

# SN74AXCH1T45 Single-Bit Dual-Supply Bus Transceiver

## with Configurable Voltage Translation, Tri-State Outputs, and Bus-Hold Inputs

### 1 Features

- Fully Configurable Dual-Rail Design Allows Each Port to Operate With a Power Supply Range from 0.65 V to 3.6 V
- Operating Temperature:  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$
- Glitch-Free Power Supply Sequencing
- Bus-hold on Data Inputs Eliminates the Need for External Pullup or Pulldown Resistors
- Maximum Quiescent Current ( $I_{\text{CCA}} + I_{\text{CCB}}$ ) of 10  $\mu\text{A}$  ( $85^{\circ}\text{C}$  Maximum) and 16  $\mu\text{A}$  ( $125^{\circ}\text{C}$  Maximum)
- Up to 500-Mbps Support When Translating from 1.8 to 3.3 V
- $V_{\text{CC}}$  Isolation Feature
  - If Either  $V_{\text{CC}}$  Input is Below 100 mV, All I/Os Outputs are Disabled and Become High-Impedance
- $I_{\text{off}}$  Supports Partial-Power-Down Mode Operation
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II
- ESD Protection Exceeds JESD 22
  - 8000-V Human Body Model
  - 1000-V Charged-Device Model

### 2 Applications

- Personal Electronics
- Enterprise and Communications
- Wireless Infrastructure
- Building Automation
- Electronic Point of Sale
- Enterprise Solid State Drive

### 3 Description

The SN74AXCH1T45 is a single-bit noninverting bus transceiver that uses two individually configurable power-supply rails. The device is operational with both  $V_{\text{CCA}}$  and  $V_{\text{CCB}}$  supplies as low as 0.65 V. The A port is designed to track  $V_{\text{CCA}}$ , which accepts any supply voltage from 0.65 V to 3.6 V. The B port is designed to track  $V_{\text{CCB}}$ , which also accepts any supply voltage from 0.65 V to 3.6 V. Additionally the SN74AXCH1T45 is compatible with a single-supply system.

The DIR pin determines the direction of signal propagation. With the DIR pin configured HIGH, translation is from Port A to Port B. With DIR configured LOW, translation is from Port B to Port A. The DIR pin is referenced to  $V_{\text{CCA}}$ , meaning that its logic-high and logic-low thresholds track with  $V_{\text{CCA}}$ .

Active bus-hold circuitry holds unused or undriven inputs at a valid logic state. Use of pullup or pulldown resistors with the bus-hold circuitry is not recommended. If a supply is present for  $V_{\text{CCA}}$  or  $V_{\text{CCB}}$ , the bus-hold circuitry always remains active on the A or B inputs respectively, independent of the state of the direction control pin.

This device is fully specified for partial-power-down applications using the  $I_{\text{off}}$  current. The  $I_{\text{off}}$  protection circuitry ensures that no excessive current is drawn from or to an input, output, or combined I/O that is biased to a specific voltage while the device is powered down.

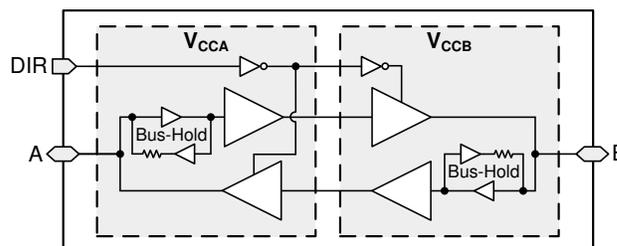
The  $V_{\text{CC}}$  isolation feature ensures that if either  $V_{\text{CCA}}$  or  $V_{\text{CCB}}$  is less than 100 mV, both I/O ports enter a high-impedance state by disabling their outputs.

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

#### Device Information

PART NUMBER	PACKAGE <sup>(1)</sup>	BODY SIZE (NOM)
SN74AXCH1T45DBV	SOT-23 (6)	2.90 mm × 1.60 mm
SN74AXCH1T45DCK	SC70 (6)	2.00 mm × 1.25 mm
SN74AXCH1T45DTQ	X2SON (6)	1.00 mm × 0.80 mm
SN74AXCH1T45DRY	SON (6)	1.40 mm × 1.00 mm

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



Functional Block Diagram



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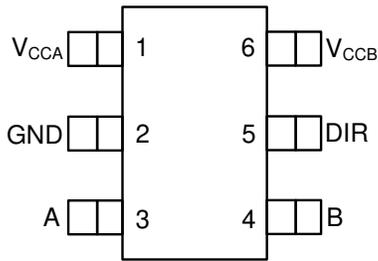
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## 4 Revision History

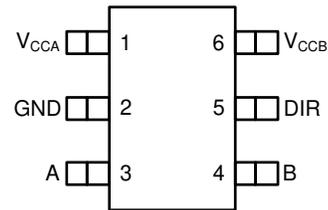
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

<b>Changes from Revision B (June 2020) to Revision C (September 2020)</b>	<b>Page</b>
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• Updated <i>Revision History</i> section.....	1
• Added pinout drawings for DBV and DTQ packages.....	3
• Added DRY package to Pin Configurations.....	3

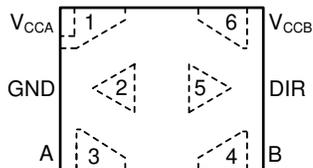
## 5 Pin Configuration and Functions



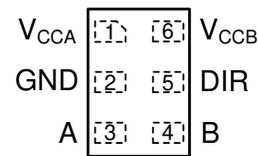
**Figure 5-1. DBV Package 6-Pin SOT-23 Top View**



**Figure 5-2. DCK Package 6-Pin SC70 Top View**



**Figure 5-3. DTQ Package 6-Pin X2SON Transparent Top View**



**Figure 5-4. DRY Package 6-Pin SON Transparent Top View**

### Pin Functions

PIN		TYPE	DESCRIPTION
NO.	NAME		
1	V <sub>CCA</sub>	—	A-port supply voltage. $0.65\text{ V} \leq V_{CCA} \leq 3.6\text{ V}$ .
2	GND	—	Ground
3	A	I/O	Input/output A. This pin is referenced to V <sub>CCA</sub> .
4	B	I/O	Input/output B. This pin is referenced to V <sub>CCB</sub> .
5	DIR	I	Direction control signal. See for functionality.
6	V <sub>CCB</sub>	—	B-port supply voltage. $0.65\text{ V} \leq V_{CCB} \leq 3.6\text{ V}$ .

## 6 Specifications

### 6.1 Absolute Maximum Ratings

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

			MIN	MAX	UNIT
V <sub>CCA</sub>	Supply voltage A		-0.5	4.2	V
V <sub>CCB</sub>	Supply voltage B		-0.5	4.2	V
V <sub>I</sub>	Input Voltage <sup>(2)</sup>	I/O Ports (A Port)	-0.5	4.2	V
		I/O Ports (B Port)	-0.5	4.2	
		Control Inputs	-0.5	4.2	
V <sub>O</sub>	Voltage applied to any output in the high-impedance or power-off state <sup>(2)</sup>	A Port	-0.5	4.2	V
		B Port	-0.5	4.2	
V <sub>O</sub>	Voltage applied to any output in the high or low state <sup>(2) (3)</sup>	A Port	-0.5 V <sub>CCA</sub> + 0.2		V
		B Port	-0.5 V <sub>CCB</sub> + 0.2		
I <sub>IK</sub>	Input clamp current	V <sub>I</sub> < 0	-50		mA
I <sub>OK</sub>	Output clamp current	V <sub>O</sub> < 0	-50		mA
I <sub>O</sub>	Continuous output current		-50	50	mA
	Continuous current through V <sub>CC</sub> or GND		-100	100	mA
T <sub>J</sub>	Junction Temperature			150	°C
T <sub>stg</sub>	Storage temperature		-65	150	°C

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, 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 4.2 V maximum if the output current rating is observed.

### 6.2 ESD Ratings

			VALUE	UNIT
V <sub>(ESD)</sub>	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>	±8000	V
		Charged device model (CDM), per JEDEC specification JESD22-C101 <sup>(2)</sup>	±1000	

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
- (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

### 6.3 Recommended Operating Conditions

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

			MIN	MAX	UNIT
V <sub>CCA</sub>	Supply voltage A		0.65	3.6	V
V <sub>CCB</sub>	Supply voltage B		0.65	3.6	V
V <sub>IH</sub>	High-level input voltage	Data Inputs	V <sub>CCI</sub> = 0.65 V - 0.75 V	V <sub>CCI</sub> × 0.70	V
			V <sub>CCI</sub> = 0.76 V - 1 V	V <sub>CCI</sub> × 0.70	
			V <sub>CCI</sub> = 1.1 V - 1.95 V	V <sub>CCI</sub> × 0.65	
			V <sub>CCI</sub> = 2.3 V - 2.7 V	1.6	
			V <sub>CCI</sub> = 3 V - 3.6 V	2	
		Control Input (DIR) Referenced to V <sub>CCA</sub>	V <sub>CCA</sub> = 0.65 V - 0.75 V	V <sub>CCA</sub> × 0.70	
			V <sub>CCA</sub> = 0.76 V - 1 V	V <sub>CCA</sub> × 0.70	
			V <sub>CCA</sub> = 1.1 V - 1.95 V	V <sub>CCA</sub> × 0.65	
			V <sub>CCA</sub> = 2.3 V - 2.7 V	1.6	
			V <sub>CCA</sub> = 3 V - 3.6 V	2	
V <sub>IL</sub>	Low-level input voltage	Data Inputs	V <sub>CCI</sub> = 0.65 V - 0.75 V	V <sub>CCI</sub> × 0.30	V
			V <sub>CCI</sub> = 0.76 V - 1 V	V <sub>CCI</sub> × 0.30	
			V <sub>CCI</sub> = 1.1 V - 1.95 V	V <sub>CCI</sub> × 0.35	
			V <sub>CCI</sub> = 2.3 V - 2.7 V	0.7	
			V <sub>CCI</sub> = 3 V - 3.6 V	0.8	
		Control Input (DIR) Referenced to V <sub>CCA</sub>	V <sub>CCA</sub> = 0.65 V - 0.75 V	V <sub>CCA</sub> × 0.30	
			V <sub>CCA</sub> = 0.76 V - 1 V	V <sub>CCA</sub> × 0.30	
			V <sub>CCA</sub> = 1.1 V - 1.95 V	V <sub>CCA</sub> × 0.35	
			V <sub>CCA</sub> = 2.3 V - 2.7 V	0.7	
			V <sub>CCA</sub> = 3 V - 3.6 V	0.8	
V <sub>I</sub>	Input voltage <sup>(3)</sup>		0	3.6	V
V <sub>O</sub>	Output voltage	Active State	0	V <sub>CCO</sub>	V
		Tri-State	0	3.6	
Δt/Δv	Input transition rate			100	ns/V
T <sub>A</sub>	Operating free-air temperature		-40	125	°C

(1) V<sub>CCI</sub> is the VCC associated with the input port.

(2) V<sub>CCO</sub> is the VCC associated with the output port.

(3) All unused inputs of the device must be held at VCC or GND to ensure proper device operation. Refer to the TI application report, [Implications of Slow or Floating CMOS Inputs](#).

### 6.4 Thermal Information

THERMAL METRIC <sup>(1)</sup>	SN74AXCH1T45				UNIT	
	DBV (SOT-23)	DCK (SC70)	DTQ (X2SON)	DRY (SON)		
	6 PINS	6 PINS	6 PINS	6 PINS		
R <sub>θJA</sub>	Junction-to-ambient thermal resistance	214.0	223.9	327.8	308.3	°C/W
R <sub>θJC(top)</sub>	Junction-to-case (top) thermal resistance	151.8	150.9	194.9	206.4	°C/W
R <sub>θJB</sub>	Junction-to-board thermal resistance	93.6	75.3	248.4	181.7	°C/W
ψ <sub>JT</sub>	Junction-to-top characterization parameter	78.1	58.2	24.1	42.6	°C/W
ψ <sub>JB</sub>	Junction-to-board characterization parameter	93.4	75.0	247.6	180.8	°C/W

