

FEATURES

- Member of the Texas Instruments Widebus™ Family
- Max t_{pd} of 5.8 ns at 3.3 V
- ± 24 -mA Output Drive at 3.3 V
- Control Inputs V_{IH}/V_{IL} Levels Are Referenced to V_{CCA} Voltage
- Latch-Up Performance Exceeds 250 mA Per JESD 17

NOTE: New and improved versions of the SN74ALVC164245 are available. The new part numbers are SN74LVC16T245 and SN74LVCH16T245 and should be considered for new designs.

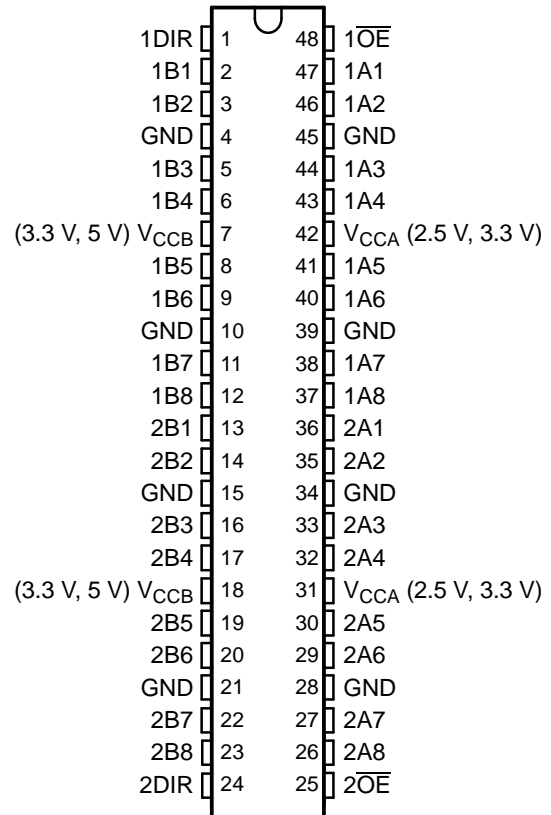
DESCRIPTION/ORDERING INFORMATION

This 16-bit (dual-octal) noninverting bus transceiver contains two separate supply rails. B port has V_{CCB} , which is set to operate at 3.3 V and 5 V. A port has V_{CCA} , which is set to operate at 2.5 V and 3.3 V. This allows for translation from a 2.5-V to a 3.3-V environment, and vice versa, or from a 3.3-V to a 5-V environment, and vice versa.

The SN74ALVC164245 is designed for asynchronous communication between data buses. The control circuitry (1DIR, 2DIR, $1\overline{OE}$, and $2\overline{OE}$) is powered by V_{CCA} .

To ensure the high-impedance state during power up or power down, the output-enable (\overline{OE}) input 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.

DGG OR DL PACKAGE
(TOP VIEW)



ORDERING INFORMATION

T_A	PACKAGE ⁽¹⁾		ORDERABLE PART NUMBER	TOP-SIDE MARKING
-40°C to 85°C	FBGA – GRD	Tape and reel	74ALVC164245GRDR	VC4245
	FBGA – ZRD (Pb-free)		74ALVC164245ZRDR	
	SSOP – DL	Tube of 25	SN74ALVC164245DL	ALVC164245
		Reel of 1000	SN74ALVC164245DLR 74ALVC164245DLRG4	
	TSSOP – DGG	Reel of 2000	SN74ALVC164245DGGR	ALVC164245
			74ALVC164245DGGRG4	
		Reel of 250	SN74ALVC164245DGGT	
			74ALVC164245DGGTE4	
	VFBGA – GQL	Reel of 1000	SN74ALVC164245KR	VC4245
	VFBGA – ZQL (Pb-free)		74ALVC164245ZQLR	

(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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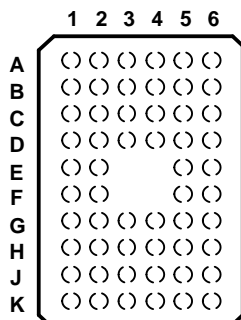
SN74ALVC164245
16-BIT 2.5-V TO 3.3-V/3.3-V TO 5-V LEVEL-SHIFTING TRANSCEIVER
WITH 3-STATE OUTPUTS

SCAS416P—MARCH 1994—REVISED NOVEMBER 2005

DESCRIPTION/ORDERING INFORMATION (CONTINUED)

The logic levels of the direction-control (DIR) input and the output-enable (\overline{OE}) input activate either the B-port outputs or the A-port outputs or place both output ports into the high-impedance mode. The device transmits data from the A bus to the B bus when the B-port outputs are activated, and from the B bus to the A bus when the A-port outputs are activated. The input circuitry on both A and B ports always is active and must have a logic HIGH or LOW level applied to prevent excess I_{CC} and I_{CCZ} .

GQL OR ZQL PACKAGE
(TOP VIEW)

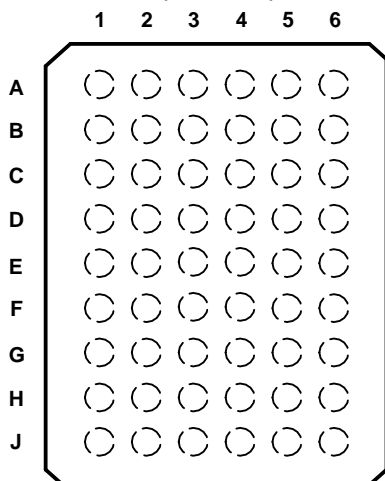


TERMINAL ASSIGNMENTS⁽¹⁾
(56-Ball GQL/ZQL Package)

	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 _{CCB}	V _{CCA}	1A3	1A4
D	1B6	1B5	GND	GND	1A5	1A6
E	1B8	1B7			1A7	1A8
F	2B1	2B2			2A2	2A1
G	2B3	2B4	GND	GND	2A4	2A3
H	2B5	2B6	V _{CCB}	V _{CCA}	2A6	2A5
J	2B7	2B8	GND	GND	2A8	2A7
K	2DIR	NC	NC	NC	NC	2 \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	1B1	NC	1DIR	1 \overline{OE}	NC	1A1
B	1B3	1B2	NC	NC	1A2	1A3
C	1B5	1B4	V _{CCB}	V _{CCA}	1A4	1A5
D	1B7	1B6	GND	GND	1A6	1A7
E	2B1	1B8	GND	GND	1A8	2A1
F	2B3	2B2	GND	GND	2A2	2A3
G	2B5	2B4	V _{CCB}	V _{CCA}	2A4	2A5
H	2B7	2B6	NC	NC	2A6	2A7
J	2B8	NC	2DIR	2 \overline{OE}	NC	2A8

