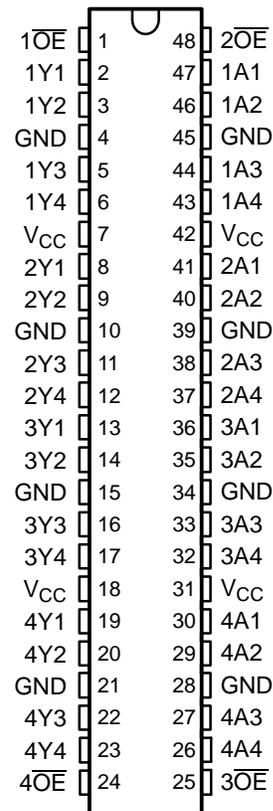


FEATURES

- **Controlled Baseline**
 - One Assembly/Test Site, One Fabrication Site
- **Enhanced Diminishing Manufacturing Sources (DMS) Support**
- **Enhanced Product-Change Notification**
- **Qualification Pedigree ⁽¹⁾**
- **Member of the Texas Instruments Widebus™ Family**
- **Operates From 1.65 V to 3.6 V**
- **Inputs Accept Voltages to 5.5 V**
- **Max t_{pd} of 4.1 ns at 3.3 V**
- **Typical V_{OLP} (Output Ground Bounce) <0.8 V at $V_{CC} = 3.3 V$, $T_A = 25^\circ C$**
- **Typical V_{OHV} (Output V_{OH} Undershoot) >2 V at $V_{CC} = 3.3 V$, $T_A = 25^\circ C$**
- **I_{off} Supports Partial-Power-Down Mode Operation**
- **Supports Mixed-Mode Signal Operation On All Ports (5-V Input/Output Voltage With 3.3-V V_{CC})**
- **Latch-Up Performance Exceeds 250 mA Per JESD 17**
- **ESD Protection Exceeds JESD 22**
 - 2000-V Human-Body Model (A114-A)
 - 1000-V Charged-Device Model (C101)

(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 PACKAGE
(TOP VIEW)



DESCRIPTION/ORDERING INFORMATION

This 16-bit buffer/driver is designed for 1.65-V to 3.6-V V_{CC} operation.

The SN74LVC16244A is designed specifically to improve the performance and density of 3-state memory address drivers, clock drivers, and bus-oriented receivers and transmitters.

ORDERING INFORMATION

T_A	PACKAGE ⁽¹⁾	ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	TSSOP – DGG Tape and reel	CLVC16244AIDGGREP	C16244AEP

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



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SN74LVC16244A-EP
16-BIT BUFFER/DRIVER
WITH 3-STATE OUTPUTS

SCAS740A–DECEMBER 2003–REVISED JUNE 2005

DESCRIPTION/ORDERING INFORMATION (CONTINUED)

The device can be used as four 4-bit buffers, two 8-bit buffers, or one 16-bit buffer. It provides true outputs and symmetrical active-low output-enable (\overline{OE}) inputs.

Inputs can be driven from either 3.3-V or 5-V devices. This feature allows the use of this device as a translator in a mixed 3.3-V/5-V system environment.