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

## 6.5 Electrical Characteristics

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

PARAMETER	TEST CONDITIONS	V <sub>CCA</sub>	V <sub>CCB</sub>	Operating free-air temperature (T <sub>A</sub> )						UNIT	
				–40°C to 85°C			–40°C to 125°C				
				MIN	TYP <sup>(3)</sup>	MAX	MIN	TYP	MAX		
V <sub>OH</sub>	High-level output voltage V <sub>I</sub> = V <sub>IH</sub>	0.7 V - 3.6 V	0.7 V - 3.6 V	V <sub>CCO</sub> – 0.1			V <sub>CCO</sub> – 0.1			V	
				I <sub>OH</sub> = –100 μA	0.65 V	0.65 V	0.55	0.55			
				I <sub>OH</sub> = –200 μA	0.76 V	0.76 V	0.58	0.58			
				I <sub>OH</sub> = –500 μA	0.85 V	0.85 V	0.65	0.65			
				I <sub>OH</sub> = –3 mA	1.1 V	1.1 V	0.85	0.85			
				I <sub>OH</sub> = –6 mA	1.4 V	1.4 V	1.05	1.05			
				I <sub>OH</sub> = –8 mA	1.65 V	1.65 V	1.2	1.2			
				I <sub>OH</sub> = –9 mA	2.3 V	2.3 V	1.75	1.75			
				I <sub>OH</sub> = –12 mA	3 V	3 V	2.3	2.3			
V <sub>OL</sub>	Low-level output voltage V <sub>I</sub> = V <sub>IL</sub>	0.7 V - 3.6 V	0.7 V - 3.6 V				0.1			V	
				I <sub>OL</sub> = 100 μA	0.65 V	0.65 V	0.1	0.1			
				I <sub>OL</sub> = 200 μA	0.76 V	0.76 V	0.18	0.18			
				I <sub>OL</sub> = 500 μA	0.85 V	0.85 V	0.2	0.2			
				I <sub>OL</sub> = 3 mA	1.1 V	1.1 V	0.25	0.25			
				I <sub>OL</sub> = 6 mA	1.4 V	1.4 V	0.35	0.35			
				I <sub>OL</sub> = 8 mA	1.65 V	1.65 V	0.45	0.45			
				I <sub>OL</sub> = 9 mA	2.3 V	2.3 V	0.55	0.55			
				I <sub>OL</sub> = 12 mA	3 V	3 V	0.7	0.7			
I <sub>BHL</sub>	Bus-hold low sustaining current <sup>(4)</sup>	V <sub>I</sub> = 0.20 V	0.65 V	0.65 V	4			4			μA
					V <sub>I</sub> = 0.23 V	0.76 V	0.76 V	8	7		
					V <sub>I</sub> = 0.26 V	0.85 V	0.85 V	10	10		
					V <sub>I</sub> = 0.39 V	1.1 V	1.1 V	20	20		
					V <sub>I</sub> = 0.49 V	1.4 V	1.4 V	40	30		
					V <sub>I</sub> = 0.58 V	1.65 V	1.65 V	55	45		
					V <sub>I</sub> = 0.7 V	2.3 V	2.3 V	90	80		
					V <sub>I</sub> = 0.8 V	3 V	3 V	145	135		
I <sub>BHH</sub>	Bus-hold high sustaining current <sup>(5)</sup>	V <sub>I</sub> = 0.45 V	0.65 V	0.65 V	–4			–4			μA
					V <sub>I</sub> = 0.53 V	0.76 V	0.76 V	–8	–7		
					V <sub>I</sub> = 0.59 V	0.85 V	0.85 V	–10	–10		
					V <sub>I</sub> = 0.71 V	1.1 V	1.1 V	–20	–20		
					V <sub>I</sub> = 0.91 V	1.4 V	1.4 V	–40	–30		
					V <sub>I</sub> = 1.07 V	1.65 V	1.65 V	–55	–45		
					V <sub>I</sub> = 1.6 V	2.3 V	2.3 V	–90	–80		
					V <sub>I</sub> = 2.0 V	3 V	3 V	–145	–135		

## 6.5 Electrical Characteristics (continued)

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

PARAMETER	TEST CONDITIONS	V <sub>CCA</sub>	V <sub>CCB</sub>	Operating free-air temperature (T <sub>A</sub> )					UNIT		
				–40°C to 85°C			–40°C to 125°C				
				MIN	TYP <sup>(3)</sup>	MAX	MIN	TYP		MAX	
I <sub>BHLO</sub>	Bus-hold low overdrive current <sup>(6)</sup>	V <sub>I</sub> = 0 to V <sub>CC</sub>	0.75 V	0.75 V	40			40			μA
			0.84 V	0.84 V	50			50			
			0.95 V	0.95 V	65			65			
			1.3 V	1.3 V	105			105			
			1.6 V	1.6 V	150			150			
			1.95 V	1.95 V	205			205			
			2.7 V	2.7 V	335			335			
3.6 V	3.6 V	480			480						
I <sub>BHHO</sub>	Bus-hold high overdrive current <sup>(7)</sup>	V <sub>I</sub> = 0 to V <sub>CC</sub>	0.75 V	0.75 V	–40			–40			μA
			0.84 V	0.84 V	–50			–50			
			0.95 V	0.95 V	–65			–65			
			1.3 V	1.3 V	–105			–105			
			1.6 V	1.6 V	–150			–150			
			1.95 V	1.95 V	–205			–205			
			2.7 V	2.7 V	–335			–335			
3.6 V	3.6 V	–480			–480						
I <sub>I</sub>	Input leakage current	Control input (DIR): V <sub>I</sub> = V <sub>CCA</sub> or GND	0.65 V - 3.6 V	0.65 V - 3.6 V	–0.5	0.5	–1	1	μA		
		A or B Port: V <sub>i</sub> = V <sub>CCI</sub> or GND	0.65 V - 3.6 V	0.65 V - 3.6 V	–4	4	–8	8			
I <sub>off</sub>	Partial power down current	A or B Port: V <sub>i</sub> or V <sub>o</sub> = 0 V - 3.6 V	0 V	0 V - 3.6 V	–8	8	–12	12	μA		
			0 V - 3.6 V	0 V	–8	8	–12	12			
I <sub>CCA</sub>	V <sub>CCA</sub> supply current	V <sub>I</sub> = V <sub>CCI</sub> or GND	I <sub>o</sub> = 0	0.65 V - 3.6 V	0.65 V - 3.6 V	8			12	μA	
				0 V	3.6 V	–2			–8		
				3.6 V	0 V	2			8		
I <sub>CCB</sub>	V <sub>CCB</sub> supply current	V <sub>I</sub> = V <sub>CCI</sub> or GND	I <sub>o</sub> = 0	0.65 V - 3.6 V	0.65 V - 3.6 V	8			12	μA	
				0 V	3.6 V	2			8		
				3.6 V	0 V	–2			–8		
I <sub>CCA</sub> + I <sub>CCB</sub>	Combined supply current	V <sub>I</sub> = V <sub>CCI</sub> or GND	I <sub>o</sub> = 0	0.65 V - 3.6 V	0.65 V - 3.6 V	10			16	μA	
C <sub>i</sub>	Control input capacitance	V <sub>I</sub> = 3.3 V or GND		3.3 V	3.3 V	4.3			4.3	pF	
C <sub>io</sub>	Data I/O capacitance, A Port	V <sub>O</sub> = 1.65 V DC +1 MHz -16 dBm sine wave		3.3 V	0 V	7.4			7.4	pF	
C <sub>io</sub>	Data I/O capacitance, B Port	V <sub>O</sub> = 1.65 V DC +1 MHz -16 dBm sine wave		0 V	3.3 V	7.4			7.4	pF	

(1) V<sub>CCI</sub> is the VCC associated with the input port.

(2) V<sub>CCO</sub> is the VCC associated with the output port.

(3) All typical data is taken at 25°C.

(4) The bus-hold circuit can sink at least the minimum low sustaining current at V<sub>IL</sub>(MAX). I<sub>BHL</sub> should be measured after lowering V<sub>I</sub> to GND and then raising it to V<sub>IL</sub>(MAX).

(5) The bus-hold circuit can source at least the minimum high sustaining current at V<sub>IH</sub>(MIN). I<sub>BHH</sub> should be measured after raising V<sub>I</sub> to V<sub>CC</sub> and then lowering it to V<sub>IH</sub>(MIN).

(6) An external driver must source at least I<sub>BHLO</sub> to switch this node from low to high.

(7) An external driver must sink at least I<sub>BHHO</sub> to switch this node from high to low.

## 6.6 Switching Characteristics, $V_{CCA} = 0.7\text{ V}$

PARAMETER	FROM	TO	Test Conditions	B-Port Supply Voltage ( $V_{CCB}$ )																UNIT
				0.7 ± 0.05 V		0.8 ± 0.04 V		0.9 ± 0.045 V		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		
				MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
$t_{pd}$ Propagation delay	A	B	-40°C to 85°C	0.5	181	0.5	119	0.5	85	0.5	51	0.5	49	0.5	52	0.5	65	0.5	152	ns
			-40°C to 125°C	0.5	181	0.5	119	0.5	85	0.5	51	0.5	49	0.5	52	0.5	65	0.5	152	
	B	A	-40°C to 85°C	0.5	181	0.5	162	0.5	136	0.5	96	0.5	91	0.5	89	0.5	88	0.5	88	
			-40°C to 125°C	0.5	181	0.5	162	0.5	136	0.5	96	0.5	91	0.5	89	0.5	88	0.5	88	
$t_{dis}$ Disable time	DIR	A	-40°C to 85°C	0.5	152	0.5	152	0.5	152	0.5	152	0.5	152	0.5	152	0.5	152	0.5	152	ns
			-40°C to 125°C	0.5	152	0.5	152	0.5	152	0.5	152	0.5	152	0.5	152	0.5	152	0.5	152	
	DIR	B	-40°C to 85°C	0.5	170	0.5	127	0.5	102	0.5	48	0.5	42	0.5	46	0.5	58	0.5	108	
			-40°C to 125°C	0.5	170	0.5	127	0.5	102	0.5	48	0.5	42	0.5	46	0.5	58	0.5	108	
$t_{en}$ Enable time	DIR	A	-40°C to 85°C	0.5	343	0.5	278	0.5	231	0.5	141	0.5	132	0.5	134	0.5	144	0.5	193	ns
			-40°C to 125°C	0.5	343	0.5	278	0.5	231	0.5	141	0.5	132	0.5	134	0.5	144	0.5	193	
	DIR	B	-40°C to 85°C	0.5	326	0.5	257	0.5	222	0.5	194	0.5	191	0.5	191	0.5	197	0.5	277	
			-40°C to 125°C	0.5	326	0.5	257	0.5	222	0.5	194	0.5	191	0.5	191	0.5	197	0.5	277	

## 6.7 Switching Characteristics, $V_{CCA} = 0.8\text{ V}$

PARAMETER	FROM	TO	Test Conditions	B-Port Supply Voltage ( $V_{CCB}$ )																UNIT
				0.7 ± 0.05 V		0.8 ± 0.04 V		0.9 ± 0.045 V		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		
				MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
$t_{pd}$ Propagation delay	A	B	-40°C to 85°C	0.5	162	0.5	98	0.5	65	0.5	33	0.5	28	0.5	26	0.5	27	0.5	37	ns
			-40°C to 125°C	0.5	162	0.5	98	0.5	65	0.5	33	0.5	28	0.5	26	0.5	27	0.5	37	
	B	A	-40°C to 85°C	0.5	119	0.5	98	0.5	81	0.5	54	0.5	45	0.5	44	0.5	43	0.5	42	
			-40°C to 125°C	0.5	119	0.5	98	0.5	81	0.5	54	0.5	45	0.5	44	0.5	43	0.5	42	
$t_{dis}$ Disable time	DIR	A	-40°C to 85°C	0.5	107	0.5	107	0.5	107	0.5	107	0.5	107	0.5	107	0.5	107	0.5	107	ns
			-40°C to 125°C	0.5	107	0.5	107	0.5	107	0.5	107	0.5	107	0.5	107	0.5	107	0.5	107	
	DIR	B	-40°C to 85°C	0.5	160	0.5	117	0.5	90	0.5	39	0.5	31	0.5	29	0.5	29	0.5	37	
			-40°C to 125°C	0.5	160	0.5	117	0.5	90	0.5	39	0.5	31	0.5	29	0.5	29	0.5	37	
$t_{en}$ Enable time	DIR	A	-40°C to 85°C	0.5	268	0.5	205	0.5	165	0.5	90	0.5	74	0.5	71	0.5	70	0.5	77	ns
			-40°C to 125°C	0.5	268	0.5	205	0.5	165	0.5	90	0.5	74	0.5	71	0.5	70	0.5	77	
	DIR	B	-40°C to 85°C	0.5	257	0.5	194	0.5	161	0.5	130	0.5	125	0.5	126	0.5	125	0.5	132	
			-40°C to 125°C	0.5	257	0.5	194	0.5	161	0.5	130	0.5	125	0.5	126	0.5	125	0.5	132	

## 6.8 Switching Characteristics, $V_{CCA} = 0.9\text{ V}$

PARAMETER	FROM	TO	Test Conditions	B-Port Supply Voltage ( $V_{CCB}$ )																UNIT
				0.7 ± 0.05 V		0.8 ± 0.04 V		0.9 ± 0.045 V		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		
				MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
$t_{pd}$ Propagation delay	A	B	-40°C to 85°C	0.5	135	0.5	81	0.5	54	0.5	24	0.5	18	0.5	17	0.5	15	0.5	18	ns
			-40°C to 125°C	0.5	135	0.5	81	0.5	54	0.5	24	0.5	18	0.5	17	0.5	15	0.5	18	
	B	A	-40°C to 85°C	0.5	86	0.5	65	0.5	54	0.5	41	0.5	30	0.5	26	0.5	23	0.5	23	
			-40°C to 125°C	0.5	86	0.5	65	0.5	54	0.5	41	0.5	30	0.5	26	0.5	23	0.5	23	
$t_{dis}$ Disable time	DIR	A	-40°C to 85°C	0.5	79	0.5	79	0.5	79	0.5	79	0.5	79	0.5	79	0.5	79	0.5	79	ns
			-40°C to 125°C	0.5	79	0.5	79	0.5	79	0.5	79	0.5	79	0.5	79	0.5	79	0.5	79	
	DIR	B	-40°C to 85°C	0.5	154	0.5	111	0.5	85	0.5	34	0.5	27	0.5	25	0.5	21	0.5	23	
			-40°C to 125°C	0.5	154	0.5	111	0.5	85	0.5	34	0.5	27	0.5	25	0.5	21	0.5	23	
$t_{en}$ Enable time	DIR	A	-40°C to 85°C	0.5	227	0.5	166	0.5	131	0.5	71	0.5	53	0.5	48	0.5	42	0.5	44	ns
			-40°C to 125°C	0.5	227	0.5	166	0.5	131	0.5	71	0.5	53	0.5	48	0.5	42	0.5	44	
	DIR	B	-40°C to 85°C	0.5	206	0.5	152	0.5	125	0.5	96	0.5	91	0.5	89	0.5	89	0.5	92	
			-40°C to 125°C	0.5	206	0.5	152	0.5	125	0.5	96	0.5	91	0.5	89	0.5	89	0.5	92	

