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# TEXAS INSTRUMENTS

**SN74LVCHR16245A**

SCAS582Q −NOVEMBER 1996−REVISED OCTOBER 2014

## SN74LVCHR16245A 16-Bit Bus Transceiver With 3-State Outputs

## 1 Features

- Member of the Texas Instruments Widebus™ Family
- Operates From 1.65 V to 3.6 V
- Inputs Accept Voltages to 5.5 V
- Max $t_{pd}$ of 4.8 ns at 3.3 V
- Typical $V_{OLP}$ (Output Ground Bounce) < 0.8 V at $V_{CC}$ = 3.3 V, $T_A$ = 25°C
- Typical $V_{OHV}$ (Output $V_{OH}$ Undershoot) > 2 V at $V_{CC}$ = 3.3 V, $T_A$ = 25°C
- Supports Mixed-Mode Signal Operation on All Ports (5-V Input/Output Voltage With 3.3-V $V_{CC}$)
- Bus Hold on Data Inputs Eliminates the Need for External Pullup or Pulldown Resistors
- All Outputs Have Equivalent 26-Ω Series Resistors, So No External Resistors Are Required
- $I_{off}$ Supports Live Insertion, Partial Power-Down Mode, and Back-Drive Protection
- Latch-Up Performance Exceeds 250 mA Per JESD 17
- ESD Protection Exceeds JESD 22
  - 2000-V Human-Body Model
  - 200-V Machine Model

## 2 Applications

- Telecom Infrastructures
- Industrial Transport
- Wireless Infrastructures
- Servers
- Tests and Measurements

## 3 Description

This 16-bit (dual-octal) noninverting bus transceiver is designed for 1.65-V to 3.6-V $V_{CC}$ operation.

The SN74LVCHR16245A device is designed for asynchronous communication between data buses. The control-function implementation minimizes external-timing requirements.

### Device Information[1]

| PART NUMBER | PACKAGE | BODY SIZE (NOM) |
|---|---|---|
| SN74LVCHR16245A | TSSOP (48) | 12.50 mm × 6.10 mm |
| | SSOP (48) | 15.88 mm × 7.49 mm |
| | TVSOP (48) | 9.70 mm × 4.40 mm |

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

## 4 Simplified Schematic



To Seven Other Channels

To Seven Other Channels

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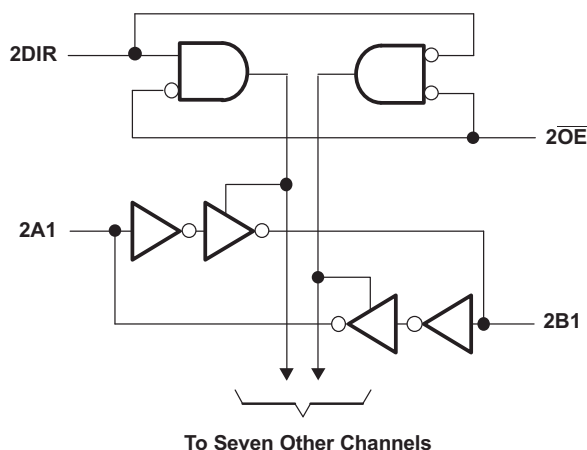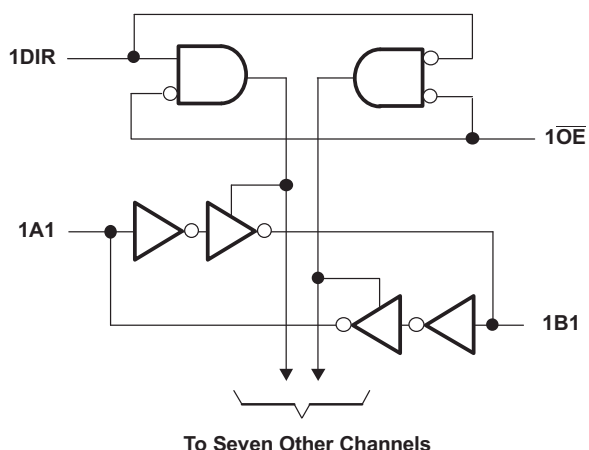
**SN74LVCHR16245A**

SCAS582Q – NOVEMBER 1996 – REVISED OCTOBER 2014

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# Table of Contents

# 5  Revision History

**Changes from Revision P (December 2005) to Revision Q**        **Page**

**TEXAS INSTRUMENTS**

**SN74LVCHR16245A**

# 6 Pin Configuration and Functions

**DGG, DGV, OR DL PACKAGE**
**(TOP VIEW)**

| | | |
|---|---|---|
| 1DIR | 1 48 | 1$\overline{OE}$ |
| 1B1 | 2 47 | 1A1 |
| 1B2 | 3 46 | 1A2 |
| GND | 4 45 | GND |
| 1B3 | 5 44 | 1A3 |
| 1B4 | 6 43 | 1A4 |
| $V_{CC}$ | 7 42 | $V_{CC}$ |
| 1B5 | 8 41 | 1A5 |
| 1B6 | 9 40 | 1A6 |
| GND | 10 39 | GND |
| 1B7 | 11 38 | 1A7 |
| 1B8 | 12 37 | 1A8 |
| 2B1 | 13 36 | 2A1 |
| 2B2 | 14 35 | 2A2 |
| GND | 15 34 | GND |
| 2B3 | 16 33 | 2A3 |
| 2B4 | 17 32 | 2A4 |
| $V_{CC}$ | 18 31 | $V_{CC}$ |
| 2B5 | 19 30 | 2A5 |
| 2B6 | 20 29 | 2A6 |
| GND | 21 28 | GND |
| 2B7 | 22 27 | 2A7 |
| 2B8 | 23 26 | 2A8 |
| 2DIR | 24 25 | 2$\overline{OE}$ |
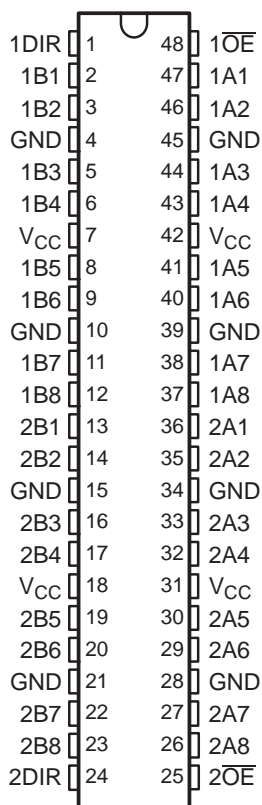
**Pin Functions**

| PIN | | I/O | DESCRIPTION |
|---|---|---|---|
| NO. | NAME | | |
| 1 | 1DIR | I | 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 | $V_{CC}$ | — | 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 |
| 17 | 2B4 | I/O | 2B4 input or output |
| 18 | $V_{CC}$ | — | Power pin |

Product Folder Links: *SN74LVCHR16245A*

**Pin Functions (continued)**

| PIN | | I/O | DESCRIPTION |
|---|---|---|---|
| NO. | NAME | | |
| 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 | I | Direction pin 2 |
| 25 | 2$\overline{\text{OE}}$ | 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$_{CC}$ | — | 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$_{CC}$ | — | 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$\overline{\text{OE}}$ | I | Output Enable 1 |

Product Folder Links: *SN74LVCHR16245A*

**TEXAS INSTRUMENTS**

**SN74LVCHR16245A**

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**GQL OR ZQL PACKAGE**
**(TOP VIEW)**
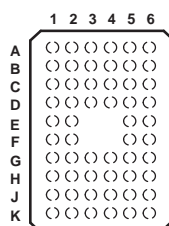


**Table 1. Pin Assignments[1]**
**(56-Ball GQL or ZQL Package)**

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

(1) NC – No internal connection

**GRD OR ZRD PACKAGE**
**(TOP VIEW)**
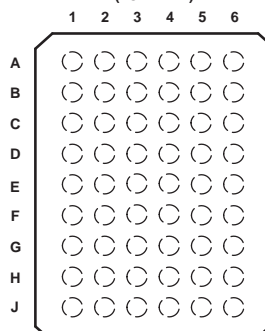


**Table 2. Pin Assignments[1]**
**(54-Ball GRD or ZRD Package)**

|   | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| A | 1B1 | NC | 1DIR | 1$\overline{\text{OE}}$ | NC | 1A1 |
| B | 1B3 | 1B2 | NC | NC | 1A2 | 1A3 |
| C | 1B5 | 1B4 | V$_{CC}$ | V$_{CC}$ | 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$_{CC}$ | V$_{CC}$ | 2A4 | 2A5 |
| H | 2B7 | 2B6 | NC | NC | 2A6 | 2A7 |
| J | 2B8 | NC | 2DIR | 2$\overline{\text{OE}}$ | NC | 2A8 |

(1) NC – No internal connection

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Product Folder Links: *SN74LVCHR16245A*

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**SN74LVCHR16245A**

SCAS582Q – NOVEMBER 1996 – REVISED OCTOBER 2014

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## 7 Specifications

### 7.1 Absolute Maximum Ratings[1]

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

| | | | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| $V_{CC}$ | Supply voltage range | | −0.5 | 6.5 | V |
| $V_I$ | Input voltage range[2] | | −0.5 | 6.5 | V |
| $V_O$ | Voltage range applied to any output in the high-impedance or power-off state[2] | | −0.5 | 6.5 | V |
| $V_O$ | Voltage range applied to any output in the high or low state[2][3] | | −0.5 | $V_{CC}$ + 0.5 | V |
| $I_{IK}$ | 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 |

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) The input negative-voltage and output voltage ratings may be exceeded if the input and output current ratings are observed.
(3) The value of $V_{CC}$ is provided in the *Recommended Operating Conditions* table.

