3.3-V ABT 16-Bit Buffers/Drivers With 3-State Outputs

Check for Samples: SN54LVTH16244A, SN74LVTH16244A

FEATURES

- **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°C**
- **I_{off} and Power-Up 3-State Support Hot Insertion**
- **Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors**
- **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)**

DESCRIPTION

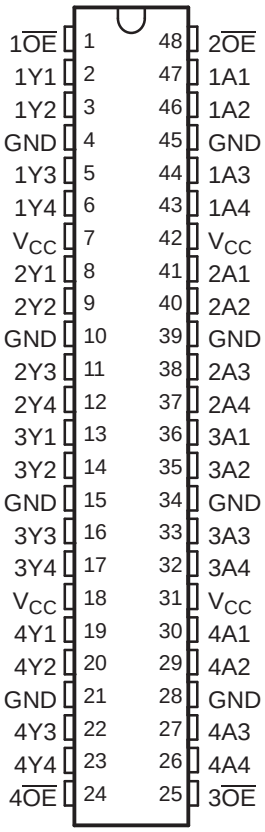
The 'LVTH16244A devices are 16-bit buffers and line drivers designed for low-voltage (3.3-V) V_{CC} operation, but with the capability to provide a TTL interface to a 5-V system environment. These devices can be used as four 4-bit buffers, two 8-bit buffers, or one 16-bit buffer. These devices provide true outputs and symmetrical active-low output-enable ($\overline{OE}$) inputs.

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.

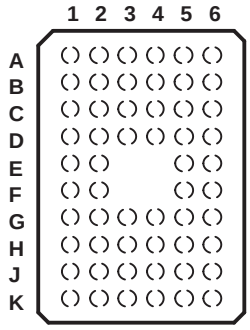
When V_{CC} is between 0 and 1.5 V, the devices are in the high-impedance state during power up or power down. However, to ensure the high-impedance state above 1.5 V, $\overline{OE}$ should be tied to V_{CC} through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

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.

SN54LVTH16244A . . . WD PACKAGE
SN74LVTH16244A . . . DGG, DGV, OR DL PACKAGE
(TOP VIEW)



GQL OR ZQL PACKAGE
(TOP VIEW)

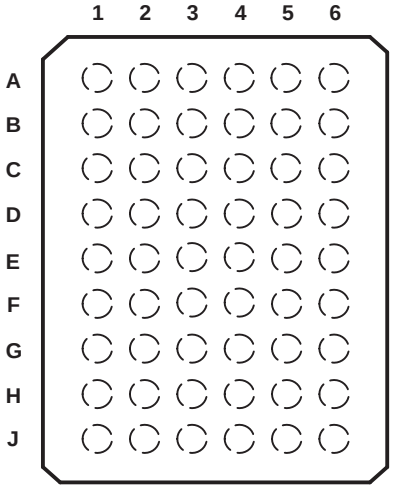


TERMINAL ASSIGNMENTS(1)
(56-Ball GQL/ZQL Package)

	1	2	3	4	5	6
A	$1\overline{OE}$	NC	NC	NC	NC	$2\overline{OE}$
B	1Y2	1Y1	GND	GND	1A1	1A2
C	1Y4	1Y3	V_{CC}	V_{CC}	1A3	1A4
D	2Y2	2Y1	GND	GND	2A1	2A2
E	2Y4	2Y3			2A3	2A4
F	3Y1	3Y2			3A2	3A1
G	3Y3	3Y4	GND	GND	3A4	3A3
H	4Y1	4Y2	V_{CC}	V_{CC}	4A2	4A1
J	4Y3	4Y4	GND	GND	4A4	4A3
K	$4\overline{OE}$	NC	NC	NC	NC	$3\overline{OE}$

(1) NC – No internal connection

GRD OR ZRD PACKAGE
(TOP VIEW)



TERMINAL ASSIGNMENTS(1)
(54-Ball GRD/ZRD Package)

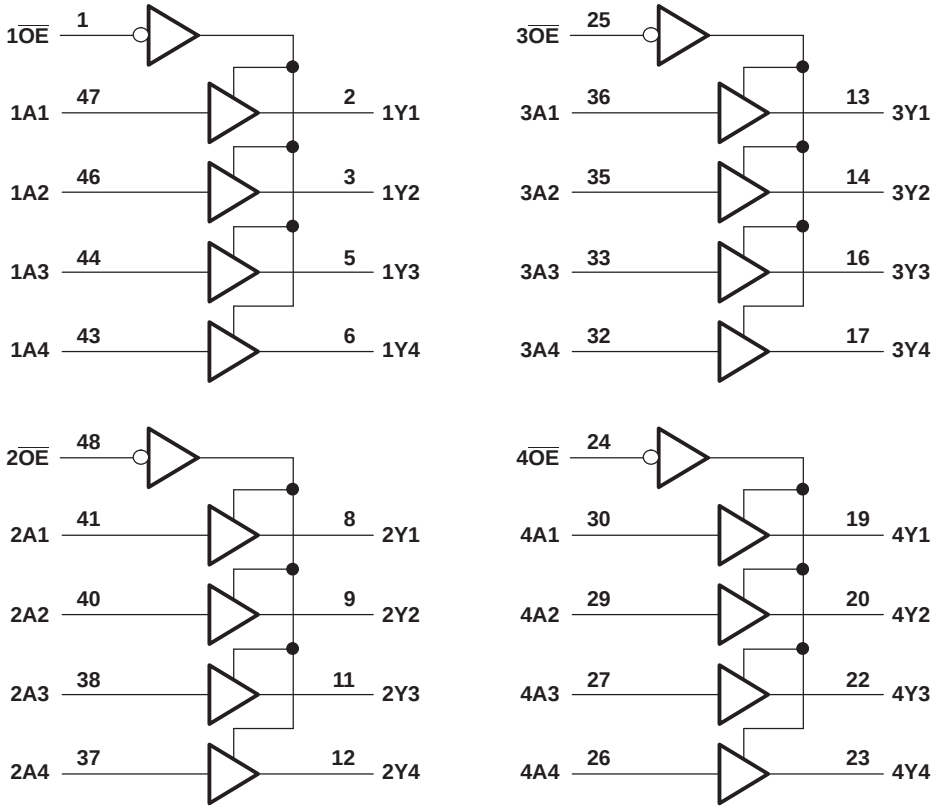
	1	2	3	4	5	6
A	1Y1	NC	$1\overline{OE}$	$2\overline{OE}$	NC	1A1
B	1Y3	1Y2	NC	NC	1A2	1A3
C	2Y1	1Y4	V_{CC}	V_{CC}	1A4	2A1
D	2Y3	2Y2	GND	GND	2A2	2A3
E	3Y1	2Y4	GND	GND	2A4	3A1
F	3Y3	3Y2	GND	GND	3A2	3A3
G	4Y1	3Y4	V_{CC}	V_{CC}	3A4	4A1
H	4Y3	4Y2	NC	NC	4A2	4A3
J	4Y4	NC	$4\overline{OE}$	$3\overline{OE}$	NC	4A4

