TEXAS INSTRUMENTS
SN74LXC2T45-Q1
SCES929A – JANUARY 2022 – REVISED MAY 2022

# SN74LXC2T45-Q1 Automotive Dual-Bit Dual-Supply Bus Transceiver with Configurable Level Shifting

## 1 Features

- AEC-Q100 qualified for automotive applications
- Fully configurable dual-rail design allows each port to operate from 1.1 V to 5.5 V
- Robust, glitch-free power supply sequencing
- Up to 420-Mbps support for 3.3 V to 5.0 V
- Schmitt-trigger inputs allow for slow or noisy inputs
- I/O's with integrated dynamic pull-down resistors help reduce external component count
- Control inputs with integrated static pull-down resistors allow for floating control inputs
- High drive strength (up to 32 mA at 5 V)
- Low power consumption
  - 3-µA maximum (25°C)
  - 6-µA maximum (–40°C to 125°C)
- $V_{CC}$ isolation and $V_{CC}$ disconnect ($I_{off-float}$) feature
  - If either $V_{CC}$ supply is < 100 mV or disconnected, all I/O's get pulled-down and then become high-impedance
- $I_{off}$ supports partial-power-down mode operation
- Compatible with LVC family level shifters
- Control logic (DIR) are referenced to $V_{CCA}$
- Operating temperature from –40°C to +125°C
- Latch-up performance exceeds 100 mA per JESD 78, class II
- ESD protection exceeds JESD 22
  - 4000-V human-body model
  - 1000-V charged-device model

## 2 Applications

- Eliminate slow or noisy input signals
- Driving indicator LEDs or Buzzers
- Debouncing a mechanical switch
- Infotainment head unit
- ADAS fusion

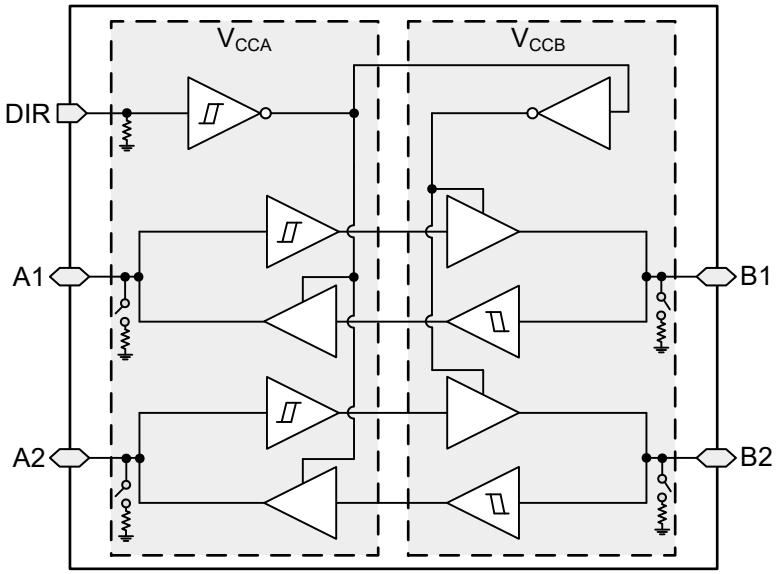
## 3 Description

The SN74LXC2T45-Q1 is a dual-bit, dual-supply noninverting bidirectional voltage level translation device. Ax pins and control pin (DIR) are referenced to $V_{CCA}$ logic levels, and Bx pins are referenced to $V_{CCB}$ logic levels. The A port is able to accept I/O voltages ranging from 1.1 V to 5.5 V, while the B port can accept I/O voltages from 1.1 V to 5.5 V. A high on DIR allows data transmission from A to B and a low on DIR allows data transmission from B to A. See *Device Functional Modes* for a summary of the operation of the control logic.

**Device Information**(1)

| PART NUMBER | PACKAGE | BODY SIZE (NOM) |
|---|---|---|
| SN74LXC2T45-Q1 | VSSOP (DCU) (8) | 2.30 mm × 2.00 mm |
| | SON (DTT) (8) | 1.95 mm × 1.00 mm |

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




**Functional Block Diagram**

An IMPORTANT NOTICE at the end of this data sheet addresses availability, warranty, changes, use in safety-critical applications, intellectual property matters and other important disclaimers. PRODUCTION DATA.

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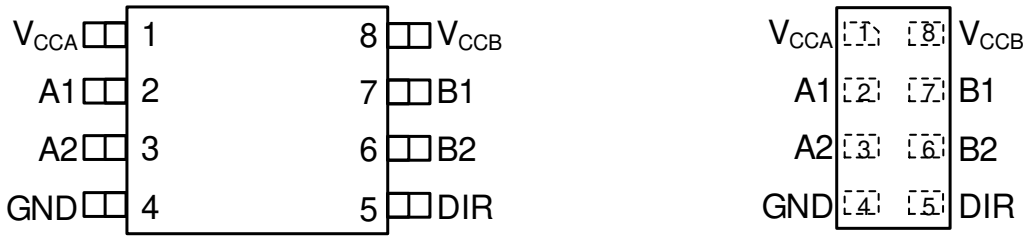
## 4 Revision History

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

| Changes from Revision * (January 2022) to Revision A (May 2022) | Page |
|---|---|
| • Changed the status of the data sheet from: *Advanced Information* to: *Production Data* | 1 |


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## 5 Pin Configuration and Functions




**All Package,s are on the same relative scale**

**Figure 5-1. DCU and DTT Package, 8-Pin VSSOP and SON Transparent (Top View)**

**Table 5-1. Pin Functions**

| PIN | | TYPE(1) | DESCRIPTION |
|---|---|---|---|
| NAME | DCU, DTT | | |
| $V_{CCA}$ | 1 | — | A-port supply voltage. 1.1 V ≤ $V_{CCA}$ ≤ 5.5 V. |
| A1 | 2 | I/O | Input/output A1. Referenced to $V_{CCA}$. |
| A2 | 3 | I/O | Input/output A2. Referenced to $V_{CCA}$. |
| GND | 4 | I/O | Ground. |
| DIR | 5 | I | Direction-control signal for all ports. Referenced to $V_{CCA}$. |
| B2 | 6 | I/O | Input/output B2. Referenced to $V_{CCB}$. |
| B1 | 7 | I/O | Input/output B1. Referenced to $V_{CCB}$. |
| $V_{CCB}$ | 8 | — | B-port supply voltage. 1.1 V ≤ $V_{CCB}$ ≤ 5.5 V. |

(1) I = input, O = output

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# 6 Specifications

## 6.1 Absolute Maximum Ratings

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

| | | | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| $V_{CCA}$ | Supply voltage A | | –0.5 | 6.5 | V |
| $V_{CCB}$ | Supply voltage B | | –0.5 | 6.5 | V |
| $V_I$ | Input Voltage(2) | I/O Ports (A Port) | –0.5 | 6.5 | V |
| | | I/O Ports (B Port) | –0.5 | 6.5 | |
| | | Control Inputs | –0.5 | 6.5 | |
| $V_O$ | Voltage applied to any output in the high-impedance or power-off state(2) | A Port | –0.5 | 6.5 | V |
| | | B Port | –0.5 | 6.5 | |
| $V_O$ | Voltage applied to any output in the high or low state(2) (3) | A Port | –0.5 | $V_{CCA}$ + 0.5 | V |
| | | 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 | 50 | mA |
| | Continuous current through $V_{CC}$ or GND | | –200 | 200 | mA |
| $T_j$ | Junction Temperature | | | 150 | °C |
| $T_{stg}$ | Storage temperature | | –65 | 150 | °C |

(1) Operation outside the *Absolute Maximum Ratings* may cause permanent device damage. *Absolute Maximum Ratings* do not imply functional operation of the device at these or any other conditions beyond those listed under *Recommended Operating Conditions*.. If used outside the *Recommended Operating Conditions* but within the *Absolute Maximum Ratings*, the device may not be fully functional, and this may affect device reliability, functionality, performance, and shorten the device lifetime.
(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 6.5 V maximum if the output current rating is observed.

## 6.2 ESD Ratings

| | | | VALUE | UNIT |
|---|---|---|---|---|
| $V_{(ESD)}$ | Electrostatic discharge | Human body model (HBM), per AEC Q100-002(1) | ±4000 | 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


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## 6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted) (1) (2) (3)

| | | | | MIN | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{CCA}$ | Supply voltage A | | | 1.1 | 5.5 | V |
| $V_{CCB}$ | Supply voltage B | | | 1.1 | 5.5 | V |
| $I_{OH}$ | High-level output current | | $V_{CCO}$ = 1.1 V | | –0.1 | mA |
| | | | $V_{CCO}$ = 1.4 V | | –4 | |
| | | | $V_{CCO}$ = 1.65 V | | –8 | |
| | | | $V_{CCO}$ = 2.3 V | | –12 | |
| | | | $V_{CCO}$ = 3 V | | –24 | |
| | | | $V_{CCO}$ = 4.5 V | | –32 | |
| $I_{OL}$ | Low-level output current | | $V_{CCO}$ = 1.1 V | | 0.1 | mA |
| | | | $V_{CCO}$ = 1.4 V | | 4 | |
| | | | $V_{CCO}$ = 1.65 V | | 8 | |
| | | | $V_{CCO}$ = 2.3 V | | 12 | |
| | | | $V_{CCO}$ = 3 V | | 24 | |
| | | | $V_{CCO}$ = 4.5 V | | 32 | |
| $V_I$ | Input voltage (3) | | | 0 | 5.5 | V |
| $V_O$ | Output voltage | Active State | | 0 | $V_{CCO}$ | V |
| | | Tri-State | | 0 | 5.5 | |
| $T_A$ | Operating free-air temperature | | | –40 | 125 | °C |

(1) $V_{CCI}$ is the $V_{CC}$ associated with the input port.
(2) $V_{CCO}$ is the $V_{CC}$ associated with the output port.
(3) All control inputs and data I/Os of this device have weak pulldowns to ensure the line is not floating when undefined external to the device. The input leakage from these weak pulldowns is defined by the $I_I$ specification indicated under Electrical Characteristics

## 6.4 Thermal Information

| THERMAL METRIC(1) | | SN74LXC2T45-Q1 | | UNIT |
|---|---|---|---|---|
| | | DCU (VSSOP) | DTT (SON) | |
| | | 8 PINS | 8 PINS | |
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance | 247.7 | 209.0 | °C/W |
| $R_{\theta JC(top)}$ | Junction-to-case (top) thermal resistance | 96.7 | 139.3 | °C/W |
| $R_{\theta JB}$ | Junction-to-board thermal resistance | 159.1 | 107.5 | °C/W |
| $Y_{JT}$ | Junction-to-top characterization parameter | 38.2 | 16.6 | °C/W |
| $Y_{JB}$ | Junction-to-board characterization parameter | 158.2 | 107.3 | °C/W |

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

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## 6.5 Electrical Characteristics

