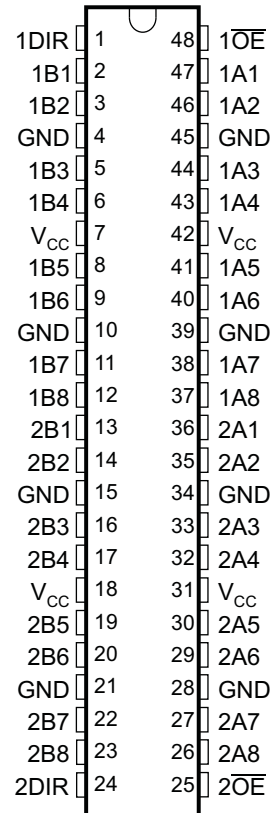


FEATURES

- **Controlled Baseline**
 - One Assembly
 - One 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**
- **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, $T_A = 25^\circ\text{C}$**
- **Distributed V_{CC} and GND Pins Minimize High-Speed Switching Noise**
- **Flow-Through Architecture Optimizes PCB Layout**
- **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)

(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, DGV, OR DL PACKAGE
(TOP VIEW)



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.

Widebus is a trademark of Texas Instruments.

SN74LVTH16245A-EP

3.3-V ABT 16-BIT BUS TRANSCEIVER

WITH 3-STATE OUTPUTS

SCAS693G—APRIL 2003—REVISED OCTOBER 2006

DESCRIPTION/ORDERING INFORMATION

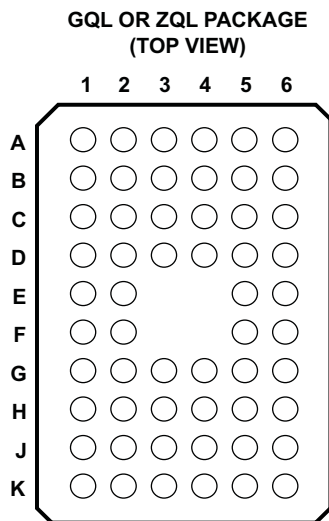
The SN74LVTH16245A is a 16-bit (dual-octal) noninverting 3-state transceiver designed for low-voltage (3.3-V) V_{CC} operation, but with the capability to provide a TTL interface to a 5-V system environment.

This device can be used as two 8-bit transceivers or one 16-bit transceiver. It allows data transmission from the A bus to the B bus or from the B bus to the A bus, depending on the logic level at the direction-control (DIR) input. The output-enable (OE) input can be used to disable the devices so that the buses effectively are isolated.

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 V 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, 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.



TERMINAL ASSIGNMENTS⁽¹⁾

	1	2	3	4	5	6
A	1DIR	NC	NC	NC	NC	1 \overline{OE}
B	1B2	1B1	GND	GND	1A1	1A2
C	1B4	1B3	V_{CC}	V_{CC}	1A3	1A4
D	1B6	1B5	GND	GND	1A5	1A6
E	1B8	1B7			1A7	1A8
F	2B1	2B2			12A2	2A1
G	2B3	2B4	GND	GND	2A4	2A3
H	2B5	2B6	V_{CC}	V_{CC}	2A6	2A5
J	2B7	2B8	GND	GND	2A8	2A7
K	2DIR	NC	NC	NC	NC	2 \overline{OE}

(1) NC – no internal connection

ORDERING INFORMATION

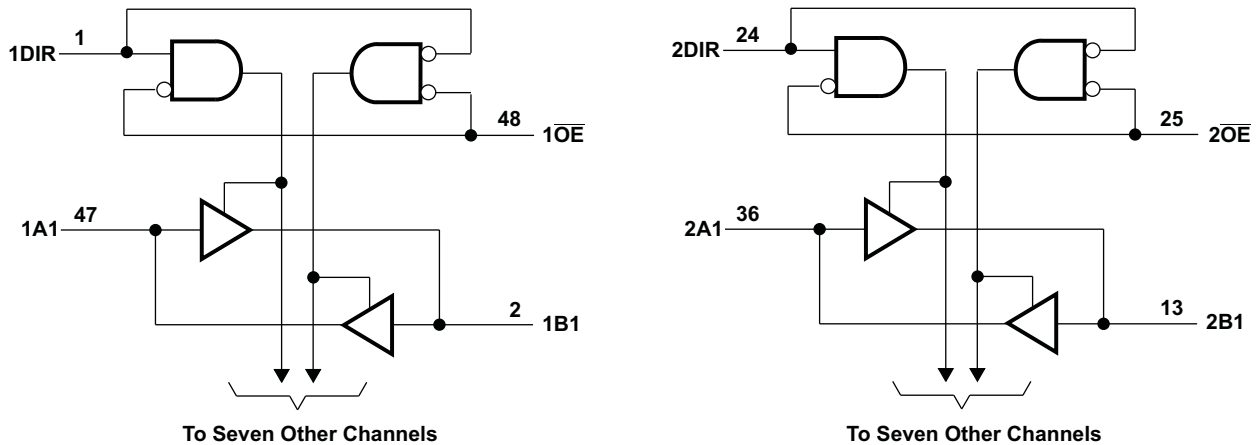
T_A	PACKAGE ⁽¹⁾		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 125°C	SSOP – DL	Tape and reel	CLVTH16245AQDLREP	LH16245AEP
	TSSOP – DGG	Tape and reel	CLVTH16245AQDGGREP	LH16245AEP
–40°C to 85°C	TVSOP – DGV	Tape and reel	CLVTH16245AIDGVREP	LL245AEP
	VFBGA – GQL	Tape and reel	CLVTH16245AIGQLREP	LL245AEP
	VFBGA – ZQL (Pb-free)		CLVTH16245AIZQLREP	
–55°C to 125°C	SSOP – DL	Tape and reel	CLVTH16245AMDREP	LH16245AEP

