

## SN74LVCR2245A Octal Bus Transceiver with 3-State Outputs

### 1 Features

- Operates From 1.65 V to 3.6 V
- Inputs Accept Voltages to 5.5 V
- Max  $t_{pd}$  of 6.3 ns at 3.3 V
- All Outputs Have Equivalent 26- $\Omega$  Series Resistors, So No External Resistors are Required
- Typical  $V_{OLP}$  (Output Ground Bounce)  $< 0.8$  V at  $V_{CC} = 3.3$  V,  $T_A = 25^\circ\text{C}$
- Typical  $V_{OHV}$  (Output  $V_{OH}$  Undershoot)  $> 2$  V at  $V_{CC} = 3.3$  V,  $T_A = 25^\circ\text{C}$
- Supports Mixed-Mode Signal Operation on All Ports (5-V Input/Output Voltage With 3.3-V  $V_{CC}$ )
- $I_{off}$  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
  - 1000-V Charged-Device Model

### 2 Applications

- Wearable Health and Fitness Devices
- Network Switches
- Servers
- Tests and Measurements

### 3 Description

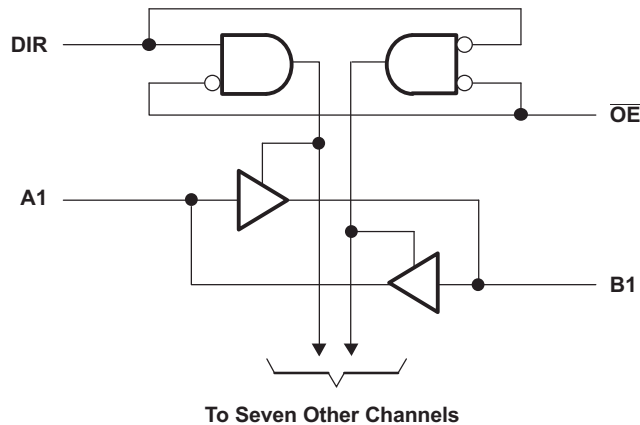
The SN74LVCR2245A device is an octal bus transceiver is designed for 1.65-V to 3.6-V  $V_{CC}$  operation.

Device Information<sup>(1)</sup>

| PART NUMBER   | PACKAGE     | BODY SIZE (NOM)    |
|---------------|-------------|--------------------|
| SN74LVCR2245A | SSOP (20)   | 8.65 mm x 3.90 mm  |
|               | TVSSOP (20) | 5.00 mm x 4.40 mm  |
|               | VQFN (20)   | 4.50 mm x 3.50 mm  |
|               | SOIC (20)   | 12.80 mm x 7.50 mm |
|               | TSSOP (20)  | 6.50 mm x 4.40 mm  |

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

### 4 Simplified Schematic



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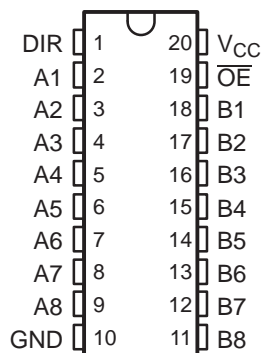
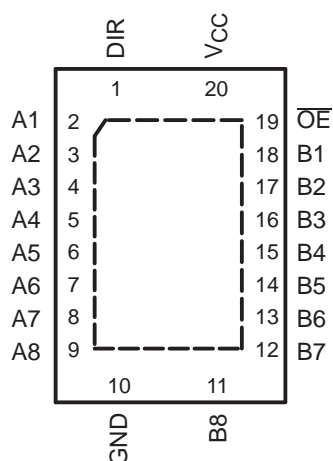
## 5 Revision History

### Changes from Revision M (March 2005) to Revision N

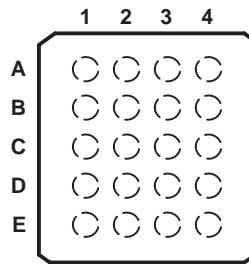
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|   |   |
|---|---|
| • Added <i>Applications</i> , <i>Device Information</i> table, <i>Pin Functions</i> table, <i>Handling Ratings</i> table, <i>Thermal Information</i> table, <i>Typical Characteristics</i> , <i>Feature Description</i> section, <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. ....   | 1 |
| • Changed $I_{off}$ bullet in <i>Features</i> section. ....   | 1 |
| • Changed MAX operating temperature to 125°C in <i>Recommended Operating Conditions</i> table. ....   | 6 |
| • Added –40°C to 125°C temperature range to <i>Electrical Characteristics</i> table. ....   | 7 |
| • Changed <i>Switching Characteristics, –40°C to 85°C</i> table. ....   | 7 |
| • Added <i>Switching Characteristics, –40°C to 125°C</i> table. ....  | 8 |

## 6 Pin Configuration and Functions

**DB, DBQ, DGV, DW, NS, OR PW PACKAGE  
(TOP VIEW)**

**RGY PACKAGE  
(TOP VIEW)**

**Pin Functions**

| PIN |                 | TYPE | DESCRIPTION        |
|-----|-----------------|------|--------------------|
| NO. | NAME            |      |                    |
| 1   | DIR             | I    | Direction Pin      |
| 2   | A1              | I/O  | A1 Input or Output |
| 3   | A2              | I/O  | A2 Input or Output |
| 4   | A3              | I/O  | A3 Input or Output |
| 5   | A4              | I/O  | A4 Input or Output |
| 6   | A5              | I/O  | A5 Input or Output |
| 7   | A6              | I/O  | A6 Input or Output |
| 8   | A7              | I/O  | A7 Input or Output |
| 9   | A8              | I/O  | A8 Input or Output |
| 10  | GND             | —    | Ground Pin         |
| 11  | B8              | I/O  | B8 Input or Output |
| 12  | B7              | I/O  | B7 Input or Output |
| 13  | B6              | I/O  | B6 Input or Output |
| 14  | B5              | I/O  | B5 Input or Output |
| 15  | B4              | I/O  | B4 Input or Output |
| 16  | B3              | I/O  | B3 Input or Output |
| 17  | B2              | I/O  | B2 Input or Output |
| 18  | B1              | I/O  | B1 Input or Output |
| 19  | $\overline{OE}$ | I    | Output Enable      |
| 20  | V <sub>CC</sub> | —    | Power Pin          |

**GQN OR ZQN PACKAGE  
(TOP VIEW)**

**Table 1. Pin Assignments**

|   | 1   | 2   | 3        | 4               |
|---|-----|-----|----------|-----------------|
| A | A1  | DIR | $V_{CC}$ | $\overline{OE}$ |
| B | A3  | B2  | A2       | B1              |
| C | A5  | A4  | B4       | B3              |
| D | A7  | B6  | A6       | B5              |
| E | GND | A8  | B8       | B7              |

## 7 Specifications

### 7.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

|                 |   | MIN                | MAX                   | UNIT    |
|-----------------|---|--------------------|-----------------------|---------|
| V <sub>CC</sub> | Supply voltage range  | -0.5               | 6.5                   | V       |
| V <sub>I</sub>  | Input voltage range <sup>(2)</sup>  | -0.5               | 6.5                   | V       |
| V <sub>O</sub>  | Voltage range applied to any output in the high-impedance or power-off state <sup>(2)</sup> | -0.5               | 6.5                   | V       |
| V <sub>O</sub>  | Voltage range applied to any output in the high or low state <sup>(2)</sup> <sup>(3)</sup>  | -0.5               | V <sub>CC</sub> + 0.5 | V       |
| I <sub>IK</sub> | Input clamp current   | V <sub>I</sub> < 0 |                       | -50 mA  |
| I <sub>OK</sub> | Output clamp current  | V <sub>O</sub> < 0 |                       | -50 mA  |
| I <sub>O</sub>  | Continuous output current   |                    |                       | ±50 mA  |
|                 | Continuous current through V <sub>CC</sub> 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<sub>CC</sub> is provided in the *Recommended Operating Conditions* table.

### 7.2 Handling Ratings

|                    |                           | MIN  | MAX | UNIT |
|--------------------|---------------------------|--|-----|------|
| T <sub>stg</sub>   | Storage temperature range | -65  | 150 | °C   |
| V <sub>(ESD)</sub> | Electrostatic discharge   | Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins <sup>(1)</sup>              |     | V    |
|                    |                           | Charged device model (CDM), per JEDEC specification JESD22-C101, all pins <sup>(2)</sup> |     |      |

- (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.