### 7.2 Handling Ratings

| | | | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| $T_{stg}$ | Storage temperature range | | −65 | 150 | °C |
| $V_{(ESD)}$ | Electrostatic discharge | Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins[1] | 0 | 2000 | V |
| | | Charged device model (CDM), per JEDEC specification JESD22-C101, all pins[2] | 0 | 2000 | |

(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.

Product Folder Links: *SN74LVCHR16245A*

## 7.3 Recommended Operating Conditions

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

|  |  |  | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| $V_{CC}$ | Supply voltage | Operating | 1.65 | 3.6 | V |
|  |  | Data retention only | 1.5 |  |  |
| $V_{IH}$ | High-level input voltage | $V_{CC}$ = 1.65 V to 1.95 V | $0.65 \times V_{CC}$ |  | V |
|  |  | $V_{CC}$ = 2.3 V to 2.7 V | 1.7 |  |  |
|  |  | $V_{CC}$ = 2.7 V to 3.6 V | 2 |  |  |
| $V_{IL}$ | Low-level input voltage | $V_{CC}$ = 1.65 V to 1.95 V |  | $0.35 \times V_{CC}$ | V |
|  |  | $V_{CC}$ = 2.3 V to 2.7 V |  | 0.7 |  |
|  |  | $V_{CC}$ = 2.7 V to 3.6 V |  | 0.8 |  |
| $V_I$ | Input voltage |  | 0 | 5.5 | V |
| $V_O$ | Output voltage | High or low state | 0 | $V_{CC}$ | V |
|  |  | 3-state | 0 | 5.5 |  |
| $I_{OH}$ | High-level output current | $V_{CC}$ = 1.65 V |  | −2 | mA |
|  |  | $V_{CC}$ = 2.3 V |  | −4 |  |
|  |  | $V_{CC}$ = 2.7 V |  | −8 |  |
|  |  | $V_{CC}$ = 3 V |  | −12 |  |
| $I_{OL}$ | Low-level output current | $V_{CC}$ = 1.65 V |  | 2 | mA |
|  |  | $V_{CC}$ = 2.3 V |  | 4 |  |
|  |  | $V_{CC}$ = 2.7 V |  | 8 |  |
|  |  | $V_{CC}$ = 3 V |  | 12 |  |
| Δt/Δv | Input transition rise or fall rate |  |  | 10 | ns/V |
| $T_A$ | Operating free-air temperature |  | −40 | 125 | °C |

(1)  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* (SCBA004).

## 7.4 Thermal Information

|  | THERMAL METRIC[1] | SN74LVCHR16245A | | | UNIT |
|---|---|---|---|---|---|
|  |  | DGG | DGV | DL |  |
|  |  | 48 PINS | | |  |
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance | 64.3 | 78.4 | 68.4 | °C/W |
| $R_{\theta JC(top)}$ | Junction-to-case (top) thermal resistance | 17.6 | 30.7 | 34.7 |  |
| $R_{\theta JB}$ | Junction-to-board thermal resistance | 31.5 | 41.8 | 41.0 |  |
| $\psi_{JT}$ | Junction-to-top characterization parameter | 1.1 | 3.8 | 12.3 |  |
| $\psi_{JB}$ | Junction-to-board characterization parameter | 31.2 | 41.3 | 40.4 |  |

(1)  For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report (SPRA953).

**TEXAS INSTRUMENTS**

**SN74LVCHR16245A**

SCAS582Q – NOVEMBER 1996 – REVISED OCTOBER 2014

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## 7.5 Electrical Characteristics

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

| PARAMETER | | TEST CONDITIONS | | $V_{CC}$ | MIN | TYP[1] | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| $V_{OH}$ | | $I_{OH} = -100$ µA | | 1.65 V to 3.6 V | $V_{CC} - 0.2$ | | | V |
| | | $I_{OH} = -2$ mA | | 1.65 V | 1.2 | | | |
| | | $I_{OH} = -4$ mA | | 2.3 V | 1.7 | | | |
| | | | | 2.7 V | 2.2 | | | |
| | | $I_{OH} = -6$ mA | | 3 V | 2.4 | | | |
| | | $I_{OH} = -8$ mA | | 2.7 V | 2 | | | |
| | | $I_{OH} = -12$ mA | | 3 V | 2 | | | |
| $V_{OL}$ | | $I_{OL} = 100$ µA | | 1.65 V to 3.6 V | | | 0.2 | V |
| | | $I_{OL} = 2$ mA | | 1.65 V | | | 0.45 | |
| | | $I_{OL} = 4$ mA | | 2.3 V | | | 0.7 | |
| | | | | 2.7 V | | | 0.4 | |
| | | $I_{OL} = 6$ mA | | 3 V | | | 0.55 | |
| | | $I_{OL} = 8$ mA | | 2.7 V | | | 0.6 | |
| | | $I_{OL} = 12$ mA | | 3 V | | | 0.8 | |
| $I_I$ | Control inputs | $V_I = 0$ to 5.5 V | | 3.6 V | | | ±5 | µA |
| $I_{I(hold)}$ | A or B port | $V_I = 0.58$ V | | 1.65 V | 15 | | | µA |
| | | $V_I = 1.07$ V | | | −15 | | | |
| | | $V_I = 0.7$ V | | 2.3 V | 45 | | | |
| | | $V_I = 1.7$ V | | | −45 | | | |
| | | $V_I = 0.8$ V | | 3 V | 75 | | | |
| | | $V_I = 2$ V | | | −75 | | | |
| | | $V_I = 0$ to 3.6 V [2] | | 3.6 V | | | ±500 | |
| $I_{off}$ | | $V_I$ or $V_O = 5.5$ V | | 0 | | | ±10 | µA |
| $I_{OZ}$ [3] | | $V_O = 0$ V or ($V_{CC}$ to 5.5 V) | | 2.3 V to 3.6 V | | | ±5 | µA |
| $I_{CC}$ | | $V_I = V_{CC}$ or GND | $I_O = 0$ | 3.6 V | | | 20 | µA |
| | | 3.6 V ≤ $V_I$ ≤ 5.5 V [4] | | | | | 20 | |
| $\Delta I_{CC}$ | | One input at $V_{CC} - 0.6$ V, Other inputs at $V_{CC}$ or GND | | 2.7 V to 3.6 V | | | 500 | µA |
| $C_i$ | Control inputs | $V_I = V_{CC}$ or GND | | 3.3 V | | 3 | | pF |
| $C_{io}$ | A or B port | $V_O = V_{CC}$ or GND | | 3.3 V | | 12 | | pF |

(1) All typical values are at $V_{CC} = 3.3$ V, $T_A = 25$°C.
(2) This is the bus-hold maximum dynamic current. It is the minimum overdrive current required to switch the input from one state to another.
(3) For the total leakage current in an I/O port, please consult the $I_{I(hold)}$ specification for the input voltage condition 0 V < $V_I$ < $V_{CC}$, and the $I_{OZ}$ specification for the input voltage conditions $V_I = 0$ V or $V_I = V_{CC}$ to 5.5 V. The bus-hold current, at input voltages greater than $V_{CC}$, is negligible.
(4) This applies in the disabled state only.

Product Folder Links: *SN74LVCHR16245A*

# TEXAS INSTRUMENTS

**SN74LVCHR16245A**

## 7.6  Switching Characteristics

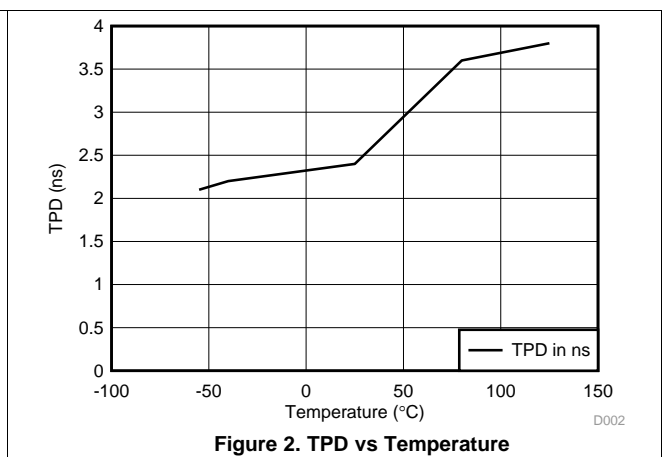over recommended operating free-air temperature range (unless otherwise noted) (see Figure 3)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | $V_{CC}$ = 1.8 V ± 0.15 V | | $V_{CC}$ = 2.5 V ± 0.2 V | | $V_{CC}$ = 2.7 V | | $V_{CC}$ = 3.3 V ± 0.3 V | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX | |
| $t_{pd}$ | A or B | B or A | 1 | 12.5 | 1 | 9.5 | 1 | 5.7 | 1.5 | 4.8 | ns |
| $t_{en}$ | $\overline{OE}$ | A or B | 1 | 15.8 | 1 | 12.2 | 1 | 7.9 | 1.5 | 6.3 | ns |
| $t_{dis}$ | $\overline{OE}$ | A or B | 1 | 19.2 | 1 | 11.9 | 1 | 8.3 | 2.2 | 7.4 | ns |

