TEXAS INSTRUMENTS

**TXS0108E**

SCES642H – DECEMBER 2007 – REVISED MAY 2020

# TXS0108E 8-Bit Bi-directional, Level-Shifting, Voltage Translator for Open-Drain and Push-Pull Applications

## 1 Features

- No direction-control signal needed
- Maximum data rates
  - 110 Mbps (push pull)
  - 1.2 Mbps (open drain)
- 1.4 V to 3.6 V on A port and 1.65 V to 5.5 V on B port ($V_{CCA} \leq V_{CCB}$)
- No power-supply sequencing required – either $V_{CCA}$ or $V_{CCB}$ can be ramped first
- Latch-up performance exceeds 100 mA per JESD 78, Class II
- ESD protection exceeds JESD 22 (A Port)
  - 2000-V human body model (A114-B)
  - 150-V machine model (A115-A)
  - 1000-V charged-device model (C101)
- IEC 61000-4-2 ESD (B port)
  - ±8 kV contact discharge
  - ±6 kV Air-gap discharge

## 2 Applications

- Handsets
- Smartphones
- Tablets
- Desktop PCs

## 3 Description

This device is an 8-bit non-inverting level translator that uses two separate configurable power-supply rails. The A port tracks the $V_{CCA}$ pin supply voltage. The $V_{CCA}$ pin accepts any supply voltage between 1.4 V and 3.6 V. The B port tracks the $V_{CCB}$ pin supply voltage. The $V_{CCB}$ pin accepts any supply voltage between 1.65 V and 5.5 V. Two input supply pins allows for low Voltage bidirectional translation between any of the 1.5 V, 1.8 V, 2.5 V, 3.3 V, and 5 V voltage nodes.

When the output-enable (OE) input is low, all outputs are placed in the high-impedance (Hi-Z) state.

To ensure the Hi-Z state during power-up or power-down periods, tie OE to GND through a pull-down resistor. The minimum value of the resistor is determined by the current-sourcing capability of the driver.

### Device Information[1]

| PART NUMBER | PACKAGE | BODY SIZE (NOM) |
|---|---|---|
| TXS0108EPW | TSSOP (20) | 6.50 mm × 6.40 mm |
| TXS0108ERGY | VQFN (20) | 4.50 mm × 3.50 mm |
| TXS0108EZXY | UFBGA (20) | 3.00 mm × 2.50 mm |
| TXS0108ENME | NFBGA (20) | 3.00 mm × 2.50 mm |

(1) For all available packages, see the orderable addendum at the end of the datasheet.
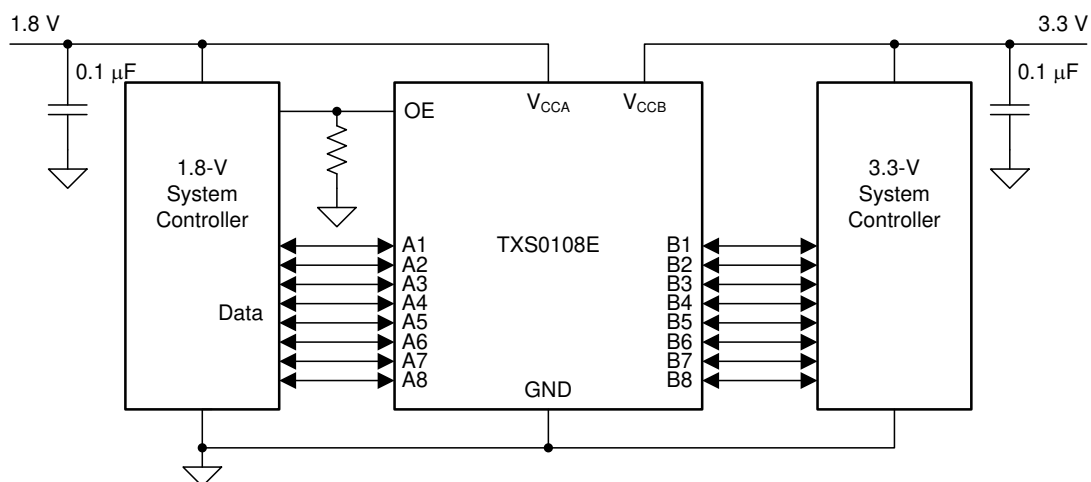
**Simplified Application**

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## 4 Revision History

**Changes from Revision G (April 2020) to Revision H**     **Page**

- Changed $V_{CCB}$ MAX from 5.5 V to 6.5 V in Absolute Maximum Ratings table .................................................................... 5

**Changes from Revision F (January 2019) to Revision G**     **Page**

- Added NME package (NFBGA) ................................................................................................................................. 1
- Changed $V_{CCA}$ MIN from 1.2 to 1.4 V in the Recommended Operating Conditions table ......................................................... 6

**Changes from Revision E (February 2018) to Revision F**     **Page**

- Changed $T_A$ from 125°C to 85°C in the *Recommended Operating Conditions* table .............................................................. 6

**Changes from Revision D (February 2016) to Revision E**     **Page**

- Added junction temperature .................................................................................................................................... 5

**Changes from Revision C (December 2014) to Revision D**     **Page**

- Made changes to *ESD Ratings* ................................................................................................................................ 1

**Changes from Revision B (November 2013) to Revision C**     **Page**

- Added *Pin Configuration and Functions* section, *ESD Ratings* table, *Feature Description* section, *Device Functional Modes*, *Application and Implementation* section, *Power Supply Recommendations* section, *Layout* section, *Device and Documentation Support* section, and *Mechanical, Packaging, and Orderable Information* section ............................ 1

Product Folder Links: *TXS0108E*

# 5 Pin Configuration and Functions

**ZXY Package**
**20-Bump UFBGA**
**(Bottom View)**
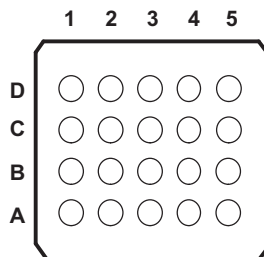
**NME Package**
**20-Bump NFBGA**
**(Bottom View)**
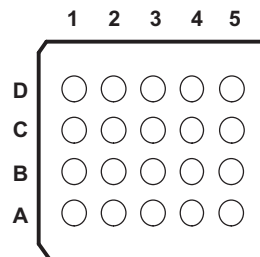
**Pin Assignments for ZXY and NME Packages**

|   | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **D** | VCCB | B2 | B4 | B6 | B8 |
| **C** | B1 | B3 | B5 | B7 | GND |
| **B** | A1 | A3 | A5 | A7 | OE |
| **A** | VCCA | A2 | A4 | A6 | A8 |

**PW Package**
**20-Pin TSSOP**
**(TOP VIEW)**

| | | |
|---|---|---|
| A1 | 1 | 20 B1 |
| VCCA | 2 | 19 VCCB |
| A2 | 3 | 18 B2 |
| A3 | 4 | 17 B3 |
| A4 | 5 | 16 B4 |
| A5 | 6 | 15 B5 |
| A6 | 7 | 14 B6 |
| A7 | 8 | 13 B7 |
| A8 | 9 | 12 B8 |
| OE | 10 | 11 GND |
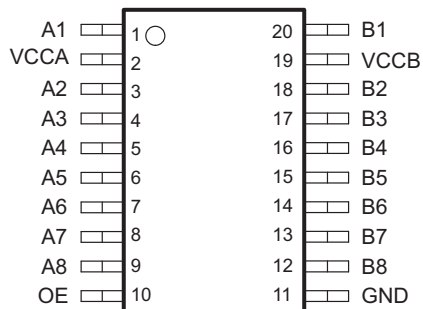
**RGY PACKAGE**
**20-Pin VQFN**
**(TOP VIEW)**

Exposed
Center
Pad

| | |
|---|---|
| A1 (1) | B1 (20) |
| VCCA (2) | (19) VCCB |
| A2 (3) | (18) B2 |
| A3 (4) | (17) B3 |
| A4 (5) | (16) B4 |
| A5 (6) | (15) B5 |
| A6 (7) | (14) B6 |
| A7 (8) | (13) B7 |
| A8 (9) | (12) B8 |
| OE (10) | GND (11) |
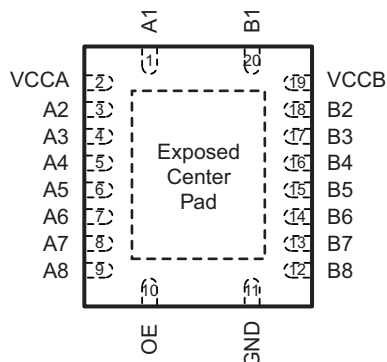
The exposed center pad, if used, must be connected as a secondary ground or left electrically open.

Product Folder Links: TXS0108E

## Pin Functions

| PIN NO. NAME | PIN NO. PW, RGY | PIN NO. ZXY, NME | TYPE[1] | DESCRIPTION |
|---|---|---|---|---|
| A1 | 1 | B1 | I/O | Input/output 1. Referenced to $V_{CCA}$ |
| A2 | 3 | A2 | I/O | Input/output 2. Referenced to $V_{CCA}$ |
| A3 | 4 | B2 | I/O | Input/output 3. Referenced to $V_{CCA}$ |
| A4 | 5 | A3 | I/O | Input/output 4. Referenced to $V_{CCA}$ |
| A5 | 6 | B3 | I/O | Input/output 5. Referenced to $V_{CCA}$ |
| A6 | 7 | A4 | I/O | Input/output 6. Referenced to $V_{CCA}$ |
| A7 | 8 | B4 | I/O | Input/output 7. Referenced to $V_{CCA}$ |
| A8 | 9 | A5 | I/O | Input/output 8. Referenced to $V_{CCA}$ |
| B1 | 20 | C 1 | I/O | Input/output 1. Referenced to $V_{CCB}$ |
| B2 | 18 | D2 | I/O | Input/output 2. Referenced to $V_{CCB}$ |
| B3 | 17 | C2 | I/O | Input/output 3. Referenced to $V_{CCB}$ |
| B4 | 16 | D3 | I/O | Input/output 4. Referenced to $V_{CCB}$ |
| B5 | 15 | C3 | I/O | Input/output 5. Referenced to $V_{CCB}$ |
| B6 | 14 | D4 | I/O | Input/output 6. Referenced to $V_{CCB}$ |
| B7 | 13 | C4 | I/O | Input/output 7. Referenced to $V_{CCB}$ |
| B8 | 12 | D5 | I/O | Input/output 8. Referenced to $V_{CCB}$ |
| GND | 11 | C5 | — | Ground |
| OE | 10 | B5 | I | Tri-state output-mode enable. Pull OE low to place all outputs in 3-state mode. Referenced to $V_{CCA}$. |
| VCCA | 2 | A1 | P | A-port supply voltage. 1.4 V ≤ $V_{CCA}$ ≤ 3.6 V, $V_{CCA}$ ≤ $V_{CCB}$. |
| VCCB | 19 | D1 | P | B-port supply voltage. 1.65 V ≤ $V_{CCB}$ ≤ 5.5 V. |
| Thermal Pad | | | — | For the RGY package, the exposed center thermal pad must be either be connected to Ground or left electrically opened. |

