

SN74ALVC164245 16-Bit 2.5-V to 3.3-V or 3.3-V to 5-V Level-Shifting Transceiver With 3-State Outputs

1 Features

- Member of the Texas Instruments Widebus™ Family
- Maximum 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

2 Applications

- Electronic Points of Sale
- Printers and Other Peripherals
- Motor Drives
- Wireless and Telecom Infrastructures
- Wearable Health and Fitness Devices

3 Description

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.

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} .

Device Information⁽¹⁾

| PART NUMBER | PACKAGE | BODY SIZE (NOM) |
|----------------|---------------------------|--------------------|
| SN74ALVC164245 | TSSOP (48) | 12.50 mm x 6.10 mm |
| | SSOP (48) | 15.88 mm x 7.49 mm |
| | BGA MICROSTAR JUNIOR (56) | 7.00 mm x 4.50 mm |
| | BGA MICROSTAR JUNIOR (54) | 8.00 mm x 5.50 mm |

(1) For all available packages, see the orderable addendum at the end of the data sheet.

Logic Diagram (Positive Logic)

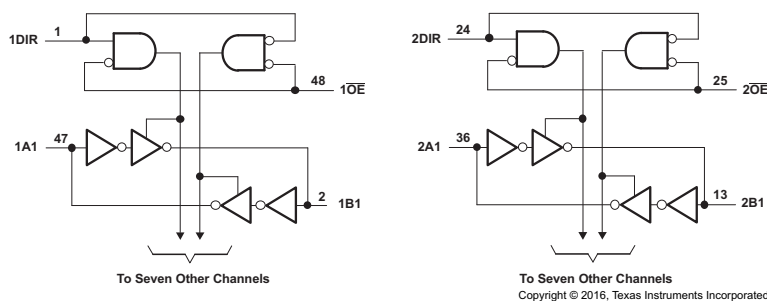


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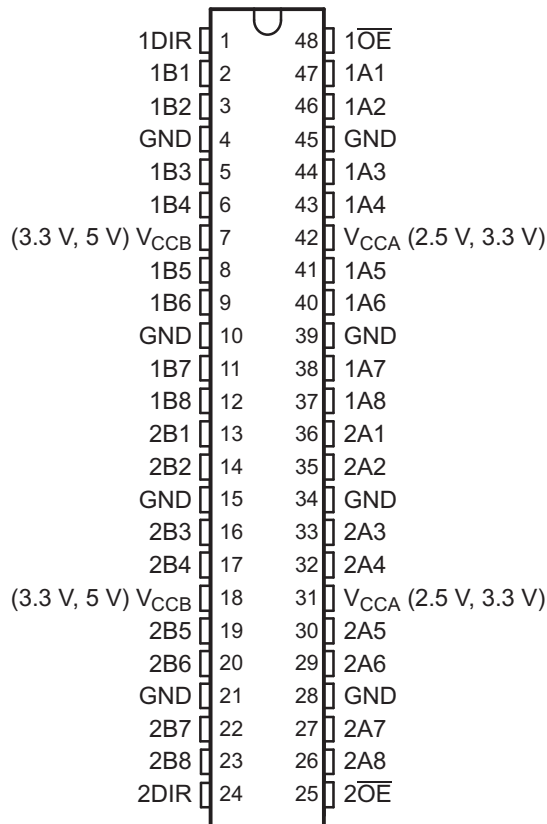
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4 Revision History

| Changes from Revision P (November 2005) to Revision Q | Page |
|--|----------|
| • Added <i>ESD Ratings</i> table, <i>Feature Description</i> section, <i>Device Functional Modes</i> , <i>Application and Implementation</i> section, <i>Power Supply Recommendations</i> section, <i>Layout</i> section, <i>Device and Documentation Support</i> section, and <i>Mechanical, Packaging, and Orderable Information</i> section | 1 |
| • Deleted <i>Ordering Information</i> table; see POA at the end of the data sheet..... | 1 |
| • Changed values in the <i>Thermal Information</i> table to align with JEDEC standards..... | 8 |

5 Pin Configuration and Functions

**DGG and DL Packages
48-Pin TSSOP and BGA MICROSTAR JUNIOR
Top View**

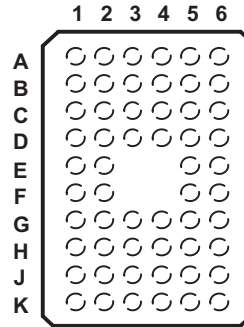


Pin Functions

| PIN | | I/O | DESCRIPTION |
|-----|----------------------------------|-----|---------------------|
| NO. | NAME | | |
| 1 | 1DIR | — | Direction Pin 1 |
| 2 | 1B1 | I/O | 1B1 input or output |
| 3 | 1B2 | I/O | 1B2 input or output |
| 4 | GND | — | Ground pin |
| 5 | 1B3 | I/O | 1B3 input or output |
| 6 | 1B4 | I/O | 1B4 input or output |
| 7 | V _{CCB} (3.3 V, 5 V) | — | Power pin |
| 8 | 1B5 | I/O | 1B5 input or output |
| 9 | 1B6 | I/O | 1B6 input or output |
| 10 | GND | — | Ground pin |
| 11 | 1B7 | I/O | 1B7 input or output |
| 12 | 1B8 | I/O | 1B8 input or output |
| 13 | 2B1 | I/O | 2B1 input or output |
| 14 | 2B2 | I/O | 2B2 input or output |
| 15 | GND | — | Ground pin |
| 16 | 2B3 | I/O | 2B3 input or output |

Pin Functions (continued)

| PIN | | I/O | DESCRIPTION |
|-----|-----------------------------|-----|---------------------|
| NO. | NAME | | |
| 17 | 2B4 | I/O | 2B4 input or output |
| 18 | V_{CCB} (3.3 V, 5 V) | — | Power pin |
| 19 | 2B5 | I/O | 2B5 input or output |
| 20 | 2B6 | I/O | 2B6 input or output |
| 21 | GND | — | Ground pin |
| 22 | 2B7 | I/O | 2B7 input or output |
| 23 | 2B8 | I/O | 2B8 input or output |
| 24 | 2DIR | — | Direction pin 2 |
| 25 | $2\overline{OE}$ | I | Output Enable 2 |
| 26 | 2A8 | I/O | 2A8 input or output |
| 27 | 2A7 | I/O | 2A7 input or output |
| 28 | GND | — | Ground pin |
| 29 | 2A6 | I/O | 2A6 input or output |
| 30 | 2A5 | I/O | 2A5 input or output |
| 31 | V_{CCA} (2.5 V, 3.3 V) | — | Power pin |
| 32 | 2A4 | I/O | 2A4 input or output |
| 33 | 2A3 | I/O | 2A3 input or output |
| 34 | GND | — | Ground pin |
| 35 | 2A2 | I/O | 2A2 input or output |
| 36 | 2A1 | I/O | 2A1 input or output |
| 37 | 1A8 | I/O | 1A8 input or output |
| 38 | 1A7 | I/O | 1A7 input or output |
| 39 | GND | — | Ground pin |
| 40 | 1A6 | I/O | 1A6 input or output |
| 41 | 1A5 | I/O | 1A5 input or output |
| 42 | V_{CCA} (2.5 V, 3.3 V) | — | Power pin |
| 43 | 1A4 | I/O | 1A4 input or output |
| 44 | 1A3 | I/O | 1A3 input or output |
| 45 | GND | — | Ground pin |
| 46 | 1A2 | I/O | 1A2 input or output |
| 47 | 1A1 | I/O | 1A1 input or output |
| 48 | $1\overline{OE}$ | I | Output Enable 1 |



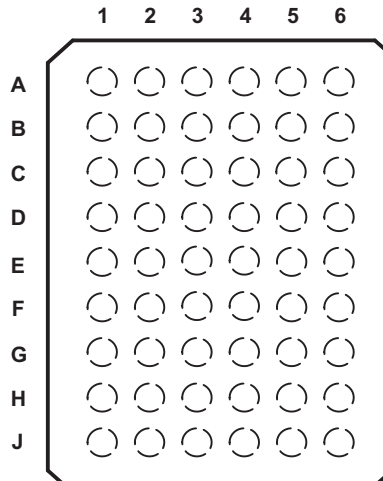
**Table 1. Pin Assignments⁽¹⁾
(56-Ball GQL or ZQL Package)**

| | 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

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**Table 2. Pin Assignments⁽¹⁾
(54-Ball GRD or ZRD Package)**

| | 1 | 2 | 3 | 4 | 5 | 6 |
|----------|-----|-----|-----------|------------------|-----|-----|
| A | 1B1 | NC | 1DIR | $\overline{1OE}$ | 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 | $\overline{2OE}$ | NC | 2A8 |

(1) NC – No internal connection

6 Specifications

6.1 Absolute Maximum Ratings

over operating free-air temperature range for V_{CCB} at 5 V and V_{CCA} at 3.3 V (unless otherwise noted)⁽¹⁾

| | | MIN | MAX | UNIT | | |
|-----------|---|---------------------------------|------|-----------------|-----|----|
| V_{CC} | Supply voltage | V_{CCA} | -0.5 | 4.6 | V | |
| | | V_{CCB} | -0.5 | 6 | | |
| V_I | Input voltage | 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 | |
| T_{stg} | Storage temperature | | | -65 | 150 | °C |

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. 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.

