

## TXS0108E-Q1 8-Bit Bi-directional, Level-Shifting, Voltage Translator for Open-Drain and Push-Pull Applications

### 1 Features

- AEC-Q100 Qualified for Automotive Applications
  - Device Temperature Grade 1:  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$
  - Device HBM ESD Classification Level 2
  - Device CDM ESD Classification Level C6
- 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 ( $V_{\text{CCA}} \leq V_{\text{CCB}}$ )
- No Power-Supply Sequencing Required – Either  $V_{\text{CCA}}$  or  $V_{\text{CCB}}$  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)
  - 1000 V Charged-Device Model (C101)
- IEC 61000-4-2 ESD (B Port)
  - $\pm 8$  kV Contact Discharge
  - $\pm 6$  kV Air-Gap Discharge

### 2 Applications

- Automotive

### 3 Description

This 8-bit non-inverting translator uses two separate configurable power-supply rails. The A port tracks the  $V_{\text{CCA}}$  pin supply voltage. The  $V_{\text{CCA}}$  pin accepts any supply voltage between 1.4 V and 3.6 V. The B port tracks the  $V_{\text{CCB}}$  pin supply voltage. The  $V_{\text{CCB}}$  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.

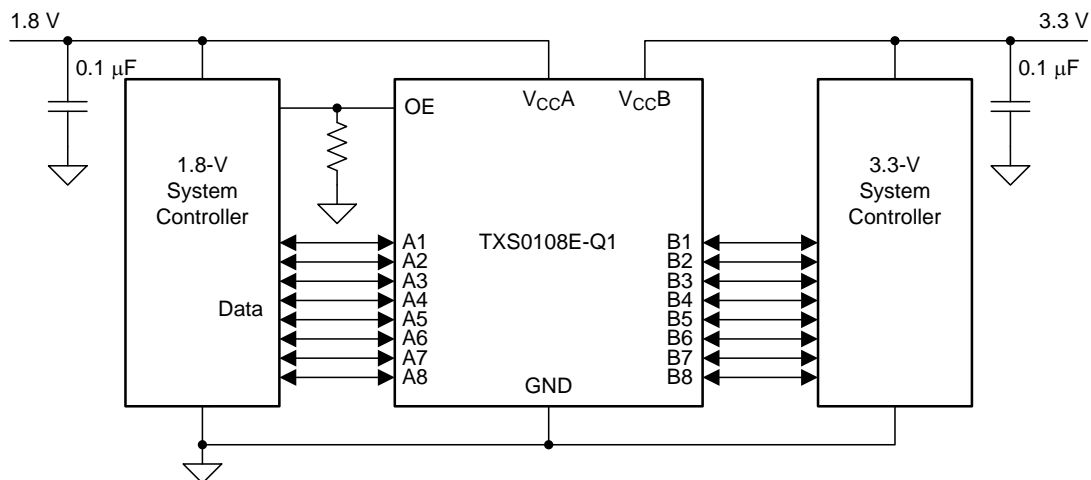
To ensure the Hi-Z state during power-up or power-down periods, tie OE to GND through a pull-down resistor.

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

| PART NUMBER | PACKAGE    | BODY SIZE (NOM)   |
|-------------|------------|-------------------|
| TXS0108E-Q1 | TSSOP (20) | 6.50 mm x 6.40 mm |

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

#### Simplified Application



## Table of Contents

|   |           |  |           |
|---|-----------|--|-----------|
| <b>1 Features</b> .....   | <b>1</b>  | 7.1 Load Circuits .....  | <b>13</b> |
| <b>2 Applications</b> .....   | <b>1</b>  | 7.2 Voltage Waveforms .....                                      | <b>14</b> |
| <b>3 Description</b> .....  | <b>1</b>  | <b>8 Detailed Description</b> .....                              | <b>15</b> |
| <b>4 Revision History</b> .....   | <b>2</b>  | 8.1 Overview .....   | <b>15</b> |
| <b>5 Pin Configuration and Functions</b> .....                                  | <b>3</b>  | 8.2 Functional Block Diagram .....                               | <b>15</b> |
| <b>6 Specifications</b> .....   | <b>4</b>  | 8.3 Feature Description .....                                    | <b>15</b> |
| 6.1 Absolute Maximum Ratings .....  | <b>4</b>  | 8.4 Device Functional Modes .....                                | <b>17</b> |
| 6.2 ESD Ratings .....   | <b>4</b>  | <b>9 Application and Implementation</b> .....                    | <b>18</b> |
| 6.3 Recommended Operating Conditions .....                                      | <b>5</b>  | 9.1 Application Information .....                                | <b>18</b> |
| 6.4 Thermal Information .....   | <b>5</b>  | 9.2 Typical Application .....                                    | <b>18</b> |
| 6.5 Electrical Characteristics .....  | <b>6</b>  | <b>10 Power Supply Recommendations</b> .....                     | <b>20</b> |
| 6.6 Timing Requirements: $V_{CCA} = 1.5\text{ V} \pm 0.1\text{ V}$ .....        | <b>6</b>  | <b>11 Layout</b> .....   | <b>20</b> |
| 6.7 Timing Requirements: $V_{CCA} = 1.8\text{ V} \pm 0.15\text{ V}$ .....       | <b>7</b>  | 11.1 Layout Guidelines .....                                     | <b>20</b> |
| 6.8 Timing Requirements: $V_{CCA} = 2.5\text{ V} \pm 0.2\text{ V}$ .....        | <b>7</b>  | 11.2 Layout Example .....  | <b>20</b> |
| 6.9 Timing Requirements: $V_{CCA} = 3.3\text{ V} \pm 0.3\text{ V}$ .....        | <b>7</b>  | <b>12 Device and Documentation Support</b> .....                 | <b>21</b> |
| 6.10 Switching Characteristics: $V_{CCA} = 1.5\text{ V} \pm 0.1\text{ V}$ ..... | <b>8</b>  | 12.1 Community Resources .....                                   | <b>21</b> |
| 6.11 Switching Characteristics: $V_{CCA} = 1.8\text{ V} \pm 0.15\text{ V}$ ..   | <b>9</b>  | 12.2 Trademarks .....  | <b>21</b> |
| 6.12 Switching Characteristics: $V_{CCA} = 2.5\text{ V} \pm 0.2\text{ V}$ ..    | <b>10</b> | 12.3 Electrostatic Discharge Caution .....                       | <b>21</b> |
| 6.13 Switching Characteristics: $V_{CCA} = 3.3\text{ V} \pm 0.3\text{ V}$ ..    | <b>11</b> | 12.4 Glossary .....  | <b>21</b> |
| 6.14 Typical Characteristics .....  | <b>12</b> | <b>13 Mechanical, Packaging, and Orderable Information</b> ..... | <b>21</b> |
| <b>7 Parameter Measurement Information</b> .....                                | <b>13</b> |  |           |

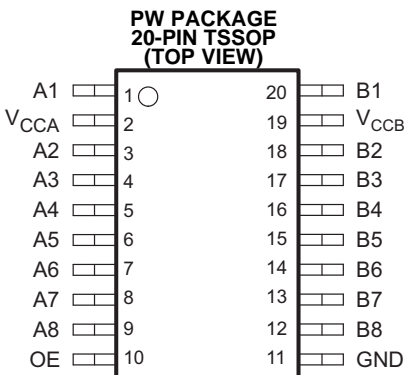
## 4 Revision History

### Changes from Original (June 2015) to Revision A

**Page**

|                                       |          |
|---------------------------------------|----------|
| • Made changes to Pin Functions ..... | <b>1</b> |
|---------------------------------------|----------|

