

## FEATURES

- Member of the Texas Instruments Widebus™ Family
- UBT™ Transceiver Combines D-Type Latches and D-Type Flip-Flops for Operation in Transparent, Latched, or Clocked Modes
- Operates From 1.65 V to 3.6 V
- Max  $t_{pd}$  of 4.4 ns at 3.3 V
- $\pm 12$ -mA Output Drive at 3.3 V
- Outputs Ports Have Equivalent 26- $\Omega$  Series Resistors, So No External Resistors Are Required
- Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors
- Latch-Up Performance Exceeds 250 mA Per JESD 17
- ESD Protection Exceeds JESD 22
  - 2000-V Human-Body Model (A114-A)
  - 200-V Machine Model (A115-A)

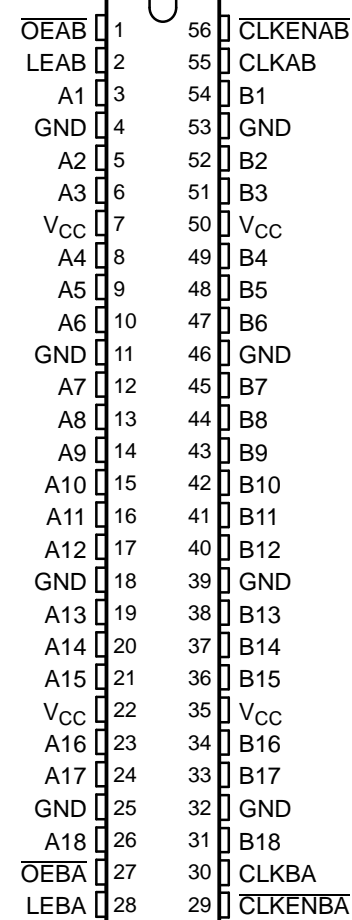
## DESCRIPTION/ORDERING INFORMATION

This 18-bit universal bus transceiver is designed for 1.65-V to 3.6-V  $V_{CC}$  operation.

The SN74ALVCHR16601 combines D-type latches and D-type flip-flops to allow data flow in transparent, latched, clocked, and clock-enabled modes.

Data flow in each direction is controlled by output-enable ( $\overline{OEAB}$  and  $\overline{OEBA}$ ), latch-enable (LEAB and LEBA), and clock (CLKAB and CLKBA) inputs. The clock can be controlled by the clock-enable ( $\overline{CLKENAB}$  and  $\overline{CLKENBA}$ ) inputs. For A-to-B data flow, the device operates in the transparent mode when LEAB is high. When LEAB is low, the A data is latched if CLKAB is held at a high or low logic level. If LEAB is low, the A data is stored in the latch/flip-flop on the low-to-high transition of CLKAB. When  $\overline{OEAB}$  is low, the outputs are active. When  $\overline{OEAB}$  is high, the outputs are in the high-impedance state.

DGG, DGV, OR DL PACKAGE  
(TOP VIEW)



## ORDERING INFORMATION

$T_A$	PACKAGE <sup>(1)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING
-40°C to 85°C	SSOP - DL	Tube	SN74ALVCHR16601DL	ALVCHR16601
		Tape and reel	SN74ALVCHR16601LR	
	TSSOP - DGG	Tape and reel	SN74ALVCHR16601GR	ALVCHR16601
	TVSOP - DGV	Tape and reel	SN74ALVCHR16601VR	VR601

(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).



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.

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**SN74ALVCHR16601**  
**18-BIT UNIVERSAL BUS TRANSCEIVER**  
**WITH 3-STATE OUTPUTS**

SCES123I–SEPTEMBER 1997–REVISED SEPTEMBER 2004

**DESCRIPTION/ORDERING INFORMATION (CONTINUED)**

Data flow for B to A is similar to that of A to B, but uses  $\overline{OEBA}$ , LEBA, CLKBA, and  $\overline{CLKENBA}$ .

The outputs include equivalent 26-Ω series resistors to reduce overshoot and undershoot.

To ensure the high-impedance state during power up or power down,  $\overline{OE}$  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.

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.