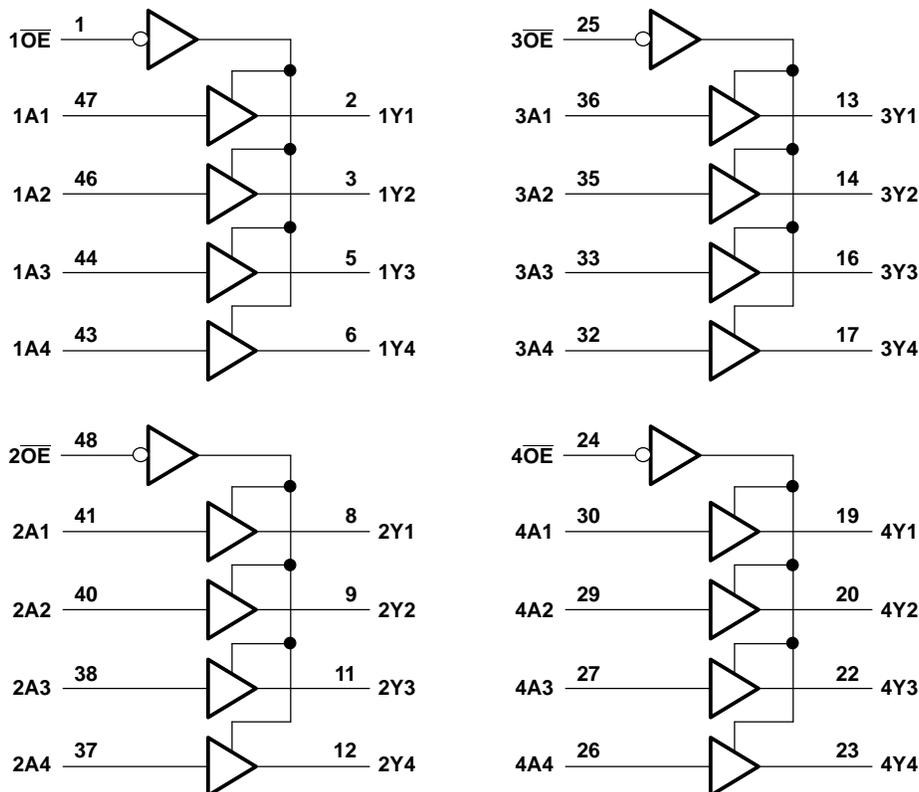
This device is fully specified for partial-power-down applications using I_{off} . The I_{off} circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down.

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.

FUNCTION TABLE
(EACH 4-BIT BUFFER)

INPUTS		OUTPUT
\overline{OE}	A	Y
L	H	H
L	L	L
H	X	Z

LOGIC DIAGRAM (POSITIVE LOGIC)



Absolute Maximum Ratings⁽¹⁾

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

		MIN	MAX	UNIT
V_{CC}	Supply voltage range	-0.5	6.5	V
V_I	Input voltage range ⁽²⁾	-0.5	6.5	V
V_O	Voltage range applied to any output in the high-impedance or power-off state ⁽²⁾	-0.5	6.5	V
V_O	Voltage range applied to any output in the high or low state ⁽²⁾⁽³⁾	-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		±50	mA
	Continuous current through each V_{CC} or GND		±100	mA
θ_{JA}	Package thermal impedance ⁽⁴⁾		70	°C/W
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 current ratings are observed.
- (3) The value of V_{CC} is provided in the recommended operating conditions table.
- (4) The package thermal impedance is calculated in accordance with JESD 51-7.

Recommended Operating Conditions⁽¹⁾

		MIN	MAX	UNIT	
V_{CC}	Supply voltage	Operating	1.65	3.6	V
		Data retention only	1.5		
V_{IH}	High-level input voltage	$V_{CC} = 1.65\text{ V to }1.95\text{ V}$	$0.65 \times V_{CC}$	V	
		$V_{CC} = 2.3\text{ V to }2.7\text{ V}$	1.7		
		$V_{CC} = 2.7\text{ V to }3.6\text{ V}$	2		
V_{IL}	Low-level input voltage	$V_{CC} = 1.65\text{ V to }1.95\text{ V}$	$0.35 \times V_{CC}$	V	
		$V_{CC} = 2.3\text{ V to }2.7\text{ V}$	0.7		
		$V_{CC} = 2.7\text{ V to }3.6\text{ V}$	0.8		
V_I	Input voltage	0	5.5	V	
V_O	Output voltage	High or low state	0	V_{CC}	V
		3-state	0	5.5	
I_{OH}	High-level output current	$V_{CC} = 1.65\text{ V}$	-4	mA	
		$V_{CC} = 2.3\text{ V}$	-8		
		$V_{CC} = 2.7\text{ V}$	-12		
		$V_{CC} = 3\text{ V}$	-24		
I_{OL}	Low-level output current	$V_{CC} = 1.65\text{ V}$	4	mA	
		$V_{CC} = 2.3\text{ V}$	8		
		$V_{CC} = 2.7\text{ V}$	12		
		$V_{CC} = 3\text{ V}$	24		
$\Delta t/\Delta v$	Input transition rise or fall rate		10	ns/V	
T_A	Operating free-air temperature	-40	85	°C	

- (1) All unused 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.