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

FUNCTION TABLE
(each 8-bit section)

INPUTS		OPERATION
\overline{OE}	DIR	
L	L	B data to A bus
L	H	A data to B bus
H	X	Isolation

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	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	$V_{CC} + 0.5$	V
I_O	Current into any output in the low state	SN74LVTH16245A(Q/M)	96	mA
		SN74LVTH16245AI	128	
I_O	Current into any output in the high state ⁽³⁾	SN74LVTH16245A(Q/M)	48	mA
		SN74LVTH16245AI	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	
T_{stg}	Storage temperature range	-65	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.
- The input and output negative-voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
- This current flows only when the output is in the high state and $V_O > V_{CC}$.
- The package thermal impedance is calculated in accordance with JESD 51-7.

SN74LVTH16245A-EP
3.3-V ABT 16-BIT BUS TRANSCEIVER
WITH 3-STATE OUTPUTS

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Recommended Operating Conditions⁽¹⁾

		SN74LVTH16245AQ		SN74LVTH16245AI		SN74LVTH16245AM		UNIT
		MIN	MAX	MIN	MAX	MIN	MAX	
V _{CC}	Supply voltage	2.7	3.6	2.7	3.6	2.7	3.6	V
V _{IH}	High-level input voltage	2		2		2		V
V _{IL}	Low-level input voltage		0.8		0.8		0.8	V
V _I	Input voltage		5.5		5.5		5.5	V
I _{OH}	High-level output current		–24		–32		–24	mA
I _{OL}	Low-level output current		24		64		24	mA
Δt/Δv	Input transition rise or fall rate	Outputs enabled		10	10	10	10	ns/V
Δt/ΔV _{CC}	Power-up ramp rate	200		200		200		μs/V
T _A	Operating free-air temperature	–40	125	–40	85	–55	125	°C

(1) All unused control inputs of the device must be held at V_{CC} or GND to ensure proper device operation. See the TI application report, *Implications of Slow or Floating CMOS Inputs* (SCBA004).

Electrical Characteristics

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

PARAMETER		TEST CONDITIONS	SN74LVTH16245AQ			SN74LVTH16245AI			SN74LVTH16245AM			UNIT		
			MIN	TYP ⁽¹⁾	MAX	MIN	TYP ⁽¹⁾	MAX	MIN	TYP ⁽¹⁾	MAX			
V_{IK}		$V_{CC} = 2.7\text{ V}$, $I_I = -18\text{ mA}$	-1.2			-1.2			-1.2			V		
V_{OH}		$V_{CC} = 2.7\text{ V to }3.6\text{ V}$, $I_{OH} = -100\text{ }\mu\text{A}$	$V_{CC} - 0.2$			$V_{CC} - 0.2$			$V_{CC} - 0.2$			V		
		$V_{CC} = 2.7\text{ V}$, $I_{OH} = -8\text{ mA}$	2.4			2.4			2.4					
		$V_{CC} = 3.3\text{ V}$	$I_{OH} = -24\text{ mA}$		2			$I_{OH} = -32\text{ mA}$		2				
V_{OL}		$V_{CC} = 2.7\text{ V}$	$I_{OL} = 100\text{ }\mu\text{A}$		0.2			$I_{OL} = 24\text{ mA}$		0.5			V	
			$I_{OL} = 24\text{ mA}$		0.5			$I_{OL} = 16\text{ mA}$		0.4				
		$V_{CC} = 3\text{ V}$	$I_{OL} = 16\text{ mA}$		0.4			$I_{OL} = 32\text{ mA}$		0.5				
			$I_{OL} = 32\text{ mA}$		0.5			$I_{OL} = 64\text{ mA}$		0.55				
			$I_{OL} = 64\text{ mA}$		0.55									
I_I		Control inputs	$V_{CC} = 3.6\text{ V}$, $V_I = V_{CC}$ or GND		± 1			± 1		± 1			μA	
			$V_{CC} = 0$ or 3.6 V , $V_I = 5.5\text{ V}$		10			10		10				
		A or B port ⁽²⁾	$V_{CC} = 3.6\text{ V}$	$V_I = 5.5\text{ V}$		20			20		20			
				$V_I = V_{CC}$		5			1		5			
			$V_I = 0$		-5			-5		-5				
I_{off}		$V_{CC} = 0$, V_I or $V_O = 0$ to 4.5 V				± 100						μA		
$I_{I(\text{hold})}$ ⁽³⁾		A or B port	$V_{CC} = 3\text{ V}$	$V_I = 0.8\text{ V}$		75			75		75			μA
				$V_I = 2\text{ V}$		-75			-75		-75			
		$V_{CC} = 3.6\text{ V}$, $V_I = 0$ to 3.6 V					500			-750				
I_{OZPU}		$V_{CC} = 0$ to 1.5 V , $V_O = 0.5\text{ V to }3\text{ V}$, $\overline{OE} = \text{don't care}$	± 100			± 100			± 100			μA		
I_{OZPD}		$V_{CC} = 1.5\text{ V to }0$, $V_O = 0.5\text{ V to }3\text{ V}$, $\overline{OE} = \text{don't care}$	± 100			± 100			± 100			μA		
I_{CC}		$V_{CC} = 3.6\text{ V}$, $I_O = 0$, $V_I = V_{CC}$ 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⁾		$V_{CC} = 3\text{ V to }3.6\text{ V}$, One input at $V_{CC} - 0.6\text{ V}$, Other inputs at V_{CC} or GND	0.2			0.2			0.2			mA		
C_i		$V_I = 3\text{ V or }0$	4			4			4			pF		
C_{io}		$V_O = 3\text{ V or }0$	10			10			10			pF		