### 7.3 Recommended Operating Conditions

 over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

|                 |                                    | MIN                                | MAX                    | UNIT                   |      |
|-----------------|------------------------------------|------------------------------------|------------------------|------------------------|------|
| V <sub>CC</sub> | Supply voltage                     | Operating                          | 1.65                   | 3.6                    | V    |
|                 |                                    | Data retention only                | 1.5                    |                        |      |
| V <sub>IH</sub> | High-level input voltage           | V <sub>CC</sub> = 1.65 V to 1.95 V | 0.65 × V <sub>CC</sub> |                        | V    |
|                 |                                    | V <sub>CC</sub> = 2.3 V to 2.7 V   | 1.7                    |                        |      |
|                 |                                    | V <sub>CC</sub> = 2.7 V to 3.6 V   | 2                      |                        |      |
| V <sub>IL</sub> | Low-level input voltage            | V <sub>CC</sub> = 1.65 V to 1.95 V |                        | 0.35 × V <sub>CC</sub> | V    |
|                 |                                    | V <sub>CC</sub> = 2.3 V to 2.7 V   |                        | 0.7                    |      |
|                 |                                    | V <sub>CC</sub> = 2.7 V to 3.6 V   |                        | 0.8                    |      |
| V <sub>I</sub>  | Input voltage                      | 0                                  | 5.5                    | V                      |      |
| V <sub>O</sub>  | Output voltage                     | High or low state                  | 0                      | V <sub>CC</sub>        | V    |
|                 |                                    | 3-state                            | 0                      | 5.5                    |      |
| I <sub>OH</sub> | High-level output current          | V <sub>CC</sub> = 1.65 V           |                        | -2                     | mA   |
|                 |                                    | V <sub>CC</sub> = 2.3 V            |                        | -4                     |      |
|                 |                                    | V <sub>CC</sub> = 2.7 V            |                        | -8                     |      |
|                 |                                    | V <sub>CC</sub> = 3 V              |                        | -12                    |      |
| I <sub>OL</sub> | Low-level output current           | V <sub>CC</sub> = 1.65 V           |                        | 2                      | mA   |
|                 |                                    | V <sub>CC</sub> = 2.3 V            |                        | 4                      |      |
|                 |                                    | V <sub>CC</sub> = 2.7 V            |                        | 8                      |      |
|                 |                                    | V <sub>CC</sub> = 3 V              |                        | 12                     |      |
| Δt/Δv           | Input transition rise or fall rate |                                    |                        | 10                     | ns/V |
| T <sub>A</sub>  | Operating free-air temperature     | -40                                | 125                    |                        | °C   |

(1) All unused inputs of the device must be held at V<sub>CC</sub> 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 <sup>(1)</sup> |  | DW   | DBQ  | DGV   | DB   | NS   | PW    | RGY  | UNIT |
|-------------------------------|--|------|------|-------|------|------|-------|------|------|
| R <sub>θJA</sub>              | Junction-to-ambient thermal resistance       | 88.3 | 94.7 | 114.7 | 94.5 | 74.7 | 102.5 | 41.4 | °C/W |
| R <sub>θJC(top)</sub>         | Junction-to-case (top) thermal resistance    | 51.1 | 47.9 | 29.8  | 56.2 | 40.5 | 35.9  | 47.7 |      |
| R <sub>θJB</sub>              | Junction-to-board thermal resistance         | 50.9 | 45.0 | 56.2  | 49.7 | 42.3 | 53.5  | 17.1 |      |
| ψ <sub>JT</sub>               | Junction-to-top characterization parameter   | 20.0 | 11.0 | 0.8   | 18.1 | 14.3 | 2.2   | 1.4  |      |
| ψ <sub>JB</sub>               | Junction-to-board characterization parameter | 50.5 | 44.6 | 55.5  | 49.2 | 41.9 | 52.9  | 17.1 |      |
| R <sub>θJC(bot)</sub>         | Junction-to-case (bottom) thermal resistance | —    | —    | —     | —    | —    | —     | 9.8  |      |

(1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report ([SPRA953](http://www.ti.com/lit/zip/Spra953)).

## 7.5 Electrical Characteristics

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

| PARAMETER                      | TEST CONDITIONS   | V <sub>CC</sub> | TA = 25°C             |                    |     | –40°C to 85°C         |                    |     | –40°C to 125°C        |                    |     | UNIT |
|--------------------------------|---|-----------------|-----------------------|--------------------|-----|-----------------------|--------------------|-----|-----------------------|--------------------|-----|------|
|                                |   |                 | MIN                   | TYP <sup>(1)</sup> | MAX | MIN                   | TYP <sup>(1)</sup> | MAX | MIN                   | TYP <sup>(1)</sup> | MAX |      |
| V <sub>OH</sub>                | I <sub>OH</sub> = –100 μA   | 1.65 V to 3.6 V | V <sub>CC</sub> – 0.2 |                    |     | V <sub>CC</sub> – 0.2 |                    |     | V <sub>CC</sub> – 0.2 |                    |     | V    |
|                                | I <sub>OH</sub> = –2 mA   | 1.65 V          | 1.2                   |                    |     | 1.2                   |                    |     | 1.2                   |                    |     |      |
|                                | I <sub>OH</sub> = –4 mA   | 2.3 V           | 1.7                   |                    |     | 1.7                   |                    |     | 1.7                   |                    |     |      |
|                                |   | 2.7 V           | 2.2                   |                    |     | 2.2                   |                    |     | 2.2                   |                    |     |      |
|                                | I <sub>OH</sub> = –6 mA   | 3 V             | 2.4                   |                    |     | 2.4                   |                    |     | 2.4                   |                    |     |      |
|                                | I <sub>OH</sub> = –8 mA   | 2.7 V           | 2                     |                    |     | 2                     |                    |     | 2                     |                    |     |      |
| I <sub>OH</sub> = –12 mA       | 3 V   | 2               |                       |                    | 2   |                       |                    | 2   |                       |                    |     |      |
| V <sub>OL</sub>                | I <sub>OL</sub> = 100 μA  | 1.65 V to 3.6 V | 0.2                   |                    |     | 0.2                   |                    |     | 0.2                   |                    |     | V    |
|                                | I <sub>OL</sub> = 2 mA  | 1.65 V          | 0.45                  |                    |     | 0.45                  |                    |     | 0.45                  |                    |     |      |
|                                | I <sub>OL</sub> = 4 mA  | 2.3 V           | 0.7                   |                    |     | 0.7                   |                    |     | 0.7                   |                    |     |      |
|                                |   | 2.7 V           | 0.4                   |                    |     | 0.4                   |                    |     | 0.4                   |                    |     |      |
|                                | I <sub>OL</sub> = 6 mA  | 3 V             | 0.55                  |                    |     | 0.55                  |                    |     | 0.55                  |                    |     |      |
|                                | I <sub>OL</sub> = 8 mA  | 2.7 V           | 0.6                   |                    |     | 0.6                   |                    |     | 0.6                   |                    |     |      |
| I <sub>OL</sub> = 12 mA        | 3 V   | 0.8             |                       |                    | 0.8 |                       |                    | 0.8 |                       |                    |     |      |
| I <sub>I</sub>                 | Contr of inputs<br>V <sub>I</sub> = 0 to 5.5 V                                  | 3.6 V           | ±5                    |                    |     | ±5                    |                    |     | ±5                    |                    |     | μA   |
| I <sub>off</sub>               | V <sub>I</sub> or V <sub>O</sub> = 5.5 V  | 0               | ±10                   |                    |     | ±10                   |                    |     | ±10                   |                    |     | μA   |
| I <sub>OZ</sub> <sup>(2)</sup> | V <sub>O</sub> = 0 to 5.5 V   | 3.6 V           | ±10                   |                    |     | ±10                   |                    |     | ±10                   |                    |     | μA   |
| I <sub>CC</sub>                | V <sub>I</sub> = V <sub>CC</sub> or GND   | 3.6 V           | 10                    |                    |     | 10                    |                    |     | 10                    |                    |     | μA   |
|                                | 3.6 V ≤ V <sub>I</sub> ≤ 5.5 V <sup>(3)</sup>                                   |                 | 10                    |                    |     | 10                    |                    |     | 10                    |                    |     |      |
| ΔI <sub>CC</sub>               | One input at V <sub>CC</sub> – 0.6 V,<br>Other inputs at V <sub>CC</sub> or GND | 2.7 V to 3.6 V  | 500                   |                    |     | 500                   |                    |     | 500                   |                    |     | μA   |
| C <sub>i</sub>                 | Contr of inputs<br>V <sub>I</sub> = V <sub>CC</sub> or GND                      | 3.3 V           | 4                     |                    |     |                       |                    |     |                       |                    |     | pF   |
| C <sub>io</sub>                | A or B ports<br>V <sub>O</sub> = V <sub>CC</sub> or GND                         | 3.3 V           | 5.5                   |                    |     |                       |                    |     |                       |                    |     | pF   |

 (1) All typical values are at V<sub>CC</sub> = 3.3 V, T<sub>A</sub> = 25°C.