## 5 Pin Configuration and Functions



### Pin Functions

| PIN       |     | TYPE <sup>(1)</sup> | DESCRIPTION   |
|-----------|-----|---------------------|---|
| NAME      | NO. |                     |   |
| A1        | 1   | I/O                 | Input/output 1. Referenced to $V_{CCA}$   |
| A2        | 3   | I/O                 | Input/output 2. Referenced to $V_{CCA}$   |
| A3        | 4   | I/O                 | Input/output 3. Referenced to $V_{CCA}$   |
| A4        | 5   | I/O                 | Input/output 4. Referenced to $V_{CCA}$   |
| A5        | 6   | I/O                 | Input/output 5. Referenced to $V_{CCA}$   |
| A6        | 7   | I/O                 | Input/output 6. Referenced to $V_{CCA}$   |
| A7        | 8   | I/O                 | Input/output 7. Referenced to $V_{CCA}$   |
| A8        | 9   | I/O                 | Input/output 8. Referenced to $V_{CCA}$   |
| B1        | 20  | I/O                 | Input/output 1. Referenced to $V_{CCB}$   |
| B2        | 18  | I/O                 | Input/output 2. Referenced to $V_{CCB}$   |
| B3        | 17  | I/O                 | Input/output 3. Referenced to $V_{CCB}$   |
| B4        | 16  | I/O                 | Input/output 4. Referenced to $V_{CCB}$   |
| B5        | 15  | I/O                 | Input/output 5. Referenced to $V_{CCB}$   |
| B6        | 14  | I/O                 | Input/output 6. Referenced to $V_{CCB}$   |
| B7        | 13  | I/O                 | Input/output 7. Referenced to $V_{CCB}$   |
| B8        | 12  | I/O                 | Input/output 8. Referenced to $V_{CCB}$   |
| GND       | 11  | G                   | Ground  |
| OE        | 10  | I                   | 3-state output-mode enable. Pull OE low to place all outputs in 3-state mode. Referenced to $V_{CCA}$ . |
| $V_{CCA}$ | 2   | I                   | A-port supply voltage. $1.5\text{ V} \leq V_{CCA} \leq 3.6\text{ V}$ , $V_{CCA} \leq V_{CCB}$ .         |
| $V_{CCB}$ | 19  | I                   | B-port supply voltage. $1.65\text{ V} \leq V_{CCB} \leq 5.5\text{ V}$ .                                 |

(1) I = Input, O = Output, I/O = Bi-directional, G = Ground

## 6 Specifications

### 6.1 Absolute Maximum Ratings<sup>(1)</sup>

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

|                  |   |                    | MIN  | MAX                    | UNIT |
|------------------|---|--------------------|------|------------------------|------|
| V <sub>CCA</sub> | Supply voltage  |                    | -0.5 | 4.6                    | V    |
| V <sub>CCB</sub> |   |                    | -0.5 | 5.5                    | V    |
| V <sub>I</sub>   | Input voltage <sup>(2)</sup>  | A port             | -0.5 | 4.6                    | V    |
|                  |   | B port             | -0.5 | 6.5                    |      |
| V <sub>O</sub>   | Voltage range applied to any output in the high-impedance or power-off state <sup>(2)</sup> | A port             | -0.5 | 4.6                    | V    |
|                  |   | B port             | -0.5 | 6.5                    |      |
| V <sub>O</sub>   | Voltage range applied to any output in the high or low state <sup>(2) (3)</sup>             | A port             | -0.5 | V <sub>CCA</sub> + 0.5 | V    |
|                  |   | B port             | -0.5 | V <sub>CCB</sub> + 0.5 |      |
| 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  | 50                     | mA   |
|                  | Continuous current through V <sub>CCA</sub> , V <sub>CCB</sub> , or GND                     |                    | -100 | 100                    | mA   |
| T <sub>stg</sub> | Storage temperature   |                    | -65  | 150                    | °C   |

- (1) Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, 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<sub>CCA</sub> and V<sub>CCB</sub> are provided in the recommended operating conditions table.

### 6.2 ESD Ratings

|                    |                         |   | VALUE | UNIT |
|--------------------|-------------------------|---|-------|------|
| V <sub>(ESD)</sub> | Electrostatic discharge | Human-body model (HBM), per AEC Q100-002 <sup>(1)</sup> | ±2000 | V    |
|                    |                         | Charged-device model (CDM), per AEC Q100-011            | ±1000 |      |

- (1) AEC Q100-002 indicates that HBM stressing shall be in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

### 6.3 Recommended Operating Conditions

 over operating free-air temperature range (unless otherwise noted)<sup>(1)(2)</sup>

|                  |                                    |                       | V <sub>CCA</sub> (V) | V <sub>CCB</sub> (V) | MIN                     | MAX              | UNIT                    |      |
|------------------|------------------------------------|-----------------------|----------------------|----------------------|-------------------------|------------------|-------------------------|------|
| V <sub>CCA</sub> | Supply voltage <sup>(3)</sup>      |                       |                      |                      | 1.4                     | 3.6              | V                       |      |
| V <sub>CCB</sub> |                                    |                       |                      |                      | 1.65                    | 5.5              |                         |      |
| V <sub>IH</sub>  | High-level input voltage           | A-Port I/Os           | 1.4 to 1.95          | 1.65 to 5.5          | V <sub>CCI</sub> – 0.2  | V <sub>CCI</sub> | V                       |      |
|                  |                                    |                       | 1.95 to 3.6          |                      | V <sub>CCI</sub> – 0.4  | V <sub>CCI</sub> |                         |      |
|                  |                                    | B-Port I/Os           | 1.4 to 3.6           |                      | V <sub>CCI</sub> – 0.4  | V <sub>CCI</sub> |                         |      |
|                  |                                    |                       |                      |                      | V <sub>CCA</sub> × 0.65 | 5.5              |                         |      |
| V <sub>IL</sub>  | Low-level input voltage            | A-Port I/Os           | 1.4 to 1.95          |                      | 1.65 to 5.5             | 0                | 0.15                    | V    |
|                  |                                    |                       | 1.95 to 3.6          |                      |                         | 0                | 0.15                    |      |
|                  |                                    | B-Port I/Os           | 1.4 to 3.6           |                      |                         | 0                | 0.15                    |      |
|                  |                                    |                       |                      |                      |                         | 0                | V <sub>CCA</sub> × 0.35 |      |
| Δt/Δv            | Input transition rise or fall rate | A-Port I/Os Push-pull | 1.4 to 3.6           |                      |                         |                  | 10                      | ns/V |
|                  |                                    | B-Port I/Os Push-pull |                      |                      |                         |                  |                         |      |
|                  |                                    | Control input         |                      |                      |                         |                  |                         |      |
| T <sub>A</sub>   | Operating free-air temperature     |                       |                      |                      |                         | –40              | 125                     | °C   |

- (1) V<sub>CCI</sub> is the V<sub>CC</sub> associated with the data input port.  
 (2) V<sub>CCO</sub> is the V<sub>CC</sub> associated with the output port.  
 (3) V<sub>CCA</sub> must be less than or equal to V<sub>CCB</sub>, and V<sub>CCA</sub> must not exceed 3.6 V.

### 6.4 Thermal Information

| THERMAL METRIC <sup>(1)</sup> |  | TXS0108E-Q1 | UNIT |
|-------------------------------|--|-------------|------|
|                               |  | PW (TSSOP)  |      |
|                               |  | 20 PINS     |      |
| R <sub>θJA</sub>              | Junction-to-ambient thermal resistance       | 101.5       | °C/W |
| R <sub>θJC(top)</sub>         | Junction-to-case (top) thermal resistance    | 35.9        |      |
| R <sub>θJB</sub>              | Junction-to-board thermal resistance         | 52.4        |      |
| ψ <sub>JT</sub>               | Junction-to-top characterization parameter   | 2.3         |      |
| ψ <sub>JB</sub>               | Junction-to-board characterization parameter | 51.9        |      |
| R <sub>θJC(bot)</sub>         | Junction-to-case (bottom) thermal resistance | —           |      |