6.2 ESD Ratings

| | | VALUE | UNIT | |
|-------------|-------------------------|--|-------|---|
| $V_{(ESD)}$ | Electrostatic discharge | Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾ | ±2000 | V |
| | | Charged-device model (CDM), per JEDEC specification JESD22-C101 ⁽²⁾ | ±1000 | |

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

6.3 Recommended Operating Conditions: V_{CCB} at 3.3 V

for V_{CCB} at 3.3 V and 5 V⁽¹⁾

| | | 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 | $V_{CCB} = 3\text{ V to }3.6\text{ V}$ | 0.7 | V |
| | | $V_{CCB} = 4.5\text{ V to }5.5\text{ V}$ | 0.8 | |
| 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. see the TI application report, *Implications of Slow or Floating CMOS Inputs* (SCBA004).

6.4 Recommended Operating Conditions: V_{CCA} at 2.5 V

 for V_{CCA} at 2.5 V and 3.3 V⁽¹⁾

| | | | MIN | MAX | UNIT |
|---------------------|------------------------------------|---|-----|-----------|------|
| V_{CCA} | Supply voltage | | 2.3 | 3.6 | V |
| V_{IH} | High-level input voltage | $V_{CCA} = 2.3 \text{ V to } 2.7 \text{ V}$ | 1.7 | | V |
| | | $V_{CCA} = 3 \text{ V to } 3.6 \text{ V}$ | 2 | | |
| V_{IL} | Low-level input voltage | $V_{CCA} = 2.3 \text{ V to } 2.7 \text{ V}$ | | 0.7 | V |
| | | $V_{CCA} = 3 \text{ V to } 3.6 \text{ V}$ | | 0.8 | |
| V_{IA} | Input voltage | | 0 | V_{CCA} | V |
| V_{OA} | Output voltage | | 0 | V_{CCA} | V |
| I_{OH} | High-level output current | $V_{CCA} = 2.3 \text{ V}$ | | -18 | mA |
| | | $V_{CCA} = 3 \text{ V}$ | | -24 | |
| I_{OL} | Low-level output current | $V_{CCA} = 2.3 \text{ V}$ | | 18 | mA |
| | | $V_{CCA} = 3 \text{ V}$ | | 24 | |
| $\Delta t/\Delta v$ | Input transition rise or fall rate | | | 10 | ns/V |
| T_A | Operating free-air temperature | | -40 | 85 | °C |

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

6.5 Thermal Information

| THERMAL METRIC ⁽¹⁾ | SN74ALVC164245 | | | | UNIT | |
|-------------------------------|--|--------------|----------------------------------|----------------------------------|------|------|
| | DGG (TSSOP) | DL (SSOP) | ZQL (BGA MICROSTAR JUNIOR) | ZRD (BGA MICROSTAR JUNIOR) | | |
| | 48 PINS | 48 PINS | 56 PINS | 54 PINS | | |
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance | 60.7 | 63.6 | 54.5 | 50.7 | °C/W |
| $R_{\theta JC(top)}$ | Junction-to-case (top) thermal resistance | 14.3 | 30.1 | 19.1 | 17.9 | °C/W |
| $R_{\theta JB}$ | Junction-to-board thermal resistance | 27.7 | 36.2 | 21.7 | 20.2 | °C/W |
| Ψ_{JT} | Junction-to-top characterization parameter | 0.5 | 8.1 | 0.5 | 0.5 | °C/W |
| Ψ_{JB} | Junction-to-board characterization parameter | 27.6 | 35.6 | 21.7 | 19.9 | °C/W |

(1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC Package Thermal Metrics](#) application report.

6.6 Electrical Characteristics: $V_{CCA} = 2.7\text{ V to }3.6\text{ V}$

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 | | | |
| | | $I_{OH} = -12\ \text{mA}$ | | 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 | |
| | | $I_{OL} = 24\ \text{mA}$ | | 4.5 V to 5.5 V | | | 0.55 | |
| 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 supply current increase for each input that is at one of the specified TTL voltage levels, rather than at 0 or the associated V_{CC} .

6.7 Electrical Characteristics: $V_{CCA} = 2.3 \text{ V to } 2.7 \text{ V}$

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} .

6.8 Switching Characteristics

over recommended operating free-air temperature range (unless otherwise noted) (see [Figure 2](#) through [Figure 5](#))

| 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 | |

6.9 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 | |

6.10 Typical Characteristics

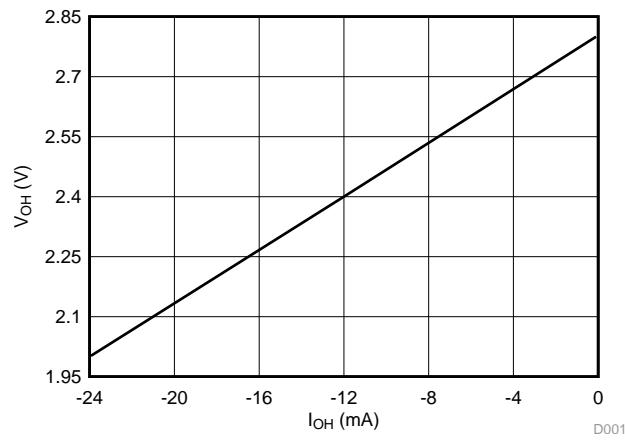
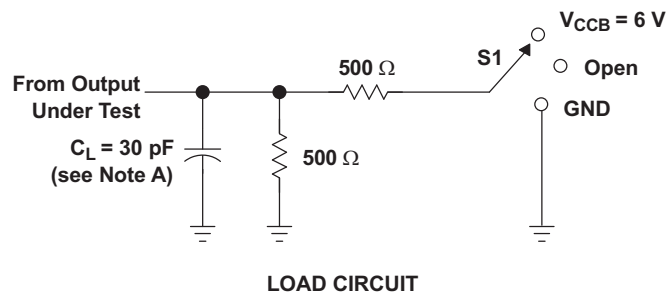


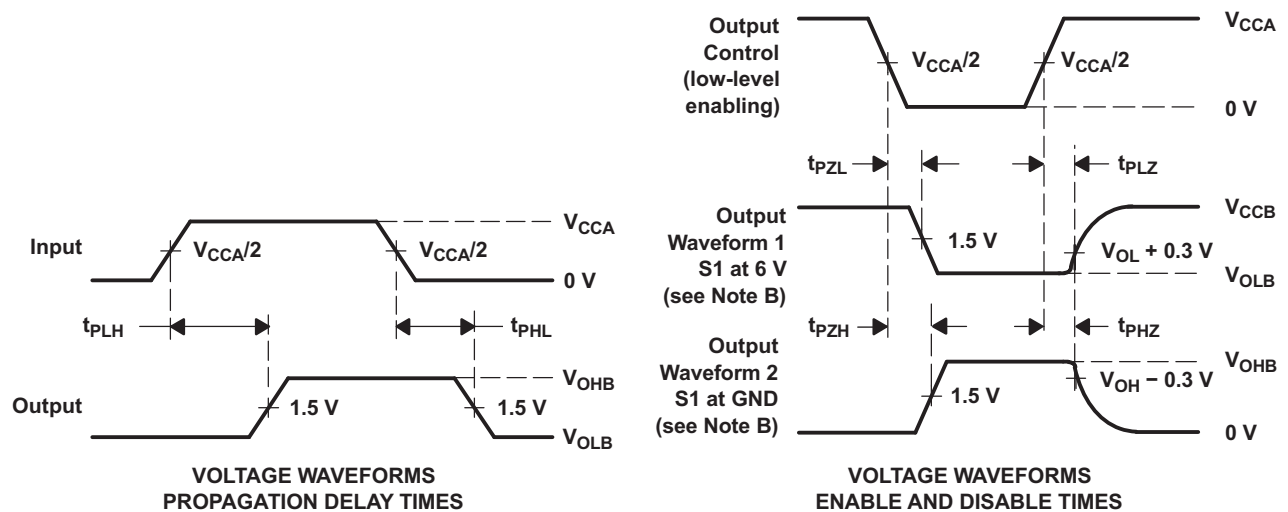
Figure 1. V_{OH} vs I_{OH}

7 Parameter Measurement Information

7.1 $V_{CCA} = 2.5\text{ V} \pm 0.2\text{ V}$ to $V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$



