3
V_{CC}	7	50	V_{CC}
Y4	8	49	A4
Y5	9	48	A5
Y6	10	47	A6
GND	11	46	GND
Y7	12	45	A7
Y8	13	44	A8
Y9	14	43	A9
Y10	15	42	A10
Y11	16	41	A11
Y12	17	40	A12
GND	18	39	GND
Y13	19	38	A13
Y14	20	37	A14
Y15	21	36	A15
V_{CC}	22	35	V_{CC}
Y16	23	34	A16
Y17	24	33	A17
GND	25	32	GND
Y18	26	31	A18
OE	27	30	CLK
LE	28	29	GND

NC – No internal connection

† 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 SN74LVTH16835 is an 18-bit universal bus driver 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.



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description/ordering information (continued)

Data flow from A to Y is controlled by the output-enable (\overline{OE}) input. This device operates 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 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.

ORDERING INFORMATION

TA	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
-40°C to 85°C	TSSOP – DGG	Tape and reel	CLVTH16835IDGGREP	LH16835EP

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

FUNCTION TABLE

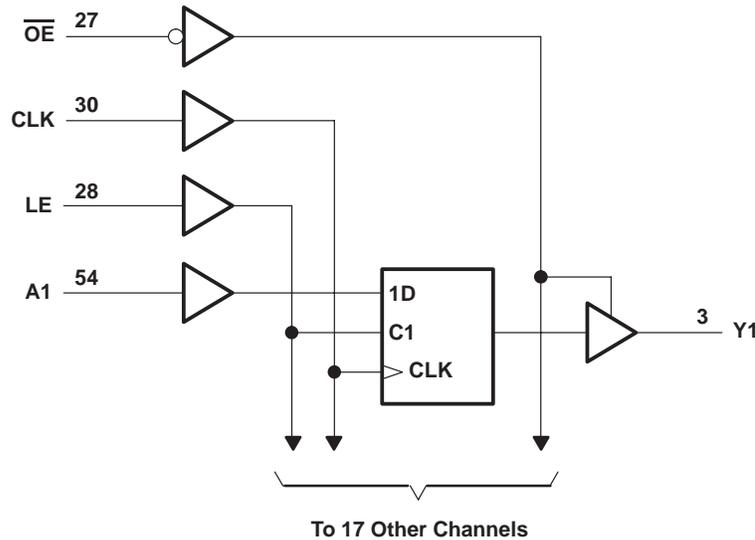
INPUTS				OUTPUT
\overline{OE}	LE	CLK	A	Y
H	X	X	X	Z
L	H	X	L	L
L	H	X	H	H
L	L	↑	L	L
L	L	↑	H	H
L	L	H	X	Y_0^\dagger
L	L	L	X	Y_0^\ddagger

† 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



logic diagram (positive logic)



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	128 mA
Current into any output in the high state, I_O (see Note 2)	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)	81°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.

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recommended operating conditions (see Note 4)

		MIN	MAX	UNIT
V _{CC}	Supply voltage	2.7	3.6	V
V _{IH}	High-level input voltage	2		V
V _{IL}	Low-level input voltage		0.8	V
V _I	Input voltage		5.5	V
I _{OH}	High-level output current		-32	mA
I _{OL}	Low-level output current		64	mA
Δt/Δv	Input transition rise or fall rate		10	ns/V
Δt/ΔV _{CC}	Power-up ramp rate	200		μs/V
T _A	Operating free-air temperature	-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.

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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 V, I _I = -18 mA			-1.2	V
V _{OH}		V _{CC} = 2.7 V to 3.6 V, I _{OH} = -100 μA	V _{CC} -0.2			V
		V _{CC} = 2.7 V, I _{OH} = -8 mA	2.4			
		V _{CC} = 3 V, I _{OH} = -32 mA	2			
V _{OL}		V _{CC} = 2.7 V	I _{OL} = 100 μA		0.2	V
			I _{OL} = 24 mA		0.5	
		V _{CC} = 3 V	I _{OL} = 16 mA		0.4	
			I _{OL} = 32 mA		0.5	
			I _{OL} = 64 mA		0.55	
I _I		Control inputs V _{CC} = 0 or 3.6 V, V _I = 5.5 V			10	μA
			A inputs V _{CC} = 3.6 V	V _I = V _{CC} or GND		
		V _I = V _{CC}		1		
		V _I = 0		-5		
I _{off}		V _{CC} = 0, V _I or V _O = 0 to 4.5 V			±100	μA
I _{I(hold)}		A inputs V _{CC} = 3 V	V _I = 0.8 V		75	μA
			V _I = 2 V		-75	
		V _{CC} = 3.6 V‡, V _I = 0 to 3.6 V				
I _{OZH}		V _{CC} = 3.6 V, V _O = 3 V			5	μA
I _{OZL}		V _{CC} = 3.6 V, V _O = 0.5 V			-5	μA
I _{OZPU}		V _{CC} = 0 to 1.5 V, V _O = 0.5 V to 3 V, \overline{OE} = don't care			±100	μA
I _{OZPD}		V _{CC} = 1.5 V to 0, V _O = 0.5 V to 3 V, \overline{OE} = don't care			±100	μA
I _{CC}		V _{CC} = 3.6 V, I _O = 0, V _I = V _{CC} or GND	Outputs high		0.19	mA
			Outputs low		5	
			Outputs disabled		0.19	
ΔI _{CC} §		V _{CC} = 3 V to 3.6 V, One input at V _{CC} - 0.6 V, Other inputs at V _{CC} or GND			0.2	mA
C _i		V _I = 3 V or 0			3.5	pF
C _o		V _O = 3 V or 0			9	pF