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

## 6.5 Electrical Characteristics<sup>(1)(2)(3)</sup>

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

| PARAMETER                           | TEST CONDITIONS   | V <sub>CCA</sub> (V)                     | V <sub>CCB</sub> (V) | T <sub>A</sub> = 25°C |     |     | T <sub>A</sub> = -40°C to 125°C |     | UNIT |    |    |
|-------------------------------------|---|--|----------------------|-----------------------|-----|-----|---------------------------------|-----|------|----|----|
|                                     |   |  |                      | MIN                   | TYP | MAX | MIN                             | MAX |      |    |    |
| V <sub>OHA</sub>                    | I <sub>OH</sub> = -20 μA,<br>V <sub>IB</sub> ≥ V <sub>CCB</sub> - 0.4 V | 1.4 to 3.6                               | 1.65 to 5.5          |                       |     |     | V <sub>CCA</sub> × 0.67         |     | V    |    |    |
| V <sub>OLA</sub>                    | I <sub>OL</sub> = 180 μA, V <sub>IB</sub> ≤ 0.15 V                      | 1.4                                      | 1.65 to 5.5          |                       |     |     | 0.4                             |     | V    |    |    |
|                                     | I <sub>OL</sub> = 220 μA, V <sub>IB</sub> ≤ 0.15 V                      | 1.65                                     |                      | 0.4                   |     |     |                                 |     |      |    |    |
|                                     | I <sub>OL</sub> = 300 μA, V <sub>IB</sub> ≤ 0.15 V                      | 2.3                                      |                      | 0.4                   |     |     |                                 |     |      |    |    |
|                                     | I <sub>OL</sub> = 400 μA, V <sub>IB</sub> ≤ 0.15 V                      | 3  |                      | 0.55                  |     |     |                                 |     |      |    |    |
| V <sub>OHB</sub>                    | I <sub>OH</sub> = -20 μA,<br>V <sub>IA</sub> ≥ V <sub>CCA</sub> - 0.2 V | 1.4 to 3.6                               | 1.65 to 5.5          |                       |     |     | V <sub>CCB</sub> × 0.67         |     | V    |    |    |
| V <sub>OLB</sub>                    | I <sub>OL</sub> = 220 μA, V <sub>IA</sub> ≤ 0.15 V                      | 1.4 to 3.6                               | 1.65                 |                       |     |     | 0.4                             |     | V    |    |    |
|                                     | I <sub>OL</sub> = 300 μA, V <sub>IA</sub> ≤ 0.15 V                      |  | 2.3                  | 0.4                   |     |     |                                 |     |      |    |    |
|                                     | I <sub>OL</sub> = 400 μA, V <sub>IA</sub> ≤ 0.15 V                      |  | 3                    | 0.55                  |     |     |                                 |     |      |    |    |
|                                     | I <sub>OL</sub> = 620 μA, V <sub>IA</sub> ≤ 0.15 V                      |  | 4.5                  | 0.55                  |     |     |                                 |     |      |    |    |
| I <sub>I</sub>                      | OE  | V <sub>I</sub> = V <sub>CCI</sub> or GND | 1.4                  | 1.65 to 5.5           | -1  |     |                                 | 1   | 2    | μA |    |
| I <sub>OZ</sub>                     | A or B port   |  | 1.4                  | 1.65 to 5.5           | -1  |     |                                 | 1   | -2   | 2  | μA |
| I <sub>CCA</sub>                    | V <sub>I</sub> = V <sub>O</sub> = Open, I <sub>O</sub> = 0              | 1.4 to 3.6                               | 2.3 to 5.5           |                       |     |     | 2                               |     | μA   |    |    |
|                                     |   | 3.6                                      | 0                    | 2                     |     |     |                                 |     |      |    |    |
|                                     |   | 0  | 5.5                  | -1                    |     |     |                                 |     |      |    |    |
| I <sub>CCB</sub>                    | V <sub>I</sub> = V <sub>O</sub> = Open, I <sub>O</sub> = 0              | 1.4 to 3.6                               | 2.3 to 5.5           |                       |     |     | 6                               |     | μA   |    |    |
|                                     |   | 3.6                                      | 0                    | -1                    |     |     |                                 |     |      |    |    |
|                                     |   | 0  | 5.5                  | 1.5                   |     |     |                                 |     |      |    |    |
| I <sub>CCA</sub> + I <sub>CCB</sub> | V <sub>I</sub> = V <sub>CCI</sub> or GND,<br>I <sub>O</sub> = 0         | 1.4 to 3.6                               | 2.3 to 5.5           |                       |     |     | 8                               |     | μA   |    |    |
| I <sub>CCZA</sub>                   | V <sub>I</sub> = V <sub>O</sub> = Open,<br>I <sub>O</sub> = 0, OE = GND | 1.4 to 3.6                               | 1.65 to 5.5          |                       |     |     | 2                               |     | μA   |    |    |
| I <sub>CCZB</sub>                   | V <sub>I</sub> = V <sub>O</sub> = Open,<br>I <sub>O</sub> = 0, OE = GND | 1.4 to 3.6                               | 1.65 to 5.5          |                       |     |     | 6                               |     | μA   |    |    |
| C <sub>i</sub>                      | OE  |  | 3.3                  | 3.3                   |     | 4.5 |                                 |     | 6.75 | pF |    |
| C <sub>io</sub>                     | A port  |  | 3.3                  | 3.3                   |     | 6   |                                 |     | 7.6  | pF |    |
|                                     | B port  |  |                      |                       |     | 5.5 |                                 |     | 6.9  |    |    |

- (1) V<sub>CCO</sub> is the V<sub>CC</sub> associated with the output port.
- (2) V<sub>CCI</sub> is the V<sub>CC</sub> associated with the input port.
- (3) V<sub>CCA</sub> must be less than or equal to V<sub>CCB</sub>, and V<sub>CCA</sub> must not exceed 3.6 V.

## 6.6 Timing Requirements: V<sub>CCA</sub> = 1.5 V ± 0.1 V

 over recommended operating free-air temperature range, V<sub>CCA</sub> = 1.5 V ± 0.1 V (unless otherwise noted)

|                |            | V <sub>CC B</sub> = 1.8 V ± 0.15 V |     | V <sub>CC B</sub> = 2.5 V ± 0.2 V |     | V <sub>CC B</sub> = 3.3 V ± 0.3 V |     | V <sub>CC B</sub> = 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 | 0.8                                |     | 0.8                               |     | 1                                 |     | 1                               |     |      |
| t <sub>w</sub> | Push-pull  | 25                                 |     | 16.7                              |     | 16.7                              |     | 16.7                            |     | ns   |
|                | Open-drain | 1250                               |     | 1250                              |     | 1000                              |     | 1000                            |     |      |

### 6.7 Timing Requirements: $V_{CCA} = 1.8\text{ V} \pm 0.15\text{ V}$

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

|       |                |            | $V_{CCB} = 1.8\text{ V} \pm 0.15\text{ V}$ |     | $V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$ |     | $V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$ |     | $V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$ |     | UNIT |
|-------|----------------|------------|--|-----|---|-----|---|-----|---|-----|------|
|       |                |            | MIN  | MAX | MIN                                       | MAX | MIN                                       | MAX | MIN                                     | MAX |      |
|       | Data rate      | Push-pull  | 45   |     | 65  |     | 70  |     | 70                                      |     | Mbps |
|       |                | Open-drain | 0.8  |     | 0.8                                       |     | 0.8                                       |     | 1                                       |     |      |
| $t_w$ | Pulse duration | Push-pull  | 22.2                                       |     | 15.3                                      |     | 15.3                                      |     | 15.3                                    |     | ns   |
|       |                | Open-drain | 1250                                       |     | 1250                                      |     | 1250                                      |     | 1000                                    |     |      |

### 6.8 Timing Requirements: $V_{CCA} = 2.5\text{ V} \pm 0.2\text{ V}$

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

|       |                |            | $V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$ |     | $V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$ |     | $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$ |     | UNIT |
|-------|----------------|------------|---|-----|---|-----|--|-----|------|
|       |                |            | MIN                                       | MAX | MIN                                       | MAX | MIN                                    | MAX |      |
|       | Data rate      | Push-pull  | 80  |     | 95  |     | 100                                    |     | Mbps |
|       |                | Open-drain | 0.8                                       |     | 0.8                                       |     | 1                                      |     |      |
| $t_w$ | Pulse duration | Push-pull  | 12.5                                      |     | 10.5                                      |     | 10                                     |     | ns   |
|       |                | Open-drain | 1250                                      |     | 1250                                      |     | 1000                                   |     |      |

### 6.9 Timing Requirements: $V_{CCA} = 3.3\text{ V} \pm 0.3\text{ V}$

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

|       |                |            | $V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$ |     | $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$ |     | UNIT |
|-------|----------------|------------|---|-----|--|-----|------|
|       |                |            | MIN                                       | MAX | MIN                                    | MAX |      |
|       | Data rate      | Push-pull  | 100                                       |     | 110                                    |     | Mbps |
|       |                | Open-drain | 0.8                                       |     | 1.2                                    |     |      |
| $t_w$ | Pulse duration | Push-pull  | 10  |     | 9.1                                    |     | ns   |
|       |                | Open-drain | 1250                                      |     | 833                                    |     |      |