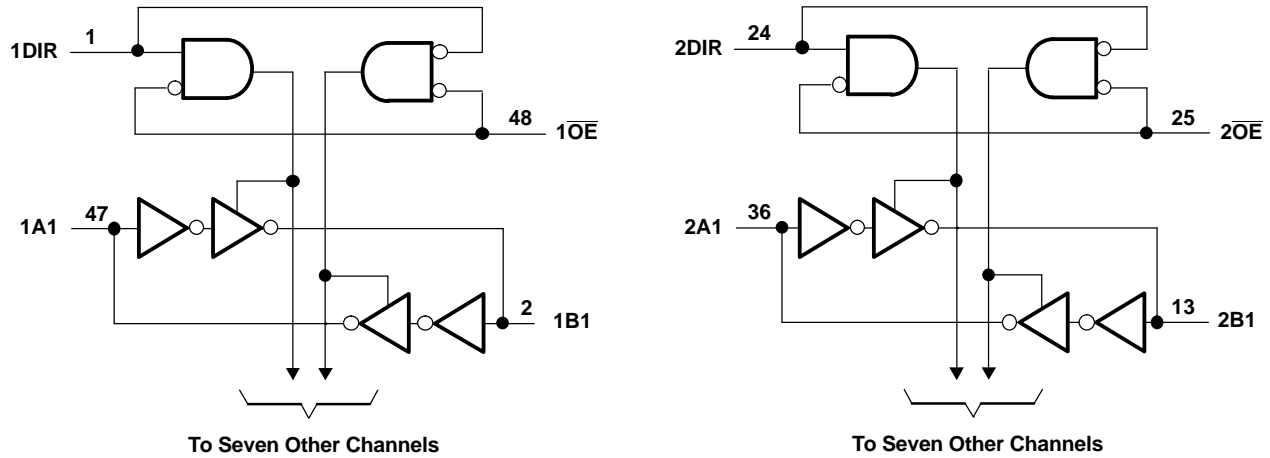
(1) NC – No internal connection

FUNCTION TABLE⁽¹⁾
(EACH 8-BIT SECTION)

CONTROL INPUTS		OUTPUT CIRCUITS		OPERATION
\overline{OE}	DIR	A PORT	B PORT	
L	L	Enabled	Hi-Z	B data to A bus
L	H	Hi-Z	Enabled	A data to B bus
H	X	Hi-Z	Hi-Z	Isolation

(1) Input circuits of the data I/Os always are active.

LOGIC DIAGRAM (POSITIVE LOGIC)



Absolute Maximum Ratings⁽¹⁾

over operating free-air temperature range for V_{CCB} at 5 V and V_{CCA} at 3.3 V (unless otherwise noted)

		MIN	MAX	UNIT		
V_{CC}	Supply voltage range	V_{CCA}	-0.5	4.6	V	
		V_{CCB}	-0.5	6		
V_I	Input voltage range	Except I/O ports ⁽²⁾	-0.5	6	V	
		I/O port A ⁽³⁾	-0.5	$V_{CCA} + 0.5$		
		I/O port B ⁽²⁾	-0.5	$V_{CCB} + 0.5$		
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⁾	DGG package		70	°C/W	
		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) This value is limited to 6 V maximum.
- (3) This value is limited to 4.6 V maximum.
- (4) The package thermal impedance is calculated in accordance with JESD 51-7.

SN74ALVC164245
16-BIT 2.5-V TO 3.3-V/3.3-V TO 5-V LEVEL-SHIFTING TRANSCEIVER
WITH 3-STATE OUTPUTS

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Recommended Operating Conditions⁽¹⁾

for V_{CCB} at 3.3 V and 5 V

		MIN	MAX	UNIT
V_{CCB}	Supply voltage	3	5.5	V
V_{IH}	High-level input voltage	2		V
V_{IL}	Low-level input voltage	$V_{CCB} = 3 \text{ V to } 3.6 \text{ V}$		V
		$V_{CCB} = 4.5 \text{ V to } 5.5 \text{ V}$		
V_{IB}	Input voltage	0	V_{CCB}	V
V_{OB}	Output voltage	0	V_{CCB}	V
I_{OH}	High-level output current		-24	mA
I_{OL}	Low-level output current		24	mA
$\Delta t/\Delta v$	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.

Recommended Operating Conditions⁽¹⁾

for V_{CCA} at 2.5 V and 3.3 V

		MIN	MAX	UNIT
V_{CCA}	Supply voltage	2.3	3.6	V
V_{IH}	High-level input voltage	$V_{CCA} = 2.3 \text{ V to } 2.7 \text{ V}$		V
		$V_{CCA} = 3 \text{ V to } 3.6 \text{ V}$		
V_{IL}	Low-level input voltage	$V_{CCA} = 2.3 \text{ V to } 2.7 \text{ V}$		V
		$V_{CCA} = 3 \text{ V to } 3.6 \text{ V}$		
V_{IA}	Input voltage	0	V_{CCA}	V
V_{OA}	Output voltage	0	V_{CCA}	V
I_{OH}	High-level output current	$V_{CCA} = 2.3 \text{ V}$		mA
		$V_{CCA} = 3 \text{ V}$		
I_{OL}	Low-level output current	$V_{CCA} = 2.3 \text{ V}$		mA
		$V_{CCA} = 3 \text{ V}$		
$\Delta t/\Delta v$	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.

Electrical Characteristics

over recommended operating free-air temperature range for $V_{CCA} = 2.7\text{ V to }3.6\text{ V}$ and $V_{CCB} = 4.5\text{ V to }5.5\text{ V}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	V_{CCA}	V_{CCB}	MIN	TYP ⁽¹⁾	MAX	UNIT
V_{OH}	B to A	$I_{OH} = -100\ \mu\text{A}$	2.7 V to 3.6 V		$V_{CC} - 0.2$			V
		$I_{OH} = -12\ \text{mA}$	2.7 V		2.2			
		$I_{OH} = -24\ \text{mA}$	3 V		2.4			
	A to B	$I_{OH} = -100\ \mu\text{A}$		4.5 V	4.3			
				5.5 V	5.3			
		$I_{OH} = -24\ \text{mA}$		4.5 V	3.7			
			5.5 V	4.7				
V_{OL}	B to A	$I_{OL} = 100\ \mu\text{A}$	2.7 V to 3.6 V				0.2	V
		$I_{OL} = 12\ \text{mA}$	2.7 V				0.4	
		$I_{OL} = 24\ \text{mA}$	3 V				0.55	
	A to B	$I_{OL} = 100\ \mu\text{A}$		4.5 V to 5.5 V			0.2	
				4.5 V to 5.5 V			0.55	
		$I_{OL} = 24\ \text{mA}$						
I_i	Control inputs	$V_i = V_{CCA}/V_{CCB}$ or GND	3.6 V	5.5 V			± 5	μA
$I_{OZ}^{(2)}$	A or B port	$V_O = V_{CCA}/V_{CCB}$ or GND	3.6 V	5.5 V			± 10	μA
I_{CC}		$V_i = V_{CCA}/V_{CCB}$ or GND, $I_O = 0$	3.6 V	5.5 V			40	μA
$\Delta I_{CC}^{(3)}$		One input at $V_{CCA}/V_{CCB} - 0.6\text{ V}$, Other inputs at V_{CCA}/V_{CCB} or GND	3 V to 3.6 V	4.5 V to 5.5 V			750	μA
C_i	Control inputs	$V_i = V_{CCA}/V_{CCB}$ or GND	3.3 V	5 V		6.5		pF
C_{io}	A or B port	$V_O = V_{CCA}/V_{CCB}$ or GND	3.3 V	3.3 V		8.5		pF

(1) Typical values are measured at $V_{CCA} = 3.3\text{ V}$ and $V_{CCB} = 5\text{ V}$, $T_A = 25^\circ\text{C}$.