(1)  I = input, O = output, I/O = input and output, P = power

Product Folder Links: TXS0108E

# 6 Specifications

## 6.1 Absolute Maximum Ratings[1]

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

| | | MIN | MAX | UNIT |
|---|---|---|---|---|
| Supply voltage, $V_{CCA}$ | | −0.5 | 4.6 | V |
| Supply voltage, $V_{CCB}$ | | −0.5 | 6.5 | V |
| Input voltage, $V_I$[2] | A port | −0.5 | 4.6 | V |
| | B port | −0.5 | 6.5 | |
| Voltage applied to any output in the high-impedance or power-off state, $V_O$[2] | A port | −0.5 | 4.6 | V |
| | B port | −0.5 | 6.5 | |
| Voltage applied to any output in the high or low state, $V_O$[2] [3] | A port | −0.5 | $V_{CCA}$ + 0.5 | V |
| | B port | −0.5 | $V_{CCB}$ + 0.5 | V |
| Input clamp current, $I_{IK}$ | $V_I$ < 0 | | −50 | mA |
| Output clamp current, $I_{OK}$ | $V_O$ < 0 | | −50 | mA |
| Continuous output current, $I_O$ | | −50 | 50 | mA |
| Continuous current through $V_{CCA}$, $V_{CCB}$, or GND | | −100 | 100 | mA |
| Junction temperature, $T_J$ | | | 150 | °C |
| Storage temperature, $T_{stg}$ | | −65 | 150 | °C |

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

## 6.2 ESD Ratings

| | | | VALUE | UNIT |
|---|---|---|---|---|
| $V_{(ESD)}$ | Electrostatic discharge | Human body model (HBM), per ANSI/ESDA/JEDEC JS-001[1] | ±2000 | V |
| | | Charged-device model (CDM), per JEDEC specification JESD22-C101[2] | ±1000 | |
| | | Machine model (MM) | ±150 | |
| | | IEC 61000-4-2 ESD (B Port) Contact Discharge | ±8000 | |
| | | IEC 61000-4-2 ESD (B Port) Air-Gap Discharge | ±6000 | |

(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.

*Submit Documentation Feedback*    5

Product Folder Links: *TXS0108E*

## 6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)[1][2]

| | | | | MIN | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{CCA}$ | Supply voltage[3] | | | 1.4 | 3.6 | V |
| $V_{CCB}$ | Supply voltage[3] | | | 1.65 | 5.5 | V |
| $V_{IH}$ | High-level input voltage | A-Port I/Os | $V_{CCA}$ (V) = 1.4 to 1.95 | $V_{CCB}$ (V) = 1.65 to 5.5 | $V_{CCI}$ − 0.2 | $V_{CCI}$ | V |
| | | | $V_{CCA}$ (V) = 1.95 to 3.6 | $V_{CCB}$ (V) = 1.65 to 5.5 | $V_{CCI}$ − 0.4 | $V_{CCI}$ | |
| | | B-Port I/Os | $V_{CCA}$ (V) = 1.4 to 3.6 | $V_{CCB}$ (V) = 1.65 to 5.5 | $V_{CCI}$ − 0.4 | $V_{CCI}$ | V |
| | | OE | $V_{CCA}$ (V) = 1.4 to 3.6 | $V_{CCB}$ (V) = 1.65 to 5.5 | $V_{CCA}$ × 0.65 | 5.5 | V |
| $V_{IL}$ | Low-level input voltage | A-Port I/Os | $V_{CCA}$ (V) = 1.4 to 1.95 | $V_{CCB}$ (V) = 1.65 to 5.5 | 0 | 0.15 | V |
| | | | $V_{CCA}$ (V) = 1.95 to 3.6 | $V_{CCB}$ (V) = 1.65 to 5.5 | 0 | 0.15 | |
| | | B-Port I/Os | $V_{CCA}$ (V) = 1.4 to 3.6 | $V_{CCB}$ (V) = 1.65 to 5.5 | 0 | 0.15 | V |
| | | OE | $V_{CCA}$ (V) = 1.4 to 3.6 | $V_{CCB}$ (V) = 1.65 to 5.5 | 0 | $V_{CCA}$ × 0.35 | V |
| $\Delta t/\Delta v$ | Input transition rise or fall rate | A-Port I/Os Push-pull | $V_{CCA}$ (V) = 1.4 to 3.6 | $V_{CCB}$ (V) = 1.65 to 5.5 | | 10 | ns/V |
| | | B-Port I/Os Push-pull | $V_{CCA}$ (V) = 1.4 to 3.6 | $V_{CCB}$ (V) = 1.65 to 5.5 | | 10 | ns/V |
| | | Control input | $V_{CCA}$ (V) = 1.4 to 3.6 | $V_{CCB}$ (V) = 1.65 to 5.5 | | 10 | ns/V |
| $T_A$ | Operating free-air temperature | | | −40 | 85 | °C |

(1)   $V_{CCI}$ is the $V_{CC}$ associated with the data input port.
(2)   $V_{CCO}$ is the $V_{CC}$ associated with the output port.
(3)   $V_{CCA}$ must be less than or equal to $V_{CCB}$, and $V_{CCA}$ must not exceed 3.6 V.

## 6.4 Thermal Information

| | | TXS0108E | | | | |
|---|---|---|---|---|---|---|
| THERMAL METRIC[1] | | PW (TSSOP) | RGY (VQFN) | ZXY (UFBGA) | NME (NFBGA) | UNIT |
| | | 20 PINS | 20 PINS | 20 PINS | 20 PINS | |
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance | 101.5 | 34.7 | 101.5 | 131.4 | °C/W |
| $R_{\theta JC(top)}$ | Junction-to-case (top) thermal resistance | 35.9 | 39.5 | 35.9 | 56.5 | °C/W |
| $R_{\theta JB}$ | Junction-to-board thermal resistance | 52.4 | 12.7 | 52.4 | 83.2 | °C/W |
| $\psi_{JT}$ | Junction-to-top characterization parameter | 2.3 | 0.9 | 2.3 | 1.5 | °C/W |
| $\psi_{JB}$ | Junction-to-board characterization parameter | 51.9 | 12.7 | 51.9 | 82.6 | °C/W |
| $R_{\theta JC(bot)}$ | Junction-to-case (bottom) thermal resistance | — | 7.5 | — | — | °C/W |

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

## 6.5 Electrical Characteristics: $T_A = -40°C$ to $85°C^{(1)(2)(3)}$

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

| | PARAMETER | TEST CONDITIONS | $V_{CCA}$ (V) | $V_{CCB}$ (V) | $T_A = 25°C$ | | | $T_A = -40°C$ to $85°C$ | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP | MAX | MIN | MAX | |
| $V_{OHA}$ | Port A output high voltage | $I_{OH} = -20$ μA $V_{IB} \geq V_{CCB} - 0.4$ V | 1.4 | 1.65 to 5.5 | | $V_{CCA} \times 0.67$ | | | | V |
| $V_{OLA}$ | Port A output low voltage | $I_{OL} = 180$ μA, $V_{IB} \leq 0.15$ V | 1.4 | 1.65 to 5.5 | | | | | 0.4 | V |
| | | $I_{OL} = 220$ μA, $V_{IB} \leq 0.15$ V | 1.65 | 1.65 to 5.5 | | | | | 0.4 | |
| | | $I_{OL} = 300$ μA, $V_{IB} \leq 0.15$ V | 2.3 | 1.65 to 5.5 | | | | | 0.4 | |
| | | $I_{OL} = 400$ μA, $V_{IB} \leq 0.15$ V | 3 | 1.65 to 5.5 | | | | | 0.55 | |
| $V_{OHB}$ | Port B output high voltage | $I_{OH} = -20$ μA, $V_{IA} \geq V_{CCA} - 0.2$ V | 1.4 | 1.65 to 5.5 | | $V_{CCB} \times 0.67$ | | | | V |
| $V_{OLB}$ | Port B output low voltage | $I_{OL} = 220$ μA, $V_{IA} \leq 0.15$ V | 1.4 to 3.6 | 1.65 | | | | | 0.4 | V |
| | | $I_{OL} = 300$ μA, $V_{IA} \leq 0.15$ V | 1.4 to 3.6 | 2.3 | | | | | 0.4 | |
| | | $I_{OL} = 400$ μA, $V_{IA} \leq 0.15$ V | 1.4 to 3.6 | 3 | | | | | 0.55 | |
| | | $I_{OL} = 620$ μA, $V_{IA} \leq 0.15$ V | 1.4 to 3.6 | 4.5 | | | | | 0.55 | |
| $I_I$ | Input leakage current | OE: $V_I = V_{CCI}$ or GND | 1.4 | 1.65 to 5.5 | −1 | | 1 | | 2 | μA |
| $I_{OZ}$ | High-impedance state output current | A or B port | 1.4 | 1.65 to 5.5 | −1 | | 1 | −2 | 2 | μA |
| $I_{CCA}$ | $V_{CCA}$ supply current | $V_I = V_O$ = Open, $I_O = 0$ | 1.4 | 1.65 to 5.5 | | 1.5 | | −2 | 2 | μA |
| | | | 1.5 to 3.6 | 2.3 to 5.5 | | | | | 2 | |
| | | | 3.6 | 0 | | | | | 2 | |
| | | | 0 | 5.5 | | | | | −1 | |
| $I_{CCB}$ | $V_{CCB}$ supply current | $V_I = V_O$ = Open, $I_O = 0$ | 1.4 | 1.65 to 5.5 | | 1.5 | | | | μA |
| | | | 1.5 to 3.6 | 2.3 to 5.5 | | | | | 6 | |
| | | | 3.6 | 0 | | | | | −1 | |
| | | | 0 | 5.5 | | | | | 1.4 | |
| $I_{CCA}$ + $I_{CCB}$ | Combined supply current | $V_I = V_{CCI}$ or GND, $I_O = 0$ | 1.4 | 2.3 to 5.5 | | 3 | | | | μA |
| | | | 1.5 to 3.6 | 2.3 to 5.5 | | | | | 8 | |
| $I_{CCZA}$ | High-impedance state $V_{CCA}$ supply current | $V_I = V_O$ = Open, $I_O = 0$, OE = GND | 1.4 | 1.65 to 5.5 | | 0.05 | | | | μA |
| $I_{CCZB}$ | High-impedance state $V_{CCB}$ supply current | $V_I = V_O$ = Open, $I_O = 0$, OE = GND | 1.4 | 1.65 to 5.5 | | 4 | | | | μA |
| $C_i$ | Input capacitance | OE | 3.3 | 3.3 | | 4.5 | | | 5.5 | pF |
| $C_{io}$ | Input-to-output internal capacitance | A port | 3.3 | 3.3 | | 6 | | | 7 | pF |
| | | B port | 3.3 | 3.3 | | 5.5 | | | 6 | |

(1) $V_{CCO}$ is the $V_{CC}$ associated with the output port.
(2) $V_{CCI}$ is the $V_{CC}$ associated with the input port.
(3) $V_{CCA}$ must be less than or equal to $V_{CCB}$, and $V_{CCA}$ must not exceed 3.6 V.