## 7.7  Operating Characteristics

$T_A$ = 25°C

| PARAMETER | | TEST CONDITIONS | $V_{CC}$ = 1.8 V TYP | $V_{CC}$ = 2.5 V TYP | $V_{CC}$ = 3.3 V TYP | UNIT |
|---|---|---|---|---|---|---|
| $C_{pd}$ | Power dissipation capacitance per transceiver | Outputs enabled | f = 10 MHz | 36 | 36 | 39 | pF |
| | | Outputs disabled | | 3 | 3 | 4 | |

## 7.8  Typical Characteristics



Figure 1. TPD vs $V_{CC}$



Figure 2. TPD vs Temperature

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Product Folder Links: *SN74LVCHR16245A*

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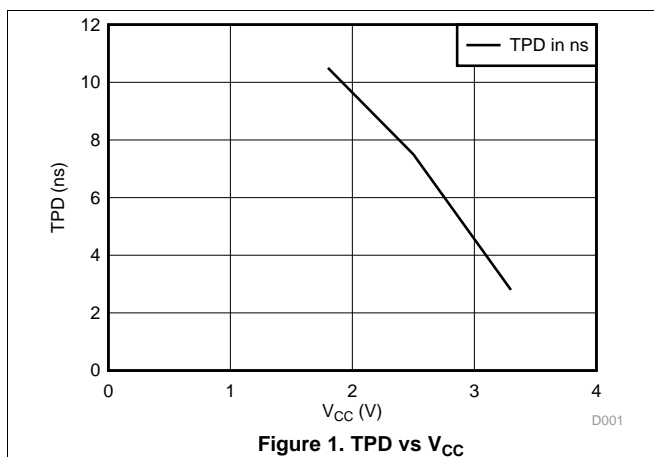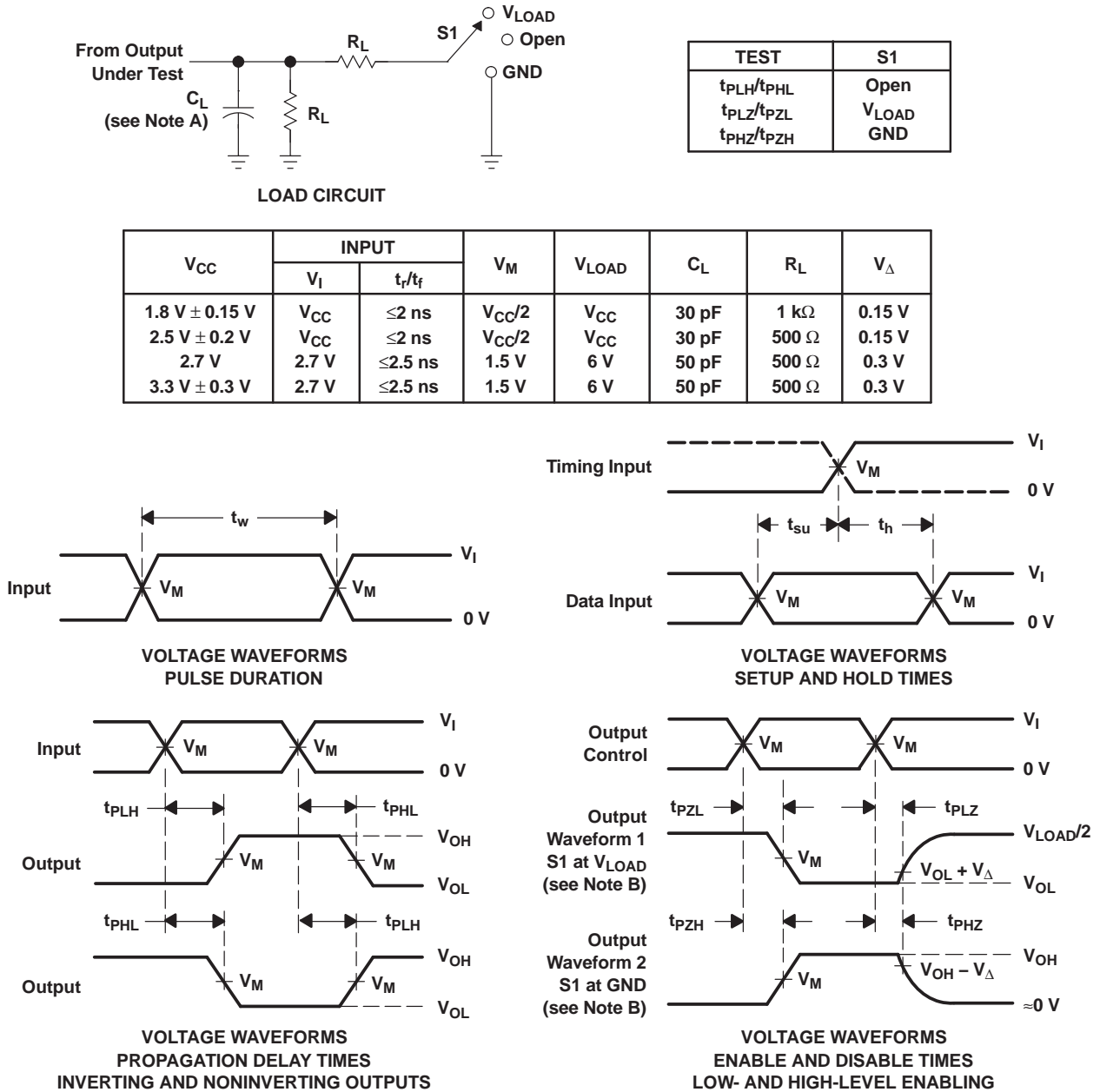
**SN74LVCHR16245A**

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# 8 Parameter Measurement Information



**LOAD CIRCUIT**

| TEST | S1 |
|---|---|
| $t_{PLH}/t_{PHL}$ | Open |
| $t_{PLZ}/t_{PZL}$ | $V_{LOAD}$ |
| $t_{PHZ}/t_{PZH}$ | GND |

| $V_{CC}$ | INPUT | | $V_M$ | $V_{LOAD}$ | $C_L$ | $R_L$ | $V_\Delta$ |
|---|---|---|---|---|---|---|---|
| | $V_I$ | $t_r/t_f$ | | | | | |
| 1.8 V ± 0.15 V | $V_{CC}$ | ≤2 ns | $V_{CC}/2$ | $V_{CC}$ | 30 pF | 1 kΩ | 0.15 V |
| 2.5 V ± 0.2 V | $V_{CC}$ | ≤2 ns | $V_{CC}/2$ | $V_{CC}$ | 30 pF | 500 Ω | 0.15 V |
| 2.7 V | 2.7 V | ≤2.5 ns | 1.5 V | 6 V | 50 pF | 500 Ω | 0.3 V |
| 3.3 V ± 0.3 V | 2.7 V | ≤2.5 ns | 1.5 V | 6 V | 50 pF | 500 Ω | 0.3 V |



**VOLTAGE WAVEFORMS**
**PULSE DURATION**

**VOLTAGE WAVEFORMS**
**SETUP AND HOLD TIMES**

**VOLTAGE WAVEFORMS**
**PROPAGATION DELAY TIMES**
**INVERTING AND NONINVERTING OUTPUTS**

**VOLTAGE WAVEFORMS**
**ENABLE AND DISABLE TIMES**
**LOW- AND HIGH-LEVEL ENABLING**

NOTES: A. $C_L$ includes probe and jig capacitance.
B. Waveform 1 is for an output with internal conditions such that the output is low, except when disabled by the output control.
Waveform 2 is for an output with internal conditions such that the output is high, except when disabled by the output control.
C. All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz, $Z_O$ = 50 Ω.
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 $t_{pd}$.
H. All parameters and waveforms are not applicable to all devices.

**Figure 3. Load Circuit and Voltage Waveforms**

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**TEXAS INSTRUMENTS**

**SN74LVCHR16245A**

# 9 Detailed Description

## 9.1 Overview

This 16-bit (dual-octal) noninverting bus transceiver is designed for 1.65-V to 3.6-V $V_{CC}$ operation.

The SN74LVCHR16245A 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 disable the device so that the buses are effectively isolated.

All outputs, which are designed to sink up to 12 mA, include equivalent 26-Ω series resistors to reduce overshoot and undershoot.

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/5-V system environment.

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.

This device is fully specified for partial-power-down applications using $I_{off}$. The $I_{off}$ circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down.