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

 (2) Unused pins at V_{CC} or GND

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

 (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.

SN74LVTH16245A-EP

3.3-V ABT 16-BIT BUS TRANSCEIVER

WITH 3-STATE OUTPUTS

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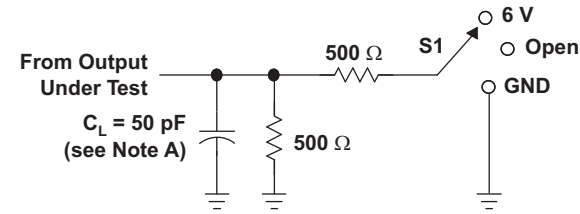
Switching Characteristics

over operating free-air temperature range, $C_L = 50$ pF (unless otherwise noted) (see [Figure 1](#))

PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN74LVTH16245AQ SN74LVTH16245AM				SN74LVTH16245AI				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 ⁽¹⁾	MAX	MIN		MAX
t_{PLH}	A or B	B or A	0.5	4.5	4.6		1.5	2.3	3.3	3.7		ns
t_{PHL}			0.5	4.4	3.9		1.3	2.1	3.3	3.5		
t_{PZH}	\overline{OE}	A or B	0.5	6.5	6.6		1.5	2.8	4.5	5.3		ns
t_{PZL}			0.5	5.4	6.2		1.6	2.9	4.6	5.2		
t_{PHZ}	\overline{OE}	A or B	1	6.8	7		2.3	3.7	5.1	5.5		ns
t_{PLZ}			1	6.2	6.3		2.2	3.5	5.1	5.4		
$t_{sk(o)}$								0.5		0.5	ns	

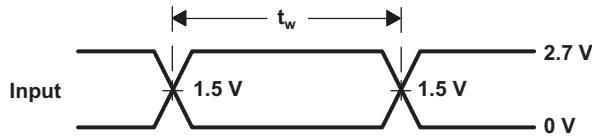
(1) All typical values are at $V_{CC} = 3.3\text{ V}$, $T_A = 25^\circ\text{C}$.

PARAMETER MEASUREMENT INFORMATION

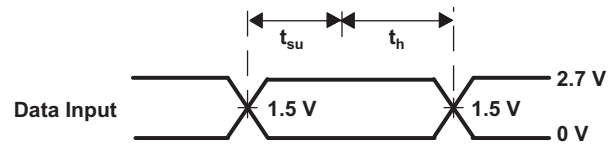
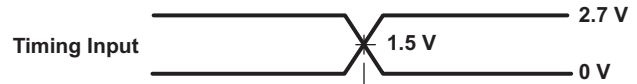


LOAD CIRCUIT

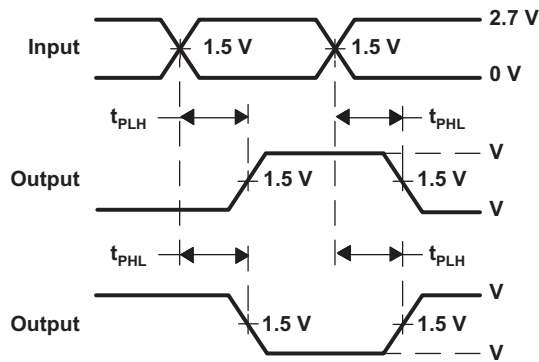
TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	6 V
t_{PHZ}/t_{PZH}	GND



