

SN74ABTE16246

11-BIT INCIDENT-WAVE SWITCHING BUS TRANSCEIVER WITH 3-STATE AND OPEN-COLLECTOR OUTPUTS

SCBS227J – JULY 1993 – REVISED AUGUST 2003

- Member of the Texas Instruments Widebus™ Family
- Supports the VME64 ETL Specification
- Reduced TTL-Compatible Input Threshold Range
- High-Drive Outputs ($I_{OH} = -60\text{ mA}$, $I_{OL} = 90\text{ mA}$) Support Equivalent 25- Ω Incident-Wave Switching
- V_{CCBIAS} Pin Minimizes Signal Distortion During Live Insertion
- Internal Pullup Resistor on $\overline{OE}$ Keeps Outputs in High-Impedance State During Power Up or Power Down
- Distributed V_{CC} and GND Pins Minimize High-Speed Switching Noise
- Equivalent 25- Ω Series Damping Resistor on B Port
- Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors

description/ordering information

The SN74ABTE16246 is an 11-bit noninverting transceiver designed for asynchronous two-way communication between buses. This device has open-collector and 3-state outputs. The device 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 ($\overline{OE}$) input can be used to disable the device so that the buses are effectively isolated. When $\overline{OE}$ is low, the device is active.

The B port has an equivalent 25- Ω series output resistor to reduce ringing. Active bus-hold inputs on the B port hold unused or floating inputs at a valid logic level.

The A port provides for the precharging of the outputs via V_{CCBIAS} , which establishes a voltage between 1.3 V and 1.7 V when V_{CC} is not connected.

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.

DGG OR DL PACKAGE
(TOP VIEW)

11 $\overline{OE}$	1	48	V_{CCBIAS}
11DIR	2	47	11A
11B	3	46	10DIR
GND	4	45	GND
10B	5	44	10A
9B	6	43	9A
V_{CC}	7	42	V_{CC}
8BI	8	41	9DIR
8BO	9	40	8A
GND	10	39	GND
7BO	11	38	7A
6BI	12	37	7BI
6BO	13	36	6A
5BO	14	35	5A
GND	15	34	GND
4BO	16	33	5BI
4BI	17	32	4A
V_{CC}	18	31	V_{CC}
3BO	19	30	3A
2BI	20	29	3BI
GND	21	28	GND
2BO	22	27	2A
1BO	23	26	1A
1BI	24	25	$\overline{OE}$

ORDERING INFORMATION

T_A	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
-40°C to 85°C	SSOP – DL	Tube	SN74ABTE16246DL	ABTE16246
		Tape and reel	SN74ABTE16246DLR	
	TSSOP – DGG	Tape and reel	SN74ABTE16246DGGR	ABTE16246

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



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FUNCTION TABLE

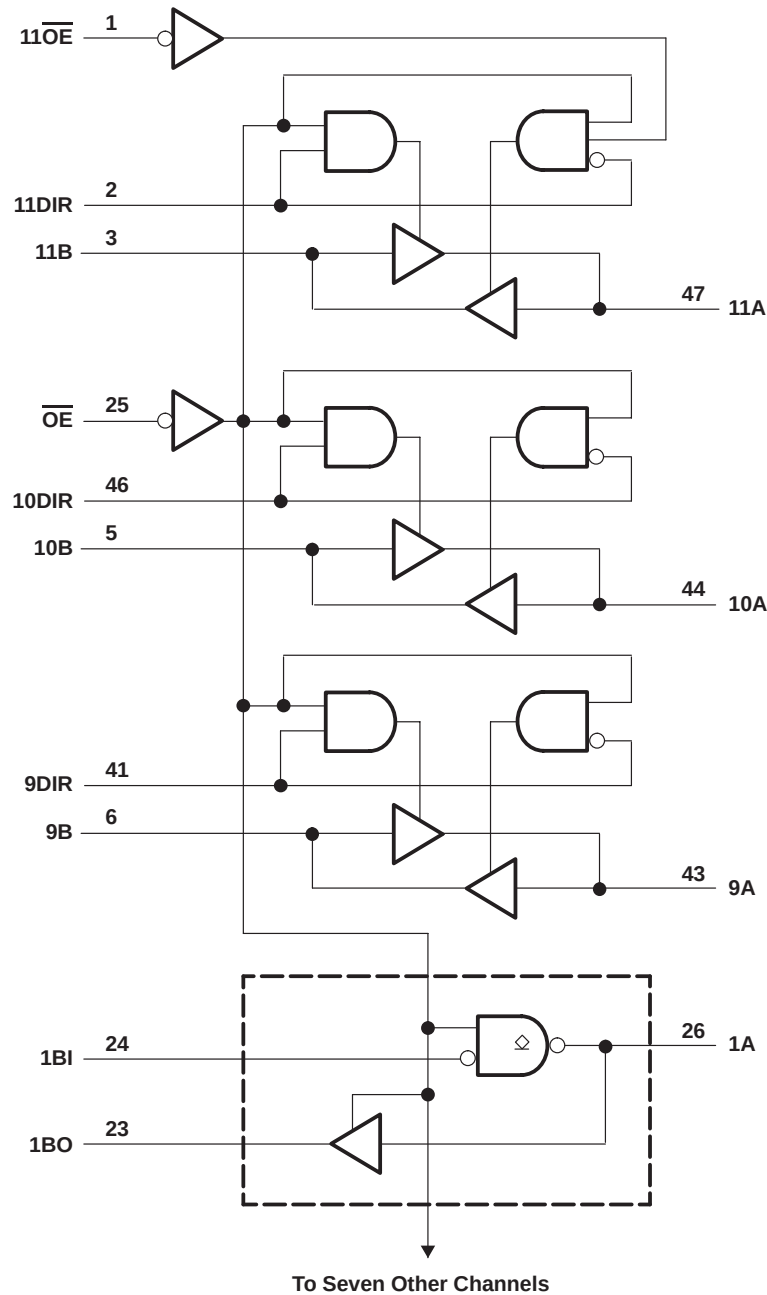
INPUTS					OPERATION
$\overline{\text{OE}}$	9DIR	10DIR	11DIR	$\overline{\text{11OE}}$	
H	X	X	X	X	Isolation
L	X	X	X	X	1BI–8BI data to 1A–8A bus (OC [†]), 1A–8A data to 1BO–8BO bus
L	L	X	X	X	9A data to 9B bus
L	H	X	X	X	9B data to 9A bus
L	X	L	X	X	10A data to 10B bus
L	X	H	X	X	10B data to 10A bus
L	X	X	L	L	11A data to 11B bus
L	X	X	L	H	11A, 11B isolation
L	X	X	H	X	11B data to 11A bus