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

| PARAMETER | | TEST CONDITIONS | $V_{CCA}$ | $V_{CCB}$ | Operating free-air temperature ($T_A$) | | | | | | | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 25°C | | | –40°C to 85°C | | | –40°C to 125°C | | | |
| | | | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_{T+}$ | Positive-going input-threshold voltage | Data Inputs (Ax, Bx) (Referenced to $V_{CCI}$) | 1.1 V | 1.1 V | | | | 0.44 | | 0.88 | 0.44 | | 0.88 | V |
| | | | 1.4 V | 1.4 V | | | | 0.60 | | 0.98 | 0.60 | | 0.98 | |
| | | | 1.65 V | 1.65 V | | | | 0.76 | | 1.13 | 0.76 | | 1.13 | |
| | | | 2.3 V | 2.3 V | | | | 1.08 | | 1.56 | 1.08 | | 1.56 | |
| | | | 3 V | 3 V | | | | 1.48 | | 1.92 | 1.48 | | 1.92 | |
| | | | 4.5 V | 4.5 V | | | | 2.19 | | 2.74 | 2.19 | | 2.74 | |
| | | | 5.5 V | 5.5 V | | | | 2.65 | | 3.33 | 2.65 | | 3.33 | |
| | | Control Input (DIR) (Referenced to $V_{CCA}$) | 1.1 V | 1.1 V | | | | 0.44 | | 0.88 | 0.44 | | 0.88 | V |
| | | | 1.4 V | 1.4 V | | | | 0.60 | | 0.98 | 0.60 | | 0.98 | |
| | | | 1.65 V | 1.65 V | | | | 0.76 | | 1.13 | 0.76 | | 1.13 | |
| | | | 2.3 V | 2.3 V | | | | 1.08 | | 1.56 | 1.08 | | 1.56 | |
| | | | 3 V | 3 V | | | | 1.48 | | 1.92 | 1.48 | | 1.92 | |
| | | | 4.5 V | 4.5 V | | | | 2.19 | | 2.74 | 2.19 | | 2.74 | |
| | | | 5.5 V | 5.5 V | | | | 2.65 | | 3.33 | 2.65 | | 3.33 | |
| $V_{T-}$ | Negative-going input-threshold voltage | Data Inputs (Ax, Bx) (Referenced to $V_{CCI}$) | 1.1 V | 1.1 V | | | | 0.17 | | 0.48 | 0.17 | | 0.48 | V |
| | | | 1.4 V | 1.4 V | | | | 0.28 | | 0.59 | 0.28 | | 0.59 | |
| | | | 1.65 V | 1.65 V | | | | 0.35 | | 0.69 | 0.35 | | 0.69 | |
| | | | 2.3 V | 2.3 V | | | | 0.56 | | 0.97 | 0.56 | | 0.97 | |
| | | | 3 V | 3 V | | | | 0.89 | | 1.5 | 0.89 | | 1.5 | |
| | | | 4.5 V | 4.5 V | | | | 1.51 | | 1.97 | 1.51 | | 1.97 | |
| | | | 5.5 V | 5.5 V | | | | 1.88 | | 2.4 | 1.88 | | 2.4 | |
| | | Control Input (DIR) (Referenced to $V_{CCA}$) | 1.1 V | 1.1 V | | | | 0.17 | | 0.48 | 0.17 | | 0.48 | V |
| | | | 1.4 V | 1.4 V | | | | 0.28 | | 0.6 | 0.28 | | 0.6 | |
| | | | 1.65 V | 1.65 V | | | | 0.35 | | 0.71 | 0.35 | | 0.71 | |
| | | | 2.3 V | 2.3 V | | | | 0.56 | | 1 | 0.56 | | 1 | |
| | | | 3 V | 3 V | | | | 0.89 | | 1.5 | 0.89 | | 1.5 | |
| | | | 4.5 V | 4.5 V | | | | 1.51 | | 2 | 1.51 | | 2 | |
| | | | 5.5 V | 5.5 V | | | | 1.88 | | 2.46 | 1.88 | | 2.46 | |
| $\Delta V_T$ | Input-threshold hysteresis ($V_{T+} - V_{T-}$) | Data Inputs (Ax, Bx) (Referenced to $V_{CCI}$) | 1.1 V | 1.1 V | | | | 0.2 | | 0.4 | 0.2 | | 0.4 | V |
| | | | 1.4 V | 1.4 V | | | | 0.25 | | 0.5 | 0.25 | | 0.5 | |
| | | | 1.65 V | 1.65 V | | | | 0.3 | | 0.55 | 0.3 | | 0.55 | |
| | | | 2.3 V | 2.3 V | | | | 0.38 | | 0.65 | 0.38 | | 0.65 | |
| | | | 3 V | 3 V | | | | 0.46 | | 0.72 | 0.46 | | 0.72 | |
| | | | 4.5 V | 4.5 V | | | | 0.58 | | 0.93 | 0.58 | | 0.93 | |
| | | | 5.5 V | 5.5 V | | | | 0.69 | | 1.06 | 0.69 | | 1.06 | |
| | | Control Input (DIR) (Referenced to $V_{CCA}$) | 1.1 V | 1.1 V | | | | 0.2 | | 0.4 | 0.2 | | 0.4 | V |
| | | | 1.4 V | 1.4 V | | | | 0.25 | | 0.5 | 0.25 | | 0.5 | |
| | | | 1.65 V | 1.65 V | | | | 0.3 | | 0.55 | 0.3 | | 0.55 | |
| | | | 2.3 V | 2.3 V | | | | 0.38 | | 0.65 | 0.38 | | 0.65 | |
| | | | 3 V | 3 V | | | | 0.46 | | 0.72 | 0.46 | | 0.72 | |
| | | | 4.5 V | 4.5 V | | | | 0.58 | | 0.93 | 0.58 | | 0.93 | |
| | | | 5.5 V | 5.5 V | | | | 0.69 | | 1.06 | 0.69 | | 1.06 | |


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## 6.5 Electrical Characteristics (continued)

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

| PARAMETER | | TEST CONDITIONS | $V_{CCA}$ | $V_{CCB}$ | Operating free-air temperature ($T_A$) | | | | | | | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 25°C | | | –40°C to 85°C | | | –40°C to 125°C | | | |
| | | | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_{OH}$ | High-level output voltage (3) | $I_{OH}$ = –100 µA | 1.1 V – 5.5 V | 1.1 V – 5.5 V | | | | $V_{CCO}$ – 0.1 | | | $V_{CCO}$ – 0.1 | | | V |
| | | $I_{OH}$ = –4 mA | 1.4 V | 1.4 V | | | | 1 | | | 1 | | | |
| | | $I_{OH}$ = –8 mA | 1.65 V | 1.65 V | | | | 1.2 | | | 1.2 | | | |
| | | $I_{OH}$ = –12 mA | 2.3 V | 2.3 V | | | | 1.9 | | | 1.9 | | | |
| | | $I_{OH}$ = –24 mA | 3 V | 3 V | | | | 2.4 | | | 2.4 | | | |
| | | $I_{OH}$ = –32 mA | 4.5 V | 4.5 V | | | | 3.8 | | | 3.8 | | | |
| $V_{OL}$ | Low-level output voltage (4) | $I_{OL}$ = 100 µA | 1.1 V – 5.5 V | 1.1 V – 5.5 V | | | | | | 0.1 | | | 0.1 | V |
| | | $I_{OL}$ = 4 mA | 1.4 V | 1.4 V | | | | | | 0.3 | | | 0.3 | |
| | | $I_{OL}$ = 8 mA | 1.65 V | 1.65 V | | | | | | 0.45 | | | 0.45 | |
| | | $I_{OL}$ = 12 mA | 2.3 V | 2.3 V | | | | | | 0.3 | | | 0.3 | |
| | | $I_{OL}$ = 24 mA | 3 V | 3 V | | | | | | 0.55 | | | 0.55 | |
| | | $I_{OL}$ = 32 mA | 4.5 V | 4.5 V | | | | | | 0.55 | | | 0.55 | |
| $I_I$ | Input leakage current | Control input (DIR) $V_I$ = $V_{CCA}$ or GND | 1.1 V – 5.5 V | 1.1 V – 5.5 V | -0.1 | | 1 | -0.1 | | 2 | -0.1 | | 2 | µA |
| | | Data Inputs (5) (Ax, Bx) $V_I$ = $V_{CCI}$ or GND | 1.1 V – 5.5 V | 1.1 V – 5.5 V | –0.3 | | 1 | –1 | | 1 | –2 | | 2 | µA |
| $I_{off}$ | Partial power down current | A Port or B Port $V_I$ or $V_O$ = 0 V – 5.5 V | 0 V | 0 V – 5.5 V | –1 | | 1 | –2 | | 2 | –2.5 | | 2.5 | µA |
| | | | 0 V – 5.5 V | 0 V | –1 | | 1 | –2 | | 2 | –2.5 | | 2.5 | |
| $I_{off-float}$ | Floating supply Partial power down current | A Port or B Port $V_I$ or $V_O$ = GND | Floating (6) | 0 V – 5.5 V | –1.5 | | 1.5 | –2 | | 2 | –2.5 | | 2.5 | µA |
| | | | 0 V – 5.5 V | Floating (6) | –1.5 | | 1.5 | –2 | | 2 | –2.5 | | 2.5 | |
| $I_{CCA}$ | $V_{CCA}$ supply current | $V_I$ = $V_{CCI}$ or GND $I_O$ = 0 | 1.1 V – 5.5 V | 1.1 V – 5.5 V | | | 2 | | | 3 | | | 6 | µA |
| | | | 0 V | 5.5 V | –0.2 | | | –0.5 | | | –1 | | | |
| | | | 5.5 V | 0 V | | | 1 | | | 2 | | | 4 | |
| | | $V_I$ = GND $I_O$ = 0 | 5.5 V | Floating (6) | | | 2 | | | 3 | | | 6 | |
| $I_{CCB}$ | $V_{CCB}$ supply current | $V_I$ = $V_{CCI}$ or GND $I_O$ = 0 | 1.1 V – 5.5 V | 1.1 V – 5.5 V | | | 2 | | | 3 | | | 6 | µA |
| | | | 0 V | 5.5 V | | | 1 | | | 2 | | | 4 | |
| | | | 5.5 V | 0 V | –0.2 | | | –0.5 | | | –1 | | | |
| | | $V_I$ = GND $I_O$ = 0 | Floating (6) | 5.5 V | | | 2 | | | 3 | | | 6 | |
| $I_{CCA}$ + $I_{CCB}$ | Combined supply current | $V_I$ = $V_{CCI}$ or GND $I_O$ = 0 | 1.1 V – 5.5 V | 1.1 V – 5.5 V | | | 3 | | | 4 | | | 6 | µA |

## 6.5 Electrical Characteristics (continued)

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

| PARAMETER | | TEST CONDITIONS | $V_{CCA}$ | $V_{CCB}$ | Operating free-air temperature ($T_A$) | | | | | | | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 25°C | | | –40°C to 85°C | | | –40°C to 125°C | | | |
| | | | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| $\Delta I_{CCA}$ | $V_{CCA}$ additional supply current per input | Control input (DIR): $V_I = V_{CCA} – 0.6$ V A port = VCCA or GND B Port = open | 3.0 V – 5.5 V | 3.0 V – 5.5 V | | | | | | 50 | | | 75 | µA |
| | | A Port: $V_I = V_{CCA} – 0.6$ V DIR = $V_{CCA}$, B Port = open | 3.0 V – 5.5 V | 3.0 V – 5.5 V | | | | | | 50 | | | 75 | |
| $\Delta I_{CCB}$ | $V_{CCB}$ additional supply current per input | B Port: $V_I = V_{CCB}$ - 0.6 V DIR = GND, A Port = open | 3.0 V – 5.5 V | 3.0 V – 5.5 V | | | | | | 50 | | | 75 | µA |
| $C_i$ | Control Input Capacitance | $V_I$ = 3.3 V or GND | 3.3 V | 3.3 V | | 2.2 | | | | 5 | | | 5 | pF |
| $C_{io}$ | Data I/O Capacitance | $V_{CCO}$ = 0V $V_O$ = 1.65 V DC +1 MHz -16 dBm sine wave | 3.3 V | 3.3 V | | 4.4 | | | | 10 | | | 10 | pF |

(1) $V_{CCI}$ is the $V_{CC}$ associated with the input port.
(2) $V_{CCO}$ is the $V_{CC}$ associated with the output port.
(3) Tested at $V_I = V_{T+(MAX)}$
(4) Tested at $V_I = V_{T-(MIN)}$
(5) For I/O ports, the parameter $I_I$ includes the $I_{OZ}$ current.
(6) Floating is defined as a node that is both not actively driven by an external device and has leakage not exeeding 10 nA.