(2) For I/O ports, the parameter I_{OZ} includes the input leakage current.

(3) This is the increase in supply current for each input that is at one of the specified TTL voltage levels, rather than at 0 or the associated V_{CC} .

Electrical Characteristics

over recommended operating free-air temperature range for $V_{CCA} = 2.3\text{ V to }2.7\text{ V}$ and $V_{CCB} = 3\text{ V to }3.6\text{ V}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	V_{CCA}	V_{CCB}	MIN	MAX	UNIT
V_{OH}	B to A	$I_{OH} = -100\ \mu\text{A}$	2.3 V to 2.7 V	3 V to 3.6 V	$V_{CCA} - 0.2$		V
		$I_{OH} = -8\ \text{mA}$	2.3 V	3 V to 3.6 V	1.7		
		$I_{OH} = -12\ \text{mA}$	2.7 V	3 V to 3.6 V	1.8		
	A to B	$I_{OH} = -100\ \mu\text{A}$	2.3 V to 2.7 V	3 V to 3.6 V	$V_{CCB} - 0.2$		
		$I_{OH} = -18\ \text{mA}$	2.3 V to 2.7 V	3 V	2.2		
V_{OL}	B to A	$I_{OL} = 100\ \mu\text{A}$	2.3 V to 2.7 V	3 V to 3.6 V		0.2	V
		$I_{OL} = 12\ \text{mA}$	2.3 V	3 V to 3.6 V		0.6	
	A to B	$I_{OL} = 100\ \mu\text{A}$	2.3 V to 2.7 V	3 V to 3.6 V		0.2	
		$I_{OL} = 18\ \text{mA}$	2.3 V	3 V		0.55	
I_i	Control inputs	$V_i = V_{CCA}/V_{CCB}$ or GND	2.3 V to 2.7 V	3 V to 3.6 V		± 5	μA
$I_{OZ}^{(1)}$	A or B port	$V_O = V_{CCA}/V_{CCB}$ or GND	2.3 V to 2.7 V	3 V to 3.6 V		± 10	μA
I_{CC}		$V_i = V_{CCA}/V_{CCB}$ or GND, $I_O = 0$	2.3 V to 2.7 V	3 V to 3.6 V		20	μA
$\Delta I_{CC}^{(2)}$		One input at $V_{CCA}/V_{CCB} - 0.6\text{ V}$, Other inputs at V_{CCA}/V_{CCB} or GND	2.3 V to 2.7 V	3 V to 3.6 V		750	μA

(1) For I/O ports, the parameter I_{OZ} includes the input leakage current.

(2) This is the increase in supply current for each input that is at one of the specified TTL voltage levels, rather than at 0 or the associated V_{CC} .

SN74ALVC164245
16-BIT 2.5-V TO 3.3-V/3.3-V TO 5-V LEVEL-SHIFTING TRANSCEIVER
WITH 3-STATE OUTPUTS

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Switching Characteristics

over recommended operating free-air temperature range (unless otherwise noted) (see [Figure 1](#) through [Figure 4](#))

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$		$V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$				UNIT
			$V_{CCA} = 2.5\text{ V} \pm 0.2\text{ V}$		$V_{CCA} = 2.7\text{ V}$		$V_{CCA} = 3.3\text{ V} \pm 0.3\text{ V}$		
			MIN	MAX	MIN	MAX	MIN	MAX	
t_{pd}	A	B	7.6		5.9		1 5.8		ns
	B	A	7.6		6.7		1.2 5.8		
t_{en}	\overline{OE}	B	11.5		9.3		1 8.9		ns
t_{dis}	\overline{OE}	B	10.5		9.2		2.1 9.5		ns
t_{en}	\overline{OE}	A	12.3		10.2		2 9.1		ns
t_{dis}	\overline{OE}	A	9.3		9		2.9 8.6		ns

Operating Characteristics

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

PARAMETER		TEST CONDITIONS	$V_{CCB} = 3.3\text{ V}$	$V_{CCB} = 5\text{ V}$	UNIT
			$V_{CCA} = 2.5\text{ V}$	$V_{CCA} = 3.3\text{ V}$	
			TYP	TYP	
C_{pd} Power dissipation capacitance	Outputs enabled (B)	$C_L = 50\text{ pF}, f = 10\text{ MHz}$	55	56	pF
	Outputs disabled (B)		27	6	
	Outputs enabled (A)	$C_L = 50\text{ pF}, f = 10\text{ MHz}$	118	56	
	Outputs disabled (A)		58	6	

POWER-UP CONSIDERATIONS⁽¹⁾

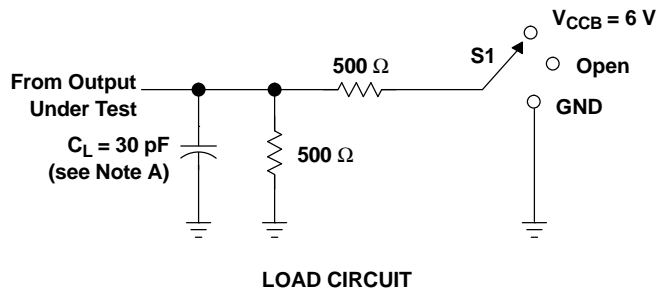
TI level-translation devices offer an opportunity for successful mixed-voltage signal design. A proper power-up sequence always should be followed to avoid excessive supply current, bus contention, oscillations, or other anomalies caused by improperly biased device pins. Take these precautions to guard against such power-up problems:

1. Connect ground before any supply voltage is applied.
 2. Power up the control side of the device (V_{CCA} for all four of these devices).
 3. Tie \overline{OE} to V_{CCA} with a pullup resistor so that it ramps with V_{CCA} .
 4. Depending on the direction of the data path, DIR can be high or low. If DIR high is needed (A data to B bus), ramp it with V_{CCA} . Otherwise, keep DIR low.
- (1) Refer to the TI application report, *Texas Instruments Voltage-Level-Translation Devices*, literature number SCEA021.