SN74LVC16244A-EP

16-BIT BUFFER/DRIVER

WITH 3-STATE OUTPUTS

SCAS740A–DECEMBER 2003–REVISED JUNE 2005

Electrical Characteristics

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

PARAMETER	TEST CONDITIONS	V _{CC}	MIN	TYP ⁽¹⁾	MAX	UNIT	
V _{OH}	I _{OH} = -100 μA	1.65 V to 3.6 V	V _{CC} - 0.2			V	
	I _{OH} = -4 mA	1.65 V	1.2				
	I _{OH} = -8 mA	2.3 V	1.7				
	I _{OH} = -12 mA	2.7 V	2.2				
		3 V	2.4				
I _{OH} = -24 mA	3 V	2.2					
V _{OL}	I _{OL} = 100 μA	1.65 V to 3.6 V	0.2			V	
	I _{OL} = 4 mA	1.65 V	0.45				
	I _{OL} = 8 mA	2.3 V	0.7				
	I _{OL} = 12 mA	2.7 V	0.4				
	I _{OL} = 24 mA	3 V	0.55				
I _I	V _I = 0 to 5.5 V	3.6 V	±5			μA	
I _{off}	V _I or V _O = 5.5 V	0	±10			μA	
I _{OZ}	V _O = 0 to 5.5 V	3.6 V	±10			μA	
I _{CC}	V _I = V _{CC} or GND	3.6 V	I _O = 0			20	μA
	3.6 V ≤ V _I ≤ 5.5 V ⁽²⁾					20	
ΔI _{CC}	One input at V _{CC} - 0.6 V, Other inputs at V _{CC} or GND	2.7 V to 3.6 V	500			μA	
C _i	V _I = V _{CC} or GND	3.3 V	5.5			pF	
C _o	V _O = V _{CC} or GND	3.3 V	6			pF	

(1) All typical values are at V_{CC} = 3.3 V, T_A = 25°C.

(2) This applies in the disabled state only.

Switching Characteristics

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

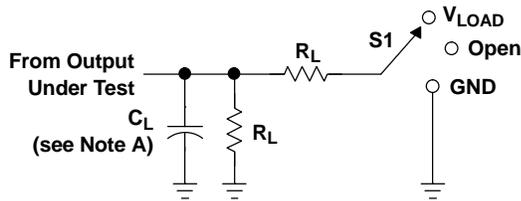
PARAMETER	FROM (INPUT)	TO (OUTPUT)	V _{CC} = 1.8 V ± 0.15 V		V _{CC} = 2.5 V ± 0.2 V		V _{CC} = 2.7 V		V _{CC} = 3.3 V ± 0.3 V		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
t _{pd}	A	Y	1.5	6.6	1	3.9	1	4.7	1.1	4.1	ns
t _{en}	\overline{OE}	Y	1.5	7.5	1	4.7	1	5.8	1	4.6	ns
t _{dis}	\overline{OE}	Y	1.5	10.3	1	5.3	1	6.2	1.8	5.8	ns
t _{sk(o)}									1		ns

Operating Characteristics

T_A = 25°C

PARAMETER	TEST CONDITIONS	V _{CC} = 1.8 V	V _{CC} = 2.5 V	V _{CC} = 3.3 V	UNIT	
		TYP	TYP	TYP		
C _{pd} Power dissipation capacitance per buffer/driver	Outputs enabled	f = 10 MHz	33	35	39	pF
	Outputs disabled		2	3	4	

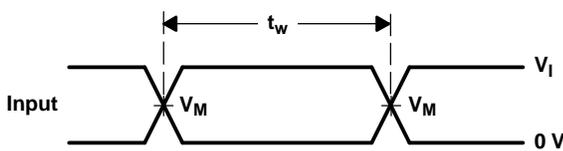
PARAMETER MEASUREMENT INFORMATION



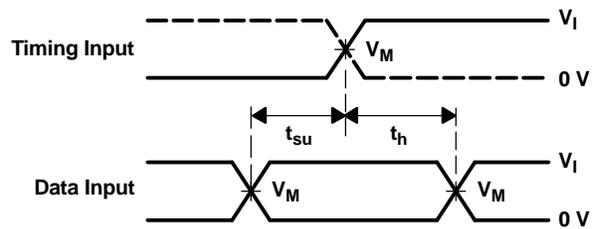
LOAD CIRCUIT

TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	V_{LOAD}
t_{PHZ}/t_{PZH}	GND