## 6.6 Timing Requirements: $V_{CCA} = 1.5$ V ± 0.1 V

over recommended operating free-air temperature range, $V_{CCA} = 1.5$ V ± 0.1 V (unless otherwise noted)

| | | | $V_{CCB} = 1.8$ V ± 0.15 V | | $V_{CCB} = 2.5$ V ± 0.2 V | | $V_{CCB} = 3.3$ V ± 0.3 V | | $V_{CCB} = 5$ V ± 0.5 V | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX | |
| | Data rate | Push-pull | | 40 | | 60 | | 60 | | 50 | Mbps |
| | | Open-drain | | 2 | | 2 | | 2 | | 2 | |
| $t_w$ | Pulse duration | Push-pull (Data inputs) | 25 | | 16.7 | | 16.7 | | 20 | | ns |
| | | Open-drain (Data inputs) | 500 | | 500 | | 500 | | 500 | | |

Product Folder Links: TXS0108E

## 6.7 Timing Requirements: V<sub>CCA</sub> = 1.8 V ± 0.15 V

over recommended operating free-air temperature range, $V_{CCA}$ = 1.8 V ± 0.15 V (unless otherwise noted)

| | | | $V_{CCB}$ = 1.8 V ± 0.15 V | | $V_{CCB}$ = 2.5 V ± 0.2 V | | $V_{CCB}$= 3.3 V ± 0.3 V | | $V_{CCB}$= 5 V ± 0.5 V | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX | |
| Data rate | | Push-pull | | 40 | | 60 | | 60 | | 60 | Mbps |
| | | Open-drain | | 2 | | 2 | | 2 | | 2 | |
| $t_w$ | Pulse duration | Data inputs | Push-pull | 25 | 16.7 | | 16.7 | | 16.7 | | ns |
| | | | Open-drain | 500 | 500 | | 500 | | 500 | | |

## 6.8 Timing Requirements: V<sub>CCA</sub> = 2.5 V ± 0.2 V

over recommended operating free-air temperature range, $V_{CCA}$ = 2.5 V ± 0.2 V (unless otherwise noted)

| | | | $V_{CCB}$ = 2.5 V ± 0.2 V | | $V_{CCB}$ = 3.3 V ± 0.3 V | | $V_{CC}$ = 5 V ± 0.5 V | | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | MAX | MIN | MAX | MIN | MAX | |
| Data rate | | Push-pull | | 60 | | 60 | | 60 | Mbps |
| | | Open-drain | | 2 | | 2 | | 2 | |
| $t_w$ | Pulse duration | Data inputs | Push-pull | 16.7 | | 16.7 | | 16.7 | | ns |
| | | | Open-drain | 500 | | 500 | | 500 | | |

## 6.9 Timing Requirements: V<sub>CCA</sub> = 3.3 V ± 0.3 V

over recommended operating free-air temperature range, $V_{CCA}$ = 3.3 V ± 0.3 V (unless otherwise noted)

| | | | $V_{CCB}$ = 3.3 V ± 0.3 V | | $V_{CCB}$ = 5 V ± 0.5 V | | UNIT |
|---|---|---|---|---|---|---|---|
| | | | MIN | MAX | MIN | MAX | |
| Data rate | | Push-pull | | 60 | | 60 | Mbps |
| | | Open-drain | | 2 | | 2 | |
| $t_w$ | Pulse duration | Data inputs | Push-pull | 16.7 | | 16.7 | | ns |
| | | | Open-drain | 500 | | 500 | | |

Product Folder Links: *TXS0108E*

## 6.10 Switching Characteristics: $V_{CCA}$ = 1.5 V ± 0.1 V

over recommended operating free-air temperature range, $V_{CCA}$ = 1.5 V ± 0.1 V (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | $V_{CCB}$ = 1.8 V ± 0.15 V | | $V_{CCB}$ = 2.5 V ± 0.2 V | | $V_{CCB}$ = 3.3 V ± 0.3 V | | $V_{CCB}$ = 5 V ± 0.5 V | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX | |
| $t_{PHL}$ | Propagation delay time (high-to-low output) | A-to-B | Push-pull driving | | 11 | | 9.2 | | 8.6 | | 8.6 | ns |
| | | | Open-drain driving | 4 | 14.4 | 3.6 | 12.8 | 3.5 | 12.2 | 3.5 | 12 | |
| $t_{PLH}$ | Propagation delay time (low-to-high output) | A-to-B | Push-pull driving | | 12 | | 10 | | 9.8 | | 9.7 | |
| | | | Open-drain driving | 182 | 720 | 143 | 554 | 114 | 473 | 81 | 384 | |
| $t_{PHL}$ | Propagation delay time (high-to-low output) | B-to-A | Push-pull driving | | 12.7 | | 11.1 | | 11 | | 12 | ns |
| | | | Open-drain driving | 3.4 | 13.2 | 3.1 | 9.6 | 2.8 | 8.5 | 2.5 | 7.5 | |
| $t_{PLH}$ | Propagation delay time (low-to-high output) | B-to-A | Push-pull driving | | 9.5 | | 6.2 | | 5.1 | | 1.6 | |
| | | | Open-drain driving | 186 | 745 | 147 | 603 | 118 | 519 | 84 | 407 | |
| $t_{en}$ | Enable time | OE-to-A or B | Push-pull driving | | 200 | | 200 | | 200 | | 200 | ns |
| $t_{dis}$ | Disable time | OE-to-A or B | Push-pull driving | | 28.1 | | 22 | | 20.1 | | 19.6 | ns |
| $t_{rA}$ | Input rise time | A-port rise time | Push-pull driving | 3.5 | 13.1 | 3 | 9.8 | 3.1 | 9 | 3.2 | 8.3 | ns |
| | | | Open-drain driving | 147 | 982 | 115 | 716 | 92 | 592 | 66 | 481 | |
| $t_{rB}$ | Input rise time | B-port rise time | Push-pull driving | 2.9 | 11.4 | 1.9 | 7.4 | 0.9 | 4.7 | 0.7 | 2.6 | ns |
| | | | Open-drain driving | 135 | 1020 | 91 | 756 | 58 | 653 | 20 | 370 | |
| $t_{fA}$ | Input fall time | A-port fall time | Push-pull driving | 2.3 | 9.9 | 1.7 | 7.7 | 1.6 | 6.8 | 1.7 | 6 | ns |
| | | | Open-drain driving | 2.4 | 10 | 2.1 | 7.9 | 1.7 | 7 | 1.5 | 6.2 | |
| $t_{fB}$ | Input fall time | B-port fall time | Push-pull driving | 2 | 8.7 | 1.3 | 5.5 | 0.9 | 3.8 | 0.8 | 3.1 | |
| | | | Open-drain driving | 1.2 | 11.5 | 1.3 | 8.6 | 1 | 9.6 | 0.5 | 7.7 | |
| $t_{SK(O)}$ | Skew (time), output | Channel-to-channel skew | Push-pull driving | | 1 | 1 | 1 | | 1.1 | | 1 | ns |
| | Maximum data rate | A or B | Push-pull driving | 40 | | 60 | | 60 | | 50 | | Mbps |
| | | | Open-drain driving | 2 | | 2 | | 2 | | 2 | | |

Product Folder Links: TXS0108E

## 6.11 Switching Characteristics: V$_{CCA}$ = 1.8 V ± 0.15 V

over recommended operating free-air temperature range, V$_{CCA}$ = 1.8 V ± 0.15 V (unless otherwise noted)

| PARA-METER | | TEST CONDITIONS | | V$_{CCB}$ = 1.8 V ± 0.15 V | | V$_{CCB}$ = 2.5 V ± 0.2 V | | V$_{CCB}$ = 3.3 V ± 0.3 V | | V$_{CCB}$ = 5 V ± 0.5 V | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX | |
| t$_{PHL}$ | Propagation delay time (high-to-low output) | A-to-B | Push-pull driving | | 8.2 | | 6.4 | | 5.7 | | 5.6 | ns |
| | | | Open-drain driving | 3.6 | 11.4 | 3.2 | 9.9 | 3.1 | 9.3 | 3.1 | 8.9 | |
| t$_{PLH}$ | Propagation delay time (low-to-high output) | A-to-B | Push-pull driving | | 9 | | 2.1 | | 6.5 | | 6.3 | |
| | | | Open-drain driving | 194 | 729 | 155 | 584 | 126 | 466 | 90 | 346 | |
| t$_{PHL}$ | Propagation delay time (high-to-low output) | B-to-A | Push-pull driving | | 9.8 | | 8 | | 7.4 | | 7 | ns |
| | | | Open-drain driving | 3.4 | 12.1 | 2.8 | 8.5 | 2.5 | 7.3 | 2.1 | 6.2 | |
| t$_{PLH}$ | Propagation delay time (low-to-high output) | B-to-A | Push-pull driving | | 10.2 | | 7 | | 5.8 | | 5 | |
| | | | Open-drain driving | 197 | 733 | 159 | 578 | 129 | 459 | 93 | 323 | |
| t$_{en}$ | Enable time | OE-to-A or B | Push-pull driving | | 200 | | 200 | | 200 | | 200 | ns |
| t$_{dis}$ | Disable time | OE-to-A or B | Push-pull driving | | 25.1 | | 18.8 | | 16.5 | | 15.3 | ns |
| t$_{rA}$ | Input rise time | A-port rise time | Push-pull driving | 3.1 | 11.9 | 2.6 | 8.6 | 2.7 | 7.8 | 2.8 | 7.2 | ns |
| | | | Open-drain driving | 155 | 996 | 124 | 691 | 100 | 508 | 72 | 350 | |
| t$_{rB}$ | Input rise time | B-port rise time | Push-pull driving | 2.8 | 10.5 | 1.8 | 7.2 | 1.2 | 5.2 | 0.7 | 2.7 | ns |
| | | | Open-drain driving | 132 | 1001 | 106 | 677 | 73 | 546 | 32 | 323 | |
| t$_{fA}$ | Input fall time | A-port fall time | Push-pull driving | 2.1 | 8.8 | 1.6 | 6.6 | 1.4 | 5.7 | 1.4 | 4.9 | ns |
| | | | Open-drain driving | 2.2 | 9 | 1.7 | 6.7 | 1.4 | 5.8 | 1.2 | 5.2 | |
| t$_{fB}$ | Input fall time | B-port fall time | Push-pull driving | 2 | 8.3 | 1.3 | 5.4 | 0.9 | 3.9 | 0.7 | 3 | ns |
| | | | Open-drain driving | 0.8 | 10.5 | 0.7 | 10.7 | 1 | 9.6 | 0.6 | 7.8 | |
| t$_{SK(O)}$ | Skew (time), output | Channel-to-channel skew | Push-pull driving | | 1 | | 1 | | 1 | | 1 | ns |
| | Maximum data rate | A or B | Push-pull driving | 40 | | 60 | | 60 | | 60 | | Mbps |
| | | | Open-drain driving | 2 | | 2 | | 2 | | 2 | | |