(1) NC – No internal connection

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)



Pin numbers shown are for the DGG, DGV, DL, and WD packages.

ABSOLUTE MAXIMUM RATINGS(1)

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(2)		–0.5	7	V
V_O	Voltage range applied to any output in the high-impedance or power-off state(2)		–0.5	7	V
V_O	Voltage range applied to any output in the high state(2)		–0.5	V_{CC} + 0.5	
I_O	Current into any output in the low state	SN54LVTH16244A		96	V
		SN74LVTH16244A		128	
I_O	Current into any output in the high state(3)	SN54LVTH16244A		48	V
		SN74LVTH16244A		64	
I_{IK}	Input clamp current	V_I < 0		–50	mA
I_{OK}	Output clamp current	V_O < 0		–50	mA
θ_{JA}	Package thermal impedance(4)	DGG package		70	°C/W
		DGV package		58	
		DL package		63	
		GQL/ZQL package		42	
		GRD/ZRD package		36	
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 clamp-current ratings are observed.
(3) The current flows only when the output is in the high state and $V_O > V_{CC}$.
(4) The package thermal impedance is calculated in accordance with JESD 51-7.

RECOMMENDED OPERATING CONDITIONS(1)

			SN54LVTH16244A		SN74LVTH16244A		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			–25		–32	mA
I_{OL}	Low-level output current			48		64	mA
$\Delta t/\Delta v$	Input transition rise or fall rate	Outputs enabled		10		10	ns/V
$\Delta t/\Delta V_{CC}$	Power-up ramp rate		200		200		μs/V
T_A	Operating free-air temperature		–55	125	–40	125	°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.

ELECTRICAL CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS		SN54LVTH16244A			–40°C to 85°C SN74LVTH16244A			Recommended –40°C to 125C SN74LVTH16244A			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{IK}		V_{CC} = 2.7 V,	I_I = –18 mA			–1.2			–1.2			–1.2	V
V_{OH}		V_{CC} = 2.7 V to 3.6 V,	I_{OL} = –100 µA	V_{CC} – 0.2			V_{CC} – 0.2			V_{CC} – 0.2			V
		V_{CC} = 2.7 V,	I_{OH} = –8 mA	2.4					2.4			2.4	
		V_{CC} = 3 V	I_{OH} = –24 mA	2									
			I_{OH} = –32 mA						2			2	
V_{OL}		V_{CC} = 2.7 V	I_{OL} = 100 µA			0.2			0.2			0.2	V
			I_{OL} = 24 mA			0.5			0.5			0.5	
		V_{CC} = 3 V	I_{OL} = 16 mA			0.4			0.4			0.4	
			I_{OL} = 32 mA			0.5			0.5			0.5	
			I_{OL} = 48 mA			0.55							
			I_{OL} = 64 mA						0.55			0.55	
I_I		V_{CC} = 0 or 3.6 V,	V_I = 5.5 V			50			10			10	µA
	Control inputs	V_{CC} = 3.6 V,	V_I = V_{CC} or GND			±1	±1			±1			
	Data inputs	V_{CC} = 3.6 V	V_I = V_{CC}			1			1			1	
			V_I = 0			–5			–5			–5	
I_{off}		V_{CC} = 0,	V_I or V_O = 0 to 4.5 V				±100			±100			µA
$I_{I(hold)}$	Data inputs	V_{CC} = 3 V	V_I = 0.8 V	75					75			75	µA
			V_I = 2 V	–75					–75			–75	
		V_{CC} = 3.6 V(2),	V_I = 0 to 3.6 V						500 –750			500 –750	
I_{OZH}		V_{CC} = 3.6 V,	V_O = 3 V			5			5			5	µA
I_{OZL}		V_{CC} = 3.6 V,	V_O = 0.5 V			–5			–5			–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(3)	±100			±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(3)	±100			±100			µA
I_{CC}		V_{CC} = 3.6 V, I_O = 0, V_I = V_{CC} or GND	Outputs high			0.19			0.19			0.19	mA
			Outputs low			5			5			5	
			Outputs disabled			0.19			0.19			0.19	
ΔI_{CC}(4)		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			0.2			0.2	mA
C_i		V_I = 3 V or 0 V			4			4			4		pF
C_o		V_O = 3 V or 0 V			9			9			9		pF

(1) All typical values are at V_{CC} = 3.3 V, T_A = 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) On products compliant to MIL-PRF-38535, this parameter does not apply.
(4) This is the increase in supply current for each input that is at the specified TTL voltage level, rather than V_{CC} or GND.