## 6.9 Switching Characteristics, $V_{CCA} = 1.2\text{ V}$

PARAMETER	FROM	TO	Test Conditions	B-Port Supply Voltage ( $V_{CCB}$ )																UNIT
				0.7 ± 0.05 V		0.8 ± 0.04 V		0.9 ± 0.045 V		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		
				MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
$t_{pd}$ Propagation delay	A	B	-40°C to 85°C	0.5	95	0.5	54	0.5	41	0.5	16	0.5	11	0.5	9	0.5	8	0.5	8	ns
			-40°C to 125°C	0.5	95	0.5	54	0.5	41	0.5	16	0.5	11	0.5	9	0.5	8	0.5	8	
	B	A	-40°C to 85°C	0.5	51	0.5	33	0.5	24	0.5	16	0.5	13	0.5	11	0.5	8	0.5	8	
			-40°C to 125°C	0.5	51	0.5	33	0.5	24	0.5	16	0.5	13	0.5	11	0.5	8	0.5	8	
$t_{dis}$ Disable time	DIR	A	-40°C to 85°C	0.5	28	0.5	28	0.5	28	0.5	28	0.5	28	0.5	28	0.5	28	0.5	28	ns
			-40°C to 125°C	0.5	28	0.5	28	0.5	28	0.5	28	0.5	28	0.5	28	0.5	28	0.5	28	
	DIR	B	-40°C to 85°C	0.5	148	0.5	105	0.5	78	0.5	30	0.5	23	0.5	20	0.5	16	0.5	16	
			-40°C to 125°C	0.5	148	0.5	105	0.5	78	0.5	30	0.5	23	0.5	20	0.5	16	0.5	16	
$t_{en}$ Enable time	DIR	A	-40°C to 85°C	0.5	191	0.5	129	0.5	96	0.5	43	0.5	34	0.5	30	0.5	23	0.5	22	ns
			-40°C to 125°C	0.5	191	0.5	129	0.5	96	0.5	43	0.5	34	0.5	30	0.5	23	0.5	22	
	DIR	B	-40°C to 85°C	0.5	116	0.5	75	0.5	61	0.5	41	0.5	37	0.5	36	0.5	35	0.5	35	
			-40°C to 125°C	0.5	116	0.5	75	0.5	61	0.5	41	0.5	37	0.5	36	0.5	35	0.5	35	

## 6.10 Switching Characteristics, $V_{CCA} = 1.5\text{ V}$

PARAMETER	FROM	TO	Test Conditions	B-Port Supply Voltage ( $V_{CCB}$ )														UNIT		
				0.7 ± 0.05 V		0.8 ± 0.04 V		0.9 ± 0.045 V		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	
				MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX		MIN	MAX
$t_{pd}$ Propagation delay	A	B	-40°C to 85°C	0.5	91	0.5	45	0.5	30	0.5	13	0.5	9	0.5	8	0.5	6	0.5	6	ns
			-40°C to 125°C	0.5	91	0.5	45	0.5	30	0.5	13	0.5	9	0.5	8	0.5	6	0.5	6	
	B	A	-40°C to 85°C	0.5	49	0.5	28	0.5	18	0.5	11	0.5	9	0.5	8	0.5	6	0.5	5	
			-40°C to 125°C	0.5	49	0.5	28	0.5	18	0.5	11	0.5	9	0.5	8	0.5	6	0.5	5	
$t_{dis}$ Disable time	DIR	A	-40°C to 85°C	0.5	20	0.5	20	0.5	20	0.5	20	0.5	20	0.5	20	0.5	20	0.5	20	ns
			-40°C to 125°C	0.5	20	0.5	20	0.5	20	0.5	20	0.5	20	0.5	20	0.5	20	0.5	20	
	DIR	B	-40°C to 85°C	0.5	146	0.5	103	0.5	76	0.5	28	0.5	21	0.5	19	0.5	15	0.5	14	
			-40°C to 125°C	0.5	146	0.5	103	0.5	76	0.5	28	0.5	21	0.5	19	0.5	15	0.5	14	
$t_{en}$ Enable time	DIR	A	-40°C to 85°C	0.5	186	0.5	124	0.5	89	0.5	38	0.5	29	0.5	26	0.5	20	0.5	18	ns
			-40°C to 125°C	0.5	186	0.5	124	0.5	89	0.5	38	0.5	29	0.5	26	0.5	20	0.5	18	
	DIR	B	-40°C to 85°C	0.5	104	0.5	58	0.5	43	0.5	31	0.5	28	0.5	27	0.5	25	0.5	25	
			-40°C to 125°C	0.5	104	0.5	58	0.5	43	0.5	31	0.5	28	0.5	27	0.5	25	0.5	25	

## 6.11 Switching Characteristics, $V_{CCA} = 1.8\text{ V}$

PARAMETER	FROM	TO	Test Conditions	B-Port Supply Voltage ( $V_{CCB}$ )														UNIT		
				0.7 ± 0.05 V		0.8 ± 0.04 V		0.9 ± 0.045 V		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	
				MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX		MIN	MAX
$t_{pd}$ Propagation delay	A	B	-40°C to 85°C	0.5	89	0.5	44	0.5	26	0.5	11	0.5	8	0.5	7	0.5	6	0.5	5	ns
			-40°C to 125°C	0.5	89	0.5	44	0.5	26	0.5	11	0.5	8	0.5	7	0.5	6	0.5	5	
	B	A	-40°C to 85°C	0.5	52	0.5	26	0.5	17	0.5	9	0.5	8	0.5	7	0.5	6	0.5	5	
			-40°C to 125°C	0.5	52	0.5	26	0.5	17	0.5	9	0.5	8	0.5	7	0.5	6	0.5	5	
$t_{dis}$ Disable time	DIR	A	-40°C to 85°C	0.5	17	0.5	17	0.5	17	0.5	17	0.5	17	0.5	17	0.5	17	0.5	17	ns
			-40°C to 125°C	0.5	17	0.5	17	0.5	17	0.5	17	0.5	17	0.5	17	0.5	17	0.5	17	
	DIR	B	-40°C to 85°C	0.5	147	0.5	103	0.5	76	0.5	27	0.5	20	0.5	18	0.5	14	0.5	13	
			-40°C to 125°C	0.5	147	0.5	103	0.5	76	0.5	27	0.5	20	0.5	18	0.5	14	0.5	13	
$t_{en}$ Enable time	DIR	A	-40°C to 85°C	0.5	185	0.5	122	0.5	86	0.5	35	0.5	27	0.5	24	0.5	19	0.5	17	ns
			-40°C to 125°C	0.5	185	0.5	122	0.5	86	0.5	35	0.5	27	0.5	24	0.5	19	0.5	17	
	DIR	B	-40°C to 85°C	0.5	100	0.5	54	0.5	37	0.5	27	0.5	25	0.5	24	0.5	22	0.5	22	
			-40°C to 125°C	0.5	100	0.5	54	0.5	37	0.5	27	0.5	25	0.5	24	0.5	22	0.5	22	

### 6.12 Switching Characteristics, $V_{CCA} = 2.5\text{ V}$

PARAMETER	FROM	TO	Test Conditions	B-Port Supply Voltage ( $V_{CCB}$ )																UNIT
				0.7 ± 0.05 V		0.8 ± 0.04 V		0.9 ± 0.045 V		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		
				MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
$t_{pd}$ Propagation delay	A	B	-40°C to 85°C	0.5	88	0.5	42	0.5	23	0.5	8	0.5	6	0.5	6	0.5	5	0.5	5	ns
			-40°C to 125°C	0.5	88	0.5	42	0.5	23	0.5	8	0.5	6	0.5	6	0.5	5	0.5	5	
	B	A	-40°C to 85°C	0.5	65	0.5	27	0.5	15	0.5	8	0.5	6	0.5	6	0.5	5	0.5	4	
			-40°C to 125°C	0.5	65	0.5	27	0.5	15	0.5	8	0.5	6	0.5	6	0.5	5	0.5	4	
$t_{dis}$ Disable time	DIR	A	-40°C to 85°C	0.5	13	0.5	13	0.5	13	0.5	13	0.5	13	0.5	13	0.5	13	0.5	13	ns
			-40°C to 125°C	0.5	13	0.5	13	0.5	13	0.5	13	0.5	13	0.5	13	0.5	13	0.5	13	
	DIR	B	-40°C to 85°C	0.5	146	0.5	102	0.5	75	0.5	27	0.5	19	0.5	17	0.5	13	0.5	12	
			-40°C to 125°C	0.5	146	0.5	102	0.5	75	0.5	27	0.5	19	0.5	17	0.5	13	0.5	12	
$t_{en}$ Enable time	DIR	A	-40°C to 85°C	0.5	191	0.5	122	0.5	85	0.5	33	0.5	25	0.5	22	0.5	17	0.5	16	ns
			-40°C to 125°C	0.5	191	0.5	122	0.5	85	0.5	33	0.5	25	0.5	22	0.5	17	0.5	16	
	DIR	B	-40°C to 85°C	0.5	95	0.5	50	0.5	31	0.5	20	0.5	18	0.5	17	0.5	17	0.5	17	
			-40°C to 125°C	0.5	95	0.5	50	0.5	31	0.5	20	0.5	18	0.5	17	0.5	17	0.5	17	

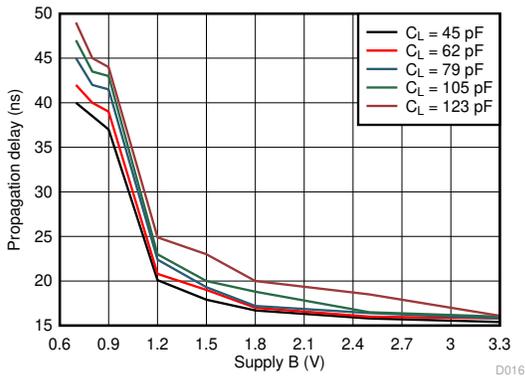
### 6.13 Switching Characteristics, $V_{CCA} = 3.3\text{ V}$

PARAMETER	FROM	TO	Test Conditions	B-Port Supply Voltage ( $V_{CCB}$ )																UNIT
				0.7 ± 0.05 V		0.8 ± 0.04 V		0.9 ± 0.045 V		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		
				MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
$t_{pd}$ Propagation delay	A	B	-40°C to 85°C	0.5	87	0.5	42	0.5	23	0.5	8	0.5	5	0.5	5	0.5	4	0.5	4	ns
			-40°C to 125°C	0.5	87	0.5	42	0.5	23	0.5	8	0.5	5	0.5	5	0.5	4	0.5	4	
	B	A	-40°C to 85°C	0.5	154	0.5	37	0.5	18	0.5	8	0.5	6	0.5	5	0.5	5	0.5	4	
			-40°C to 125°C	0.5	154	0.5	37	0.5	18	0.5	8	0.5	6	0.5	5	0.5	5	0.5	4	
$t_{dis}$ Disable time	DIR	A	-40°C to 85°C	0.5	12	0.5	12	0.5	12	0.5	12	0.5	12	0.5	12	0.5	12	0.5	12	ns
			-40°C to 125°C	0.5	12	0.5	12	0.5	12	0.5	12	0.5	12	0.5	12	0.5	12	0.5	12	
	DIR	B	-40°C to 85°C	0.5	147	0.5	102	0.5	75	0.5	26	0.5	19	0.5	17	0.5	13	0.5	12	
			-40°C to 125°C	0.5	147	0.5	102	0.5	75	0.5	26	0.5	19	0.5	17	0.5	13	0.5	12	
$t_{en}$ Enable time	DIR	A	-40°C to 85°C	0.5	275	0.5	129	0.5	88	0.5	34	0.5	24	0.5	21	0.5	17	0.5	16	ns
			-40°C to 125°C	0.5	275	0.5	129	0.5	88	0.5	34	0.5	24	0.5	21	0.5	17	0.5	16	
	DIR	B	-40°C to 85°C	0.5	94	0.5	49	0.5	30	0.5	18	0.5	16	0.5	16	0.5	15	0.5	15	
			-40°C to 125°C	0.5	94	0.5	49	0.5	30	0.5	18	0.5	16	0.5	16	0.5	15	0.5	15	

## 6.14 Operating Characteristics: $T_A = 25^\circ\text{C}$

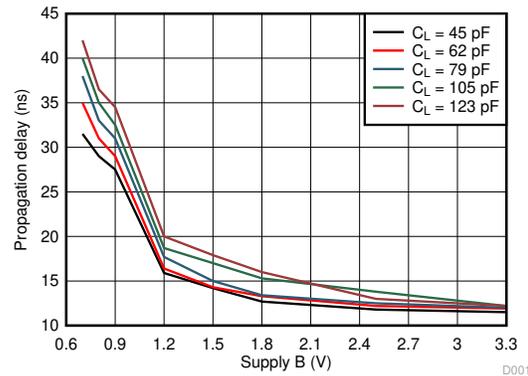
PARAMETER		TEST CONDITIONS	$V_{CCA}$	$V_{CCB}$	MIN	TYP	MAX	UNIT
$C_{pdA}$	Power Dissipation Capacitance per transceiver (A to B: outputs enabled)	CL = 0, RL = Open f = 1 MHz, tr = tf = 1 ns	0.7 V	0.7 V		2.0		pF
			0.8 V	0.8 V		2.0		
			0.9 V	0.9 V		2.0		
			1.2 V	1.2 V		2.0		
			1.5 V	1.5 V		1.9		
			1.8 V	1.8 V		2.0		
			2.5 V	2.5 V		2.4		
				3.3 V	3.3 V		3.0	
	Power Dissipation Capacitance per transceiver (B to A: outputs enabled)	CL = 0, RL = Open f = 1 MHz, tr = tf = 1 ns	0.7 V	0.7 V		12		pF
			0.8 V	0.8 V		12		
			0.9 V	0.9 V		12		
			1.2 V	1.2 V		12		
			1.5 V	1.5 V		13		
			1.8 V	1.8 V		13		
2.5 V			2.5 V		17			
			3.3 V	3.3 V		21		
$C_{pdB}$	Power Dissipation Capacitance per transceiver (A to B: outputs enabled)	CL = 0, RL = Open f = 1 MHz, tr = tf = 1 ns	0.7 V	0.7 V		12		pF
			0.8 V	0.8 V		12		
			0.9 V	0.9 V		12		
			1.2 V	1.2 V		12		
			1.5 V	1.5 V		13		
			1.8 V	1.8 V		13		
			2.5 V	2.5 V		17		
				3.3 V	3.3 V		21	
	Power Dissipation Capacitance per transceiver (B to A: outputs enabled)	CL = 0, RL = Open f = 1 MHz, tr = tf = 1 ns	0.7 V	0.7 V		2.1		pF
			0.8 V	0.8 V		2.2		
			0.9 V	0.9 V		2.2		
			1.2 V	1.2 V		2.2		
			1.5 V	1.5 V		2.3		
			1.8 V	1.8 V		2.3		
2.5 V			2.5 V		2.6			
			3.3 V	3.3 V		3.3		