[†] OC = Open-collector outputs

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logic diagram (positive logic)



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absolute maximum ratings over operating free-air temperature range (unless otherwise noted)[†]

Supply voltage range, V_{CC} and V_{CCBIAS}	–0.5 V to 7 V
Input voltage range, V_I (except I/O ports) (see Note 1)	–0.5 V to 7 V
Voltage range applied to any output in the high or power-off state, V_O	–0.5 V to 5.5 V
Current into any output in the low state, I_O	128 mA
Input clamp current, I_{IK} ($V_I < 0$)	–18 mA
Output clamp current, I_{OK} ($V_O < 0$)	–50 mA
Package thermal impedance, θ_{JA} (see Note 2): DGG package	70°C/W
DL package	63°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. The package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions (see Note 3)

			MIN	NOM	MAX	UNIT
V _{CC} , V _{CCBIAS}	Supply voltage		4.5	5	5.5	V
V _{IH}	High-level input voltage	$\overline{OE}$	2			V
		Except $\overline{OE}$	1.6			
V _{IL}	Low-level input voltage	$\overline{OE}$	0.8			V
		Except $\overline{OE}$	1.4			
V _{OH}	High-level output voltage	1A–8A	0	5.5		V
V _I	Input voltage		0	V _{CC}		V
I _{OH}	High-level output current	B bus	–12			mA
		9A–11A	–64			
I _{OL}	Low-level output current	B bus	12			mA
		A bus	90			
Δt/Δv	Input transition rise or fall rate	Outputs enabled	10			ns/V
T _A	Operating free-air temperature		–40	85		°C

NOTE 3: 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} = 4.5 V, I _I = −18 mA				−1.2	V
V _{OH}	B port	V _{CC} = 5.5 V,	I _{OH} = −100 μA			V _{CC} −0.2	V
		V _{CC} = 4.5 V	I _{OH} = −1 mA	2.4			
		I _{OH} = −12 mA	2				
	9A–11A	V _{CC} = 5.5 V,	I _{OH} = −1 mA	4.5			
		V _{CC} = 4.5 V	I _{OH} = −32 mA	2.4			
			I _{OH} = −64 mA	2			
I _{OH}	1A–8A	V _{CC} = 4.5 V,	V _{OH} = 5.5 V	20		μA	
V _{OL}	B port	V _{CC} = 4.5 V	I _{OL} = 1 mA	0.4		V	
			I _{OL} = 12 mA	0.8			
	A port	V _{CC} = 4.5 V	I _{OL} = 64 mA	0.55			
			I _{OL} = 90 mA	0.9			
V _{hys}				100		mV	
I _I (hold)	B port	V _{CC} = 4.5 V	V _I = 0.8 V	100		μA	
			V _I = 2 V	−100			
		V _{CC} = 5.5 V,	V _I = 0 to 5.5 V	±500			
I _I	Control inputs	V _{CC} = 5.5 V	V _I = V _{CC} or GND	±1		μA	
	A or B ports	V _{CC} = 5.5 V, $\overline{OE}$ = V _{CC}		±20			
I _{OZH} [‡]	9A–11A	V _{CC} = 5.5 V,	V _O = 2.7 V	10		μA	
I _{OZL} [‡]	9A–11A	V _{CC} = 5.5 V,	V _O = 0.5 V	−10		μA	
I _O	A port	V _{CC} = 5.5 V,	V _O = 2.5 V	−50	−180	mA	
	B port			−25	−90		
I _{off}		V _{CC} = 0, V _I or V _O ≤ 4.5 V,	V _{CC} BIAS = 0	±100		μA	
I _{CC}	A or B ports	V _{CC} = 5.5 V, I _O = 0, V _I = V _{CC} or GND	Outputs high	28	36	mA	
			Outputs low	38	48		
			Outputs disabled	20	32		
I _{CCD}	A or B ports	V _{CC} = 5 V, C _L = 50 pF	$\overline{OE}$ high	0.02		mA/ MHz	
			$\overline{OE}$ low	0.33			
C _i	Control inputs	V _I = 2.5 V or 0.5 V		2.5	4	pF	
C _{iO}	I/O ports	V _O = 2.5 V or 0.5 V		4.5	8	pF	

[†] All typical values are at $V_{CC} = 5\text{ V}$, $T_A = 25^\circ\text{C}$.

[‡] The parameters I_{OZH} and I_{OZL} include the input leakage current.