† All typical values are at V_{CC} = 3.3 V, T_A = 25°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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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	
f_{clock}	Clock frequency	150		150		MHz
t_w	Pulse duration	LE high		3.3	3.3	ns
		CLK high or low		3.3	3.3	
t_{su}	Setup time	Data before CLK \uparrow		2.1	2.4	ns
		Data before LE \downarrow	CLK high	2.3	1.5	
			CLK low	1.5	0.5	
t_h	Hold time	Data after CLK \uparrow		1	0	ns
		Data after LE \downarrow		0.8	0.8	

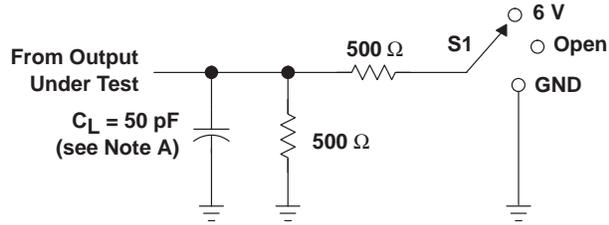
switching characteristics over recommended operating free-air temperature range, $C_L = 50\text{ pF}$ (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$			$V_{CC} = 2.7\text{ V}$		UNIT
			MIN	TYP \dagger	MAX	MIN	MAX	
f_{max}			150			150		MHz
t_{PLH}	A	Y	1.3	2.6	3.7	4		ns
t_{PHL}			1.3	2.4	3.7	4		
t_{PLH}	LE	Y	1.5	3.2	5.1	5.7		ns
t_{PHL}			1.5	3.3	5.1	5.7		
t_{PLH}	CLK	Y	1.5	3.5	5.1	5.7		ns
t_{PHL}			1.5	3.4	5.1	5.7		
t_{PZH}	$\overline{\text{OE}}$	Y	1.3	2.9	4.6	5.5		ns
t_{PZL}			1.3	3	4.6	5.5		
t_{PHZ}	$\overline{\text{OE}}$	Y	1.7	4.2	5.8	6.3		ns
t_{PLZ}			1.7	3.7	5.8	6.3		

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

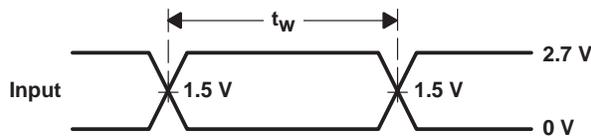


PARAMETER MEASUREMENT INFORMATION

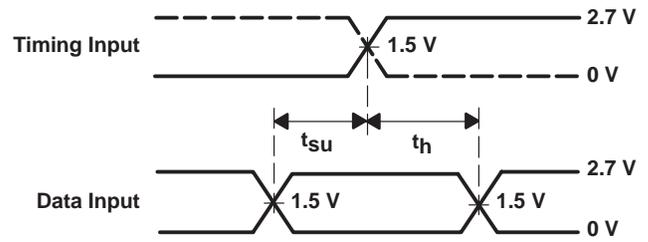


LOAD CIRCUIT

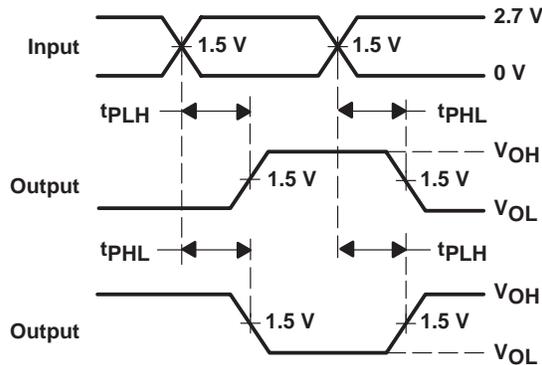
TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	6 V
t_{PHZ}/t_{PZH}	GND