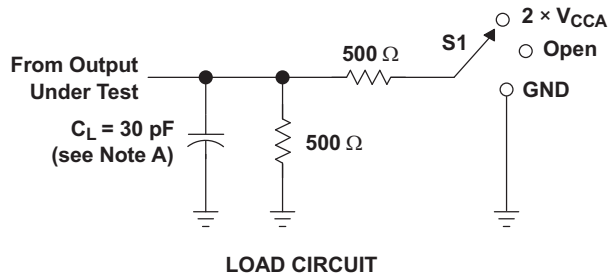
| TEST | S1 |
|-------------------|------------------------|
| t_{pd} | Open |
| t_{PLZ}/t_{PZL} | $V_{CCB} = 6\text{ V}$ |
| t_{PHZ}/t_{PZH} | GND |



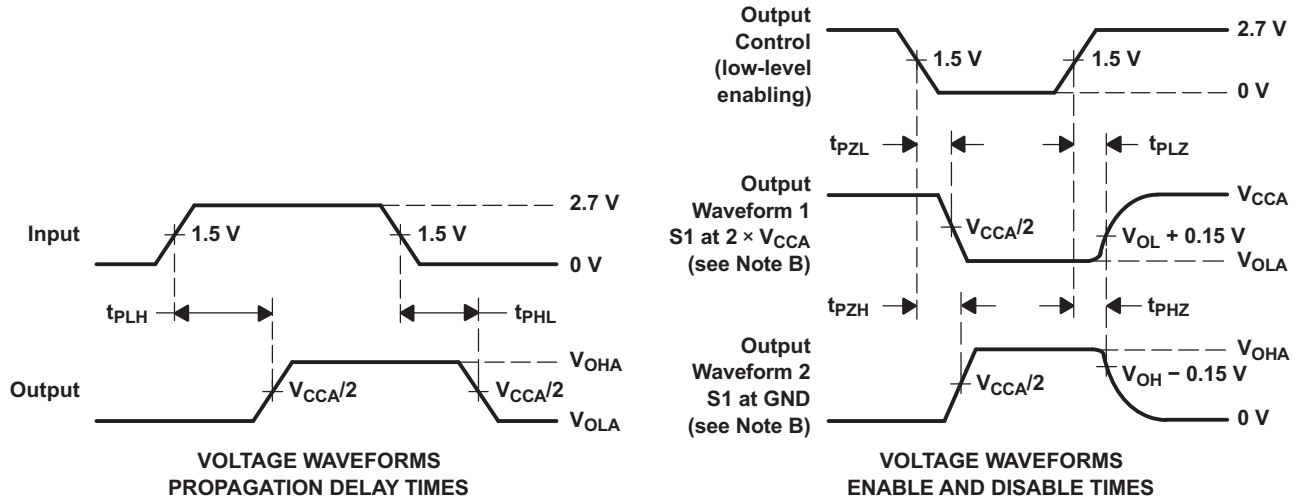
- NOTES:
- A. C_L includes probe and jig capacitance.
 - B. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high, except when disabled by the output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

7.2 $V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$ 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:
- 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} .

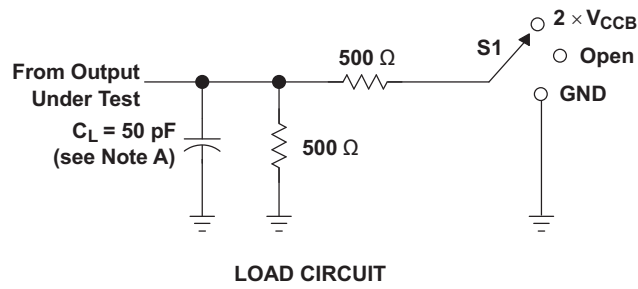
Figure 3. Load Circuit and Voltage Waveforms

SN74ALVC164245

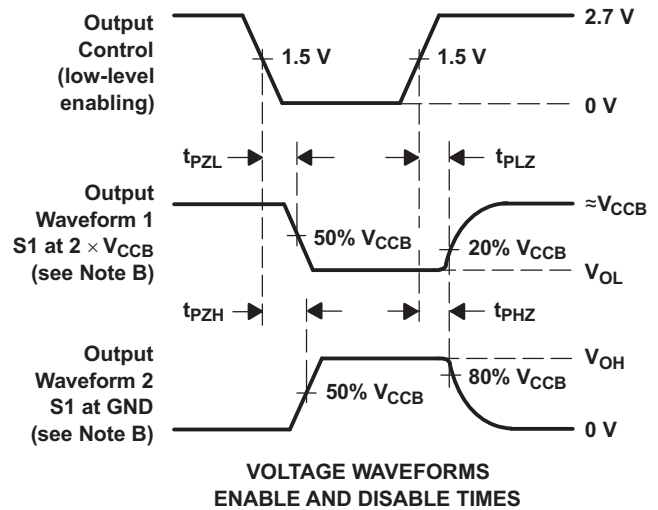
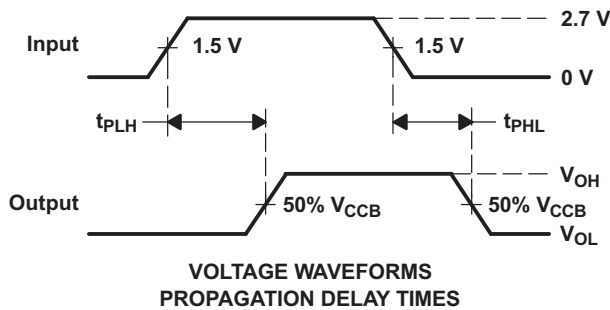
SCAS416Q – MARCH 1994 – REVISED SEPTEMBER 2016

www.ti.com

7.3 $V_{CCA} = 3.3\text{ V} \pm 0.3\text{ V}$ to $V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$



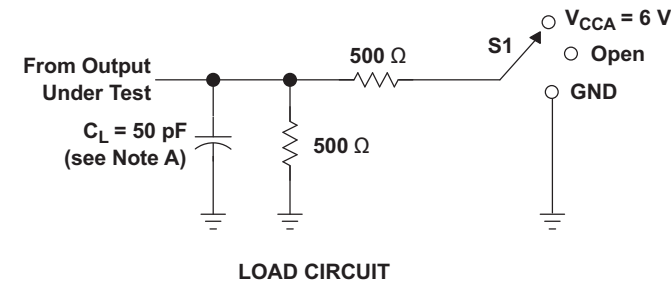
| TEST | S1 |
|-------------------|--------------------|
| t_{pd} | Open |
| t_{PLZ}/t_{PZL} | $2 \times V_{CCB}$ |
| t_{PHZ}/t_{PZH} | GND |



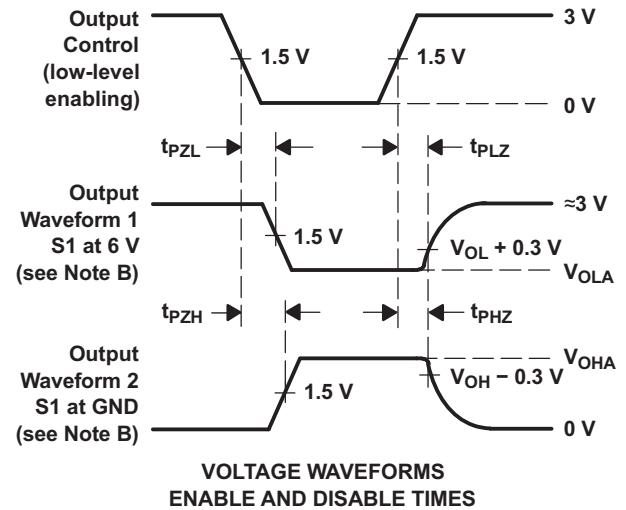
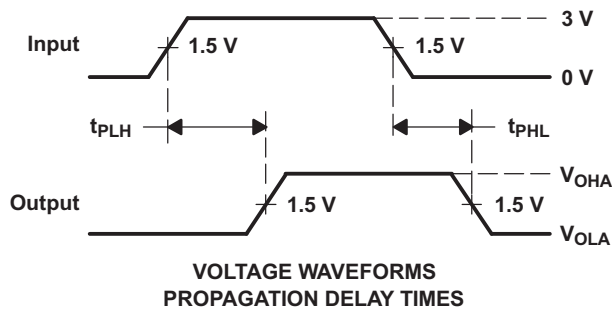
- NOTES:
- A. C_L includes probe and jig capacitance.
 - B. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high, except when disabled by the output control.
 - C. All input pulses are supplied by generators having the following characteristics: $PRR \leq 10\text{ MHz}$, $Z_O = 50\ \Omega$, $t_r \leq 2.5\text{ ns}$, $t_f \leq 2.5\text{ ns}$.
 - 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 4. Load Circuit and Voltage Waveforms

7.4 $V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$ to $V_{CCA} = 2.7\text{ V}$ and $3.3\text{ V} \pm 0.3\text{ V}$



| TEST | S1 |
|-------------------|------------------------|
| t_{pd} | Open |
| t_{PLZ}/t_{PZL} | $V_{CCA} = 6\text{ V}$ |
| 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: $PRR \leq 10\text{ MHz}$, $Z_O = 50\ \Omega$, $t_r \leq 2.5\text{ ns}$, $t_f \leq 2.5\text{ ns}$.
 - 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 5. Load Circuit and Voltage Waveforms

8 Detailed Description

8.1 Overview

The SN74ALVC16245 device is designed for asynchronous communication between data buses. The control-function implementation minimizes external timing requirements.