**6.10 Switching Characteristics:  $V_{CCA} = 1.5\text{ V} \pm 0.1\text{ V}$** 

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

| PARAMETER   | FROM (INPUT)            | TO (OUTPUT) | TEST CONDITION (DRIVING) | $V_{CCB} = 1.8\text{ V} \pm 0.15\text{ V}$ |      | $V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$ |      | $V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$ |      | $V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$ |      | UNIT |
|-------------|-------------------------|-------------|--------------------------|--|------|---|------|---|------|---|------|------|
|             |                         |             |                          | MIN  | MAX  | MIN                                       | MAX  | MIN                                       | MAX  | MIN                                     | MAX  |      |
| $t_{PHL}$   | A                       | B           | Push-pull                | 11   |      | 9.2                                       |      | 8.6                                       |      | 8.6                                     |      | ns   |
|             |                         |             | Open-drain               | 2.5  | 14.4 | 2   | 12.8 | 2   | 12.2 | 1.9                                     | 12   |      |
| $t_{PLH}$   |                         |             | Push-pull                | 12   |      | 10  |      | 9.8                                       |      | 9.7                                     |      |      |
|             |                         |             | Open-drain               | 0.9  | 720  | 0.9                                       | 554  | 1   | 473  | 1.5                                     | 384  |      |
| $t_{PHL}$   | B                       | A           | Push-pull                | 12.7                                       |      | 11.1                                      |      | 11  |      | 12                                      |      | ns   |
|             |                         |             | Open-drain               | 3.4  | 13.2 | 2.6                                       | 9.6  | 2.3                                       | 8.5  | 2                                       | 7.5  |      |
| $t_{PLH}$   |                         |             | Push-pull                | 9.5  |      | 6.2                                       |      | 5.1                                       |      | 4.2                                     |      |      |
|             |                         |             | Open-drain               | 745  |      | 603                                       |      | 519                                       |      | 407                                     |      |      |
| $t_{en}$    | OE                      | A or B      | Push-pull                | 480  |      | 480                                       |      | 480                                       |      | 480                                     |      | ns   |
| $t_{dis}$   | OE                      | A or B      |                          | 400  |      | 400                                       |      | 400                                       |      | 400                                     |      | ns   |
| $t_{rA}$    | A-port rise time        |             | Push-pull                | 3  | 13.1 | 2.4                                       | 9.8  | 2   | 9    | 2                                       | 8.9  | ns   |
|             |                         |             | Open-drain               | 220  | 982  | 180                                       | 716  | 140                                       | 592  | 100                                     | 481  |      |
| $t_{rB}$    | B-port rise time        |             | Push-pull                | 2.6  | 11.4 | 1.6                                       | 7.4  | 1   | 6    | 0.7                                     | 5    | ns   |
|             |                         |             | Open-drain               | 220  | 1020 | 150                                       | 756  | 100                                       | 653  | 40                                      | 370  |      |
| $t_{fA}$    | A-port fall time        |             | Push-pull                | 2.3  | 9.9  | 1.7                                       | 7.7  | 1.6                                       | 6.8  | 1.7                                     | 6    | ns   |
|             |                         |             | Open-drain               | 2.4  | 10   | 1.8                                       | 8.2  | 1.7                                       | 9    | 1.5                                     | 9.15 |      |
| $t_{fB}$    | B-port fall time        |             | Push-pull                | 2  | 8.7  | 1.3                                       | 5.5  | 1   | 3.8  | 1                                       | 3.1  | ns   |
|             |                         |             | Open-drain               | 2  | 11.5 | 1.3                                       | 8.6  | 1   | 9.6  | 1                                       | 7.7  |      |
| $t_{SK(O)}$ | Channel-to-channel skew |             | Push-pull                | 1  |      | 1   |      | 1   |      | 1                                       |      | ns   |



## 6.11 Switching Characteristics: $V_{CCA} = 1.8 \text{ V} \pm 0.15 \text{ V}$

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

| PARAMETER   | FROM (INPUT)            | TO (OUTPUT) | TEST CONDITION (DRIVING) | $V_{CCB} = 1.8 \text{ V} \pm 0.15 \text{ V}$ |      | $V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$ |      | $V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$ |     | $V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$ |      | UNIT |
|-------------|-------------------------|-------------|--------------------------|--|------|---|------|---|-----|---|------|------|
|             |                         |             |                          | MIN  | MAX  | MIN   | MAX  | MIN   | MAX | MIN                                       | MAX  |      |
| $t_{PHL}$   | A                       | B           | Push-pull                |  | 8.2  |   | 6.4  |   | 5.7 |   | 5.6  | ns   |
|             |                         |             | Open-drain               | 2.1  | 11.4 | 1.7   | 9.9  | 1.6   | 9.3 | 1.5                                       | 8.9  |      |
| $t_{PLH}$   |                         |             | Push-pull                |  | 9    |   | 5.6  |   | 6.5 |   | 6.3  |      |
|             |                         |             | Open-drain               | 0.15   | 729  | 0.2   | 584  | 0.3   | 466 | 0.3                                       | 346  |      |
| $t_{PHL}$   | B                       | A           | Push-pull                |  | 9.8  |   | 8    |   | 7.4 |   | 7    | ns   |
|             |                         |             | Open-drain               | 3.19   | 12.1 | 2   | 8.5  | 1.9   | 7.3 | 1.8                                       | 6.2  |      |
| $t_{PLH}$   |                         |             | Push-pull                |  | 10.2 |   | 7    |   | 5.8 |   | 5    |      |
|             |                         |             | Open-drain               |  | 733  |   | 578  |   | 459 |   | 323  |      |
| $t_{en}$    | OE                      | A or B      | Push-pull                |  | 100  |   | 100  |   | 100 |   | 100  | ns   |
| $t_{dis}$   | OE                      | A or B      |                          |  | 410  |   | 410  |   | 410 |   | 410  | ns   |
| $t_{rA}$    | A-port rise time        |             | Push-pull                | 2.7  | 11.9 | 2   | 8.6  | 1.9   | 7.8 | 1.8                                       | 7.4  | ns   |
|             |                         |             | Open-drain               | 250  | 996  | 200   | 691  | 150   | 508 | 110                                       | 365  |      |
| $t_{rB}$    | B-port rise time        |             | Push-pull                | 2.5  | 10.5 | 1.7   | 7.4  | 1.1   | 5.3 | 60  | 4.7  | ns   |
|             |                         |             | Open-drain               | 250  | 1001 | 170   | 677  | 120   | 546 | 32  | 323  |      |
| $t_{fA}$    | A-port fall time        |             | Push-pull                | 2.1  | 8.8  | 1.6   | 7.1  | 1.4   | 6.8 | 1.4                                       | 6.06 | ns   |
|             |                         |             | Open-drain               | 2.2  | 9    | 1.7   | 7.2  | 1.4   | 6.8 | 1.2                                       | 6.1  |      |
| $t_{fB}$    | B-port fall time        |             | Push-pull                | 2  | 8.3  | 1.3   | 5.4  | 0.9   | 3.9 | 0.7                                       | 3    |      |
|             |                         |             | Open-drain               | 2  | 10.5 | 1   | 10.7 | 1   | 9.6 | 0.6                                       | 7.8  |      |
| $t_{SK(O)}$ | Channel-to-channel skew |             | Push-pull                |  | 1    |   | 1    |   | 1   |   | 1    | ns   |