Product Folder Links: *TXS0108E*

## 6.12 Switching Characteristics: $V_{CCA}$ = 2.5 V ± 0.2 V

over recommended operating free-air temperature range, $V_{CCA}$ = 2.5 V ± 0.2 V (unless otherwise noted)

| PARA-METER | | TEST CONDITIONS | | $V_{CCB}$ = 2.5 V ± 0.2 V | | $V_{CCB}$ = 3.3 V ± 0.3 V | | $V_{CCB}$ = 5 V ± 0.5 V | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | MAX | MIN | MAX | MIN | MAX | |
| $t_{PHL}$ | Propagation delay time (high-to-low output) | A -to-B | Push-pull driving | | 5 | | 4 | | 3.7 | ns |
| | | | Open-drain driving | 2.4 | 6.9 | 2.3 | 6.3 | 2.2 | 5.8 | |
| $t_{PLH}$ | Propagation delay time (low-to-high output) | A -to-B | Push-pull driving | | 5.2 | | 4.3 | | 3.9 | |
| | | | Open-drain driving | 149 | 592 | 125 | 488 | 93 | 368 | |
| $t_{PHL}$ | Propagation delay time (high-to-low output) | B-to-A | Push-pull driving | | 5.4 | | 4.7 | | 4.2 | ns |
| | | | Open-drain driving | 2.5 | 7.3 | 2.2 | 6 | 1.8 | 4.9 | |
| $t_{PLH}$ | Propagation delay time (low-to-high output) | B-to-A | Push-pull driving | | 5.9 | | 4.4 | | 3.5 | |
| | | | Open-drain driving | 150 | 595 | 126 | 481 | 94 | 345 | |
| $t_{en}$ | Enable time | OE-to-A or B | Push-pull driving | | 200 | | 200 | | 200 | ns |
| $t_{dis}$ | Disable time | OE-to-A or B | Push-pull driving | | 15.7 | | 12.9 | | 11.2 | ns |
| $t_{rA}$ | Input rise time | A-port rise time | Push-pull driving | 2 | 7.3 | 2.1 | 6.4 | 2.2 | 5.8 | ns |
| | | | Open-drain driving | 110 | 692 | 93 | 529 | 68 | 369 | |
| $t_{rB}$ | Input rise time | B-port rise time | Push-pull driving | 1.8 | 6.5 | 1.3 | 5.1 | 0.7 | 3.4 | ns |
| | | | Open-drain driving | 107 | 693 | 79 | 483 | 41 | 304 | |
| $t_{fA}$ | Input fall time | A-port fall time | Push-pull driving | 1.5 | 5.7 | 1.2 | 4.7 | 1.3 | 3.8 | ns |
| | | | Open-drain driving | 1.5 | 5.6 | 1.2 | 4.7 | 1.1 | 4 | |
| $t_{fB}$ | Input fall time | B-port fall time | Push-pull driving | 1.4 | 5.4 | 0.9 | 4.1 | 0.7 | 3 | |
| | | | Open-drain driving | 0.4 | 14.2 | 0.5 | 19.4 | 0.4 | 3 | |
| $t_{SK(O)}$ | Skew (time), output | Channel-to-channel skew | Push-pull driving | | 1 | | 1.2 | | 1 | ns |
| | Maximum data rate | A or B | Push-pull driving | 60 | | 60 | | 60 | | Mbps |
| | | | Open-drain driving | 2 | | 2 | | 2 | | |

Product Folder Links: TXS0108E

## 6.13 Switching Characteristics: $V_{CCA}$ = 3.3 V ± 0.3 V

over recommended operating free-air temperature range, $V_{CCA}$ = 3.3 V ± 0.3 V (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | $V_{CCB}$ = 3.3 V ± 0.3 V | | $V_{CCB}$ = 5 V ± 0.5 V | | UNIT |
|---|---|---|---|---|---|---|---|---|
| | | | | MIN | MAX | MIN | MAX | |
| $t_{PHL}$ | Propagation delay time (high-to-low output) | A-to-B | Push-pull driving | | 3.8 | | 3.1 | ns |
| | | | Open-drain driving | 2 | 5.3 | 1.9 | 4.8 | |
| $t_{PLH}$ | Propagation delay time (low-to-high output) | A-to-B | Push-pull driving | | 3.9 | | 3.5 | |
| | | | Open-drain driving | 111 | 439 | 87 | 352 | |
| $t_{PHL}$ | Propagation delay time (high-to-low output) | B-to-A | Push-pull driving | | 4.2 | | 3.8 | ns |
| | | | Open-drain driving | 2.1 | 5.5 | 1.7 | 4.5 | |
| $t_{PLH}$ | Propagation delay time (low-to-high output) | A-to-B | Push-pull driving | | 3.8 | | 4.3 | |
| | | | Open-drain driving | 112 | 449 | 86 | 339 | |
| $t_{en}$ | Enable time | OE-to-A or B | Push-pull driving | | 200 | | 200 | ns |
| $t_{dis}$ | Disable time | OE-to-A or B | Push-pull driving | | 11.9 | | 9.8 | ns |
| $t_{rA}$ | Input rise time | A-port rise time | Push-pull driving | 1.8 | 5.7 | 1.9 | 5 | ns |
| | | | Open-drain driving | 75 | 446 | 57 | 337 | |
| $t_{rB}$ | Input rise time | B-port rise time | Push-pull driving | 1.5 | 5 | 1 | 3.6 | ns |
| | | | Open-drain driving | 72 | 427 | 40 | 290 | |
| $t_{fA}$ | Input fall time | A-port fall time | Push-pull driving | 1.2 | 4.5 | 1.1 | 3.5 | ns |
| | | | Open-drain driving | 1.1 | 4.4 | 1 | 3.7 | |
| $t_{fB}$ | Input fall time | B-port fall time | Push-pull driving | 1.1 | 4.2 | 0.8 | 3.1 | |
| | | | Open-drain driving | 1 | 4.2 | 0.8 | 3.1 | |
| $t_{SK(O)}$ | Skew (time), output | Channel-to-channel skew | Push-pull driving | | 1 | | 1 | ns |
| | Maximum data rate | A or B | Push-pull driving | 60 | | 60 | | Mbps |
| | | | Open-drain driving | 2 | | 2 | | |

## 6.14 Operating Characteristics: $V_{CCA}$ = 1.5 V to 3.3 V, $V_{CCB}$ = 1.5 V to 3.3 V

$T_A$ = 25°C

| PARAMETER | | TEST CONDITIONS | | $V_{CCA}$ = 1.5 V, $V_{CCB}$ = 1.5 V | | | $V_{CCA}$ = 1.8 V, $V_{CCB}$ = 1.8 V | | | $V_{CCA}$ = 2.5 V, $V_{CCB}$ = 2.5 V | | | $V_{CCA}$ = 2.5 V, $V_{CCB}$ = 2.5 V | | | $V_{CCA}$ = 3.3 V, $V_{CCB}$ = 3.3 V | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| $C_{pdA}$ | Power dissipation capacitance | CL = 0 f = 10 MHz tr= tf= 1 ns OE = $V_{CCA}$ (outputs enabled) | A-port input, B-port output | | 5.9 | | | 5.9 | | | 6.7 | | | 6.9 | | | 8 | | pF |
| | | | B-port input, A-port output | | 9.9 | | | 9.7 | | | 9.7 | | | 9.4 | | | 9.8 | | |
| $C_{pdB}$ | Power dissipation capacitance | | A-port input, B-port output | | 21.5 | | | 20.8 | | | 21 | | | 23.4 | | | 23 | | |
| | | | B-port input, A-port output | | 16.7 | | | 16.8 | | | 17.8 | | | 20.8 | | | 20.9 | | |
| $C_{pdA}$ | Power dissipation capacitance | CL = 0 f = 10 MHz tr= tf= 1 ns OE = $V_{CCA}$ (outputs enabled) | A-port input, B-port output | | 0.01 | | | 0.01 | | | 0.01 | | | 0.01 | | | 0.01 | | pF |
| | | | B-port input, A-port output | | 0.01 | | | 0.01 | | | 0.01 | | | 0.01 | | | 0.01 | | |
| $C_{pdB}$ | Power dissipation capacitance | | A-port input, B-port output | | 0.01 | | | 0.01 | | | 0.01 | | | 0.03 | | | 0.02 | | |
| | | | B-port input, A-port output | | 0.01 | | | 0.01 | | | 0.01 | | | 0.03 | | | 0.02 | | |

Product Folder Links: *TXS0108E*

# 7 Typical Characteristics



$V_{CCA} = 2.3$ V $V_{IL(A)} = 0.15$ V

**Figure 1. Low-Level Output Voltage ($V_{OL(Bx)}$) vs Low-Level Current ($I_{OL(Bx)}$)**



$V_{CCA} = 3.0$ V $V_{IL(A)} = 0.15$ V

**Figure 2. Low-Level Output Voltage ($V_{OL(Bx)}$) vs Low-Level Current ($I_{OL(Bx)}$)**

# 8 Parameter Measurement Information

## 8.1 Load Circuits

Figure 3 shows the push-pull driver circuit used for measuring data rate, pulse duration, propagation delay, output rise-time and fall-time. Figure 4 shows the open-drain driver circuit used for measuring data rate, pulse duration, propagation delay, output rise-time and fall-time.
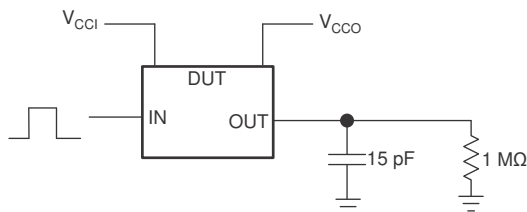


(1)   $V_{CCI}$ is the $V_{CC}$ associated with the input port.

(2)   $V_{CCO}$ is the $V_{CC}$ associated with the output port.

**Figure 3.  Data Rate, Pulse Duration, Propagation Delay, Output Rise-Time And Fall-Time Measurement Using a Push-Pull Driver**
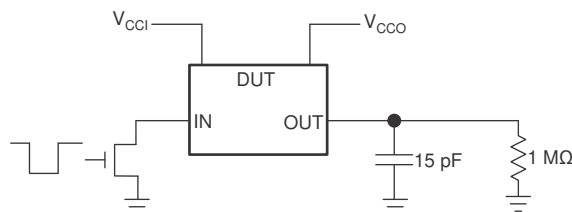


(1)   $V_{CCI}$ is the $V_{CC}$ associated with the input port.

(2)   $V_{CCO}$ is the $V_{CC}$ associated with the output port.