 (2) For I/O ports, the parameter I<sub>OZ</sub> includes the input leakage current.

(3) This applies in the disabled state only.

## 7.6 Switching Characteristics, –40°C to 85°C

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

| PARAMETER          | FROM (INPUT)    | TO (OUTPUT) | V <sub>CC</sub> = 1.8 V ± 0.15 V |     | V <sub>CC</sub> = 2.5 V ± 0.2 V |     | V <sub>CC</sub> = 2.7 V |     | V <sub>CC</sub> = 3.3 V ± 0.3 V |     | UNIT |
|--------------------|-----------------|-------------|----------------------------------|-----|---------------------------------|-----|-------------------------|-----|---------------------------------|-----|------|
|                    |                 |             | MIN                              | MAX | MIN                             | MAX | MIN                     | MAX | MIN                             | MAX |      |
| t <sub>pd</sub>    | A or B          | B or A      | 10.9                             |     | 7.9                             |     | 1                       | 7.3 | 1.5                             | 6.3 | ns   |
| t <sub>en</sub>    | $\overline{OE}$ | A or B      | 12.6                             |     | 9.6                             |     | 1                       | 9.5 | 1.5                             | 8.2 | ns   |
| t <sub>dis</sub>   | $\overline{OE}$ | A or B      | 12.1                             |     | 7.8                             |     | 1                       | 8.5 | 1.7                             | 7.8 | ns   |
| t <sub>sk(o)</sub> |                 |             | 1                                |     | 1                               |     | 1                       |     | 1                               |     | ns   |

## 7.7 Switching Characteristics, –40°C to 125°C

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

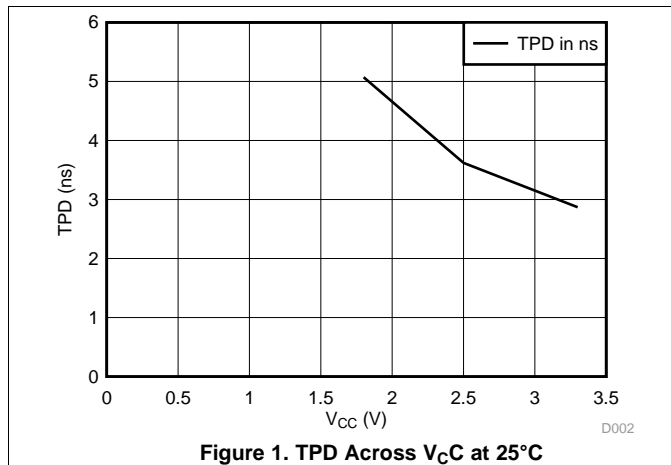
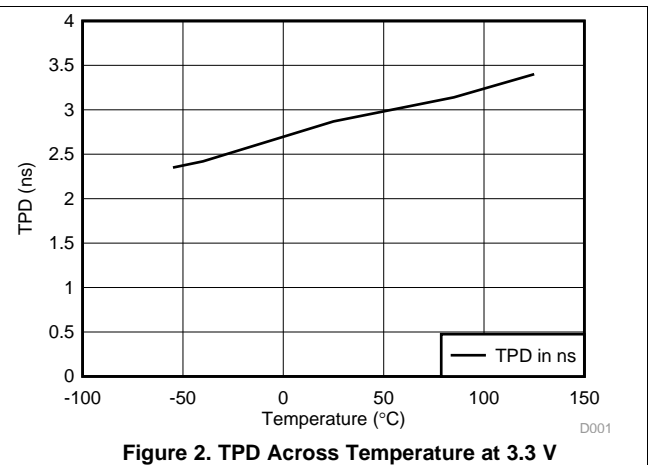
| PARAMETER   | FROM (INPUT)    | TO (OUTPUT) | $V_{CC} = 1.8\text{ V} \pm 0.15\text{ V}$ |      | $V_{CC} = 2.5\text{ V} \pm 0.2\text{ V}$ |      | $V_{CC} = 2.7\text{ V}$ |      | $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$ |     | UNIT |
|-------------|-----------------|-------------|---|------|--|------|-------------------------|------|--|-----|------|
|             |                 |             | MIN                                       | MAX  | MIN                                      | MAX  | MIN                     | MAX  | MIN                                      | MAX |      |
| $t_{pd}$    | A or B          | B or A      |   | 12.4 |  | 10   |                         | 8.3  | 1.5                                      | 7.3 | ns   |
| $t_{en}$    | $\overline{OE}$ | A or B      |   | 14.1 |  | 11.7 |                         | 10.5 | 1.5                                      | 9.2 | ns   |
| $t_{dis}$   | $\overline{OE}$ | A or B      |   | 13.6 |  | 9.9  |                         | 9.5  | 1.7                                      | 8.8 | ns   |
| $t_{sk(o)}$ |                 |             |   | 1    |  | 1    |                         | 1    |  | 1.5 | ns   |

## 7.8 Operating Characteristics

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

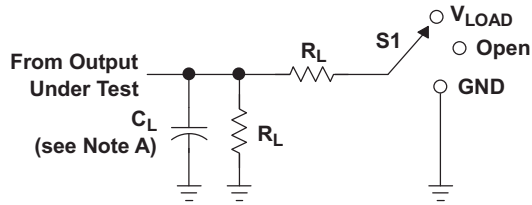
| PARAMETER |   | TEST CONDITIONS  | $V_{CC} = 1.8\text{ V}$ | $V_{CC} = 2.5\text{ V}$ | $V_{CC} = 3.3\text{ V}$ | UNIT |
|-----------|---|------------------|-------------------------|-------------------------|-------------------------|------|
|           |   |                  | TYP                     | TYP                     | TYP                     |      |
| $C_{pd}$  | Power dissipation capacitance per transceiver | Outputs enabled  | 43                      | 43                      | 48                      | pF   |
|           |   | Outputs disabled | 1                       | 1                       | 4                       |      |

