



# **SN74AVC16T245-Q1 16-Bit Dual-Supply Bus Transceiver With Configurable Voltage Translation and 3-State Outputs**

## 1 Features

- Qualified for Automotive Applications
- AEC-Q100 Qualified With the Following Results:
  - Device Temperature Grade 1: –40°C to 125°C Ambient Operating Temperature Range
  - Device HBM ESD Classification Level H3B (JESD 22 A114-A)
  - Device CDM ESD Classification Level C5 (JESD 22 C101)
- Control Inputs  $V_{IH}/V_{IL}$  Levels Are Referenced to  $V_{CCA}$  Voltage
- $V_{CC}$  Isolation Feature – If Either  $V_{CC}$  Input is at GND, Both Ports Are in the High-Impedance State
- Fully Configurable Dual-Rail Design Allows Each Port to Operate Over the Full 1.2-V to 3.6-V Power-Supply Range
- $I_{off}$  Supports Partial-Power-Down Mode Operation
- I/Os Are 4.6-V Tolerant
- Maximum Data Rates
  - 380 Mbps (1.8-V to 3.3-V Translation)
  - 200 Mbps (<1.8-V to 3.3-V Translation)
  - 200 Mbps (Translate to 2.5 V or 1.8 V)
  - 150 Mbps (Translate to 1.5 V)
  - 100 Mbps (Translate to 1.2 V)
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II

## 2 Applications

- Telematics
- Clusters
- Head Units
- Navigation Systems

## 3 Description

The SN74AVC16T245-Q1 is a 16-bit noninverting bus transceiver that uses two separate configurable power-supply rails. The SN74AVC16T245-Q1 is optimized to operate with  $V_{CCA}$  or  $V_{CCB}$  set at 1.4 V to 3.6 V. It is operational with  $V_{CCA}$  or  $V_{CCB}$  as low as 1.2 V. The A port is designed to track  $V_{CCA}$ .  $V_{CCA}$  accepts any supply voltage from 1.2 V to 3.6 V. The B port is designed to track  $V_{CCB}$ .  $V_{CCB}$  accepts any supply voltage from 1.2 V to 3.6 V. This allows for universal low-voltage bidirectional translation between any of the 1.2-V, 1.5-V, 1.8-V, 2.5-V, and 3.3-V voltage nodes.

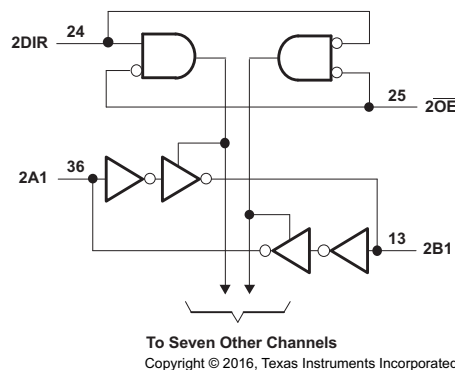
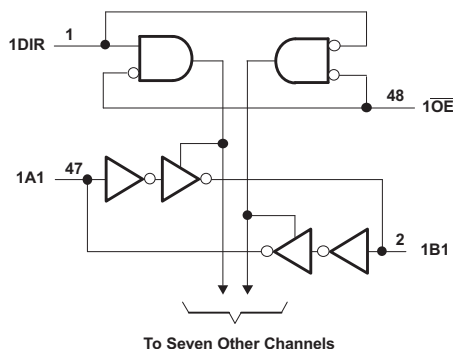
The SN74AVC16T245-Q1 is designed for asynchronous communication between data buses. The device transmits data from the A bus to the B bus or from the B bus to the A bus, depending on the logic level at the direction-control (DIR) input. The output-enable ( $\overline{OE}$ ) input can be used to disable the outputs so the buses effectively are isolated.

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

| PART NUMBER      | PACKAGE    | BODY SIZE (NOM)   |
|------------------|------------|-------------------|
| SN74AVC16T245-Q1 | TVSOP (48) | 9.70 mm x 4.40 mm |

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

### Logic Diagram (Positive Logic)



To Seven Other Channels  
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## 4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

| Changes from Original (September 2008) to Revision A   | Page |
|--|------|
| • Added <i>ESD Ratings</i> table, <i>Feature Description</i> section, <i>Device Functional Modes</i> , <i>Application and Implementation</i> section, <i>Power Supply Recommendations</i> section, <i>Layout</i> section, <i>Device and Documentation Support</i> section, and <i>Mechanical, Packaging, and Orderable Information</i> section ..... | 1    |
| • Deleted <i>Ordering Information</i> table; see the POA at the end of the data sheet .....  | 1    |
| • Deleted Overvoltage-Tolerant Inputs/Outputs Allow Mixed- Voltage-Mode Data Communications bullet from <i>Features</i> .....  | 1    |
| • Deleted ESD Protection Exceeds JESD 22 from <i>Features</i> .....  | 1    |
| • Changed the <i>Thermal Information</i> table .....   | 7    |

## 5 Description (continued)

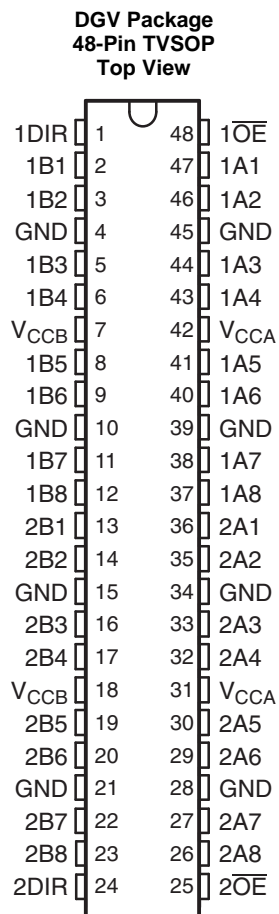
The SN74AVC16T245-Q1 is designed so that the control pins (1DIR, 2DIR,  $\overline{1OE}$ , and  $\overline{2OE}$ ) are supplied by  $V_{CCA}$ .

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

The  $V_{CC}$  isolation feature ensures that if either  $V_{CC}$  input is at GND, both ports are in the high-impedance state.

To ensure the high-impedance state during power up or power down,  $\overline{OE}$  must be tied to  $V_{CC}$  through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

## 6 Pin Configuration and Functions



### Pin Functions

| PIN  |     | I/O | DESCRIPTION                               |
|------|-----|-----|---|
| NAME | NO. |     |   |
| 1A1  | 47  | I/O | Input and output. Referenced to $V_{CCA}$ |
| 1A2  | 46  |     |   |
| 1A3  | 44  |     |   |
| 1A4  | 43  |     |   |
| 1A5  | 41  |     |   |
| 1A6  | 40  |     |   |
| 1A7  | 38  |     |   |
| 1A8  | 37  |     |   |
| 1B1  | 2   | I/O | Input and output. Referenced to $V_{CCB}$ |
| 1B2  | 3   |     |   |
| 1B3  | 5   |     |   |
| 1B4  | 6   |     |   |
| 1B5  | 8   |     |   |
| 1B6  | 9   |     |   |
| 1B7  | 11  |     |   |
| 1B8  | 12  |     |   |

### Pin Functions (continued)

| PIN               |                               | I/O | DESCRIPTION  |
|-------------------|-------------------------------|-----|--|
| NAME              | NO.                           |     |  |
| 2A1               | 36                            | I/O | Input and output. Referenced to $V_{CCA}$  |
| 2A2               | 35                            |     |  |
| 2A3               | 33                            |     |  |
| 2A4               | 32                            |     |  |
| 2A5               | 30                            |     |  |
| 2A6               | 29                            |     |  |
| 2A7               | 27                            |     |  |
| 2A8               | 26                            |     |  |
| 2B1               | 13                            | I/O | Input and output. Referenced to $V_{CCB}$  |
| 2B2               | 14                            |     |  |
| 2B3               | 16                            |     |  |
| 2B4               | 17                            |     |  |
| 2B5               | 19                            |     |  |
| 2B6               | 20                            |     |  |
| 2B7               | 22                            |     |  |
| 2B8               | 23                            |     |  |
| 1DIR              | 1                             | I   | Direction-control signal   |
| 2DIR              | 24                            |     |  |
| 1 $\overline{OE}$ | 48                            | —   | Tri-State output-mode enables. Pull $\overline{OE}$ high to place all outputs in Tri-State mode. Referenced to $V_{CCA}$ |
| 2 $\overline{OE}$ | 25                            |     |  |
| GND               | 4, 10, 15, 21, 45, 39, 34, 28 | —   | Ground   |
| $V_{CCA}$         | 42, 31                        | —   | A-port supply voltage. $1.2\text{ V} \leq V_{CCB} \leq 3.6\text{ V}$   |
| $V_{CCB}$         | 7, 18                         | —   | B-port supply voltage. $1.2\text{ V} \leq V_{CCB} \leq 3.6\text{ V}$   |

## 7 Specifications

### 7.1 Absolute Maximum Ratings

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

|                        |   | MIN                | MAX  | UNIT            |
|------------------------|---|--------------------|------|-----------------|
| $V_{CCA}$<br>$V_{CCB}$ | Supply voltage  | –0.5               | 4.6  | V               |
| $V_I$                  | Input voltage <sup>(2)</sup>  | I/O ports (A port) | –0.5 | 4.6             |
|                        |   | I/O ports (B port) | –0.5 | 4.6             |
|                        |   | Control inputs     | –0.5 | 4.6             |
| $V_O$                  | Voltage applied to any output in the high-impedance or power-off state <sup>(2)</sup> | A port             | –0.5 | 4.6             |
|                        |   | B port             | –0.5 | 4.6             |
| $V_O$                  | Voltage applied to any output in the high or low state <sup>(2)(3)</sup>              | A port             | –0.5 | $V_{CCA} + 0.5$ |
|                        |   | B port             | –0.5 | $V_{CCB} + 0.5$ |
| $I_{IK}$               | Input clamp current   | $V_I < 0$          | –50  | mA              |
| $I_{OK}$               | Output clamp current  | $V_O < 0$          | –50  | mA              |
| $I_O$                  | Continuous output current   |                    | ±50  | mA              |
|                        | Continuous current through each $V_{CCA}$ , $V_{CCB}$ , and GND                       |                    | ±100 | mA              |
| $T_{stg}$              | Storage temperature   | –65                | 150  | °C              |

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) The input voltage and output negative-voltage ratings may be exceeded if the input and output current ratings are observed.
- (3) The output positive-voltage rating may be exceeded up to 4.6 V maximum if the output current rating is observed.