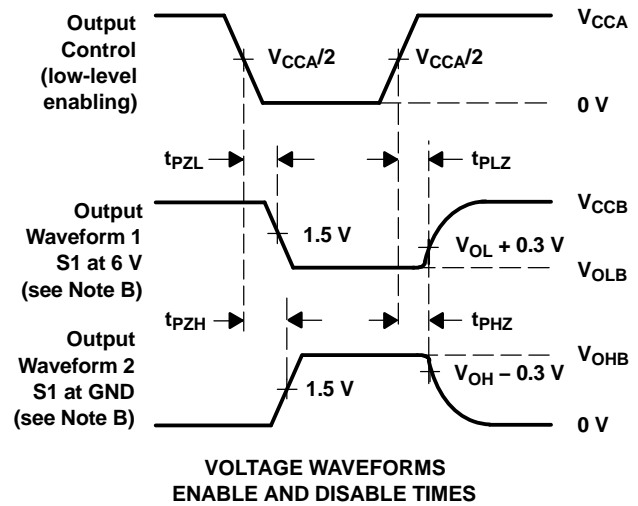
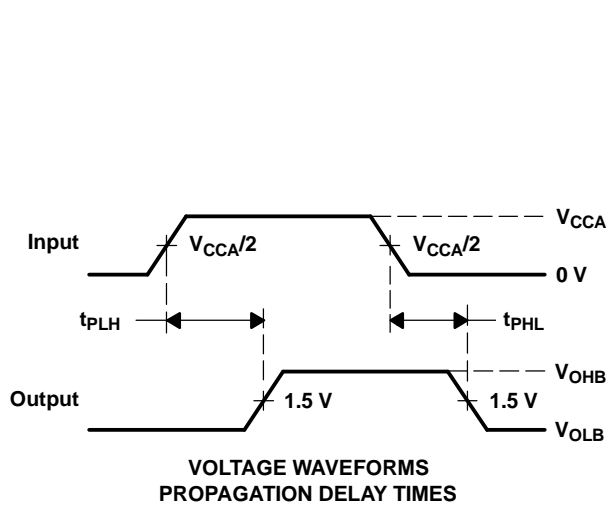
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WITH 3-STATE OUTPUTS

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PARAMETER MEASUREMENT INFORMATION
 $V_{CCA} = 2.5\text{ V} \pm 0.2\text{ V}$ to $V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$



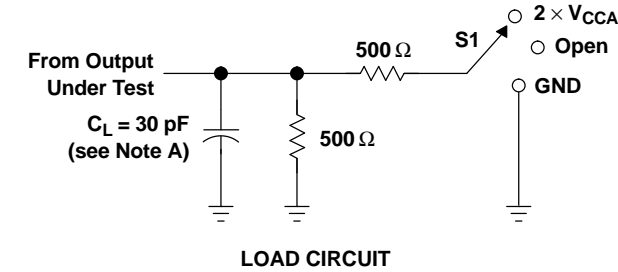
TEST	S1
t_{pd}	Open
t_{PLZ}/t_{PZL}	$V_{CCB} = 6\text{ V}$
t_{PHZ}/t_{PZH}	GND



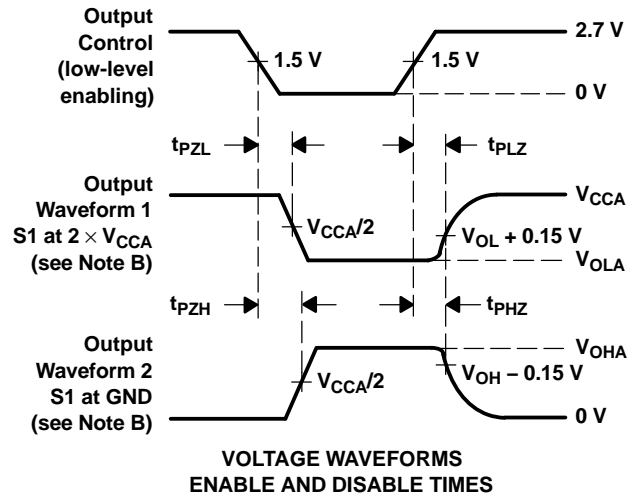
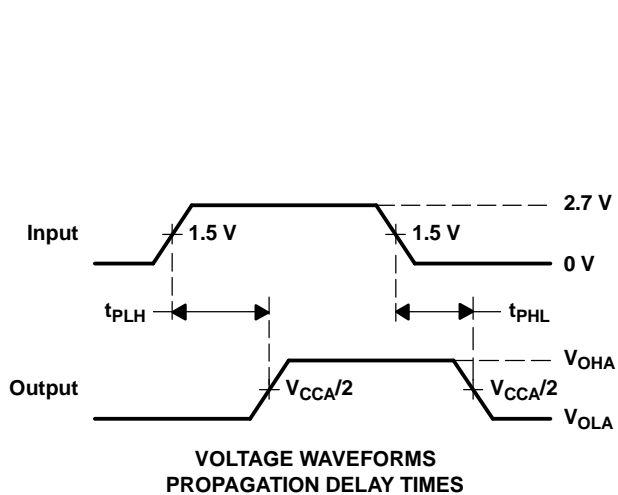
- NOTES: A. C_L includes probe and jig capacitance.
B. Waveform 1 is for an output with internal conditions such that the output is low, except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high, except when disabled by the output control.
C. All input pulses are supplied by generators having the following characteristics: $PRR \leq 10\text{ MHz}$, $Z_O = 50\ \Omega$, $t_r \leq 2\text{ ns}$, $t_f \leq 2\text{ ns}$.
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} .

Figure 1. Load Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION
 $V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$ to $V_{CCA} = 2.5\text{ V} \pm 0.2\text{ V}$



TEST	S1
t_{pd}	Open
t_{PLZ}/t_{PZL}	2 $\times V_{CCA}$
t_{PHZ}/t_{PZH}	GND



- 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: $PRR \leq 10\text{ MHz}$, $Z_O = 50\ \Omega$, $t_r \leq 2\text{ ns}$, $t_f \leq 2\text{ ns}$.
 - 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} .

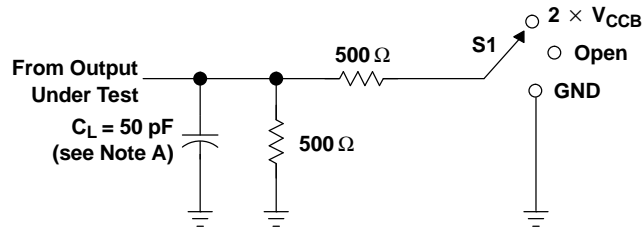
Figure 2. Load Circuit and Voltage Waveforms

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WITH 3-STATE OUTPUTS

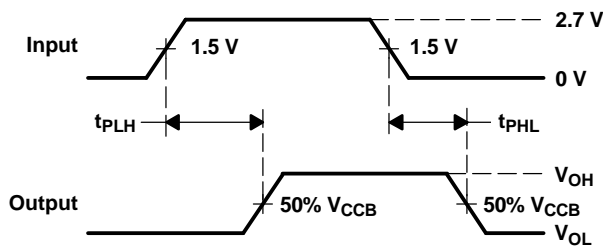
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PARAMETER MEASUREMENT INFORMATION

$V_{CCA} = 3.3\text{ V} \pm 0.3\text{ V}$ to $V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$