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## 6.6 Switching Characteristics: $T_{sk}$, $T_{MAX}$

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

| PARAMETER | TEST CONDITIONS | | $V_{CCI}$ | $V_{CCO}$ | Operating free-air temperature ($T_A$) -40°C to 125°C MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| $T_{MAX}$ - Maximum Data Rate | 50% Duty Cycle Input<br>One channel switching<br>20% of pulse > 0.7*$V_{CCO}$<br>20% of pulse < 0.3*$V_{CCO}$ | Up Translation | 3.0 V – 3.6 V | 4.5 V – 5.5 V | 200 | 420 | | Mbps |
| | | | 2.25 V – 2.75 V | 4.5 V – 5.5 V | 150 | 300 | | |
| | | | 1.65 V – 1.95 V | 4.5 V – 5.5 V | 100 | 200 | | |
| | | | 1.1 V – 1.3 V | 4.5 V – 5.5 V | 20 | 40 | | |
| | | | 1.65 V – 1.95 V | 3.0 V – 3.6 V | 100 | 210 | | |
| | | | 1.1 V – 1.3 V | 3.0 V – 3.6 V | 10 | 20 | | |
| | | | 1.1 V – 1.3 V | 1.65 V – 1.95 V | 5 | 10 | | |
| | | Down Translation | 4.5 V – 5.5 V | 3.0 V – 3.6 V | 100 | 210 | | |
| | | | 4.5 V – 5.5 V | 2.25 V – 2.75 V | 75 | 140 | | |
| | | | 4.5 V – 5.5 V | 1.65 V – 1.95 V | 50 | 75 | | |
| | | | 4.5 V – 5.5 V | 1.1 V – 1.3 V | 15 | 30 | | |
| | | | 3.0 V – 3.6 V | 1.65 V – 1.95 V | 40 | 75 | | |
| | | | 3.0 V – 3.6 V | 1.1 V – 1.3 V | 10 | 20 | | |
| | | | 1.65 V – 1.95 V | 1.1 V – 1.3 V | 5 | 10 | | |
| $t_{sk}$ - Output skew | Timing skew between any two switching outputs within the same device | Up Translation | 3.0 V – 3.6 V | 4.5 V – 5.5 V | | | 0.2 | ns |
| | | | 1.65 V – 1.95 V | 4.5 V – 5.5 V | | | 0.5 | |
| | | | 1.1 V – 1.3 V | 4.5 V – 5.5 V | | | 3.5 | |
| | | | 1.65 V – 1.95 V | 3.0 V – 3.6 V | | | 0.5 | |
| | | | 1.1 V – 1.3 V | 3.0 V – 3.6 V | | | 3.5 | |
| | | | 1.1 V – 1.3 V | 1.65 V – 1.95 V | | | 2.5 | |
| | | Down Translation | 4.5 V – 5.5 V | 3.0 V – 3.6 V | | | 0.2 | |
| | | | 4.5 V – 5.5 V | 1.65 V – 1.95 V | | | 0.5 | |
| | | | 4.5 V – 5.5 V | 1.1 V – 1.3 V | | | 2 | |
| | | | 3.0 V – 3.6 V | 1.65 V – 1.95 V | | | 0.5 | |
| | | | 3.0 V – 3.6 V | 1.1 V – 1.3 V | | | 2 | |
| | | | 1.65 V – 1.95 V | 1.1 V – 1.3 V | | | 2 | |

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## 6.7 Switching Characteristics, $V_{CCA}$ = 1.2 ± 0.1 V

See Figure 7-1 and Table 7-1 for test circuit and loading. See Figure 7-2, Figure 7-3, and Figure 7-4 for measurement waveforms.

| PARAMETER | | FROM | TO | Test Conditions | B-Port Supply Voltage ($V_{CCB}$) | | | | | | | | | | | | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1.2 ± 0.1 V | | | 1.5 ± 0.1 V | | | 1.8 ± 0.15 V | | | 2.5 ± 0.2 V | | | 3.3 ± 0.3 V | | | 5.0 ± 0.5 V | | | |
| | | | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| $t_{pd}$ | Propagation delay | A | B | -40°C to 85°C | 1 | | 84 | 1 | | 40 | 1 | | 35 | 1 | | 32 | 1 | | 33 | 1 | | 47 | ns |
| | | | | -40°C to 125°C | 1 | | 54 | 1 | | 36 | 1 | | 32 | 1 | | 29 | 1 | | 29 | 1 | | 33 | |
| | | B | A | -40°C to 85°C | 1 | | 84 | 1 | | 70 | 1 | | 66 | 1 | | 59 | 1 | | 56 | 1 | | 57 | |
| | | | | -40°C to 125°C | 1 | | 54 | 1 | | 46 | 1 | | 43 | 1 | | 37 | 1 | | 36 | 1 | | 35 | |
| $t_{dis}$ | Disable time | DIR | A | -40°C to 85°C | 6 | | 84 | 6 | | 63 | 6 | | 63 | 6 | | 63 | 6 | | 63 | 6 | | 63 | ns |
| | | | | -40°C to 125°C | 8 | | 52 | 8 | | 52 | 8 | | 52 | 8 | | 52 | 8 | | 52 | 8 | | 52 | |
| | | DIR | B | -40°C to 85°C | 13 | | 95 | 10 | | 56 | 9 | | 50 | 7 | | 63 | 6 | | 63 | 6 | | 42 | |
| | | | | -40°C to 125°C | 19 | | 82 | 16 | | 57 | 15 | | 52 | 12 | | 44 | 12 | | 43 | 10 | | 42 | |
| $t_{en}$ | Enable time | DIR | A | -40°C to 85°C | 24 | | 158 | 19 | | 117 | 17 | | 106 | 15 | | 93 | 15 | | 91 | 14 | | 92 | ns |
| | | | | -40°C to 125°C | 31 | | 131 | 27 | | 98 | 25 | | 88 | 21 | | 77 | 20 | | 74 | 19 | | 72 | |
| | | DIR | B | -40°C to 85°C | 16 | | 126 | 14 | | 97 | 13 | | 93 | 12 | | 90 | 12 | | 91 | 12 | | 105 | |
| | | | | -40°C to 125°C | 20 | | 102 | 18 | | 83 | 17 | | 78 | 16 | | 73 | 16 | | 72 | 15 | | 75 | |


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## 6.8 Switching Characteristics, $V_{CCA}$ = 1.5 ± 0.1 V

See Figure 7-1 and Table 7-1 for test circuit and loading. See Figure 7-2, Figure 7-3, and Figure 7-4 for measurement waveforms.

| PARAMETER | | FROM | TO | Test Conditions | B-Port Supply Voltage ($V_{CCB}$) | | | | | | | | | | | | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1.2 ± 0.1 V | | | 1.5 ± 0.1 V | | | 1.8 ± 0.15 V | | | 2.5 ± 0.2 V | | | 3.3 ± 0.3 V | | | 5.0 ± 0.5 V | | | |
| | | | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| $t_{pd}$ | Propagation delay | A | B | -40°C to 85°C | 1 | | 70 | 1 | | 29 | 1 | | 24 | 1 | | 20 | 1 | | 19 | 1 | | 19 | ns |
| | | | | -40°C to 125°C | 1 | | 46 | 1 | | 29 | 1 | | 24 | 1 | | 21 | 1 | | 19 | 1 | | 20 | |
| | | B | A | -40°C to 85°C | 1 | | 39 | 1 | | 29 | 1 | | 26 | 1 | | 23 | 1 | | 21 | 1 | | 21 | |
| | | | | -40°C to 125°C | 1 | | 36 | 1 | | 29 | 1 | | 26 | 1 | | 23 | 1 | | 21 | 1 | | 21 | |
| $t_{dis}$ | Disable time | DIR | A | -40°C to 85°C | 3 | | 29 | 3 | | 29 | 3 | | 29 | 3 | | 29 | 3 | | 29 | 3 | | 29 | ns |
| | | | | -40°C to 125°C | 5 | | 29 | 5 | | 29 | 5 | | 29 | 5 | | 29 | 5 | | 29 | 5 | | 29 | |
| | | DIR | B | -40°C to 85°C | 11 | | 78 | 8 | | 45 | 7 | | 38 | 5 | | 31 | 5 | | 30 | 4 | | 28 | |
| | | | | -40°C to 125°C | 17 | | 70 | 14 | | 46 | 11 | | 40 | 10 | | 32 | 9 | | 31 | 8 | | 29 | |
| $t_{en}$ | Enable time | DIR | A | -40°C to 85°C | 19 | | 113 | 15 | | 69 | 13 | | 59 | 11 | | 49 | 11 | | 46 | 9 | | 44 | ns |
| | | | | -40°C to 125°C | 27 | | 101 | 23 | | 70 | 21 | | 61 | 18 | | 51 | 17 | | 48 | 15 | | 45 | |
| | | DIR | B | -40°C to 85°C | 12 | | 91 | 10 | | 53 | 9 | | 48 | 8 | | 43 | 8 | | 41 | 7 | | 41 | |
| | | | | -40°C to 125°C | 16 | | 71 | 14 | | 54 | 13 | | 49 | 12 | | 44 | 12 | | 42 | 11 | | 42 | |

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## 6.9 Switching Characteristics, $V_{CCA}$ = 1.8 ± 0.15 V

See Figure 7-1 and Table 7-1 for test circuit and loading. See Figure 7-2, Figure 7-3, and Figure 7-4 for measurement waveforms.

| PARAMETER | | FROM | TO | Test Conditions | B-Port Supply Voltage ($V_{CCB}$) | | | | | | | | | | | | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1.2 ± 0.1 V | | | 1.5 ± 0.1 V | | | 1.8 ± 0.15 V | | | 2.5 ± 0.2 V | | | 3.3 ± 0.3 V | | | 5.0 ± 0.5 V | | | |
| | | | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| $t_{pd}$ | Propagation delay | A | B | -40°C to 85°C | 1 | | 66 | 1 | | 26 | 1 | | 21 | 1 | | 17 | 1 | | 16 | 1 | | 15 | ns |
| | | | | -40°C to 125°C | 1 | | 43 | 1 | | 27 | 1 | | 22 | 1 | | 18 | 1 | | 17 | 1 | | 16 | |
| | | B | A | -40°C to 85°C | 1 | | 35 | 1 | | 24 | 1 | | 21 | 1 | | 18 | 1 | | 17 | 1 | | 17 | |
| | | | | -40°C to 125°C | 1 | | 32 | 1 | | 24 | 1 | | 22 | 1 | | 19 | 1 | | 18 | 1 | | 17 | |
| $t_{dis}$ | Disable time | DIR | A | -40°C to 85°C | 2 | | 22 | 2 | | 22 | 2 | | 23 | 2 | | 23 | 2 | | 22 | 2 | | 22 | ns |
| | | | | -40°C to 125°C | 4 | | 23 | 4 | | 31 | 4 | | 23 | 4 | | 23 | 4 | | 23 | 4 | | 23 | |
| | | DIR | B | -40°C to 85°C | 9 | | 73 | 7 | | 40 | 6 | | 34 | 4 | | 27 | 4 | | 25 | 3 | | 23 | |
| | | | | -40°C to 125°C | 15 | | 64 | 13 | | 42 | 11 | | 36 | 6 | | 28 | 8 | | 27 | 6 | | 25 | |
| $t_{en}$ | Enable time | DIR | A | -40°C to 85°C | 17 | | 103 | 13 | | 59 | 12 | | 50 | 9 | | 40 | 9 | | 38 | 7 | | 35 | ns |
| | | | | -40°C to 125°C | 23 | | 90 | 21 | | 61 | 19 | | 53 | 16 | | 43 | 12 | | 39 | 12 | | 37 | |
| | | DIR | B | -40°C to 85°C | 11 | | 80 | 9 | | 44 | 8 | | 39 | 7 | | 34 | 6 | | 33 | 6 | | 32 | |
| | | | | -40°C to 125°C | 14 | | 61 | 12 | | 45 | 11 | | 40 | 10 | | 36 | 10 | | 34 | 9 | | 35 | |


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## 6.10 Switching Characteristics, $V_{CCA}$ = 2.5 ± 0.2 V

See Figure 7-1 and Table 7-1 for test circuit and loading. See Figure 7-2, Figure 7-3, and Figure 7-4 for measurement waveforms.