## 7.9 Typical Characteristics


**Figure 1. TPD Across  $V_{CC}$  at 25°C**

**Figure 2. TPD Across Temperature at 3.3V**



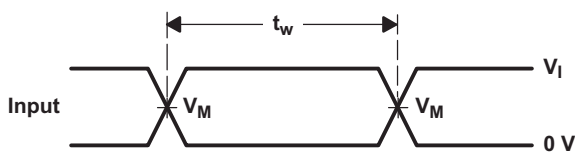
## 8 Parameter Measurement Information



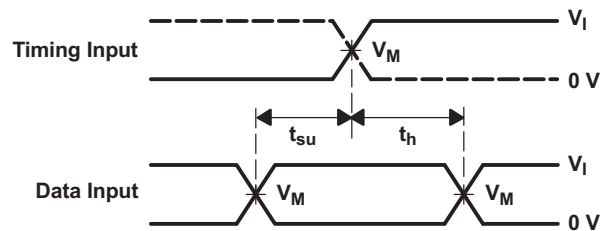
LOAD CIRCUIT

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

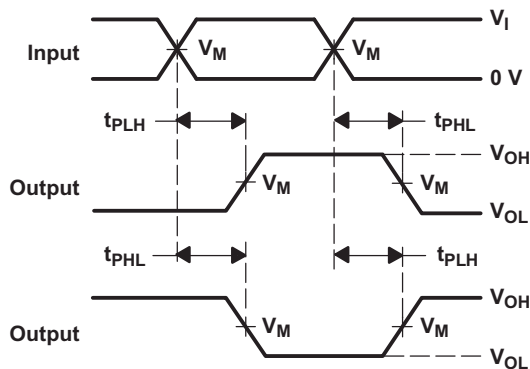
| $V_{CC}$                         | INPUTS   |                      | $V_M$      | $V_{LOAD}$        | $C_L$ | $R_L$        | $V_{\Delta}$ |
|----------------------------------|----------|----------------------|------------|-------------------|-------|--------------|--------------|
|                                  | $V_I$    | $t_r/t_f$            |            |                   |       |              |              |
| $1.8\text{ V} \pm 0.15\text{ V}$ | $V_{CC}$ | $\leq 2\text{ ns}$   | $V_{CC}/2$ | $2 \times V_{CC}$ | 30 pF | 1 k $\Omega$ | 0.15 V       |
| $2.5\text{ V} \pm 0.2\text{ V}$  | $V_{CC}$ | $\leq 2\text{ ns}$   | $V_{CC}/2$ | $2 \times V_{CC}$ | 30 pF | 500 $\Omega$ | 0.15 V       |
| 2.7 V                            | 2.7 V    | $\leq 2.5\text{ ns}$ | 1.5 V      | 6 V               | 50 pF | 500 $\Omega$ | 0.3 V        |
| $3.3\text{ V} \pm 0.3\text{ V}$  | 2.7 V    | $\leq 2.5\text{ ns}$ | 1.5 V      | 6 V               | 50 pF | 500 $\Omega$ | 0.3 V        |



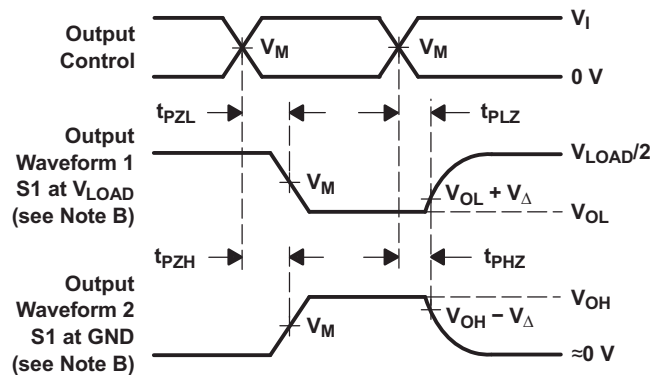
VOLTAGE WAVEFORMS PULSE DURATION



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:
- $C_L$  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:  $PRR \leq 10\text{ MHz}$ ,  $Z_O = 50\ \Omega$ .
  - 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  $t_{pd}$ .
  - All parameters and waveforms are not applicable to all devices.

Figure 3. Load Circuit and Voltage Waveforms

## 9 Detailed Description

### 9.1 Overview

This octal bus transceiver is designed for 1.65-V to 3.6-V  $V_{CC}$  operation.

The SN74LVCR2245A device is designed for asynchronous communication between data buses. The device transmits data 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 the buses are effectively isolated.

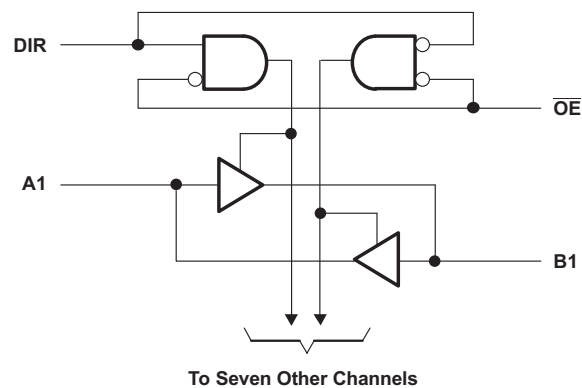
All outputs, which are designed to sink up to 12 mA, include equivalent 26- $\Omega$  resistors to reduce overshoot and undershoot.

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.

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.

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.

### 9.2 Functional Block Diagram



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

### 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

### 9.4 Device Functional Modes

**Table 2. Function Table**

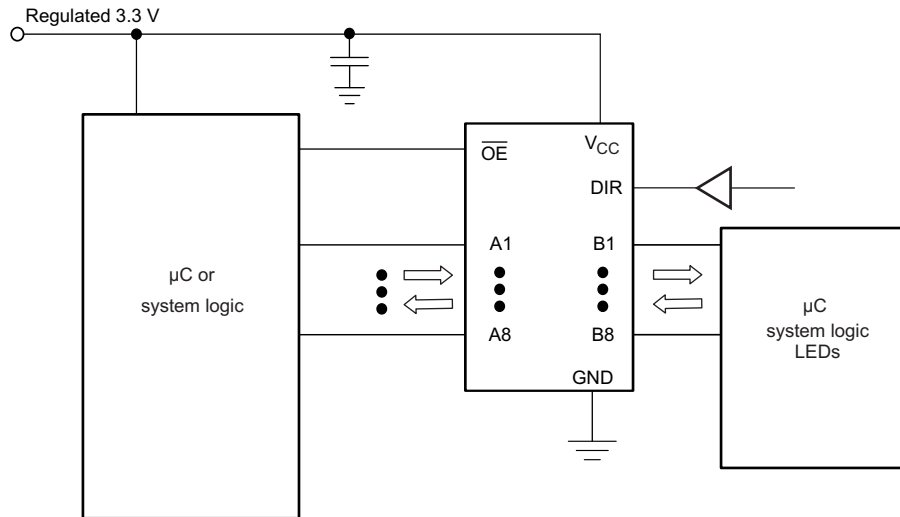
| INPUTS          |     | OPERATION       |
|-----------------|-----|-----------------|
| $\overline{OE}$ | DIR |                 |
| L               | L   | B data to A bus |
| L               | H   | A data to B bus |
| H               | X   | Isolation       |

## 10 Application and Implementation

### 10.1 Application Information

This 8-bit octal noninverting bus transceiver is designed for 1.65-V to 3.6-V  $V_{CC}$  operation. 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. 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.

### 10.2 Typical Application



**Figure 5. Typical Application Schematic**

#### 10.2.1 Design Requirements

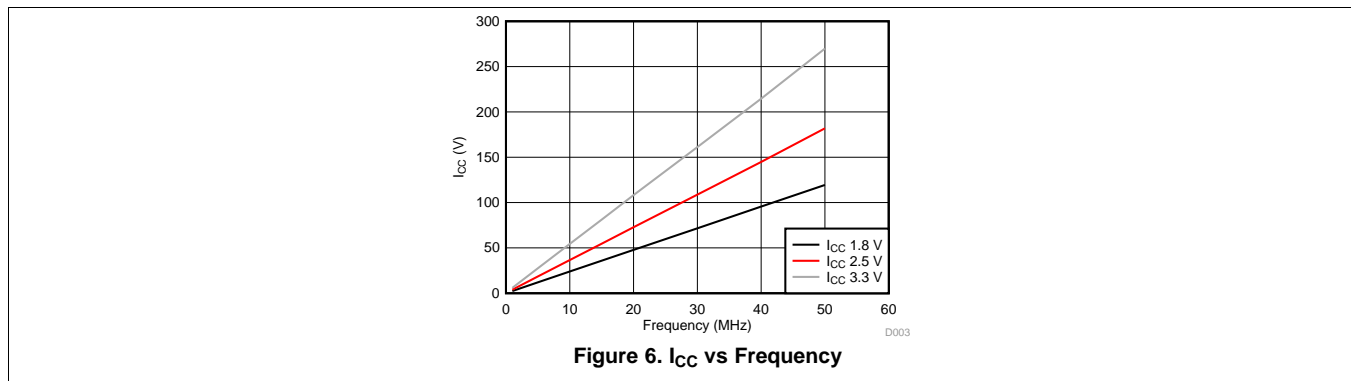
This device uses CMOS technology and has balanced output drive. Care should be taken to avoid bus contention because it can drive currents that would exceed maximum limits. The high drive will also create fast edges into light loads, so routing and load conditions should be considered to prevent ringing.