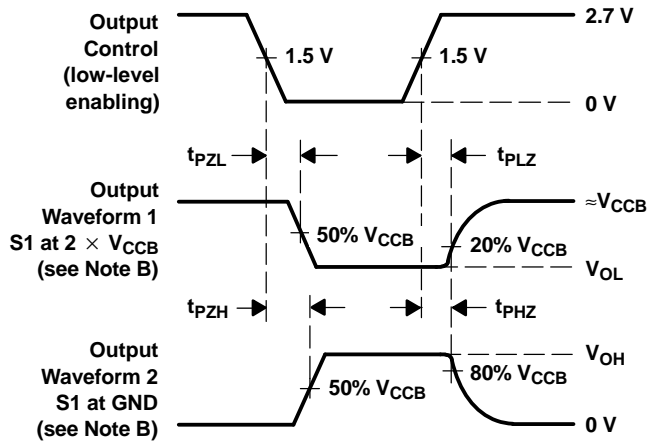


LOAD CIRCUIT



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES

TEST	S1
t_{pd}	Open
t_{PLZ}/t_{PZL}	2 $\times V_{CCB}$
t_{PHZ}/t_{PZH}	GND

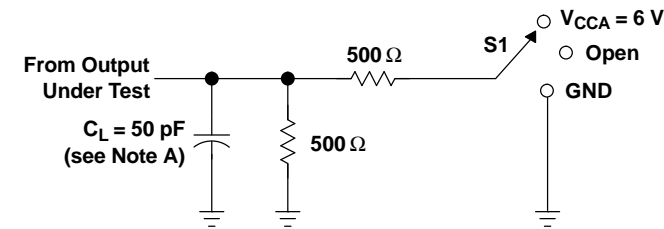


VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

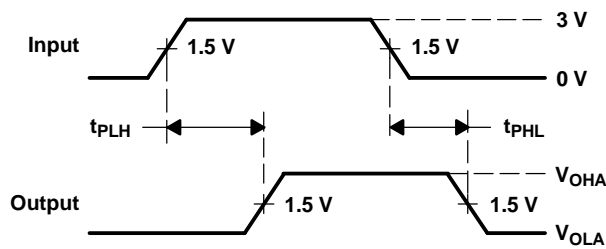
- NOTES: A. C_L includes probe and jig capacitance.
B. Waveform 1 is for an output with internal conditions such that the output is low, except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high, except when disabled by the output control.
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_{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} .

Figure 3. Load Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION
 $V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$ to $V_{CCA} = 2.7\text{ V}$ and $3.3\text{ V} \pm 0.3\text{ V}$

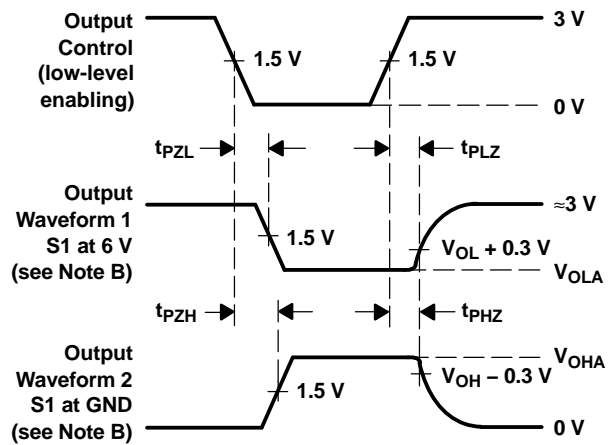


LOAD CIRCUIT



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES

TEST	S1
t_{pd}	Open
t_{PLZ}/t_{PZL}	$V_{CCA} = 6\text{ V}$
t_{PHZ}/t_{PZH}	GND



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: $PRR \leq 10\text{ MHz}$, $Z_O = 50\ \Omega$, $t_r \leq 2.5\text{ ns}$, $t_f \leq 2.5\text{ ns}$.
 - 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} .

Figure 4. 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⁾
74ALVC164245DGGRE4	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
74ALVC164245DGGRG4	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
74ALVC164245DGGTE4	ACTIVE	TSSOP	DGG	48	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
74ALVC164245DLG4	ACTIVE	SSOP	DL	48	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
74ALVC164245DLRG4	ACTIVE	SSOP	DL	48	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
74ALVC164245GRDR	ACTIVE	BGA MICROSTAR JUNIOR	GRD	54	1000	TBD	SNPB	Level-1-240C-UNLIM
74ALVC164245ZQLR	ACTIVE	BGA MICROSTAR JUNIOR	ZQL	56	1000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM
74ALVC164245ZRDR	ACTIVE	BGA MICROSTAR JUNIOR	ZRD	54	1000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM
SN74ALVC164245DGGR	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74ALVC164245DGGT	ACTIVE	TSSOP	DGG	48	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74ALVC164245DL	ACTIVE	SSOP	DL	48	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74ALVC164245DLR	ACTIVE	SSOP	DL	48	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74ALVC164245KR	ACTIVE	BGA MICROSTAR JUNIOR	GQL	56	1000	TBD	SNPB	Level-1-240C-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)

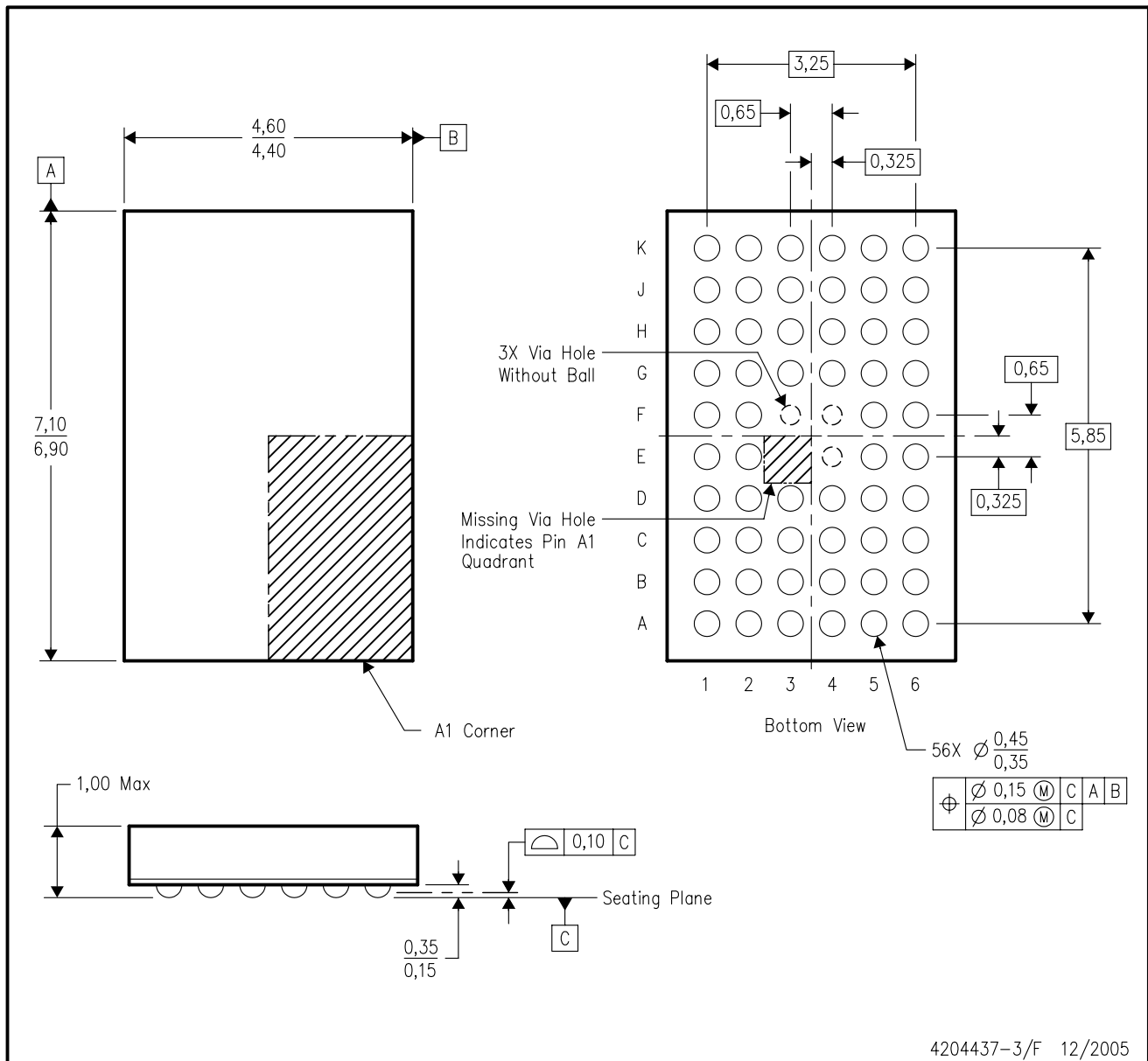
(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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ZQL (R-PBGA-N56)