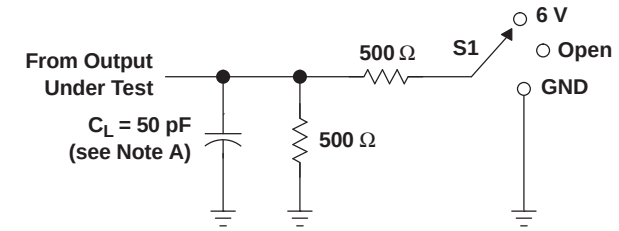
SWITCHING CHARACTERISTICS

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN54LVTH16244A				–40°C to 85°C SN74LVTH16244A				Recommended –40°C to 125C SN74LVTH16244A				UNIT
			V_{CC} = 3.3 V ± 0.3 V		V_{CC} = 2.7 V		V_{CC} = 3.3 V ± 0.3 V			V_{CC} = 2.7 V	V_{CC} = 3.3 V ± 0.3 V			V_{CC} = 2.7 V	
			MIN	MAX	MIN	MAX	MIN	TYP	MAX	MIN MAX	MIN	TYP	MAX	MIN MAX	
t_{PLH}	A	Y	1.1	4.4		4.6	1.2	2.3	3.2	3.7	1.2	2.3	4.4	4.6	ns
t_{PHL}			1.1	3.6		3.9	1.2	2	3.2	3.7	1.2	2	3.6	3.9	
t_{PZH}	$\overline{OE}$	Y	1.1	4.6		5.4	1.2	2.6	4	5	1.2	2.6	4.6	5.4	ns
t_{PZL}			1.1	5.4		6.2	1.2	2.7	4	5	1.2	2.7	5.4	6.2	
t_{PHZ}	$\overline{OE}$	Y	1.6	5.7		6.2	2.2	3.3	4.5	5	2.2	3.3	5.7	6.2	ns
t_{PLZ}			1.2	5		4.7	2	3.1	4.2	4.4	2	3.1	5	4.7	
$t_{sk(LH)}$									0.5				0.5		ns
$t_{sk(HL)}$									0.5				0.5		

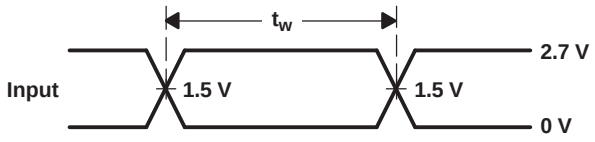
(1) All typical values are at V_{CC} = 3.3 V, T_A = 25°C.

PARAMETER MEASUREMENT INFORMATION

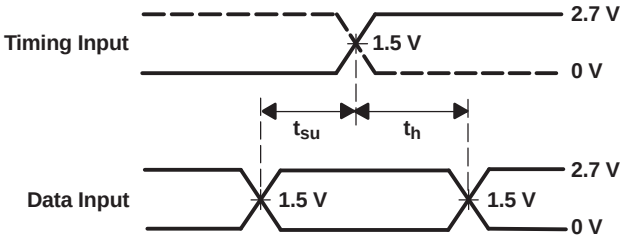


LOAD CIRCUIT

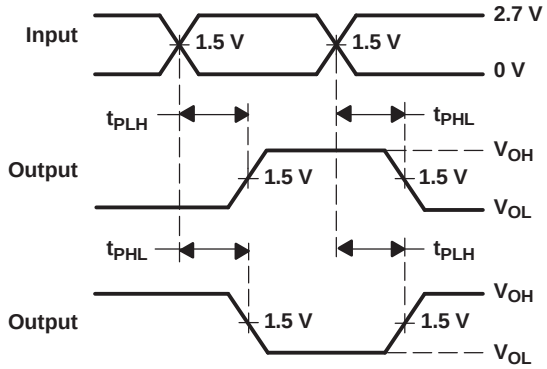
TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	6 V
t_{PHZ}/t_{PZH}	GND



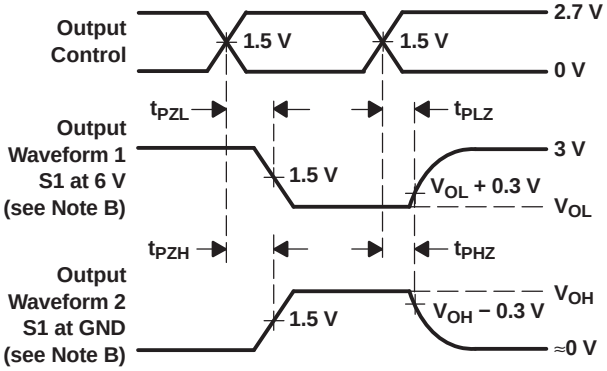
VOLTAGE WAVEFORMS
PULSE DURATION



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 ≤ 10 MHz, Z_O = 50 Ω, t_r ≤ 2.5 ns, t_f ≤ 2.5 ns.
D. The outputs are measured one at a time, with one transition per measurement.

Figure 1. Load Circuit and Voltage Waveforms

REVISION HISTORY

Changes from Revision T (November 2006) to Revision U	Page
• Updated document to new TI data sheet format - no specification changes.	1
• Removed ordering information.	1
• Updated operating temperature range.	5

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
5962-9668501QXA	ACTIVE	CFP	WD	48	15	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-9668501QX A SNJ54LVTH16244 AWD	Samples
5962-9668501VXA	ACTIVE	CFP	WD	48	15	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-9668501VX A SNV54LVTH16244 AWD	Samples
74LVTH16244ADGGRE4	ACTIVE	TSSOP	DGG	48	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LVTH16244A	Samples
74LVTH16244ADGGRG4	ACTIVE	TSSOP	DGG	48	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LVTH16244A	Samples
SN74LVTH16244ADGGR	ACTIVE	TSSOP	DGG	48	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LVTH16244A	Samples
SN74LVTH16244ADGVR	ACTIVE	TVSOP	DGV	48	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LL244A	Samples
SN74LVTH16244ADL	ACTIVE	SSOP	DL	48	25	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LVTH16244A	Samples
SN74LVTH16244ADLG4	ACTIVE	SSOP	DL	48	25	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LVTH16244A	Samples
SN74LVTH16244ADLR	ACTIVE	SSOP	DL	48	1000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LVTH16244A	Samples
SNJ54LVTH16244AWD	ACTIVE	CFP	WD	48	15	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-9668501QX A SNJ54LVTH16244 AWD	Samples

(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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

OTHER QUALIFIED VERSIONS OF SN54LVTH16244A, SN54LVTH16244A-SP, SN74LVTH16244A :

- Catalog : SN74LVTH16244A, SN54LVTH16244A
- Enhanced Product : SN74LVTH16244A-EP, SN74LVTH16244A-EP
- Military : SN54LVTH16244A
- Space : SN54LVTH16244A-SP