**6.12 Switching Characteristics:  $V_{CCA} = 2.5\text{ V} \pm 0.2\text{ V}$** 

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

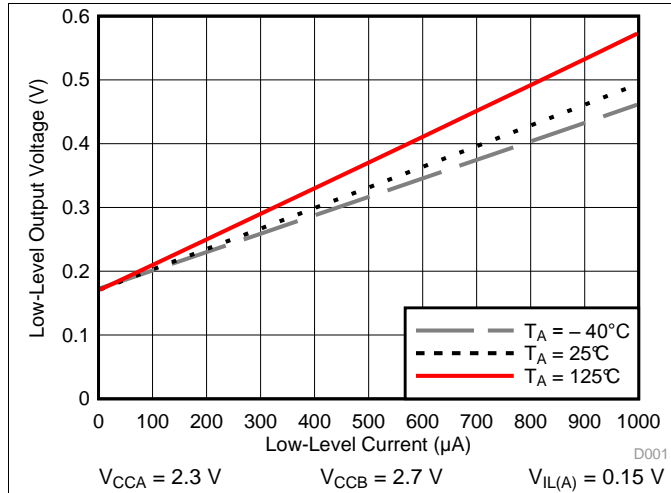
| PARA-METER  | FROM (INPUT)            | TO (OUTPUT) | TEST CONDITION (DRIVING) | $V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$ |      | $V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$ |      | $V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$ |      | UNIT |
|-------------|-------------------------|-------------|--------------------------|---|------|---|------|---|------|------|
|             |                         |             |                          | MIN                                       | MAX  | MIN                                       | MAX  | MIN                                     | MAX  |      |
| $t_{PHL}$   | A                       | B           | Push-pull                | 5   |      | 4   |      | 3.7                                     |      | ns   |
|             |                         |             | Open-drain               | 6.2                                       |      | 6.3                                       |      | 5.8                                     |      |      |
| $t_{PLH}$   |                         |             | Push-pull                | 5.2                                       |      | 4.3                                       |      | 3.9                                     |      |      |
|             |                         |             | Open-drain               | 5   |      | 17.5                                      |      | 15.5                                    |      |      |
| $t_{PHL}$   | B                       | A           | Push-pull                | 5.4                                       |      | 4.7                                       |      | 4.2                                     |      | ns   |
|             |                         |             | Open-drain               | 7.3                                       |      | 6   |      | 4.9                                     |      |      |
| $t_{PLH}$   |                         |             | Push-pull                | 5.9                                       |      | 4.4                                       |      | 3.5                                     |      |      |
|             |                         |             | Open-drain               | 5   |      | 5   |      | 5                                       |      |      |
| $t_{en}$    | OE                      | A or B      | Push-pull                | 100                                       |      | 100                                       |      | 100                                     |      | ns   |
| $t_{dis}$   | OE                      | A or B      |                          | 400                                       |      | 400                                       |      | 400                                     |      | ns   |
| $t_{rA}$    | A-port rise time        |             | Push-pull                | 1.89                                      | 7.3  | 1.6                                       | 6.4  | 1.5                                     | 5.8  | ns   |
|             |                         |             | Open-drain               | 110.00                                    | 692  | 157                                       | 529  | 116                                     | 377  |      |
| $t_{rB}$    | B-port rise time        |             | Push-pull                | 1.70                                      | 6.5  | 1.3                                       | 5.1  | 0.9                                     | 4.32 | ns   |
|             |                         |             | Open-drain               | 107.00                                    | 693  | 140                                       | 483  | 77                                      | 304  |      |
| $t_{fA}$    | A-port fall time        |             | Push-pull                | 1.50                                      | 5.7  | 1.2                                       | 4.7  | 1.3                                     | 3.8  | ns   |
|             |                         |             | Open-drain               | 1.50                                      | 5.6  | 1.2                                       | 4.7  | 1.1                                     | 4.2  |      |
| $t_{fB}$    | B-port fall time        |             | Push-pull                | 1.40                                      | 5.4  | 0.9                                       | 4.1  | 0.7                                     | 3    |      |
|             |                         |             | Open-drain               | 0.40                                      | 14.2 | 0.5                                       | 19.4 | 0.4                                     | 3    |      |
| $t_{SK(O)}$ | Channel-to-channel skew |             | Push-pull                | 1   |      | 1   |      | 1                                       |      | ns   |

**6.13 Switching Characteristics:  $V_{CCA} = 3.3\text{ V} \pm 0.3\text{ V}$** 

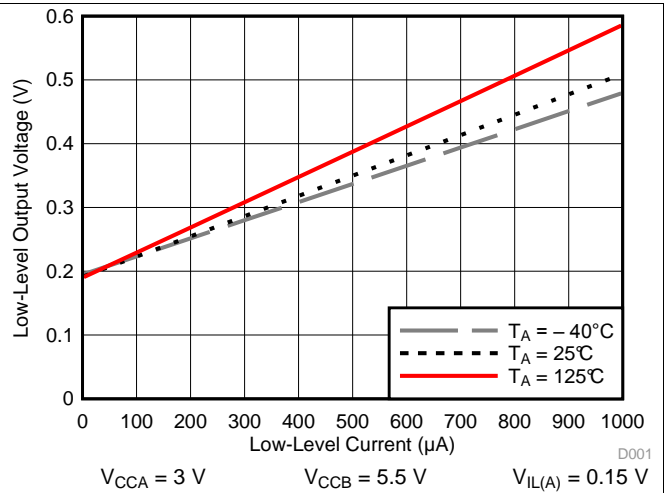
 over recommended operating free-air temperature range,  $V_{CCA} = 3.3\text{ V} \pm 0.3\text{ V}$  (unless otherwise noted)

| PARAMETER   | FROM (INPUT)            | TO (OUTPUT) | TEST CONDITION (DRIVING) | $V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$ |      | $V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$ |      | UNIT |
|-------------|-------------------------|-------------|--------------------------|---|------|---|------|------|
|             |                         |             |                          | MIN                                       | MAX  | MIN                                     | MAX  |      |
| $t_{PHL}$   | A                       | B           | Push-pull                |   | 3.8  |   | 3.28 | ns   |
|             |                         |             | Open-drain               |   | 5.3  |   | 4.8  |      |
| $t_{PLH}$   |                         |             | Push-pull                |   | 3.9  |   | 3.5  |      |
|             |                         |             | Open-drain               |   | 5    |   | 12.5 |      |
| $t_{PHL}$   | B                       | A           | Push-pull                |   | 4.2  |   | 3.8  | ns   |
|             |                         |             | Open-drain               |   | 5.5  |   | 4.5  |      |
| $t_{PLH}$   |                         |             | Push-pull                |   | 4.32 |   | 4.3  |      |
|             |                         |             | Open-drain               |   | 5    |   | 5    |      |
| $t_{en}$    | OE                      | A or B      | Push-pull                |   | 100  |   | 100  | ns   |
| $t_{dis}$   | OE                      | A or B      |                          |   | 400  |   | 400  | ns   |
| $t_{rA}$    | A-port rise time        |             | Push-pull                | 1.5                                       | 5.7  | 1.4                                     | 5    | ns   |
|             |                         |             | Open-drain               | 129                                       | 446  | 99.6                                    | 337  |      |
| $t_{rB}$    | B-port rise time        |             | Push-pull                | 1.35                                      | 5    | 1                                       | 4.24 | ns   |
|             |                         |             | Open-drain               | 129                                       | 427  | 77                                      | 290  |      |
| $t_{fA}$    | A-port fall time        |             | Push-pull                | 1.4                                       | 4.5  | 1.3                                     | 3.5  | ns   |
|             |                         |             | Open-drain               | 1.4                                       | 4.4  | 1.2                                     | 3.7  |      |
| $t_{fB}$    | B-port fall time        |             | Push-pull                | 1.3                                       | 4.2  | 1.1                                     | 3.1  | ns   |
|             |                         |             | Open-drain               | 1.3                                       | 4.2  | 1.1                                     | 3.1  |      |
| $t_{SK(O)}$ | Channel-to-channel skew |             | Push-pull                |   | 1    |   | 1    | ns   |