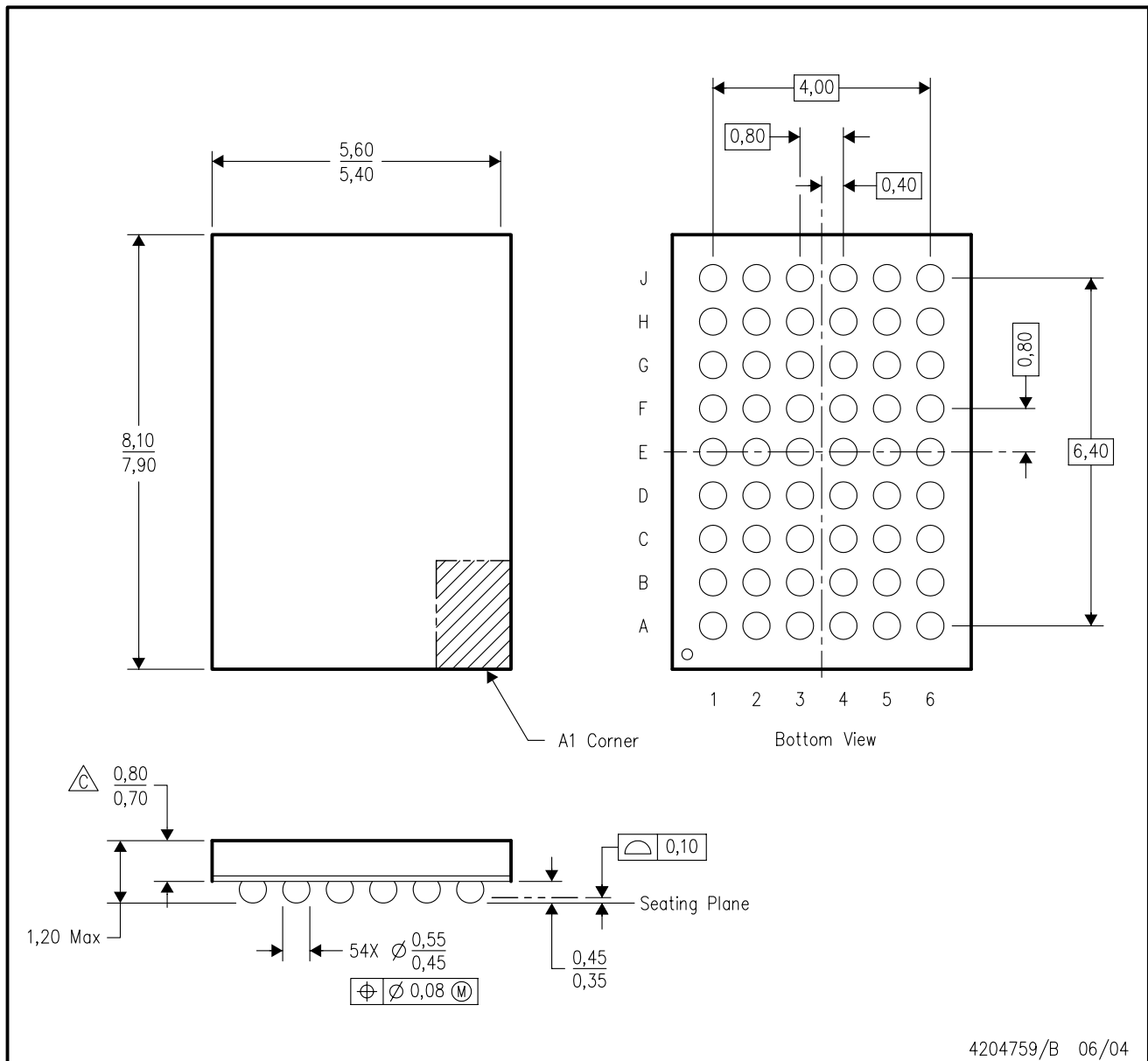
PLASTIC BALL GRID ARRAY



- 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-225 variation BA.
 - D. This package is lead-free. Refer to the 56 GQL package (drawing 4200583) for tin-lead (SnPb).

GRD (R-PBGA-N54)