#### 10.2.2 Detailed Design Procedure

1. Recommended Input Conditions
  - For rise time and fall time specifications, see  $\Delta t/\Delta V$  in the [Recommended Operating Conditions](#) table.
  - For 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. Recommended 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)

### 10.2.3 Application Curves



## 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<sub>CC</sub> 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<sub>CC</sub> 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.

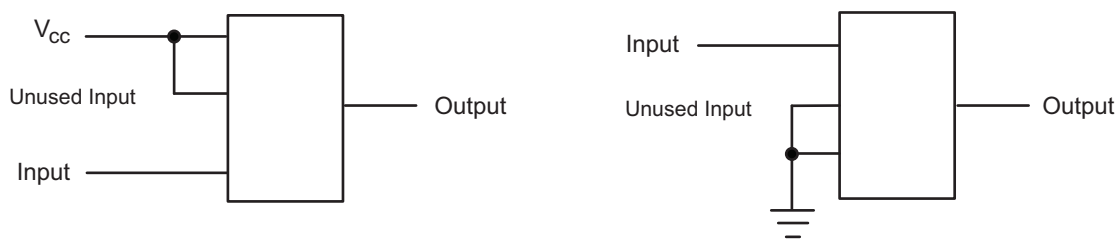
## 12 Layout

### 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<sub>CC</sub>, 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**

## 13 Device and Documentation Support

### 13.1 Trademarks

All 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.

**PACKAGING INFORMATION**

| Orderable Device   | Status<br>(1) | Package Type         | Package Drawing | Pins | Package Qty | Eco Plan<br>(2)         | Lead/Ball Finish<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|--------------------|---------------|----------------------|-----------------|------|-------------|-------------------------|-------------------------|----------------------|--------------|-------------------------|-------------------------|
| 74LVCR2245ADBQRG4  | ACTIVE        | SSOP                 | DBQ             | 20   | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-2-260C-1 YEAR  | -40 to 125   | LVCR2245A               | <a href="#">Samples</a> |
| SN74LVCR2245ADBQR  | ACTIVE        | SSOP                 | DBQ             | 20   | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-2-260C-1 YEAR  | -40 to 125   | LVCR2245A               | <a href="#">Samples</a> |
| SN74LVCR2245ADBR   | ACTIVE        | SSOP                 | DB              | 20   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 125   | LER245A                 | <a href="#">Samples</a> |
| SN74LVCR2245ADGVR  | ACTIVE        | TVSOP                | DGV             | 20   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 125   | LER245A                 | <a href="#">Samples</a> |
| SN74LVCR2245ADW    | ACTIVE        | SOIC                 | DW              | 20   | 25          | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 125   | LVCR2245A               | <a href="#">Samples</a> |
| SN74LVCR2245ADWR   | ACTIVE        | SOIC                 | DW              | 20   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 125   | LVCR2245A               | <a href="#">Samples</a> |
| SN74LVCR2245ANSR   | ACTIVE        | SO                   | NS              | 20   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 125   | LVCR2245A               | <a href="#">Samples</a> |
| SN74LVCR2245APW    | ACTIVE        | TSSOP                | PW              | 20   | 70          | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 125   | LER245A                 | <a href="#">Samples</a> |
| SN74LVCR2245APWE4  | ACTIVE        | TSSOP                | PW              | 20   | 70          | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 125   | LER245A                 | <a href="#">Samples</a> |
| SN74LVCR2245APWR   | ACTIVE        | TSSOP                | PW              | 20   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 125   | LER245A                 | <a href="#">Samples</a> |
| SN74LVCR2245APWRE4 | ACTIVE        | TSSOP                | PW              | 20   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 125   | LER245A                 | <a href="#">Samples</a> |
| SN74LVCR2245APWRG4 | ACTIVE        | TSSOP                | PW              | 20   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 125   | LER245A                 | <a href="#">Samples</a> |
| SN74LVCR2245APWT   | ACTIVE        | TSSOP                | PW              | 20   | 250         | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 125   | LER245A                 | <a href="#">Samples</a> |
| SN74LVCR2245ARGYR  | ACTIVE        | VQFN                 | RGY             | 20   | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-2-260C-1 YEAR  | -40 to 125   | LER245A                 | <a href="#">Samples</a> |
| SN74LVCR2245AZQNR  | ACTIVE        | BGA MICROSTAR JUNIOR | ZQN             | 20   | 1000        | Green (RoHS & no Sb/Br) | SNAGCU                  | Level-1-260C-UNLIM   | -40 to 85    | LER245A                 | <a href="#">Samples</a> |

<sup>(1)</sup> 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.

<sup>(2)</sup> **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of  $\leq 1000$ ppm threshold. Antimony trioxide based flame retardants must also meet the  $\leq 1000$ ppm threshold requirement.

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

<sup>(4)</sup> There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

<sup>(5)</sup> 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.

<sup>(6)</sup> **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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**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 |
|-------------------|----------------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| SN74LVCR2245ADBQR | SSOP                 | DBQ             | 20   | 2500 | 330.0              | 16.4               | 6.5     | 9.0     | 2.1     | 8.0     | 16.0   | Q1            |
| SN74LVCR2245ADBR  | SSOP                 | DB              | 20   | 2000 | 330.0              | 16.4               | 8.2     | 7.5     | 2.5     | 12.0    | 16.0   | Q1            |
| SN74LVCR2245ADGVR | TVSOP                | DGV             | 20   | 2000 | 330.0              | 12.4               | 6.9     | 5.6     | 1.6     | 8.0     | 12.0   | Q1            |
| SN74LVCR2245ADWR  | SOIC                 | DW              | 20   | 2000 | 330.0              | 24.4               | 10.8    | 13.3    | 2.7     | 12.0    | 24.0   | Q1            |
| SN74LVCR2245ANSR  | SO                   | NS              | 20   | 2000 | 330.0              | 24.4               | 8.4     | 13.0    | 2.5     | 12.0    | 24.0   | Q1            |
| SN74LVCR2245APWR  | TSSOP                | PW              | 20   | 2000 | 330.0              | 16.4               | 6.95    | 7.1     | 1.6     | 8.0     | 16.0   | Q1            |
| SN74LVCR2245APWT  | TSSOP                | PW              | 20   | 250  | 330.0              | 16.4               | 6.95    | 7.1     | 1.6     | 8.0     | 16.0   | Q1            |
| SN74LVCR2245ARGYR | VQFN                 | RGY             | 20   | 3000 | 330.0              | 12.4               | 3.8     | 4.8     | 1.6     | 8.0     | 12.0   | Q1            |
| SN74LVCR2245AZQNR | BGA MICROSTAR JUNIOR | ZQN             | 20   | 1000 | 330.0              | 12.4               | 3.3     | 4.3     | 1.6     | 8.0     | 12.0   | Q1            |



**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

| Device            | Package Type         | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|-------------------|----------------------|-----------------|------|------|-------------|------------|-------------|
| SN74LVCR2245ADBQR | SSOP                 | DBQ             | 20   | 2500 | 367.0       | 367.0      | 38.0        |
| SN74LVCR2245ADBR  | SSOP                 | DB              | 20   | 2000 | 367.0       | 367.0      | 38.0        |
| SN74LVCR2245ADGVR | TVSOP                | DGV             | 20   | 2000 | 367.0       | 367.0      | 35.0        |
| SN74LVCR2245ADWR  | SOIC                 | DW              | 20   | 2000 | 367.0       | 367.0      | 45.0        |
| SN74LVCR2245ANSR  | SO                   | NS              | 20   | 2000 | 367.0       | 367.0      | 45.0        |
| SN74LVCR2245APWR  | TSSOP                | PW              | 20   | 2000 | 367.0       | 367.0      | 38.0        |
| SN74LVCR2245APWT  | TSSOP                | PW              | 20   | 250  | 367.0       | 367.0      | 38.0        |
| SN74LVCR2245ARGYR | VQFN                 | RGY             | 20   | 3000 | 367.0       | 367.0      | 35.0        |
| SN74LVCR2245AZQNR | BGA MICROSTAR JUNIOR | ZQN             | 20   | 1000 | 336.6       | 336.6      | 28.6        |

# DW0020A



# PACKAGE OUTLINE

## SOIC - 2.65 mm max height

SOIC



**NOTES:**

1. All linear dimensions are in millimeters. Dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.43 mm per side.
5. Reference JEDEC registration MS-013.