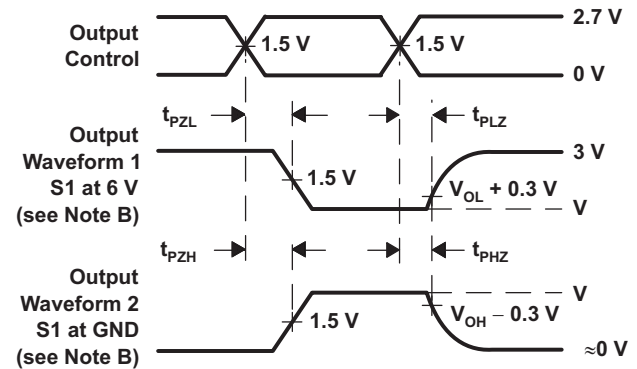
VOLTAGE WAVEFORMS
PULSE DURATION



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 $\leq 10 \text{ MHz}$, $Z_O = 59 \Omega$, $t_r \leq 2.5 \text{ ns}$, $t_f \leq 2.5 \text{ ns}$.
 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)	Op Temp (°C)	Top-Side Markings (4)	Samples
8V16245AMDLREPG4	ACTIVE	SSOP	DL	48	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	LVTH16245AEP	Samples
CLVTH16245AIDGVREP	ACTIVE	TVSOP	DGV	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LL245AEP	Samples
CLVTH16245AIZQLREP	ACTIVE	BGA MICROSTAR JUNIOR	ZQL	56		TBD	Call TI	Call TI	-40 to 85	LL245AEP	Samples
CLVTH16245AMDLREP	ACTIVE	SSOP	DL	48	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	LVTH16245AEP	Samples
CLVTH16245AQDGGREP	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	LH16245AEP	Samples
CLVTH16245AQDLREP	ACTIVE	SSOP	DL	48	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	LH16245AEP	Samples
V62/04602-01XE	ACTIVE	SSOP	DL	48	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	LH16245AEP	Samples
V62/04602-01YE	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	LH16245AEP	Samples
V62/04602-02UA	ACTIVE	BGA MICROSTAR JUNIOR	GQL	56		TBD	Call TI	Call TI	-40 to 85		Samples
V62/04602-02ZE	ACTIVE	TVSOP	DGV	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LL245AEP	Samples
V62/04602-03XE	ACTIVE	SSOP	DL	48	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	LVTH16245AEP	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) 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.

⁽⁴⁾ Multiple Top-Side Markings will be inside parentheses. Only one Top-Side 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 Top-Side Marking for that device.

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In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

OTHER QUALIFIED VERSIONS OF SN74LVTH16245A-EP :

- Catalog: [SN74LVTH16245A](#)
- Automotive: [SN74LVTH16245A-Q1](#)
- Military: [SN54LVTH16245A](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects
- Military - QML certified for Military and Defense Applications

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
CLVTH16245AIDGVREP	TVSOP	DGV	48	2000	330.0	16.4	7.1	10.2	1.6	12.0	16.0	Q1
CLVTH16245AMDLEP	SSOP	DL	48	1000	330.0	32.4	11.35	16.2	3.1	16.0	32.0	Q1
CLVTH16245AQDGGREP	TSSOP	DGG	48	2000	330.0	24.4	8.6	15.8	1.8	12.0	24.0	Q1
CLVTH16245AQDLREP	SSOP	DL	48	1000	330.0	32.4	11.35	16.2	3.1	16.0	32.0	Q1