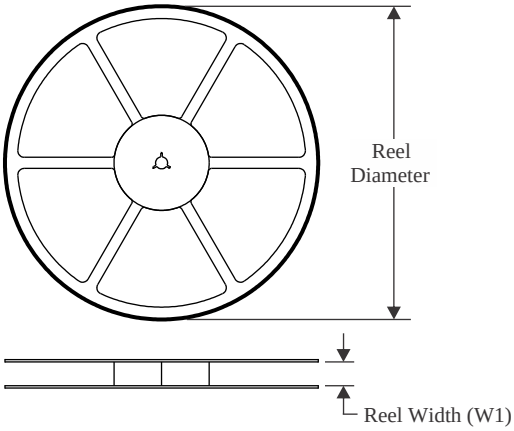
NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Enhanced Product - Supports Defense, Aerospace and Medical Applications
- Military - QML certified for Military and Defense Applications

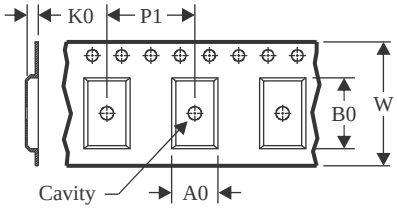
- Space - Radiation tolerant, ceramic packaging and qualified for use in Space-based application

TAPE AND REEL INFORMATION

REEL DIMENSIONS

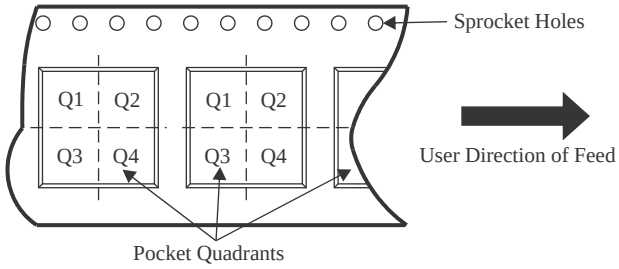


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

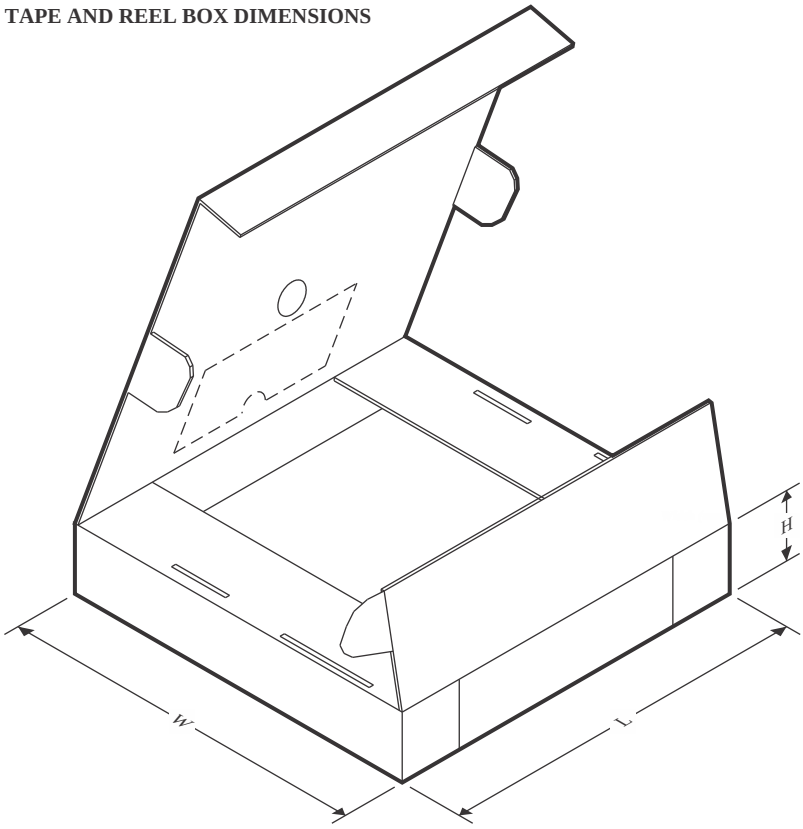
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
SN74LVTH16244ADGGR	TSSOP	DGG	48	2000	330.0	24.4	8.6	13.0	1.8	12.0	24.0	Q1
SN74LVTH16244ADGVR	TVSOP	DGV	48	2000	330.0	16.4	7.1	10.2	1.6	12.0	16.0	Q1
SN74LVTH16244ADLR	SSOP	DL	48	1000	330.0	32.4	11.35	16.2	3.1	16.0	32.0	Q1

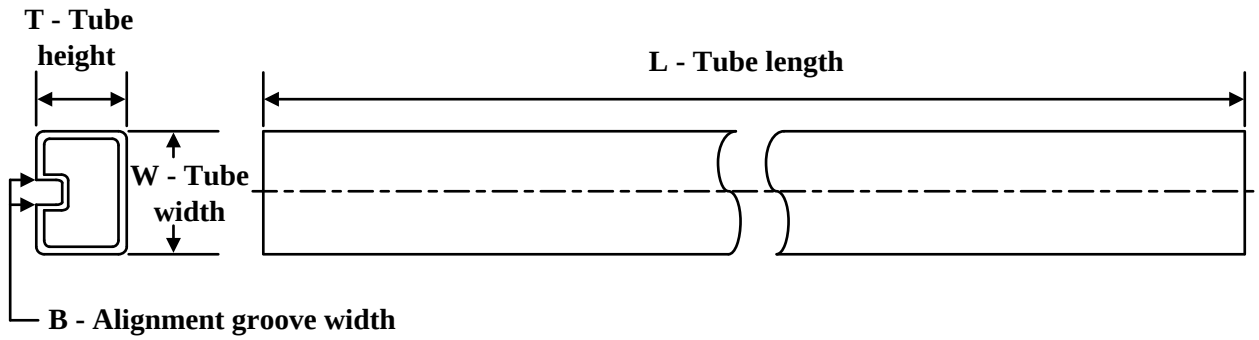
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74LVTH16244ADGGR	TSSOP	DGG	48	2000	367.0	367.0	45.0
SN74LVTH16244ADGVR	TVSOP	DGV	48	2000	356.0	356.0	35.0
SN74LVTH16244ADLR	SSOP	DL	48	1000	367.0	367.0	55.0