### 7.2 ESD Ratings

|             |                         | VALUE   | UNIT  |
|-------------|-------------------------|---|-------|
| $V_{(ESD)}$ | Electrostatic discharge | Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup> | ±8000 |
|             |                         | Charged-device model (CDM), per JEDEC specification JESD22-C101   | ±1000 |
|             |                         | Machine model (MM), per JEDEC specification JESD22-A115-A         | ±200  |

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

### 7.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted) <sup>(1)(2)(3)</sup>

|  |                                    |   | V <sub>CCI</sub> | V <sub>CCO</sub> | MIN                     | MAX              | UNIT |
|--|------------------------------------|---|------------------|------------------|-------------------------|------------------|------|
| V <sub>CCA</sub> ,<br>V <sub>CCB</sub> | Supply voltage                     |   |                  |                  | 1.2                     | 3.6              | V    |
| V <sub>IH</sub>                        | High-level input voltage           | Data inputs <sup>(4)</sup>                              | 1.2 V to 1.95 V  |                  | V <sub>CCI</sub> × 0.65 |                  | V    |
|  |                                    |   | 1.95 V to 2.7 V  |                  | 1.6                     |                  |      |
|  |                                    |   | 2.7 V to 3.6 V   |                  | 2                       |                  |      |
| V <sub>IL</sub>                        | Low-level input voltage            | Data inputs <sup>(4)</sup>                              | 1.2 V to 1.95 V  |                  | V <sub>CCI</sub> × 0.35 |                  | V    |
|  |                                    |   | 1.95 V to 2.7 V  |                  | 0.7                     |                  |      |
|  |                                    |   | 2.7 V to 3.6 V   |                  | 0.8                     |                  |      |
| V <sub>IH</sub>                        | High-level input voltage           | DIR<br>(referenced to V <sub>CCA</sub> ) <sup>(5)</sup> | 1.2 V to 1.95 V  |                  | V <sub>CCA</sub> × 0.65 |                  | V    |
|  |                                    |   | 1.95 V to 2.7 V  |                  | 1.6                     |                  |      |
|  |                                    |   | 2.7 V to 3.6 V   |                  | 2                       |                  |      |
| V <sub>IL</sub>                        | Low-level input voltage            | DIR<br>(referenced to V <sub>CCA</sub> ) <sup>(5)</sup> | 1.2 V to 1.95 V  |                  | V <sub>CCA</sub> × 0.35 |                  | V    |
|  |                                    |   | 1.95 V to 2.7 V  |                  | 0.7                     |                  |      |
|  |                                    |   | 2.7 V to 3.6 V   |                  | 0.8                     |                  |      |
| V <sub>I</sub>                         | Input voltage                      |   |                  |                  | 0                       | 3.6              | V    |
| V <sub>O</sub>                         | Output voltage                     | Active state  |                  |                  | 0                       | V <sub>CCO</sub> | V    |
|  |                                    | 3-state   |                  |                  | 0                       | 3.6              |      |
| I <sub>OH</sub>                        | High-level output current          |   |                  | 1.2 V            |                         | −3               | mA   |
|  |                                    |   |                  | 1.4 V to 1.6 V   |                         | −6               |      |
|  |                                    |   |                  | 1.65 V to 1.95 V |                         | −8               |      |
|  |                                    |   |                  | 2.3 V to 2.7 V   |                         | −9               |      |
|  |                                    |   |                  | 3 V to 3.6 V     |                         | −12              |      |
| I <sub>OL</sub>                        | Low-level output current           |   |                  | 1.2 V            |                         | 3                | mA   |
|  |                                    |   |                  | 1.4 V to 1.6 V   |                         | 6                |      |
|  |                                    |   |                  | 1.65 V to 1.95 V |                         | 8                |      |
|  |                                    |   |                  | 2.3 V to 2.7 V   |                         | 9                |      |
|  |                                    |   |                  | 3 V to 3.6 V     |                         | 12               |      |
| Δt/Δv                                  | Input transition rise or fall rate |   |                  |                  |                         | 5                | ns/V |
| 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) All unused data inputs of the device must be held at V<sub>CCI</sub> or GND to ensure proper device operation. See [Implications of Slow or Floating CMOS Inputs](#).

(4) For V<sub>CCI</sub> values not specified in the data sheet, V<sub>IH</sub> min = V<sub>CCI</sub> × 0.7 V, V<sub>IL</sub> max = V<sub>CCI</sub> × 0.3 V.

(5) For V<sub>CCA</sub> values not specified in the data sheet, V<sub>IH</sub> min = V<sub>CCA</sub> × 0.7 V, V<sub>IL</sub> max = V<sub>CCA</sub> × 0.3 V.

### 7.4 Thermal Information

| THERMAL METRIC <sup>(1)</sup> |  | SN74AVC16T245-Q1 | UNIT |
|-------------------------------|--|------------------|------|
|                               |  | DGV (TVSOP)      |      |
|                               |  | 48 PINS          |      |
| R <sub>θJA</sub>              | Junction-to-ambient thermal resistance       | 77.2             | °C/W |
| R <sub>θJC(top)</sub>         | Junction-to-case (top) thermal resistance    | 31.4             | °C/W |
| R <sub>θJB</sub>              | Junction-to-board thermal resistance         | 39.5             | °C/W |
| ψ <sub>JT</sub>               | Junction-to-top characterization parameter   | 3.5              | °C/W |
| ψ <sub>JB</sub>               | Junction-to-board characterization parameter | 39               | °C/W |
| R <sub>θJC(bot)</sub>         | Junction-to-case (bottom) thermal resistance | N/A              | °C/W |