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live-insertion specifications over recommended operating free-air temperature range

PARAMETER		TEST CONDITIONS			MIN	TYP [†]	MAX	UNIT
I_{CC} (V_{CCBIAS})		$V_{CC} = 0$ to 4.5 V,	$V_{CCBIAS} = 4.5$ V to 5.5 V,	$I_{O(DC)} = 0$		250	700	μA
		$V_{CC} = 4.5$ V to 5.5 V [‡] ,	$V_{CCBIAS} = 4.5$ V to 5.5 V,	$I_{O(DC)} = 0$			20	
V_O	A port	$V_{CC} = 0$	$V_{CCBIAS} = 4.5$ V to 5.5 V		1.1	1.5	1.9	V
			$V_{CCBIAS} = 4.75$ V to 5.25 V		1.3	1.5	1.7	
I_O	A port	$V_{CC} = 0$,	$V_{CCBIAS} = 4.5$ V	$V_O = 0$	-20		-100	μA
				$V_O = 3$ V	20		100	

[†] All typical values are at $V_{CC} = 5$ V, $T_A = 25^\circ C$.[‡] $V_{CC} - 0.5$ V < V_{CCBIAS}

switching characteristics over recommended ranges of supply voltage and operating free-air temperature, $C_L = 50$ pF (unless otherwise noted) (see Figure 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CC} = 5$ V, $T_A = 25^\circ C$			MIN	MAX	UNIT
			MIN	TYP	MAX			
t_{PLH}	A	B	1.5	3.1	4.2	1.5	5.2	ns
t_{PHL}			1.5	3.5	4.6	1.5	5.2	
t_{PLH}	9B–11B	9A–11A	1.5	3	3.8	1.5	4.5	ns
t_{PHL}			1.5	3.2	4	1.5	4.5	
$t_{PLH}^{\S}$	1B–8B	1A–8A	1.5	3.2	4	1.5	4.5	ns
$t_{PLH}^{\P}$			7.5	8.9	9.7	7.5	10.3	
t_{PHL}			1.5	3.2	4	1.5	4.5	
t_{PZH}	$\overline{OE}$	9A–11A	2	4.3	5.3	2	6.2	ns
t_{PZL}		1A–11A	2	4.4	5.4	2	6.8	
t_{PZH}	$\overline{OE}$	B	2	4.3	6	2	7.1	ns
t_{PZL}			2	4.5	6.4	2	7.3	
t_{PHZ}	$\overline{OE}$	9A–11A	2	4.2	5.9	2	6.7	ns
t_{PLZ}		1A–11A	2	3.5	4.6	2	5.1	
t_{PHZ}	$\overline{OE}$	B	2.5	4.3	6.2	2.5	7	ns
t_{PLZ}			2	3.6	5	2	5.5	

^{\S} Measurement point is $V_{OL} + 0.3$ V.^{\P} Measurement point is $V_{OL} + 1.5$ V.

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extended switching characteristics over recommended ranges of supply voltage and operating free-air temperature, $C_L = 50$ pF (unless otherwise noted) (see Figure 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD	$V_{CC} = 5$ V, $T_A = 25^\circ\text{C}$			MIN	MAX	UNIT
				MIN	TYP	MAX			
t_{PLH}	9B–11B	9A–11A	$R_X = 13\ \Omega$	1.5	3.2	4	1.5	4.8	ns
t_{PHL}				1.5	3.8	4.7	1.5	5.6	
t_{PHL}	1B–8B	1A–8A	$R_X = 13\ \Omega$	1.5	3.3	4.2	1.5	4.8	ns
t_{PLH}	9B–11B	9A–11A	$R_X = 26\ \Omega$	1.5	3.1	4	1.5	4.6	ns
t_{PHL}				1.5	3.5	4.4	1.5	4.9	
t_{PHL}	1B–8B	1A–8A	$R_X = 26\ \Omega$	1.5	3.1	4	1.5	4.4	ns
t_{PLH}	9B–11B	1A–8A	$R_X = 56\ \Omega$	1.5	3	3.8	1.5	4.5	ns
t_{PHL}				1.5	3.3	4.2	1.5	4.7	
t_{PHL}	1B–8B	1A–8A	$R_X = 56\ \Omega$	1.5	3	4	1.5	4.4	ns
$t_{sk(p)}$	B	A	$R_X = \text{Open}$		0.1	0.6		2	ns
	A	B	$R_X = \text{Open}$		0.4	0.8		2	
	B	A	$R_X = 26\ \Omega$		0.3	0.8		2	
$t_{sk(o)}$	B	A	$R_X = \text{Open}$		0.3	0.7		1.3	ns
	A	B	$R_X = \text{Open}$		0.7	1.1		1.3	
	B	A	$R_X = 26\ \Omega$		0.5	1		1.3	
$t_t^\dagger$	B	A	$R_X = 26\ \Omega$	0.5	0.8	1.5	0.5	1.5	ns
$t_t^\ddagger$	A	B	$R_X = \text{Open}$	3.5	5.5	7.3	3.5	7.9	ns

$^\dagger t_t$ is measured between 1 V and 2 V of the output waveform.