# EXAMPLE BOARD LAYOUT

DW0020A

SOIC - 2.65 mm max height

SOIC



LAND PATTERN EXAMPLE  
SCALE:6X



SOLDER MASK DETAILS

4220724/A 05/2016

NOTES: (continued)

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

# EXAMPLE STENCIL DESIGN

DW0020A

SOIC - 2.65 mm max height

SOIC



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

4220724/A 05/2016

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

ZQN (R-PBGA-N20)

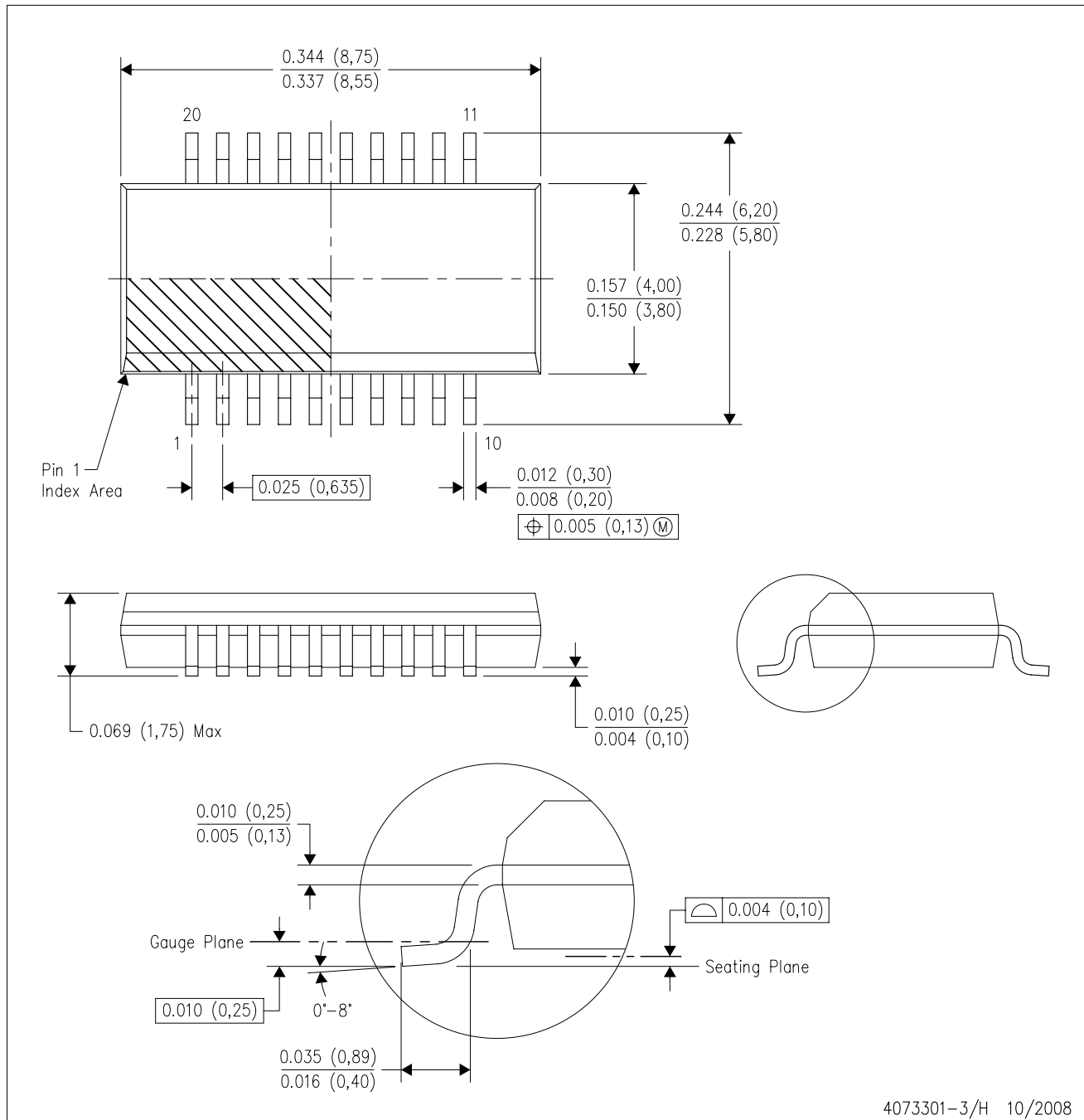
PLASTIC BALL GRID ARRAY



- 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 BC-2.
  - D. This package is lead-free. Refer to the 20 GQN package (drawing 4200704) for tin-lead (SnPb).

DBQ (R-PDSO-G20)

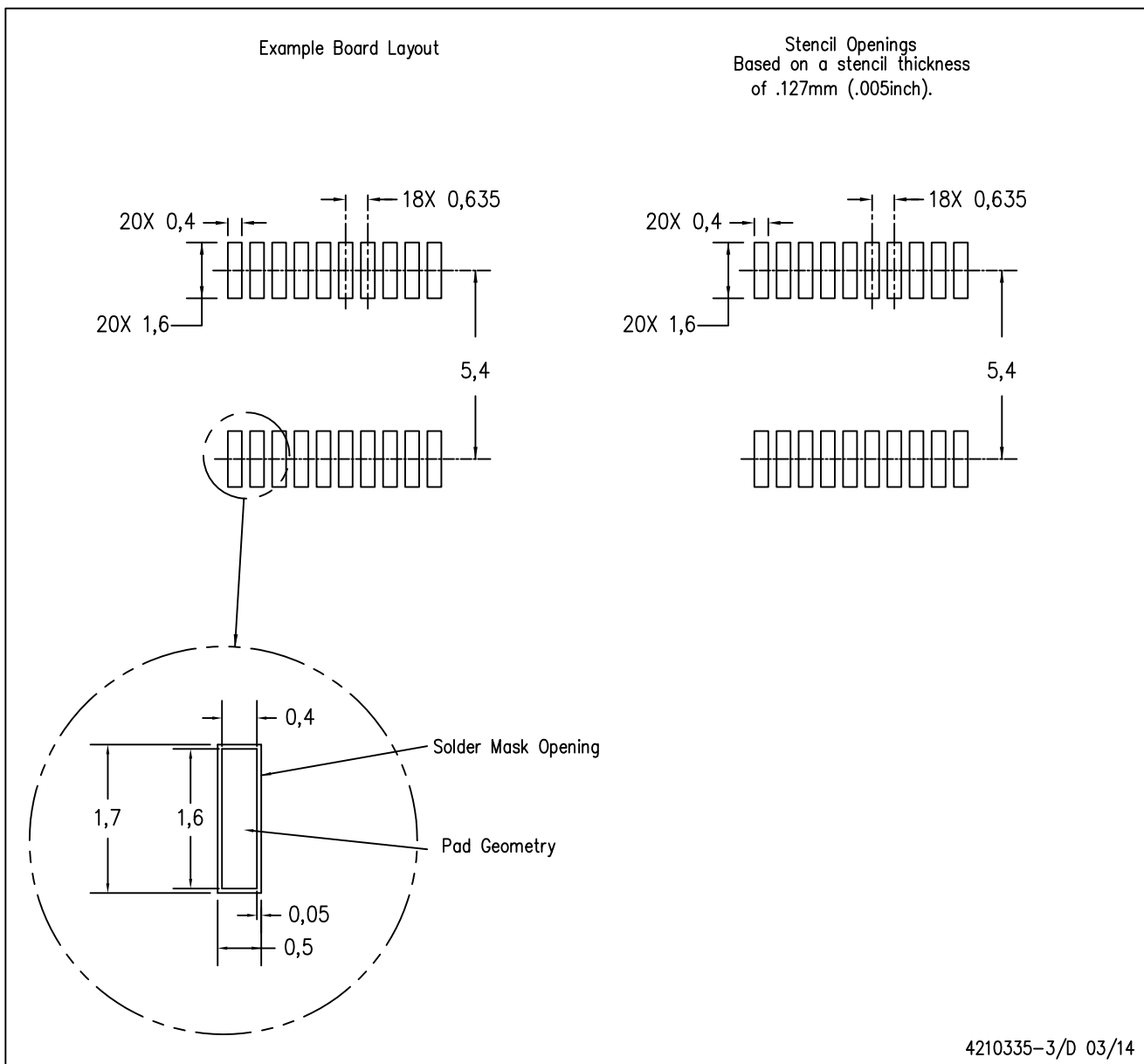
PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15) per side.
  - D. Falls within JEDEC MO-137 variation AD.