## 6.15 Typical Characteristics



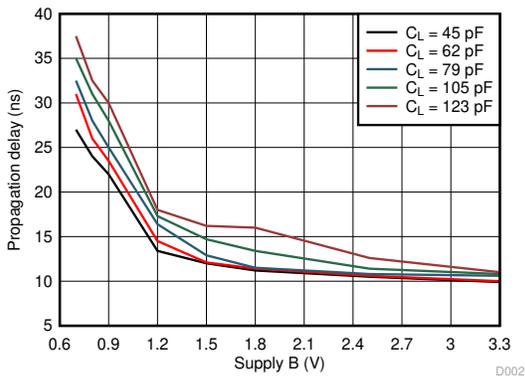
$T_A = 25^\circ\text{C}$   $V_{CCA} = 0.7\text{ V}$

**Figure 6-1. Typical Propagation Delay of Low-to-High (A to B) vs Load Capacitance**



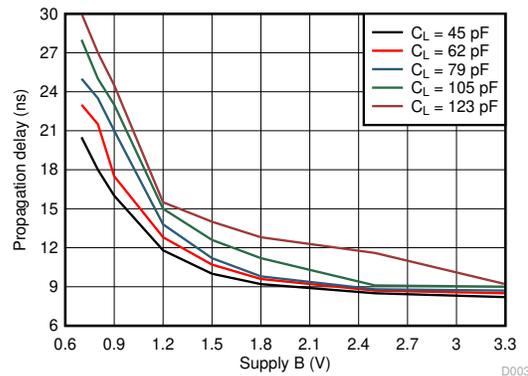
$T_A = 25^\circ\text{C}$   $V_{CCA} = 0.8\text{ V}$

**Figure 6-2. Typical Propagation Delay of Low-to-High (A to B) vs Load Capacitance**



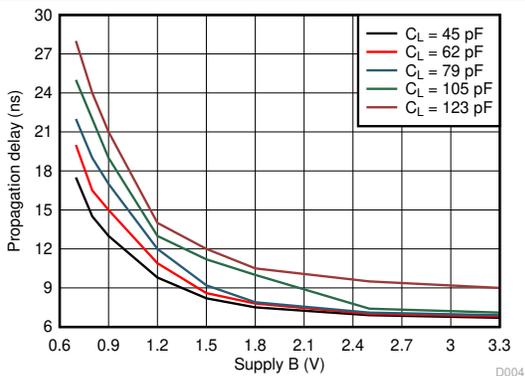
$T_A = 25^\circ\text{C}$   $V_{CCA} = 0.9\text{ V}$

**Figure 6-3. Typical Propagation Delay of Low-to-High (A to B) vs Load Capacitance**



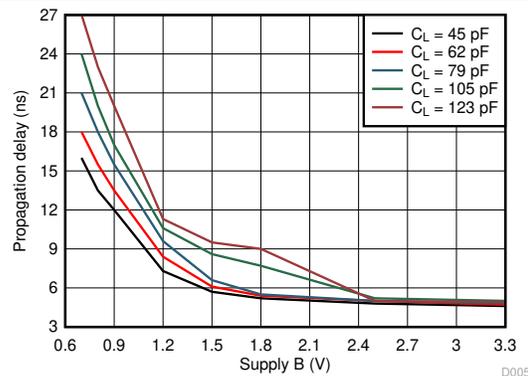
$T_A = 25^\circ\text{C}$   $V_{CCA} = 1.2\text{ V}$

**Figure 6-4. Typical Propagation Delay of Low-to-High (A to B) vs Load Capacitance**



$T_A = 25^\circ\text{C}$   $V_{CCA} = 1.5\text{ V}$

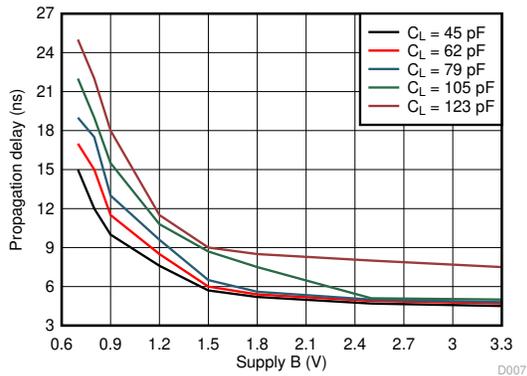
**Figure 6-5. Typical Propagation Delay of Low-to-High (A to B) vs Load Capacitance**



$T_A = 25^\circ\text{C}$   $V_{CCA} = 1.8\text{ V}$

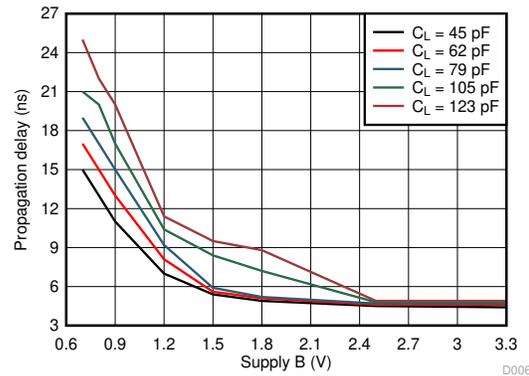
**Figure 6-6. Typical Propagation Delay of Low-to-High (A to B) vs Load Capacitance**

### 6.15 Typical Characteristics (continued)



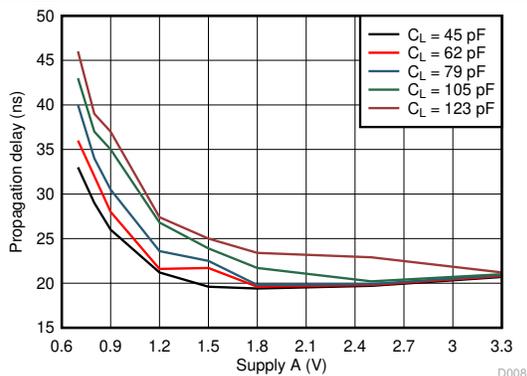
$T_A = 25^\circ\text{C}$   $V_{CCA} = 3.3\text{ V}$

**Figure 6-7. Typical Propagation Delay of Low-to-High (A to B) vs Load Capacitance**



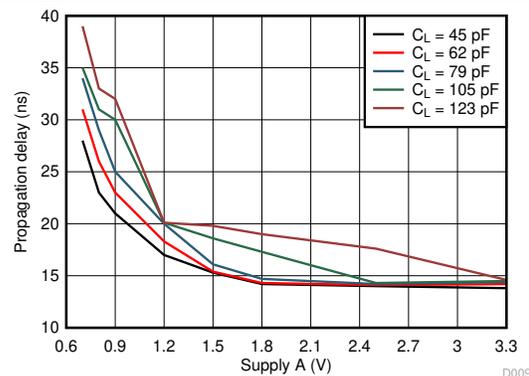
$T_A = 25^\circ\text{C}$   $V_{CCA} = 2.5\text{ V}$

**Figure 6-8. Typical Propagation Delay of Low-to-High (A to B) vs Load Capacitance**



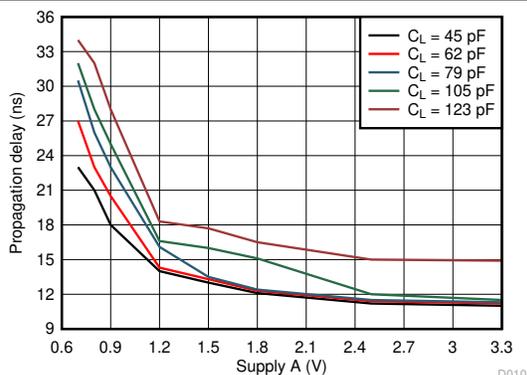
$T_A = 25^\circ\text{C}$   $V_{CCA} = 0.7\text{ V}$

**Figure 6-9. Typical Propagation Delay of Low-to-High (B to A) vs Load Capacitance**



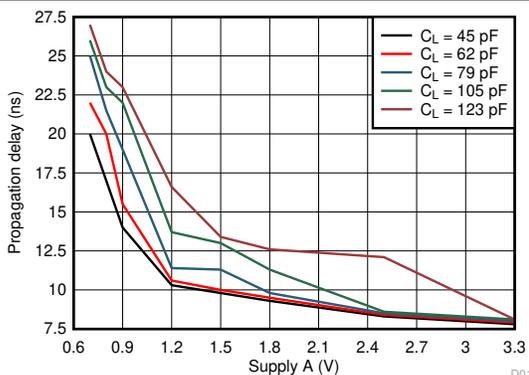
$T_A = 25^\circ\text{C}$   $V_{CCA} = 0.8\text{ V}$

**Figure 6-10. Typical Propagation Delay of Low-to-High (B to A) vs Load Capacitance**



$T_A = 25^\circ\text{C}$   $V_{CCA} = 0.9\text{ V}$

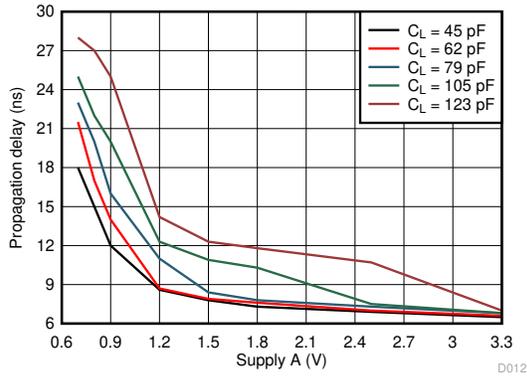
**Figure 6-11. Typical Propagation Delay of Low-to-High (B to A) vs Load Capacitance**



$T_A = 25^\circ\text{C}$   $V_{CCA} = 1.2\text{ V}$

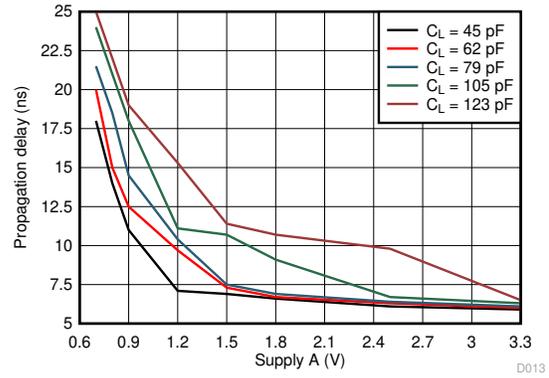
**Figure 6-12. Typical Propagation Delay of Low-to-High (B to A) vs Load Capacitance**

### 6.15 Typical Characteristics (continued)



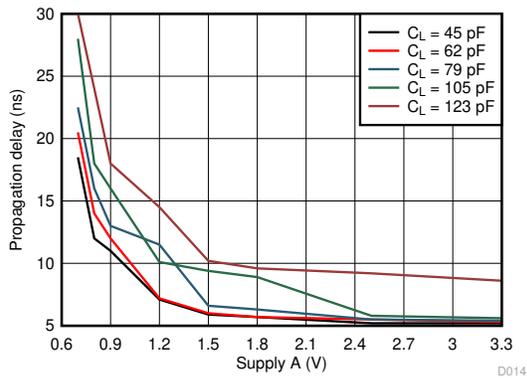
$T_A = 25^\circ\text{C}$   $V_{CCA} = 1.5\text{ V}$

**Figure 6-13. Typical Propagation Delay of Low-to-High (B to A) vs Load Capacitance**



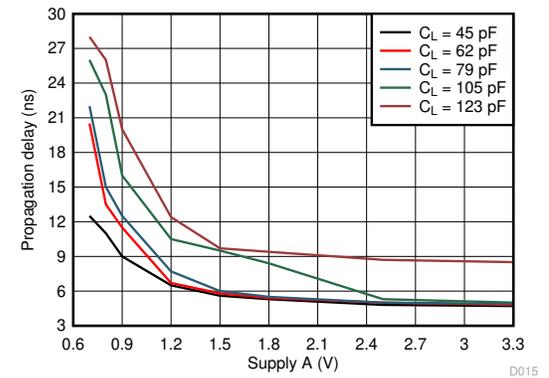
$T_A = 25^\circ\text{C}$   $V_{CCA} = 1.8\text{ V}$

**Figure 6-14. Typical Propagation Delay of Low-to-High (B to A) vs Load Capacitance**



$T_A = 25^\circ\text{C}$   $V_{CCA} = 2.5\text{ V}$

**Figure 6-15. Typical Propagation Delay of Low-to-High (B to A) vs Load Capacitance**



$T_A = 25^\circ\text{C}$   $V_{CCA} = 3.3\text{ V}$

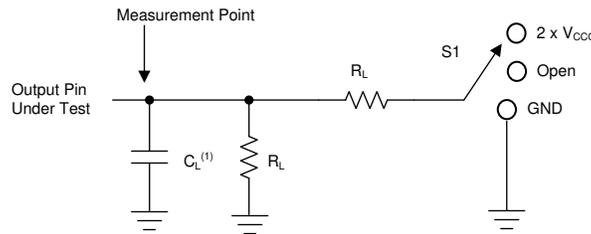
**Figure 6-16. Typical Propagation Delay of Low-to-High (B to A) vs Load Capacitance**