| PARAMETER | | FROM | TO | Test Conditions | B-Port Supply Voltage ($V_{CCB}$) | | | | | | | | | | | | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1.2 ± 0.1 V | | | 1.5 ± 0.1 V | | | 1.8 ± 0.15 V | | | 2.5 ± 0.2 V | | | 3.3 ± 0.3 V | | | 5.0 ± 0.5 V | | | |
| | | | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| $t_{pd}$ | Propagation delay | A | B | -40°C to 85°C | 1 | | 59 | 1 | | 23 | 1 | | 19 | 1 | | 15 | 1 | | 13 | 1 | | 12 | ns |
| | | | | -40°C to 125°C | 1 | | 38 | 1 | | 23 | 1 | | 19 | 1 | | 15 | 1 | | 14 | 1 | | 13 | |
| | | B | A | -40°C to 85°C | 1 | | 32 | 1 | | 20 | 1 | | 17 | 1 | | 15 | 1 | | 14 | 1 | | 13 | |
| | | | | -40°C to 125°C | 1 | | 29 | 1 | | 21 | 1 | | 18 | 1 | | 15 | 1 | | 14 | 1 | | 14 | |
| $t_{dis}$ | Disable time | DIR | A | -40°C to 85°C | 1 | | 16 | 1 | | 23 | 1 | | 16 | 1 | | 16 | 1 | | 20 | 1 | | 16 | ns |
| | | | | -40°C to 125°C | 2 | | 16 | 2 | | 16 | 2 | | 16 | 2 | | 25 | 2 | | 16 | 2 | | 16 | |
| | | DIR | B | -40°C to 85°C | 8 | | 63 | 6 | | 35 | 5 | | 29 | 3 | | 23 | 3 | | 22 | 2 | | 19 | |
| | | | | -40°C to 125°C | 13 | | 56 | 10 | | 37 | 10 | | 31 | 8 | | 25 | 7 | | 23 | 5 | | 20 | |
| $t_{en}$ | Enable time | DIR | A | -40°C to 85°C | 14 | | 91 | 11 | | 49 | 10 | | 41 | 8 | | 33 | 7 | | 30 | 6 | | 27 | ns |
| | | | | -40°C to 125°C | 21 | | 76 | 18 | | 51 | 16 | | 44 | 14 | | 35 | 13 | | 32 | 10 | | 29 | |
| | | DIR | B | -40°C to 85°C | 8 | | 67 | 6 | | 33 | 5 | | 33 | 4 | | 25 | 4 | | 24 | 4 | | 23 | |
| | | | | -40°C to 125°C | 11 | | 49 | 9 | | 34 | 8 | | 30 | 7 | | 27 | 7 | | 27 | 6 | | 24 | |

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## 6.11 Switching Characteristics, $V_{CCA}$ = 3.3 ± 0.3 V

See Figure 7-1 and Table 7-1 for test circuit and loading. See Figure 7-2, Figure 7-3, and Figure 7-4 for measurement waveforms.

| PARAMETER | | FROM | TO | Test Conditions | B-Port Supply Voltage ($V_{CCB}$) | | | | | | | | | | | | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1.2 ± 0.1 V | | | 1.5 ± 0.1 V | | | 1.8 ± 0.15 V | | | 2.5 ± 0.2 V | | | 3.3 ± 0.3 V | | | 5.0 ± 0.5 V | | | |
| | | | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| $t_{pd}$ | Propagation delay | A | B | -40°C to 85°C | 1 | | 57 | 1 | | 21 | 1 | | 17 | 1 | | 14 | 1 | | 12 | 1 | | 11 | ns |
| | | | | -40°C to 125°C | 1 | | 36 | 1 | | 22 | 1 | | 18 | 1 | | 14 | 1 | | 13 | 1 | | 12 | |
| | | B | A | -40°C to 85°C | 1 | | 33 | 1 | | 19 | 1 | | 16 | 1 | | 13 | 1 | | 12 | 1 | | 12 | |
| | | | | -40°C to 125°C | 1 | | 29 | 1 | | 19 | 1 | | 17 | 1 | | 14 | 1 | | 13 | 1 | | 12 | |
| $t_{dis}$ | Disable time | DIR | A | -40°C to 85°C | 1 | | 14 | 1 | | 14 | 1 | | 14 | 1 | | 14 | 1 | | 20 | 1 | | 14 | ns |
| | | | | -40°C to 125°C | 1 | | 34 | 1 | | 15 | 1 | | 15 | 1 | | 15 | 1 | | 15 | 1 | | 17 | |
| | | DIR | B | -40°C to 85°C | 7 | | 59 | 5 | | 32 | 5 | | 27 | 3 | | 21 | 3 | | 20 | 2 | | 18 | |
| | | | | -40°C to 125°C | 12 | | 52 | 9 | | 33 | 9 | | 29 | 7 | | 23 | 7 | | 22 | 5 | | 19 | |
| $t_{en}$ | Enable time | DIR | A | -40°C to 85°C | 13 | | 86 | 10 | | 44 | 9 | | 37 | 7 | | 30 | 7 | | 28 | 5 | | 25 | ns |
| | | | | -40°C to 125°C | 19 | | 71 | 16 | | 46 | 14 | | 39 | 12 | | 32 | 12 | | 29 | 10 | | 26 | |
| | | DIR | B | -40°C to 85°C | 8 | | 64 | 6 | | 30 | 5 | | 27 | 4 | | 23 | 4 | | 22 | 3 | | 22 | |
| | | | | -40°C to 125°C | 10 | | 46 | 9 | | 31 | 8 | | 28 | 7 | | 24 | 6 | | 23 | 6 | | 22 | |


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## 6.12 Switching Characteristics, $V_{CCA}$ = 5.0 ± 0.5 V

See Figure 7-1 and Table 7-1 for test circuit and loading. See Figure 7-2, Figure 7-3, and Figure 7-4 for measurement waveforms.

| PARAMETER | | FROM | TO | Test Conditions | B-Port Supply Voltage ($V_{CCB}$) | | | | | | | | | | | | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1.2 ± 0.1 V | | | 1.5 ± 0.1 V | | | 1.8 ± 0.15 V | | | 2.5 ± 0.2 V | | | 3.3 ± 0.3 V | | | 5.0 ± 0.5 V | | | |
| | | | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| $t_{pd}$ | Propagation delay | A | B | -40°C to 85°C | 1 | | 57 | 1 | | 21 | 1 | | 17 | 1 | | 13 | 1 | | 12 | 1 | | 11 | ns |
| | | | | -40°C to 125°C | 1 | | 36 | 1 | | 21 | 1 | | 17 | 1 | | 14 | 1 | | 12 | 1 | | 11 | |
| | | B | A | -40°C to 85°C | 1 | | 47 | 1 | | 19 | 1 | | 15 | 1 | | 12 | 1 | | 11 | 1 | | 11 | |
| | | | | -40°C to 125°C | 1 | | 33 | 1 | | 20 | 1 | | 16 | 1 | | 13 | 1 | | 12 | 1 | | 11 | |
| $t_{dis}$ | Disable time | DIR | A | -40°C to 85°C | 1 | | 12 | 1 | | 12 | 1 | | 21 | 1 | | 12 | 1 | | 15 | 1 | | 12 | ns |
| | | | | -40°C to 125°C | 1 | | 12 | 1 | | 12 | 1 | | 20 | 1 | | 12 | 1 | | 12 | 1 | | 12 | |
| | | DIR | B | -40°C to 85°C | 1 | | 57 | 1 | | 30 | 4 | | 25 | 3 | | 20 | 3 | | 19 | 2 | | 17 | |
| | | | | -40°C to 125°C | 11 | | 50 | 9 | | 31 | 8 | | 27 | 6 | | 21 | 6 | | 20 | 4 | | 18 | |
| $t_{en}$ | Enable time | DIR | A | -40°C to 85°C | 8 | | 98 | 6 | | 42 | 8 | | 34 | 7 | | 27 | 7 | | 25 | 5 | | 23 | ns |
| | | | | -40°C to 125°C | 18 | | 73 | 15 | | 44 | 13 | | 36 | 11 | | 29 | 11 | | 27 | 9 | | 24 | |
| | | DIR | B | -40°C to 85°C | 6 | | 62 | 4 | | 28 | 3 | | 24 | 3 | | 20 | 2 | | 19 | 2 | | 18 | |
| | | | | -40°C to 125°C | 9 | | 43 | 7 | | 28 | 6 | | 25 | 5 | | 21 | 4 | | 20 | 4 | | 19 | |

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## 6.13 Operating Characteristics

$T_A$ = 25°C (1)

| PARAMETER | | TEST CONDITIONS | SUPPLY VOLTAGE ($V_{CCB}$ = $V_{CCA}$) | | | | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| | | | 1.2 ± 0.1V | 1.5 ± 0.1V | 1.8 ± 0.15V | 2.5 ± 0.2V | 3.3 ± 0.3V | 5.0 ± 0.5V | |
| | | | TYP | TYP | TYP | TYP | TYP | TYP | |
| $C_{pdA}$ (2) | A to B | A Port<br>CL = 0, RL = Open<br>f = 10 MHz<br>$t_{rise}$ = $t_{fall}$ = 1 ns | 3 | 3 | 3 | 3.5 | 3.5 | 4.2 | pF |
| | B to A | | 17 | 17 | 17 | 18 | 20 | 22 | |
| $C_{pdB}$ (3) | A to B | B Port<br>CL = 0, RL = Open<br>f = 10 MHz<br>$t_{rise}$ = $t_{fall}$ = 1 ns | 17 | 17 | 17 | 18 | 20 | 22 | pF |
| | B to A | | 3 | 3 | 3 | 3.5 | 3.5 | 4.2 | |

(1) For additional information about how power dissipation capacitance affects power consumption, see the CMOS Power Consumption and $C_{pd}$ Calculation application report.
(2) A-Port power dissipation capacitance per transceiver.
(3) B-Port power dissipation capacitance per transceiver.


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## 6.14 Typical Characteristics