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

## 7.5 Electrical Characteristics

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

| PARAMETER                           |                | TEST CONDITIONS   |                                  | V <sub>CCA</sub> | V <sub>CCB</sub>                | T <sub>A</sub>                  | MIN                    | TYP | MAX | UNIT |
|-------------------------------------|----------------|---|----------------------------------|------------------|---------------------------------|---------------------------------|------------------------|-----|-----|------|
| V <sub>OH</sub>                     |                | I <sub>OH</sub> = −100 μA   | V <sub>I</sub> = V <sub>IH</sub> | 1.2 V to 3.6 V   | 1.2 V to 3.6 V                  | T <sub>A</sub> = −40°C to 125°C | V <sub>CCO</sub> − 0.2 |     |     | V    |
|                                     |                | I <sub>OH</sub> = −3 mA   |                                  | 1.2 V            | 1.2 V                           | T <sub>A</sub> = 25°C           | 0.95                   |     |     |      |
|                                     |                | I <sub>OH</sub> = −6 mA   |                                  | 1.4 V            | 1.4 V                           | T <sub>A</sub> = −40°C to 125°C | 1                      |     |     |      |
|                                     |                | I <sub>OH</sub> = −8 mA   |                                  | 1.65 V           | 1.65 V                          | T <sub>A</sub> = −40°C to 125°C | 1.15                   |     |     |      |
|                                     |                | I <sub>OH</sub> = −9 mA   |                                  | 2.3 V            | 2.3 V                           | T <sub>A</sub> = −40°C to 125°C | 1.75                   |     |     |      |
|                                     |                | I <sub>OH</sub> = −12 mA  |                                  | 3 V              | 3 V                             | T <sub>A</sub> = −40°C to 125°C | 2.3                    |     |     |      |
| V <sub>OL</sub>                     |                | I <sub>OL</sub> = 100 μA  | V <sub>I</sub> = V <sub>IL</sub> | 1.2 V to 3.6 V   | 1.2 V to 3.6 V                  | T <sub>A</sub> = −40°C to 125°C |                        |     | 0.2 | V    |
|                                     |                | I <sub>OL</sub> = 3 mA  |                                  | 1.2 V            | 1.2 V                           | T <sub>A</sub> = 25°C           | 0.15                   |     |     |      |
|                                     |                | I <sub>OL</sub> = 6 mA  |                                  | 1.4 V            | 1.4 V                           | T <sub>A</sub> = −40°C to 125°C | 0.4                    |     |     |      |
|                                     |                | I <sub>OL</sub> = 8 mA  |                                  | 1.65 V           | 1.65 V                          | T <sub>A</sub> = −40°C to 125°C | 0.45                   |     |     |      |
|                                     |                | I <sub>OL</sub> = 9 mA  |                                  | 2.3 V            | 2.3 V                           | T <sub>A</sub> = −40°C to 125°C | 0.55                   |     |     |      |
|                                     |                | I <sub>OL</sub> = 12 mA   |                                  | 3 V              | 3 V                             | T <sub>A</sub> = −40°C to 125°C | 0.7                    |     |     |      |
| I <sub>I</sub>                      | Control inputs | V <sub>I</sub> = V <sub>CCA</sub> or GND  | 1.2 V to 3.6 V                   | 1.2 V to 3.6 V   | T <sub>A</sub> = 25°C           | ±0.025                          | ±0.25                  | μA  |     |      |
|                                     |                |   |                                  |                  | T <sub>A</sub> = −40°C to 125°C |                                 | ±2                     |     |     |      |
| I <sub>off</sub>                    | A or B port    | V <sub>I</sub> or V <sub>O</sub> = 0 to 3.6 V   | 0 V                              | 0 to 3.6 V       | T <sub>A</sub> = 25°C           | ±0.1                            | ±2.5                   | μA  |     |      |
|                                     |                |   |                                  |                  | T <sub>A</sub> = −40°C to 125°C |                                 | ±10                    |     |     |      |
|                                     | A or B port    |   | 0 to 3.6 V                       | 0 V              | T <sub>A</sub> = 25°C           | ±0.5                            | ±2.5                   |     |     |      |
|                                     |                |   |                                  |                  | T <sub>A</sub> = −40°C to 125°C |                                 | ±10                    |     |     |      |
| I <sub>OZ</sub> <sup>(3)</sup>      | A or B port    | V <sub>O</sub> = V <sub>CCO</sub> or GND,<br>V <sub>I</sub> = V <sub>CCI</sub> or GND,<br>OE =V <sub>IH</sub> | 3.6 V                            | 3.6 V            | T <sub>A</sub> = 25°C           | ±0.5                            | ±2.5                   | μA  |     |      |
|                                     |                |   |                                  |                  | T <sub>A</sub> = −40°C to 125°C |                                 | ±10                    |     |     |      |
| I <sub>CCA</sub>                    |                | V <sub>I</sub> = V <sub>CCI</sub> or GND,<br>I <sub>O</sub> = 0   | 1.2 V to 3.6 V                   | 1.2 V to 3.6 V   | T <sub>A</sub> = −40°C to 125°C |                                 | 30                     | μA  |     |      |
|                                     |                |   | 0 V                              | 3.6 V            | T <sub>A</sub> = −40°C to 125°C |                                 | −40                    |     |     |      |
|                                     |                |   | 3.6 V                            | 0 V              | T <sub>A</sub> = −40°C to 125°C |                                 | 30                     |     |     |      |
| I <sub>CCB</sub>                    |                | V <sub>I</sub> = V <sub>CCI</sub> or GND,<br>I <sub>O</sub> = 0   | 1.2 V to 3.6 V                   | 1.2 V to 3.6 V   | T <sub>A</sub> = −40°C to 125°C |                                 | 30                     | μA  |     |      |
|                                     |                |   | 0 V                              | 3.6 V            | T <sub>A</sub> = −40°C to 125°C |                                 | 30                     |     |     |      |
|                                     |                |   | 3.6 V                            | 0 V              | T <sub>A</sub> = −40°C to 125°C |                                 | −40                    |     |     |      |
| I <sub>CCA</sub> + I <sub>CCB</sub> |                | V <sub>I</sub> = V <sub>CCI</sub> or GND,<br>I <sub>O</sub> = 0   | 1.2 V to 3.6 V                   | 1.2 V to 3.6 V   | T <sub>A</sub> = −40°C to 125°C |                                 | 60                     | μA  |     |      |
| C <sub>I</sub>                      | Control inputs | V <sub>I</sub> = 3.3 V or GND   | 3.3 V                            | 3.3 V            | T <sub>A</sub> = 25°C           |                                 | 3.5                    | pF  |     |      |
| C <sub>IO</sub>                     | A or B port    | V <sub>O</sub> = 3.3 V or GND   | 3.3 V                            | 3.3 V            | T <sub>A</sub> = 25°C           |                                 | 7                      | pF  |     |      |

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

## 7.6 Switching Characteristics: $V_{CCA} = 1.2\text{ V}$

over recommended operating free-air temperature range,  $V_{CCA} = 1.2\text{ V}$  (see [Figure 11](#))

| PARAMETER        | FROM<br>(INPUT) | TO<br>(OUTPUT) | V <sub>CCB</sub> = 1.2 V |     |     | V <sub>CCB</sub> = 1.5 V |     |     | V <sub>CCB</sub> = 1.8 V |     |     | V <sub>CCB</sub> = 2.5 V |     |     | V <sub>CCB</sub> = 3.3 V |     |     | UNIT |
|------------------|-----------------|----------------|--------------------------|-----|-----|--------------------------|-----|-----|--------------------------|-----|-----|--------------------------|-----|-----|--------------------------|-----|-----|------|
|                  |                 |                | MIN                      | TYP | MAX | MIN                      | TYP | MAX | MIN                      | TYP | MAX | MIN                      | TYP | MAX | MIN                      | TYP | MAX |      |
| t <sub>PLH</sub> | A               | B              | 4.1                      |     |     | 3.3                      |     |     | 3                        |     |     | 2.8                      |     |     | 3.2                      |     |     | ns   |
| t <sub>PHL</sub> |                 |                | 4.1                      |     |     | 3.3                      |     |     | 3                        |     |     | 2.8                      |     |     | 3.2                      |     |     |      |
| t <sub>PLH</sub> | B               | A              | 4.4                      |     |     | 4                        |     |     | 3.8                      |     |     | 3.6                      |     |     | 3.5                      |     |     | ns   |
| t <sub>PHL</sub> |                 |                | 4.4                      |     |     | 4                        |     |     | 3.8                      |     |     | 3.6                      |     |     | 3.5                      |     |     |      |
| t <sub>PZH</sub> | OE              | A              | 6.4                      |     |     | 6.4                      |     |     | 6.4                      |     |     | 6.4                      |     |     | 6.4                      |     |     | ns   |
| t <sub>PZL</sub> |                 |                | 6.4                      |     |     | 6.4                      |     |     | 6.4                      |     |     | 6.4                      |     |     | 6.4                      |     |     |      |
| t <sub>PZH</sub> | OE              | B              | 6                        |     |     | 4.6                      |     |     | 4                        |     |     | 3.4                      |     |     | 3.2                      |     |     | ns   |
| t <sub>PZL</sub> |                 |                | 6                        |     |     | 4.6                      |     |     | 4                        |     |     | 3.4                      |     |     | 3.2                      |     |     |      |
| t <sub>PHZ</sub> | OE              | A              | 6.6                      |     |     | 6.6                      |     |     | 6.6                      |     |     | 6.6                      |     |     | 6.8                      |     |     | ns   |
| t <sub>PLZ</sub> |                 |                | 6.6                      |     |     | 6.6                      |     |     | 6.6                      |     |     | 6.6                      |     |     | 6.8                      |     |     |      |
| t <sub>PHZ</sub> | OE              | B              | 6                        |     |     | 4.9                      |     |     | 4.9                      |     |     | 4.2                      |     |     | 5.3                      |     |     | ns   |
| t <sub>PLZ</sub> |                 |                | 6                        |     |     | 4.9                      |     |     | 4.9                      |     |     | 4.2                      |     |     | 5.3                      |     |     |      |

## 7.7 Switching Characteristics: $V_{CCA} = 1.5\text{ V} \pm 0.1\text{ V}$

over recommended operating free-air temperature range,  $V_{CCA} = 1.5\text{ V} \pm 0.1\text{ V}$  (see [Figure 11](#))

| PARAMETER        | FROM<br>(INPUT) | TO<br>(OUTPUT) | V <sub>CCB</sub> = 1.2 V |     |     | V <sub>CCB</sub> = 1.5 V ± 0.1 V |     |     | V <sub>CCB</sub> = 1.8 V ± 0.15 V |     |     | V <sub>CCB</sub> = 2.5 V ± 0.2 V |     |     | V <sub>CCB</sub> = 3.3 V ± 0.3 V |     |     | UNIT |
|------------------|-----------------|----------------|--------------------------|-----|-----|----------------------------------|-----|-----|-----------------------------------|-----|-----|----------------------------------|-----|-----|----------------------------------|-----|-----|------|
|                  |                 |                | MIN                      | TYP | MAX | MIN                              | TYP | MAX | MIN                               | TYP | MAX | MIN                              | TYP | MAX | MIN                              | TYP | MAX |      |
| t <sub>PLH</sub> | A               | B              | 3.6                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     | ns   |
| t <sub>PHL</sub> |                 |                | 3.6                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     |      |
| t <sub>PLH</sub> | B               | A              | 3.3                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     | ns   |
| t <sub>PHL</sub> |                 |                | 3.3                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     |      |
| t <sub>PZH</sub> | OE              | A              | 4.3                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     | ns   |
| t <sub>PZL</sub> |                 |                | 4.3                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     |      |
| t <sub>PZH</sub> | OE              | B              | 5.6                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     | ns   |
| t <sub>PZL</sub> |                 |                | 5.6                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     |      |
| t <sub>PHZ</sub> | OE              | A              | 4.5                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     | ns   |
| t <sub>PLZ</sub> |                 |                | 4.5                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     |      |
| t <sub>PHZ</sub> | OE              | B              | 5.5                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     | ns   |
| t <sub>PLZ</sub> |                 |                | 5.5                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     |      |