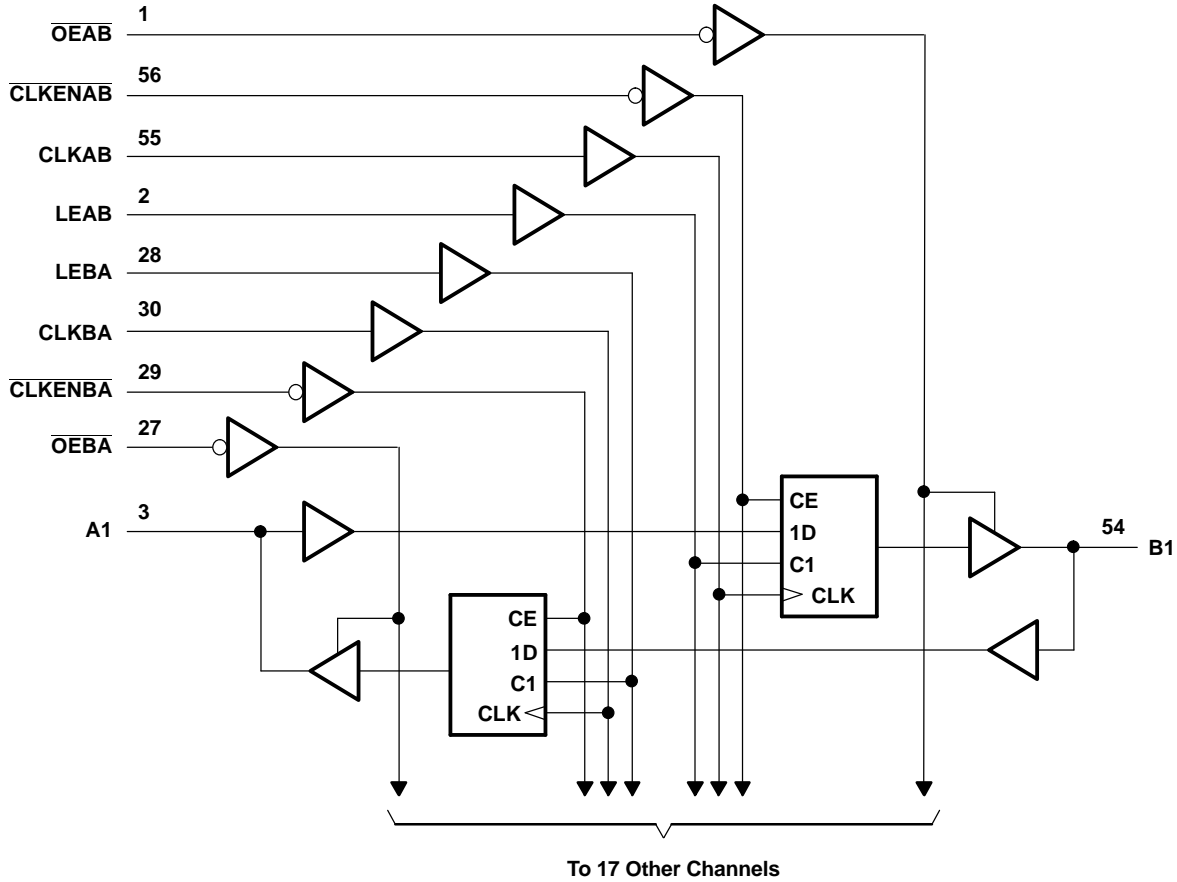
**FUNCTION TABLE<sup>(1)</sup>**

INPUTS					OUTPUT B
$\overline{CLKENAB}$	$\overline{OEAB}$	LEAB	CLKAB	A	
X	H	X	X	X	Z
X	L	H	X	L	L
X	L	H	X	H	H
H	L	L	X	X	$B_0^{(2)}$
L	L	L	↑	L	L
L	L	L	↑	H	H
L	L	L	L or H	X	$B_0^{(2)}$

(1) A-to-B data flow is shown; B-to-A flow is similar, but uses  $\overline{OEBA}$ , LEBA, CLKBA, and  $\overline{CLKENBA}$ .

(2) Output level before the indicated steady-state input conditions were established

**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	Except I/O ports <sup>(2)</sup>	-0.5	4.6
		I/O ports <sup>(2)(3)</sup>	-0.5	$V_{CC} + 0.5$
$V_O$	Output voltage range <sup>(2)(3)</sup>	-0.5	$V_{CC} + 0.5$	V
$I_{IK}$	Input clamp current	$V_I < 0$	-50	mA
$I_{OK}$	Output clamp current	$V_O < 0$	-50	mA
$I_O$	Continuous output current		$\pm 50$	mA
	Continuous current through each $V_{CC}$ or GND		$\pm 100$	mA
$\theta_{JA}$	Package thermal impedance <sup>(4)</sup>	DGG package	64	°C/W
		DGV package	48	
		DL package	56	
$T_{stg}$	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 negative-voltage and output voltage ratings may be exceeded if the input and output current ratings are observed.
- (3) This value is limited to 4.6 V maximum.
- (4) The package thermal impedance is calculated in accordance with JESD 51-7.