## 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:

- $f = 1 \text{ MHz}$
- $Z_O = 50 \Omega$
- $dv/dt \leq 1 \text{ ns/V}$

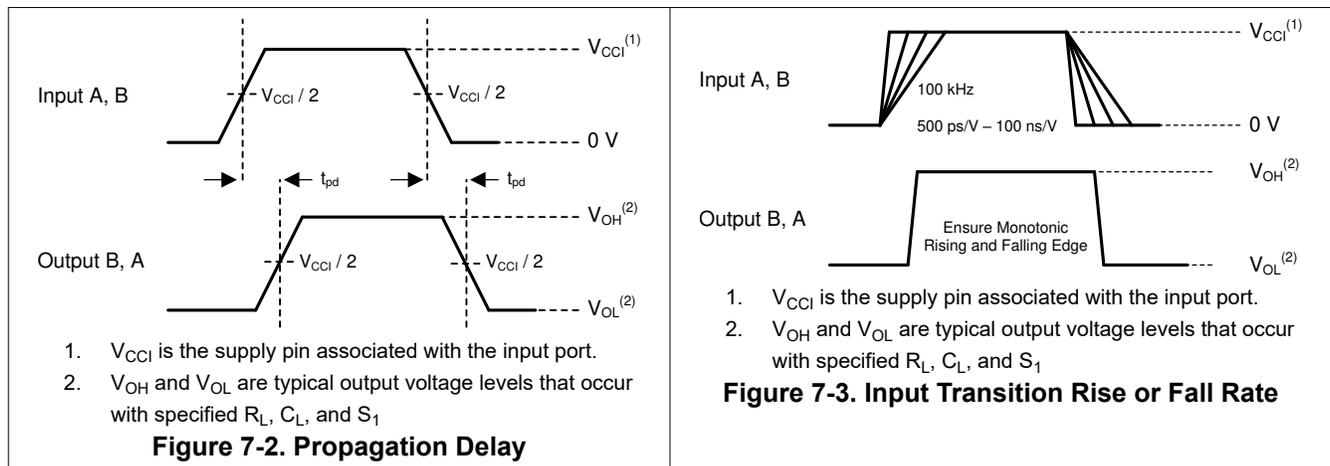


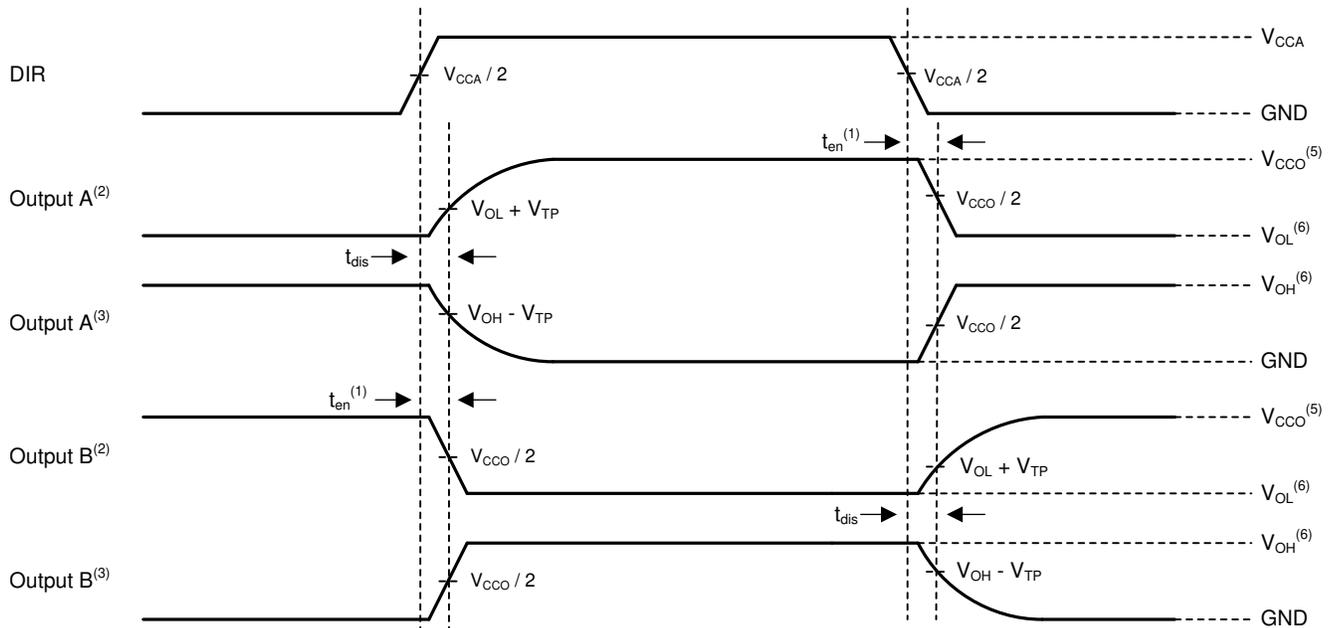
A.  $C_L$  includes probe and jig capacitance.

Figure 7-1. Load Circuit

Table 7-1. Load Circuit Conditions

Parameter	$V_{CCO}$	$R_L$	$C_L$	$S_1$	$V_{TP}$
$\Delta t/\Delta v$ Input transition rise or fall rate	0.65 V – 3.6 V	1 M $\Omega$	15 pF	Open	N/A
$t_{pd}$ Propagation (delay) time	1.1 V – 3.6 V	2 k $\Omega$	15 pF	Open	N/A
	0.65 V – 0.95 V	20 k $\Omega$	15 pF	Open	N/A
$t_{en}, t_{dis}$ Enable time, disable time	3 V – 3.6 V	2 k $\Omega$	15 pF	$2 \times V_{CCO}$	0.3 V
	1.65 V – 2.7 V	2 k $\Omega$	15 pF	$2 \times V_{CCO}$	0.15 V
	1.1 V – 1.6 V	2 k $\Omega$	15 pF	$2 \times V_{CCO}$	0.1 V
	0.65 V – 0.95 V	20 k $\Omega$	15 pF	$2 \times V_{CCO}$	0.1 V
$t_{en}, t_{dis}$ Enable time, disable time	3 V – 3.6 V	2 k $\Omega$	15 pF	GND	0.3 V
	1.65 V – 2.7 V	2 k $\Omega$	15 pF	GND	0.15 V
	1.1 V – 1.6 V	2 k $\Omega$	15 pF	GND	0.1 V
	0.65 V – 0.95 V	20 k $\Omega$	15 pF	GND	0.1 V





1. Illustrative purposes only. Enable Time is a calculation as described in the data sheet.
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 that occur with specified  $R_L$ ,  $C_L$ , and  $S_1$

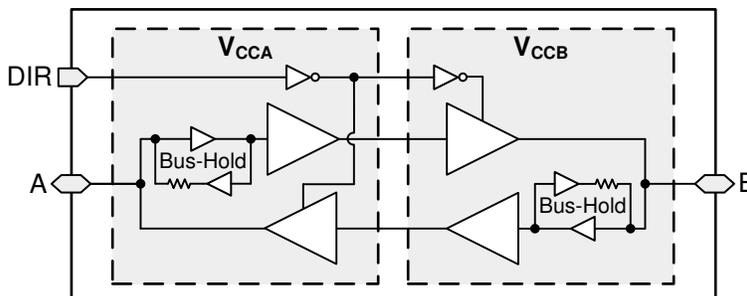
**Figure 7-4. Disable and Enable Time**

## 8 Detailed Description

### 8.1 Overview

The SN74AXCH1T45 is single-bit, dual-supply, noninverting voltage level translator. Pin A and the direction control pin are referenced to  $V_{CCA}$  logic levels and pin B is referenced to  $V_{CCB}$  logic levels, as depicted in . The A port can accept I/O voltages ranging from 0.65 V to 3.6 V, and the B port can accept I/O voltages from 0.65 V to 3.6 V. A logic high on the DIR pin enables data transmission from A to B and a logic low on the DIR pin enables data transmission from B to A.

### 8.2 Functional Block Diagram



### 8.3 Feature Description

#### 8.3.1 Standard CMOS Inputs

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 ( $R = V \div I$ ).

Signals applied to the inputs need to have fast edge rates, as defined by  $\Delta t/\Delta v$  in [Recommended Operating Conditions](#) to avoid excessive current consumption and oscillations. If a slow or noisy input signal is required, a device with a Schmitt-trigger input should be used to condition the input signal prior to the standard CMOS input.

#### 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

The inputs and outputs for this device enter a high-impedance state when either supply is  $<100\text{mV}$ .

#### 8.3.5 Over-Voltage Tolerant Inputs

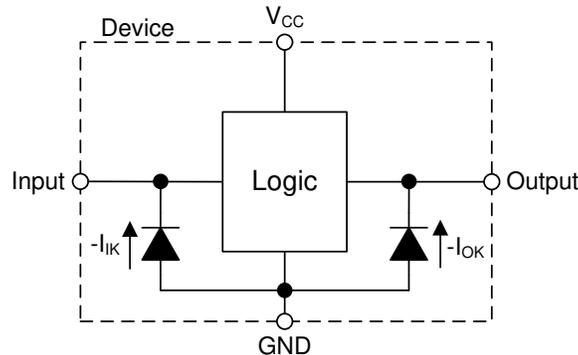
Input signals to this device can be driven above the supply voltage so long as they remain below the maximum input voltage value specified in the [Recommended Operating Conditions](#).

### 8.3.6 Negative Clamping Diodes

The inputs and outputs to this device have negative clamping diodes as depicted in [Figure 8-1](#).

**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 8-1. Electrical Placement of Clamping Diodes for Each Input and Output**

### 8.3.7 Fully Configurable Dual-Rail Design

Both the  $V_{CCA}$  and  $V_{CCB}$  pins can be supplied at any voltage from 0.65 V to 3.6 V, making the device suitable for translating between any of the voltage nodes (0.7 V, 0.8 V, 0.9 V, 1.2 V, 1.8 V, 2.5 V and 3.3 V).

### 8.3.8 Supports High-Speed Translation

The SN74AXCH1T45 device can support high data-rate applications. The translated signal data rate can be up to 500 Mbps when the signal is translated from 1.8 V to 3.3 V.

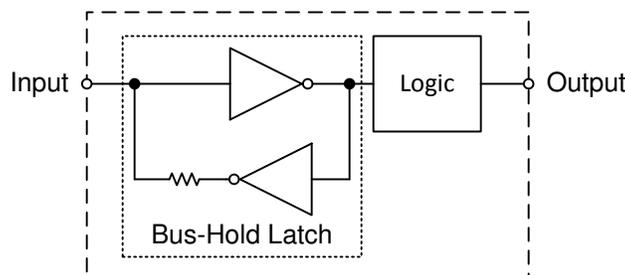
### 8.3.9 Bus-Hold Data Inputs

Each data input on this device includes a weak latch that maintains a valid logic level on the input. The state of these latches is unknown at startup and remains unknown until the input has been forced to a valid high or low state. After data has been sent through a channel, the latch then maintains the previous state on the input if the line is left floating. It is not recommended to use pull-up or pull-down resistors together with a bus-hold input, as it may cause undefined inputs to occur which leads to excessive current consumption.

Bus-hold data inputs prevent floating inputs on this device. The [Implications of Slow or Floating CMOS Inputs](#) application report explains the problems associated with leaving CMOS inputs floating.

These latches remain active at all times, independent of all control signals such as direction control or output enable.

The [Bus-Hold Circuit](#) application report has additional details regarding bus-hold inputs.



**Figure 8-2. Simplified Schematic for Device With Bus-Hold Data Inputs**

## 8.4 Device Functional Modes

Table 8-1 lists the device functions for the DIR input.

**Table 8-1. Function Table**

INPUT <sup>(1)</sup> DIR	OPERATION
L	B data to A bus
H	A data to B bus

(1) Input circuits of the data I/Os always are active.

## 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 SN74AXCH1T45 device can be used in level-translation applications for interfacing devices or systems with one another when they are operating at different interface voltages. The maximum data rate can be up to 500 Mbps when the device translate signals from 1.8 V to 3.3 V.

#### 9.1.1 Enable Times

Calculate the enable times for the SN74AXC1T45 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 SN74AXCH1T45 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 port being disabled ( $t_{dis\ max}$ ).

### 9.2 Typical Applications

#### 9.2.1 Interrupt Request Application

Figure 9-1 shows an example of the SN74AXCH1T45 being used in an application where a system controller flags an interrupt request (IRQ) to the CPU. The system controller determines the direction of the IRQ line to either flag an interrupt to the CPU or allow the CPU to drive data on the line. In this application the controller is operating at 3.3 V while the CPU can be operating as low as 0.65 V.

The SN74AXCH1T45 device is used to ensure that these devices can communicate at the appropriate voltage levels. Because the SN74AXCH1T45 does not have an output-enable ( $\overline{OE}$ ) pin, the system designer should take precautions to avoid bus contention between the CPU and controller when changing directions.

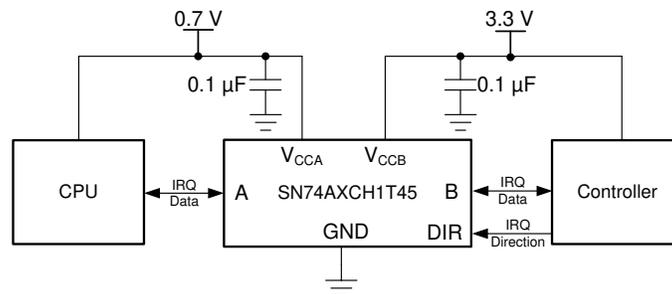


Figure 9-1. Interrupt Request Application

### 9.2.1.1 Design Requirements

For this design example, use the parameters listed in [Table 9-1](#).