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

over recommended operating free-air temperature range,  $V_{CCA} = 1.8 \text{ V} \pm 0.15 \text{ V}$  (see [Figure 11](#))

| PARAMETER        | FROM<br>(INPUT) | TO<br>(OUTPUT) | V <sub>CCB</sub> = 1.2 V |     |     | V <sub>CCB</sub> = 1.5 V ± 0.1 V |     |     | V <sub>CCB</sub> = 1.8 V ± 0.15 V |     |     | V <sub>CCB</sub> = 2.5 V ± 0.2 V |     |     | V <sub>CCB</sub> = 3.3 V ± 0.3 V |     |     | UNIT |
|------------------|-----------------|----------------|--------------------------|-----|-----|----------------------------------|-----|-----|-----------------------------------|-----|-----|----------------------------------|-----|-----|----------------------------------|-----|-----|------|
|                  |                 |                | MIN                      | TYP | MAX | MIN                              | TYP | MAX | MIN                               | TYP | MAX | MIN                              | TYP | MAX | MIN                              | TYP | MAX |      |
| t <sub>PLH</sub> | A               | B              | 3.4                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     | ns   |
| t <sub>PHL</sub> |                 |                | 3.4                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     |      |
| t <sub>PLH</sub> | B               | A              | 3                        |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     | ns   |
| t <sub>PHL</sub> |                 |                | 3                        |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     |      |
| t <sub>PZH</sub> | OE              | A              | 3.4                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     | ns   |
| t <sub>PZL</sub> |                 |                | 3.4                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     |      |
| t <sub>PZH</sub> | OE              | B              | 5.4                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     | ns   |
| t <sub>PZL</sub> |                 |                | 5.4                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     |      |
| t <sub>PHZ</sub> | OE              | A              | 4.2                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     | ns   |
| t <sub>PLZ</sub> |                 |                | 4.2                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     |      |
| t <sub>PHZ</sub> | OE              | B              | 5.2                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     | ns   |
| t <sub>PLZ</sub> |                 |                | 5.2                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     |      |

### 7.9 Switching Characteristics: $V_{CCA} = 2.5 \text{ V} \pm 0.2 \text{ V}$

over recommended operating free-air temperature range,  $V_{CCA} = 2.5 \text{ V} \pm 0.2 \text{ V}$  (see [Figure 11](#))

| PARAMETER        | FROM<br>(INPUT) | TO<br>(OUTPUT) | V <sub>CCB</sub> = 1.2 V |     |     | V <sub>CCB</sub> = 1.5 V ± 0.1 V |     |     | V <sub>CCB</sub> = 1.8 V ± 0.15 V |     |     | V <sub>CCB</sub> = 2.5 V ± 0.2 V |     |     | V <sub>CCB</sub> = 3.3 V ± 0.3 V |     |     | UNIT |  |  |     |  |  |     |  |  |     |  |  |    |
|------------------|-----------------|----------------|--------------------------|-----|-----|----------------------------------|-----|-----|-----------------------------------|-----|-----|----------------------------------|-----|-----|----------------------------------|-----|-----|------|--|--|-----|--|--|-----|--|--|-----|--|--|----|
|                  |                 |                | MIN                      | TYP | MAX | MIN                              | TYP | MAX | MIN                               | TYP | MAX | MIN                              | TYP | MAX | MIN                              | TYP | MAX |      |  |  |     |  |  |     |  |  |     |  |  |    |
| t <sub>PLH</sub> | A               | B              | 3.2                      |     |     | 0.5                              |     |     | 9.6                               |     |     | 0.5                              |     |     | 7.5                              |     |     | 0.5  |  |  | 6.3 |  |  | 0.5 |  |  | 5.8 |  |  | ns |
| t <sub>PHL</sub> |                 |                | 3.2                      |     |     | 0.5                              |     |     | 8.6                               |     |     | 0.5                              |     |     | 7.5                              |     |     | 0.5  |  |  | 6.3 |  |  | 0.5 |  |  | 5.8 |  |  |    |
| t <sub>PLH</sub> | B               | A              | 2.6                      |     |     | 0.5                              |     |     | 7.1                               |     |     | 0.5                              |     |     | 6.7                              |     |     | 0.5  |  |  | 6.3 |  |  | 0.5 |  |  | 6.2 |  |  | ns |
| t <sub>PHL</sub> |                 |                | 2.6                      |     |     | 0.5                              |     |     | 7.1                               |     |     | 0.5                              |     |     | 6.7                              |     |     | 0.5  |  |  | 6.3 |  |  | 0.5 |  |  | 6.2 |  |  |    |
| t <sub>PZH</sub> | OE              | A              | 2.5                      |     |     | 0.5                              |     |     | 8.3                               |     |     | 0.5                              |     |     | 8.3                              |     |     | 0.5  |  |  | 8.3 |  |  | 0.5 |  |  | 8.3 |  |  | ns |
| t <sub>PZL</sub> |                 |                | 2.5                      |     |     | 0.5                              |     |     | 8.3                               |     |     | 0.5                              |     |     | 8.3                              |     |     | 0.5  |  |  | 8.3 |  |  | 0.5 |  |  | 8.3 |  |  |    |
| t <sub>PZH</sub> | OE              | B              | 5.2                      |     |     | 0.5                              |     |     | 12.4                              |     |     | 0.5                              |     |     | 10.3                             |     |     | 0.5  |  |  | 8.1 |  |  | 0.5 |  |  | 7.5 |  |  | ns |
| t <sub>PZL</sub> |                 |                | 5.2                      |     |     | 0.5                              |     |     | 12.4                              |     |     | 0.5                              |     |     | 10.3                             |     |     | 0.5  |  |  | 8.1 |  |  | 0.5 |  |  | 7.5 |  |  |    |
| t <sub>PHZ</sub> | OE              | A              | 3                        |     |     | 0.5                              |     |     | 9.1                               |     |     | 0.5                              |     |     | 9.1                              |     |     | 0.5  |  |  | 9.1 |  |  | 0.5 |  |  | 9.1 |  |  | ns |
| t <sub>PLZ</sub> |                 |                | 3                        |     |     | 0.5                              |     |     | 9.1                               |     |     | 0.5                              |     |     | 9.1                              |     |     | 0.5  |  |  | 9.1 |  |  | 0.5 |  |  | 9.1 |  |  |    |
| t <sub>PHZ</sub> | OE              | B              | 5                        |     |     | 0.5                              |     |     | 10.9                              |     |     | 0.5                              |     |     | 9.6                              |     |     | 0.5  |  |  | 9.1 |  |  | 0.5 |  |  | 8.2 |  |  | ns |
| t <sub>PLZ</sub> |                 |                | 5                        |     |     | 0.5                              |     |     | 10.9                              |     |     | 0.5                              |     |     | 9.6                              |     |     | 0.5  |  |  | 9.1 |  |  | 0.5 |  |  | 8.2 |  |  |    |

## 7.10 Switching Characteristics: $V_{CCA} = 3.3\text{ V} \pm 0.3\text{ V}$

over recommended operating free-air temperature range,  $V_{CCA} = 3.3\text{ V} \pm 0.3\text{ V}$  (see [Figure 11](#))

| PARAMETER        | FROM<br>(INPUT) | TO<br>(OUTPUT) | V <sub>CCB</sub> = 1.2 V |     |     | V <sub>CCB</sub> = 1.5 V ± 0.1 V |     |     | V <sub>CCB</sub> = 1.8 V ± 0.15 V |     |     | V <sub>CCB</sub> = 2.5 V ± 0.2 V |     |     | V <sub>CCB</sub> = 3.3 V ± 0.3 V |     |     | UNIT |
|------------------|-----------------|----------------|--------------------------|-----|-----|----------------------------------|-----|-----|-----------------------------------|-----|-----|----------------------------------|-----|-----|----------------------------------|-----|-----|------|
|                  |                 |                | MIN                      | TYP | MAX | MIN                              | TYP | MAX | MIN                               | TYP | MAX | MIN                              | TYP | MAX | MIN                              | TYP | MAX |      |
| t <sub>PLH</sub> | A               | B              | 3.2                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     | ns   |
| t <sub>PHL</sub> |                 |                | 3.2                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     |      |
| t <sub>PLH</sub> | B               | A              | 2.8                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     | ns   |
| t <sub>PHL</sub> |                 |                | 2.8                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     |      |
| t <sub>PZH</sub> | OE              | A              | 2.2                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     | ns   |
| t <sub>PZL</sub> |                 |                | 2.2                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     |      |
| t <sub>PZH</sub> | OE              | B              | 5.1                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     | ns   |
| t <sub>PZL</sub> |                 |                | 5.1                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     |      |
| t <sub>PHZ</sub> | OE              | A              | 3.4                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     | ns   |
| t <sub>PLZ</sub> |                 |                | 3.4                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     |      |
| t <sub>PHZ</sub> | OE              | B              | 4.9                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     | ns   |
| t <sub>PLZ</sub> |                 |                | 4.9                      |     |     | 0.5                              |     |     | 0.5                               |     |     | 0.5                              |     |     | 0.5                              |     |     |      |