$^\ddagger t_t$ is measured between 10% and 90% of the output waveform.

extended output characteristics over recommended ranges of supply voltage and operating free-air temperature, $C_L = 50$ pF (see Figures 1 and 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	LOAD	MIN	MAX	UNIT
$t_{sk(temp)}$	A	B	$V_{CC} = \text{constant},$ $\Delta T_A = 20^\circ\text{C}$			2.5	ns
	B	A		$R_X = 56\ \Omega$		4	
$t_{sk(load)}$	B	A	$V_{CC} = \text{constant},$ Temperature = constant	$R_X = 13, 26, \text{ or } 56\ \Omega$		4	ns

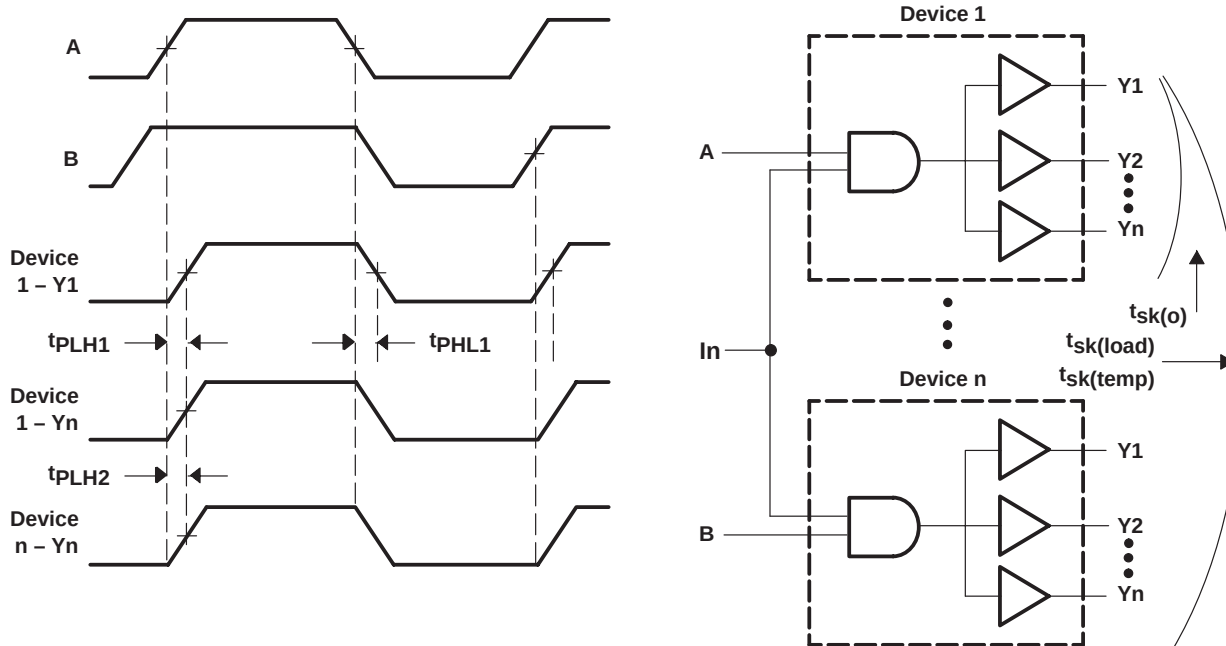
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PARAMETER MEASUREMENT INFORMATION



- NOTES:
- A. Pulse skew, $t_{sk(p)}$, is defined as the difference in propagation-delay times t_{PLH1} and t_{PHL1} on the same terminal at identical operating conditions.
 - B. Output skew, $t_{sk(o)}$, is defined as the difference in propagation delay of any two outputs of the same device switching in the same direction (e.g., $|t_{PLH1} - t_{PLH2}|$).
 - C. Temperature skew, $t_{sk(temp)}$, is the output skew of two devices, both having the same value of $V_{CC} \pm 1\%$ and with package temperature differences of 20°C .
 - D. Load skew, $t_{sk(load)}$, is measured with R_X in Figure 2 at $13\ \Omega$ for one unit and $56\ \Omega$ for the other unit.

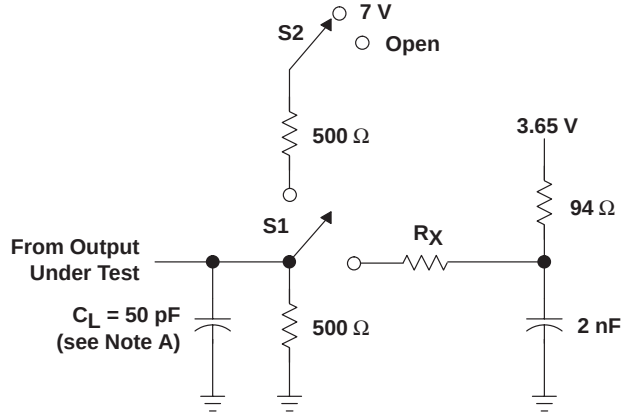
Figure 1. Voltage Waveforms for Extended Characteristics

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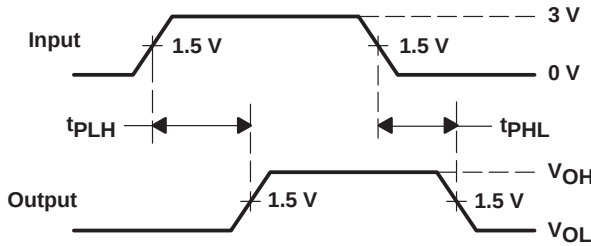
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PARAMETER MEASUREMENT INFORMATION