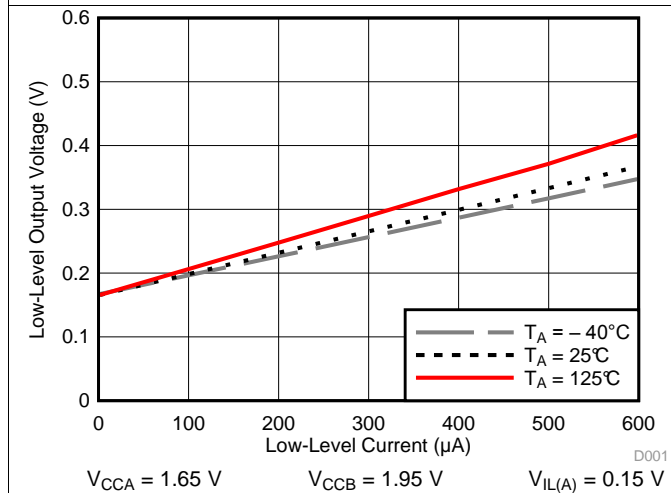
### 6.14 Typical Characteristics



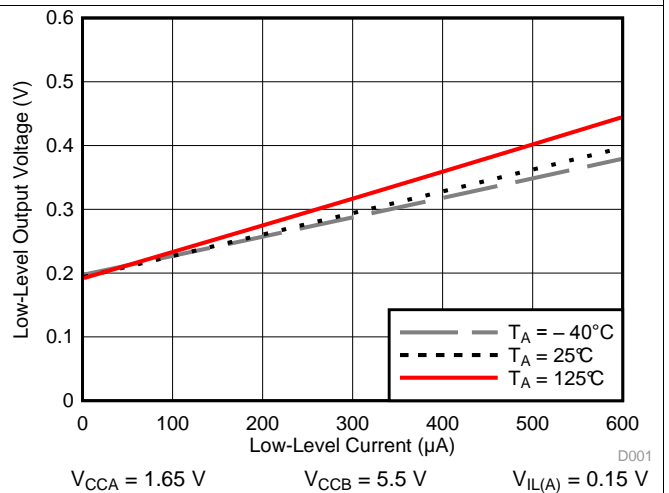
**Figure 1. Low-Level Output Voltage ( $V_{OL(Bx)}$ ) vs Low-Level Current ( $I_{OL(Bx)}$ )**



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



**Figure 3. Low-Level Output Voltage ( $V_{OL(Bx)}$ ) vs Low-Level Current ( $I_{OL(Bx)}$ )**



**Figure 4. Low-Level Output Voltage ( $V_{OL(Bx)}$ ) vs Low-Level Current ( $I_{OL(Bx)}$ )**

## 7 Parameter Measurement Information

### 7.1 Load Circuits

Figure 5 shows the push-pull driver circuit used for measuring data rate, pulse duration, propagation delay, output rise-time and fall-time. Figure 6 shows the open-drain driver circuit used for measuring data rate, pulse duration, propagation delay, output rise-time and fall-time.

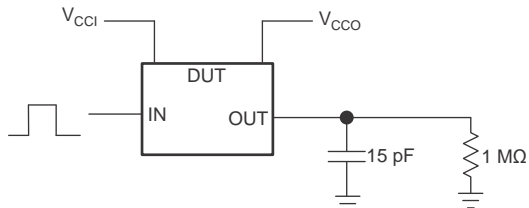


Figure 5. Data Rate, Pulse Duration, Propagation Delay, Output Rise-Time and Fall-Time Measurement Using a Push-Pull Driver

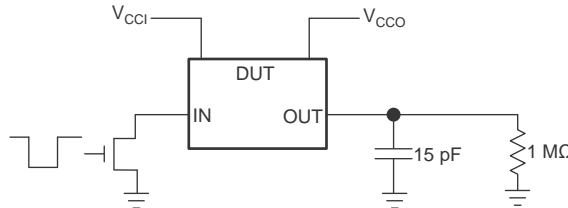
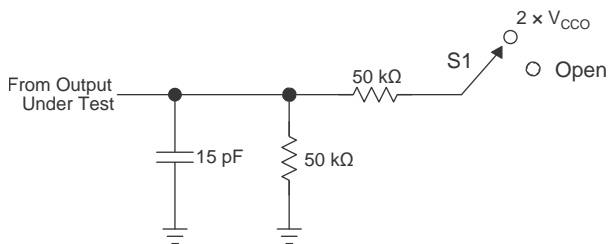


Figure 6. Data Rate (10 pF), Pulse Duration (10 pF), Propagation Delay, Output Rise-Time and Fall-Time Measurement Using an Open-Drain Driver

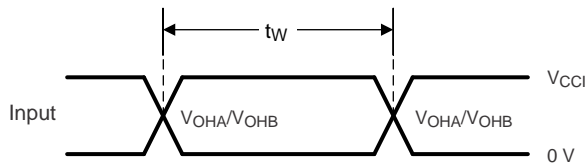


| TEST                                 | S1                 |
|--------------------------------------|--------------------|
| $t_{PZL} / t_{PLZ}$<br>( $t_{dis}$ ) | $2 \times V_{CCO}$ |
| $t_{PHZ} / t_{PZH}$<br>( $t_{en}$ )  | Open               |

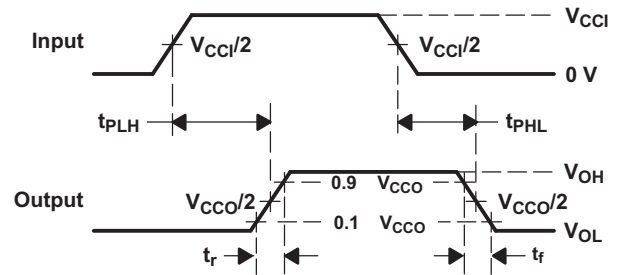
Figure 7. Load Circuit for Enable-Time and Disable-Time Measurement

1.  $t_{PLZ}$  and  $t_{PHZ}$  are the same as  $t_{dis}$ .
2.  $t_{PZL}$  and  $t_{PZH}$  are the same as  $t_{en}$ .
3.  $V_{CCI}$  is the  $V_{CC}$  associated with the input port.
4.  $V_{CCO}$  is the  $V_{CC}$  associated with the output port.

## 7.2 Voltage Waveforms

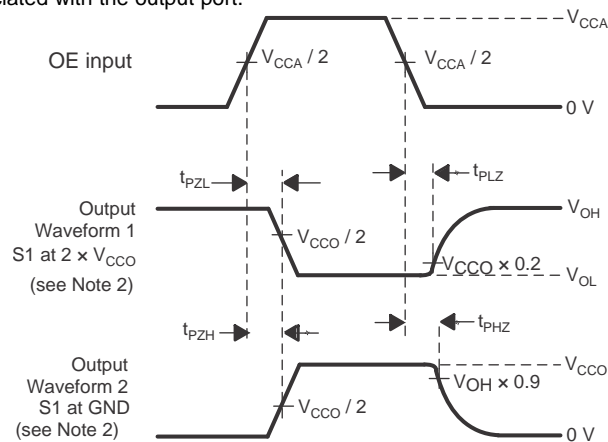


**Figure 8. Pulse Duration (Push-Pull)**



**Figure 9. Propagation Delay Times**

- $C_L$  includes probe and jig capacitance.
- Waveform 1 in Figure 10 is for an output with internal such that the output is high, except when OE is high (see Figure 7). Waveform 2 in Figure 10 is for an output with conditions such that the output is low, except when OE is high.
- All input pulses are supplied by generators having the following characteristics:  $PRR \leq 10$  MHz,  $Z_O = 50 \Omega$ ,  $dv/dt \geq 1$  V/ns.
- The outputs are measured one at a time, with one transition per measurement.
- $t_{PLZ}$  and  $t_{PHZ}$  are the same as  $t_{dis}$ .
- $t_{PZL}$  and  $t_{PZH}$  are the same as  $t_{en}$ .
- $t_{PLH}$  and  $t_{PHL}$  are the same as  $t_{pd}$ .
- $V_{CCI}$  is the  $V_{CC}$  associated with the input port.
- $V_{CCO}$  is the  $V_{CC}$  associated with the output port.