TUBE

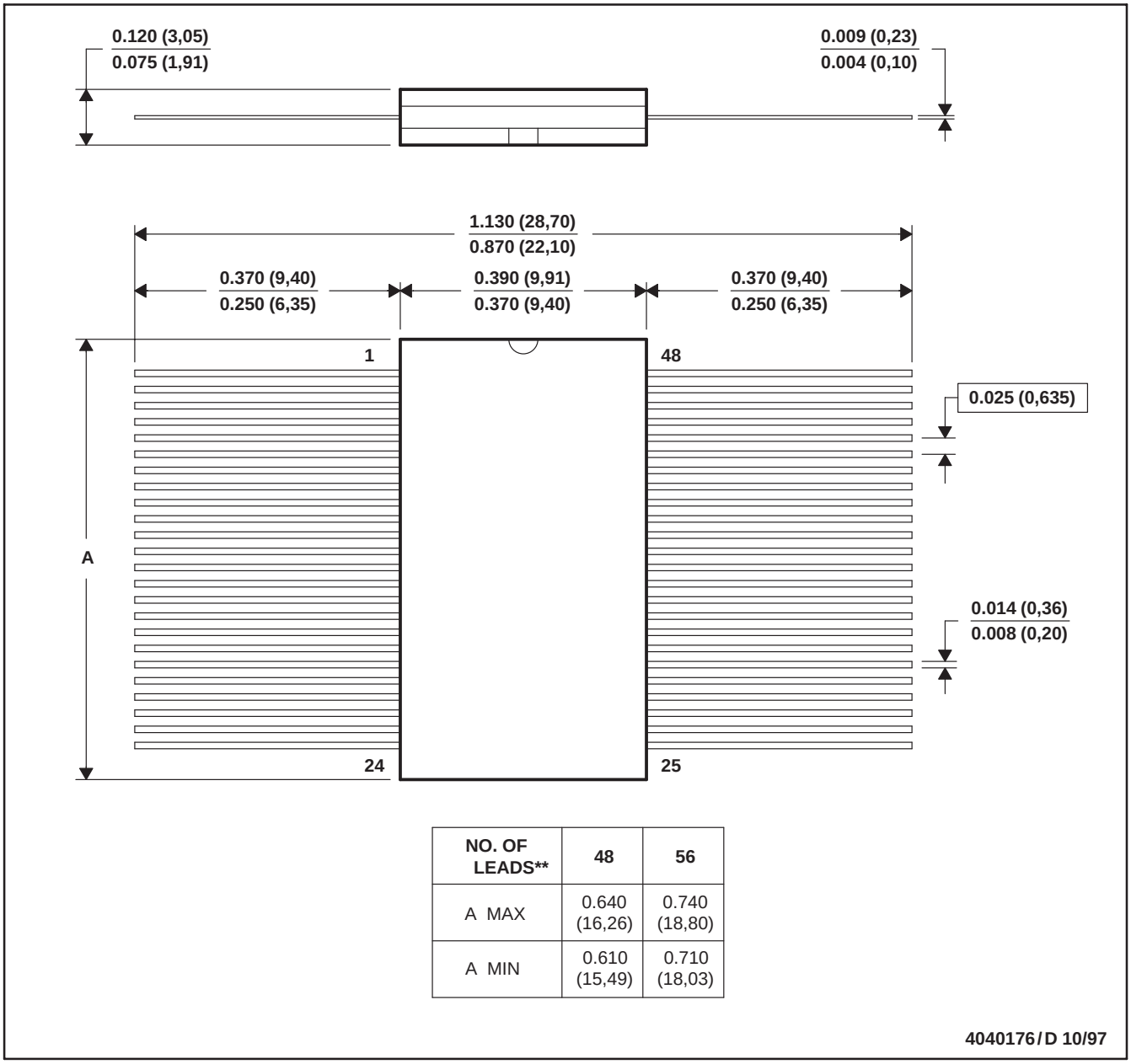


*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
SN74LVTH16244ADL	DL	SSOP	48	25	473.7	14.24	5110	7.87
SN74LVTH16244ADLG4	DL	SSOP	48	25	473.7	14.24	5110	7.87