Active bus-hold circuitry is provided to hold unused or floating data inputs at a valid logic level. Use of pullup or pulldown resistors with the bus-hold circuitry is not recommended. The bus-hold circuitry is part of the input circuit and is not disabled by $\overline{OE}$ or DIR.
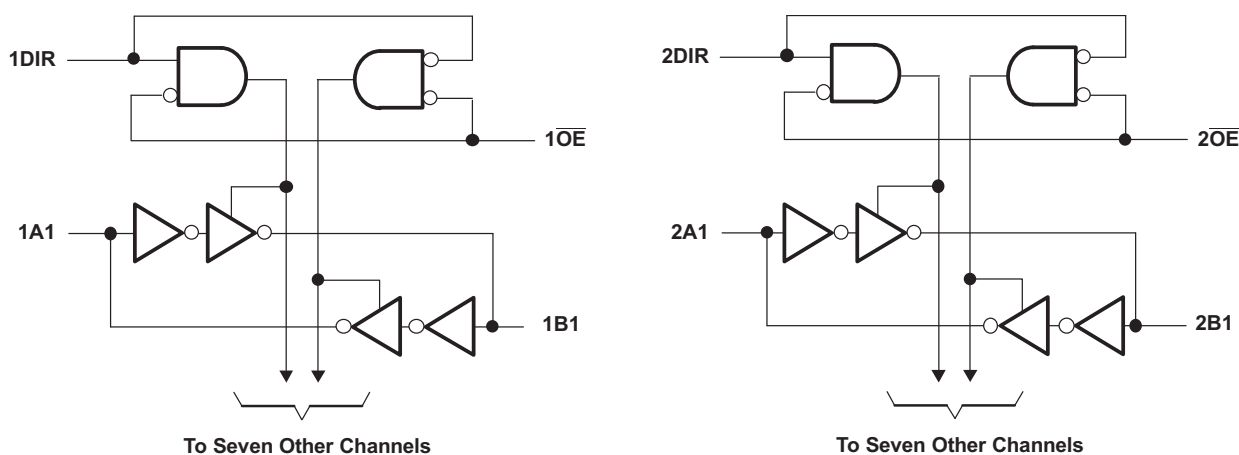
## 9.2 Functional Block Diagram



**Figure 4. Logic Diagram (Positive Logic)**

Product Folder Links: *SN74LVCHR16245A*

**TEXAS INSTRUMENTS**

**SN74LVCHR16245A**

SCAS582Q – NOVEMBER 1996 – REVISED OCTOBER 2014

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### 9.3 Feature Description

- Wide operating voltage range
  - Operates from 1.65 V to 3.6 V
- Allows down voltage translation
  - Inputs accept voltages to 5.5 V
- $I_{off}$ feature
  - Allows voltages on the inputs and outputs when $V_{CC}$ is 0 V
- All outputs have equivalent 26-Ω series resistors, so no external resistors are required
- Bus hold on data inputs eliminates the need for external pullup or pulldown resistors

### 9.4 Device Functional Modes

**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.

Product Folder Links: *SN74LVCHR16245A*

**TEXAS INSTRUMENTS**

**SN74LVCHR16245A**

# 10 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.

## 10.1 Application Information

The SN74LVCHR16245A 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. The device has 5.5-V tolerant inputs at any valid $V_{CC}$ which allows the device to be used in multi-power systems and used for down translation. All outputs have equivalent 26-$\Omega$ series resistors, so no external resistors are required. The Bus Hold feature eliminates the need for external pullup or pulldown resistors on unused or floating inputs.

## 10.2 Typical Application
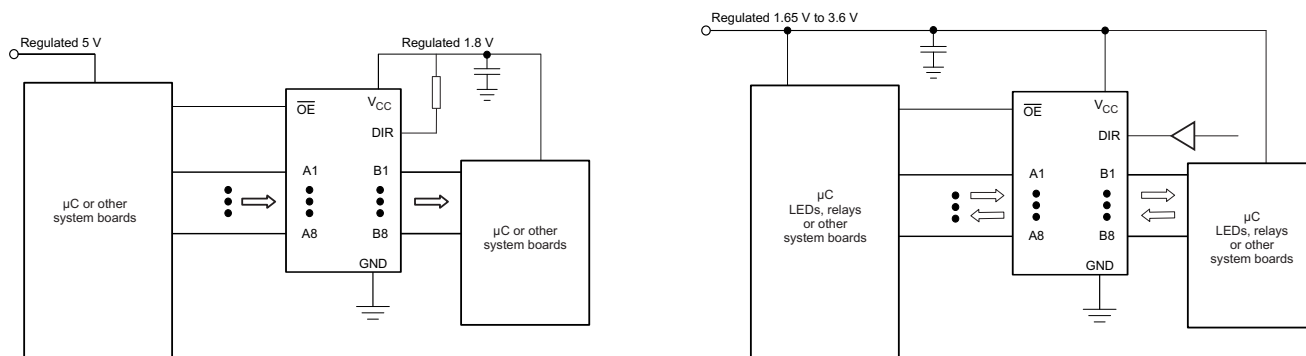


**Figure 5. Typical Application Schematic**

### 10.2.1 Design Requirements

This device uses CMOS technology and has balanced output drive. Care should be taken to avoid bus contention because it can drive currents that would exceed maximum limits. The high drive will also create fast edges into light loads, so routing and load conditions should be considered to prevent ringing.

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**SN74LVCHR16245A**
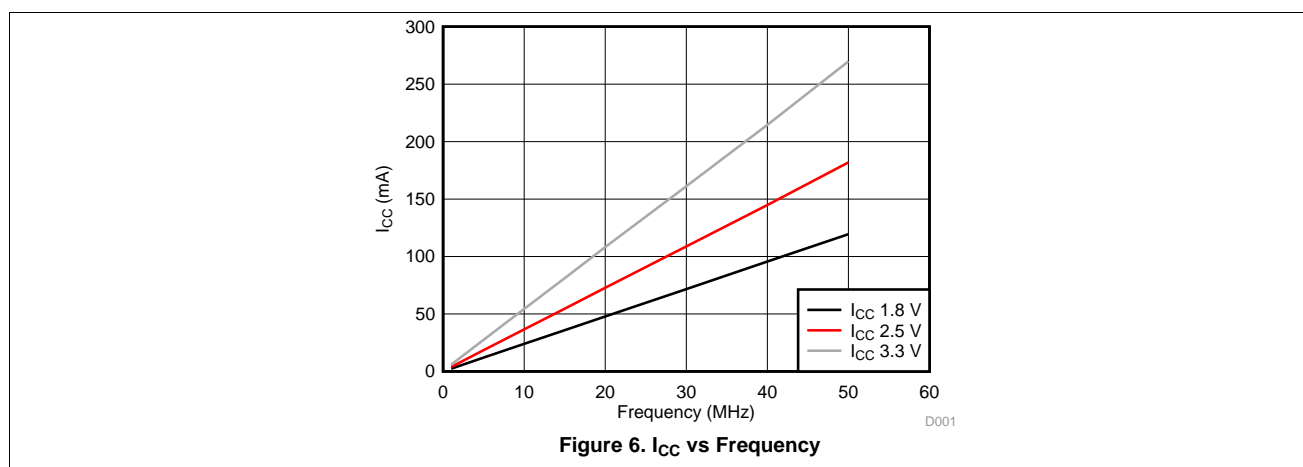
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## Typical Application (continued)

### 10.2.2   Detailed Design Procedure

1. Recommended Input Conditions:
   – Rise time and fall time specifications, see Δt/ΔV in the *Recommended Operating Conditions* table.
   – Specified high and low levels, see $V_{IH}$ and $V_{IL}$ in the *Recommended Operating Conditions* table.
   – Inputs are overvoltage tolerant allowing them to go as high as 5.5 V at any valid $V_{CC}$.
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 $V_{CC}$.

### 10.2.3   Application Curves



**Figure 6. $I_{CC}$ vs Frequency**

Product Folder Links: *SN74LVCHR16245A*

**TEXAS INSTRUMENTS**

**SN74LVCHR16245A**

## 11 Power Supply Recommendations

The power supply can be any voltage between the MIN and MAX supply voltage rating located in the *Recommended Operating Conditions* table.
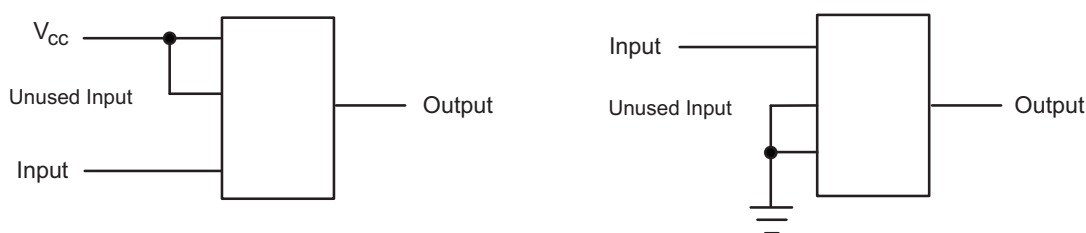
Each $V_{CC}$ pin should have a good bypass capacitor to prevent power disturbance. For devices with a single supply, 0.1 µF is recommended. If there are multiple $V_{CC}$ pins, 0.01 µF or 0.022 µF is recommended for each power pin. It is acceptable to parallel multiple bypass caps to reject different frequencies of noise. A 0.1 µF and 1 µF are commonly used in parallel. The bypass capacitor should be installed as close to the power pin as possible for best results.

## 12 Layout

### 12.1 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 Figure 7 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.

### 12.2 Layout Example



**Figure 7. Layout Diagram**

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Datasheet of SN74LVCHR16245ALR - IC BUS TRANSCVR 16BIT 48SSOP
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## 13 Device and Documentation Support

### 13.1 Trademarks

Widebus is a trademark of Texas Instruments.
All other trademarks are the property of their respective owners.

### 13.2 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.

### 13.3 Glossary

SLYZ022 — *TI Glossary*.