**Figure 4.  Data Rate (10 pF), Pulse Duration (10 pF), Propagation Delay, Output Rise-Time And Fall-Time Measurement Using an Open-Drain Driver**
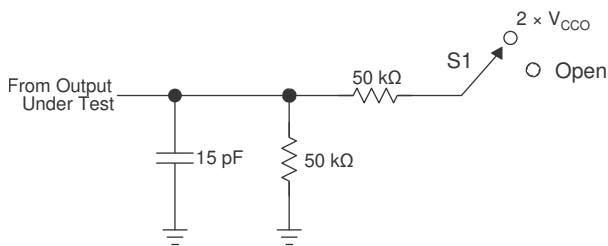


| TEST | S1 |
|---|---|
| $t_{PZL}$, $t_{PLZ}$ ($t_{dis}$) | $2 \times V_{CCO}$ |
| $t_{PHZ}$, $t_{PZH}$ ($t_{en}$) | Open |

(1)   $t_{PLZ}$ and $t_{PHZ}$ are the same as $t_{dis}$.

(2)   $t_{PZL}$ and $t_{PZH}$ are the same as $t_{en}$.

**Figure 5.  Load Circuit for Enable-Time and Disable-Time Measurement**

Product Folder Links: *TXS0108E*

## 8.2 Voltage Waveforms
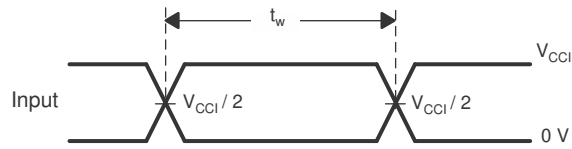


**Figure 6. Pulse Duration (Push-Pull)**
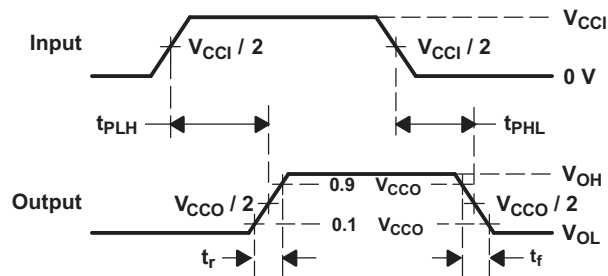


**Figure 7. Propagation Delay Times**

Product Folder Links: *TXS0108E*

# 9 Detailed Description

## 9.1 Overview

The TXS0108E device is a directionless voltage-level translator specifically designed for translating logic voltage levels. The A-port accepts I/O voltages ranging from 1.4 V to 3.6 V. The B-port accepts I/O voltages from 1.65 V to 5.5 V. The device uses pass gate architecture with edge rate accelerators (one shots) to improve the overall data rate. The pull-up resistors, commonly used in open-drain applications, have been conveniently integrated so that an external resistor is not needed. While this device is designed for open-drain applications, the device can also translate push-pull CMOS logic outputs.

## 9.2 Functional Block Diagram
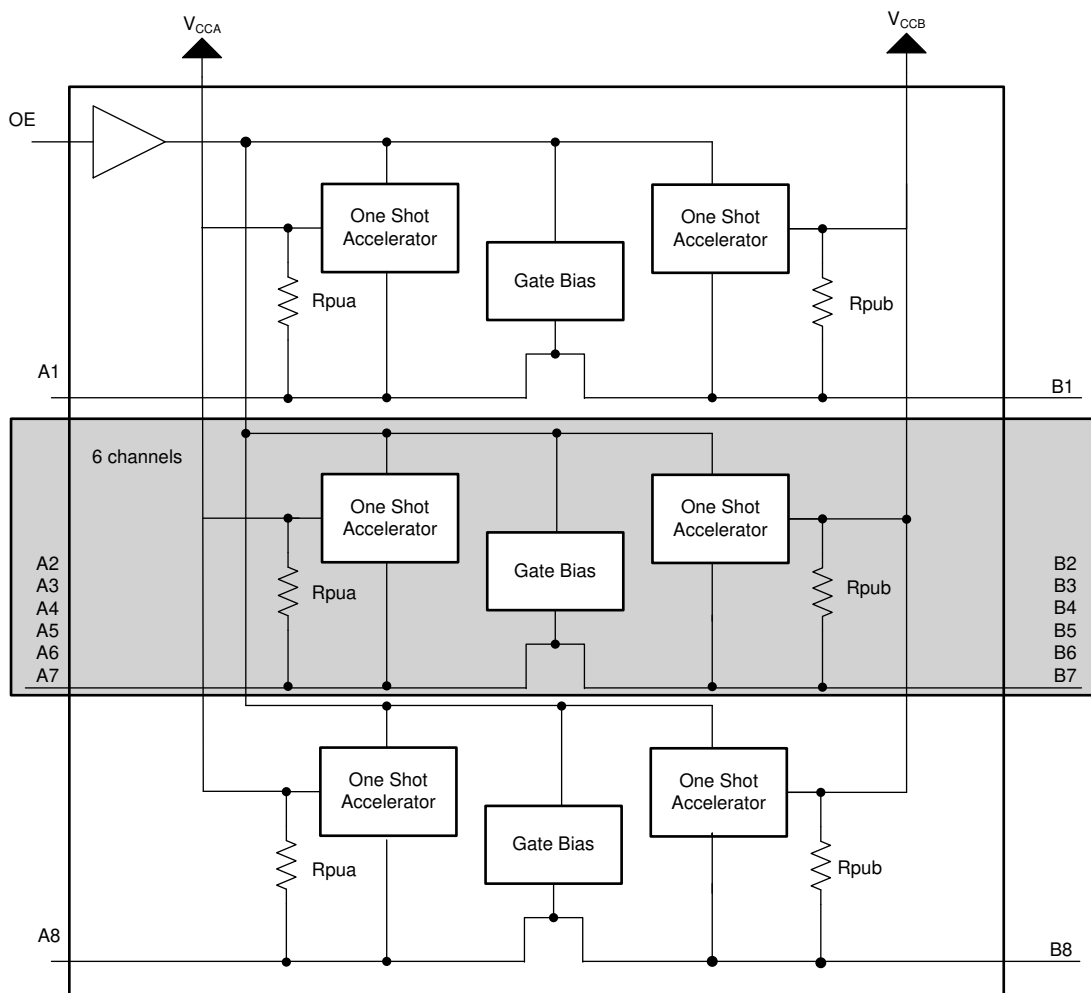


**Figure 8. Functional Block Diagram**

Each A-port I/O has a pull-up resistor ($R_{PUA}$) to $V_{CCA}$ and each B-port I/O has a pull-up resistor ($R_{PUB}$) to $V_{CCB}$. $R_{PUA}$ and $R_{PUB}$ have a value of 40 k$\Omega$ when the output is driving low. $R_{PUA}$ and $R_{PUB}$ have a value of 4 k$\Omega$ when the output is driving high. $R_{PUA}$ and $R_{PUB}$ are disabled when OE = Low.

## 9.3 Feature Description

### 9.3.1 Architecture

Figure 9 describes semi-buffered architecture design this application requires for both push-pull and open-drain mode. This application uses edge-rate accelerator circuitry (for both the high-to-low and low-to-high edges), a high-on-resistance N-channel pass-gate transistor (on the order of 300 Ω to 500 Ω) and pull-up resistors (to provide DC-bias and drive capabilities) to meet these requirements. This design needs no direction-control signal (to control the direction of data flow from A to B or from B to A). The resulting implementation supports both low-speed open-drain operation as well as high-speed push-pull operation.
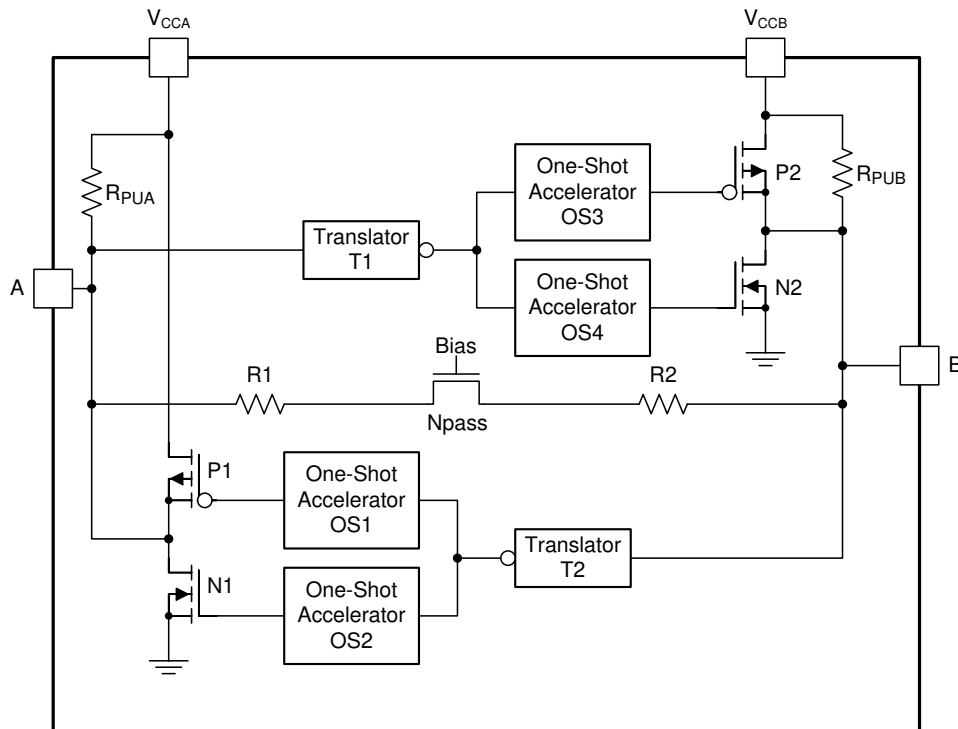


**Figure 9. Architecture of a TXS0108E Cell**

When transmitting data from A-ports to B-ports, during a rising edge the one-shot circuit (OS3) turns on the PMOS transistor (P2) for a short-duration which reduces the low-to-high transition time. Similarly, during a falling edge, when transmitting data from A to B, the one-shot circuit (OS4) turns on the N-channel MOSFET transistor (N2) for a short-duration which speeds up the high-to-low transition. The B-port edge-rate accelerator consists of one-shot circuits OS3 and OS4. Transistors P2 and N2 and serves to rapidly force the B port high or low when a corresponding transition is detected on the A port.

When transmitting data from B- to A-ports, during a rising edge the one-shot circuit (OS1) turns on the PMOS transistor (P1) for a short-duration which reduces the low-to-high transition time. Similarly, during a falling edge, when transmitting data from B to A, the one-shot circuit (OS2) turns on NMOS transistor (N1) for a short-duration and this speeds up the high-to-low transition. The A-port edge-rate accelerator consists of one-shots OS1 and OS2, transistors P1 and N1 components and form the edge-rate accelerator and serves to rapidly force the A port high or low when a corresponding transition is detected on the B port.

## Feature Description (continued)

### 9.3.2 Input Driver Requirements

The continuous DC-current *sinking* capability is determined by the external system-level open-drain (or push-pull) drivers that are interfaced to the TXS0108E I/O pins. Because the high bandwidth of these bidirectional I/O circuits is used to facilitate this fast change from an input to an output and an output to an input, they have a modest DC-current *sourcing* capability of hundreds of micro-amperes, as determined by the internal pull-up resistors.

The fall time ($t_{fA}$, $t_{fB}$) of a signal depends on the edge-rate and output impedance of the external device driving TXS0108E data I/Os, as well as the capacitive loading on the data lines.