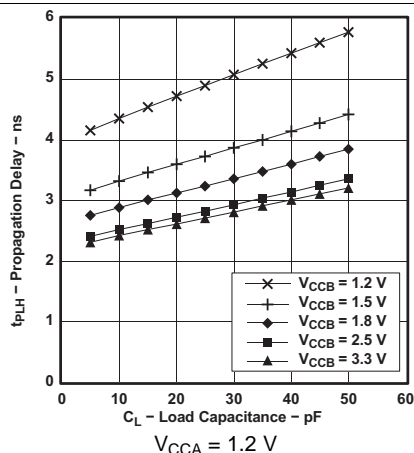
## 7.11 Operating Characteristics

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

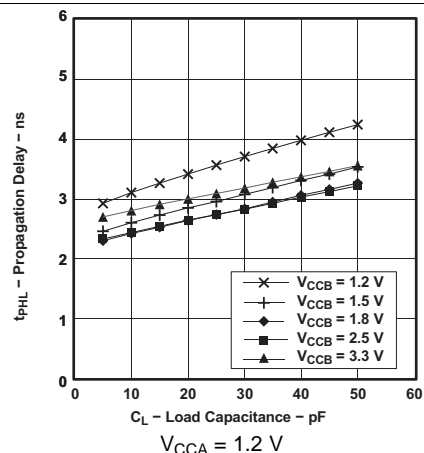
| PARAMETER                       |        |                  | TEST<br>CONDITIONS   | V <sub>CCA</sub> = V <sub>CCB</sub> = 1.2 V |     |     | V <sub>CCA</sub> = V <sub>CCB</sub> = 1.5 V |     |     | V <sub>CCA</sub> = V <sub>CCB</sub> = 1.8 V |     |     | V <sub>CCA</sub> = V <sub>CCB</sub> = 2.5 V |     |     | V <sub>CCA</sub> = V <sub>CCB</sub> = 3.3 V |     |     | UNIT |
|---------------------------------|--------|------------------|--|---|-----|-----|---|-----|-----|---|-----|-----|---|-----|-----|---|-----|-----|------|
|                                 |        |                  |  | MIN   | TYP | MAX | MIN   | TYP | MAX | MIN   | TYP | MAX | MIN   | TYP | MAX | MIN   | TYP | MAX |      |
| C <sub>pda</sub> <sup>(1)</sup> | A to B | Outputs enabled  | C <sub>L</sub> = 0,<br>f = 10 MHz,<br>t <sub>r</sub> = t <sub>f</sub> = 1 ns | 1   |     |     | 1   |     |     | 1   |     |     | 1   |     |     | 2   |     |     | pF   |
|                                 |        | Outputs disabled |  | 1   |     |     | 1   |     |     | 1   |     |     | 1   |     |     |   |     |     |      |
|                                 | B to A | Outputs enabled  |  | 13  |     |     | 13  |     |     | 14  |     |     | 15  |     |     | 16  |     |     |      |
|                                 |        | Outputs disabled |  | 1   |     |     | 1   |     |     | 1   |     |     | 1   |     |     | 1   |     |     |      |
| C <sub>pdb</sub> <sup>(1)</sup> | A to B | Outputs enabled  | C <sub>L</sub> = 0,<br>f = 10 MHz,<br>t <sub>r</sub> = t <sub>f</sub> = 1 ns | 13  |     |     | 13  |     |     | 14  |     |     | 15  |     |     | 16  |     |     | pF   |
|                                 |        | Outputs disabled |  | 1   |     |     | 1   |     |     | 1   |     |     | 1   |     |     |   |     |     |      |
|                                 | B to A | Outputs enabled  |  | 1   |     |     | 1   |     |     | 1   |     |     | 1   |     |     | 2   |     |     |      |
|                                 |        | Outputs disabled |  | 1   |     |     | 1   |     |     | 1   |     |     | 1   |     |     | 1   |     |     |      |

(1) Power dissipation capacitance per transceiver

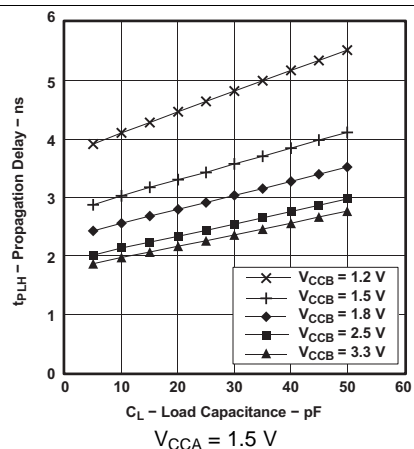
## 7.12 Typical Characteristics



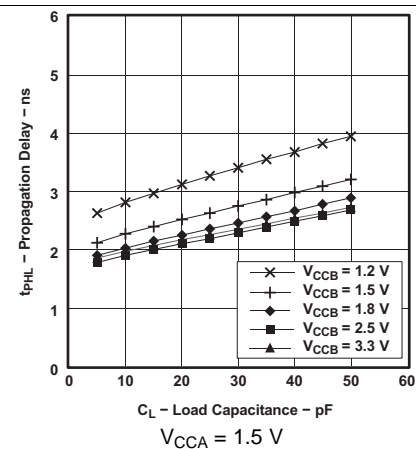
**Figure 1. Typical Propagation Delay  $t_{PLH}$  (A to B) vs Load Capacitance**



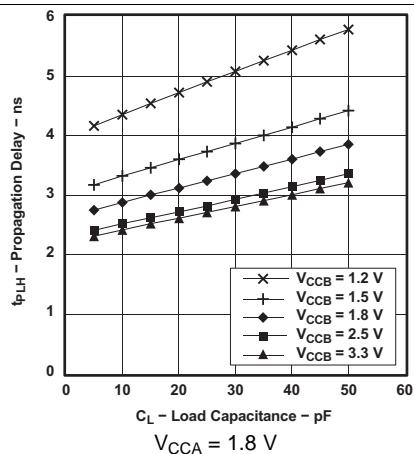
**Figure 2. Typical Propagation Delay  $t_{PHL}$  (A to B) vs Load Capacitance**



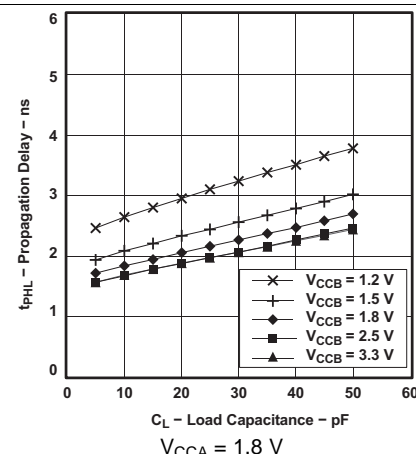
**Figure 3. Typical Propagation Delay  $t_{PLH}$  (A to B) vs Load Capacitance**



**Figure 4. Typical Propagation Delay  $t_{PHL}$  (A to B) vs Load Capacitance**

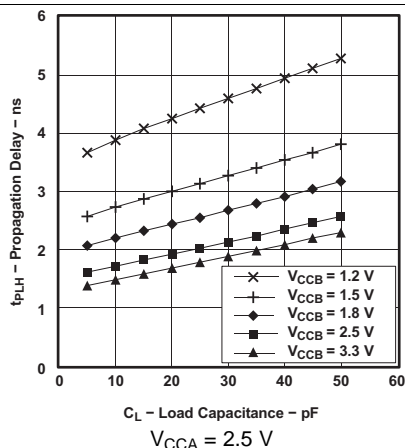


**Figure 5. Typical Propagation Delay  $t_{PLH}$  (A to B) vs Load Capacitance**

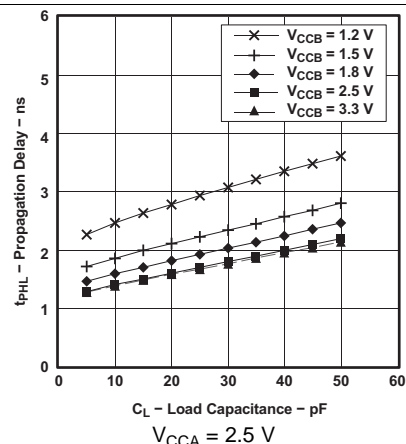


**Figure 6. Typical Propagation Delay  $t_{PHL}$  (A to B) vs Load Capacitance**

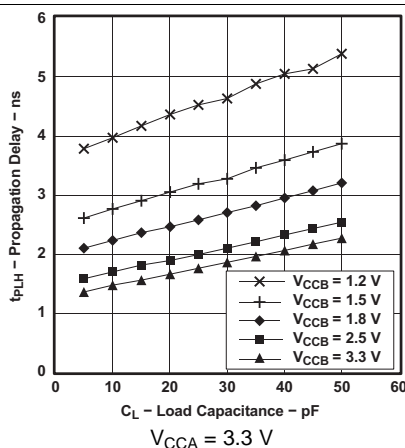
## Typical Characteristics (continued)



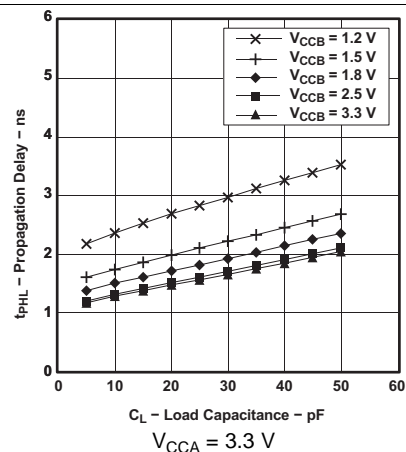
**Figure 7. Typical Propagation Delay  $t_{PLH}$  (A to B) vs Load Capacitance**