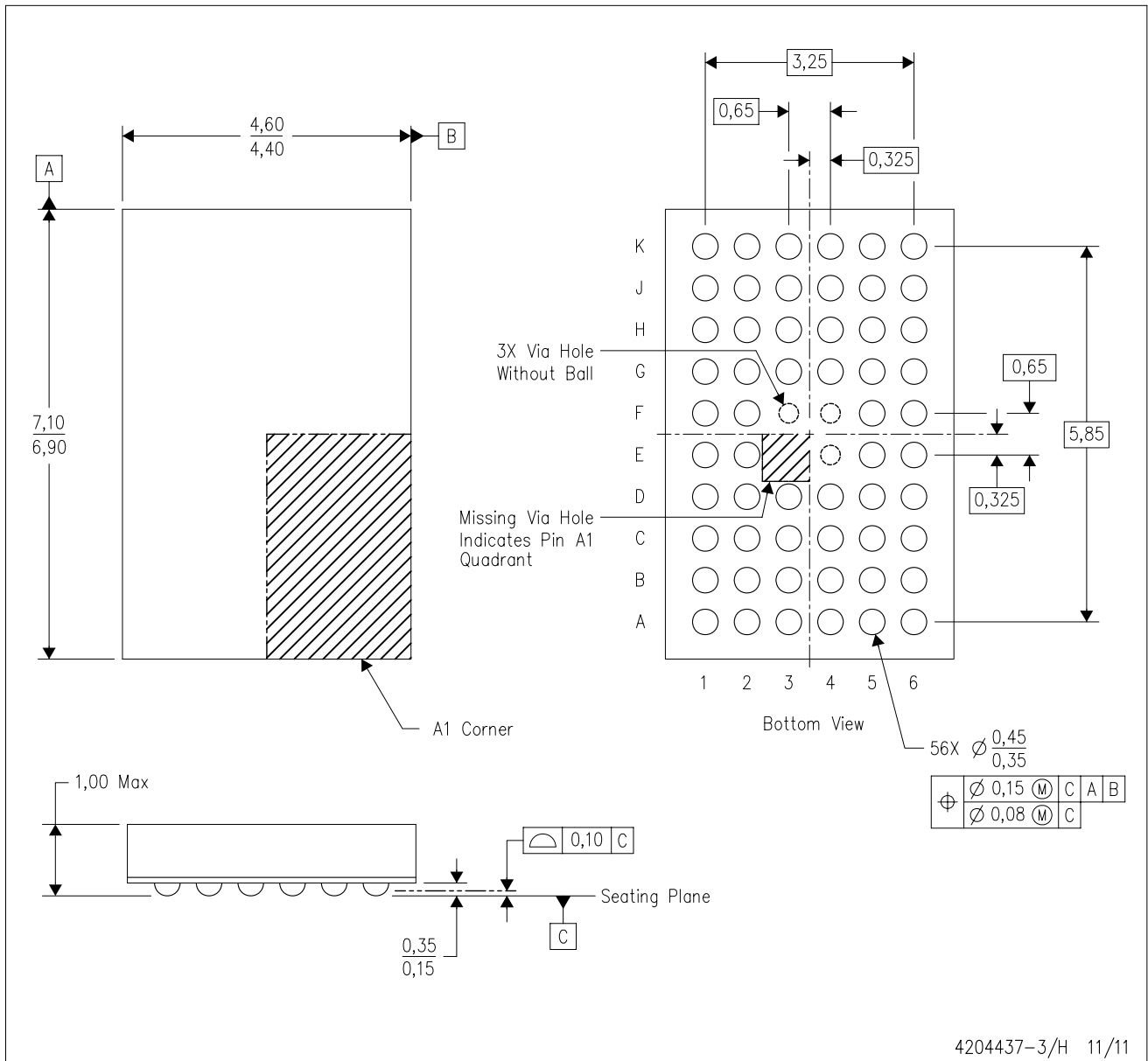
TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
CLVTH16245AIDGVREP	TVSOP	DGV	48	2000	367.0	367.0	38.0
CLVTH16245AMDLREP	SSOP	DL	48	1000	367.0	367.0	55.0
CLVTH16245AQDGGREP	TSSOP	DGG	48	2000	367.0	367.0	45.0
CLVTH16245AQLREP	SSOP	DL	48	1000	367.0	367.0	55.0

ZQL (R-PBGA-N56)