$R_X = 13, 26, \text{ or } 56 \Omega$

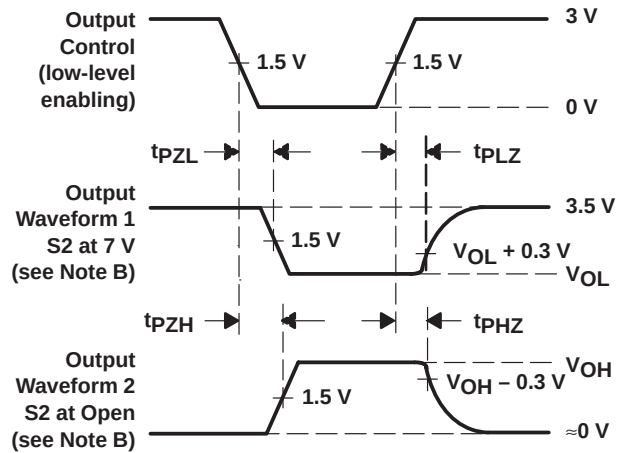
LOAD CIRCUIT



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES

SWITCHING TABLE LOADS	S1	S2
t_{PLH}/t_{PHL} (9A–11A and B port)	Up	Open
t_{PLH}/t_{PHL} (1A–8A)	Up	7 V
t_{PLZ}/t_{PZL}	Up	7 V
t_{PHZ}/t_{PZH} (except 1A–8A)	Up	Open

EXTENDED SWITCHING TABLE LOADS	S1	S2
$t_{PLH}/t_{PHL}/t_{sk}$ (A port)	Down	X
$t_{PLH}/t_{PHL}/t_{sk}$ (B port)	Up	Open
t_t (A port) (see Note E)	Down	X
t_t (B port) (see Note F)	Up	Open



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

- 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.
 E. t_t is measured between 1 V and 2 V of the output waveform.
 F. t_t is measured between 10% and 90% of the output waveform.

Figure 2. Load Circuit and Voltage Waveforms

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package Pins	Package qty Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
74ABTE16246DGGRG4	Active	Production	TSSOP (DGG) 48	2000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABTE16246
74ABTE16246DGGRG4.B	Active	Production	TSSOP (DGG) 48	2000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABTE16246
SN74ABTE16246DGGR	Active	Production	TSSOP (DGG) 48	2000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABTE16246
SN74ABTE16246DGGR.B	Active	Production	TSSOP (DGG) 48	2000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABTE16246
SN74ABTE16246DL	Active	Production	SSOP (DL) 48	25 TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABTE16246
SN74ABTE16246DL.B	Active	Production	SSOP (DL) 48	25 TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABTE16246
SN74ABTE16246DLR	Active	Production	SSOP (DL) 48	1000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABTE16246
SN74ABTE16246DLR.B	Active	Production	SSOP (DL) 48	1000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABTE16246

⁽¹⁾ **Status:** For more details on status, see our [product life cycle](#).

⁽²⁾ **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

⁽³⁾ **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

⁽⁴⁾ **Lead finish/Ball material:** Parts 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.

⁽⁵⁾ **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

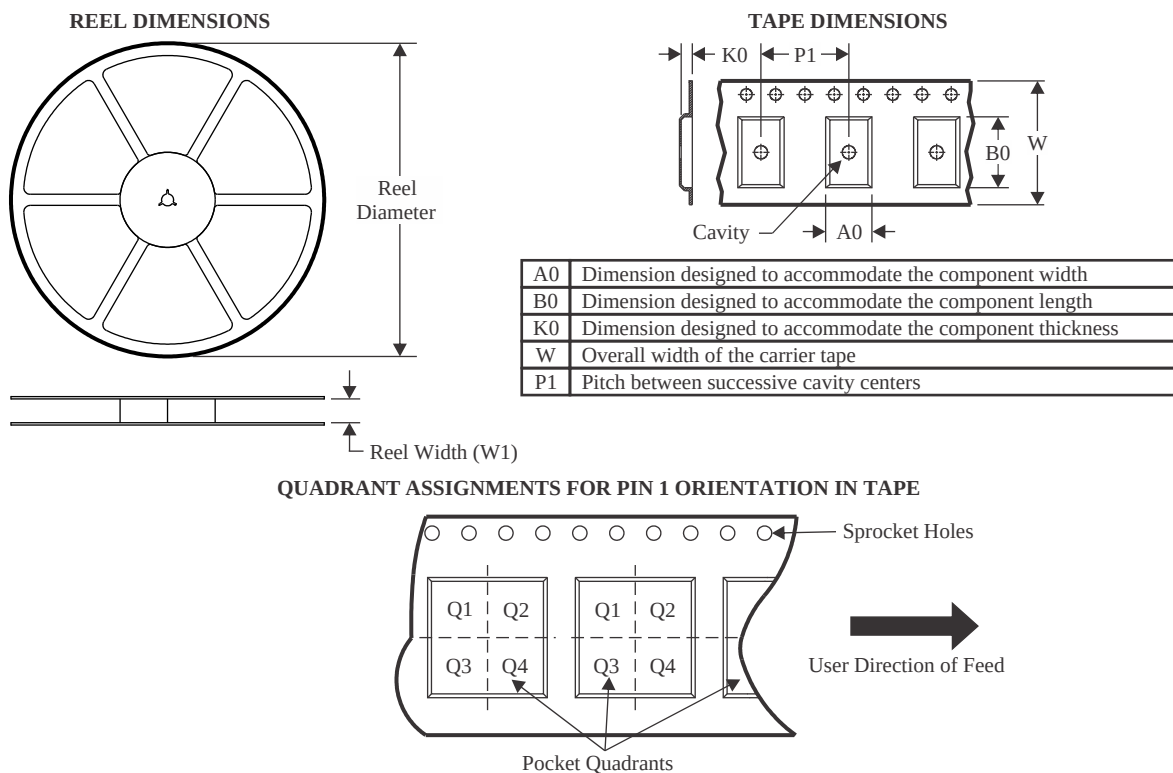
⁽⁶⁾ **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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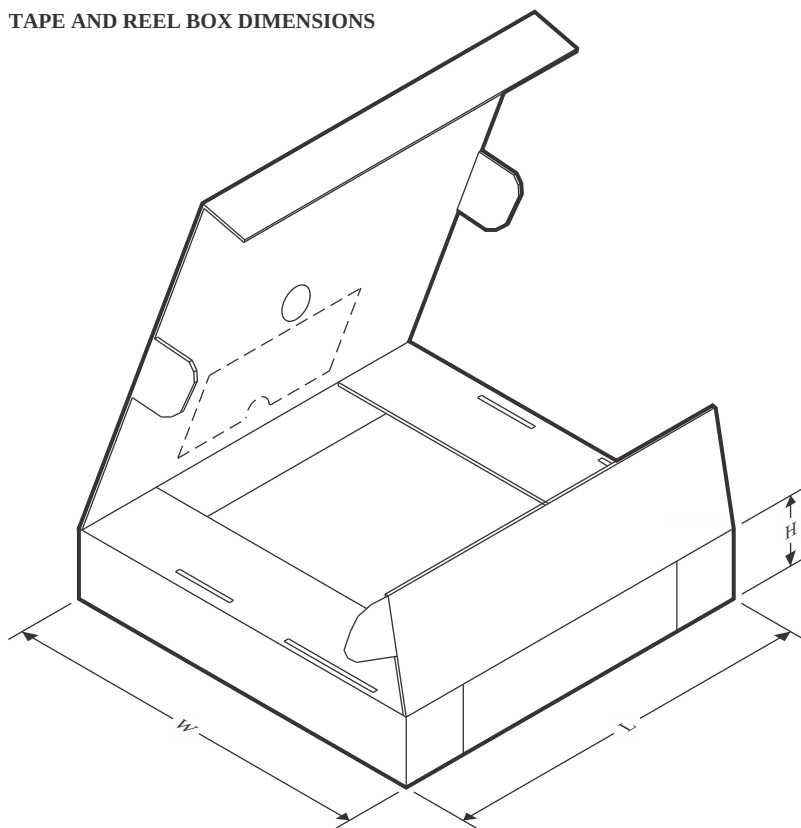
TAPE AND REEL INFORMATION