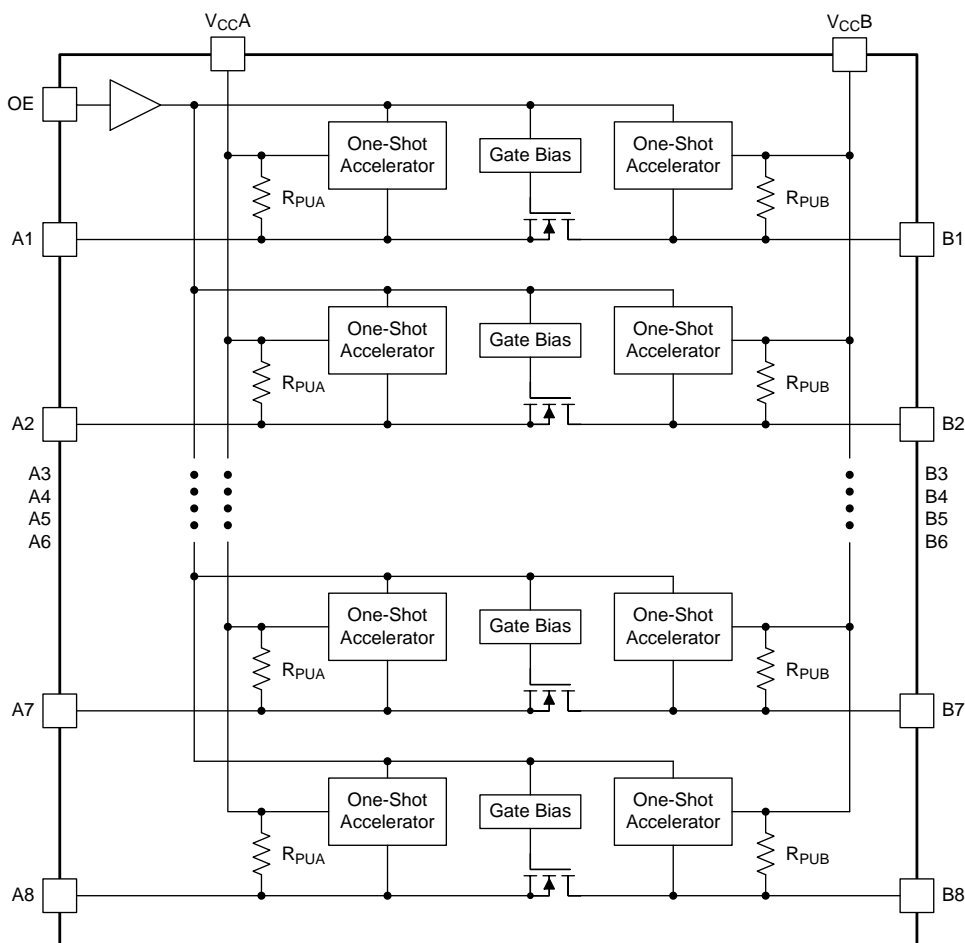
**Figure 10. Enable and Disable Times**

## 8 Detailed Description

### 8.1 Overview

The TXS0108E-Q1 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.

### 8.2 Functional Block Diagram

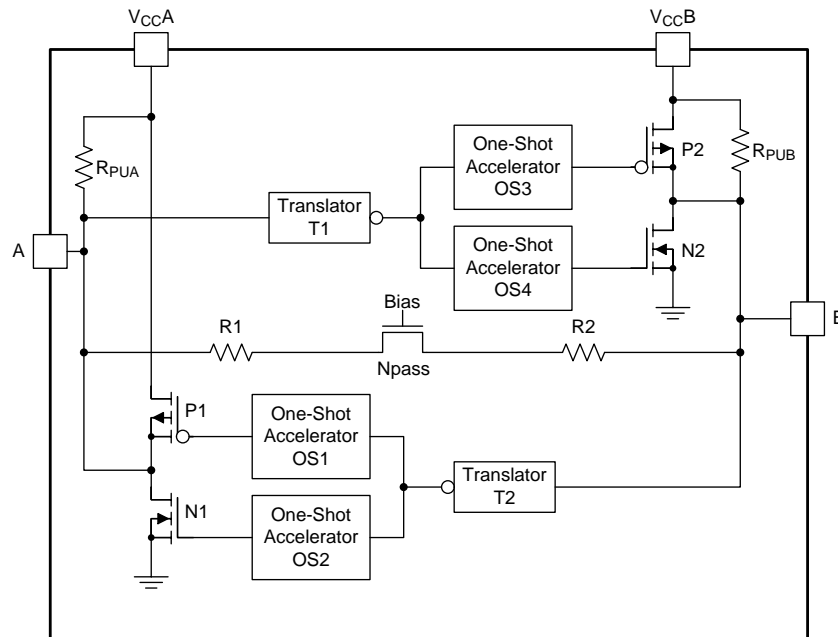


Each A-port I/O has a pull-up resistor ( $R_{PUA}$ ) to  $V_{CCA}$  and each B-port I/O has a pull-up resistor ( $R_{PUB}$ ) to  $V_{CCB}$ .  $R_{PUA}$  and  $R_{PUB}$  have a value of 40 k $\Omega$  when the output is driving low.  $R_{PUA}$  and  $R_{PUB}$  have a value of 4 k $\Omega$  when the output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

### 8.3 Feature Description

#### 8.3.1 Architecture

Figure 11 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  $\Omega$  to 500  $\Omega$ ) 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.

**Feature Description (continued)**


**Figure 11. Architecture of a TXS0108E-Q1 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.

### 8.3.2 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-Q1 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-Q1 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  $\Omega$ .



## Feature Description (continued)

### 8.3.3 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-Q1 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.

### 8.3.4 Enable and Disable

The TXS0108E-Q1 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.

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

The TXS0108E-Q1 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.

## 8.4 Device Functional Modes

The TXS0108E-Q1 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.

## 9 Application and Implementation

### NOTE

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

### 9.1 Application Information

The TXS0108E-Q1 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.

### 9.2 Typical Application

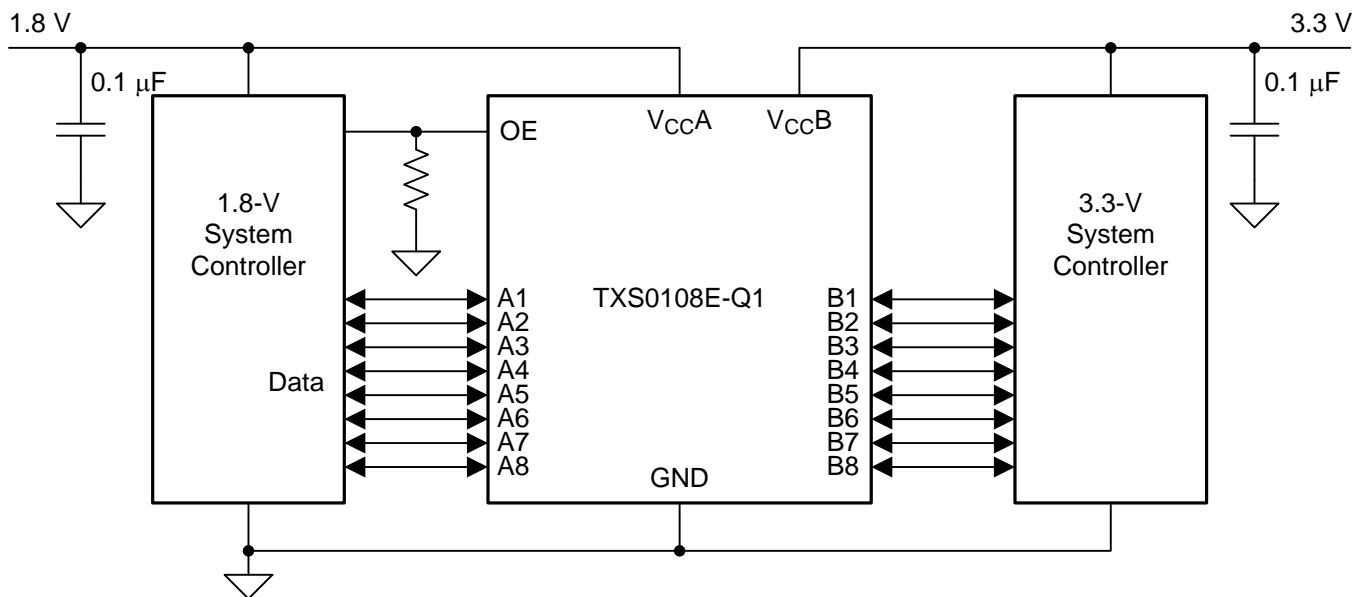


Figure 12. Typical Application Circuit

#### 9.2.1 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 |

#### 9.2.2 Detailed Design Procedure

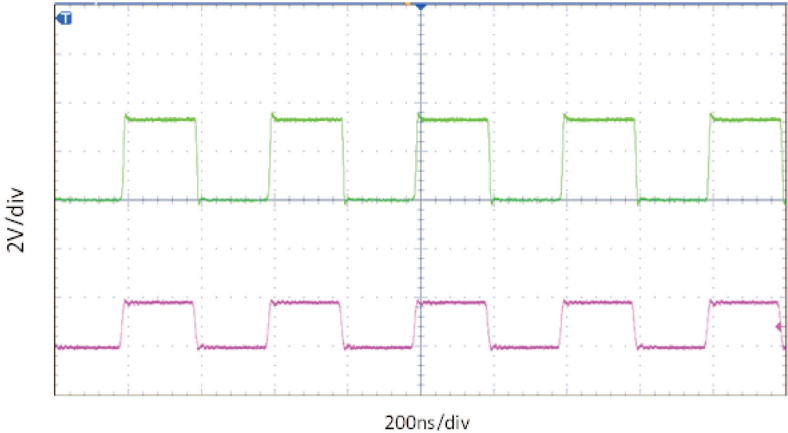
To begin the design process, determine the following:

- Input voltage range
  - Use the supply voltage of the device that is driving the TXS0108E-Q1 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-Q1 device is driving to determine the output voltage range.
  - The TXS0108E-Q1 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.