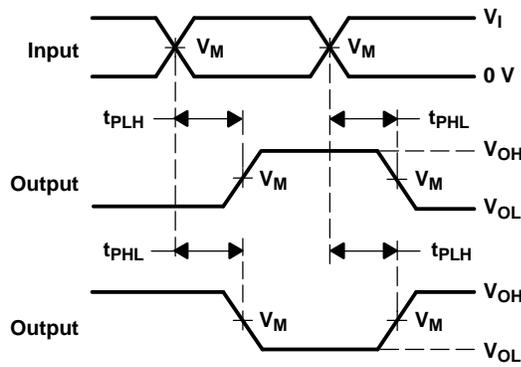
V_{CC}	INPUTS		V_M	V_{LOAD}	C_L	R_L	V_{Δ}
	V_I	t_r/t_f					
$1.8\text{ V} \pm 0.15\text{ V}$	V_{CC}	$\leq 2\text{ ns}$	$V_{CC}/2$	$2 \times V_{CC}$	30 pF	1 k Ω	0.15 V
$2.5\text{ V} \pm 0.2\text{ V}$	V_{CC}	$\leq 2\text{ ns}$	$V_{CC}/2$	$2 \times V_{CC}$	30 pF	500 Ω	0.15 V
2.7 V	2.7 V	$\leq 2.5\text{ ns}$	1.5 V	6 V	50 pF	500 Ω	0.3 V
$3.3\text{ V} \pm 0.3\text{ V}$	2.7 V	$\leq 2.5\text{ ns}$	1.5 V	6 V	50 pF	500 Ω	0.3 V



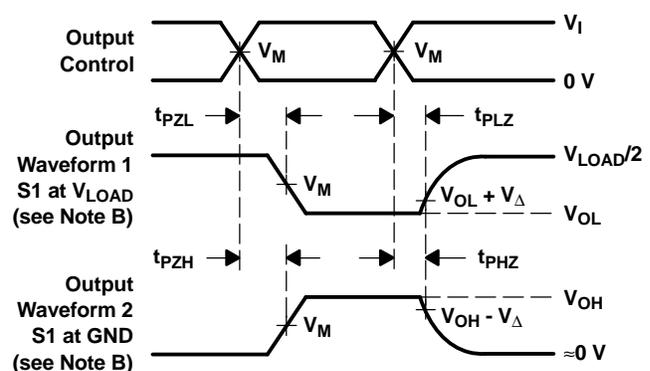
VOLTAGE WAVEFORMS
PULSE DURATION



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: $PRR \leq 10\text{ MHz}$, $Z_O = 50\ \Omega$.
 - D. The outputs are measured one at a time, with one transition per measurement.
 - E. t_{PLZ} and t_{PHZ} are the same as t_{dis} .
 - F. t_{PZL} and t_{PZH} are the same as t_{en} .
 - G. t_{PLH} and t_{PHL} are the same as t_{pd} .
 - H. All parameters and waveforms are not applicable to all devices.