*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
74ABTE16246DGGRG4	TSSOP	DGG	48	2000	330.0	24.4	8.6	13.0	1.8	12.0	24.0	Q1
SN74ABTE16246DGGR	TSSOP	DGG	48	2000	330.0	24.4	8.6	13.0	1.8	12.0	24.0	Q1
SN74ABTE16246DLR	SSOP	DL	48	1000	330.0	32.4	11.35	16.2	3.1	16.0	32.0	Q1

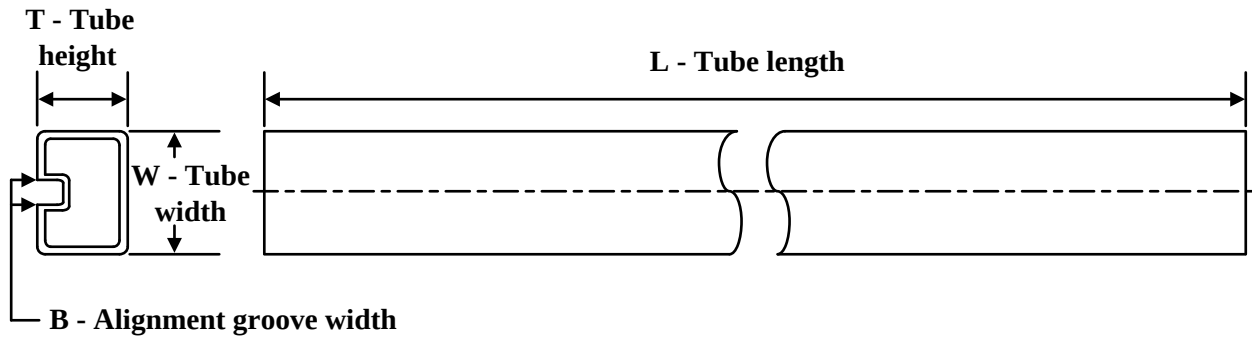
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
74ABTE16246DGGRG4	TSSOP	DGG	48	2000	356.0	356.0	45.0
SN74ABTE16246DGGR	TSSOP	DGG	48	2000	356.0	356.0	45.0
SN74ABTE16246DLR	SSOP	DL	48	1000	356.0	356.0	53.0