**Table 9-1. Design Parameters**

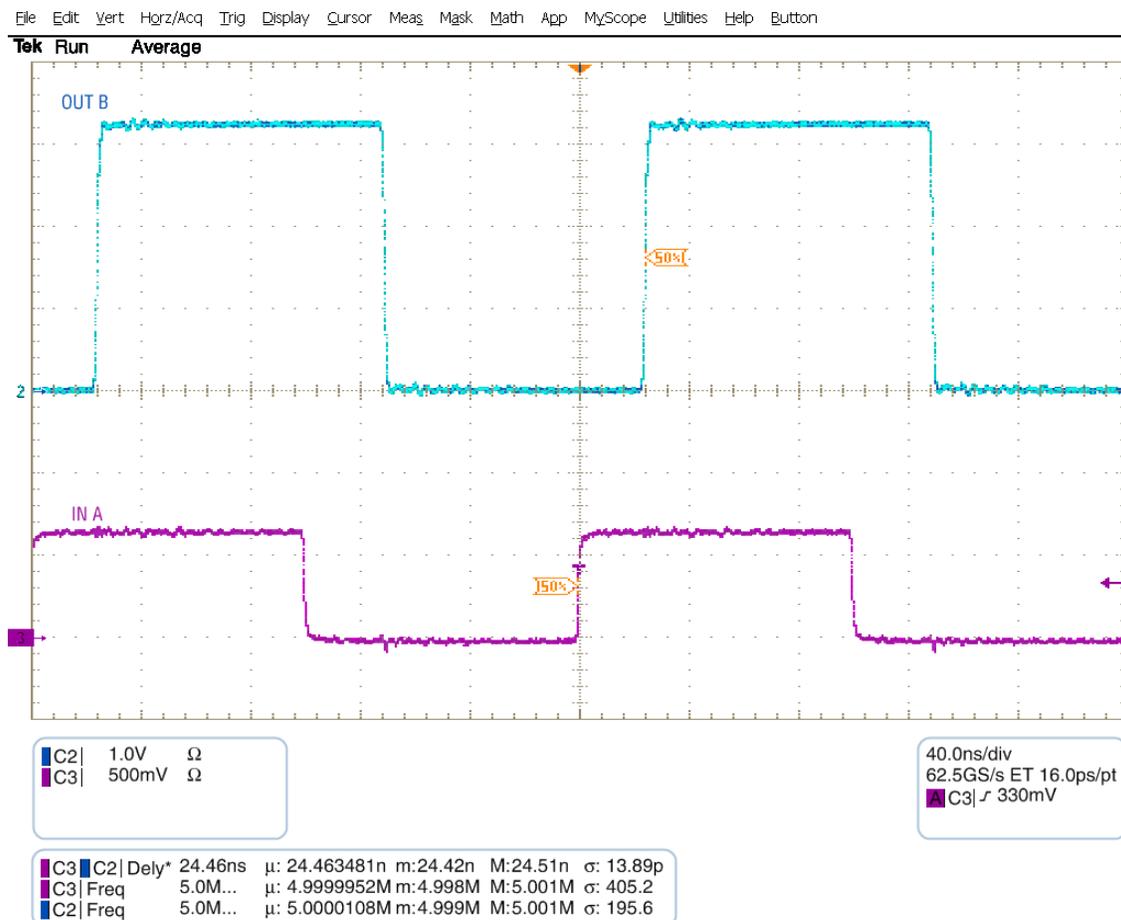
DESIGN PARAMETERS	EXAMPLE VALUES
Input voltage range	0.65 V to 3.6 V
Output voltage range	0.65 V to 3.6 V

### 9.2.1.2 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 SN74AXCH1T45 device to determine the input voltage range. For a valid logic-high, the value must exceed the high-level input voltage ( $V_{IH}$ ) of the input port. For a valid logic low the value must be less than the low-level input voltage ( $V_{IL}$ ) of the input port.
- Output voltage range
  - Use the supply voltage of the device that the SN74AXCH1T45 device is driving to determine the output voltage range.

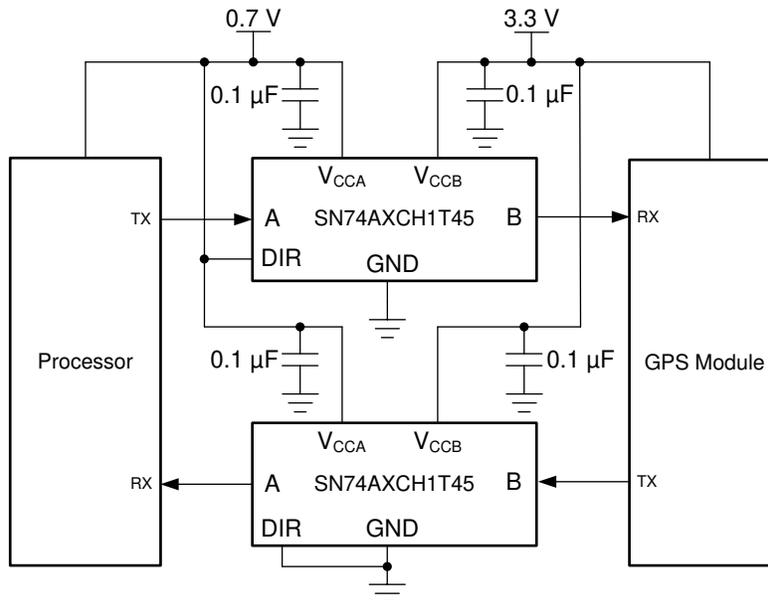
### 9.2.1.3 Application Curve



**Figure 9-2. Up Translation at 2.5 MHz (0.7 V to 3.3 V)**

### 9.2.2 Universal Asynchronous Receiver-Transmitter (UART) Interface Application

Figure 9-3 shows the SN74AXCH1T45 being used for the two-bit UART interface application. One SN74AXCH1T45 device is used to level shift the voltage and drive the TX from the processor to the GPS Module while a second SN74AXCH1T45 device is used to drive the TX Data line from the GPS Module to the Processor. Devices with bus-hold inputs remove the requirement for external pullup resistors to maintain a valid logic level at the input.



**Figure 9-3. UART Interface Application**

#### 9.2.2.1 Design Requirements

Refer to [Design Requirements](#).

#### 9.2.2.2 Detailed Design Procedure

Refer to [Detailed Design Procedure](#).

## 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. For more information regarding the power up glitch performance of the AXC family of level translators, see the [Power Sequencing for AXC Family of Devices](#) application report.

## 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.
- Use short trace lengths to avoid excessive loading.

### 11.2 Layout Example

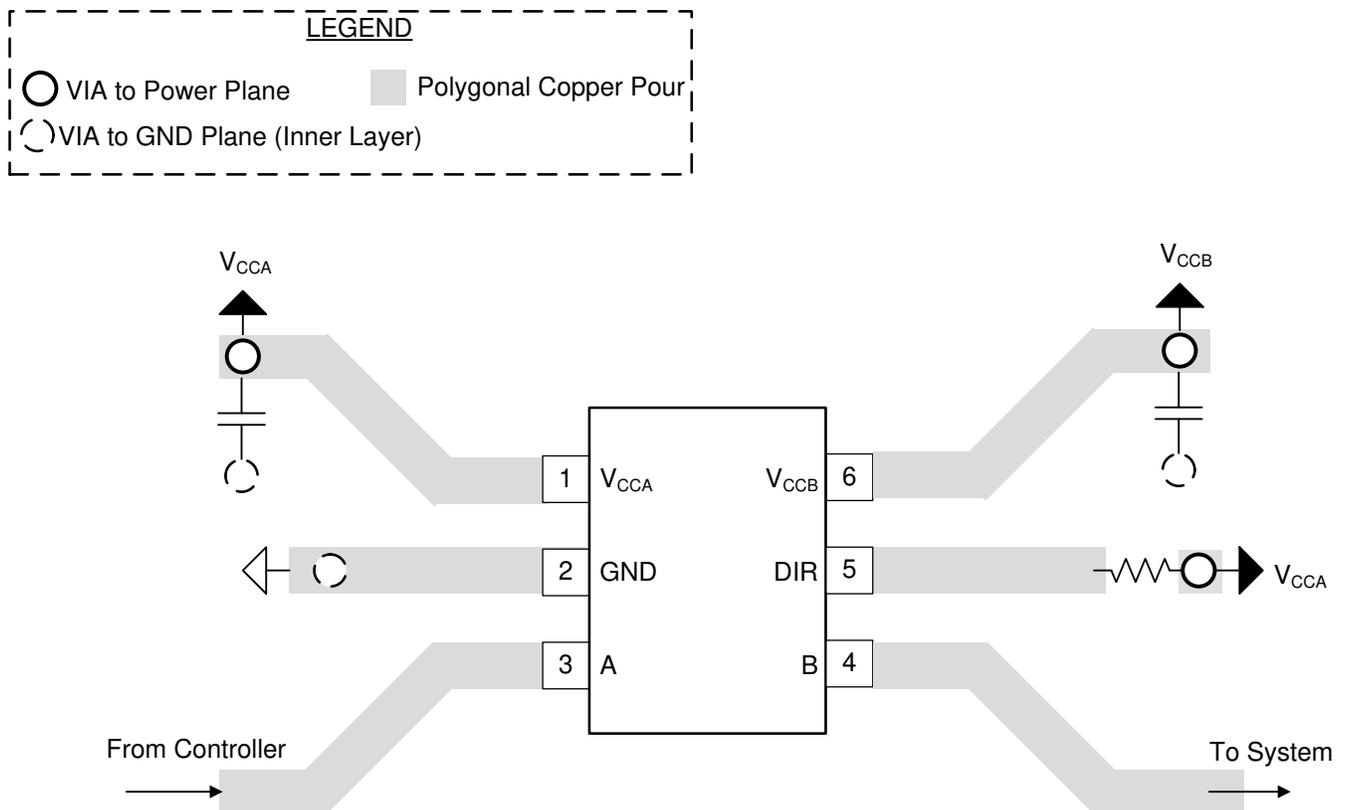


Figure 11-1. PCB Layout Example

## 12 Device and Documentation Support

### 12.1 Documentation Support

#### 12.1.1 Related Documentation

For related documentation see the following:

- Texas Instruments, [Evaluate SN74AXC1T45DRL Using a Generic EVM](#) application report
- Texas Instruments, [System Considerations For Using Bus-hold Circuits To Avoid Floating Inputs](#) application report
- Texas Instruments, [Power Sequencing for the AXC Family of Devices](#) application report
- Texas Instruments, [Implications of Slow or Floating CMOS Inputs](#) 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.

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
SN74AXCH1T45DBVR	ACTIVE	SOT-23	DBV	6	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	1PNL	<a href="#">Samples</a>
SN74AXCH1T45DCKR	ACTIVE	SC70	DCK	6	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	1CC	<a href="#">Samples</a>
SN74AXCH1T45DRY2	ACTIVE	SON	DRY	6	5000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	IR	<a href="#">Samples</a>
SN74AXCH1T45DRYR	ACTIVE	SON	DRY	6	5000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	II	<a href="#">Samples</a>
SN74AXCH1T45DTQR	ACTIVE	X2SON	DTQ	6	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	DM	<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.

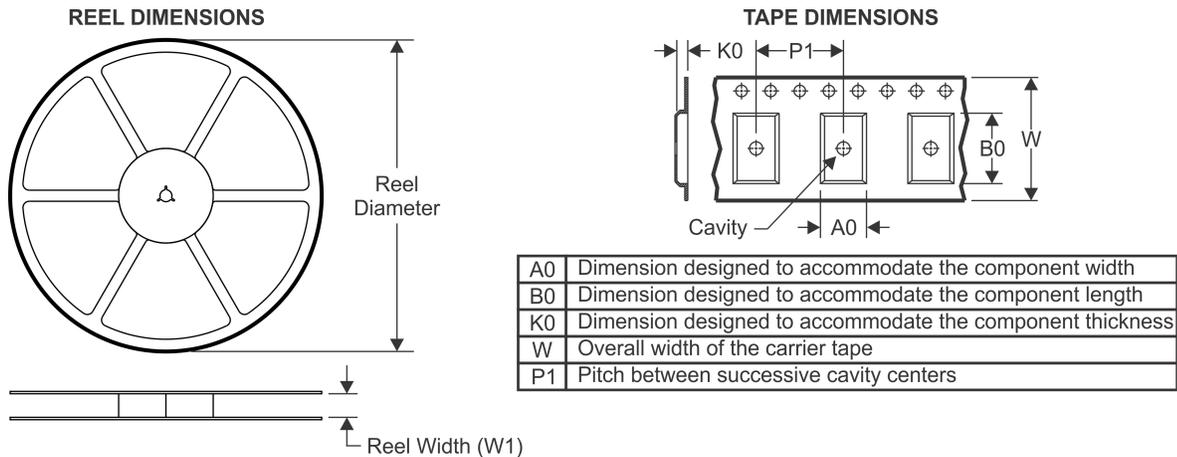
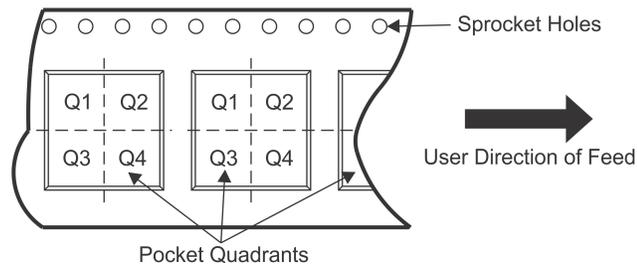
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(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.