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

## 14 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.

Product Folder Links: *SN74LVCHR16245A*

**PACKAGE OPTION ADDENDUM**

www.ti.com                                                                                                                 5-Feb-2016

## 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 74LVCHR16245AGRDR | OBSOLETE | BGA MICROSTAR JUNIOR | GRD | 54 | | TBD | Call TI | Call TI | -40 to 125 | | |
| 74LVCHR16245AGRG4 | ACTIVE | TSSOP | DGG | 48 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | LVCHR16245A | Samples |
| 74LVCHR16245ALRG4 | ACTIVE | SSOP | DL | 48 | 1000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | (LVCHR162245A ~ LVCHR16245A) | Samples |
| 74LVCHR16245AZQLR | ACTIVE | BGA MICROSTAR JUNIOR | ZQL | 56 | 1000 | Green (RoHS & no Sb/Br) | SNAGCU | Level-1-260C-UNLIM | -40 to 125 | LR245A | Samples |
| 74LVCHR16245AZRDR | ACTIVE | BGA MICROSTAR JUNIOR | ZRD | 54 | 1000 | Green (RoHS & no Sb/Br) | SNAGCU | Level-1-260C-UNLIM | -40 to 125 | LR245A | Samples |
| SN74LVCHR16245AGR | ACTIVE | TSSOP | DGG | 48 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | LVCHR16245A | Samples |
| SN74LVCHR16245AKR | OBSOLETE | BGA MICROSTAR JUNIOR | GQL | 56 | | TBD | Call TI | Call TI | -40 to 125 | LR245A | |
| SN74LVCHR16245ALR | ACTIVE | SSOP | DL | 48 | 1000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | (LVCHR162245A ~ LVCHR16245A) | Samples |
| SN74LVCHR16245AVR | ACTIVE | TVSOP | DGV | 48 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | LDR245A | Samples |

**(1)** The marketing status values are defined as follows:
**ACTIVE:** Product device recommended for new designs.
**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.
**OBSOLETE:** TI has discontinued the production of the device.

**(2)** Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
**TBD:** The Pb-Free/Green conversion plan has not been defined.
**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**PACKAGE OPTION ADDENDUM**

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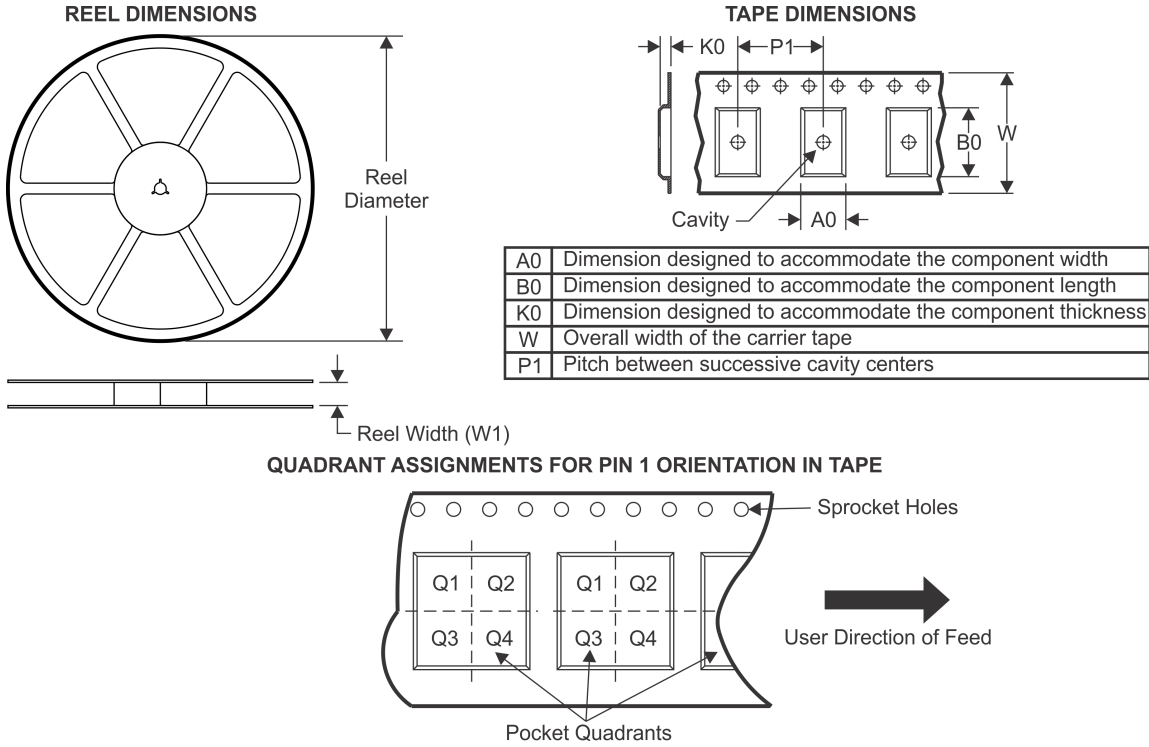
**(5)** Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

**(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.

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**TEXAS INSTRUMENTS**

# PACKAGE MATERIALS INFORMATION

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8-Nov-2013

## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**

**TAPE DIMENSIONS**

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

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**

*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|--------|-------------|-----------------|------|-----|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| 74LVCHR16245AZQLR | BGA MICROSTAR JUNIOR | ZQL | 56 | 1000 | 330.0 | 16.4 | 4.8 | 7.3 | 1.5 | 8.0 | 16.0 | Q1 |
| 74LVCHR16245AZRDR | BGA MICROSTAR JUNIOR | ZRD | 54 | 1000 | 330.0 | 16.4 | 5.8 | 8.3 | 1.55 | 8.0 | 16.0 | Q1 |
| SN74LVCHR16245AGR | TSSOP | DGG | 48 | 2000 | 330.0 | 24.4 | 8.6 | 15.8 | 1.8 | 12.0 | 24.0 | Q1 |
| SN74LVCHR16245ALR | SSOP | DL | 48 | 1000 | 330.0 | 32.4 | 11.35 | 16.2 | 3.1 | 16.0 | 32.0 | Q1 |
| SN74LVCHR16245AVR | TVSOP | DGV | 48 | 2000 | 330.0 | 16.4 | 7.1 | 10.2 | 1.6 | 12.0 | 16.0 | Q1 |

**TEXAS INSTRUMENTS**

# PACKAGE MATERIALS INFORMATION

**TAPE AND REEL BOX  DIMENSIONS**



*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| 74LVCHR16245AZQLR | BGA MICROSTAR JUNIOR | ZQL | 56 | 1000 | 336.6 | 336.6 | 28.6 |
| 74LVCHR16245AZRDR | BGA MICROSTAR JUNIOR | ZRD | 54 | 1000 | 336.6 | 336.6 | 28.6 |
| SN74LVCHR16245AGR | TSSOP | DGG | 48 | 2000 | 367.0 | 367.0 | 45.0 |
| SN74LVCHR16245ALR | SSOP | DL | 48 | 1000 | 367.0 | 367.0 | 55.0 |
| SN74LVCHR16245AVR | TVSOP | DGV | 48 | 2000 | 367.0 | 367.0 | 38.0 |

## MECHANICAL DATA

ZQL (R−PBGA−N56)                    PLASTIC BALL GRID ARRAY
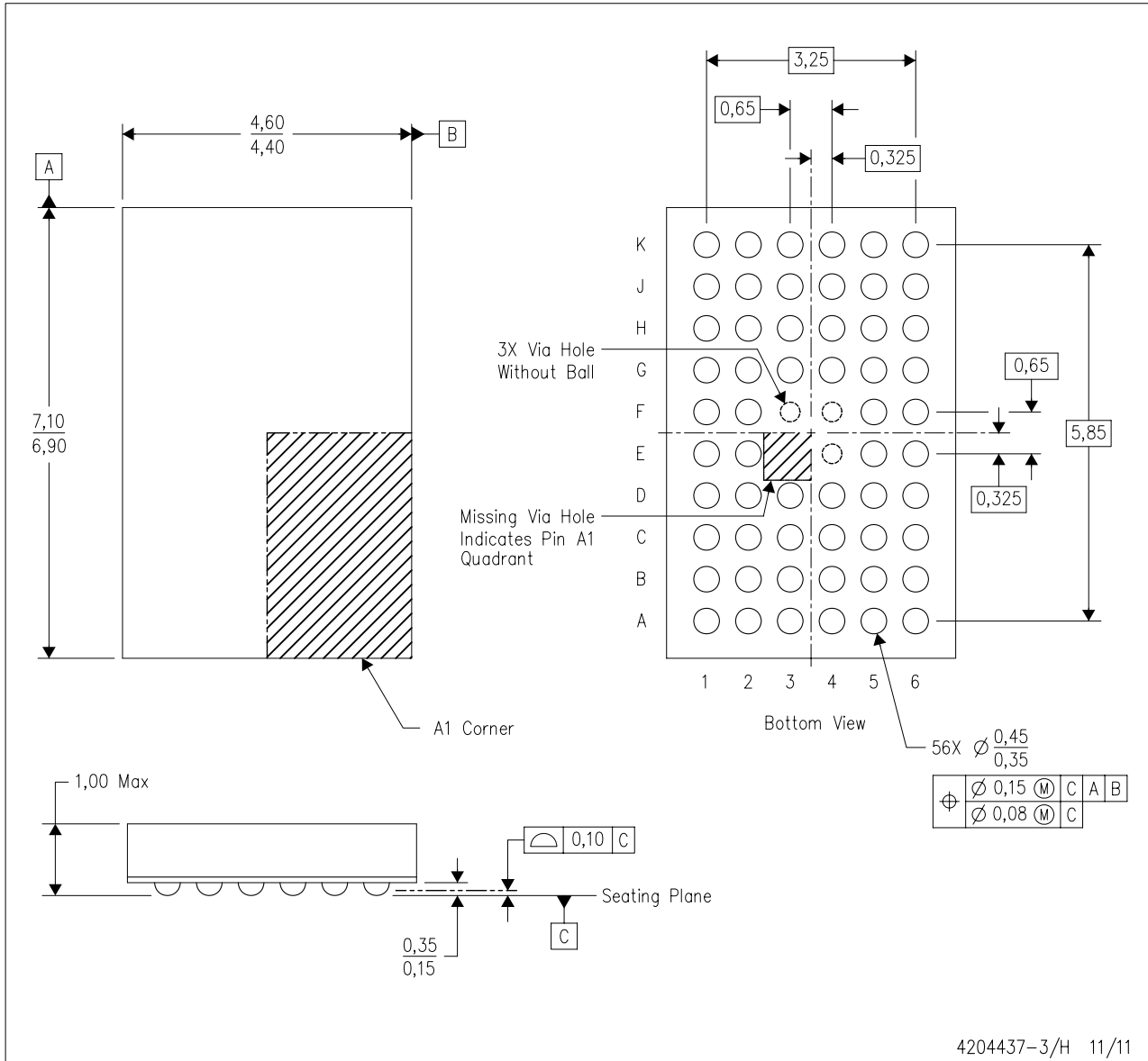