TUBE

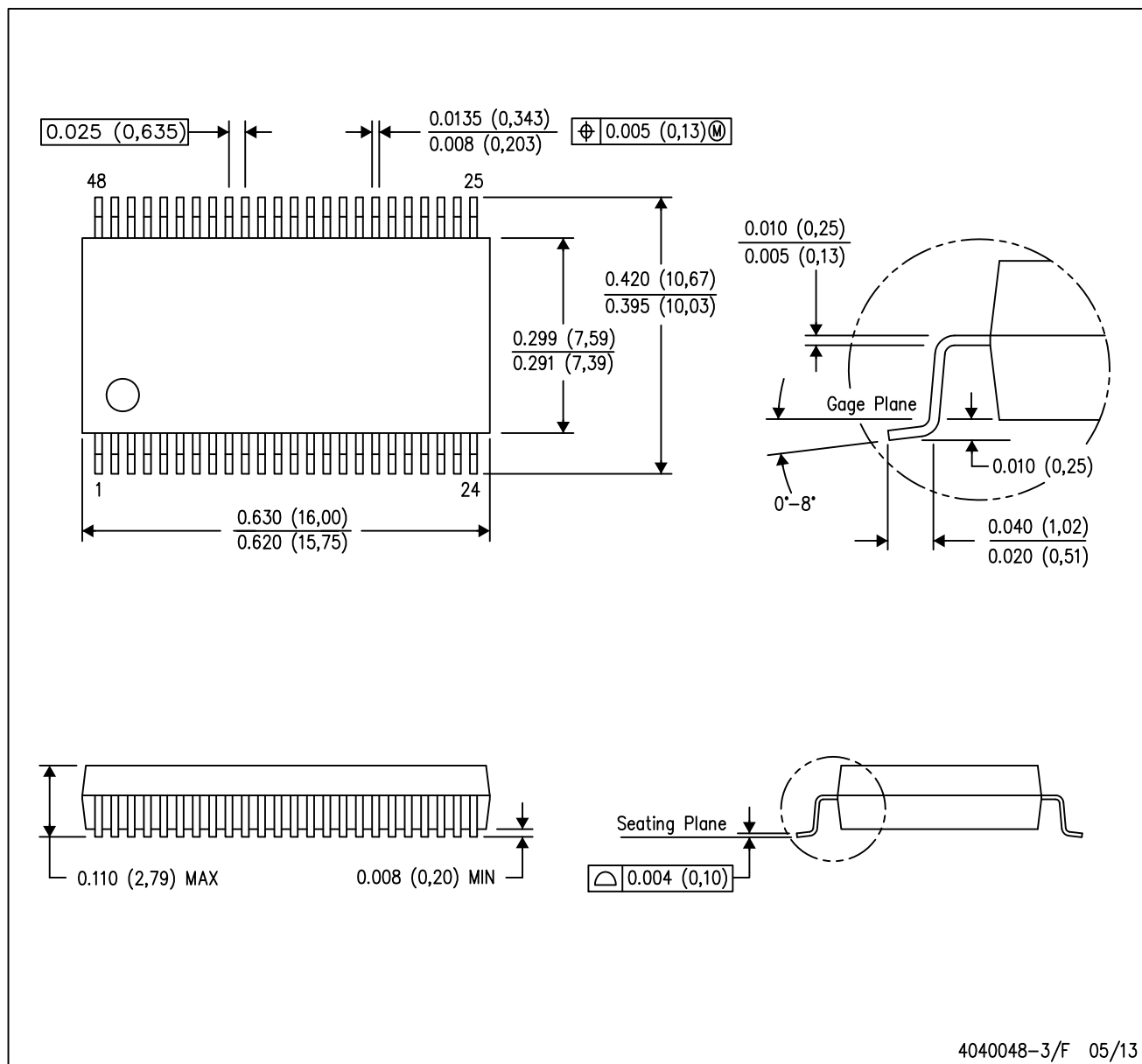


*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
SN74ABTE16246DL	DL	SSOP	48	25	473.7	14.24	5110	7.87
SN74ABTE16246DL.B	DL	SSOP	48	25	473.7	14.24	5110	7.87

DL (R-PDSO-G48)

PLASTIC SMALL-OUTLINE PACKAGE



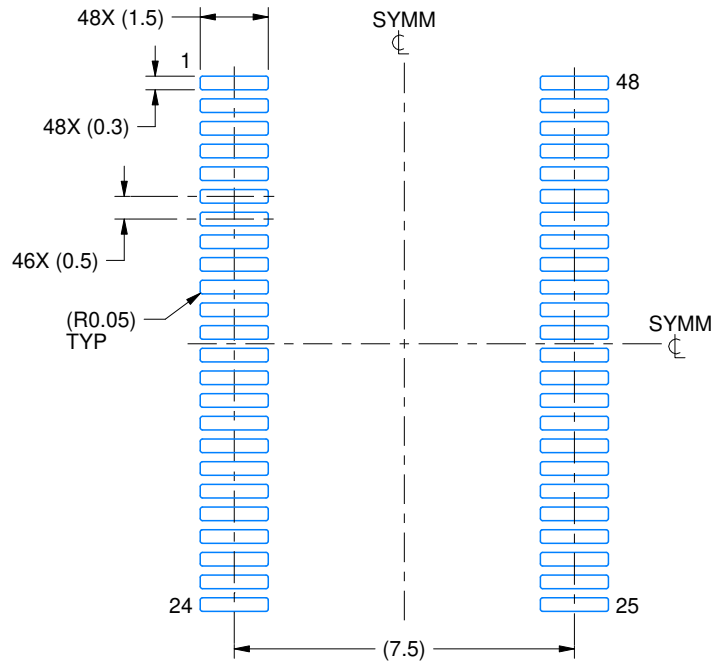
- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
 - D. Falls within JEDEC MO-118

EXAMPLE BOARD LAYOUT

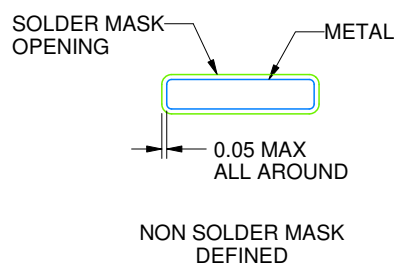
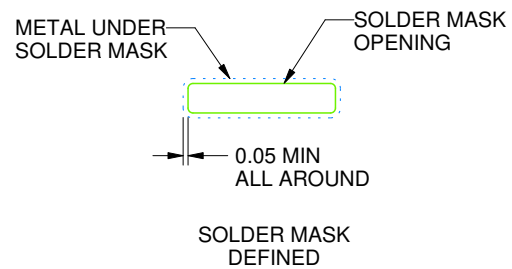
DGG0048A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
SCALE:6X



SOLDER MASK DETAILS

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NOTES: (continued)