**SN74ALVCHR16601**  
**18-BIT UNIVERSAL BUS TRANSCEIVER**  
**WITH 3-STATE OUTPUTS**

SCES123I—SEPTEMBER 1997—REVISED SEPTEMBER 2004



**RECOMMENDED OPERATING CONDITIONS<sup>(1)</sup>**

		MIN	MAX	UNIT
V <sub>CC</sub>	Supply voltage	1.65	3.6	V
V <sub>IH</sub>	High-level input voltage	V <sub>CC</sub> = 1.65 V to 1.95 V	0.65 × V <sub>CC</sub>	V
		V <sub>CC</sub> = 2.3 V to 2.7 V	1.7	
		V <sub>CC</sub> = 2.7 V to 3.6 V	2	
V <sub>IL</sub>	Low-level input voltage	V <sub>CC</sub> = 1.65 V to 1.95 V	0.35 × V <sub>CC</sub>	V
		V <sub>CC</sub> = 2.3 V to 2.7 V	0.7	
		V <sub>CC</sub> = 2.7 V to 3.6 V	0.8	
V <sub>I</sub>	Input voltage	0	V <sub>CC</sub>	V
V <sub>O</sub>	Output voltage	0	V <sub>CC</sub>	V
I <sub>OH</sub>	High-level output current	V <sub>CC</sub> = 1.65 V	-2	mA
		V <sub>CC</sub> = 2.3 V	-6	
		V <sub>CC</sub> = 2.7 V	-8	
		V <sub>CC</sub> = 3 V	-12	
I <sub>OL</sub>	Low-level output current	V <sub>CC</sub> = 1.65 V	2	mA
		V <sub>CC</sub> = 2.3 V	6	
		V <sub>CC</sub> = 2.7 V	8	
		V <sub>CC</sub> = 3 V	12	
Δt/Δv	Input transition rise or fall rate		10	ns/V
T <sub>A</sub>	Operating free-air temperature	-40	85	°C

(1) 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.

**ELECTRICAL CHARACTERISTICS**

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

PARAMETER	TEST CONDITIONS	V <sub>CC</sub>	MIN	TYP <sup>(1)</sup>	MAX	UNIT
V <sub>OH</sub>	I <sub>OH</sub> = -100 μA	1.65 V to 3.6 V	V <sub>CC</sub> - 0.2			V
	I <sub>OH</sub> = -2 mA	1.65 V	1.2			
	I <sub>OH</sub> = -4 mA	2.3 V	1.9			
	I <sub>OH</sub> = -6 mA	2.3 V	1.7			
		3 V	2.4			
	I <sub>OH</sub> = -8 mA	2.7 V	2			
I <sub>OH</sub> = -12 mA	3 V	2				
V <sub>OL</sub>	I <sub>OL</sub> = 100 μA	1.65 V to 3.6 V	0.2			V
	I <sub>OL</sub> = 2 mA	1.65 V	0.45			
	I <sub>OL</sub> = 4 mA	2.3 V	0.4			
	I <sub>OL</sub> = 6 mA	2.3 V	0.55			
		3 V	0.55			
	I <sub>OL</sub> = 8 mA	2.7 V	0.6			
I <sub>OL</sub> = 12 mA	3 V	0.8				
I <sub>I</sub>	V <sub>I</sub> = V <sub>CC</sub> or GND	3.6 V	±5			μA
I <sub>I(hold)</sub>	V <sub>I</sub> = 0.58 V	1.65 V	25			μA
	V <sub>I</sub> = 1.07 V		-25			
	V <sub>I</sub> = 0.7 V	2.3 V	45			
	V <sub>I</sub> = 1.7 V		-45			
	V <sub>I</sub> = 0.8 V	3 V	75			
	V <sub>I</sub> = 2 V		-75			
V <sub>I</sub> = 0 to 3.6 V <sup>(2)</sup>	3.6 V	±500				
I <sub>OZ</sub> <sup>(3)</sup>	V <sub>O</sub> = V <sub>CC</sub> or GND	3.6 V	±10			μA
I <sub>CC</sub>	V <sub>I</sub> = V <sub>CC</sub> or GND, I <sub>O</sub> = 0	3.6 V	40			μA
ΔI <sub>CC</sub>	One input at V <sub>CC</sub> - 0.6 V, Other inputs at V <sub>CC</sub> or GND	3 V to 3.6 V	750			μA
C <sub>i</sub>	Control inputs	V <sub>I</sub> = V <sub>CC</sub> or GND	4			pF
C <sub>io</sub>	A or B ports	V <sub>O</sub> = V <sub>CC</sub> or GND	8			pF

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

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

 (3) For I/O ports, the parameter I<sub>OZ</sub> includes the input leakage current.

**SN74ALVCHR16601**  
**18-BIT UNIVERSAL BUS TRANSCEIVER**  
**WITH 3-STATE OUTPUTS**

SCES123I—SEPTEMBER 1997—REVISED SEPTEMBER 2004

**TIMING REQUIREMENTS**

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

		$V_{CC} = 1.8\text{ V}$		$V_{CC} = 2.5\text{ V} \pm 0.2\text{ V}$		$V_{CC} = 2.7\text{ V}$		$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$		UNIT
		MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
$f_{\text{clock}}$	Clock frequency	(1)		150		150		150		MHz
$t_w$	Pulse duration	LE high		(1)		3.3		3.3		ns
		CLK high or low		(1)		3.3		3.3		
$t_{su}$	Setup time	Data before CLK $\uparrow$		(1)		2.3		2.4		ns
		Data before LE $\downarrow$	CLK high	(1)		2		1.6		
			CLK low	(1)		1.3		1.2		
		CLKEN before CLK $\uparrow$		(1)		2		2		
$t_h$	Hold time	Data after CLK $\uparrow$		(1)		0.7		0.7		ns
		Data after LE $\downarrow$	CLK high	(1)		1.3		1.6		
			CLK low	(1)		1.7		2		
		CLKEN after CLK $\uparrow$		(1)		0.3		0.5		

(1) This information was not available at the time of publication.