PLASTIC BALL GRID ARRAY



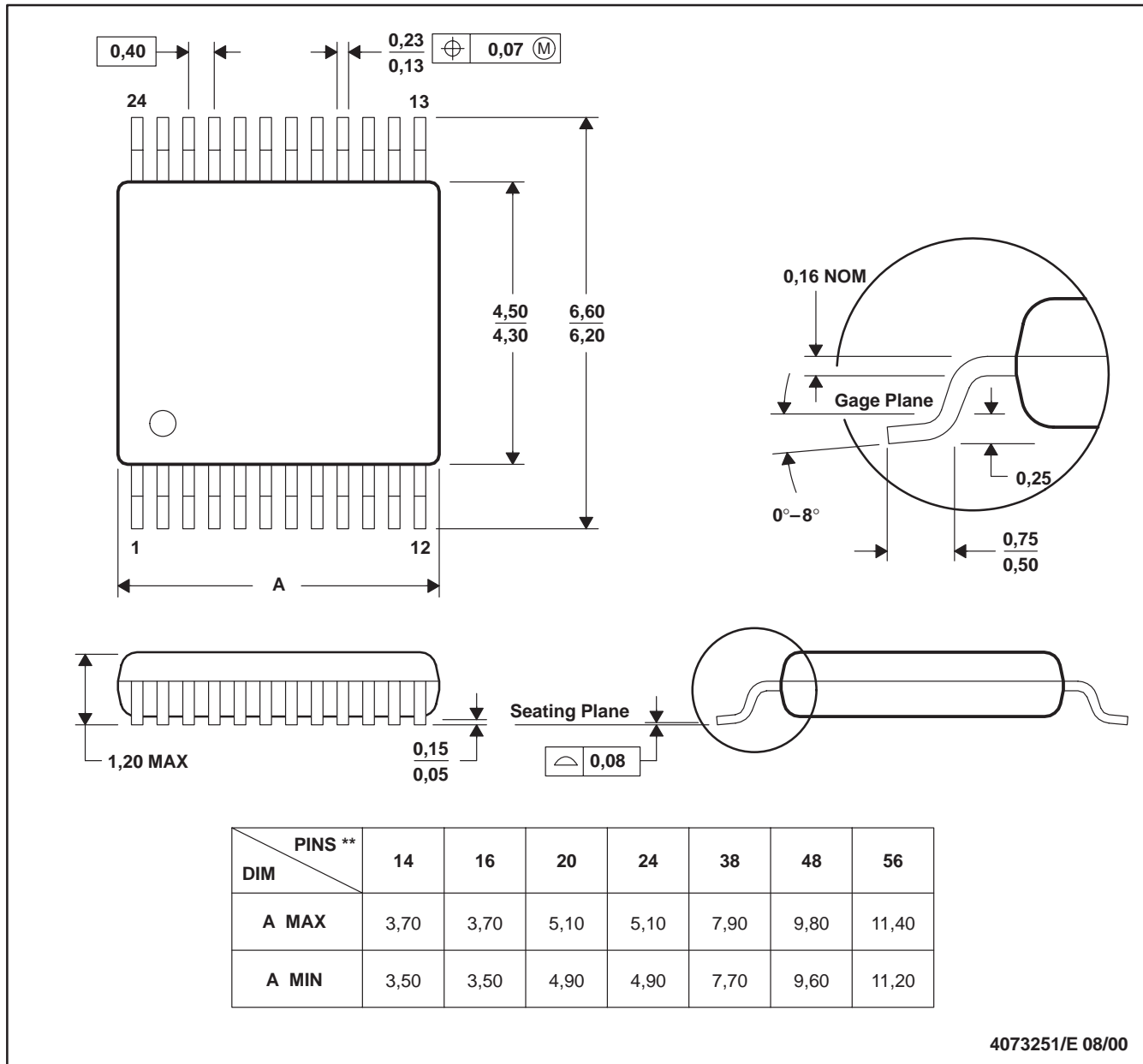
4204437-3/H 11/11

- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
 - B. This drawing is subject to change without notice.
 - C. Falls within JEDEC MO-285 variation BA-2.
 - D. This package is Pb-free. Refer to the 56 GQL package (drawing 4200583) for tin-lead (SnPb).

DGV (R-PDSO-G**)