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⁾
CLVC16244AIDGGREP	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
V62/04724-01XE	ACTIVE	TSSOP	DGG	48	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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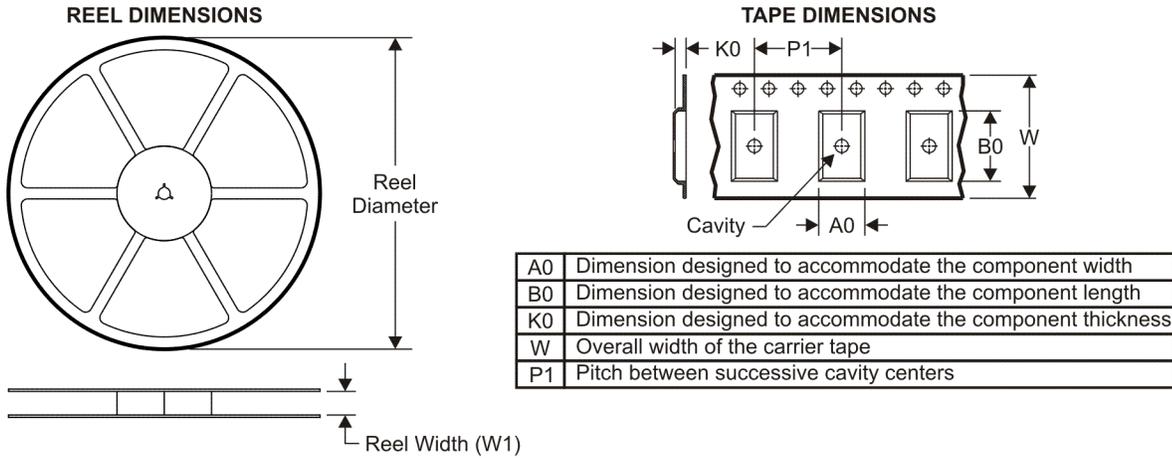
OTHER QUALIFIED VERSIONS OF SN74LVC16244A-EP :

- Catalog: [SN74LVC16244A](#)
- Automotive: [SN74LVC16244A-Q1](#)

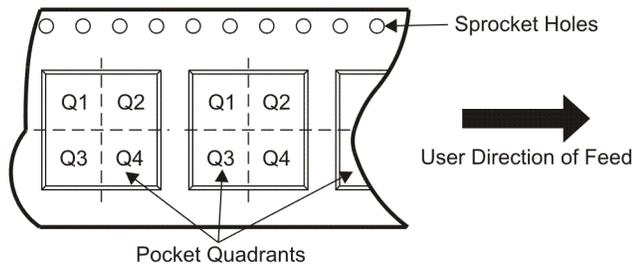
NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

TAPE AND REEL INFORMATION



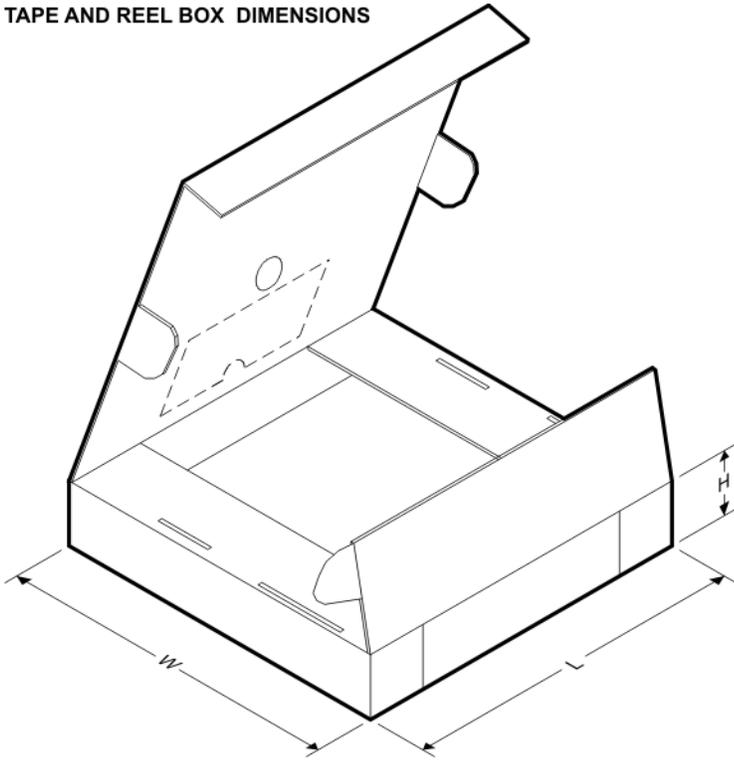
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
CLVC16244AIDGGREP	TSSOP	DGG	48	2000	330.0	24.4	8.6	15.8	1.8	12.0	24.0	Q1