**Figure 8. Typical Propagation Delay  $t_{PLH}$  (A to B) vs Load Capacitance**

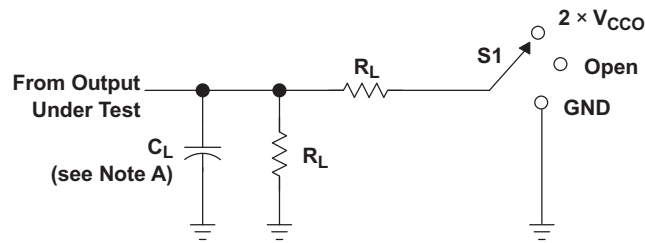


**Figure 9. Typical Propagation Delay  $t_{PLH}$  (A to B) vs Load Capacitance**



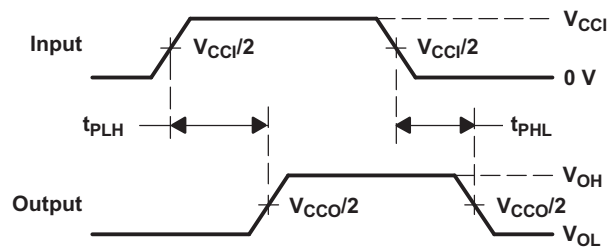
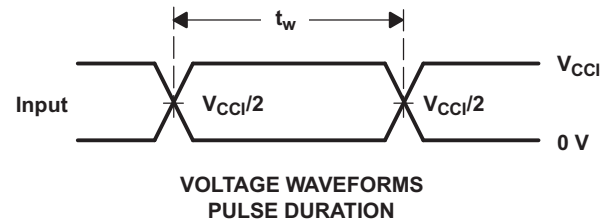
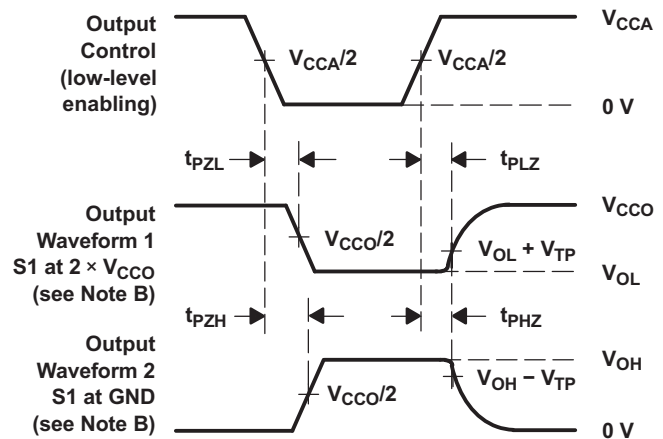
**Figure 10. Typical Propagation Delay  $t_{PLH}$  (A to B) vs Load Capacitance**

## 8 Parameter Measurement Information


**LOAD CIRCUIT**

| $V_{CCO}$          | $C_L$ | $R_L$        | $V_{TP}$ |
|--------------------|-------|--------------|----------|
| 1.2 V              | 15 pF | 2 k $\Omega$ | 0.1 V    |
| 1.5 V $\pm$ 0.1 V  | 15 pF | 2 k $\Omega$ | 0.1 V    |
| 1.8 V $\pm$ 0.15 V | 15 pF | 2 k $\Omega$ | 0.15 V   |
| 2.5 V $\pm$ 0.2 V  | 15 pF | 2 k $\Omega$ | 0.15 V   |
| 3.3 V $\pm$ 0.3 V  | 15 pF | 2 k $\Omega$ | 0.3 V    |

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


**VOLTAGE WAVEFORMS  
PROPAGATION DELAY TIMES**

**VOLTAGE WAVEFORMS  
ENABLE AND DISABLE TIMES**

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

**Figure 11. Load Circuit and Voltage Waveforms**

## 9 Detailed Description

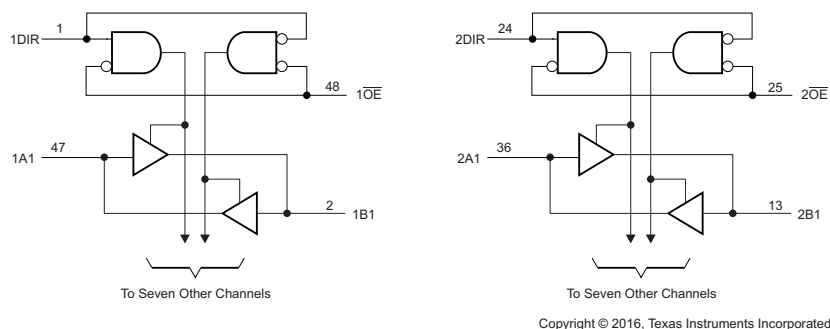
### 9.1 Overview

The SN74AVC16T245-Q1 is a 16-bit, dual-supply, noninverting, bidirectional voltage level translation. Pins A and control pins (DIR and  $\overline{OE}$ ) are supported by  $V_{CCA}$  and B pins are supported by  $V_{CCB}$ . The A port can accept I/O voltages ranging from 1.2 V to 3.6 V, while the B port can accept I/O voltages from 1.2 V to 3.6 V. A high on DIR allows data transmission from A to B and a low on DIR allows data transmission from B to A when  $\overline{OE}$  is set to low. When  $\overline{OE}$  is set to high, both A and B are in the high-impedance state.

This device is fully specified for partial-power-down applications using off output current ( $I_{off}$ ).

The  $V_{CC}$  isolation feature ensures that if either  $V_{CC}$  input is at GND, both ports are put in a high-impedance state.

### 9.2 Functional Block Diagram



### 9.3 Feature Description

#### 9.3.1 Fully Configurable Dual-Rail Design Allows Each Port to Operate Over the Full 1.2-V to 3.6-V Power-Supply Range

Both  $V_{CCA}$  and  $V_{CCB}$  can be supplied at any voltage from 1.2 V to 3.6 V, making the device suitable for translating between any of the low voltage nodes (1.2 V, 1.8 V, 2.5 V, and 3.3 V).

#### 9.3.2 Partial-Power-Down Mode Operation

This device is fully specified for partial-power-down applications using off output current ( $I_{off}$ ). The  $I_{off}$  circuitry prevents backflow current by disabling I/O output circuits when device is in partial power-down mode.

#### 9.3.3 $V_{CC}$ Isolation

The  $V_{CC}$  isolation feature ensures that if either  $V_{CCA}$  or  $V_{CCB}$  are at GND, both ports are in a high-impedance state ( $I_{OZ}$  shown in [Electrical Characteristics](#)). This prevents false logic levels from being presented to either bus.

### 9.4 Device Functional Modes

The SN74AVC16T245-Q1 is a voltage level translator that can operate from 1.2 V to 3.6 V ( $V_{CCA}$ ) and 1.2 V to 3.6 V ( $V_{CCB}$ ). The signal translation between 1.2 V and 3.6 V requires direction control and output enable control. When  $\overline{OE}$  is low and DIR is high, data transmission is from A to B. When  $\overline{OE}$  is low and DIR is low, data transmission is from B to A. When  $\overline{OE}$  is high, both output ports will be high-impedance. [Table 1](#) lists the functions.

**Table 1. Function Table (Each 16-Bit Section)**

| CONTROL INPUTS  |     | OUTPUT CIRCUITS |         | OPERATION       |
|-----------------|-----|-----------------|---------|-----------------|
| $\overline{OE}$ | DIR | A PORT          | B PORT  |                 |
| L               | L   | Enabled         | Hi-Z    | B data to A bus |
| L               | H   | Hi-Z            | Enabled | A data to B bus |
| H               | X   | Hi-Z            | Hi-Z    | Isolation       |

## 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 SN74AVC16T245-Q1 device can be used in level-shifting applications for interfacing devices and addressing mixed voltage incompatibility. The SN74AVC16T245-Q1 device is ideal for data transmission where direction is different for each channel.

#### 10.1.1 Enable Times

Calculate the enable times for the SN74AVC16T45 using the following formulas:

$$t_{PZH} \text{ (DIR to A)} = t_{PLZ} \text{ (DIR to B)} + t_{PLH} \text{ (B to A)} \quad (1)$$