WD (R-GDFP-F)** **CERAMIC DUAL FLATPACK**

48 LEADS SHOWN

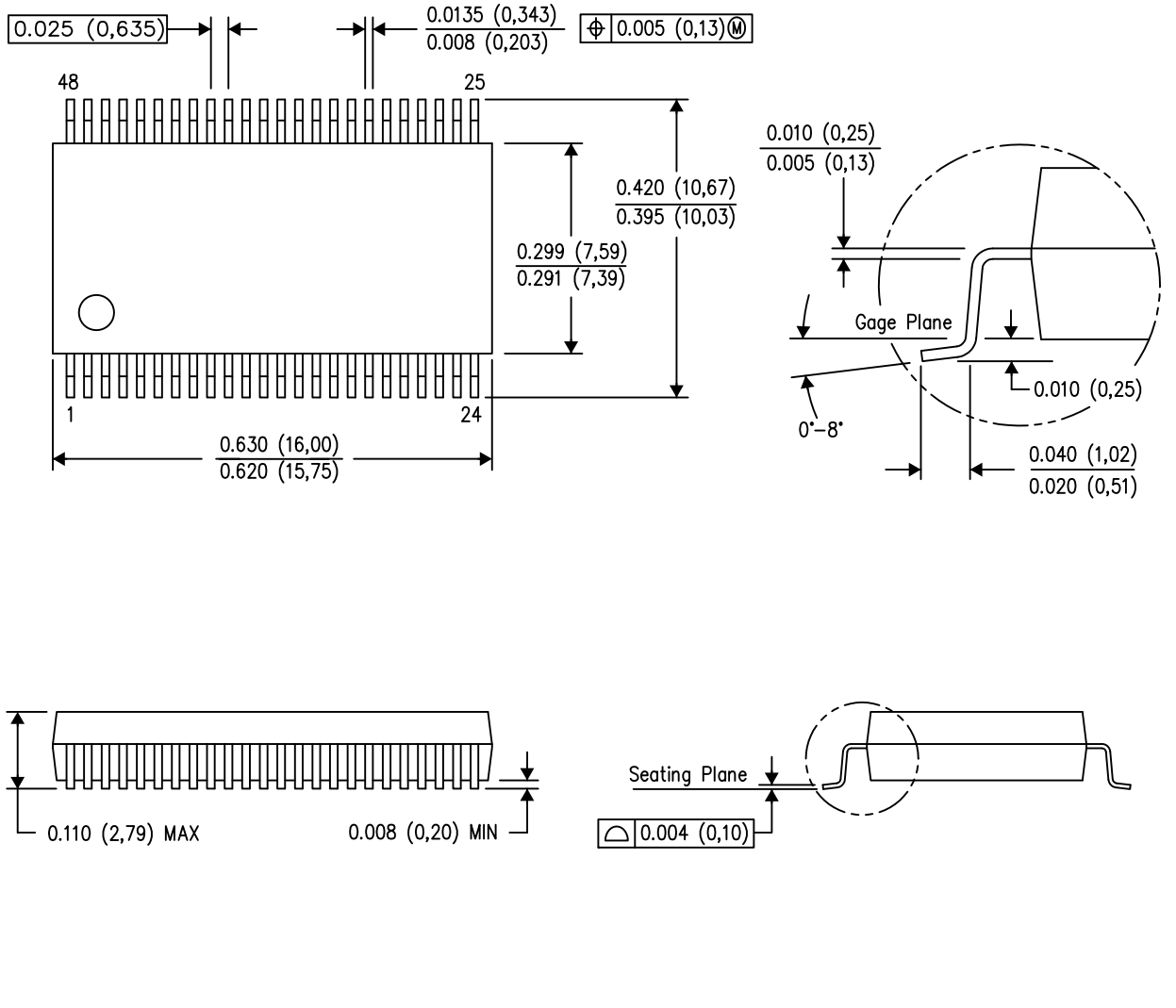


NO. OF LEADS**	48	56
A MAX	0.640 (16,26)	0.740 (18,80)
A MIN	0.610 (15,49)	0.710 (18,03)

4040176/D 10/97

NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification only
E. Falls within MIL STD 1835: GDFP1-F48 and JEDEC MO-146AA
GDFP1-F56 and JEDEC MO-146AB

DL (R–PDSO–G48) PLASTIC SMALL–OUTLINE PACKAGE

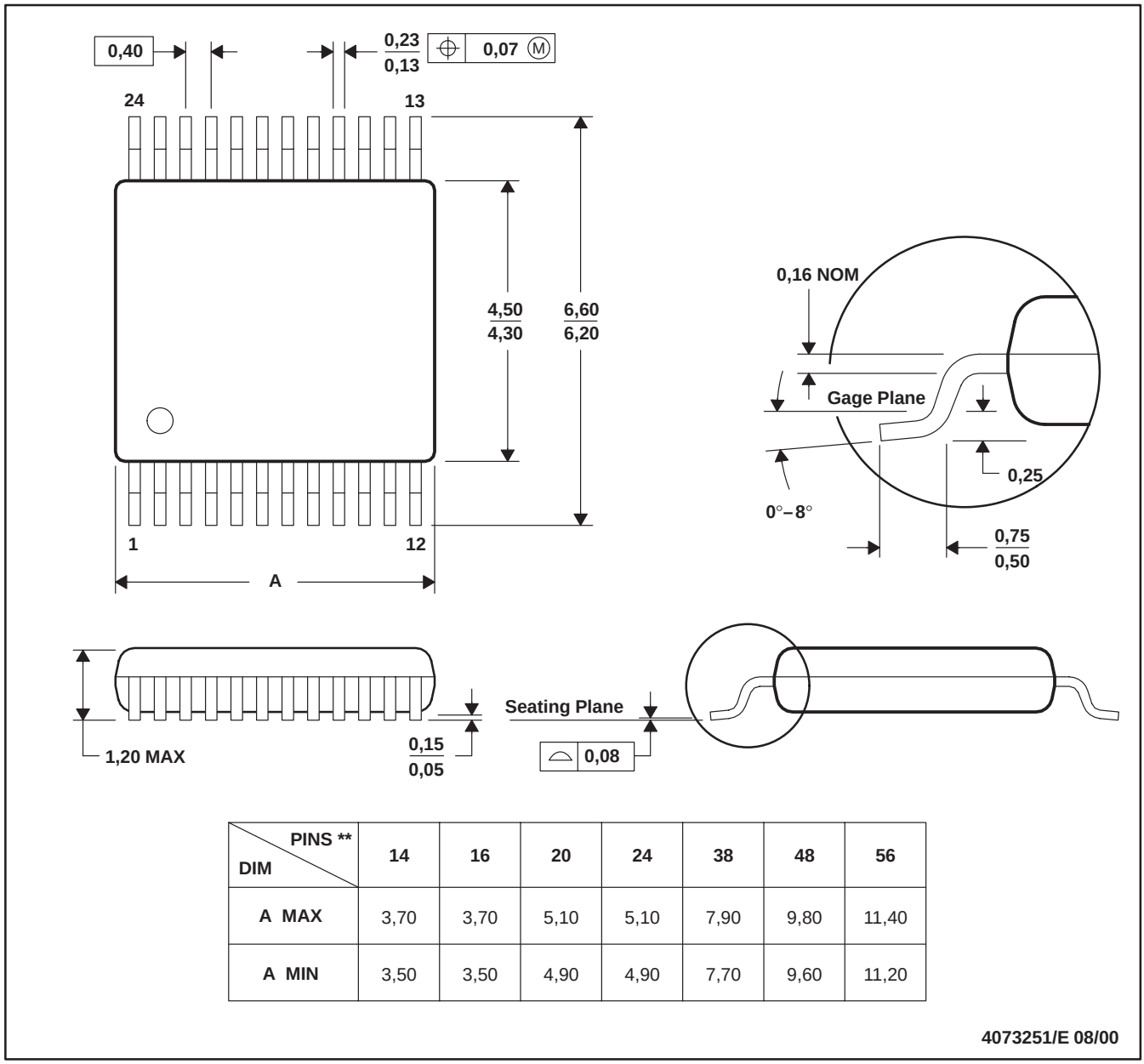


NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
D. Falls within JEDEC MO–118

PowerPAD is a trademark of Texas Instruments.