3X Via Hole Without Ball

Missing Via Hole Indicates Pin A1 Quadrant

A1 Corner

Bottom View

56X Ø 0,45 / 0,35

1,00 Max

Seating Plane

0,35 / 0,15

0,10 C

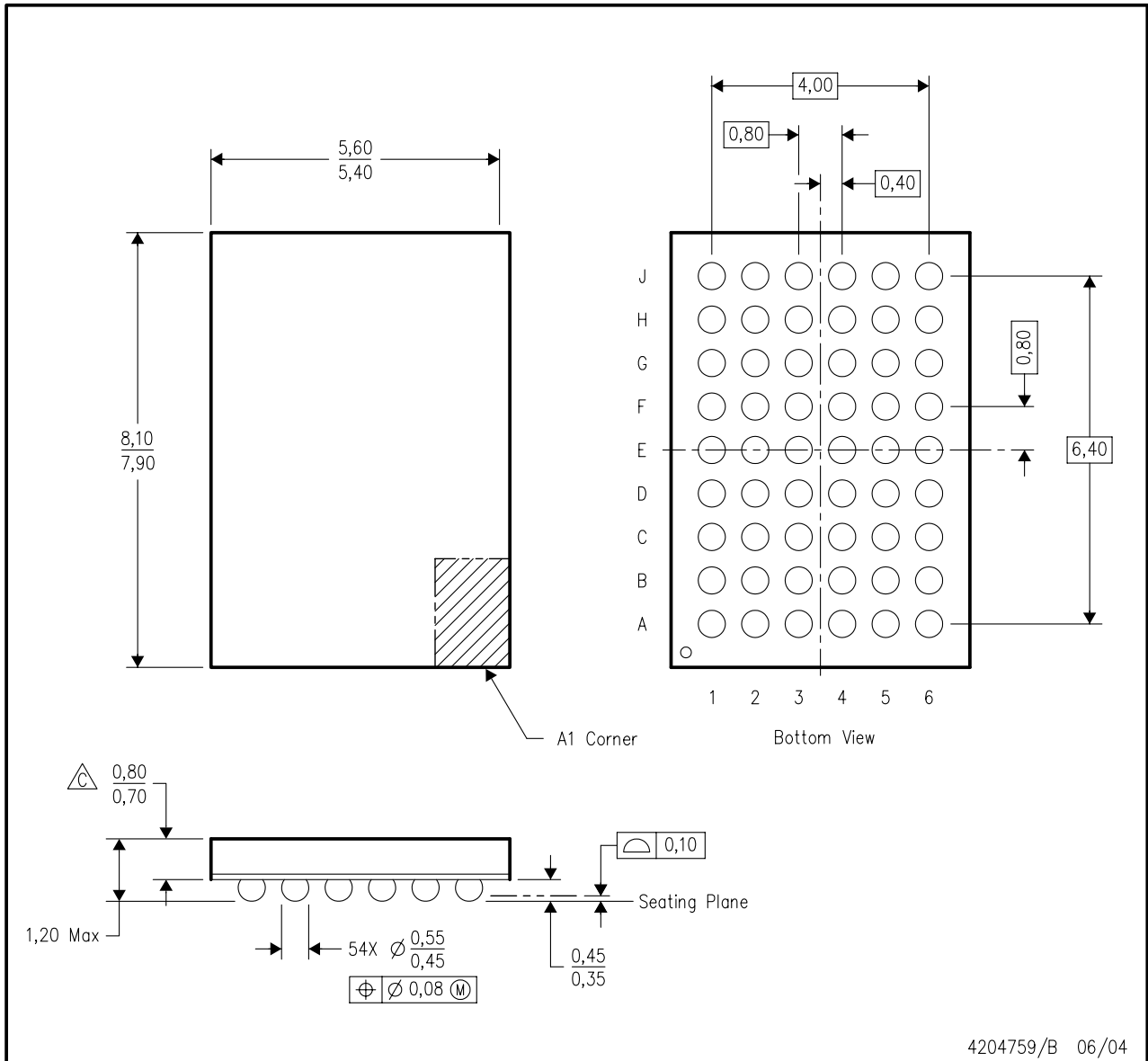⊕ | Ø 0,15 Ⓜ | C | A | B
  | Ø 0,08 Ⓜ | C |

4204437−3/H  11/11

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

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**MECHANICAL DATA**

GRD (R−PBGA−N54)                    PLASTIC BALL GRID ARRAY



A1 Corner

Bottom View

Seating Plane

54X Ø 0,55 / 0,45
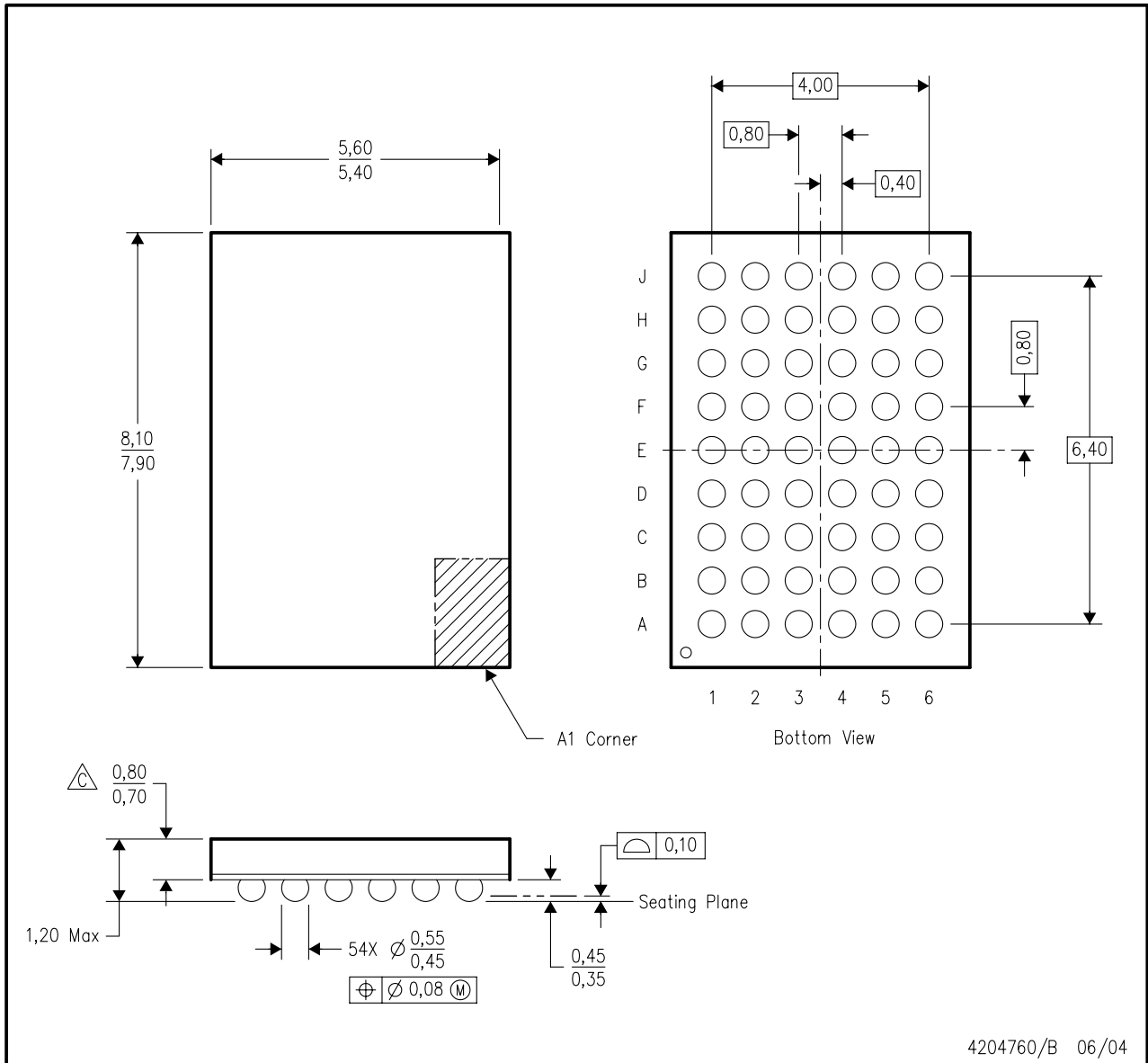
⊕ Ø 0,08 Ⓜ

1,20 Max

4204759/B   06/04

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.