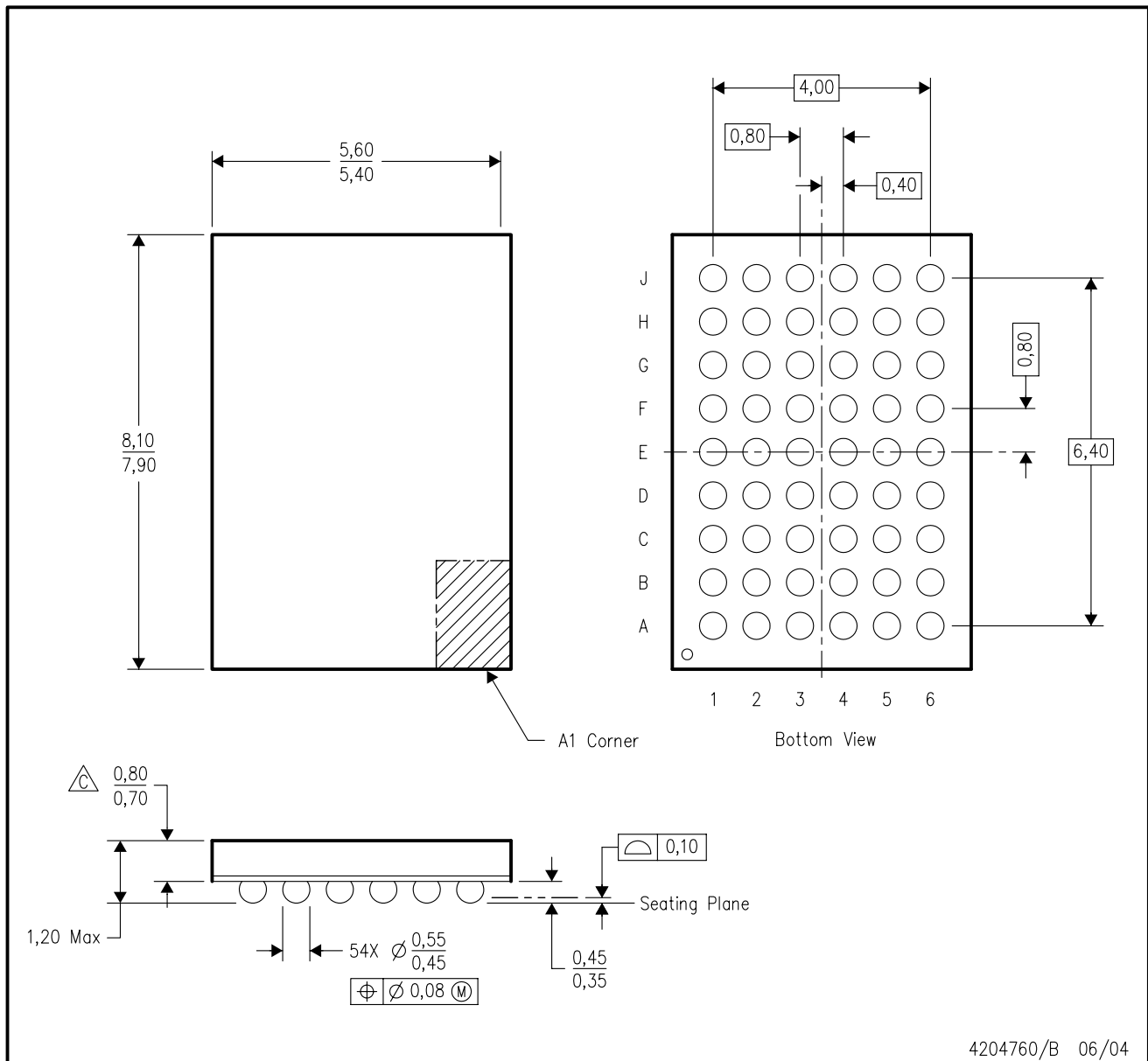
PLASTIC BALL GRID ARRAY



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C Falls within JEDEC MO-205 variation DD.
 - D. This package is tin-lead (SnPb). Refer to the 54 ZRD package (drawing 4204760) for lead-free.

ZRD (R-PBGA-N54)

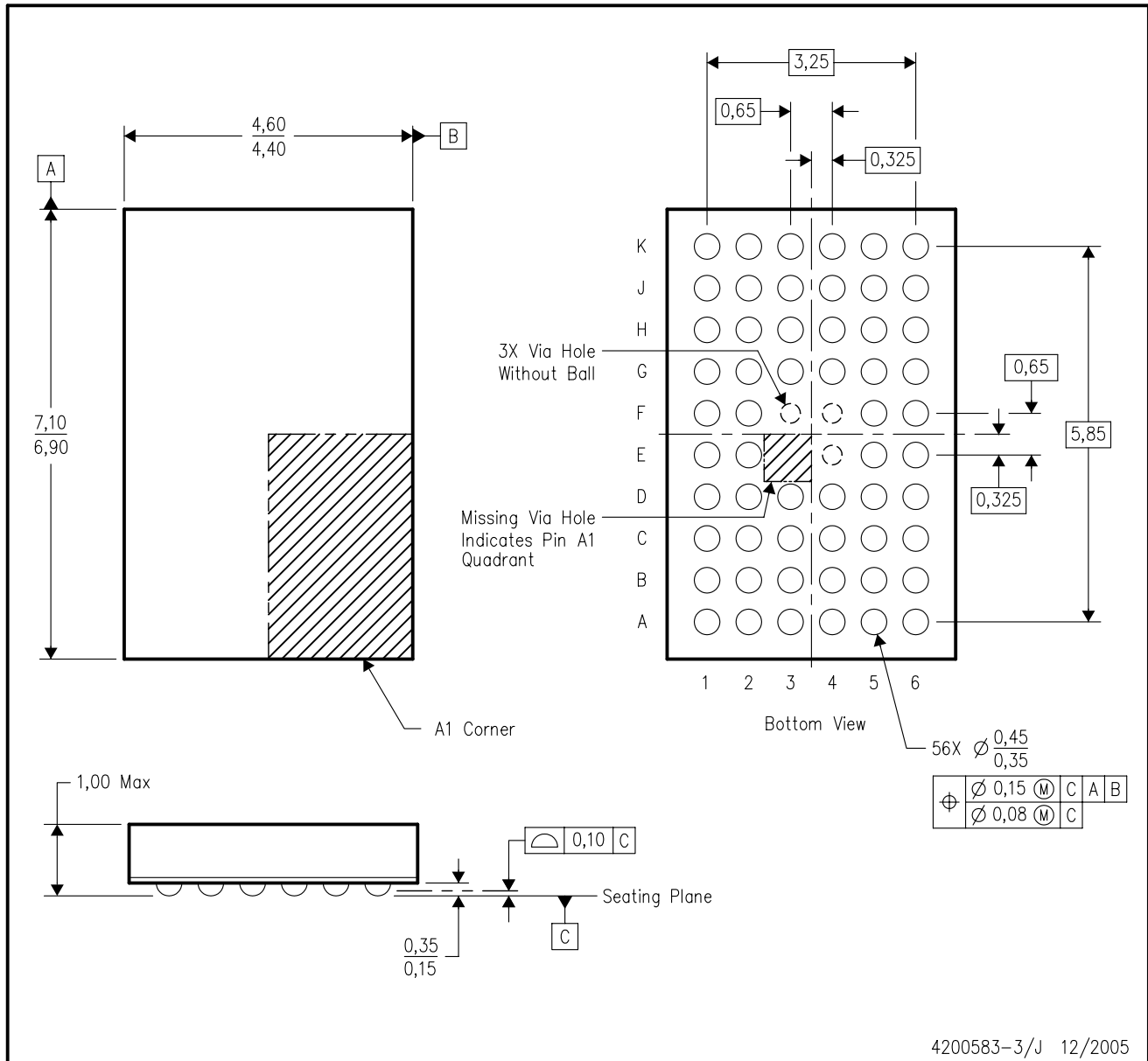
PLASTIC BALL GRID ARRAY



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - $\triangle C$ Falls within JEDEC MO-205 variation DD.
 - D. This package is lead-free. Refer to the 54 GRD package (drawing 4204759) for tin-lead (SnPb).