DBQ (R-PDSO-G20)

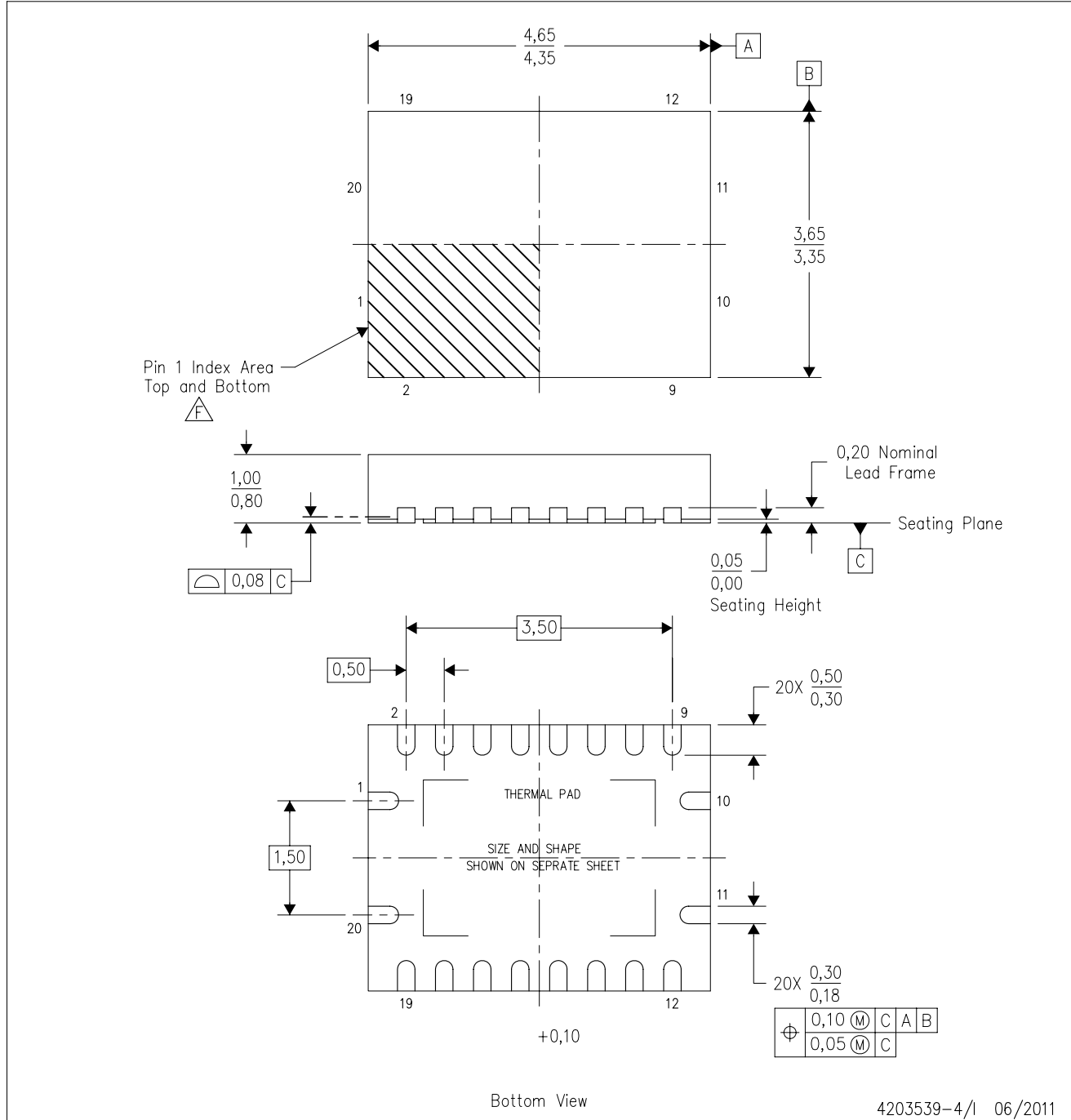
PLASTIC SMALL OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Publication IPC-7351 is recommended for alternate designs.
  - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC-7525 for other stencil recommendations.

RGY (R-PVQFN-N20)

PLASTIC QUAD FLATPACK NO-LEAD



- 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. QFN (Quad Flatpack No-Lead) package configuration.
  - D. The package thermal pad must be soldered to the board for thermal and mechanical performance.
  - E. See the additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions.
  - F. Pin 1 identifiers are located on both top and bottom of the package and within the zone indicated. The Pin 1 identifiers are either a molded, marked, or metal feature.
  - G. Package complies to JEDEC MO-241 variation BA.



RGY (R-PVQFN-N20)

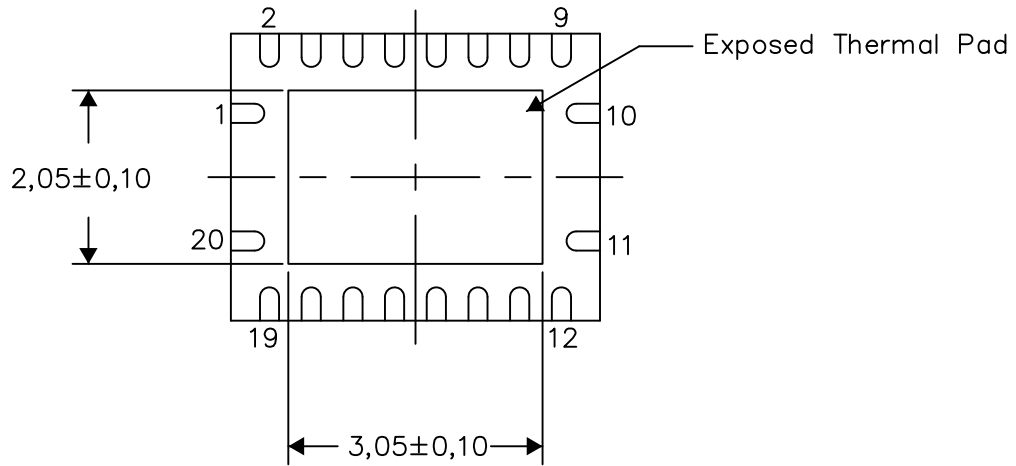
PLASTIC QUAD FLATPACK NO-LEAD

**THERMAL INFORMATION**

This package incorporates an exposed thermal pad that is designed to be attached directly to an external heatsink. The thermal pad must be soldered directly to the printed circuit board (PCB). After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For information on the Quad Flatpack No-Lead (QFN) package and its advantages, refer to Application Report, QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271. This document is available at [www.ti.com](http://www.ti.com).

The exposed thermal pad dimensions for this package are shown in the following illustration.