**SWITCHING CHARACTERISTICS**

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CC} = 1.8\text{ V}$		$V_{CC} = 2.5\text{ V} \pm 0.2\text{ V}$		$V_{CC} = 2.7\text{ V}$		$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$		UNIT
			MIN	TYP	MIN	MAX	MIN	MAX	MIN	MAX	
$f_{\text{max}}$			(1)		150		150		150		MHz
$t_{pd}$	A or B	B or A	(1)		1	4.8	5.1		1	4.4	ns
	LEAB or LEBA		(1)		1	5.5	5.8		1	5.1	
	CLKAB or CLKBA		(1)		1.2	5.9	6.3		1.4	5.4	
$t_{en}$	$\overline{OEAB}$ or $\overline{OEBA}$	B or A	(1)		1.1	6.3	6.6		1.1	5.6	ns
$t_{dis}$	$\overline{OEAB}$ or $\overline{OEBA}$	B or A	(1)		1	4.2	5.1		1.6	4.7	ns

(1) This information was not available at the time of publication.

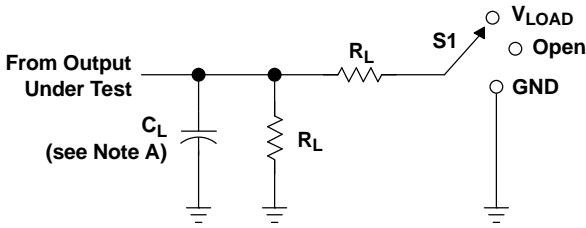
**OPERATING CHARACTERISTICS**

$T_A = 25^\circ\text{C}$

PARAMETER		TEST CONDITIONS	$V_{CC} = 1.8\text{ V}$	$V_{CC} = 2.5\text{ V}$	$V_{CC} = 3.3\text{ V}$	UNIT
			TYP	TYP	TYP	
$C_{pd}$	Power dissipation capacitance	Outputs enabled	(1)	56	63	pF
		Outputs disabled	(1)	12	13	

(1) This information was not available at the time of publication.

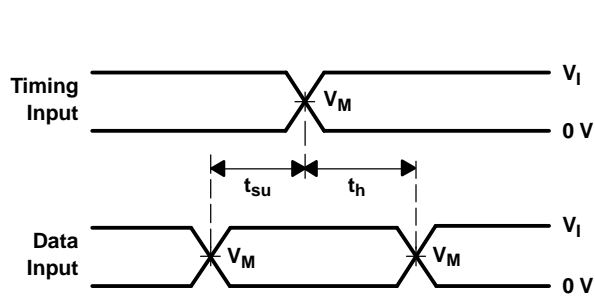
PARAMETER MEASUREMENT INFORMATION



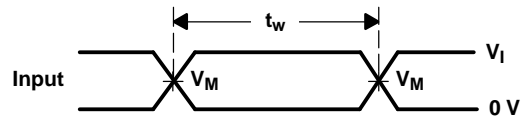
LOAD CIRCUIT

TEST	S1
$t_{pd}$ $t_{PLZ}/t_{PZL}$ $t_{PHZ}/t_{PZH}$	Open $V_{LOAD}$ GND

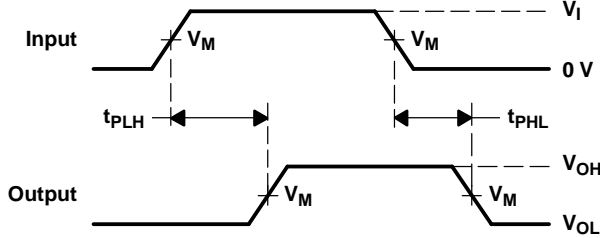
$V_{CC}$	INPUT		$V_M$	$V_{LOAD}$	$C_L$	$R_L$	$V_{\Delta}$
	$V_I$	$t_r/t_f$					
1.8 V	$V_{CC}$	$\leq 2$ ns	$V_{CC}/2$	$2 \times V_{CC}$	30 pF	1 k $\Omega$	0.15 V
$2.5 V \pm 0.2 V$	$V_{CC}$	$\leq 2$ ns	$V_{CC}/2$	$2 \times V_{CC}$	30 pF	500 $\Omega$	0.15 V
2.7 V	2.7 V	$\leq 2.5$ ns	1.5 V	6 V	50 pF	500 $\Omega$	0.3 V
$3 V \pm 0.3 V$	2.7 V	$\leq 2.5$ ns	1.5 V	6 V	50 pF	500 $\Omega$	0.3 V