Similarly, the $t_{PHL}$ and maximum data rates also depend on the output impedance of the external driver. The values for $t_{fA}$, $t_{fB}$, $t_{PHL}$, and maximum data rates in the data sheet assume that the output impedance of the external driver is less than 50 $\Omega$.

### 9.3.3 Output Load Considerations

TI recommends careful PCB layout practices with short PCB trace lengths to avoid excessive capacitive loading and to ensure that proper one-shot triggering takes place. PCB signal trace-lengths should be kept short enough such that the round trip delay of any reflection is less than the one-shot duration. This improves signal integrity by ensuring that any reflection sees a low impedance at the driver. The one-shot circuits have been designed to stay on for approximately 30 ns. The maximum capacitance of the lumped load that can be driven also depends directly on the one-shot duration. With very heavy capacitive loads, the one-shot can time-out before the signal is driven fully to the positive rail. The one-shot duration has been set to best optimize trade-offs between dynamic $I_{CC}$, load driving capability, and maximum bit-rate considerations. Both PCB trace length and connectors add to the capacitance of the TXS0108E output. Therefore, TI recommends that this lumped-load capacitance is considered in order to avoid one-shot retriggering, bus contention, output signal oscillations, or other adverse system-level affects.

### 9.3.4 Enable and Disable

The TXS0108E has an OE pin input that is used to disable the device by setting the OE pin low, which places all I/Os in the Hi-Z state. The disable time ($t_{dis}$) indicates the delay between the time when the OE pin goes low and when the outputs actually get disabled (Hi-Z). The enable time ($t_{en}$) indicates the amount of time the design must allow for the one-shot circuitry to become operational after the OE pin goes high.

### 9.3.5 Pull-up or Pull-down Resistors on I/O Lines

The TXS0108E has the smart pull-up resistors dynamically change value based on whether a low or a high is being passed through the I/O line. Each A-port I/O has a pull-up resistor ($R_{PUA}$) to $V_{CCA}$ and each B-port I/O has a pull-up resistor ($R_{PUB}$) to $V_{CCB}$. $R_{PUA}$ and $R_{PUB}$ have a value of 40 k$\Omega$ when the output is driving low. $R_{PUA}$ and $R_{PUB}$ have a value of 4 k$\Omega$ when the output is driving high. $R_{PUA}$ and $R_{PUB}$ are disabled when OE = Low. This feature provides lower static power consumption (when the I/Os are passing a low), and supports lower $V_{OL}$ values for the same size pass-gate transistor, and helps improve simultaneous switching performance.

## 9.4 Device Functional Modes

The TXS0108E device has two functional modes, enabled and disabled. To disable the device set the OE pin input low, which places all I/Os in a high impedance state. Setting the OE pin input high enables the device.

# 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 TXS0108E can be used in level-translation applications for interfacing devices or systems operating at different interface voltages with one another. The device is ideal for use in applications where an open-drain driver is connected to the data I/Os. The device is appropriate for applications where a push-pull driver is connected to the data I/Os, but the TXB0104 device, (SCES650) *4-Bit Bidirectional Voltage-Level Translator* might be a better option for such push-pull applications. The device is a semi-buffered auto-direction-sensing voltage translator design is optimized for translation applications (for example, MMC Card Interfaces) that require the system to start out in a low-speed open-drain mode and then switch to a higher speed push-pull mode.
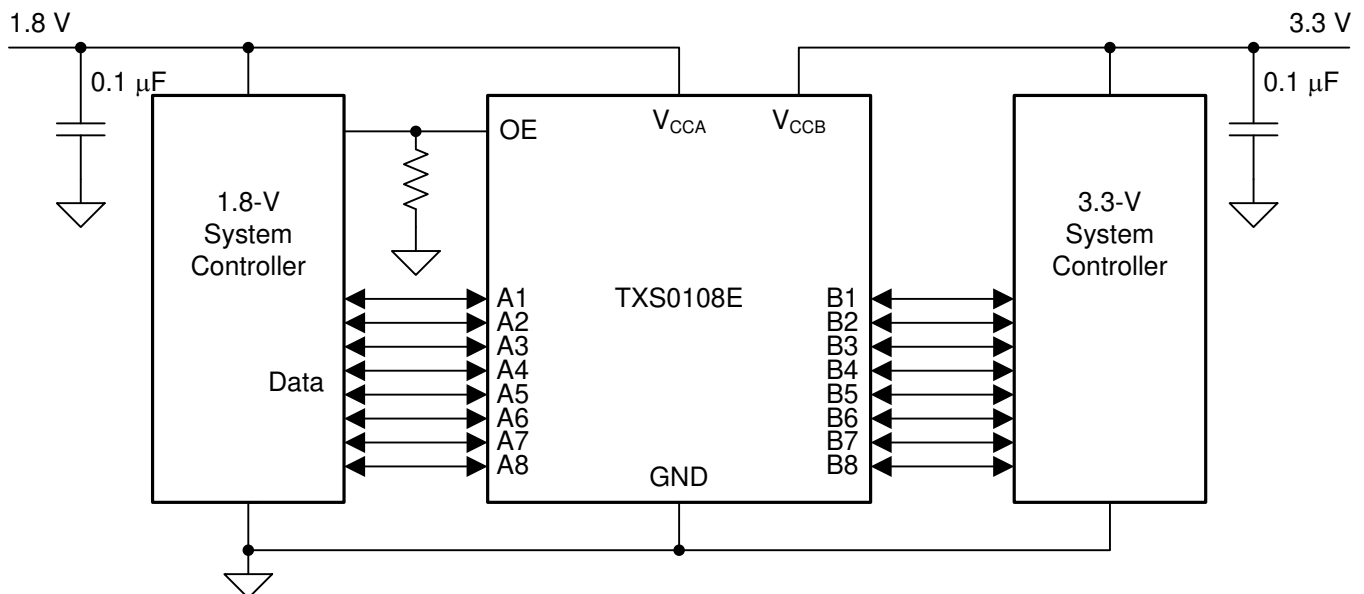
## 10.2 Typical Application



**Figure 10. Typical Application Circuit**

### 10.2.1 Design Requirements

For this design example, use the parameters listed in Table 1. Ensure that $V_{CCA} \leq V_{CCB}$.

**Table 1. Design Parameters**

| DESIGN PARAMETER | EXAMPLE VALUE |
|---|---|
| Input voltage range | 1.4 V to 3.6 V |
| Output voltage range | 1.65 V to 5.5 V |

### 10.2.2 Detailed Design Procedure

To begin the design process, determine the following:

- Input voltage range
  - Use the supply voltage of the device that is driving the TXS0108E device to determine the input voltage range. For a valid logic high the value must exceed the $V_{IH}$ of the input port. For a valid logic low the value

must be less than the $V_{IL}$ of the input port.

- Output voltage range
  - Use the supply voltage of the device that the TXS0108E device is driving to determine the output voltage range.
  - The TXS0108E device has smart internal pull-up resistors. External pull-up resistors can be added to reduce the total RC of a signal trace if necessary.
- An external pull-down resistor decreases the output VOH and VOL. Use Equation 1 to calculate the VOH as a result of an external pull-down resistor.

$$V_{OH} = V_{CCx} \times R_{PD} / (R_{PD} + 4 \text{ k}\Omega) \tag{1}$$

### 10.2.3 Application Curves
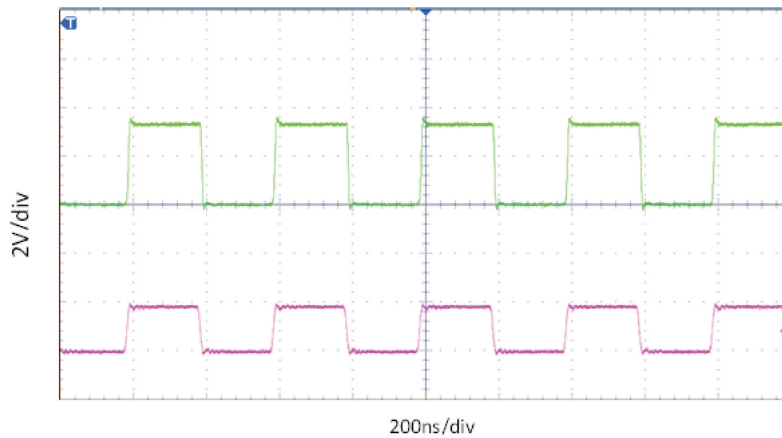


$V_{CCA}$ = 1.8 V          $V_{CCB}$ = 3.3 V

**Figure 11.  Level-Translation of a 2.5-MHz Signal**

Product Folder Links: *TXS0108E*

# 11 Power Supply Recommendations

During operation, ensure that $V_{CCA} \leq V_{CCB}$ at all times. The sequencing of each power supply will not damage the device during the power up operation, so either power supply can be ramped up first. The output-enable (OE) input circuit is designed so that it is supplied by $V_{CCA}$ and when the (OE) input is low, all outputs are placed in the high-impedance state. To ensure the high-impedance state of the outputs during power up or power down, the OE input pin must be tied to GND through a pull-down resistor and must not be enabled until $V_{CCA}$ and $V_{CCB}$ are fully ramped and stable. The minimum value of the pull-down resistor to ground is determined by the current-sourcing capability of the driver.