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 (\overline{OE}) input can be used to disable the device so that the buses are effectively isolated. To ensure the high-impedance state during power up or power down, \overline{OE} should be tied to V_{CC} through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

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

8.2 Functional Block Diagram

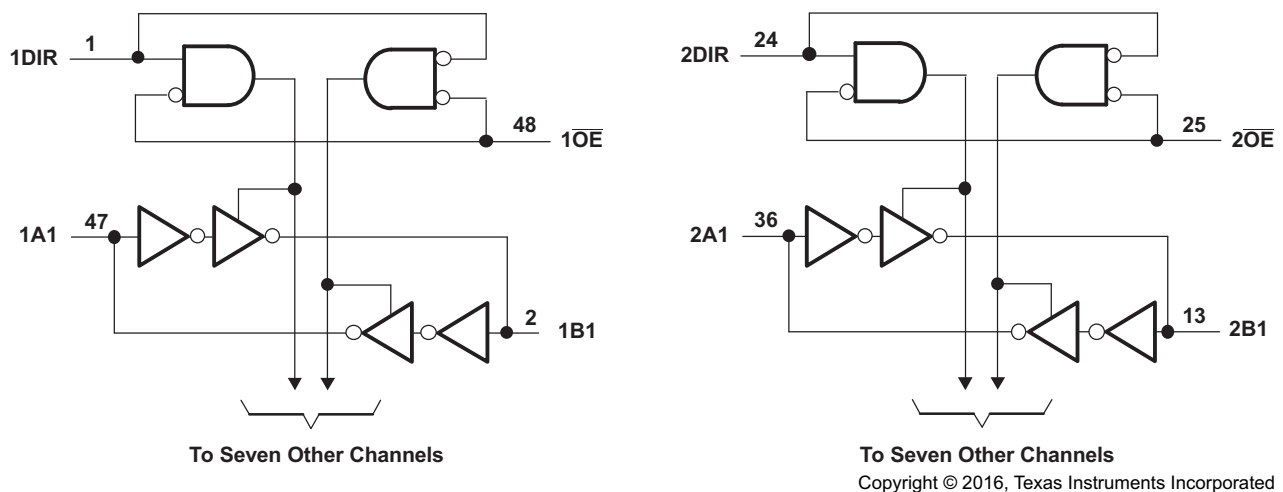


Figure 6. Logic Diagram (Positive Logic)

8.3 Feature Description

The SN74ALVC164245 can output 24 mA drive at 3.3V V_{CC} . This device allows down voltage translations and accepts input voltages to $V_{CC} + 0.5V$. This device is useful for high-speed applications because of the low t_{pd} .

8.4 Device Functional Modes

Table 3 lists the functions of the device.

Table 3. 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.

9 Application and Implementation

NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

9.1 Application Information

The SN74ALVC16245 device is a 16-bit bidirectional transceiver. 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 (\overline{OE}) input can be used to disable the device so that the buses are effectively isolated. This allows it to be used in multi-power systems and for down translation as well.

9.2 Typical Application

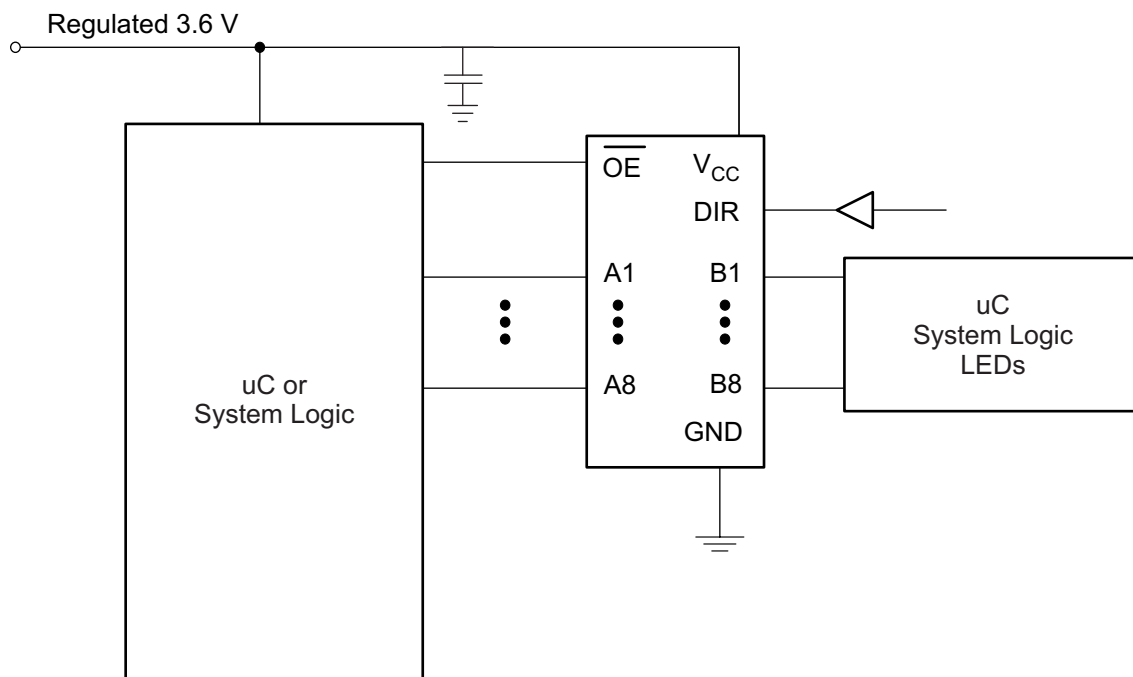


Figure 7. Typical Application Schematic

9.2.1 Design Requirements

This device uses CMOS technology and has balanced output drive. Take care to avoid bus contention because it can drive currents that would exceed maximum limits. The high drive also creates fast edges into light loads; therefore, routing and load conditions must be considered to prevent ringing.

9.2.2 Detailed Design Procedure

1. Recommended Input Conditions

- Rise time and fall time specs: See $(\Delta t/\Delta V)$ in *Recommended Operating Conditions: V_{CCB} at 3.3 V*.
- Specified high and low levels: See $(V_{IH}$ and $V_{IL})$ in *Recommended Operating Conditions: V_{CCB} at 3.3 V*.

2. Recommend Output Conditions

- Load currents should not exceed 50 mA per output and 100 mA total for the part.
- Outputs should not be pulled above V_{CC} .

Typical Application (continued)

9.2.3 Application Curve

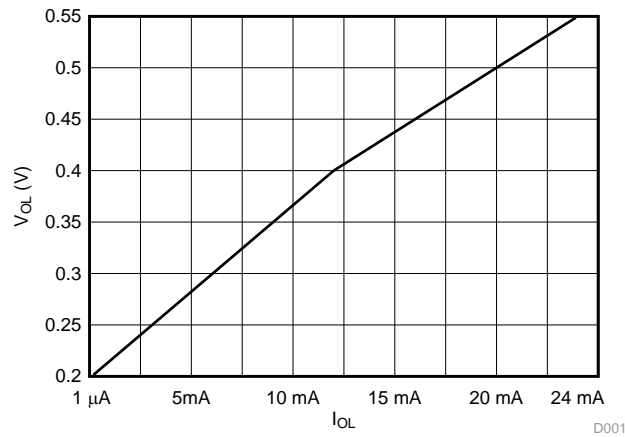


Figure 8. V_{OH} vs I_{OH}

10 Power Supply Recommendations

TI level-translation devices offer an opportunity for successful mixed-voltage signal design. A proper power-up sequence must always 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.

For more information, see the TI application report, [Texas Instruments Voltage-Level-Translation Devices \(SCEA021\)](#).

11 Layout

11.1 Layout Guidelines

When using multiple bit logic devices, inputs should not float. In many cases, functions or parts of functions of digital logic devices are unused. Some examples are when only two inputs of a triple-input AND gate are used, or when only 3 of the 4-buffer gates are used. Such input pins should not be left unconnected because the undefined voltages at the outside connections result in undefined operational states.

Specified in the [Figure 9](#) are rules that must be observed under all circumstances. All unused inputs of digital logic devices must be connected to a high or low bias to prevent them from floating. The logic level that should be applied to any particular unused input depends on the function of the device. Generally they will be tied to GND or V_{CC} , whichever makes more sense or is more convenient. It is acceptable to float outputs unless the part is a transceiver. If the transceiver has an output enable pin, it will disable the outputs section of the part when asserted. This will not disable the input section of the I/Os so they also cannot float when disabled.