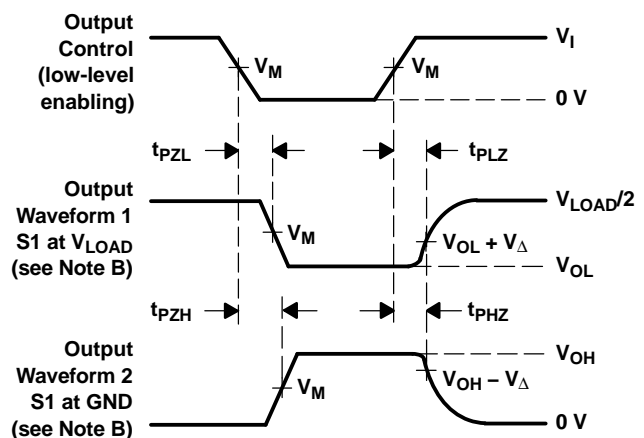
VOLTAGE WAVEFORMS  
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS  
PULSE DURATION



VOLTAGE WAVEFORMS  
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS  
ENABLE AND DISABLE TIMES

- NOTES:
- $C_L$  includes probe and jig capacitance.
  - 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.
  - All input pulses are supplied by generators having the following characteristics:  $PRR \leq 10$  MHz,  $Z_O = 50 \Omega$ .
  - The outputs are measured one at a time, with one transition per measurement.
  - $t_{PLZ}$  and  $t_{PHZ}$  are the same as  $t_{dis}$ .
  - $t_{PZL}$  and  $t_{PZH}$  are the same as  $t_{en}$ .
  - $t_{PLH}$  and  $t_{PHL}$  are the same as  $t_{pd}$ .
  - All parameters and waveforms are not applicable to all devices.

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>
74ALVCHR16601DLG4	ACTIVE	SSOP	DL	56	20	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
74ALVCHR16601GRE4	ACTIVE	TSSOP	DGG	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
74ALVCHR16601GRG4	ACTIVE	TSSOP	DGG	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
74ALVCHR16601LRG4	ACTIVE	SSOP	DL	56	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
74ALVCHR16601VRE4	ACTIVE	TVSOP	DGV	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
74ALVCHR16601VRG4	ACTIVE	TVSOP	DGV	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74ALVCHR16601DL	ACTIVE	SSOP	DL	56	20	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74ALVCHR16601GR	ACTIVE	TSSOP	DGG	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74ALVCHR16601LR	ACTIVE	SSOP	DL	56	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74ALVCHR16601VR	ACTIVE	TVSOP	DGV	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

<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)

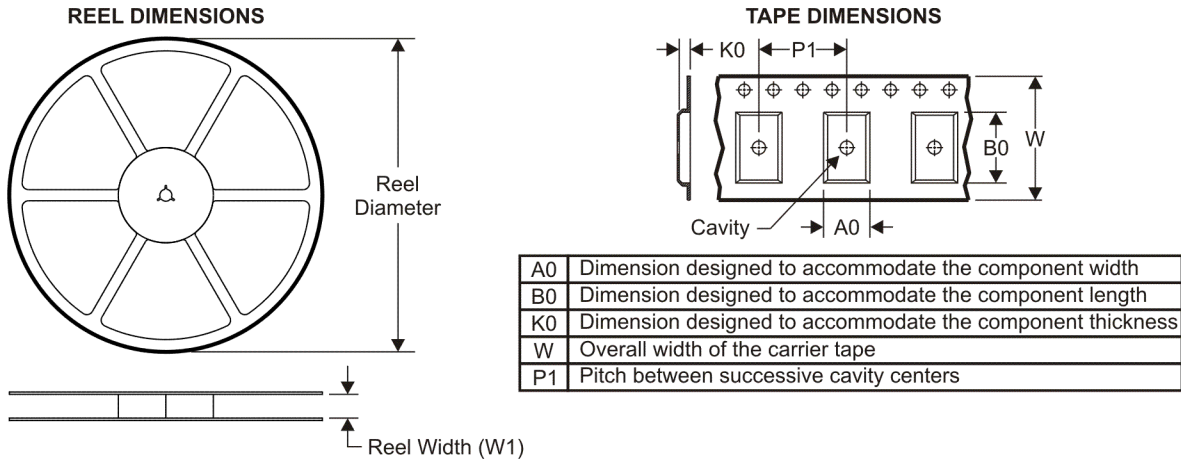
<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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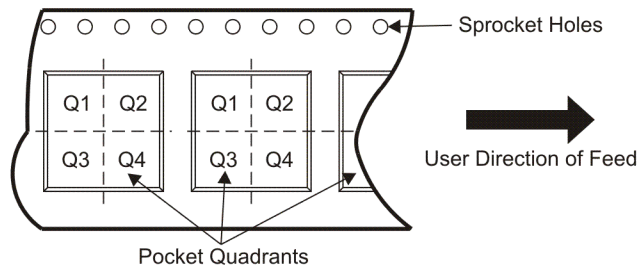
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**TAPE AND REEL INFORMATION**