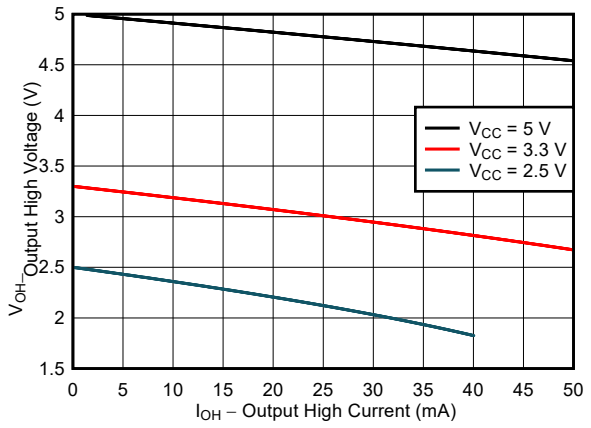



**Figure 6-1. Typical ($T_A$=25°C) Output High Voltage ($V_{OH}$) vs Source Current ($I_{OH}$)**

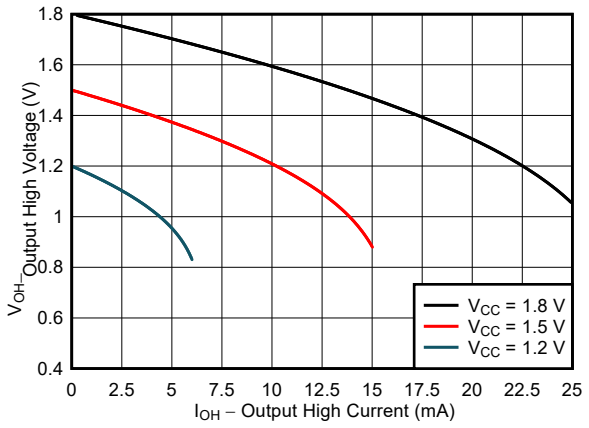



**Figure 6-2. Typical ($T_A$=25°C) Output High Voltage ($V_{OH}$) vs Source Current ($I_{OH}$)**

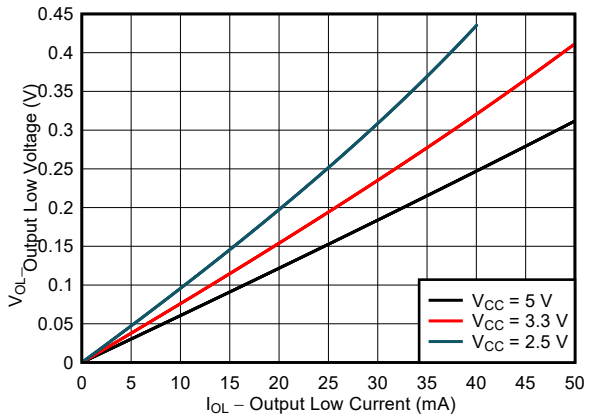



**Figure 6-3. Typical ($T_A$=25°C) Output High Voltage ($V_{OL}$) vs Sink Current ($I_{OL}$)**

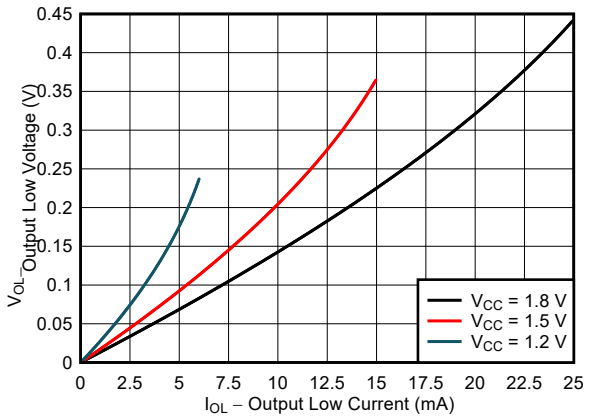



**Figure 6-4. Typical ($T_A$=25°C) Output High Voltage ($V_{OL}$) vs Sink Current ($I_{OL}$)**

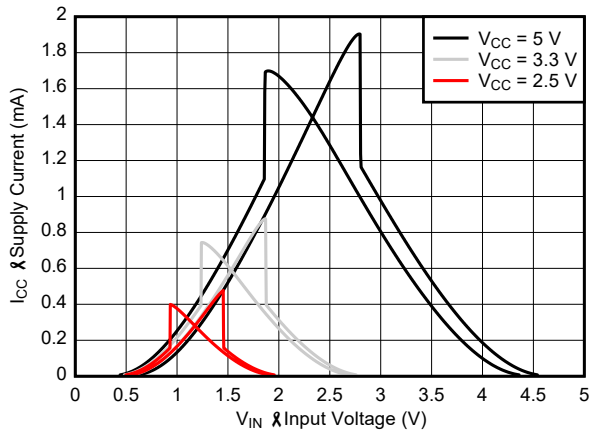



**Figure 6-5. Typical ($T_A$=25°C) Supply Current ($I_{CC}$) vs Input Voltage ($V_{IN}$)**

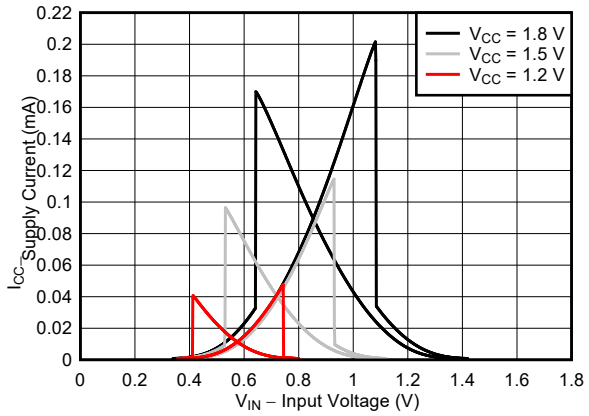



**Figure 6-6. Typical ($T_A$=25°C) Supply Current ($I_{CC}$) vs Input Voltage ($V_{IN}$)**

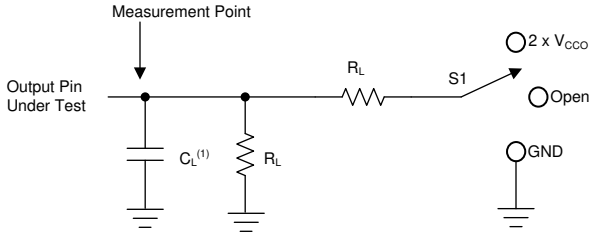
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# 7 Parameter Measurement Information

## 7.1 Load Circuit and Voltage Waveforms

Unless otherwise noted, all input pulses are supplied by generators having the following characteristics:

- f = 1 MHz
- $Z_O$ = 50 Ω
- Δt/ΔV ≤ 1 ns/V

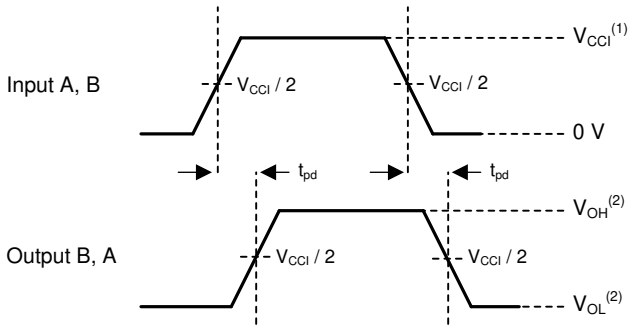



A. $C_L$ includes probe and jig capacitance.

**Figure 7-1. Load Circuit**

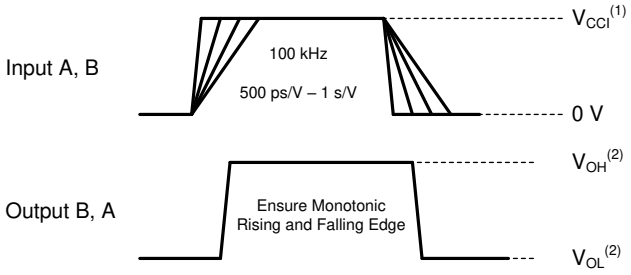
**Table 7-1. Load Circuit Conditions**

| Parameter | | $V_{CCO}$ | $R_L$ | $C_L$ | $S_1$ | $V_{TP}$ |
|---|---|---|---|---|---|---|
| $t_{pd}$ | Propagation (delay) time | 1.1 V – 5.5 V | 2 kΩ | 15 pF | Open | N/A |
| $t_{en}$, $t_{dis}$ | Enable time, disable time | 1.1 V – 1.6 V | 2 kΩ | 15 pF | 2 × $V_{CCO}$ | 0.1 V |
| | | 1.65 V – 2.7 V | 2 kΩ | 15 pF | 2 × $V_{CCO}$ | 0.15 V |
| | | 3.0 V – 5.5 V | 2 kΩ | 15 pF | 2 × $V_{CCO}$ | 0.3 V |
| $t_{en}$, $t_{dis}$ | Enable time, disable time | 1.1 V – 1.6 V | 2 kΩ | 15 pF | GND | 0.1 V |
| | | 1.65 V – 2.7 V | 2 kΩ | 15 pF | GND | 0.15 V |
| | | 3.0 V – 5.5 V | 2 kΩ | 15 pF | GND | 0.3 V |




1. $V_{CCI}$ is the supply pin associated with the input port.
2. $V_{OH}$ and $V_{OL}$ are typical output voltage levels that occur with specified $R_L$, $C_L$, and $S_1$.

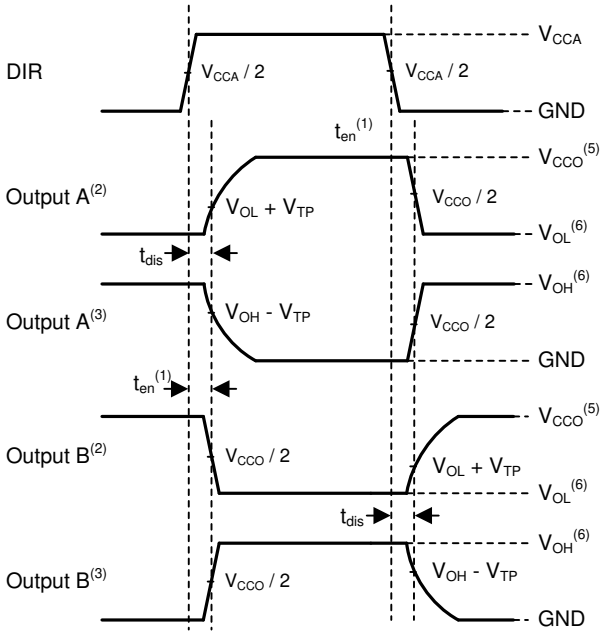
**Figure 7-2. Propagation Delay**




1. $V_{CCI}$ is the supply pin associated with the input port.
2. $V_{OH}$ and $V_{OL}$ are typical output voltage levels that occur with specified $R_L$, $C_L$, and $S_1$.

**Figure 7-3. Input Transition Rise and Fall Rate**


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1. Illustrative purposes only. Enable time is a calculation as described in Enable Times..
2. Output waveform on the condition that input is driven to a valid Logic low.
3. Output waveform on the condition that input is driven to a valid Logic high.
4. $V_{CCI}$ is the supply pin associated with the input port.
5. $V_{CCO}$ is the supply pin associated with the output port.
6. $V_{OH}$ and $V_{OL}$ are typical output voltage levels with specified $R_L$, $C_L$, and $S_1$.

**Figure 7-4. Enable Time And Disable Time**

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# 8 Detailed Description

## 8.1 Overview

The SN74LXC2T45-Q1 is a 2-bit translating transceiver that uses two individually configurable power-supply rails. The device is operational with both $V_{CCA}$ and $V_{CCB}$ supplies as low as 1.1 V and as high as 5.5 V. Additionally, the device can be operated with $V_{CCA} = V_{CCB}$. The A port is designed to track $V_{CCA}$, and the B port is designed to track $V_{CCB}$.

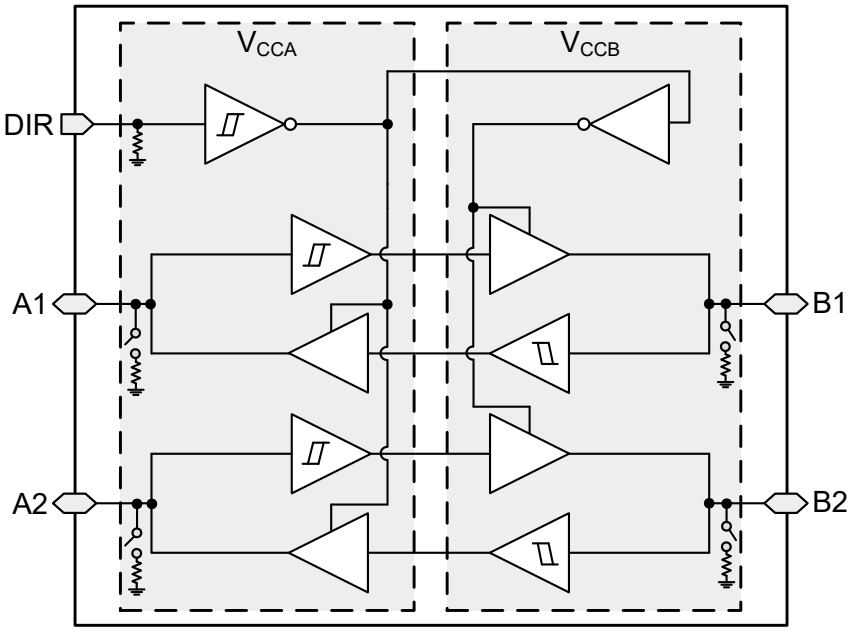
The SN74LXC2T45-Q1 device is designed for asynchronous communication between two data buses, and transmits data from the A bus to the B bus or from the B bus to the A bus based on the logic level of the direction-control input (DIR). The control pin of the SN74LXC2T45-Q1 (DIR) are referenced to $V_{CCA}$. The input circuitry on both A and B ports is always active and must have a logic HIGH or LOW level applied to prevent excess $I_{CC}$ and $I_{CCZ}$.

This device is fully specified for partial-power-down applications using the $I_{off}$ current. The $I_{off}$ protection circuitry ensures that no excessive current is drawn from or sourced into an input, output, or I/O while the device is powered down.

The $V_{CC}$ isolation or $V_{CC}$ disconnect feature ensures that if either $V_{CC}$ is less than 100 mV or disconnected with the complementary supply within the recommended operating conditions, both I/O ports are weakly pulled-down and then set to the high-impedance state by disabling their outputs while the supply current is maintained. The $I_{off\text{-}float}$ circuitry ensures that no excessive current is drawn from or sourced into an input, output, or I/O while the supply is floating.

Glitch-free power supply sequencing allows either supply rail to be powered on or off in any order while providing robust power sequencing performance.

## 8.2 Functional Block Diagram





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## 8.3 Feature Description

### 8.3.1 CMOS Schmitt-Trigger Inputs with Integrated Pulldowns

Standard CMOS inputs are high impedance and are typically modeled as a resistor in parallel with the input capacitance given in the *Electrical Characteristics*. The worst case resistance is calculated with the maximum input voltage, given in the *Absolute Maximum Ratings*, and the maximum input leakage current, given in the *Electrical Characteristics*, using ohm's law (R = V ÷ I).

The Schmitt-trigger input architecture provides hysteresis as defined by $\Delta V_T$ in the *Electrical Characteristics*, which makes this device extremely tolerant to slow or noisy inputs. Driving the inputs slowly will increase dynamic current consumption of the device. For additional information regarding Schmitt-trigger inputs, see Understanding Schmitt Triggers.