11.2 Layout Example

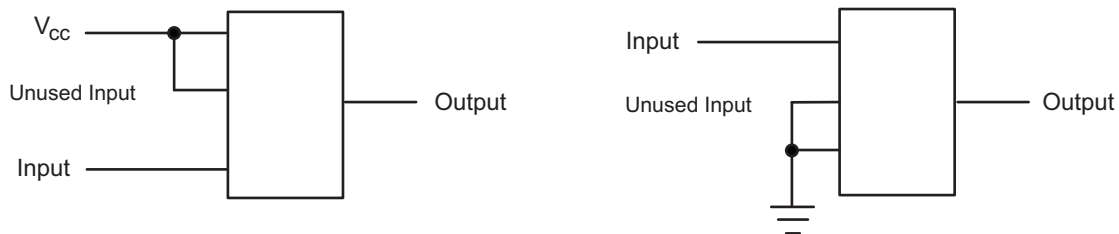


Figure 9. Layout Diagram

12 Device and Documentation Support

12.1 Documentation Support

12.1.1 Related Documentation

For related documentation see the following:

- [Texas Instruments Voltage-Level-Translation Devices](#) (SCEA021)
- [Implications of Slow or Floating CMOS Inputs](#) (SCBA004)

12.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

12.3 Community Resource

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

TI E2E™ Online Community *TI's Engineer-to-Engineer (E2E) Community*. Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

Design Support *TI's Design Support* Quickly find helpful E2E forums along with design support tools and contact information for technical support.

12.4 Trademarks

Widebus, E2E are trademarks of Texas Instruments.
All other trademarks are the property of their respective owners.

12.5 Electrostatic Discharge Caution



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

12.6 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

13 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|--------------------|---------------|----------------------------|--------------------|------|----------------|----------------------------|-------------------------|----------------------|--------------|-------------------------|-------------------------|
| 74ALVC164245DGGRE4 | ACTIVE | TSSOP | DGG | 48 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | ALVC164245 | Samples |
| 74ALVC164245DGGRG4 | ACTIVE | TSSOP | DGG | 48 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | ALVC164245 | Samples |
| 74ALVC164245DGGTE4 | ACTIVE | TSSOP | DGG | 48 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | ALVC164245 | Samples |
| 74ALVC164245DGGTG4 | ACTIVE | TSSOP | DGG | 48 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | ALVC164245 | Samples |
| 74ALVC164245DLG4 | ACTIVE | SSOP | DL | 48 | 25 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | ALVC164245 | Samples |
| 74ALVC164245DLRG4 | ACTIVE | SSOP | DL | 48 | 1000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | ALVC164245 | Samples |
| 74ALVC164245GRDR | OBSOLETE | BGA MICROSTAR JUNIOR | GRD | 54 | | TBD | Call TI | Call TI | -40 to 85 | | |
| 74ALVC164245ZQLR | ACTIVE | BGA MICROSTAR JUNIOR | ZQL | 56 | 1000 | Green (RoHS & no Sb/Br) | SNAGCU | Level-1-260C-UNLIM | -40 to 85 | VC4245 | Samples |
| 74ALVC164245ZRDR | ACTIVE | BGA MICROSTAR JUNIOR | ZRD | 54 | 1000 | Green (RoHS & no Sb/Br) | SNAGCU | Level-1-260C-UNLIM | -40 to 85 | VC4245 | Samples |
| SN74ALVC164245-W | ACTIVE | WAFERSALE | YS | 0 | | TBD | Call TI | Call TI | | | Samples |
| SN74ALVC164245DGGR | ACTIVE | TSSOP | DGG | 48 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | ALVC164245 | Samples |
| SN74ALVC164245DGGT | ACTIVE | TSSOP | DGG | 48 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | ALVC164245 | Samples |
| SN74ALVC164245DL | ACTIVE | SSOP | DL | 48 | 25 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | ALVC164245 | Samples |
| SN74ALVC164245DLR | ACTIVE | SSOP | DL | 48 | 1000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | ALVC164245 | Samples |
| SN74ALVC164245KR | OBSOLETE | BGA MICROSTAR JUNIOR | GQL | 56 | | TBD | Call TI | Call TI | -40 to 85 | | |

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

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

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 SN74ALVC164245 :

- Enhanced Product: [SN74ALVC164245-EP](#)

NOTE: Qualified Version Definitions:

- Enhanced Product - Supports Defense, Aerospace and Medical 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 |
|--------------------|----------------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| 74ALVC164245ZQLR | BGA MICROSTAR JUNIOR | ZQL | 56 | 1000 | 330.0 | 16.4 | 4.8 | 7.3 | 1.5 | 8.0 | 16.0 | Q1 |
| 74ALVC164245ZRDR | BGA MICROSTAR JUNIOR | ZRD | 54 | 1000 | 330.0 | 16.4 | 5.8 | 8.3 | 1.55 | 8.0 | 16.0 | Q1 |
| SN74ALVC164245DGGR | TSSOP | DGG | 48 | 2000 | 330.0 | 24.4 | 8.6 | 15.8 | 1.8 | 12.0 | 24.0 | Q1 |
| SN74ALVC164245DLR | SSOP | DL | 48 | 1000 | 330.0 | 32.4 | 11.35 | 16.2 | 3.1 | 16.0 | 32.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS

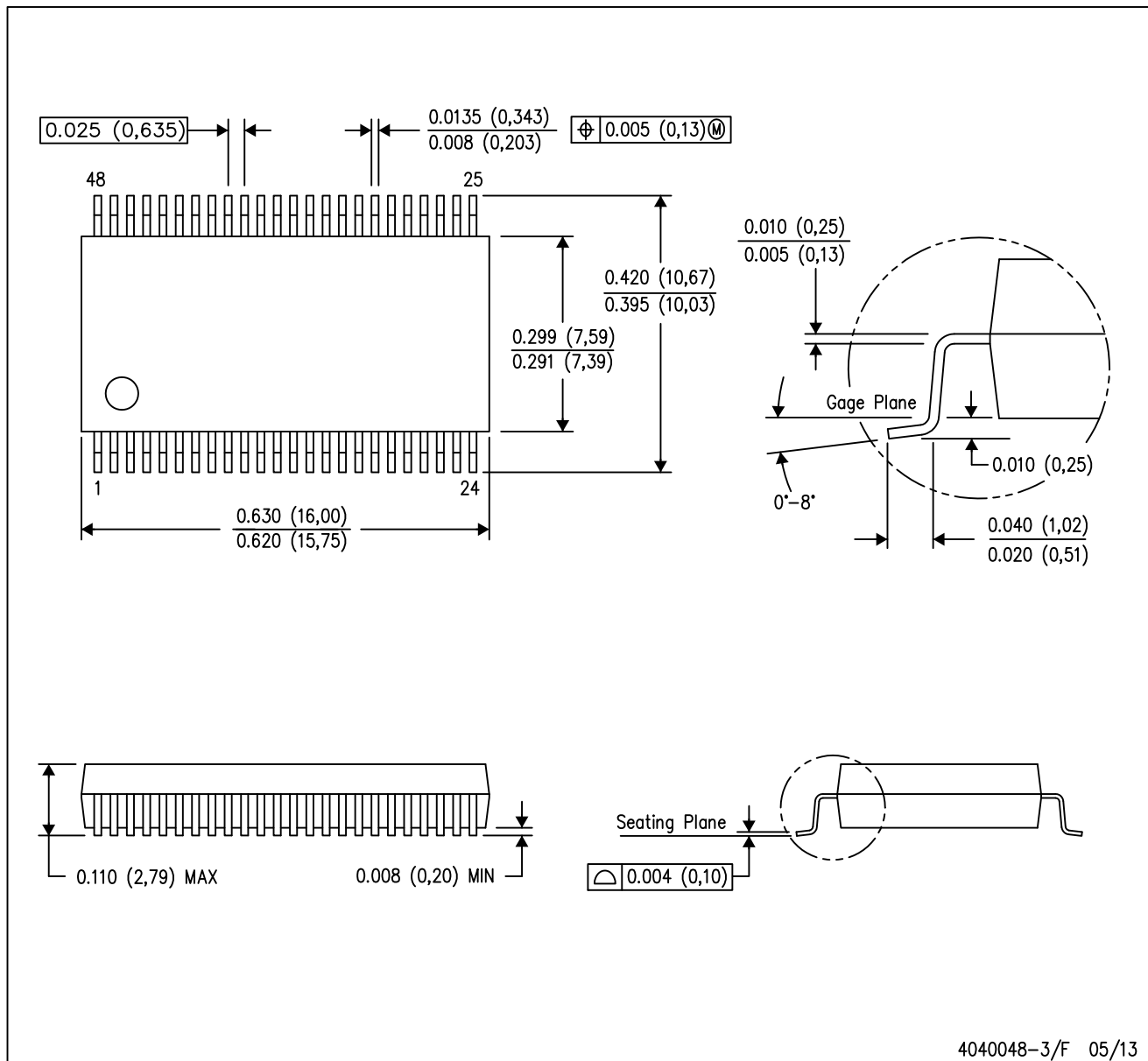

*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|--------------------|----------------------|-----------------|------|------|-------------|------------|-------------|
| 74ALVC164245ZQLR | BGA MICROSTAR JUNIOR | ZQL | 56 | 1000 | 336.6 | 336.6 | 28.6 |
| 74ALVC164245ZRDR | BGA MICROSTAR JUNIOR | ZRD | 54 | 1000 | 336.6 | 336.6 | 28.6 |
| SN74ALVC164245DGGR | TSSOP | DGG | 48 | 2000 | 367.0 | 367.0 | 45.0 |
| SN74ALVC164245DLR | SSOP | DL | 48 | 1000 | 367.0 | 367.0 | 55.0 |

MECHANICAL DATA

DL (R-PDSO-G48)

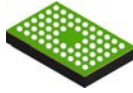
PLASTIC SMALL-OUTLINE PACKAGE



- 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.