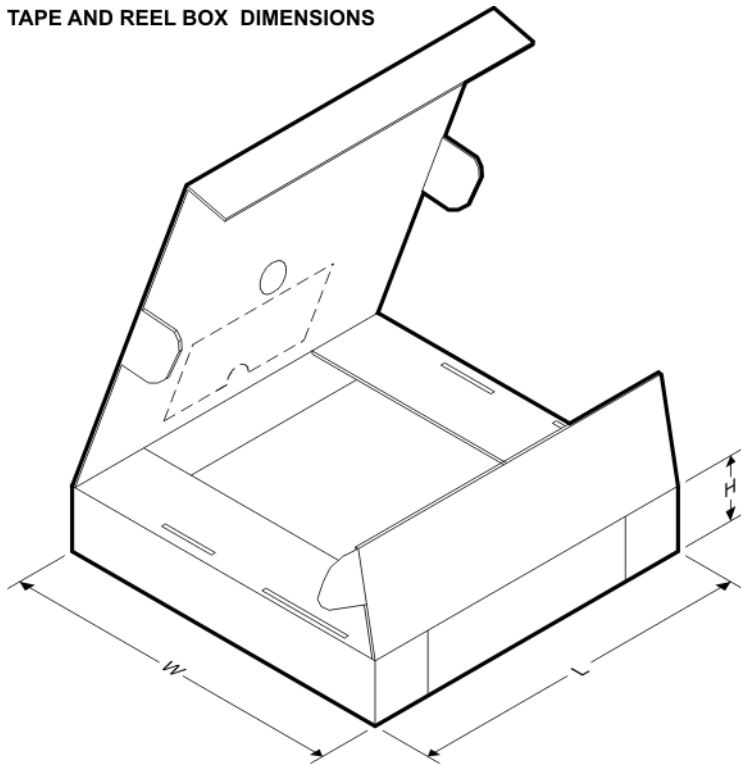
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**



\*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
SN74ALVCHR16601GR	TSSOP	DGG	56	2000	330.0	24.4	8.6	15.6	1.8	12.0	24.0	Q1
SN74ALVCHR16601LR	SSOP	DL	56	1000	330.0	32.4	11.35	18.67	3.1	16.0	32.0	Q1
SN74ALVCHR16601VR	TVSOP	DGV	56	2000	330.0	24.4	6.8	11.7	1.6	12.0	24.0	Q1

**TAPE AND REEL BOX DIMENSIONS**



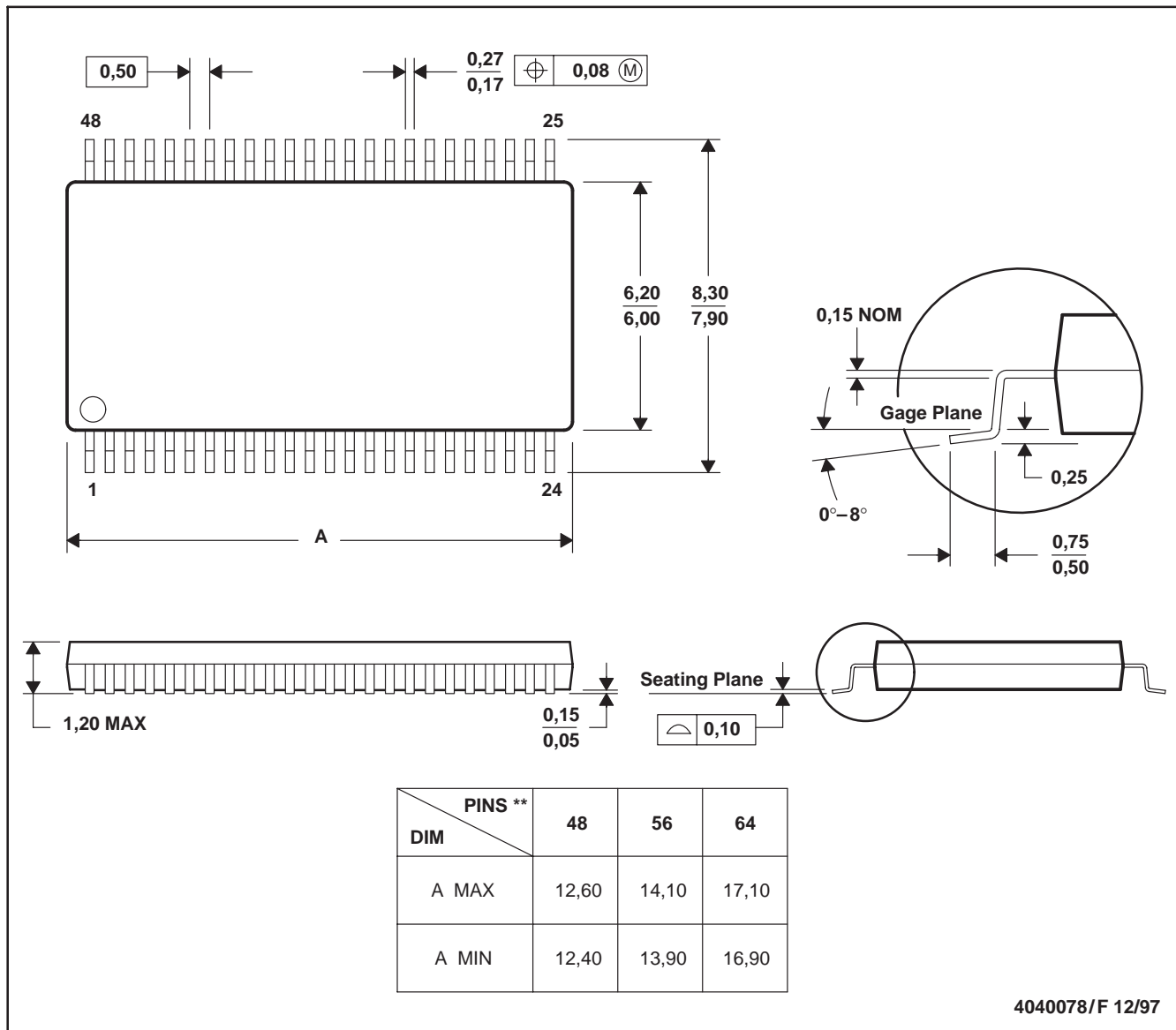
\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74ALVCHR16601GR	TSSOP	DGG	56	2000	346.0	346.0	41.0
SN74ALVCHR16601LR	SSOP	DL	56	1000	346.0	346.0	49.0
SN74ALVCHR16601VR	TVSOP	DGV	56	2000	346.0	346.0	41.0