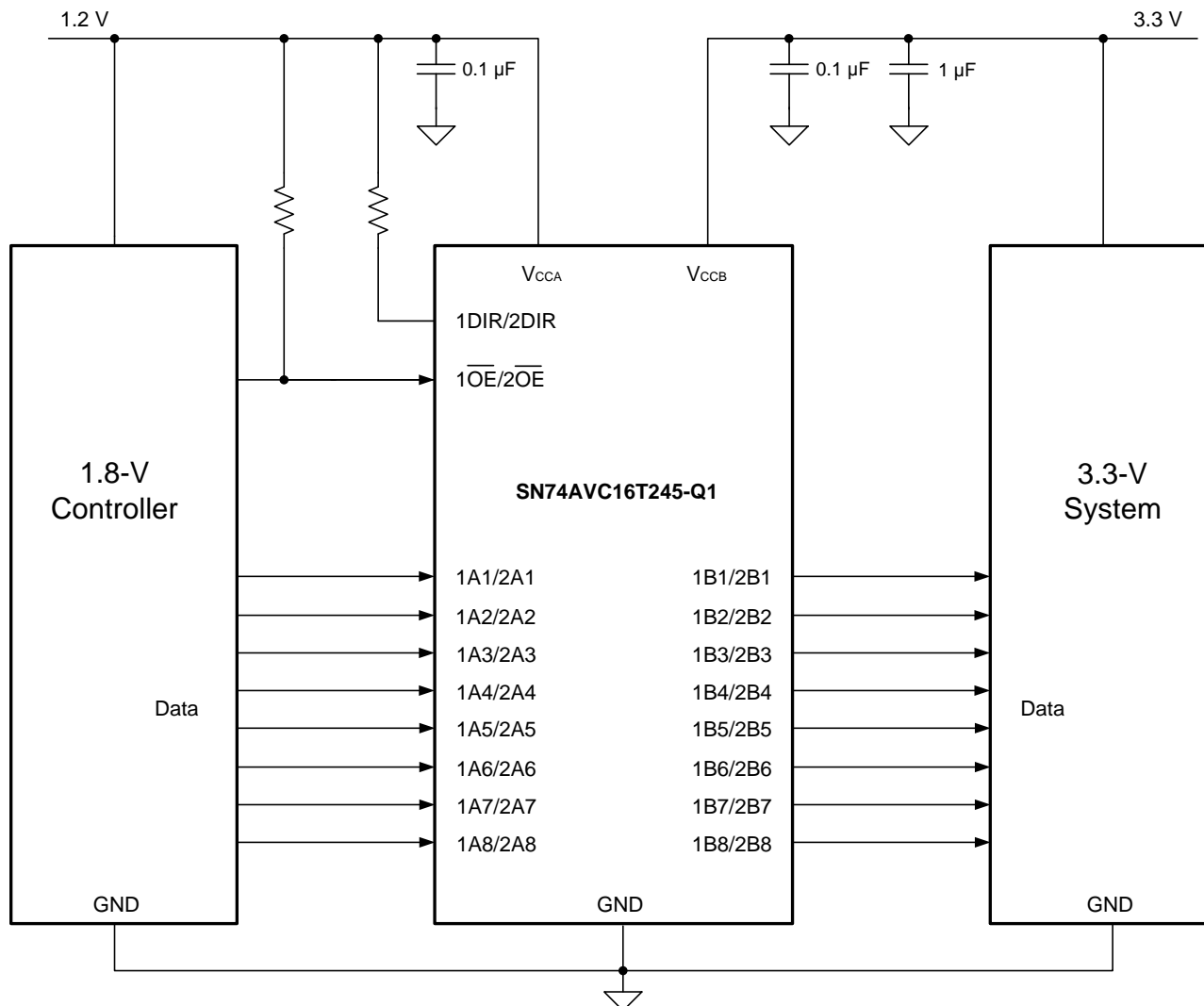
$$t_{PZL} \text{ (DIR to A)} = t_{PHZ} \text{ (DIR to B)} + t_{PHL} \text{ (B to A)} \quad (2)$$

$$t_{PZH} \text{ (DIR to B)} = t_{PLZ} \text{ (DIR to A)} + t_{PLH} \text{ (A to B)} \quad (3)$$

$$t_{PZL} \text{ (DIR to B)} = t_{PHZ} \text{ (DIR to A)} + t_{PHL} \text{ (A to B)} \quad (4)$$

In a bidirectional application, these enable times provide the maximum delay from the time the DIR bit is switched until an output is expected. For example, if the SN74AVC16T245-Q1 initially is transmitting from A to B, then the DIR bit is switched; the B port of the device must be disabled before presenting it with an input. After the B port has been disabled, an input signal applied to it appears on the corresponding A port after the specified propagation delay.

## 10.2 Typical Application



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**Figure 12. Typical Application Schematic**

### 10.2.1 Design Requirements

This device uses drivers which are enabled depending on the state of the DIR pin. The designer must know the intended flow of data and take care not to violate any of the high or low logic levels. Unused data inputs must not be floating, as this can cause excessive internal leakage on the input CMOS structure. Tie any unused input and output ports directly to ground.

For this design example, use the parameters listed in [Table 2](#).

**Table 2. Design Parameters**

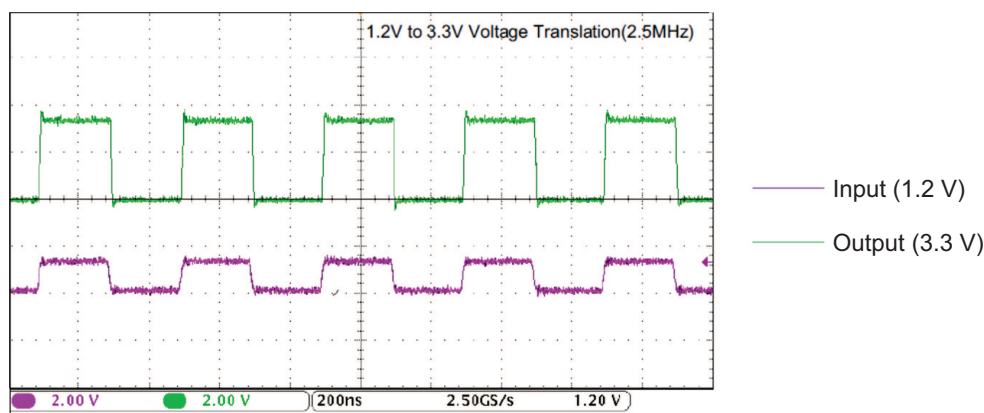
| DESIGN PARAMETER     | EXAMPLE VALUE |
|----------------------|---------------|
| Input voltage range  | 1.2 V         |
| Output voltage range | 3.3 V         |

### 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 SN74AVC16T245-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 SN74AVC16T245-Q1 device is driving to determine the output voltage range.

### 10.2.3 Application Curve



**Figure 13. Translation Up (1.2 V to 3.3 V) at 2.5 MHz**

## 11 Power Supply Recommendations

The SN74AVC16T245-Q1 device uses two separate configurable power-supply rails,  $V_{CCA}$  and  $V_{CCB}$ .  $V_{CCA}$  accepts any supply voltage from 1.2 V to 3.6 V and  $V_{CCB}$  accepts any supply voltage from 1.2 V to 3.6 V. The A port and B port are designed to track  $V_{CCA}$  and  $V_{CCB}$ , respectively, allowing for low-voltage bidirectional translation between any of the 1.2-V, 1.5-V, 1.8-V, 2.5-V, and 3.3-V voltage nodes.

The output-enable  $\overline{OE}$  input circuit is designed so that it is supplied by  $V_{CCA}$  and when the  $\overline{OE}$  input is high, 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  $\overline{OE}$  input pin must be tied to  $V_{CCA}$  through a pullup resistor and must not be enabled until  $V_{CCA}$  and  $V_{CCB}$  are fully ramped and stable. The minimum value of the pullup resistor to  $V_{CCA}$  is determined by the current-sinking capability of the driver.

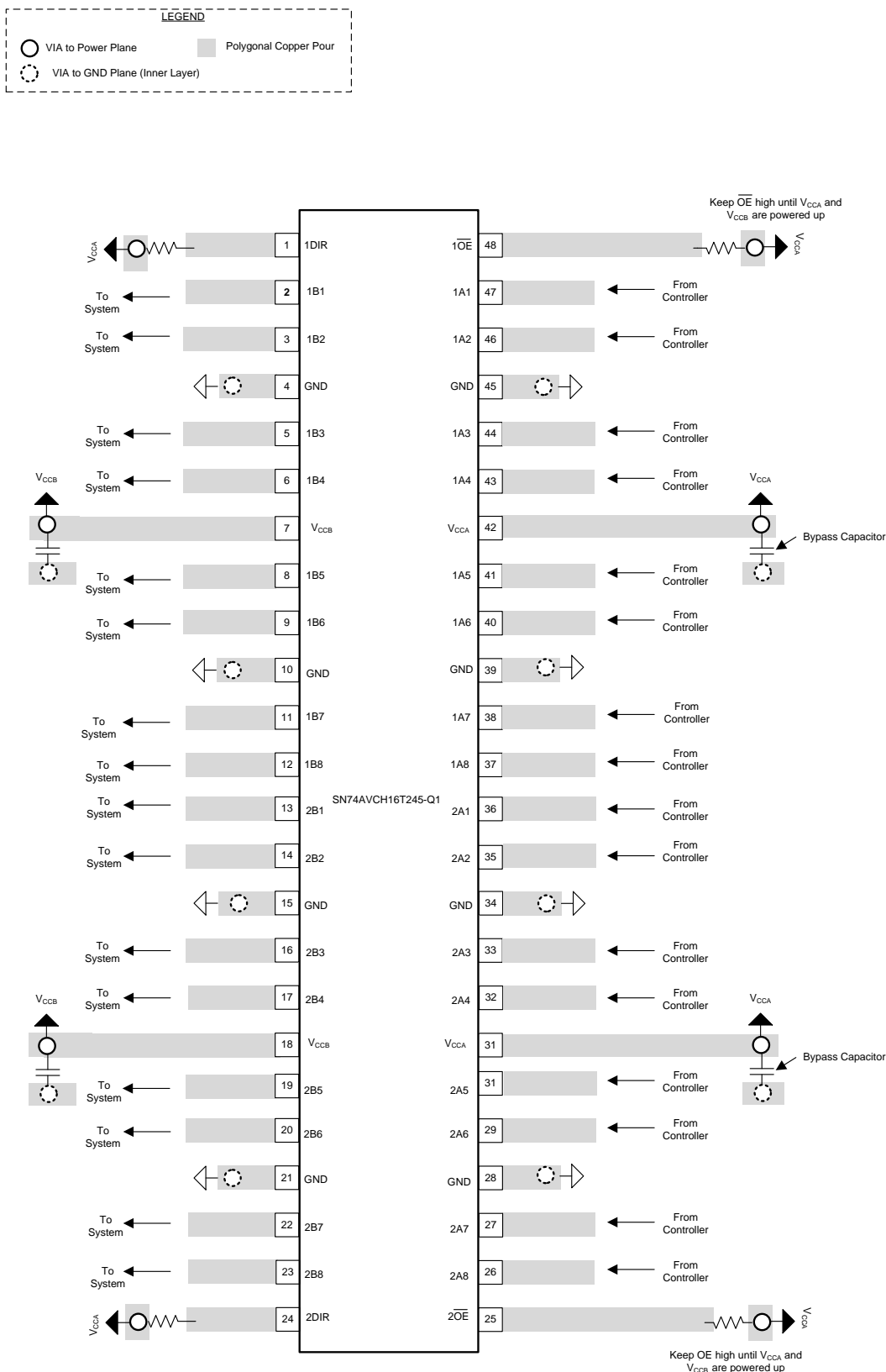
## 12 Layout

### 12.1 Layout Guidelines

To ensure reliability of the device, following common printed-circuit board layout guidelines is recommended:

- Bypass capacitors must be used on power supplies.
- Short trace lengths must be used to avoid excessive loading.
- Placing pads on the signal paths for loading capacitors or pullup resistors to help adjust rise and fall times of signals depending on the system requirements.