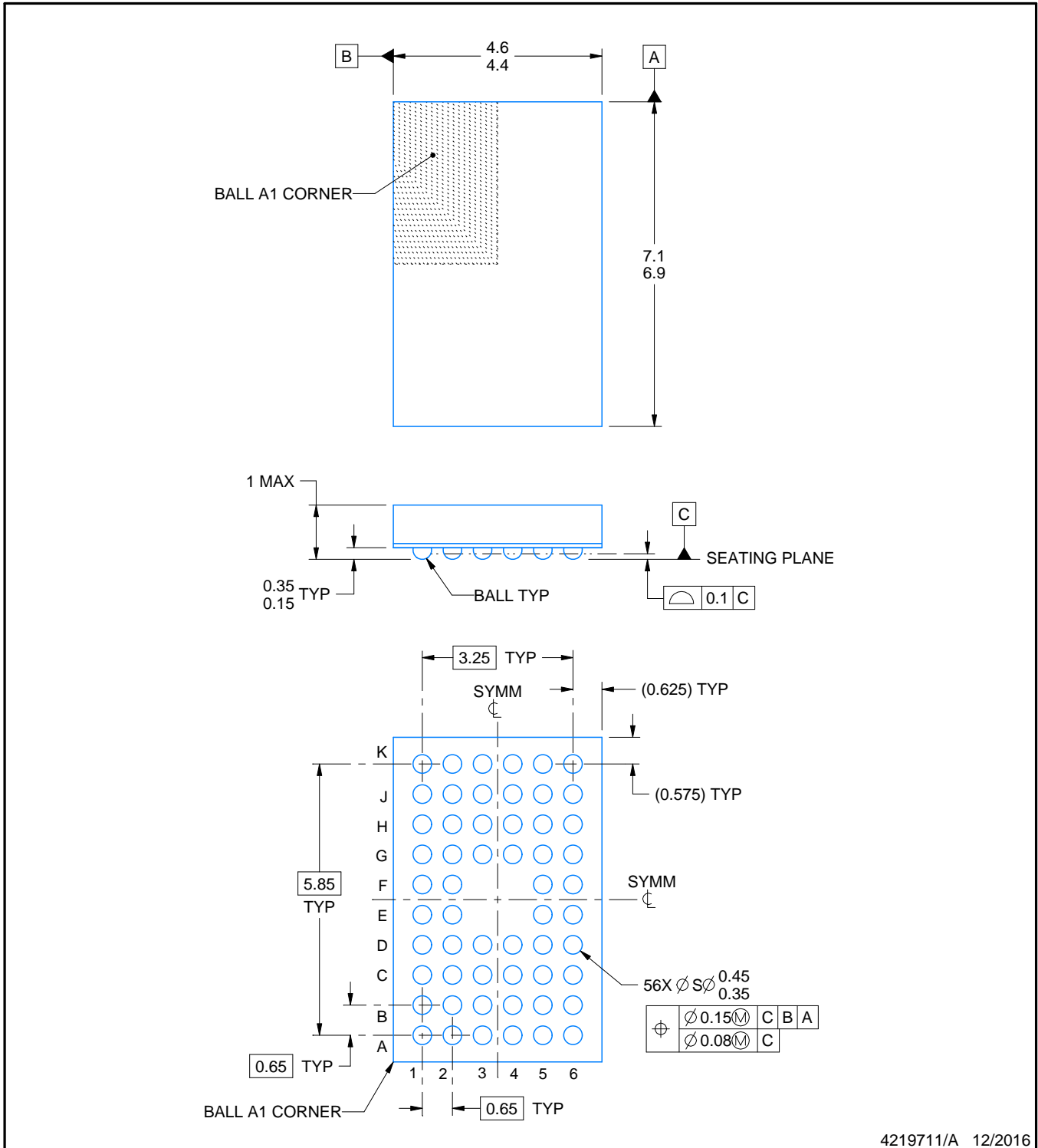
ZQL0056A



PACKAGE OUTLINE

JRBGA - 1 mm max height

PLASTIC BALL GRID ARRAY



4219711/A 12/2016

NOTES:

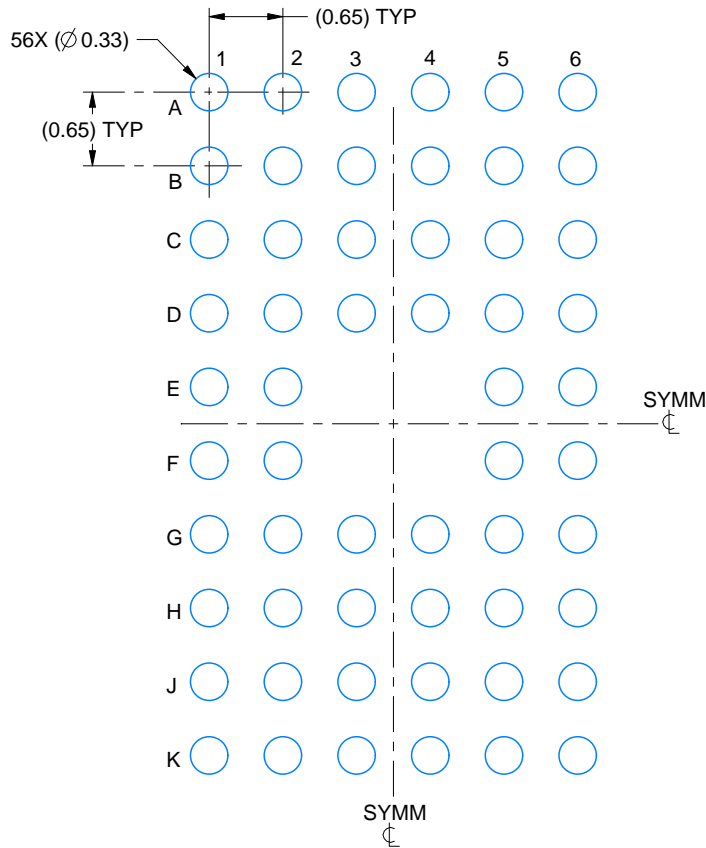
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

EXAMPLE BOARD LAYOUT

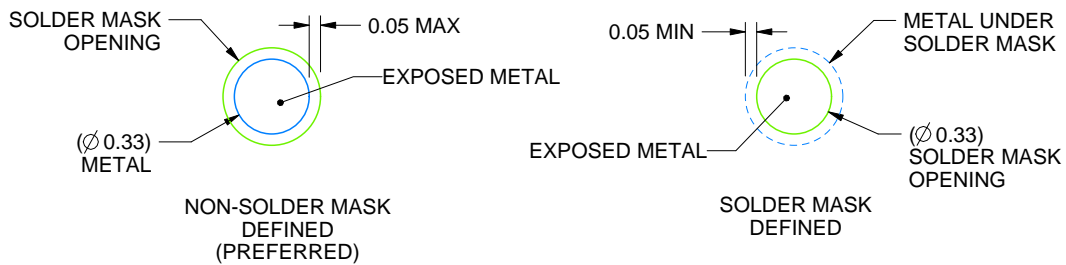
ZQL0056A

JRBGA - 1 mm max height

PLASTIC BALL GRID ARRAY



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:15X



SOLDER MASK DETAILS
NOT TO SCALE

4219711/A 12/2016

NOTES: (continued)