#### *8.3.1.1 I/O's with Integrated Dynamic Pull-Down Resistors*

Input circuits of the data I/O's are always active even when the device is disabled. It is recommended to keep a valid voltage level at the I/O's to avoid high current consumption. To help avoid floating inputs on the I/O's during disabling, this device has 100-kΩ typical integrated weak dynamic pull-downs on all data I/O's. When the device is disabled, the dynamic pull-downs are activated for only a short period of time to help drive and keep low any floating inputs before the device I/O's become high impedance. If the I/O lines are to be floated after the device is disabled, then it is recommended to keep them at a valid input voltage level using external pull-downs. This feature is ideal for loads of 30 pF or less. If greater capactive loading is present then external pull-downs are recommended. If an external pull-up is required, it should be no larger than 15 kΩ to avoid contention with the 100 kΩ internal pull-down.

#### *8.3.1.2 Control Inputs with Integrated Static Pull-Down Resistors*

Similar to the data I/O's, floating control inputs can cause high current consumption. To help avoid this concern, this device has integrated weak static pull-downs of 5 MΩ typical on the control input (DIR). These pull-downs are always present. For example, if the DIR pin is left floating, then the B port will be configured as an input and the A port configured as an output.

### 8.3.2 Balanced High-Drive CMOS Push-Pull Outputs

A balanced output allows the device to sink and source similar currents. The high drive capability of this device creates fast edges into light loads so routing and load conditions should be considered to prevent ringing. Additionally, the outputs of this device are capable of driving larger currents than the device can sustain without being damaged. The electrical and thermal limits defined in the *Absolute Maximum Ratings* must be followed at all times.

### 8.3.3 Partial Power Down ($I_{off}$)

The inputs and outputs for this device enter a high-impedance state when the device is powered down, inhibiting current backflow into the device. The maximum leakage into or out of any input or output pin on the device is specified by $I_{off}$ in the *Electrical Characteristics*.

### 8.3.4 $V_{CC}$ Isolation and $V_{CC}$ Disconnect ($I_{off\text{-}float}$)

This device has I/O's with Integrated Pull-Down Resistors. The I/O's will get pulled down and then enter a high-impedance state when either supply is < 100 mV or left floating (disconnected), while the other supply is still connected to the device. It is recommended that the I/O's for this device are not driven and kept at a logic low state prior to floating (disconnecting) either supply.

The maximum supply current is specified by $I_{CCx}$, while $V_{CCx}$ is floating, in the *Electrical Characterstics*. The maximum leakage into or out of any input or output pin on the device is specified by $I_{off(float)}$ in the *Electrical Characteristics*.

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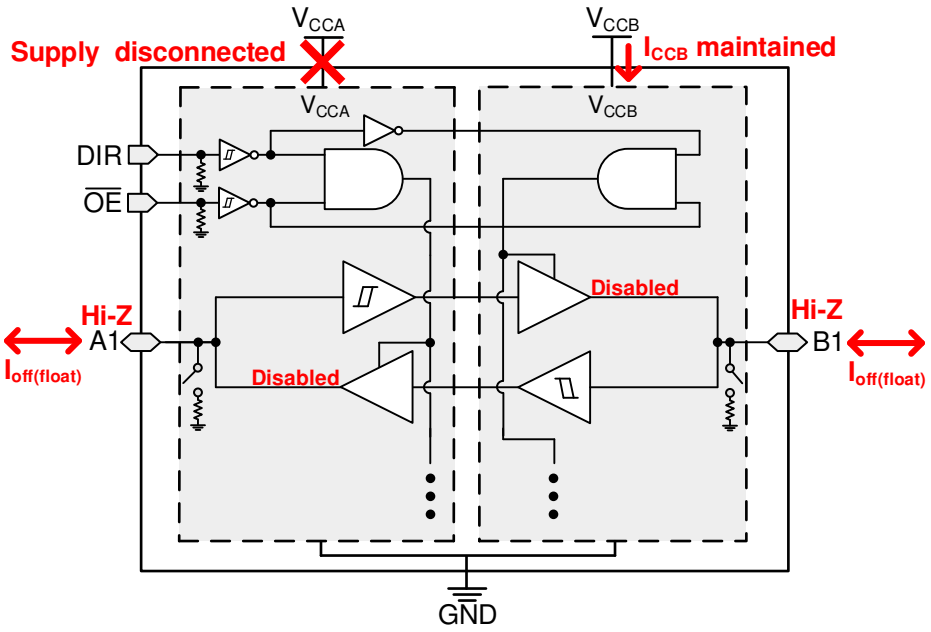



**Figure 8-1. $V_{CC}$ Disconnect Feature**

### 8.3.5 Over-Voltage Tolerant Inputs

Input signals to this device can be driven above the supply voltage so long as they remain below the maximum input voltage value specified in the *Recommended Operating Conditions*.

### 8.3.6 Glitch-Free Power Supply Sequencing

Either supply rail may be powered on or off in any order without producing a glitch on the I/Os (that is, where the output erroneously transitions to VCC when it should be held low or vice versa). Glitches of this nature can be misinterpreted by a peripheral as a valid data bit, which could trigger a false device reset of the peripheral, a false device configuration of the peripheral, or even a false data initialization by the peripheral.


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### 8.3.7 Negative Clamping Diodes

Figure 8-2 shows how the inputs and outputs to this device have negative clamping diodes.

**CAUTION**

Voltages beyond the values specified in the *Absolute Maximum Ratings* table can cause damage to the device. The input negative-voltage and output voltage ratings may be exceeded if the input and output clamp-current ratings are observed.

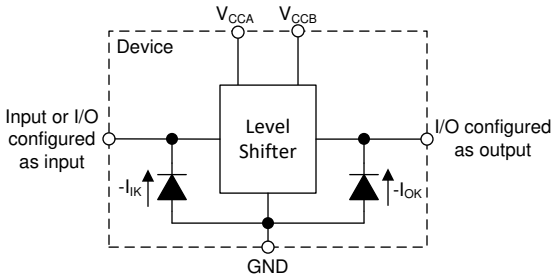



**Figure 8-2. Electrical Placement of Clamping Diodes for Each Input and Output**

### 8.3.8 Fully Configurable Dual-Rail Design

Both the $V_{CCA}$ and $V_{CCB}$ pins can be supplied at any voltage from 1.1 V to 5.5 V, making the device suitable for translating between any of the voltage nodes (1.2 V, 1.5 V, 1.8 V, 3.3 V, and 5.0 V).

### 8.3.9 Supports High-Speed Translation

The SN74LXC2T45-Q1 device can support high data-rate applications. The translated signal data rate can be up to 420 Mbps when the signal is translated from 3.3 V to 5.0 V.

## 8.4 Device Functional Modes

**Table 8-1. Function Table**

| CONTROL INPUTS (1) | PORT STATUS | | OPERATION |
|---|---|---|---|
| DIR | A PORT | B PORT | |
| L | Output (Enabled) | Input (Hi-Z) | B data to A bus |
| H | Input (Hi-Z) | Output (Enabled) | A data to B bus |

(1) Input circuits of the data I/Os are always active and should be kept at a valid logic level.

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# 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, as well as validating and testing their design implementation to confirm system functionality.

## 9.1 Application Information

The SN74LXC2T45-Q1 device can be used in level-translation applications for interfacing devices or systems operating at different interface voltages with one another. The SN74LXC2T45-Q1 device is ideal for use in applications where a push-pull driver is connected to the data I/Os. The maximum data rate can be up to 420 Mbps when device translates a signal from 3.3 V to 5.0 V.

## 9.2 Enable Times

Calculate the enable times for the SN74LXC2T45-Q1 using the following formulas:

$$t_{A_en}\text{ (DIR to A)} = t_{dis}\text{ (DIR to B)} + t_{pd}\text{ (B to A)} \quad (1)$$

$$t_{B_en}\text{ (DIR to B)} = t_{dis}\text{ (DIR to A)} + t_{pd}\text{ (A to B)} \quad (2)$$

In a bidirectional application, these enable times provide the maximum delay time from the time the DIR bit is switched until an output is expected. For example, if the SN74LXC2T45-Q1 initially is transmitting from A to B, then the DIR bit is switched; the B port of the device must be disabled ($t_{dis}$) 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 ($t_{pd}$). To avoid bus contention, care should be taken to not apply an input signal prior to the output being disabled ($t_{dis}$ maximum).

## 9.3 Typical Application

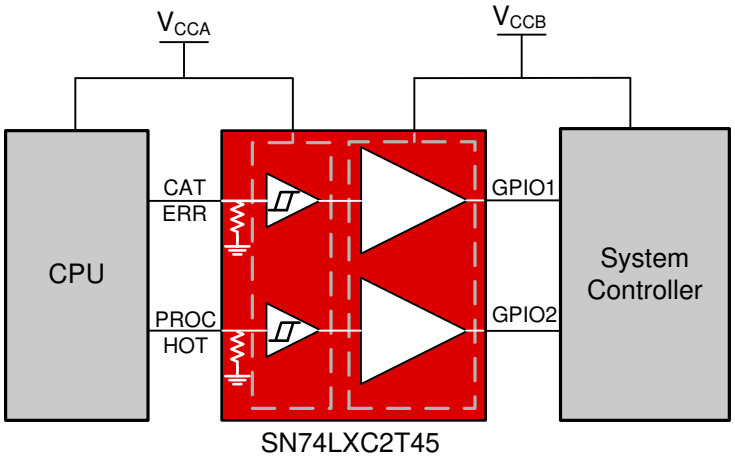



**Figure 9-1. GPIO Driver Application**


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### 9.3.1 Design Requirements

For this design example, use the parameters listed in Table 9-1.

**Table 9-1. Design Parameters**

| DESIGN PARAMETERS | EXAMPLE VALUES |
|---|---|
| Input voltage range | 1.1 V to 5.5 V |
| Output voltage range | 1.1 V to 5.5 V |

### 9.3.2 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 SN74LXC2T45-Q1 device to determine the input voltage range. For a valid logic-high, the value must exceed the positive-going input-threshold voltage ($V_{t+}$) of the input port. For a valid logic low the value must be less than the negative-going input-threshold voltage ($V_{t-}$) of the input port.
- Output voltage range
  - Use the supply voltage of the device that the SN74LXC2T45-Q1 device is driving to determine the output voltage range.

## 10 Power Supply Recommendations

Always apply a ground reference to the GND pins first. This device is designed for glitch free power sequencing without any supply sequencing requirements such as ramp order or ramp rate.

This device was designed with various power supply sequencing methods in mind to help prevent unintended triggering of downstream devices, as described in Glitch-Free Power Supply Sequencing.

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# 11 Layout

## 11.1 Layout Guidelines

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

- Use bypass capacitors on the power supply pins and place them as close to the device as possible. A 0.1 µF capacitor is recommended, but transient performance can be improved by having both 1 µF and 0.1 µF capacitors in parallel as bypass capacitors.
- The high drive capability of this device creates fast edges into light loads. So routing and load conditions should be considered to prevent ringing.

## 11.2 Layout Example

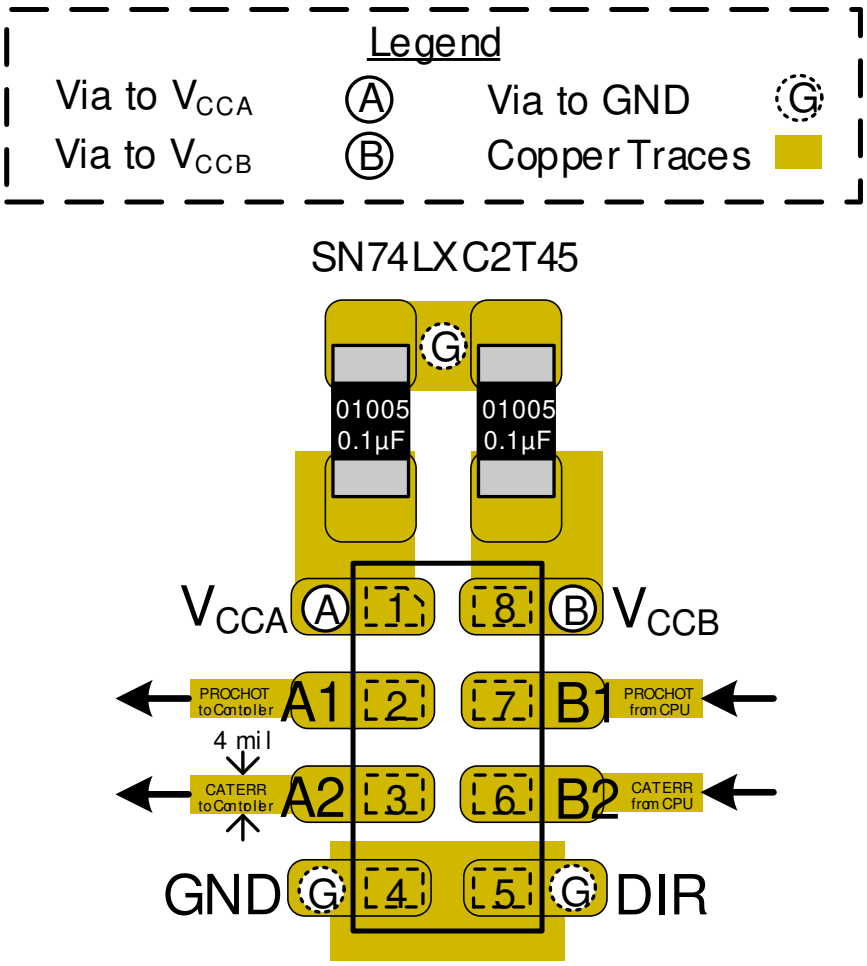



**Figure 11-1. Layout Example—SN74LXC2T45DTT**


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# 12 Device and Documentation Support

## 12.1 Documentation Support

### 12.1.1 Related Documentation

For related documentation, see the following:

- Texas Instruments, *Understanding Schmitt Triggers* application report

## 12.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Subscribe to updates* 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.