PLASTIC SMALL-OUTLINE

24 PINS SHOWN

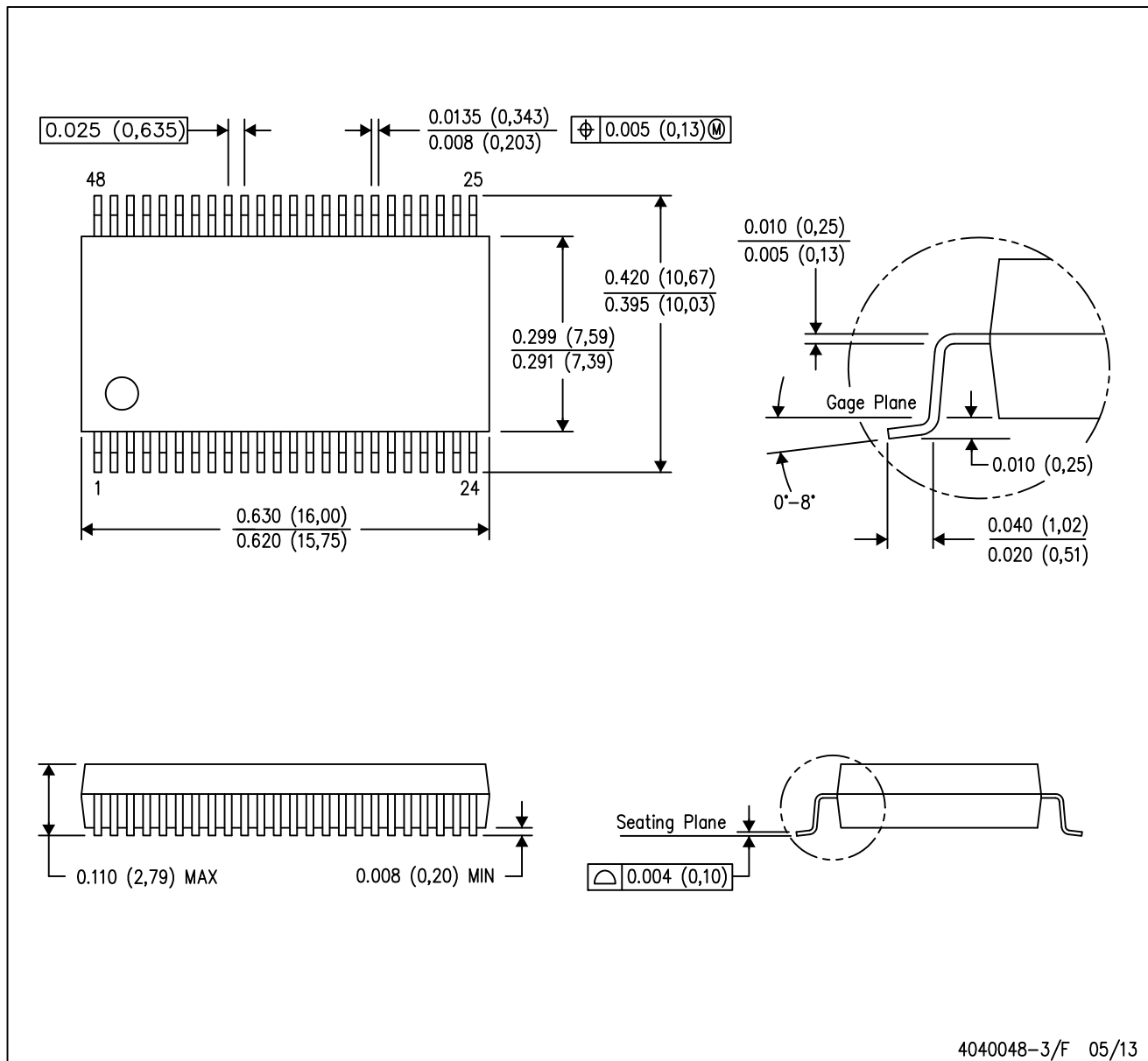


- NOTES: A. All linear dimensions are in millimeters.
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15 per side.
 D. Falls within JEDEC: 24/48 Pins – MO-153
 14/16/20/56 Pins – MO-194

MECHANICAL DATA

DL (R-PDSO-G48)

PLASTIC SMALL-OUTLINE PACKAGE

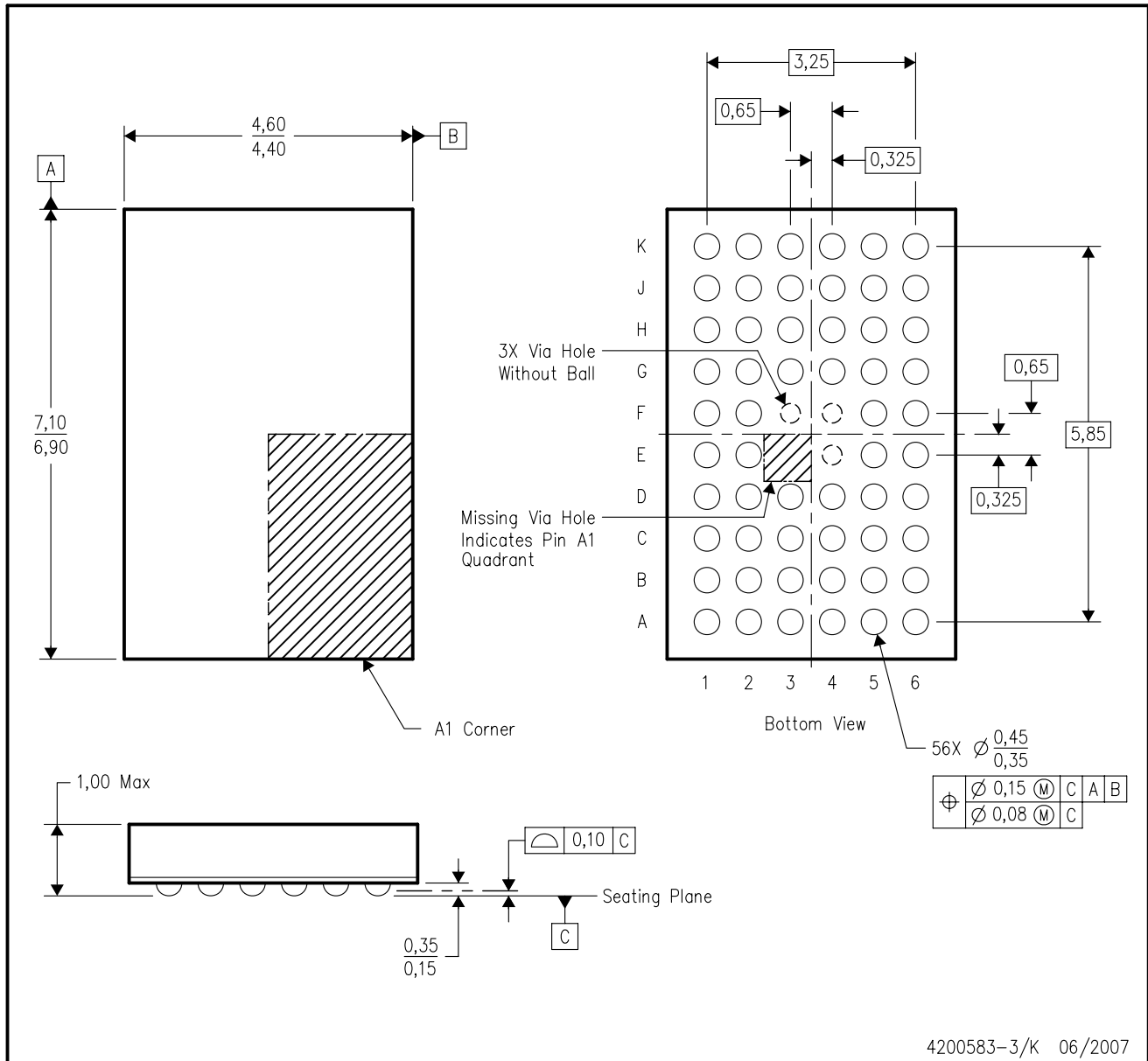


- NOTES:
- All linear dimensions are in inches (millimeters).
 - This drawing is subject to change without notice.
 - Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
 - Falls within JEDEC MO-118

PowerPAD is a trademark of Texas Instruments.