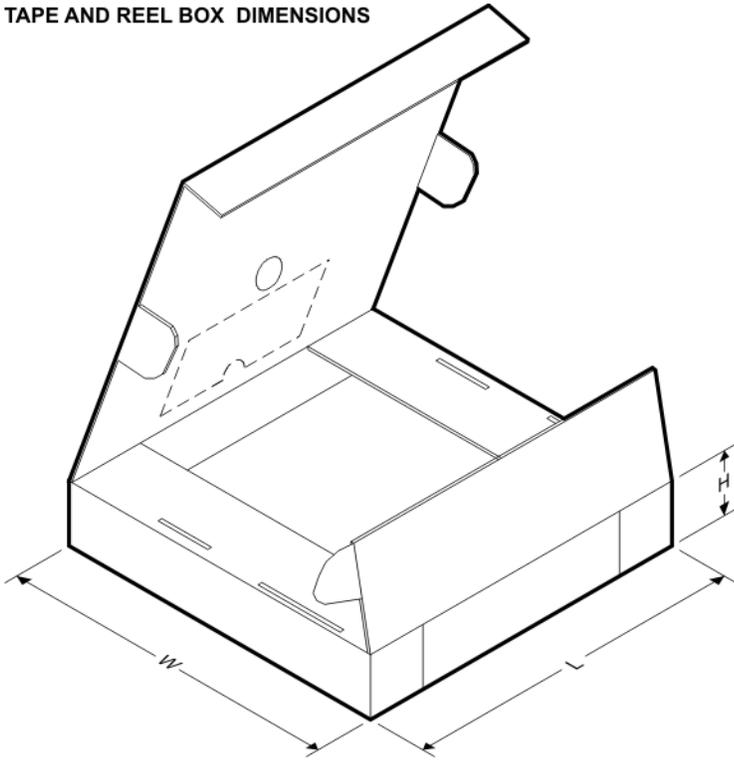
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**TAPE AND REEL INFORMATION**

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


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
SN74AXCH1T45DBVR	SOT-23	DBV	6	3000	180.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
SN74AXCH1T45DCKR	SC70	DCK	6	3000	178.0	9.0	2.4	2.5	1.2	4.0	8.0	Q3
SN74AXCH1T45DRY2	SON	DRY	6	5000	180.0	9.5	1.6	1.15	0.68	4.0	8.0	Q3
SN74AXCH1T45DRYR	SON	DRY	6	5000	180.0	9.5	1.2	1.65	0.7	4.0	8.0	Q1
SN74AXCH1T45DTQR	X2SON	DTQ	6	3000	180.0	9.5	0.94	1.13	0.5	2.0	8.0	Q2

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74AXCH1T45DBVR	SOT-23	DBV	6	3000	210.0	185.0	35.0
SN74AXCH1T45DCKR	SC70	DCK	6	3000	180.0	180.0	18.0
SN74AXCH1T45DRY2	SON	DRY	6	5000	189.0	185.0	36.0
SN74AXCH1T45DRYR	SON	DRY	6	5000	189.0	185.0	36.0
SN74AXCH1T45DTQR	X2SON	DTQ	6	3000	189.0	185.0	36.0

## GENERIC PACKAGE VIEW

**DRY 6**

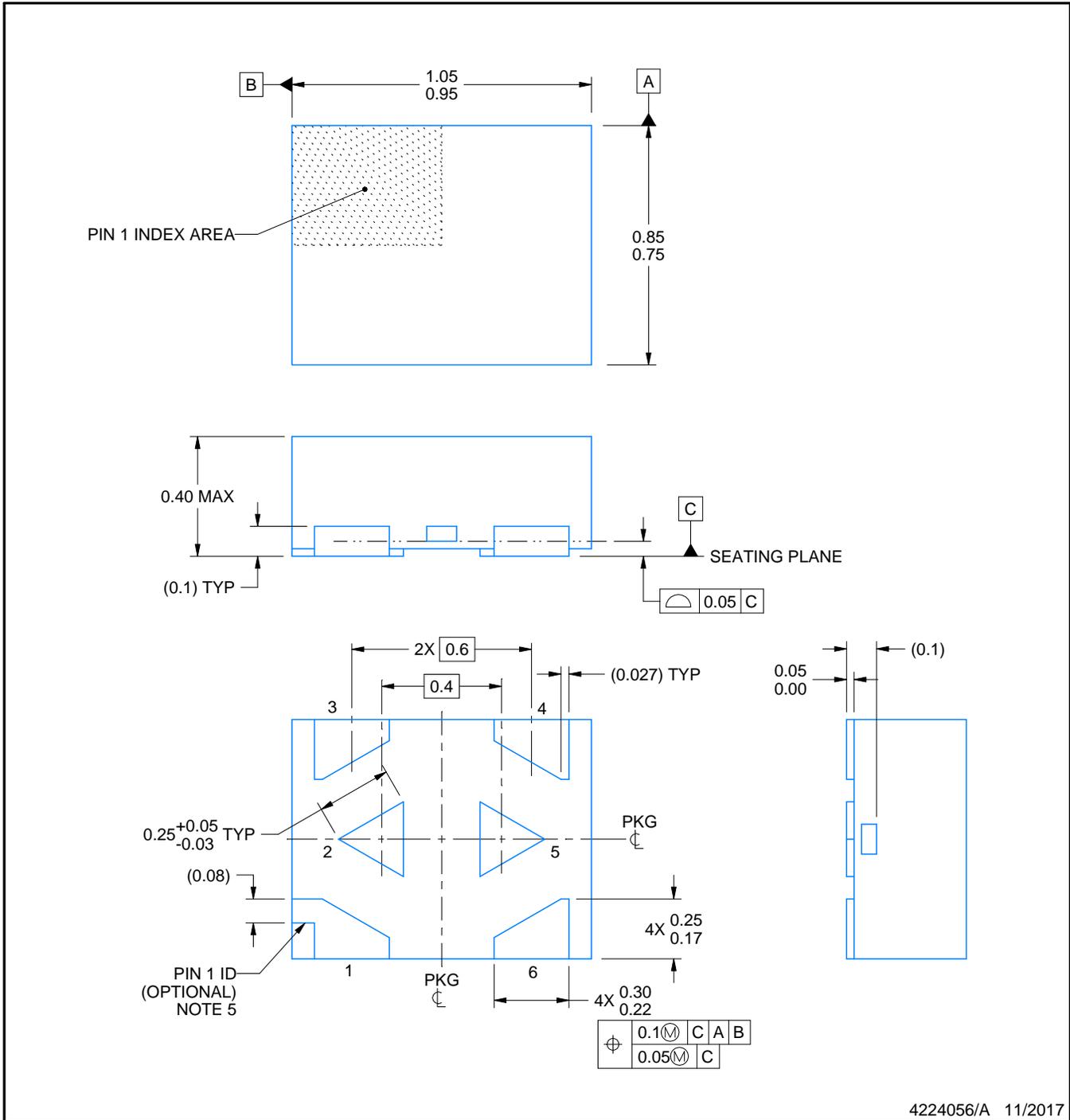
**USON - 0.6 mm max height**

PLASTIC SMALL OUTLINE - NO LEAD



Images above are just a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.

4207181/G



NOTES:

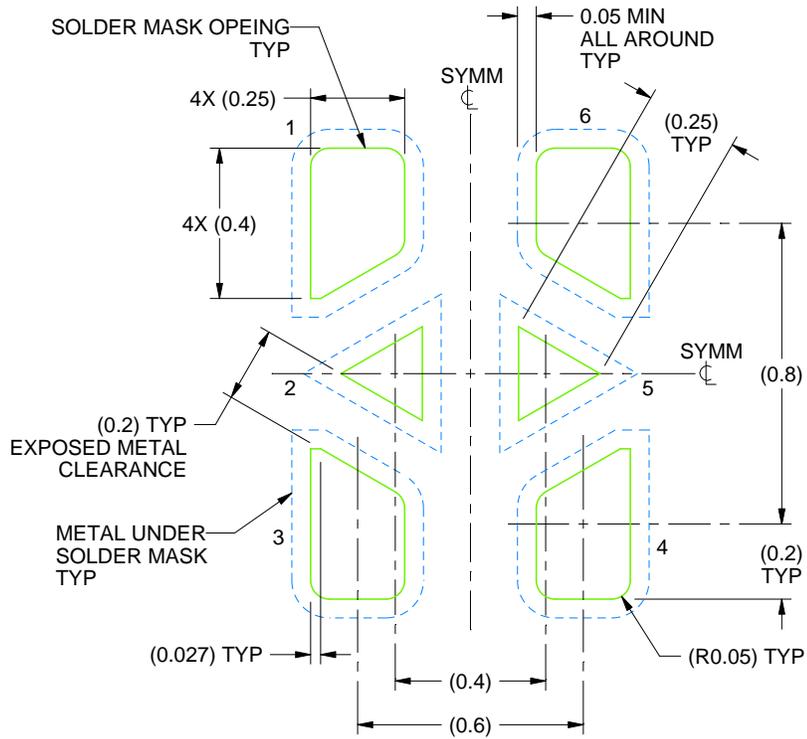
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pads must be soldered to the printed circuit board for optimal thermal and mechanical performance.
4. The size and shape of this feature may vary.
5. Features may not exist. Recommend use of pin 1 marking on top of package for orientation purposes.

# EXAMPLE BOARD LAYOUT

DTQ0006A

X2SON - 0.4 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



LAND PATTERN EXAMPLE  
SOLDER MASK DEFINED  
SCALE:50X

4224056/A 11/2017

NOTES: (continued)

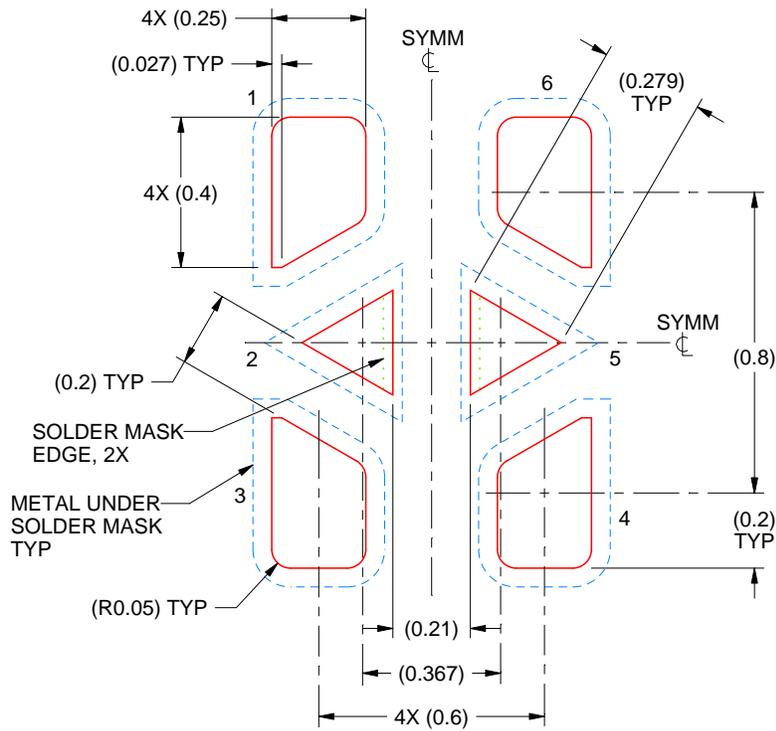
6. This package is designed to be soldered to a thermal pads on the board. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/slue271](http://www.ti.com/lit/slue271)).
7. Vias are optional depending on application, refer to device data sheet. If some or all are implemented, recommended via locations are shown.