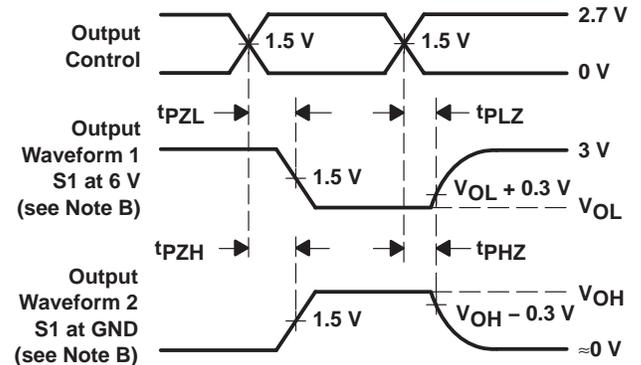
**VOLTAGE WAVEFORMS
PULSE DURATION**



**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⁾
CLVTH16835IDGGREP	ACTIVE	TSSOP	DGG	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
V62/04718-01XE	ACTIVE	TSSOP	DGG	56	2000	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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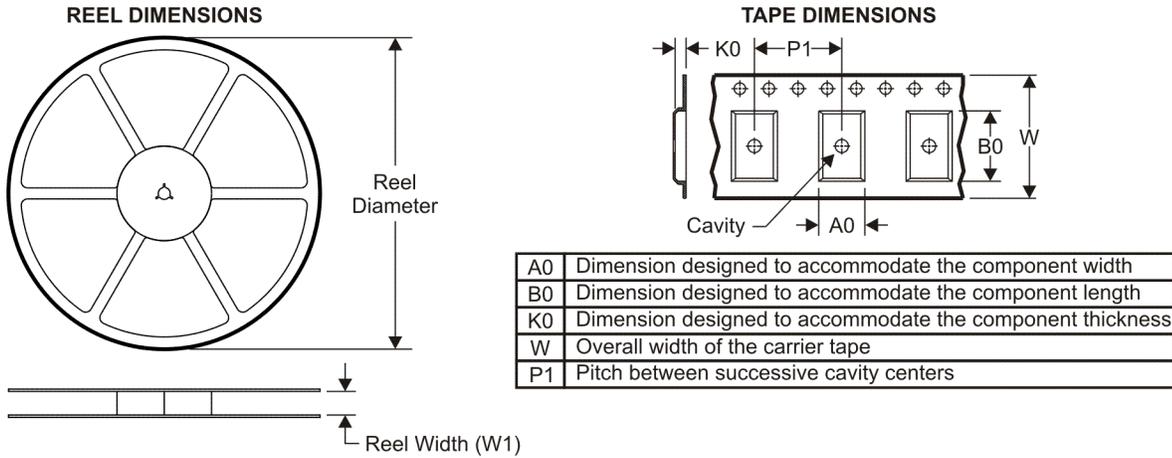
OTHER QUALIFIED VERSIONS OF SN74LVTH16835-EP :

- Catalog: [SN74LVTH16835](#)

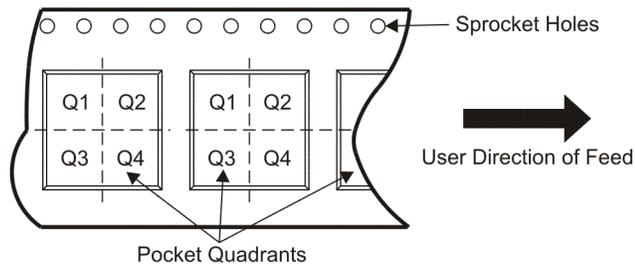
NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

TAPE AND REEL INFORMATION



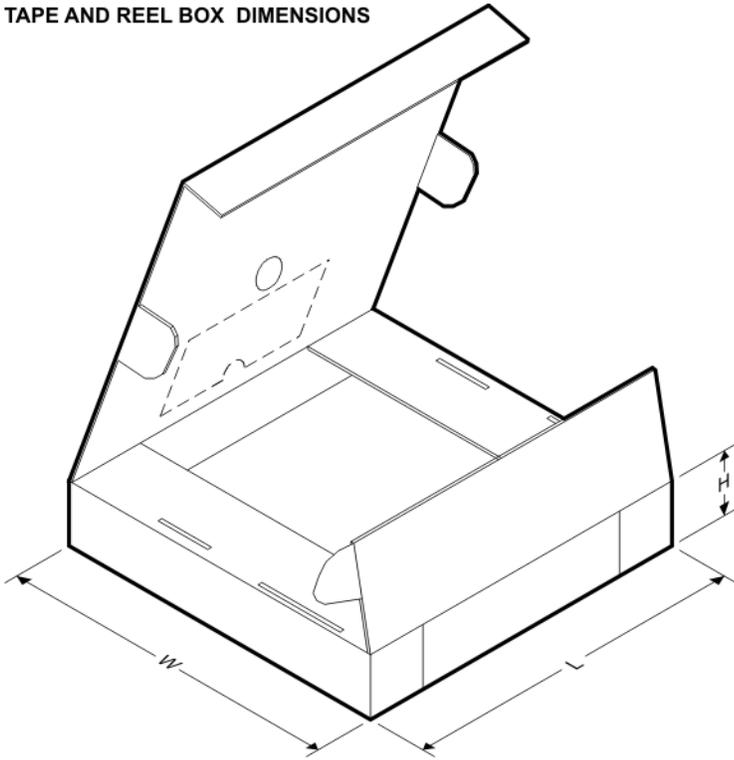
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
CLVTH16835IDGGREP	TSSOP	DGG	56	2000	330.0	24.4	8.6	15.6	1.8	12.0	24.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
CLVTH16835IDGGREP	TSSOP	DGG	56	2000	346.0	346.0	41.0

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