DGV (R-PDSO-G)** **PLASTIC SMALL-OUTLINE**

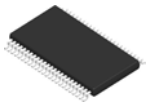
24 PINS SHOWN



DIM \ PINS **	14	16	20	24	38	48	56
A MAX	3,70	3,70	5,10	5,10	7,90	9,80	11,40
A MIN	3,50	3,50	4,90	4,90	7,70	9,60	11,20

4073251/E 08/00

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

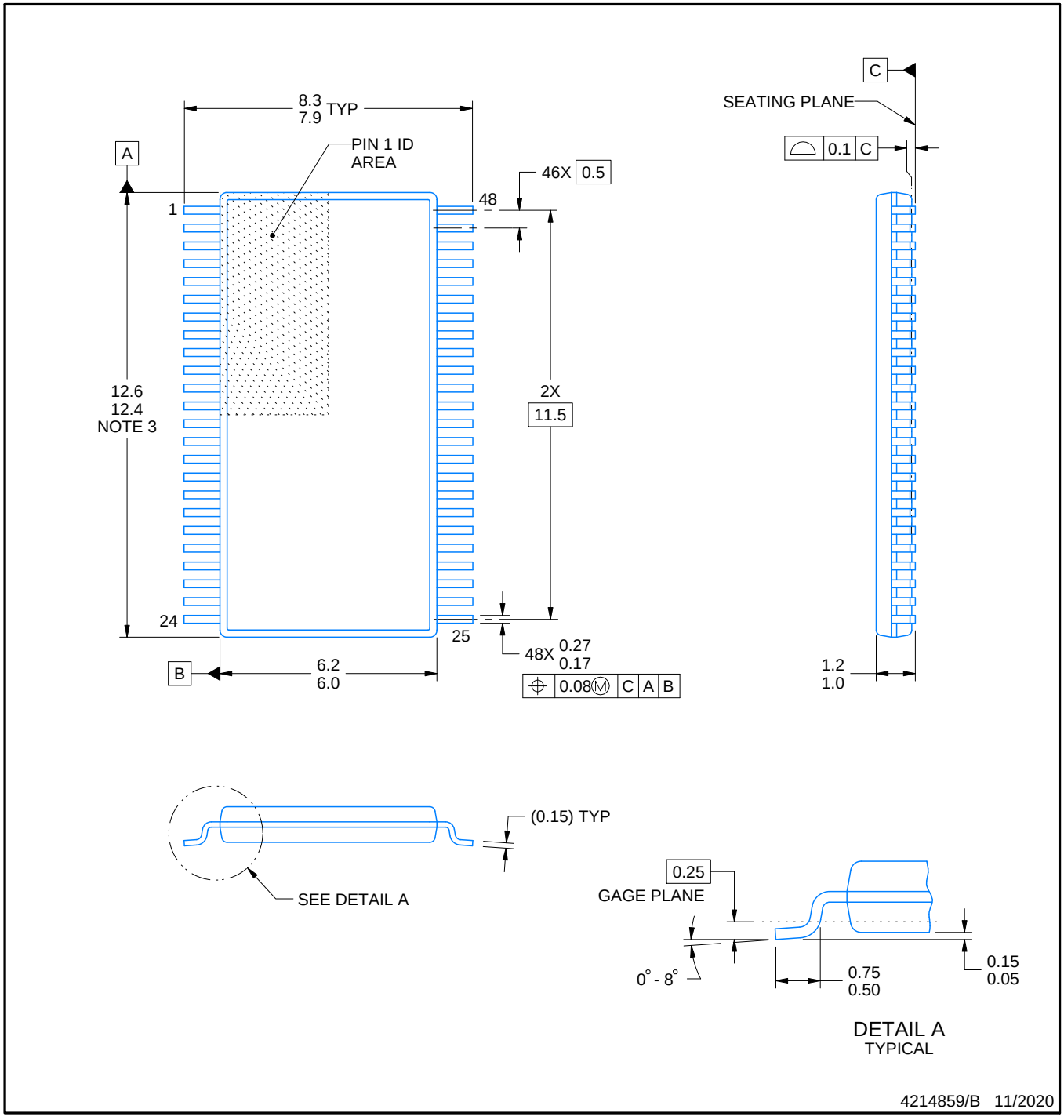


PACKAGE OUTLINE

DGG0048A

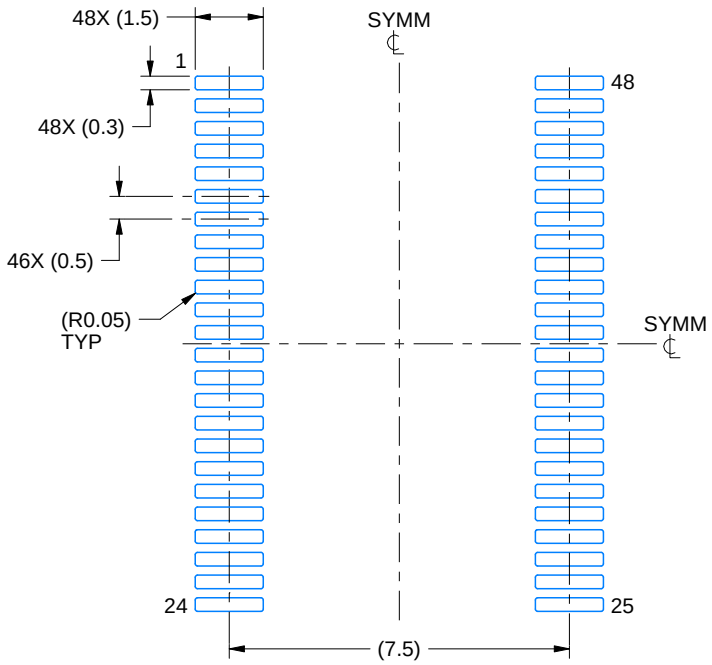
TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE

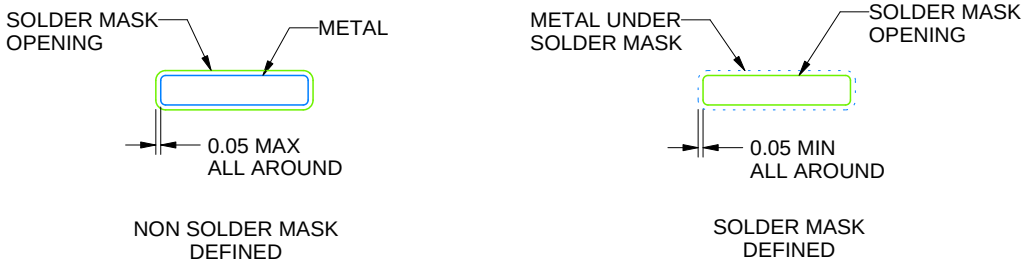


NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. Reference JEDEC registration MO-153.