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**MECHANICAL DATA**

ZRD (R−PBGA−N54)                          PLASTIC BALL GRID ARRAY

A1 Corner

Bottom View

Seating Plane

1,20 Max

54X Ø $\frac{0.55}{0.45}$

⊕ Ø 0,08 Ⓜ

4204760/B  06/04

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.
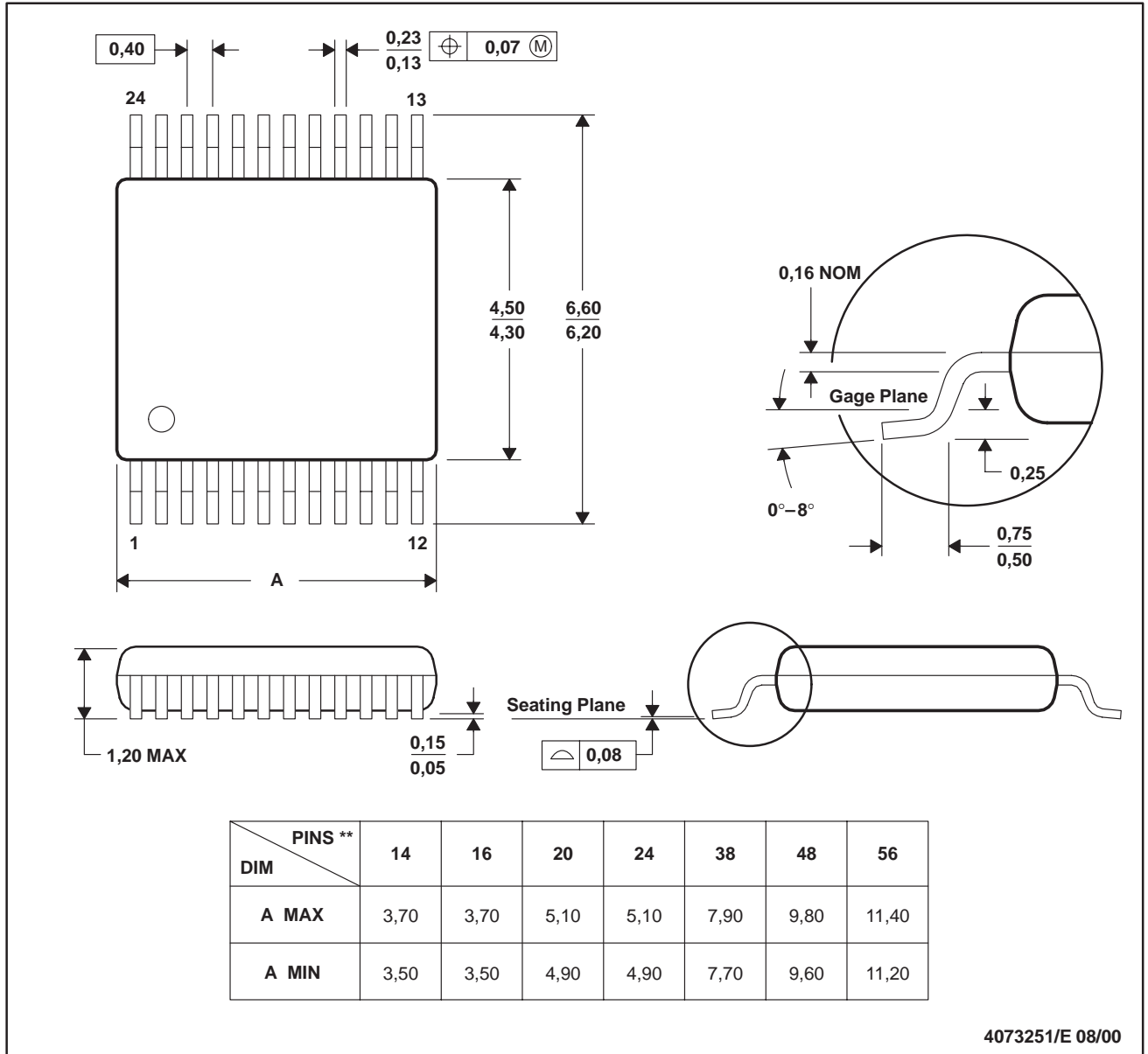         D.   This package is lead−free.  Refer to the 54 GRD package (drawing 4204759) for tin−lead (SnPb).

## MECHANICAL DATA

MPDS006C – FEBRUARY 1996 – REVISED AUGUST 2000

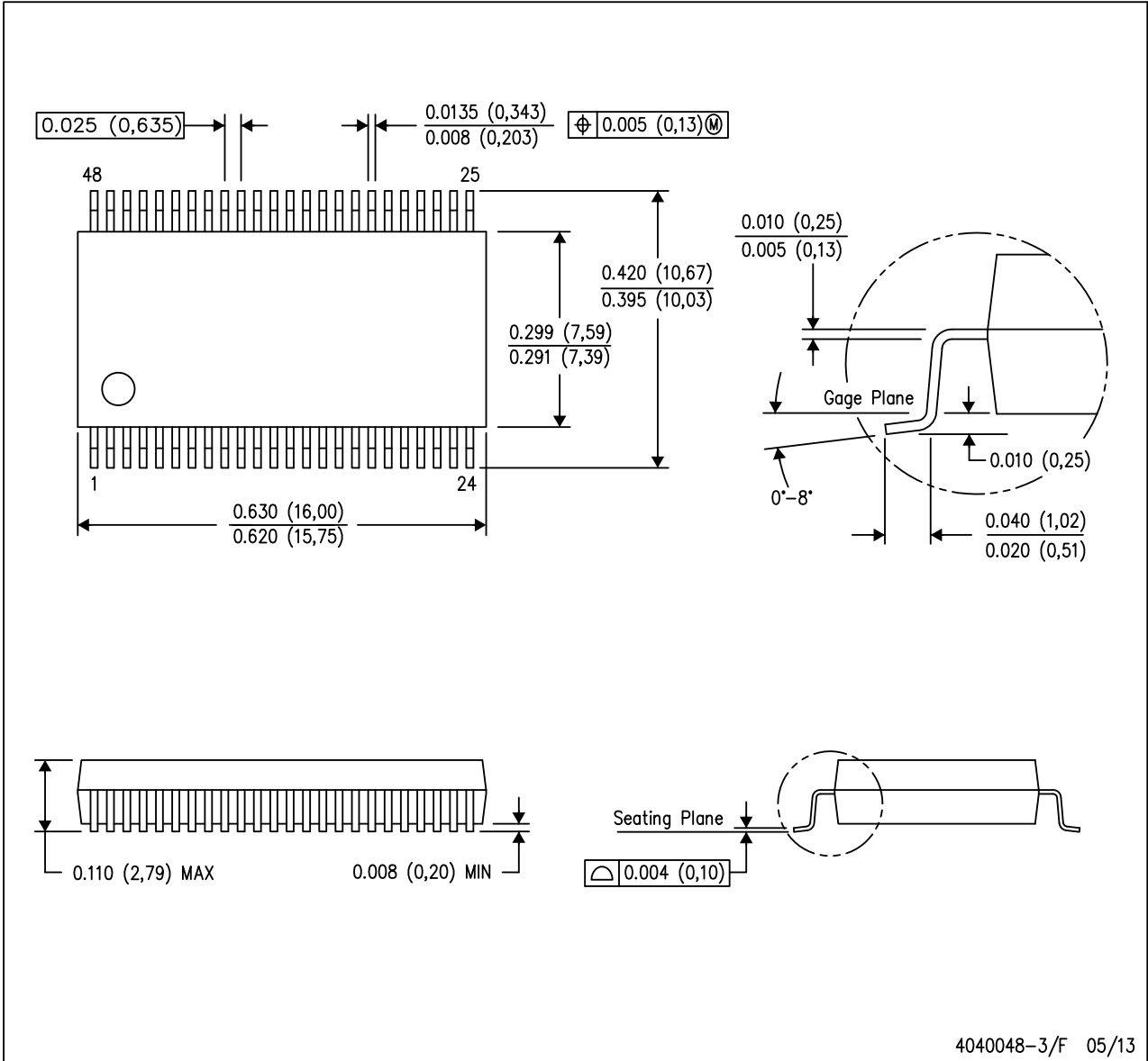**DGV (R-PDSO-G\*\*)**                                                    **PLASTIC SMALL-OUTLINE**