GQL (R-PBGA-N56)

PLASTIC BALL GRID ARRAY

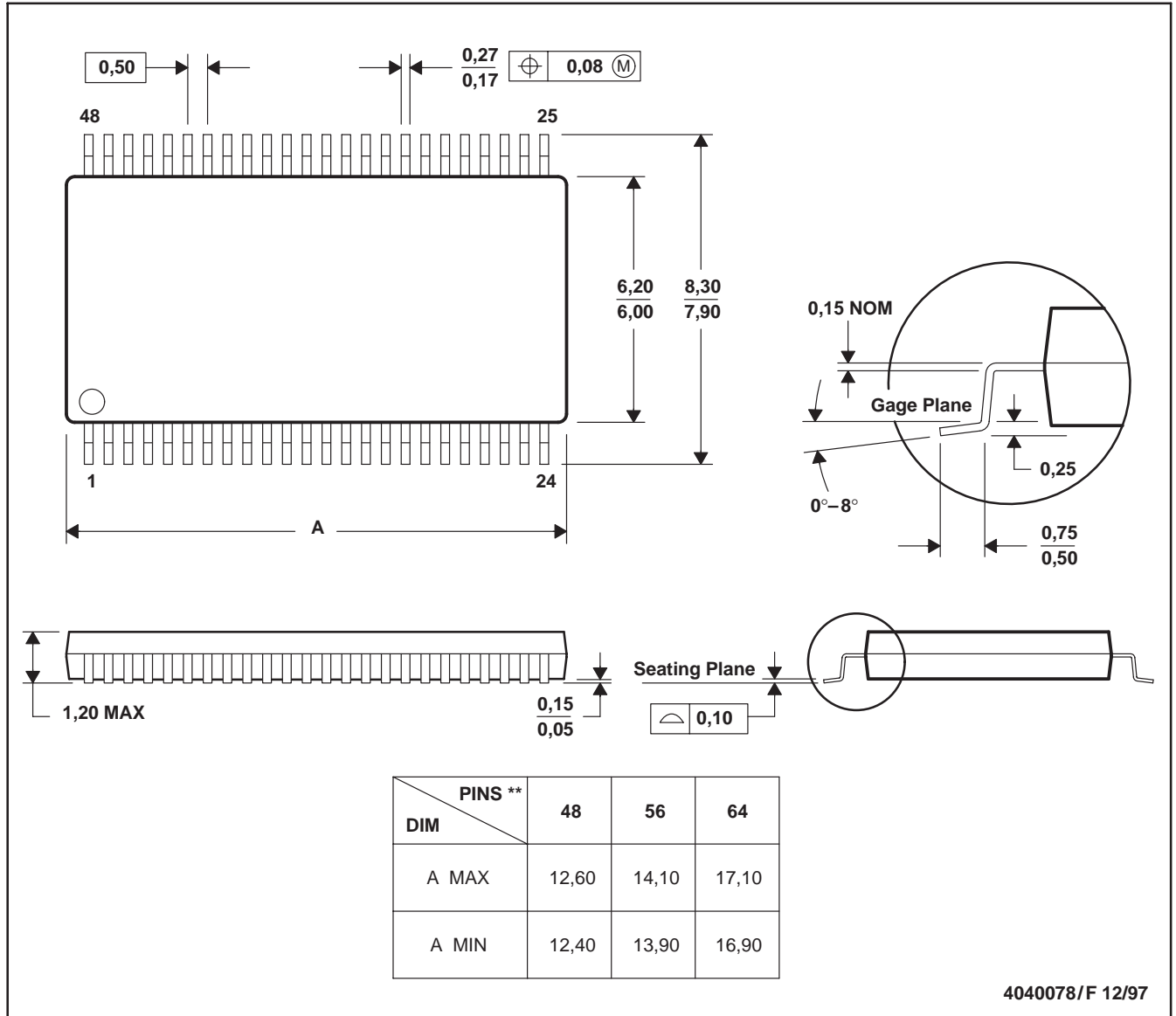


- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
 - B. This drawing is subject to change without notice.
 - C. Falls within JEDEC MO-285 variation BA-2.
 - D. This package is tin-lead (SnPb). Refer to the 56 ZQL package (drawing 4204437) for lead-free.

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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