# 12 Layout

## 12.1 Layout Guidelines

To ensure reliability of the device, following common printed-circuit board layout guidelines is recommended.
- Bypass capacitors should be used on power supplies. Place the capacitors as close as possible to the VCCA, VCCB pin and GND pin.
- Short trace lengths should be used to avoid excessive loading.
- PCB signal trace-lengths must be kept short enough so that the round-trip delay of any reflection is less than the one shot duration, approximately 30 ns, ensuring that any reflection encounters low impedance at the source driver.
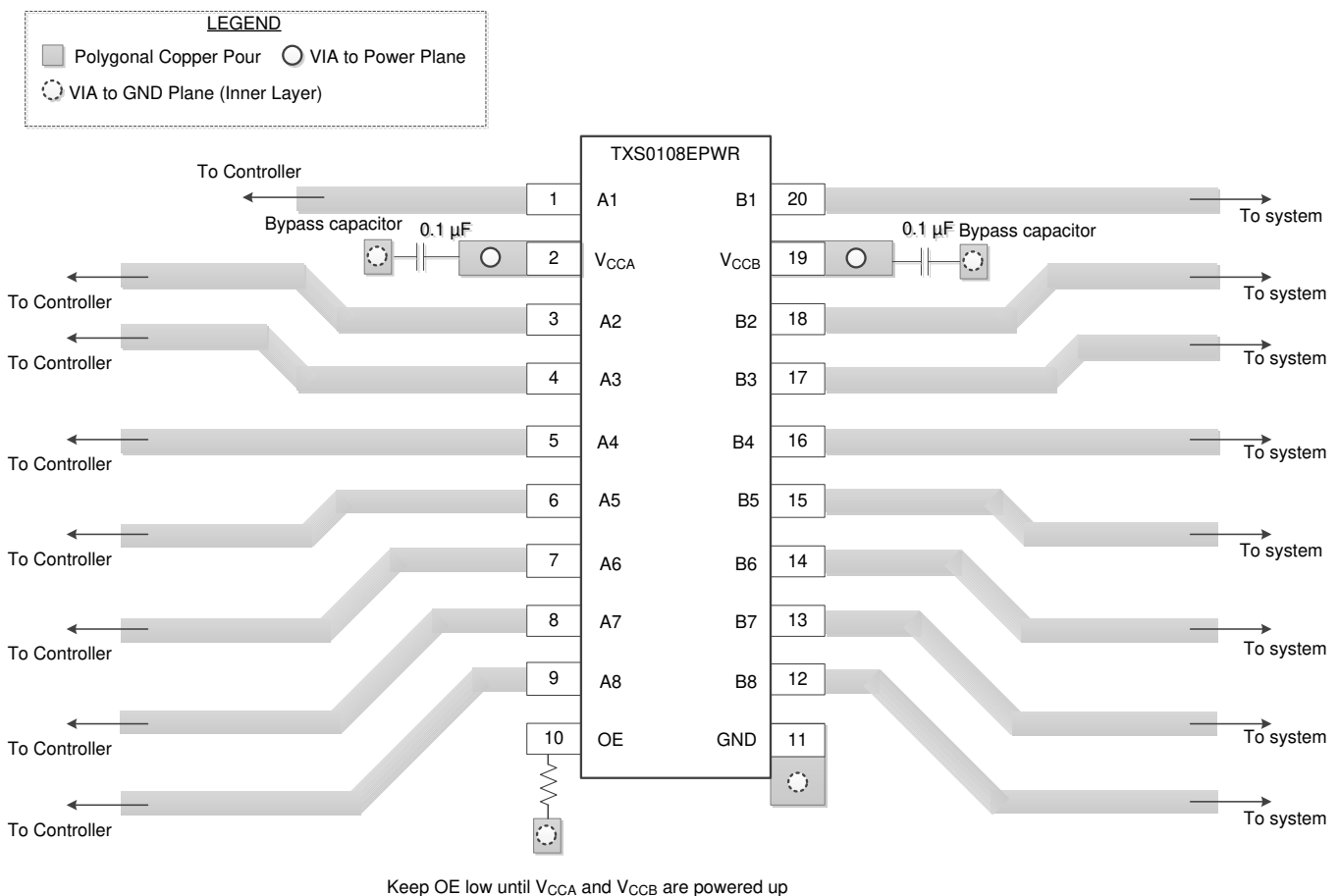
## 12.2 Layout Example



**Figure 12. Layout Example**

# 13 Device and Documentation Support

## 13.1 Support Resources

TI E2E™ support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

Linked content is provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

1. Texas Instruments, Application Note, A guide to Voltage level translation using TXS devices
2. Texas Instruments, Application Note, Factors affecting the Vol of TXS AutoBidirectional Devices
3. Texas Instruments, Application Note, Effects of Pullup and Pulldown resistors on TXS Devices

## 13.2 Trademarks

E2E is a trademark of Texas Instruments.
All other trademarks are the property of their respective owners.

## 13.3 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.

## 13.4 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.

![Texas Instruments logo]

www.ti.com

10-Dec-2020

## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead finish/ Ball material (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TXS0108ENMER | ACTIVE | NFBGA | NME | 20 | 2500 | RoHS & Green | SNAGCU | Level-2-260C-1 YEAR | -40 to 85 | 2APW | Samples |
| TXS0108EPWR | ACTIVE | TSSOP | PW | 20 | 2000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | YF08E | Samples |
| TXS0108EPWRG4 | ACTIVE | TSSOP | PW | 20 | 2000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | YF08E | Samples |
| TXS0108ERGYR | ACTIVE | VQFN | RGY | 20 | 3000 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 85 | YF08E | Samples |
| TXS0108EZXYR | LIFEBUY | BGA MICROSTAR JUNIOR | ZXY | 20 | 2500 | RoHS & Green | SNAGCU | Level-1-260C-UNLIM | -40 to 85 | YF08E | |

(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) **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 <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

**OTHER QUALIFIED VERSIONS OF TXS0108E :**

- Automotive: TXS0108E-Q1

NOTE: Qualified Version Definitions:

- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

# PACKAGE MATERIALS INFORMATION

## 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 |

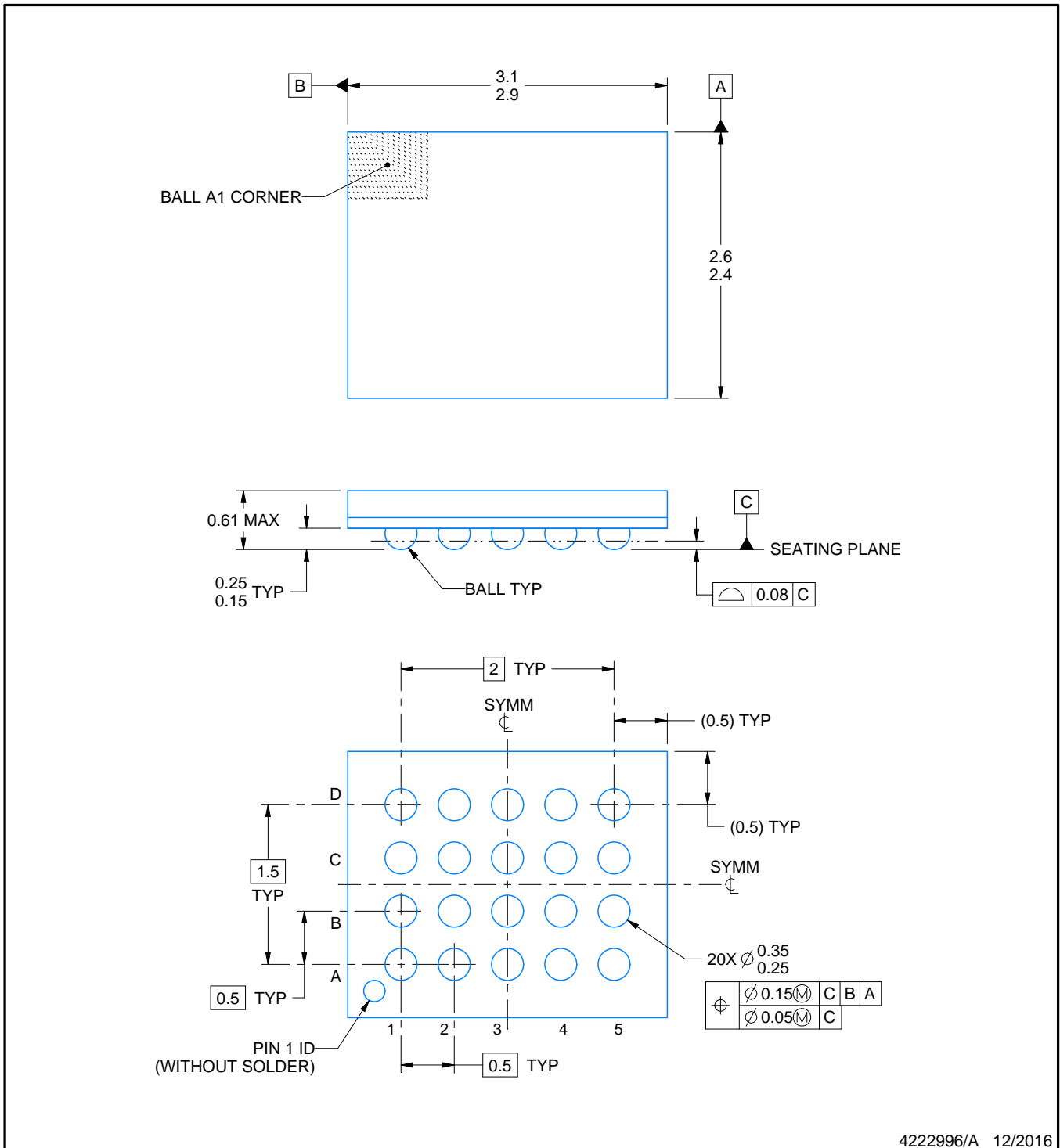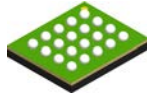**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**

*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 |
|--------|--------------|-----------------|------|-----|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TXS0108ENMER | NFBGA | NME | 20 | 2500 | 330.0 | 12.4 | 2.75 | 3.45 | 1.05 | 4.0 | 12.0 | Q2 |
| TXS0108EPWR | TSSOP | PW | 20 | 2000 | 330.0 | 16.4 | 6.95 | 7.0 | 1.4 | 8.0 | 16.0 | Q1 |
| TXS0108ERGYR | VQFN | RGY | 20 | 3000 | 330.0 | 12.4 | 3.8 | 4.8 | 1.6 | 8.0 | 12.0 | Q1 |
| TXS0108EZXYR | BGA MICROSTAR JUNIOR | ZXY | 20 | 2500 | 330.0 | 12.4 | 2.75 | 3.45 | 1.05 | 4.0 | 12.0 | Q2 |

# 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) |
|---|---|---|---|---|---|---|---|
| TXS0108ENMER | NFBGA | NME | 20 | 2500 | 350.0 | 350.0 | 43.0 |
| TXS0108EPWR | TSSOP | PW | 20 | 2000 | 853.0 | 449.0 | 35.0 |
| TXS0108ERGYR | VQFN | RGY | 20 | 3000 | 853.0 | 449.0 | 35.0 |
| TXS0108EZXYR | BGA MICROSTAR JUNIOR | ZXY | 20 | 2500 | 350.0 | 350.0 | 43.0 |

B $\leftarrow$ 3.1 / 2.9 $\rightarrow$ A

BALL A1 CORNER

2.6 / 2.4

0.61 MAX

C

SEATING PLANE

0.25 / 0.15 TYP

BALL TYP

0.08 C

2 TYP

SYMM

(0.5) TYP

(0.5) TYP

SYMM

D

C

1.5 TYP

B

A

0.5 TYP

20X $\varnothing$ 0.35 / 0.25

1  2  3  4  5

$\oplus$ | $\varnothing$ 0.15 Ⓜ | C | B | A
$\varnothing$ 0.05 Ⓜ | C

PIN 1 ID
(WITHOUT SOLDER)

0.5 TYP

4222996/A   12/2016

NOTES:

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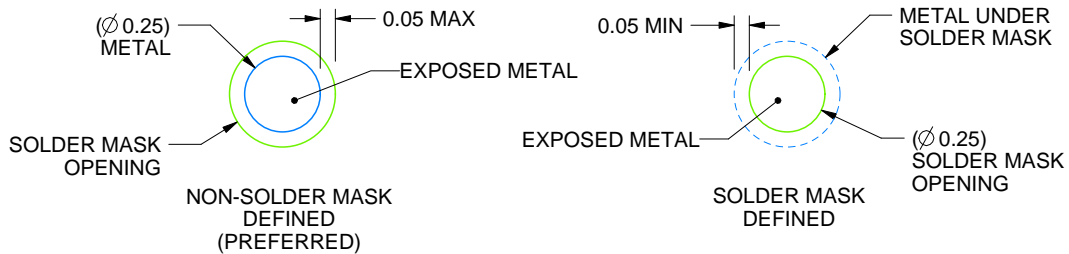2. This drawing is subject to change without notice.