## 12.2 Layout Example



**Figure 14. Recommended Layout Example**

## 13 Device and Documentation Support

### 13.1 Documentation Support

#### 13.1.1 Related Documentation

For related documentation see the following:

- [CMOS Power Consumption and Cpd Calculation](#)
- [IC Package Thermal Metrics application report](#)
- [Implications of Slow or Floating CMOS Inputs](#)

### 13.2 Receiving Notification of Documentation Updates

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

### 13.3 Community Resource

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

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

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

### 13.4 Trademarks

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

### 13.5 Electrostatic Discharge Caution



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

### 13.6 Glossary

[SLYZ022](#) — *TI Glossary*.

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

## 14 Mechanical, Packaging, and Orderable Information

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

## PACKAGING INFORMATION

| Orderable Device   | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2) | Lead finish/<br>Ball material<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|--------------------|---------------|--------------|--------------------|------|----------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|-------------------------|
| CAVC16T245QDGVQRQ1 | ACTIVE        | TVSOP        | DGV                | 48   | 2000           | RoHS & Green    | NIPDAU                               | Level-2-260C-1 YEAR  | -40 to 125   | WF245Q                  | <a href="#">Samples</a> |

(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.

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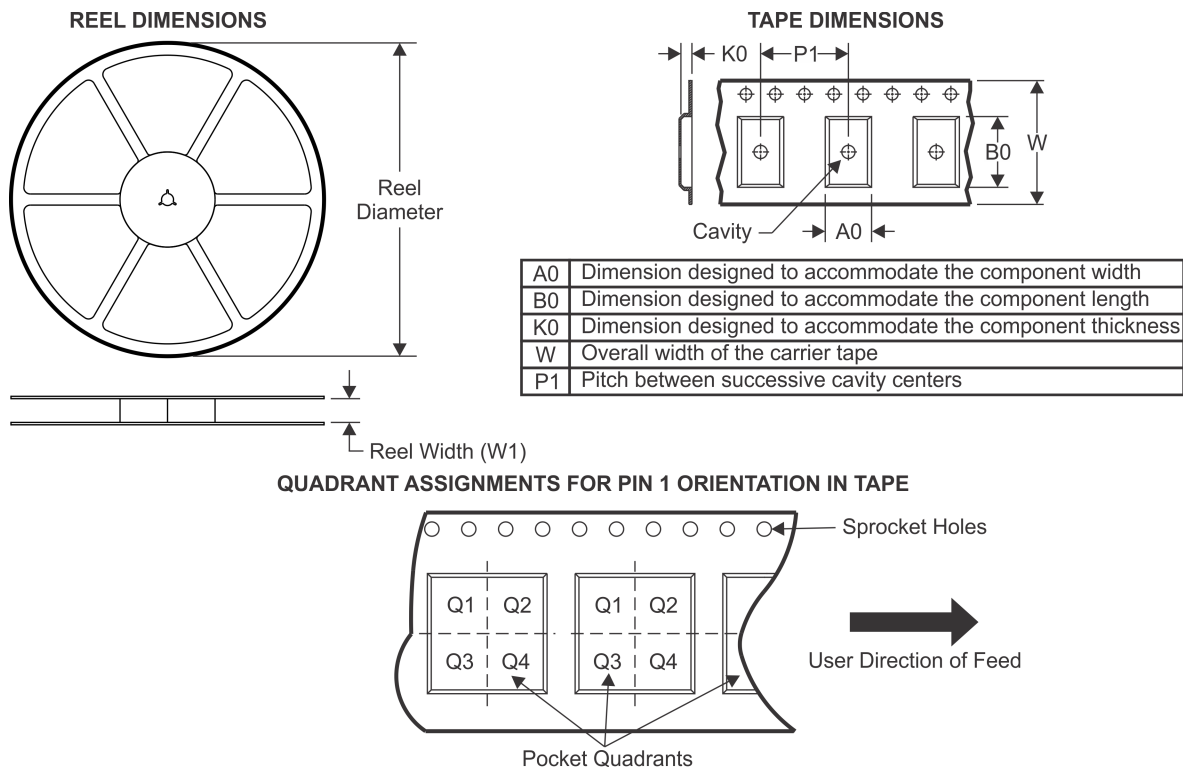
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**OTHER QUALIFIED VERSIONS OF SN74AVC16T245-Q1 :**

- 
- Catalog: [SN74AVC16T245](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

**TAPE AND REEL INFORMATION**


\*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 |
|-------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| CAVC16T245QDGVRQ1 | TVSOP        | DGV             | 48   | 2000 | 330.0              | 16.4               | 7.1     | 10.2    | 1.6     | 12.0    | 16.0   | Q1            |

## TAPE AND REEL BOX DIMENSIONS



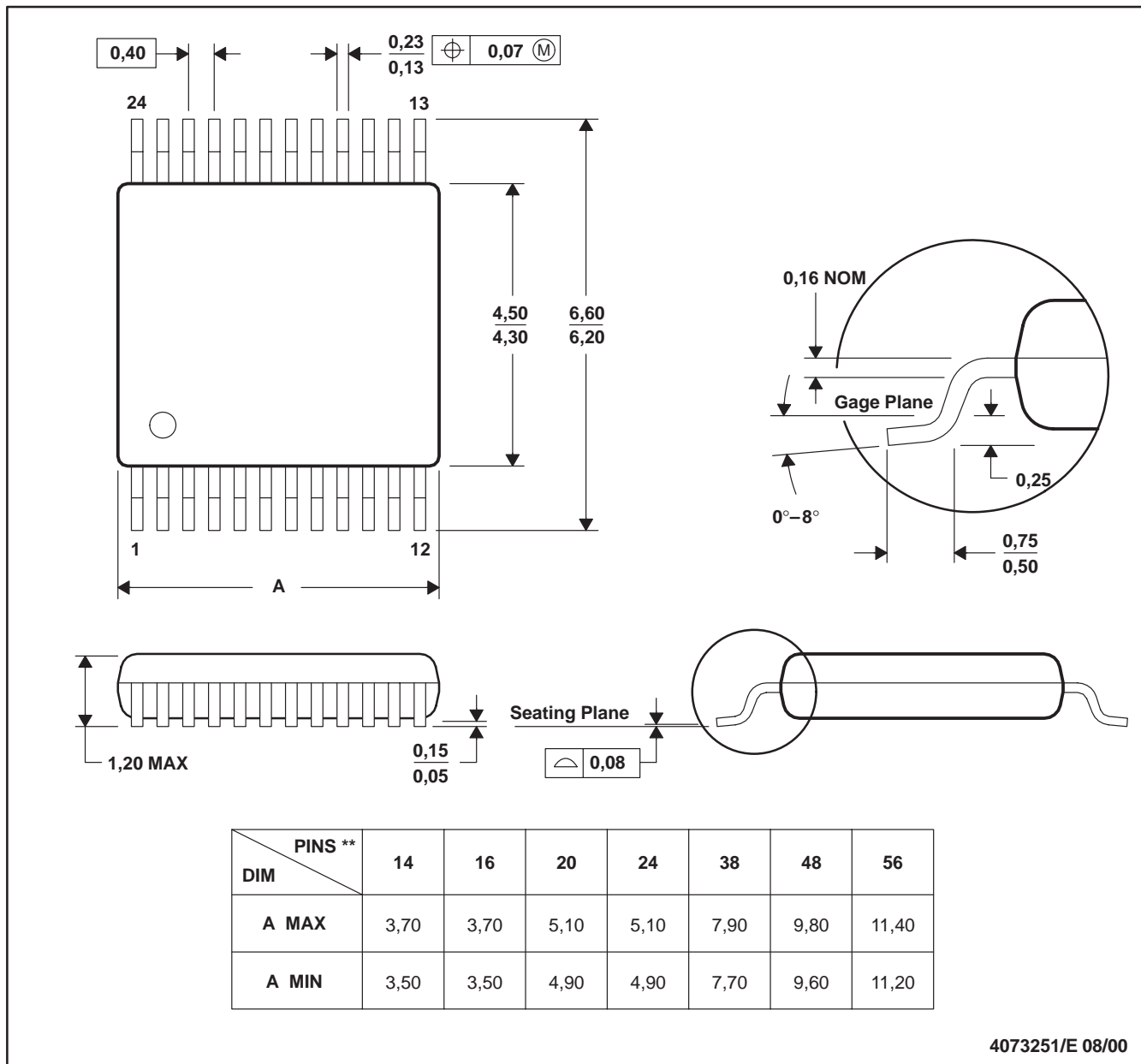
\*All dimensions are nominal

| Device             | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|--------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| CAVC16T245QDGVQRQ1 | TVSOP        | DGV             | 48   | 2000 | 853.0       | 449.0      | 35.0        |

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

## PLASTIC SMALL-OUTLINE

24 PINS SHOWN



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

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