## 12.3 Support Resources

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

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

## 12.4 Trademarks

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

## 12.5 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

## 12.6 Glossary

| | |
|---|---|
| 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.

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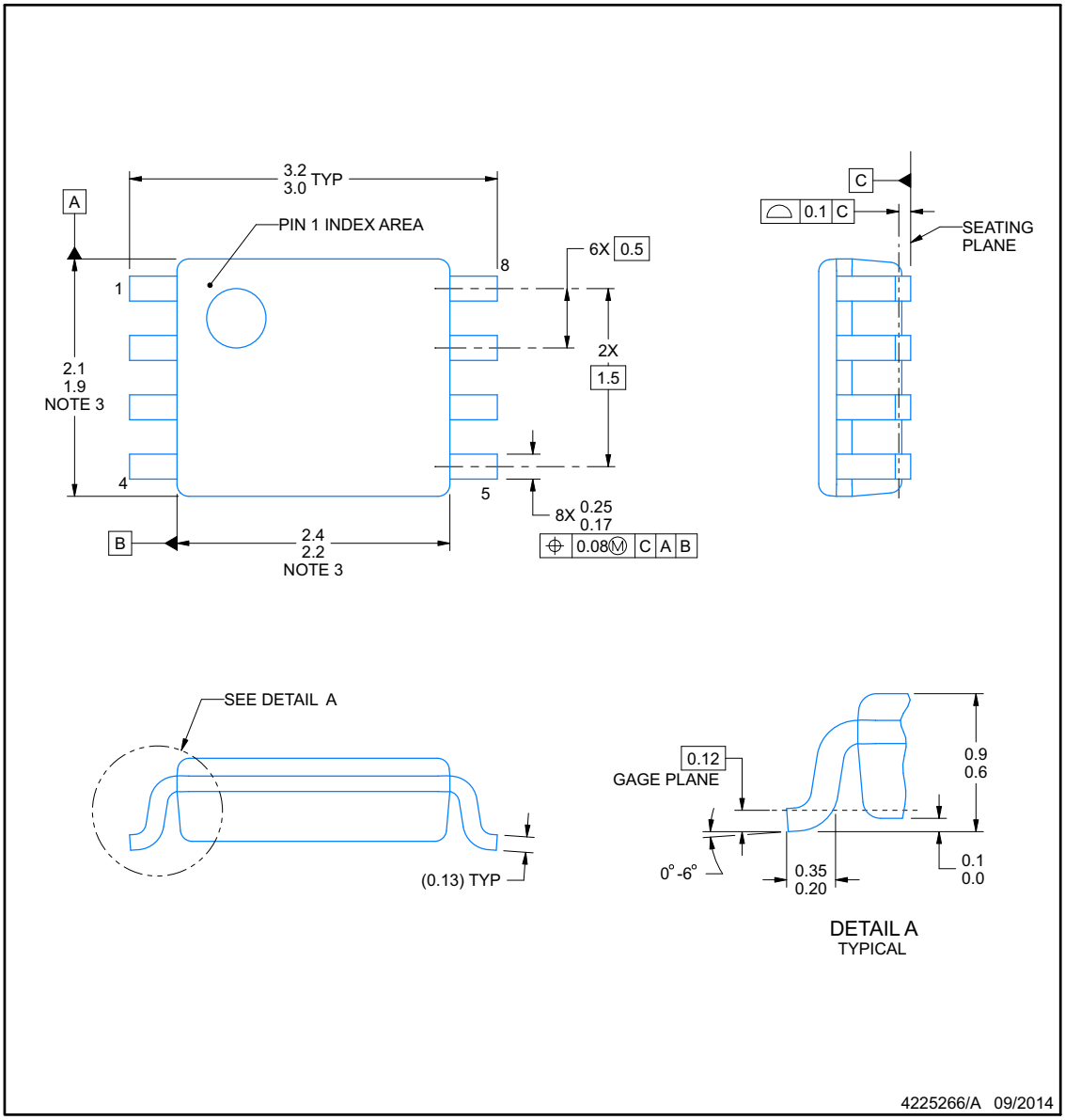
# PACKAGE OUTLINE

## DCU0008A



## VSSOP - 0.9 mm max height

SMALL OUTLINE PACKAGE




NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. Reference JEDEC registration MO-187 variation CA.

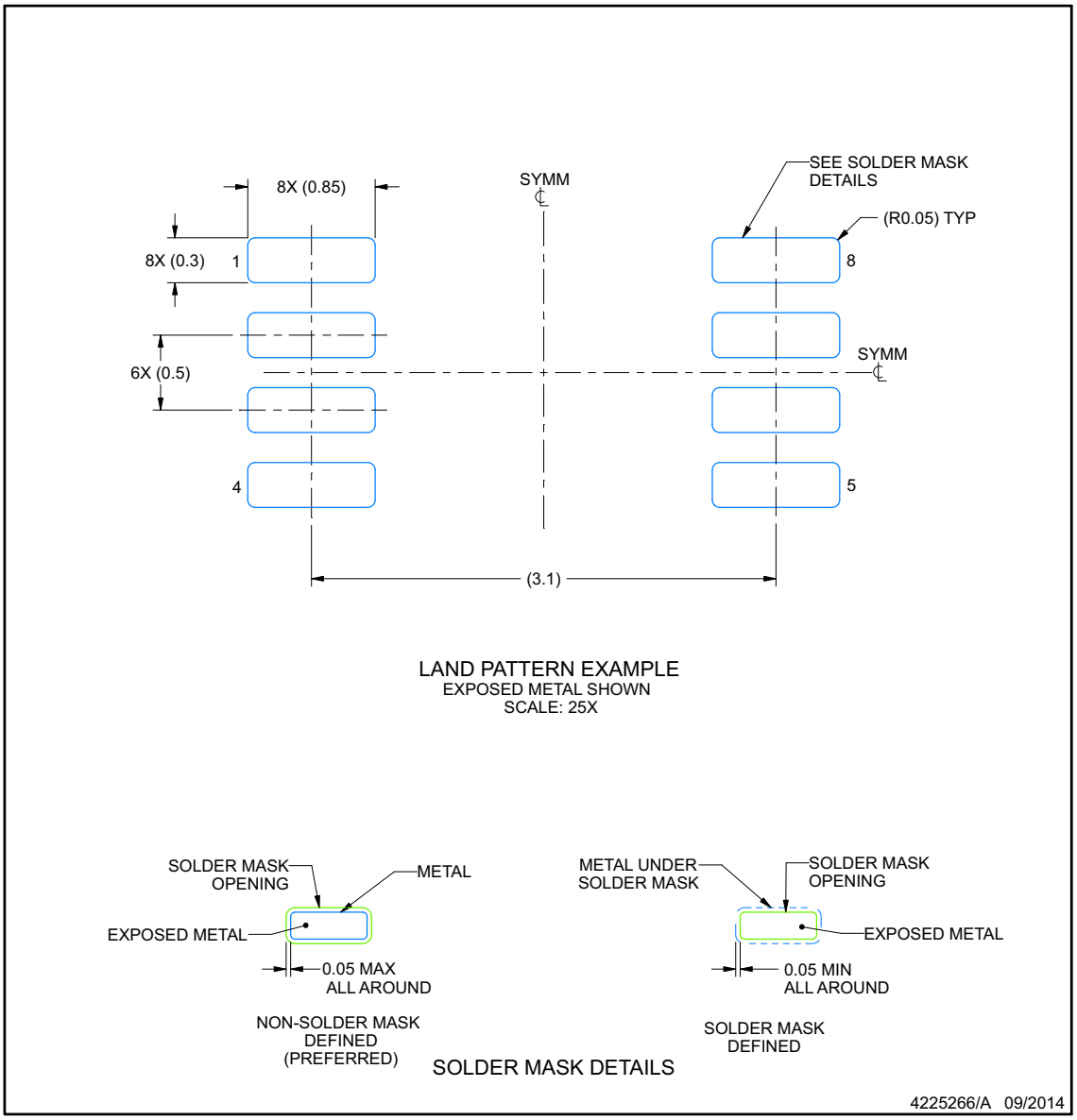

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# EXAMPLE BOARD LAYOUT

## DCU0008A

### VSSOP - 0.9 mm max height

SMALL OUTLINE PACKAGE




NOTES: (continued)

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

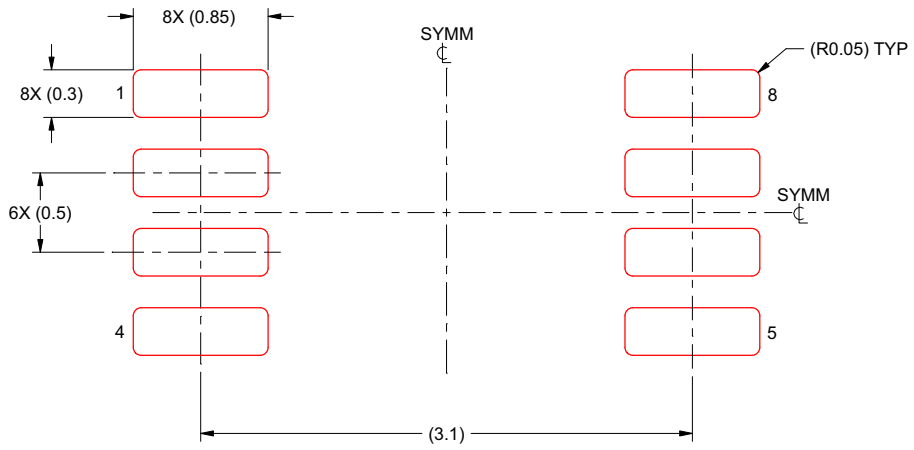


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## EXAMPLE STENCIL DESIGN

**DCU0008A** — **VSSOP - 0.9 mm max height**

SMALL OUTLINE PACKAGE




SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 25X

4225266/A 09/2014

NOTES: (continued)