## ZXY0020A

**VFBGA - 0.61 mm max height**

20X ($\emptyset$ 0.25)

(0.5) TYP

(0.5) TYP

SYMM
$\mathbb{C}$

SYMM
$\mathbb{C}$
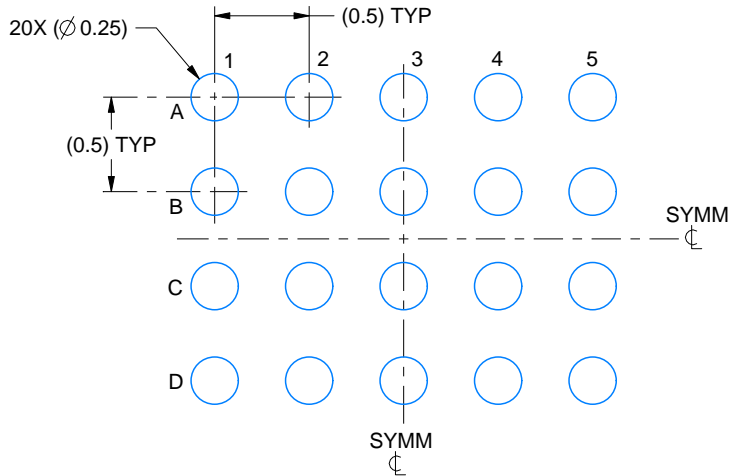
LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:25X

($\emptyset$ 0.25)
METAL

0.05 MAX

EXPOSED METAL

SOLDER MASK
OPENING

NON-SOLDER MASK
DEFINED
(PREFERRED)

METAL UNDER
SOLDER MASK

0.05 MIN

EXPOSED METAL

($\emptyset$ 0.25)
SOLDER MASK
OPENING

SOLDER MASK
DEFINED

SOLDER MASK DETAILS
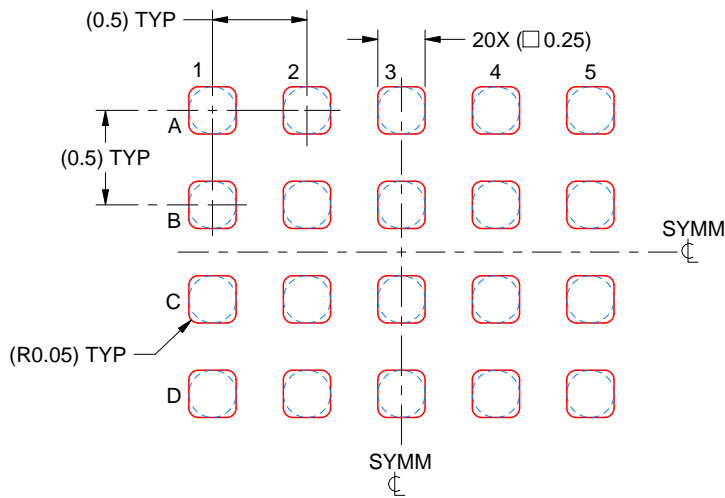NOT TO SCALE

4222996/A  12/2016

NOTES: (continued)

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

## ZXY0020A

PLASTIC BALL GRID ARRAY

(0.5) TYP

20X (□ 0.25)

1    2    3    4    5

A

(0.5) TYP

B

SYMM ₵

C

(R0.05) TYP

D

SYMM ₵

SOLDER PASTE EXAMPLE
BASED ON 0.1 mm THICK STENCIL
SCALE: 25X

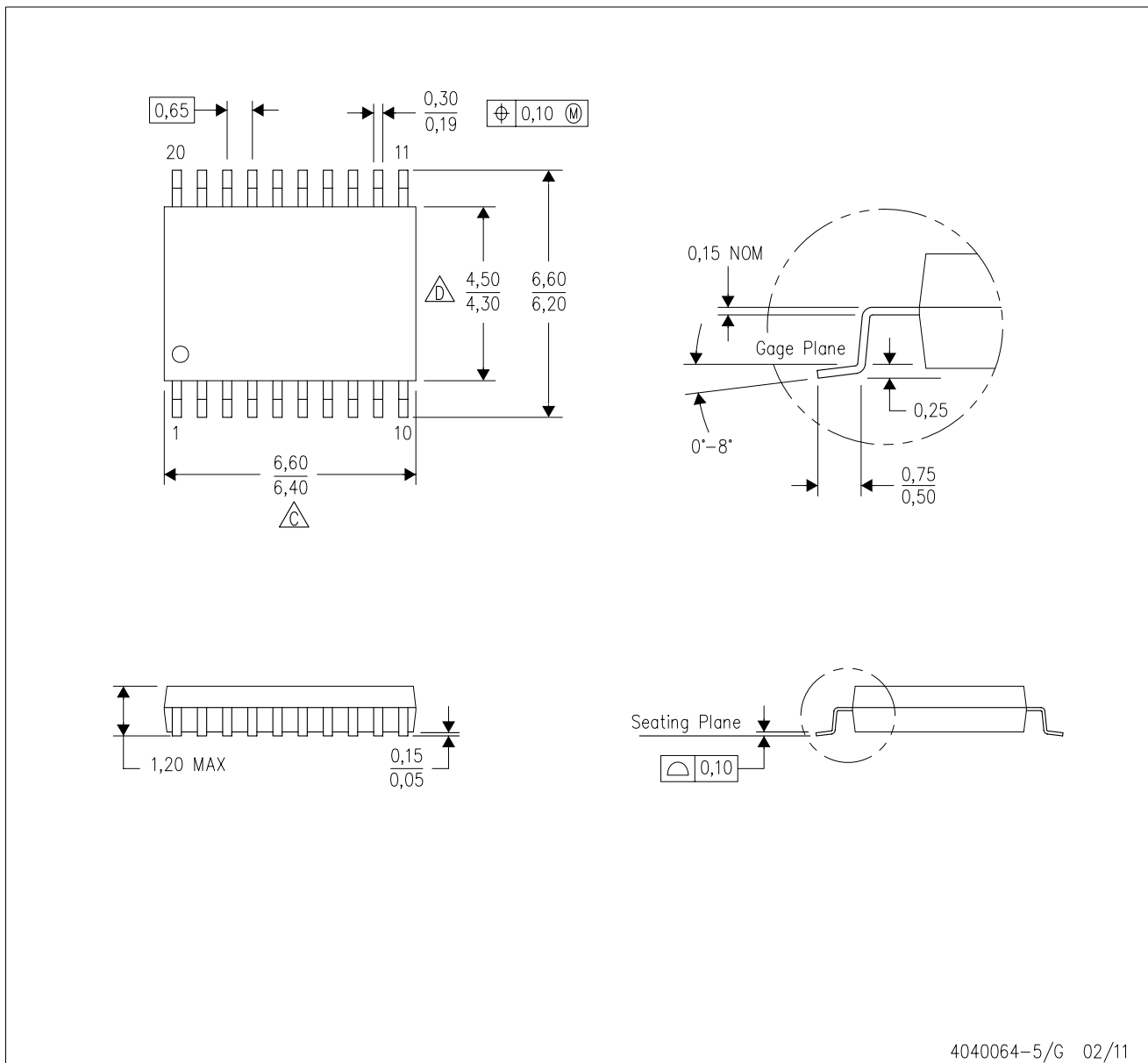4222996/A   12/2016

NOTES: (continued)

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

PW (R−PDSO−G20)                                    PLASTIC SMALL OUTLINE

0,65

0,30
0,19

⊕ | 0,10 (M)

20                    11

4,50
4,30

6,60
6,20

△D

1                    10

6,60
6,40

△C

0,15 NOM

Gage Plane

0°–8°

0,25

0,75
0,50

1,20 MAX

0,15
0,05

Seating Plane

◠ | 0,10

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.
          △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.
          △D.  Body width does not include interlead flash.  Interlead flash shall not exceed 0,25 each side.
          E.   Falls within JEDEC MO–153

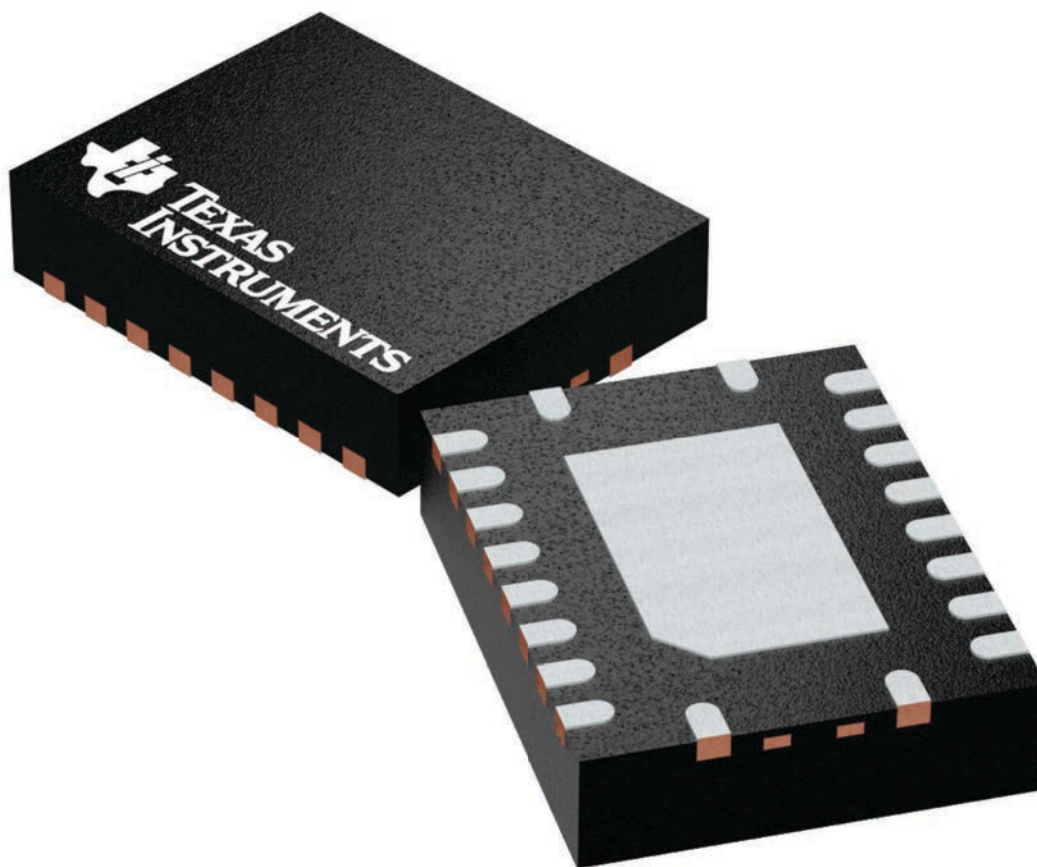This image is a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.



4225264/A