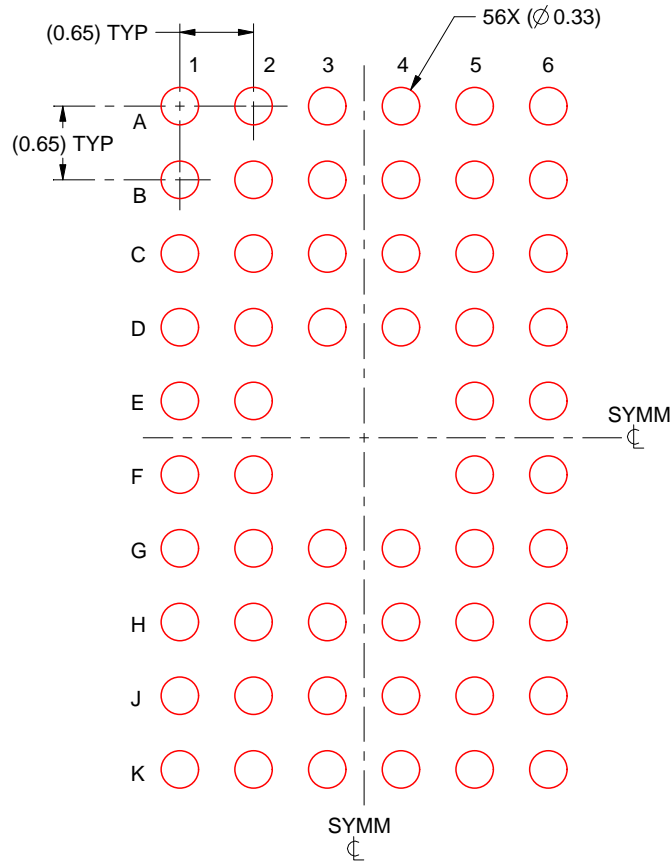
- Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints. For information, see Texas Instruments literature number SPRAA99 (www.ti.com/lit/spraa99).

EXAMPLE STENCIL DESIGN

ZQL0056A

JRBGA - 1 mm max height

PLASTIC BALL GRID ARRAY



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:15X

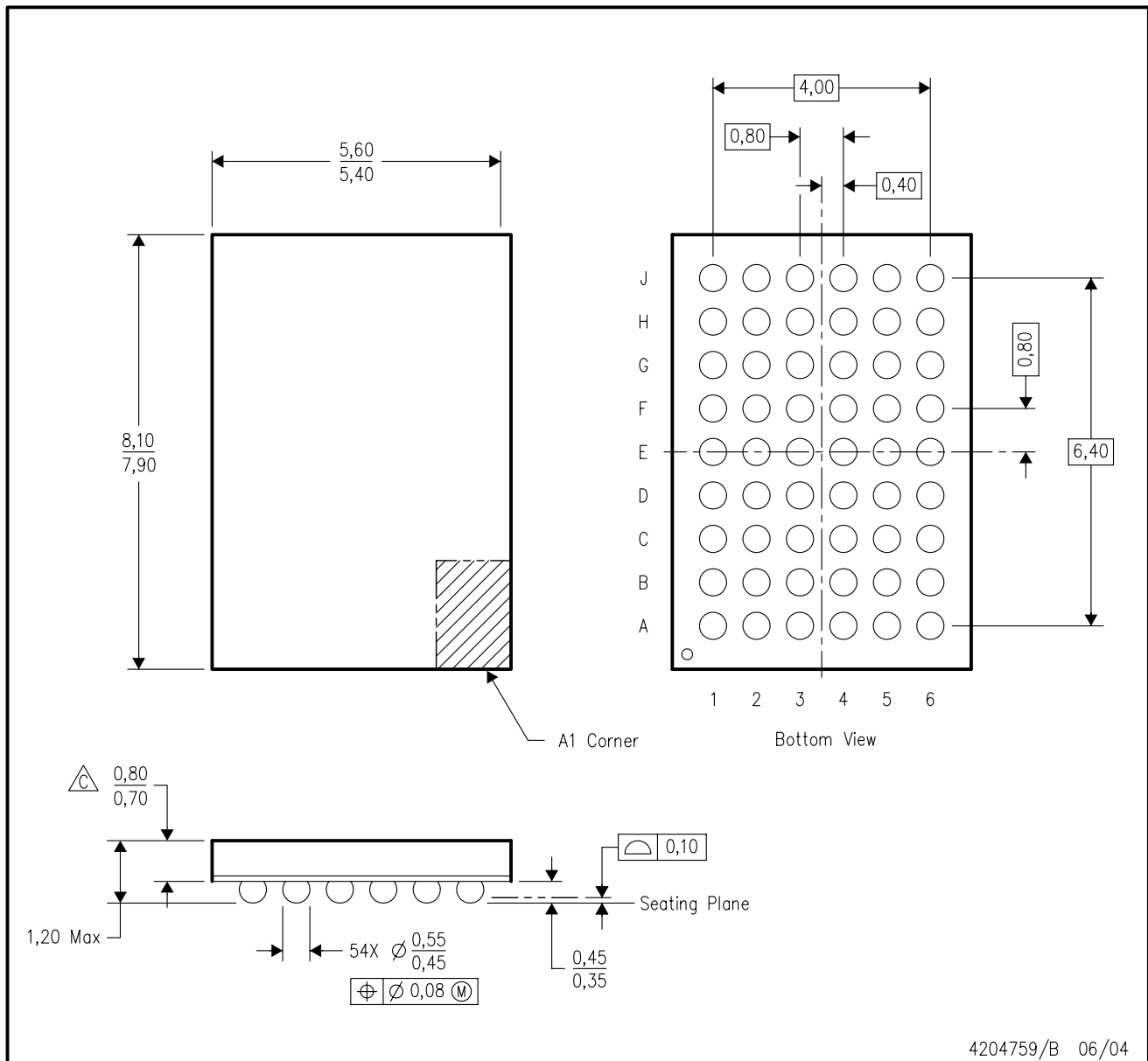
4219711/A 12/2016

NOTES: (continued)

4. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release.

GRD (R-PBGA-N54)

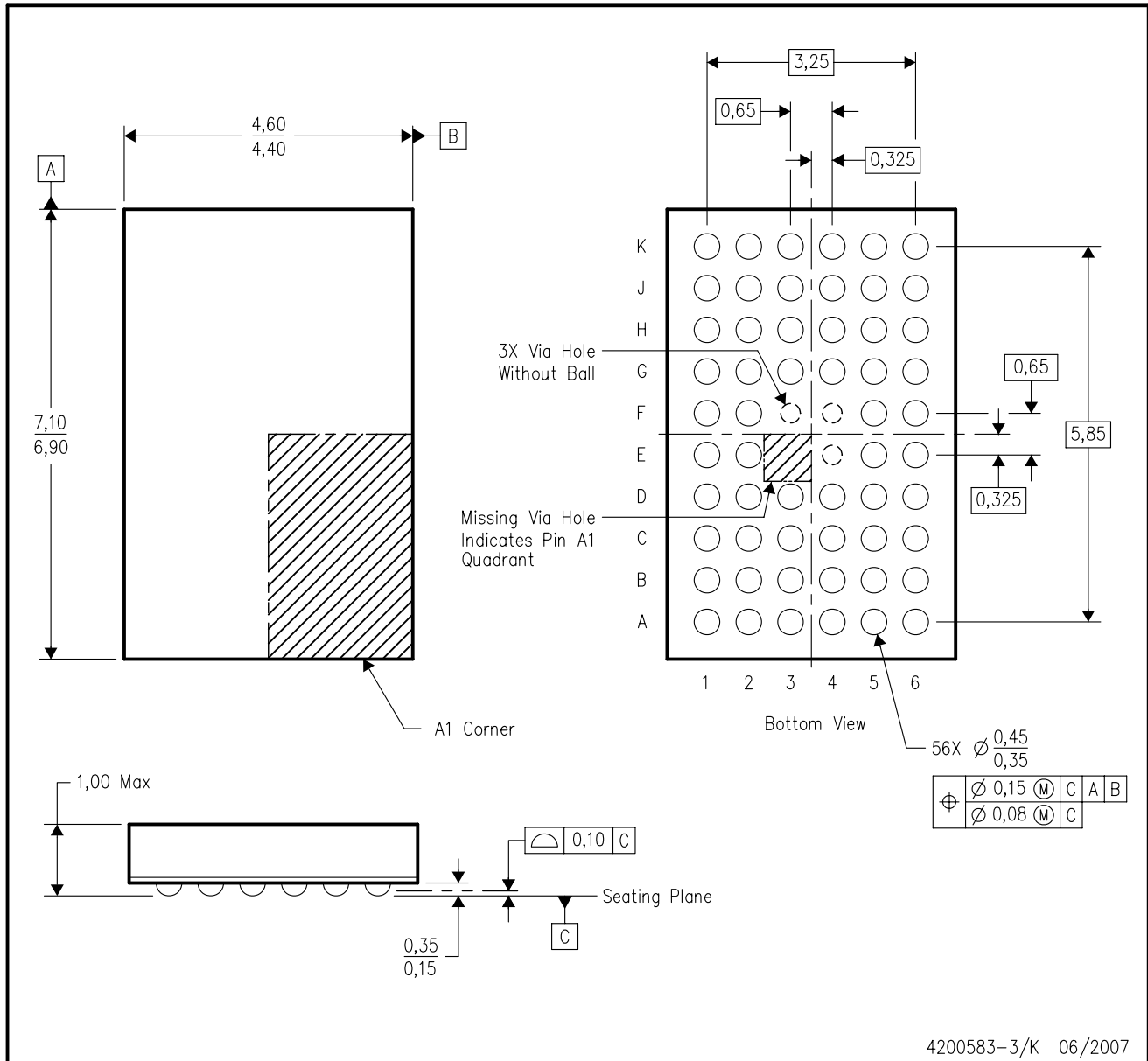
PLASTIC BALL GRID ARRAY



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - $\triangle C$ 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.