TAPE AND REEL BOX DIMENSIONS



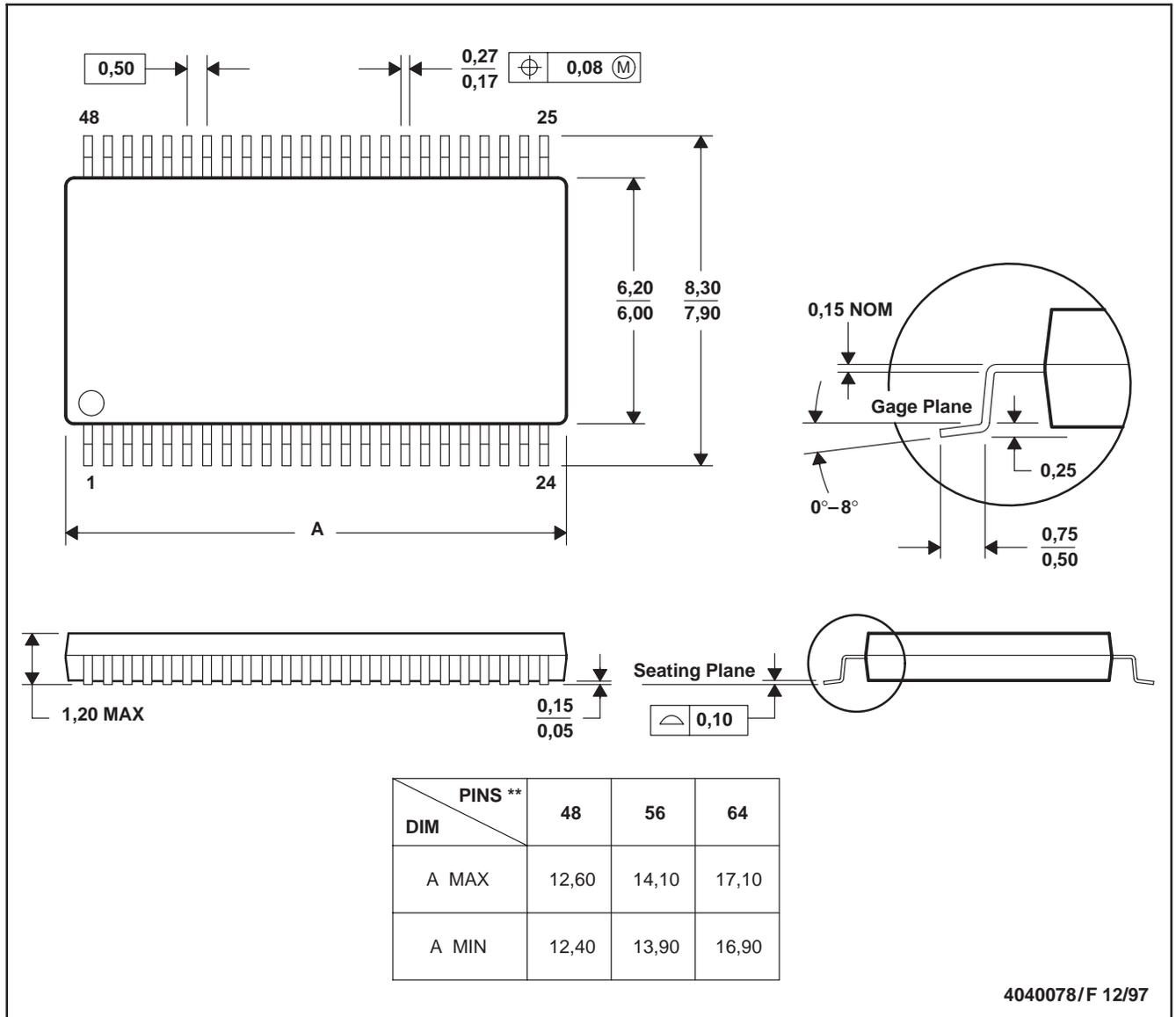
*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
CLVC16244AIDGGREP	TSSOP	DGG	48	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

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