LAND PATTERN EXAMPLE
SCALE:6X

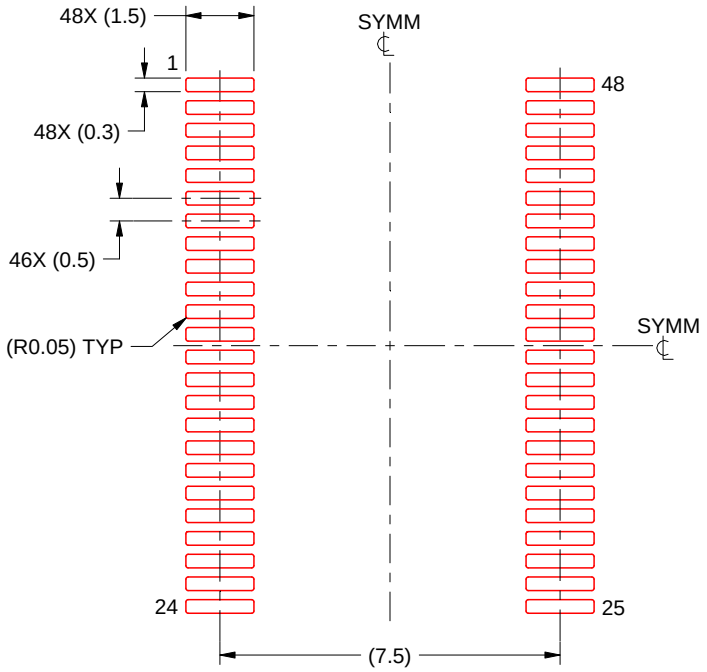


SOLDER MASK DETAILS

4214859/B 11/2020

NOTES: (continued)

5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:6X

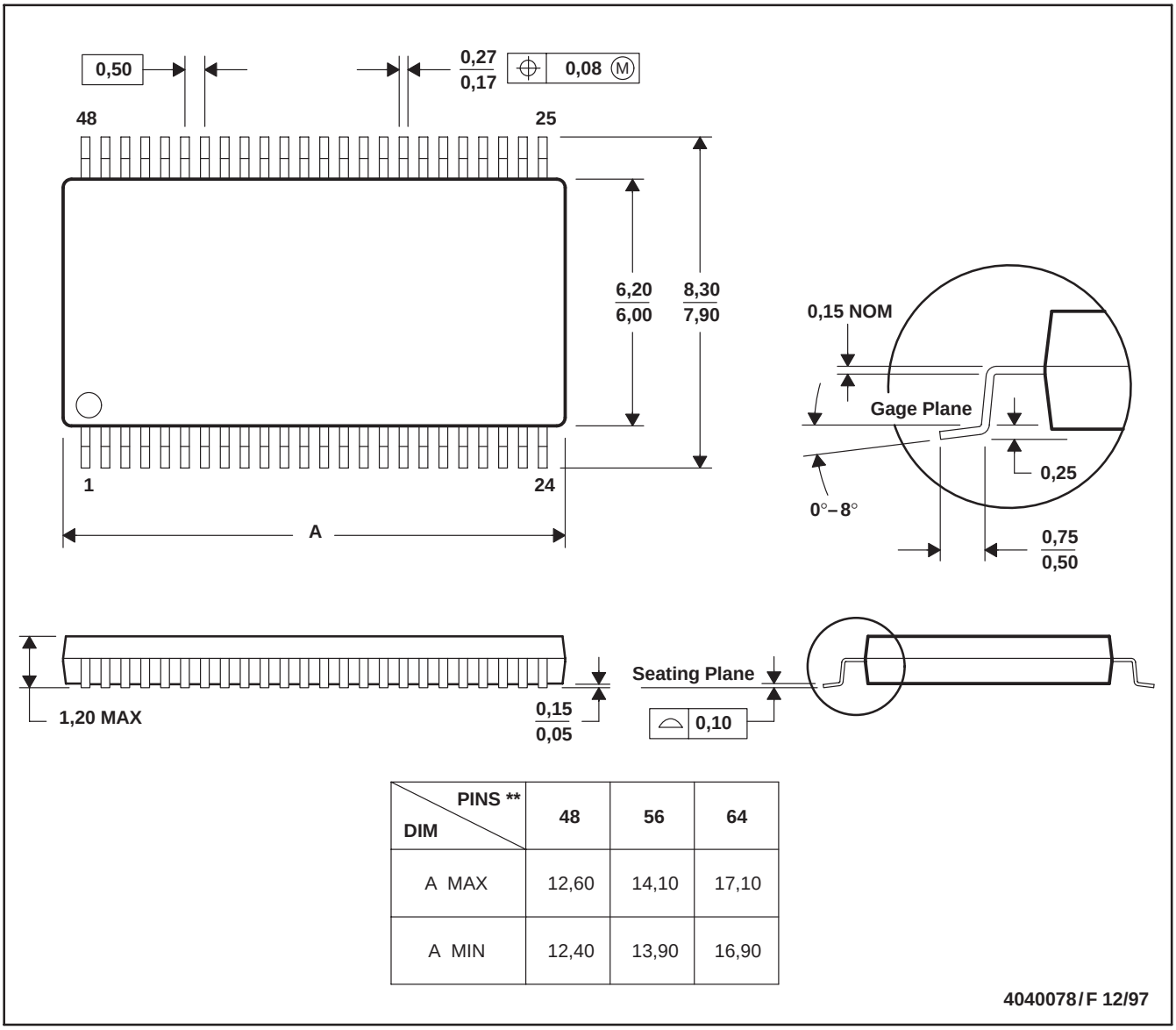
4214859/B 11/2020

NOTES: (continued)

7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
8. Board assembly site may have different recommendations for stencil design.

DGG (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

48 PINS SHOWN



DIM \ PINS **	48	56	64
A MAX	12,60	14,10	17,10
A MIN	12,40	13,90	16,90

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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