Bottom View

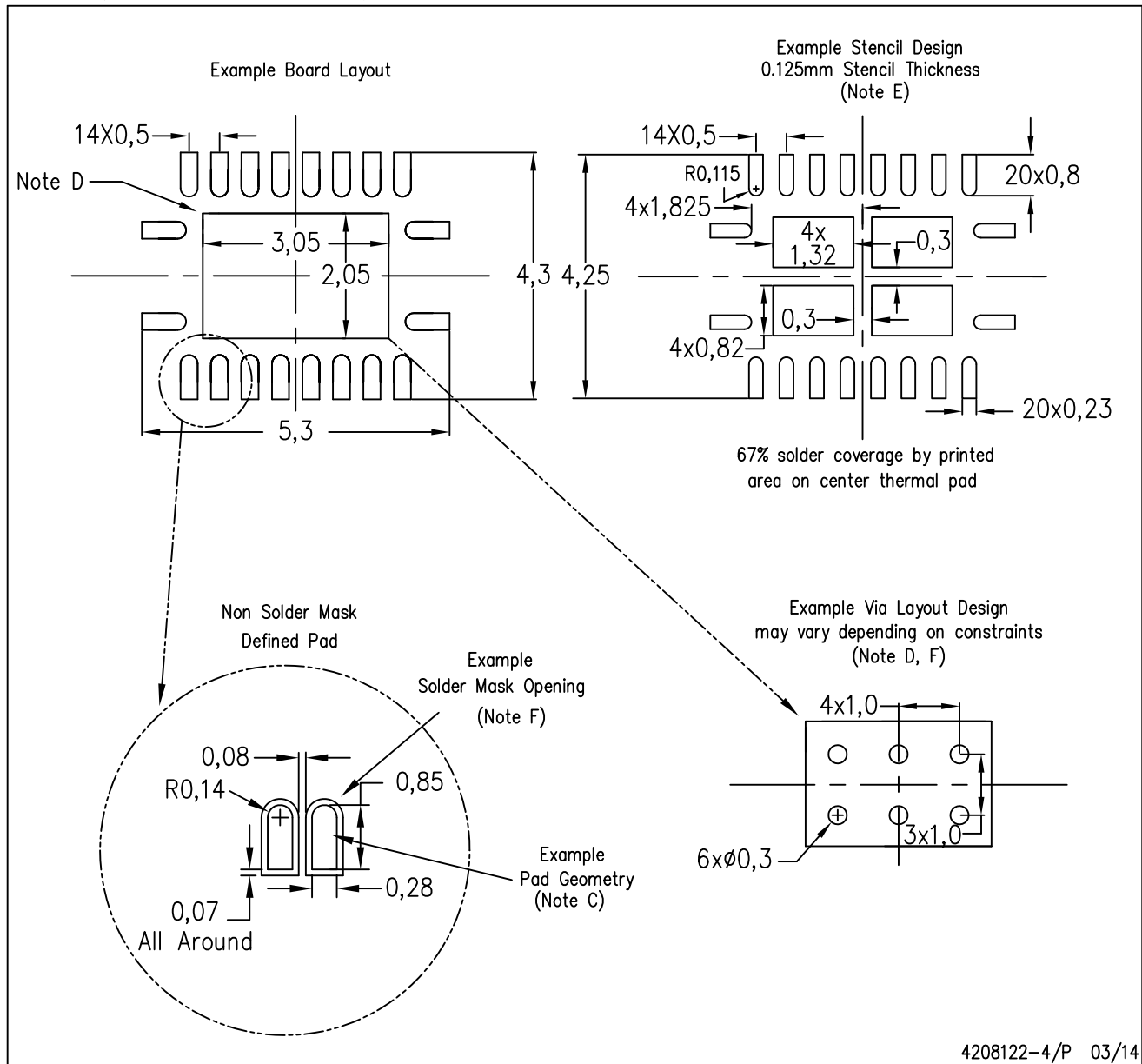
Exposed Thermal Pad Dimensions

4206353-4/P 03/14

NOTE: All linear dimensions are in millimeters

RGY (R-PVQFN-N20)

PLASTIC QUAD FLATPACK NO-LEAD



4208122-4/P 03/14

- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Publication IPC-7351 is recommended for alternate designs.
  - This package is designed to be soldered to a thermal pad on the board. Refer to Application Note, Quad Flat-Pack QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271, and also the Product Data Sheets for specific thermal information, via requirements, and recommended board layout. These documents are available at [www.ti.com](http://www.ti.com) <<http://www.ti.com>>.
  - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC 7525 for stencil design considerations.
  - Customers should contact their board fabrication site for minimum solder mask web tolerances between signal pads.

## MECHANICAL DATA

**NS (R-PDSO-G\*\*)**

**PLASTIC SMALL-OUTLINE PACKAGE**

**14-PINS SHOWN**



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

DGV (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE

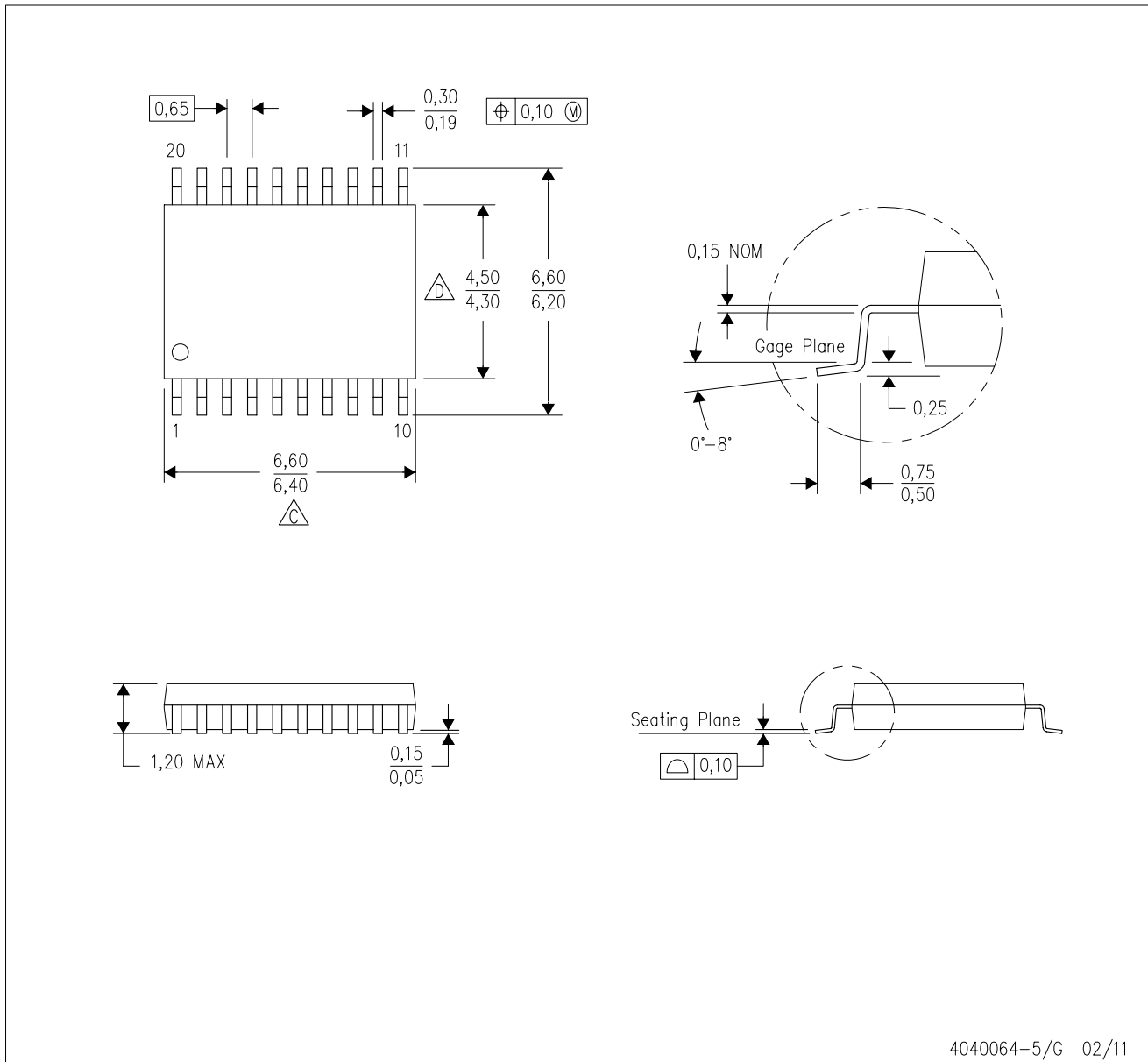
24 PINS SHOWN



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

PW (R-PDSO-G20)

PLASTIC SMALL OUTLINE



4040064-5/G 02/11

- 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.
  - $\triangle C$  Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
  - $\triangle D$  Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
  - E. Falls within JEDEC MO-153

PW (R-PDSO-G20)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Publication IPC-7351 is recommended for alternate design.
  - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
  - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

DB (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE

28 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-150

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