# EXAMPLE STENCIL DESIGN

DTQ0006A

X2SON - 0.4 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



SOLDER PASTE EXAMPLE  
BASED ON 0.07 mm THICK STENCIL

PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE  
SCALE:50X

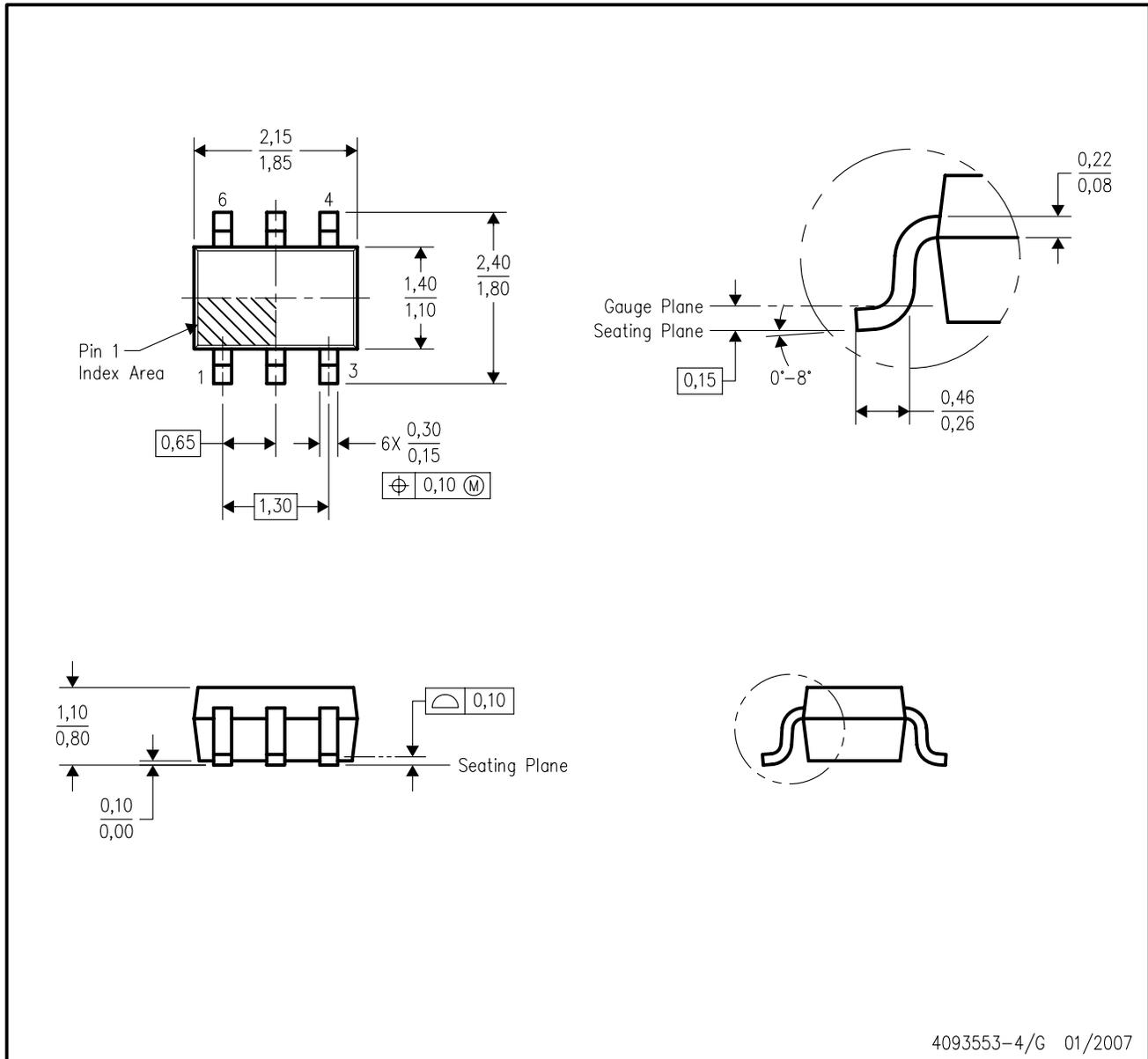
4224056/A 11/2017

NOTES: (continued)

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

DCK (R-PDSO-G6)

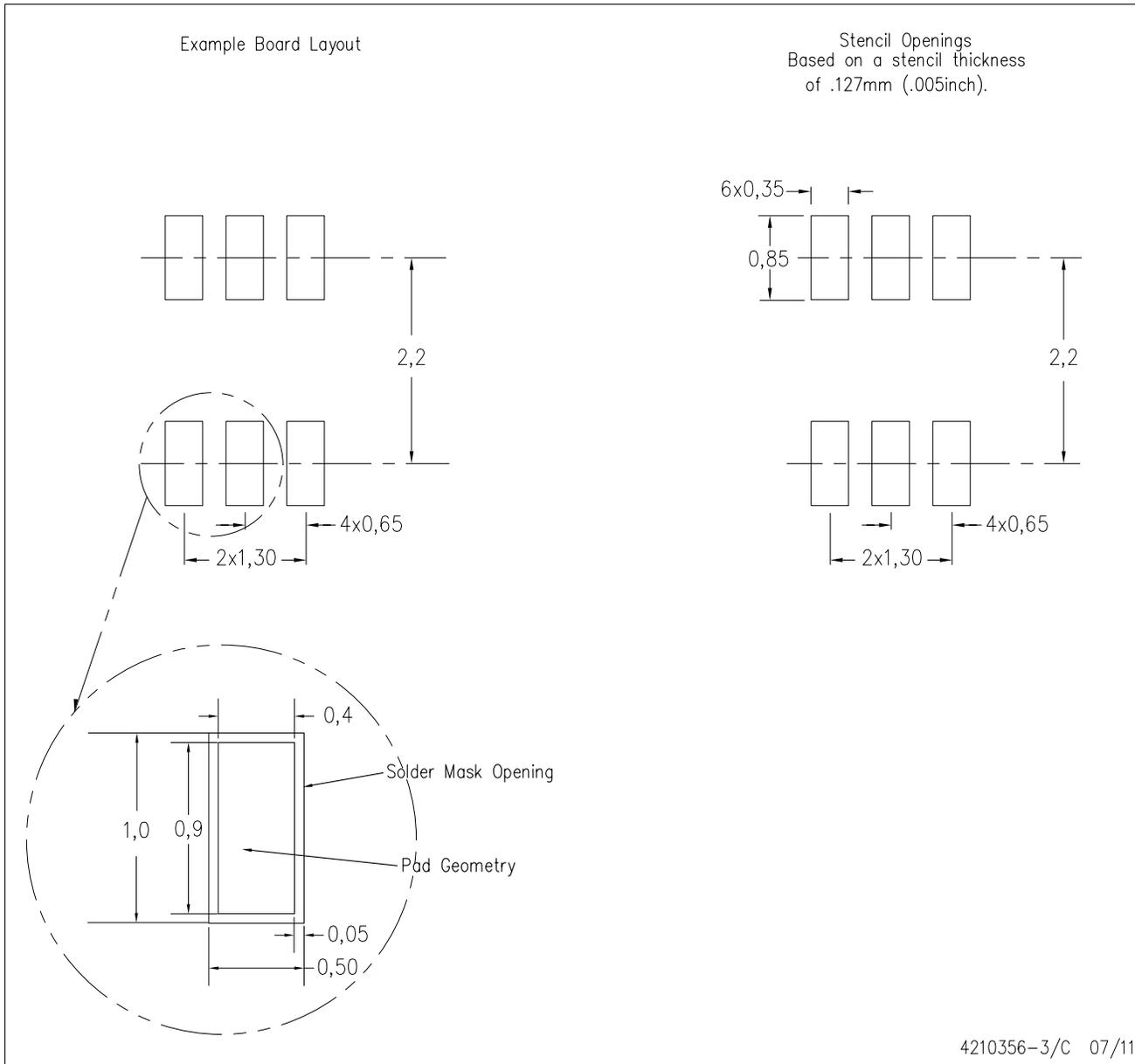
PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
  - Falls within JEDEC MO-203 variation AB.

DCK (R-PDSO-G6)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
  - D. Publication IPC-7351 is recommended for alternate designs.
  - E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC-7525 for other stencil recommendations.

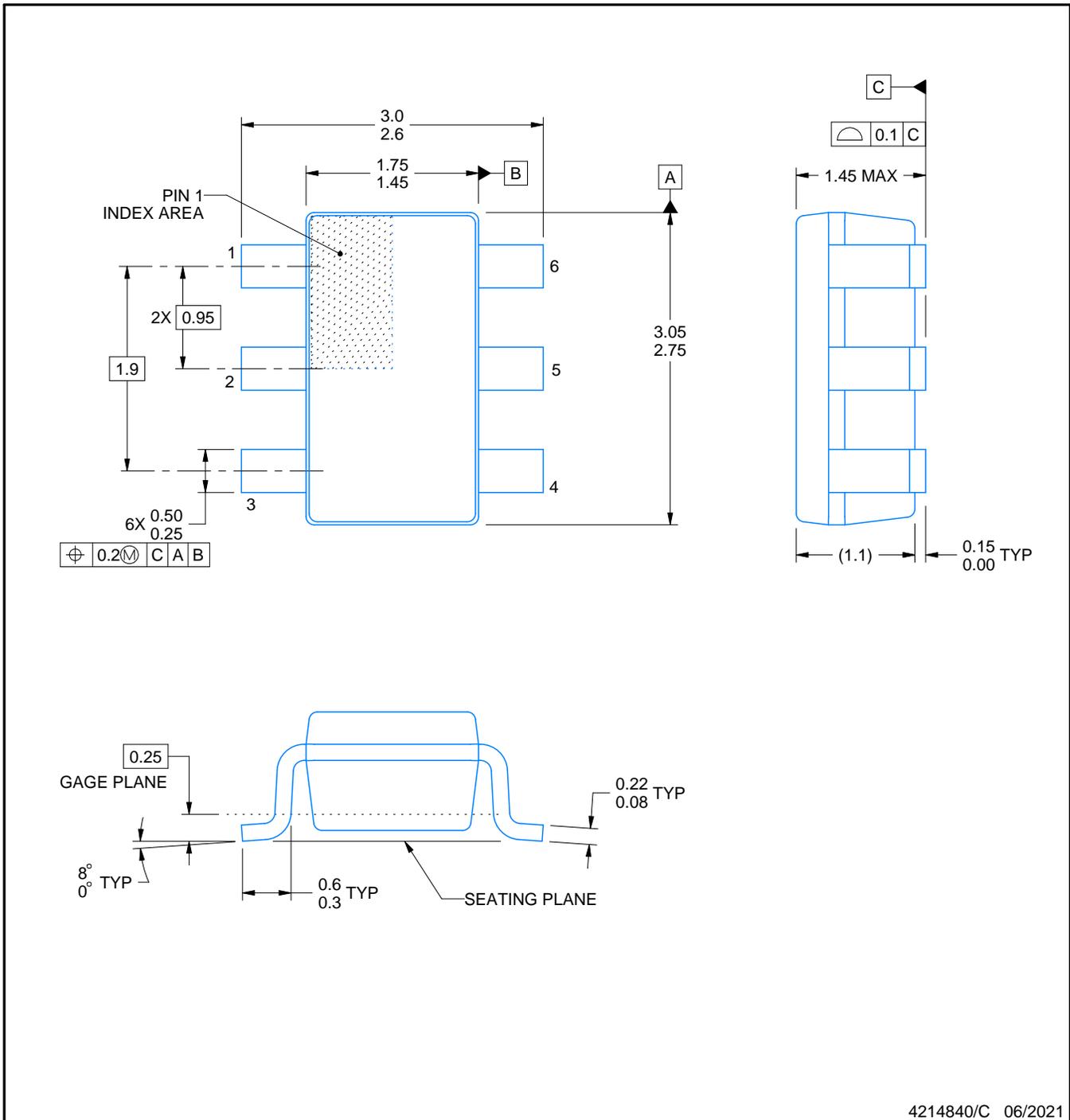
DBV0006A



# PACKAGE OUTLINE

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



4214840/C 06/2021

## NOTES:

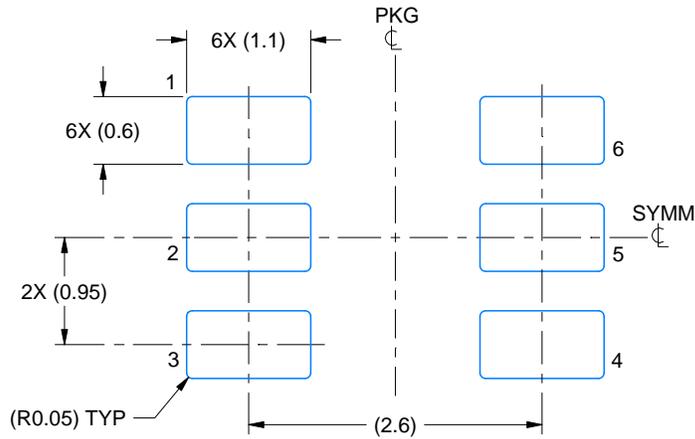
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.25 per side.
4. Leads 1,2,3 may be wider than leads 4,5,6 for package orientation.
5. Reference JEDEC MO-178.

# EXAMPLE BOARD LAYOUT

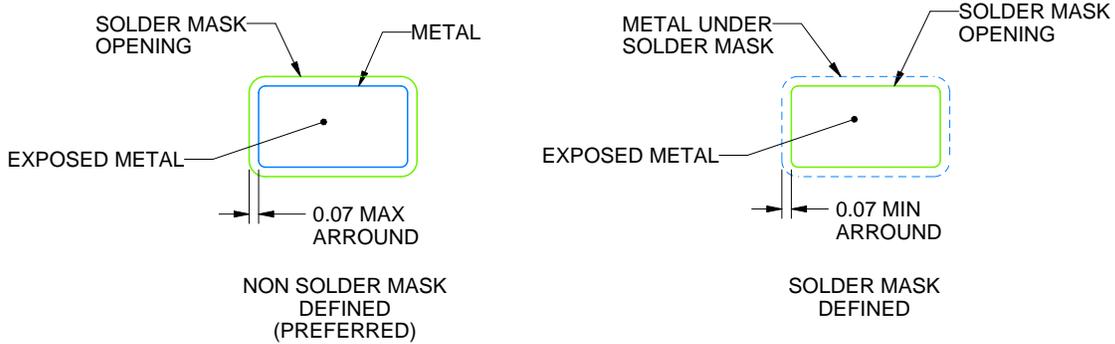
DBV0006A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:15X



SOLDER MASK DETAILS

4214840/C 06/2021

NOTES: (continued)

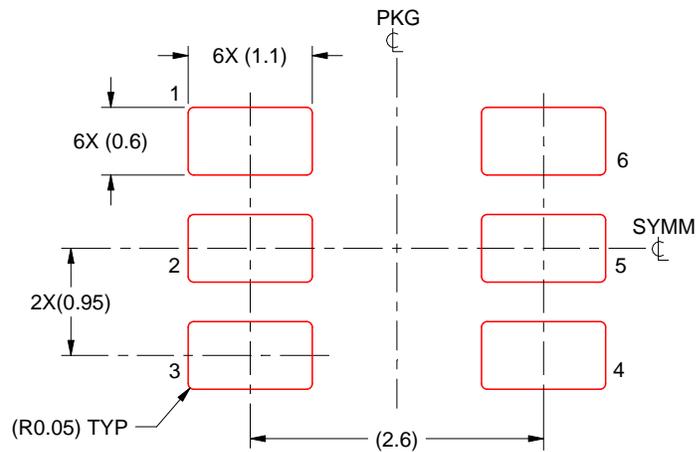
- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

DBV0006A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE:15X

4214840/C 06/2021

NOTES: (continued)

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

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