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

**9.2.3 Application Curves**



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

**Figure 13. Level-Translation of a 2.5-MHz Signal**

## 10 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.

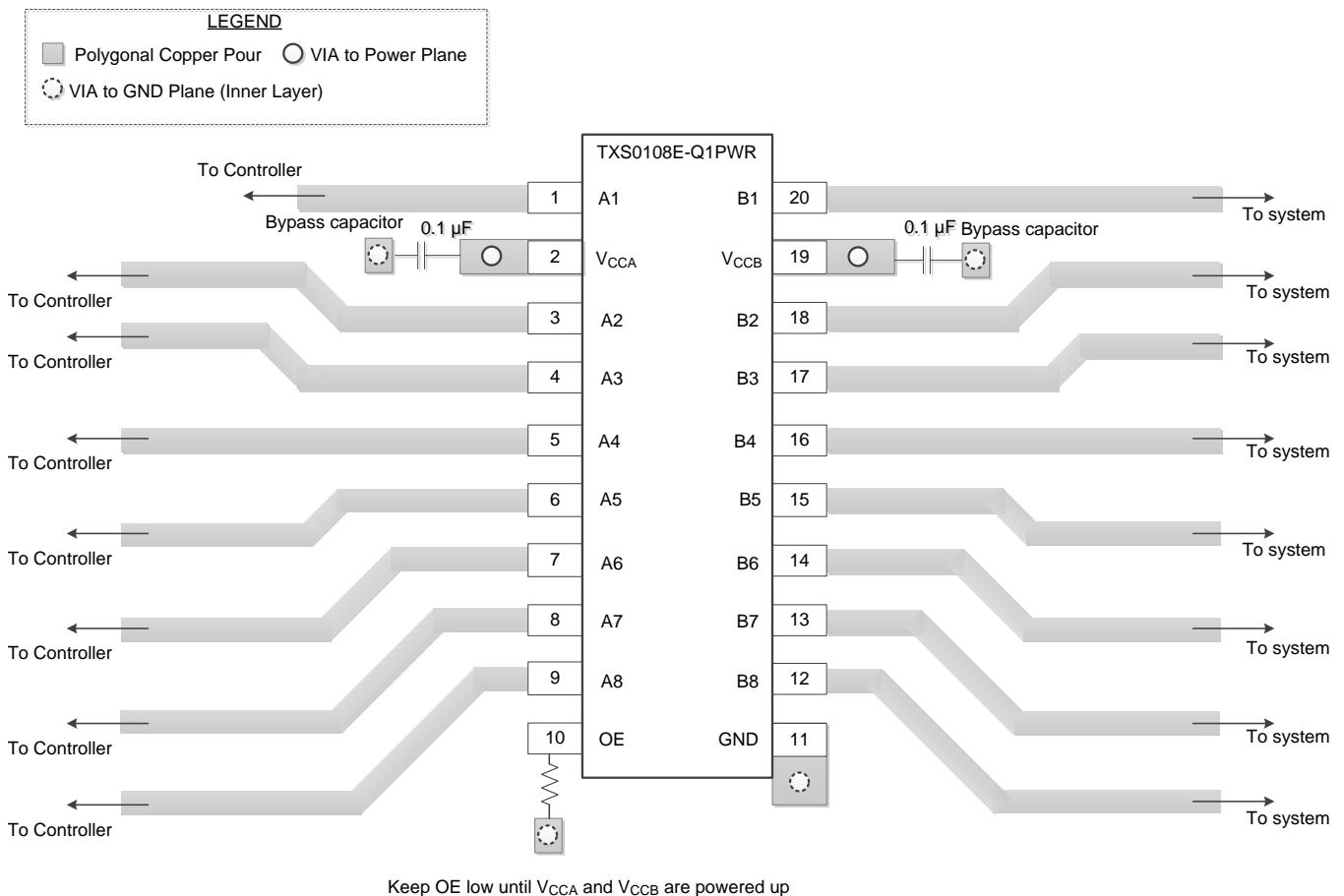
## 11 Layout

### 11.1 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.

### 11.2 Layout Example



**Figure 14. Layout Example**

## 12 Device and Documentation Support

### 12.1 Community Resources

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

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

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

### 12.2 Trademarks

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

### 12.3 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.

### 12.4 Glossary

[SLYZ022](#) — *TI Glossary*.

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

## 13 Mechanical, Packaging, and Orderable Information

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

**PACKAGING INFORMATION**

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)            | Lead/Ball Finish<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples |
|------------------|---------------|--------------|--------------------|------|----------------|----------------------------|-------------------------|----------------------|--------------|-------------------------|---------|
| TXS0108EQPWRQ1   | ACTIVE        | TSSOP        | PW                 | 20   | 2000           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 125   | YF08EQ1                 | Samples |

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

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

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

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

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

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**OTHER QUALIFIED VERSIONS OF TXS0108E-Q1 :**

- Catalog: [TXS0108E](#)

## NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

## 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 |
|----------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TXS0108EQPWRQ1 | TSSOP        | PW              | 20   | 2000 | 330.0              | 16.4               | 6.95    | 7.1     | 1.6     | 8.0     | 16.0   | Q1            |



**TAPE AND REEL BOX DIMENSIONS**



\*All dimensions are nominal

| Device         | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|----------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TXS0108EQPWRQ1 | TSSOP        | PW              | 20   | 2000 | 367.0       | 367.0      | 38.0        |

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.
  - 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

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.

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

### Products

|                              |  |
|------------------------------|--|
| Audio                        | <a href="http://www.ti.com/audio">www.ti.com/audio</a>                               |
| Amplifiers                   | <a href="http://amplifier.ti.com">amplifier.ti.com</a>                               |
| Data Converters              | <a href="http://dataconverter.ti.com">dataconverter.ti.com</a>                       |
| DLP® Products                | <a href="http://www.dlp.com">www.dlp.com</a>   |
| DSP                          | <a href="http://dsp.ti.com">dsp.ti.com</a>   |
| Clocks and Timers            | <a href="http://www.ti.com/clocks">www.ti.com/clocks</a>                             |
| Interface                    | <a href="http://interface.ti.com">interface.ti.com</a>                               |
| Logic                        | <a href="http://logic.ti.com">logic.ti.com</a>                                       |
| Power Mgmt                   | <a href="http://power.ti.com">power.ti.com</a>                                       |
| Microcontrollers             | <a href="http://microcontroller.ti.com">microcontroller.ti.com</a>                   |
| RFID                         | <a href="http://www.ti-rfid.com">www.ti-rfid.com</a>                                 |
| OMAP Applications Processors | <a href="http://www.ti.com/omap">www.ti.com/omap</a>                                 |
| Wireless Connectivity        | <a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a> |

### Applications

|                               |  |
|-------------------------------|--|
| Automotive and Transportation | <a href="http://www.ti.com/automotive">www.ti.com/automotive</a>                         |
| Communications and Telecom    | <a href="http://www.ti.com/communications">www.ti.com/communications</a>                 |
| Computers and Peripherals     | <a href="http://www.ti.com/computers">www.ti.com/computers</a>                           |
| Consumer Electronics          | <a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>                   |
| Energy and Lighting           | <a href="http://www.ti.com/energy">www.ti.com/energy</a>                                 |
| Industrial                    | <a href="http://www.ti.com/industrial">www.ti.com/industrial</a>                         |
| Medical                       | <a href="http://www.ti.com/medical">www.ti.com/medical</a>                               |
| Security                      | <a href="http://www.ti.com/security">www.ti.com/security</a>                             |
| Space, Avionics and Defense   | <a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a> |
| Video and Imaging             | <a href="http://www.ti.com/video">www.ti.com/video</a>                                   |

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)