GQL (R-PBGA-N56)

PLASTIC BALL GRID ARRAY

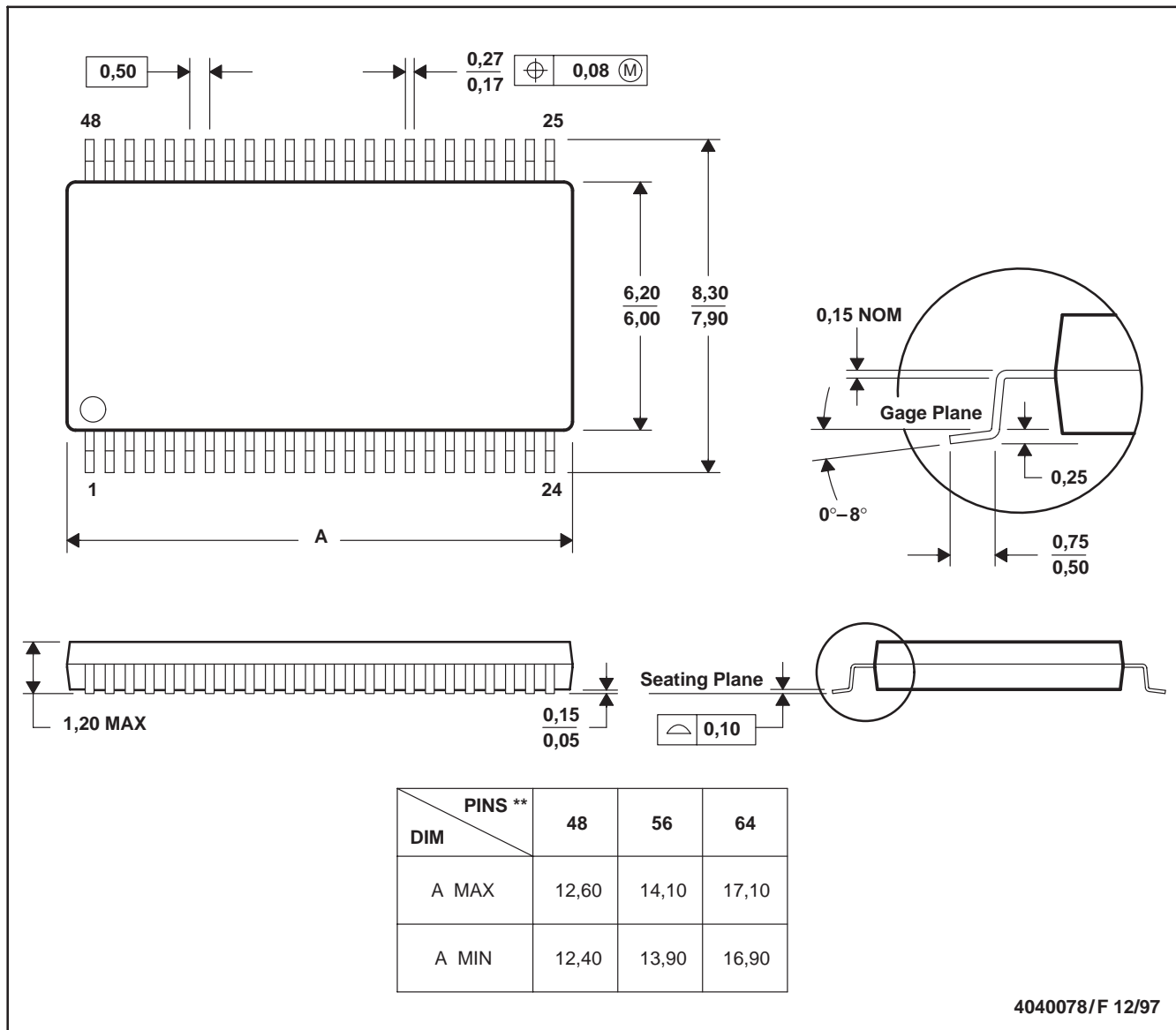


- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
 - B. This drawing is subject to change without notice.
 - C. Falls within JEDEC MO-285 variation BA-2.
 - D. This package is tin-lead (SnPb). Refer to the 56 ZQL package (drawing 4204437) for lead-free.

DGG (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

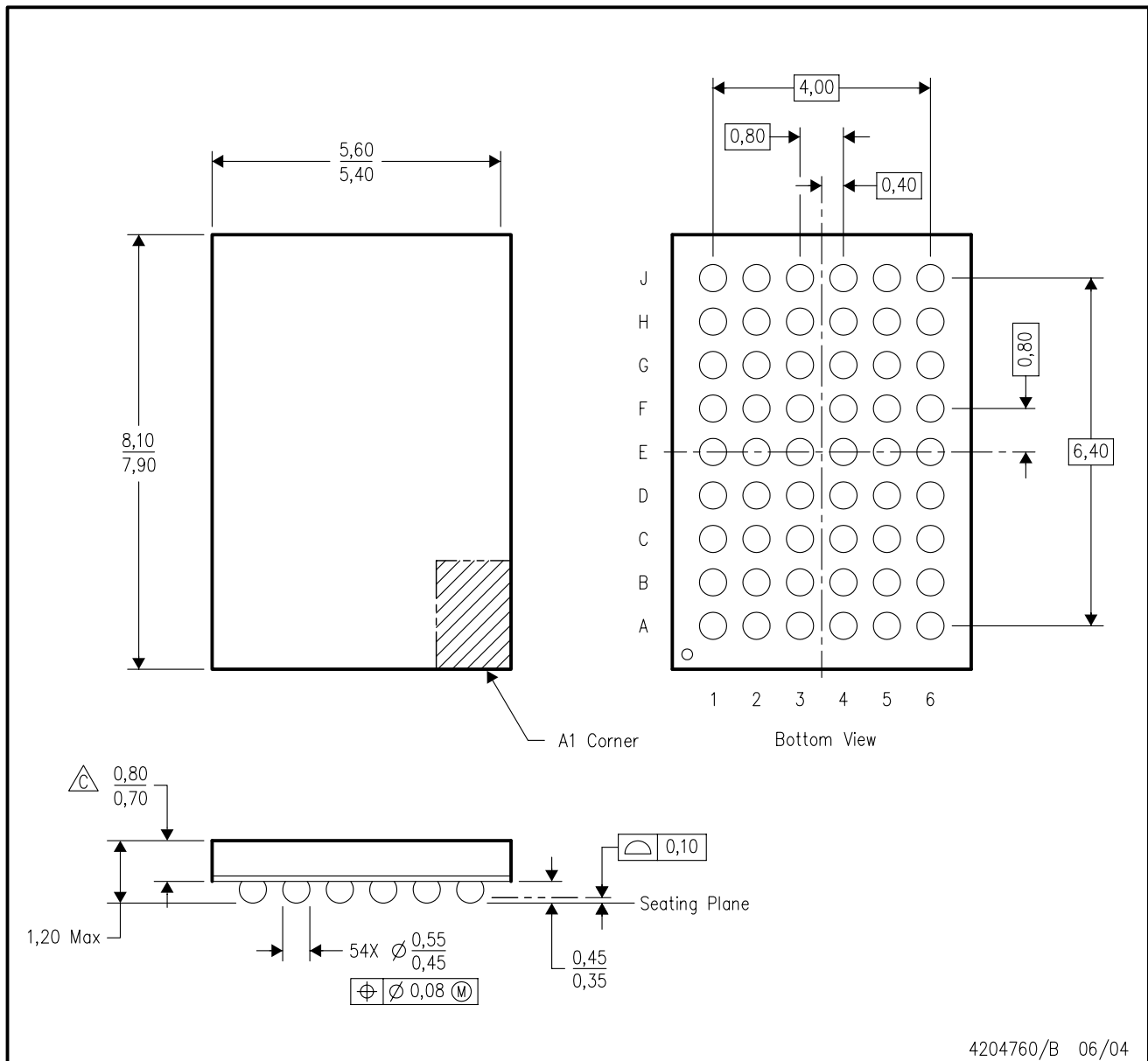
48 PINS SHOWN



- 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

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 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).

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