GQL (R-PBGA-N56)

PLASTIC BALL GRID ARRAY

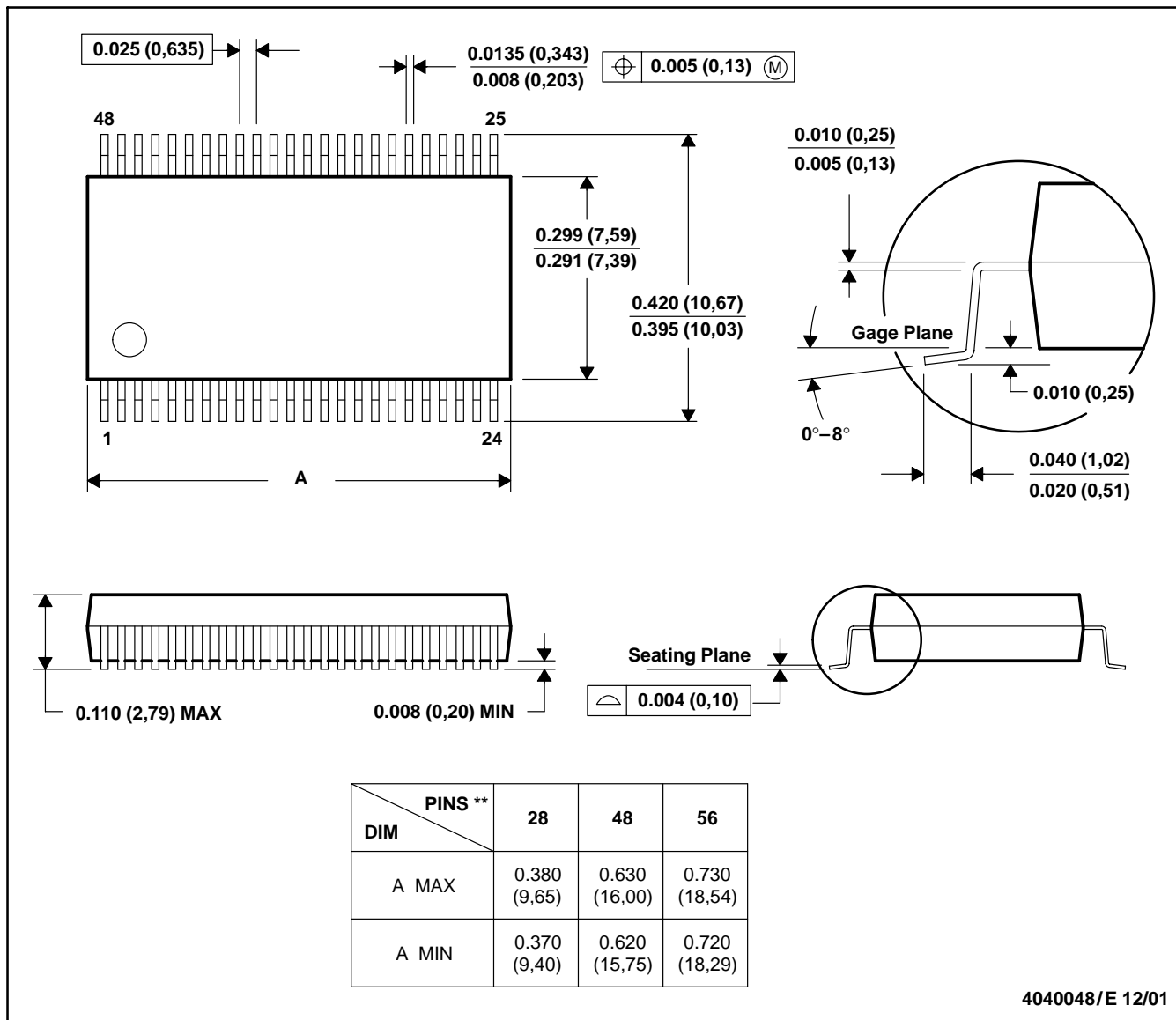


- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
 - B. This drawing is subject to change without notice.
 - C. Falls within JEDEC MO-225 variation BA.
 - D. This package is tin-lead (SnPb). Refer to the 56 ZQL package (drawing 4204437) for lead-free.

DL (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

48 PINS SHOWN

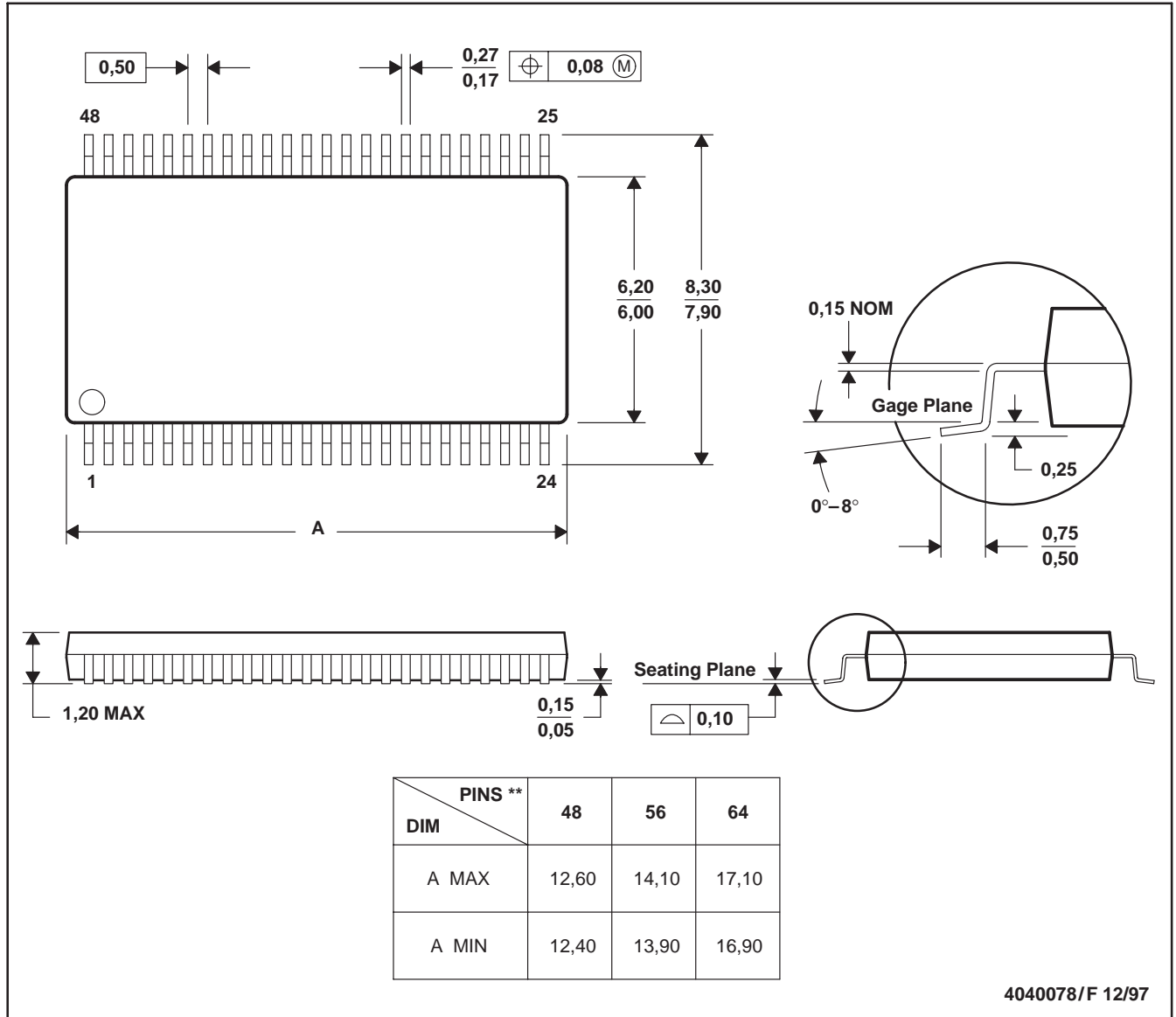


- NOTES: A. All linear dimensions are in inches (millimeters).
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
 D. Falls within JEDEC MO-118

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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