DGG (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

48 PINS SHOWN

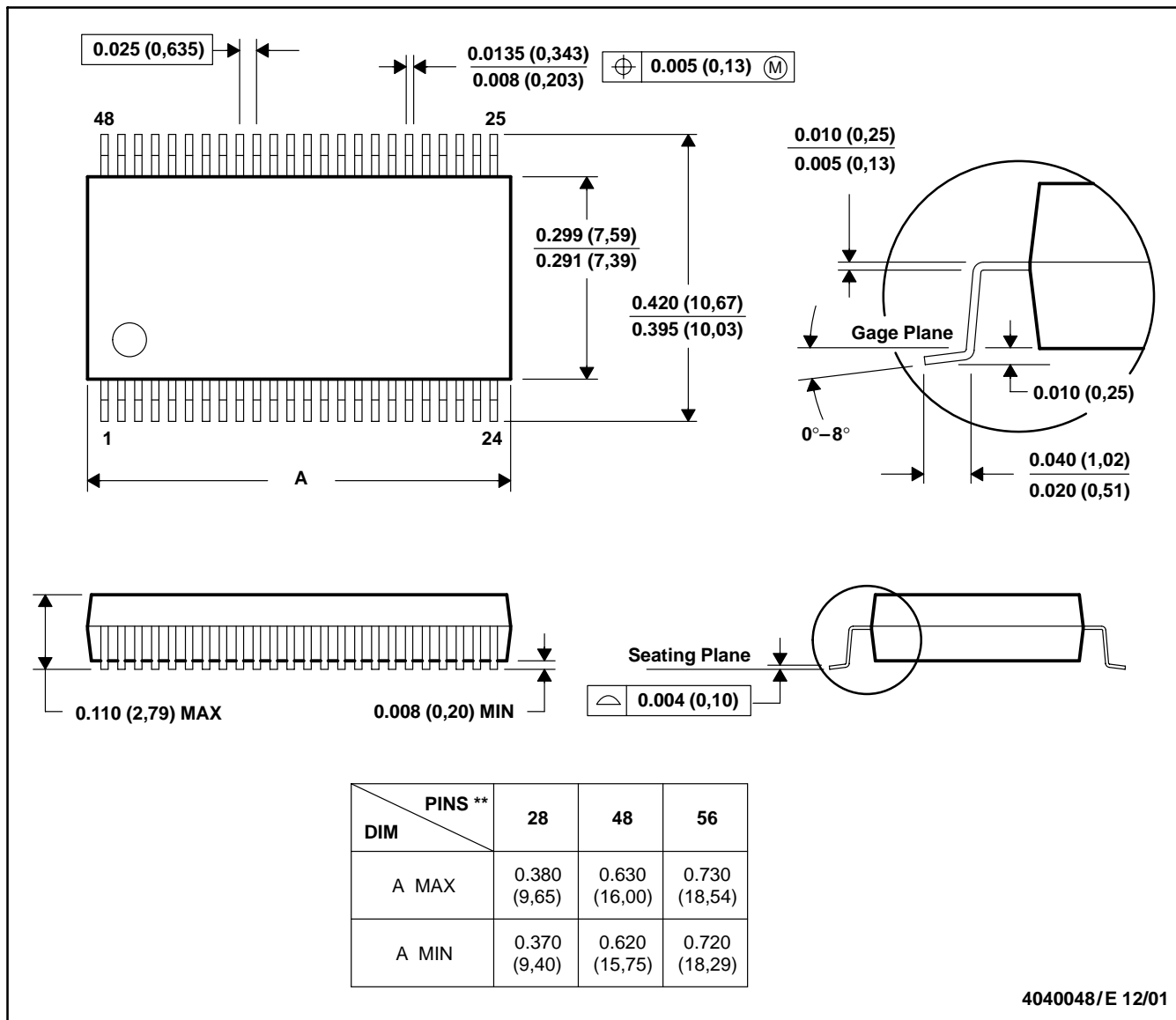


- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-153

DL (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

48 PINS SHOWN

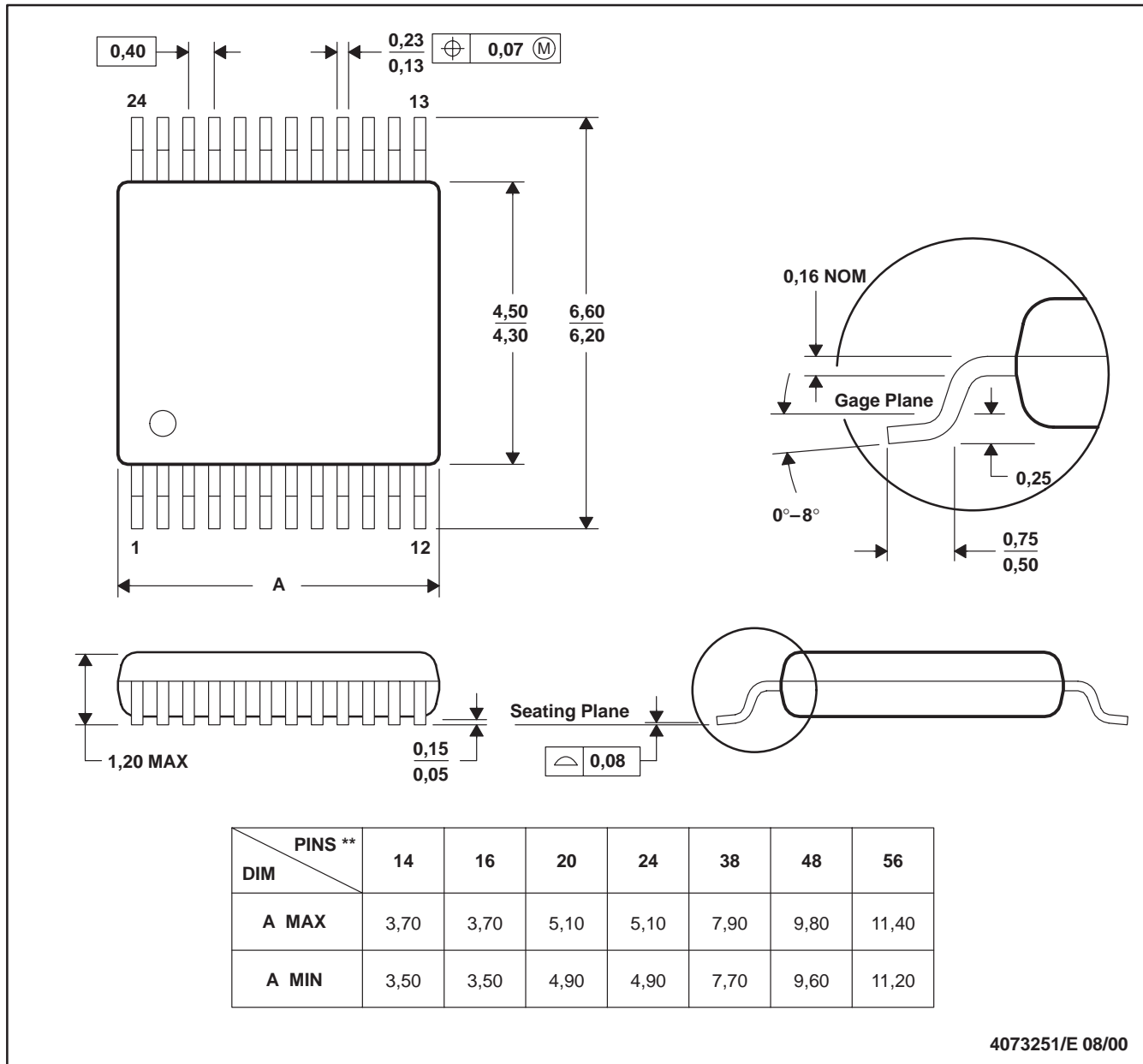


- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).  
 D. Falls within JEDEC MO-118

DGV (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE

24 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 flash or protrusion, not to exceed 0,15 per side.  
 D. Falls within JEDEC: 24/48 Pins – MO-153  
 14/16/20/56 Pins – MO-194

## IMPORTANT NOTICE

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