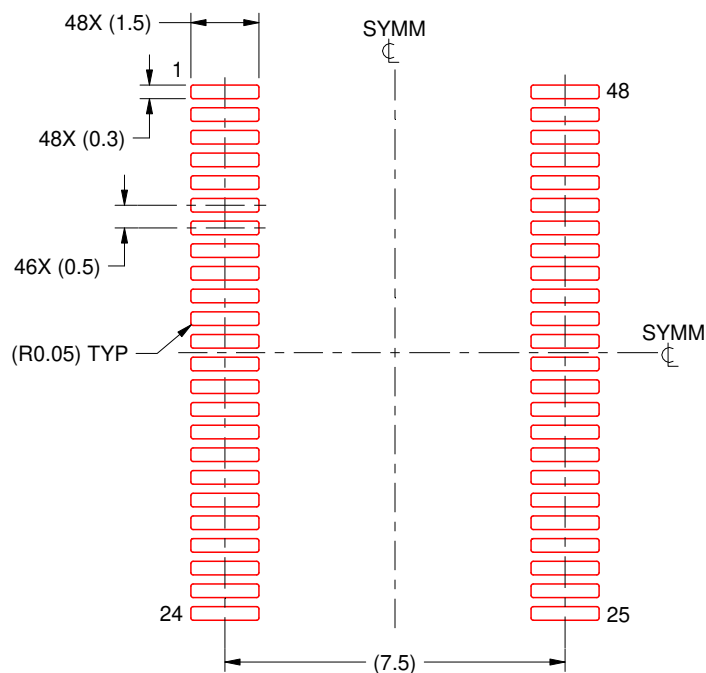
5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DGG0048A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



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

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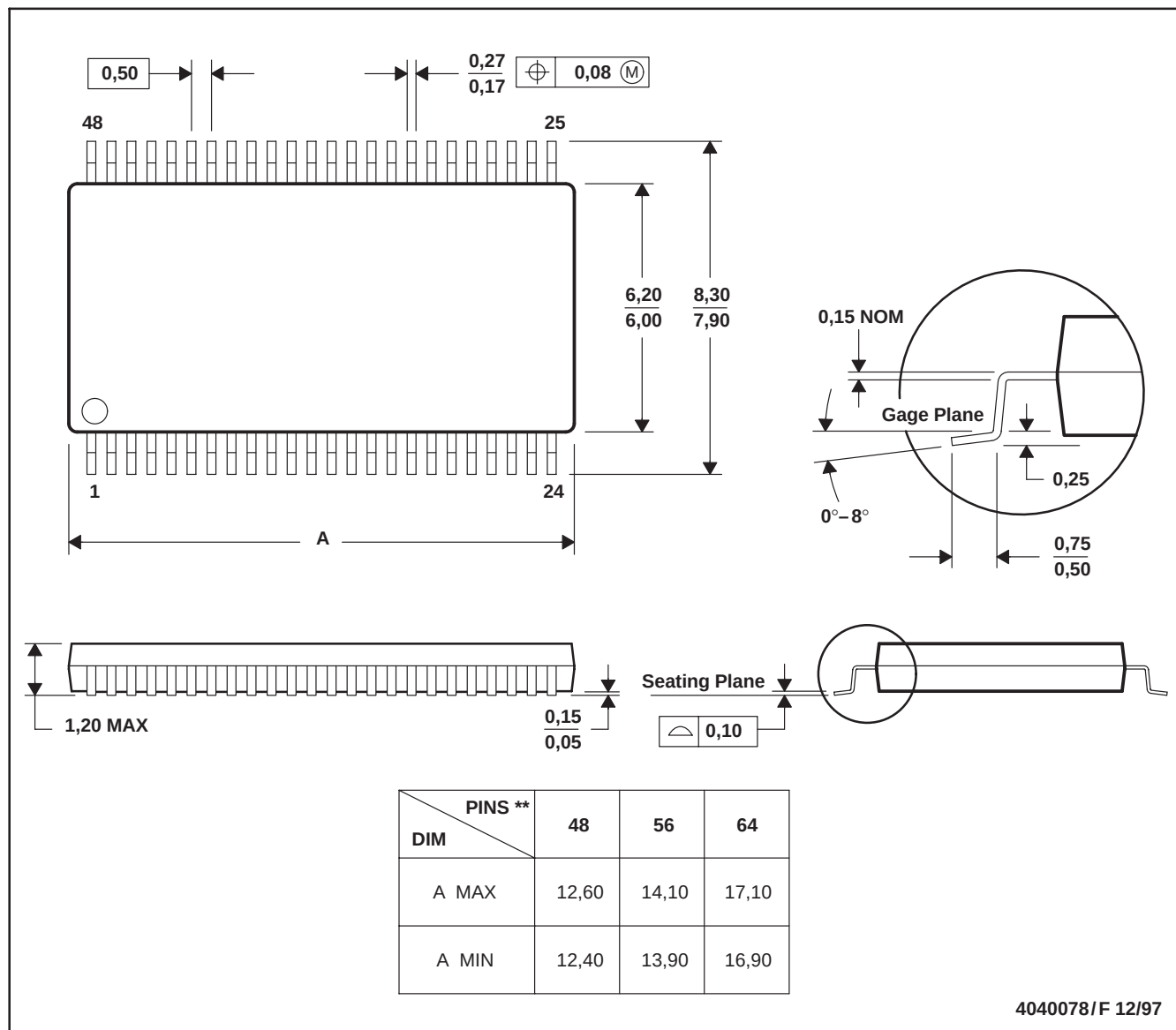
NOTES: (continued)

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



- 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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