**24 PINS SHOWN**



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

4073251/E 08/00
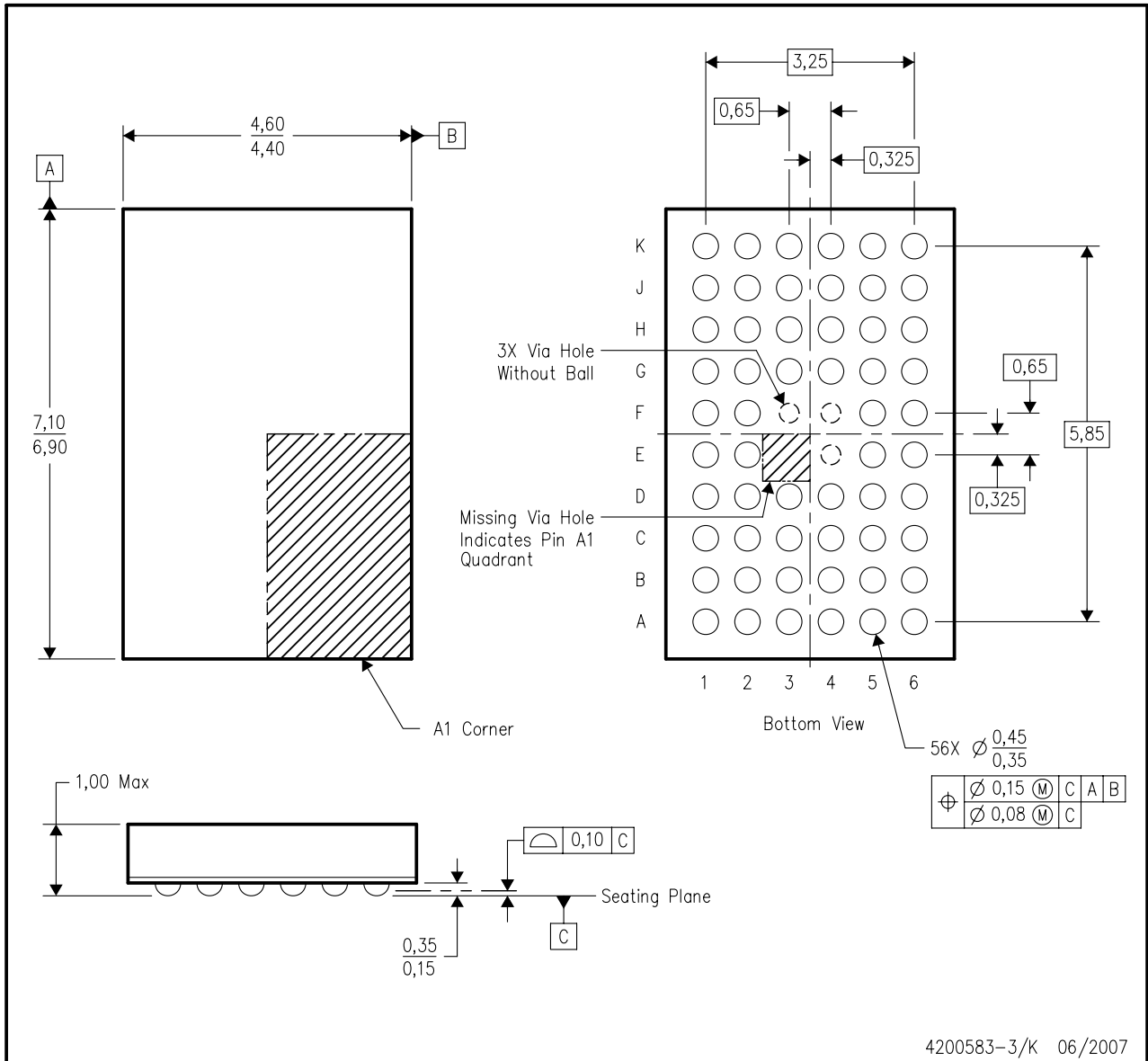
NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15 per side.
D. Falls within JEDEC: 24/48 Pins – MO-153
14/16/20/56 Pins – MO-194

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**MECHANICAL DATA**

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



4040048—3/F   05/13

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

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**MECHANICAL DATA**

GQL (R−PBGA−N56)                    PLASTIC  BALL  GRID  ARRAY



3X Via Hole
Without Ball

Missing Via Hole
Indicates Pin A1
Quadrant

A1 Corner

Bottom View

56X Ø 0,45 / 0,35

1,00 Max

0,10 C

Seating Plane

C

0,35 / 0,15

4200583−3/K   06/2007

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.

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## MECHANICAL DATA

MTSS003D – JANUARY 1995 – REVISED JANUARY 1998

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

**48 PINS SHOWN**
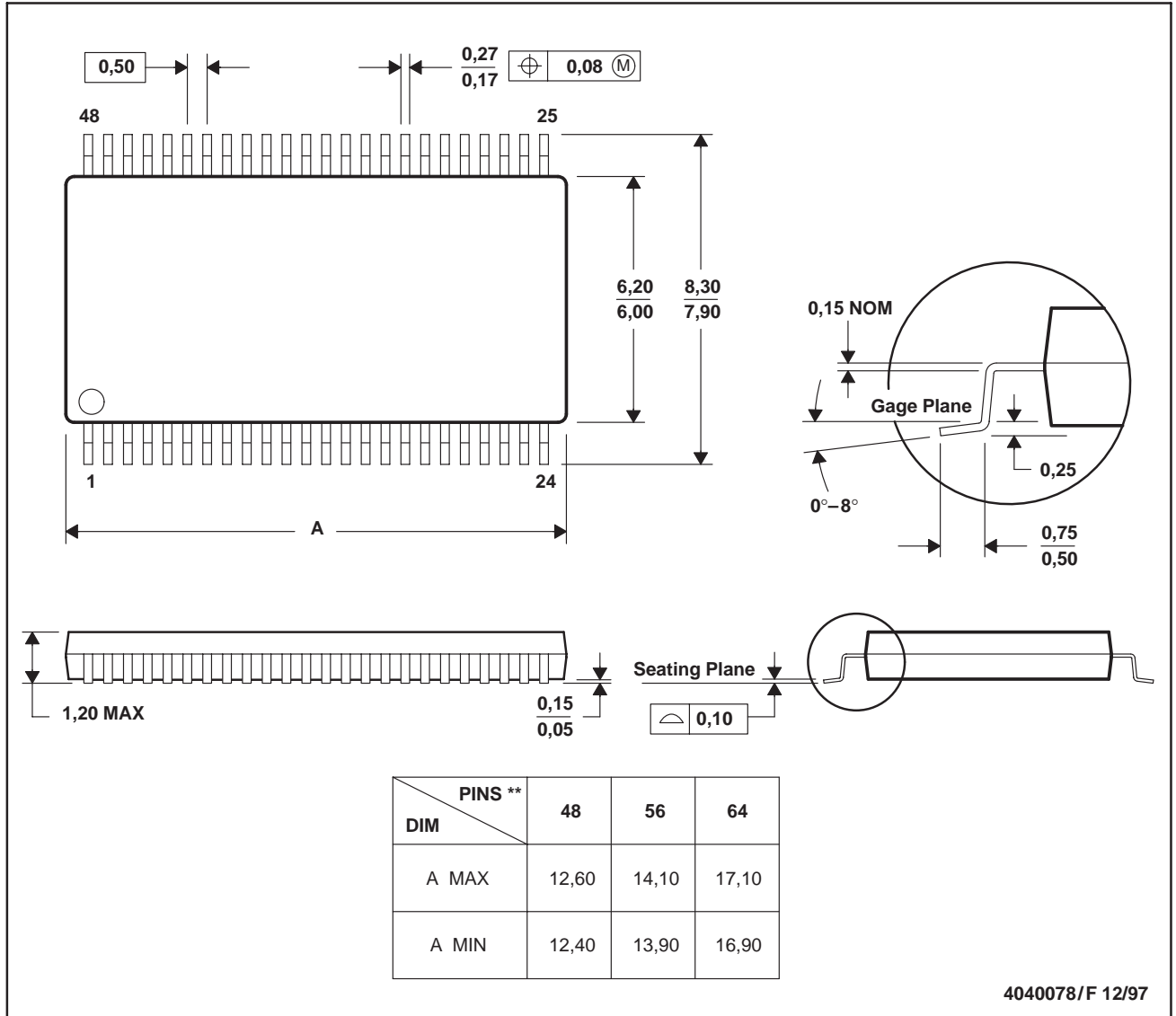


| PINS \*\* | 48 | 56 | 64 |
| DIM | | | |
|---|---|---|---|
| A  MAX | 12,60 | 14,10 | 17,10 |
| A  MIN | 12,40 | 13,90 | 16,90 |

**4040078 / F 12/97**

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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| DSP | dsp.ti.com | Energy and Lighting | www.ti.com/energy |
| Clocks and Timers | www.ti.com/clocks | Industrial | www.ti.com/industrial |
| Interface | interface.ti.com | Medical | www.ti.com/medical |
| Logic | logic.ti.com | Security | www.ti.com/security |
| Power Mgmt | power.ti.com | Space, Avionics and Defense | www.ti.com/space-avionics-defense |
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| RFID | www.ti-rfid.com | | |
| OMAP Applications Processors | www.ti.com/omap | **TI E2E Community** | e2e.ti.com |
| Wireless Connectivity | www.ti.com/wirelessconnectivity | | |