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


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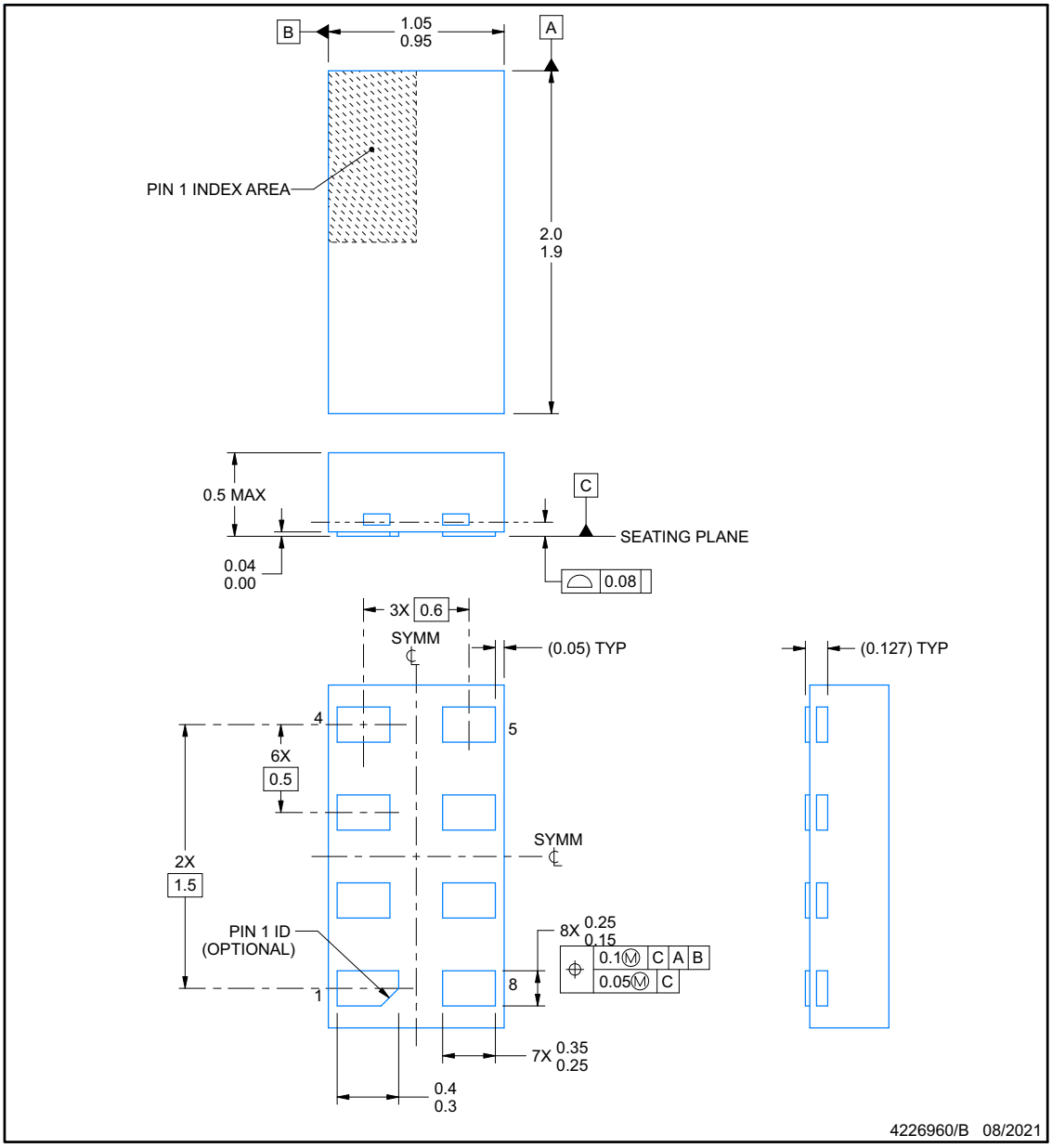
# PACKAGE OUTLINE

## DTT0008A



## X1SON - 0.5 mm max height

PLASTIC SMALL OUTLINE - NO LEAD




NOTES:

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



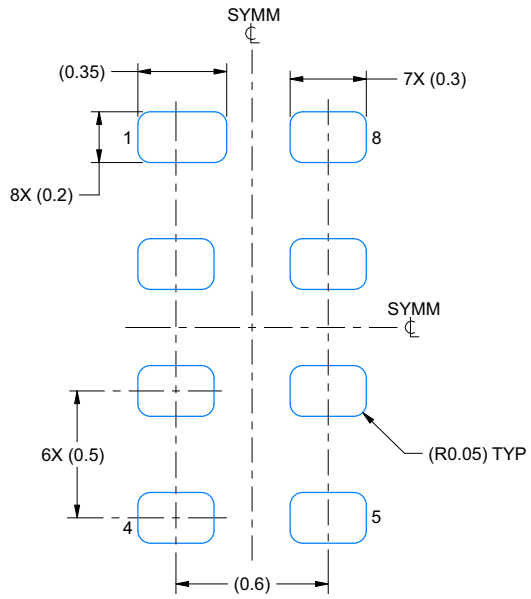
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## EXAMPLE BOARD LAYOUT

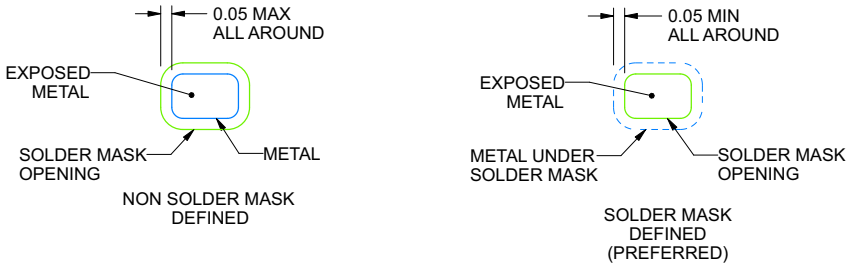
### DTT0008A

**X1SON - 0.5 mm max height**

PLASTIC SMALL OUTLINE - NO LEAD




LAND PATTERN EXAMPLE
1:1 RATIO WITH PKG SOLDER PADS
EXPOSED METAL SHOWN
SCALE:40X




SOLDER MASK DETAILS

4226960/B 08/2021

NOTES: (continued)

3. For more information, see QFN/SON PCB application report in literature No. SLUA271 (www.ti.com/lit/slua271).

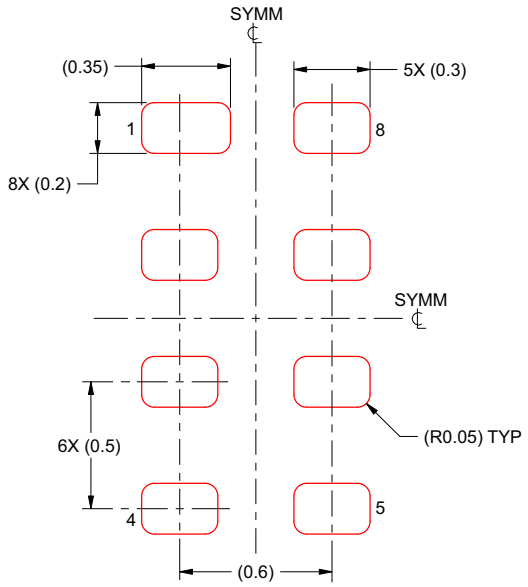

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# EXAMPLE STENCIL DESIGN

## DTT0008A

### X1SON - 0.5 mm max height

PLASTIC SMALL OUTLINE - NO LEAD




SOLDER PASTE EXAMPLE
BASED ON 0.075 - 0.1 mm THICK STENCIL
SCALE:40X

4226960/B 08/2021

NOTES: (continued)

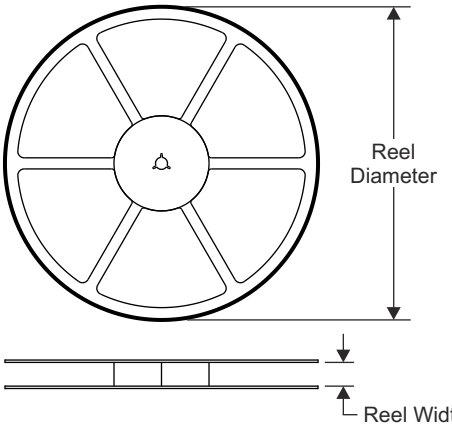
4. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.



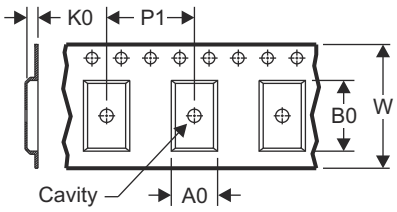
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## 13.1 Tape and Reel Information

**REEL DIMENSIONS**

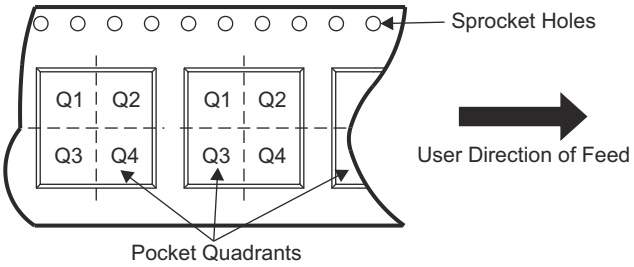



**TAPE DIMENSIONS**




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

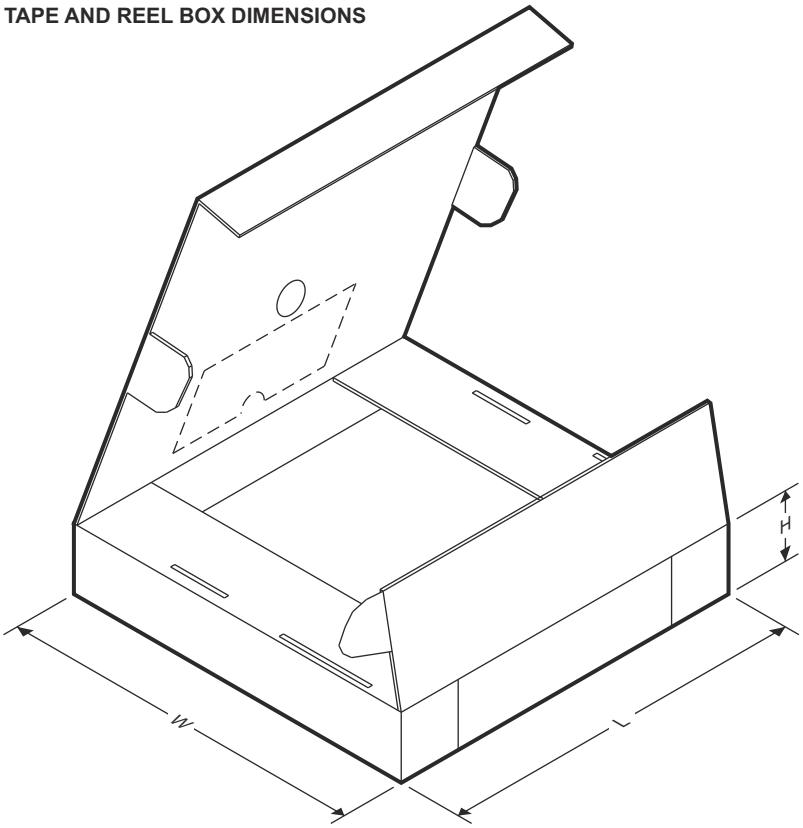
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**




| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SN74LXC8T245QDCURQ1 | VSSOP | DCU | 8 | 3000 | 178.0 | 9.0 | 2.25 | 3.35 | 1.05 | 4.0 | 8.0 | Q3 |
| SN74LXC8T245QDTTRQ1 | SON | DTT | 8 | 5000 | 180.0 | 9.0 | 1.17 | 2.17 | 0.63 | 4.0 | 8.0 | Q3 |


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**TAPE AND REEL BOX DIMENSIONS**




| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| SN74LXC8T245QDCURQ1 | VSSOP | DCU | 8 | 3000 | 180.0 | 180.0 | 18.0 |
| SN74LXC8T245QDTTRQ1 | SON | DTT | 8 | 5000 | 185.0 | 185.0 | 17.0 |

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## PACKAGING INFORMATION

| Orderable part number | Status (1) | Material type (2) | Package \| Pins | Package qty \| Carrier | RoHS (3) | Lead finish/ Ball material (4) | MSL rating/ Peak reflow (5) | Op temp (°C) | Part marking (6) |
|---|---|---|---|---|---|---|---|---|---|
| SN74LXC2T45QDCURQ1 | Active | Production | VSSOP (DCU) \| 8 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 2LFT |
| SN74LXC2T45QDCURQ1.A | Active | Production | VSSOP (DCU) \| 8 | 3000 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 2LFT |
| SN74LXC2T45QDTTRQ1 | Active | Production | X1SON (DTT) \| 8 | 5000 \| LARGE T&R | Yes | NIPDAUAG | Level-1-260C-UNLIM | -40 to 125 | 1LL |
| SN74LXC2T45QDTTRQ1.A | Active | Production | X1SON (DTT) \| 8 | 5000 \| LARGE T&R | Yes | NIPDAUAG | Level-1-260C-UNLIM | -40 to 125 | 1LL |

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts 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.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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**OTHER QUALIFIED VERSIONS OF SN74LXC2T45-Q1 :**

- Catalog : SN74LXC2T45

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

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