



**THE DATASHEET OF  
SN74AVCH1T45DCKR**



# SN74AVCH1T45 Single-Bit Dual-Supply Bus Transceiver

## With Configurable Level-Shifting, Voltage Translation, and 3-State Outputs

### 1 Features

- Available in Texas Instruments' NanoStar™ integrated circuit package
- Available in Texas Instruments' NanoFree™ package
- Control inputs (DIR)  $V_{IH}$  and  $V_{IL}$  levels are referenced to  $V_{CCA}$  voltage
- Bus hold on data inputs eliminates the need for external pullup and pulldown resistors
- $V_{CC}$  isolation
- Fully configurable dual-rail design
- I/Os are 4.6V tolerant
- $I_{off}$  supports partial-power-down mode operation
- Typical max data rates
  - 500Mbps (1.8V to 3.3V translation)
  - 320Mbps (<1.8V to 3.3V translation)
  - 320Mbps (translate to 2.5V or 1.8V)
  - 280Mbps (translate to 1.5V)
  - 240Mbps (translate to 1.2V)
- Latch-up performance exceeds 100mA per JESD 78, class II
- ESD protection exceeds JESD 22
  - Human-Body Model (A114-A): 2000V
  - Machine Model (A115-A): 200V
  - Charged-Device Model (C101): 1000V

### 2 Applications

- [Personal electronics](#)
- [Industrial](#)
- [Enterprise](#)
- Telecommunications

### 3 Description

The SN74AVCH1T45 is a single-bit noninverting bus transceiver that uses two separate configurable power-supply rails. The A port is designed to track  $V_{CCA}$ , which accepts any supply voltage from 1.2V to 3.6V. The B port is designed to track  $V_{CCB}$ , which accepts any supply voltage from 1.2V to 3.6V. This feature allows for universal low-voltage, bidirectional translation between any of the 1.2V, 1.5V, 1.8V, 2.5V, and 3.3V voltage nodes.

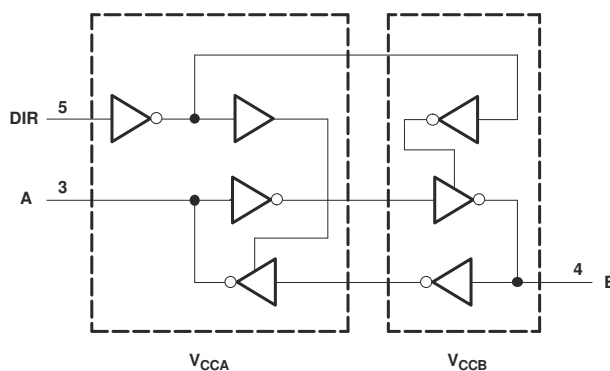
The SN74AVCH1T45 is designed for asynchronous communication between two data buses. The device transmits data from either the A bus to the B bus, or from the B bus to the A bus, depending upon the logic level at the direction-control (DIR) input.

The SN74AVCH1T45 is designed so that the DIR input is referenced to  $V_{CCA}$ .

#### Device Information

PART NUMBER	PACKAGE <sup>(1)</sup>	BODY SIZE (NOM)
SN74AVCH1T45	DCK (SC70, 6)	2.00mm × 1.25mm
	DBV (SOT-23, 6)	2.90mm × 1.60mm
	YZP (DSBGA, 6)	1.50mm × 0.90mm

(1) For all available packages, see [Section 14](#).



Logic Diagram (Positive Logic)



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## 4 Description (continued)

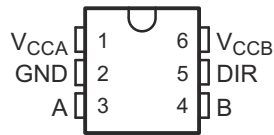
Active bus-hold circuitry holds unused or undriven inputs at a valid logic state. TI does not recommend the use of pullup or pulldown resistors with bus-hold circuitry.

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

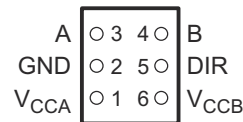
The  $V_{CC}$  isolation feature places the outputs in the high-impedance state if either  $V_{CCA}$  or  $V_{CCB}$  is at GND. The bus-hold circuitry on the powered-up side always stays active.

NanoFree package technology is a major breakthrough in IC packaging concepts, using the die as the package.

## 5 Pin Configuration and Functions



**Figure 5-1. DBV or DCK Package 6-Pin SOT-23 or SC70 Top View**



**Figure 5-2. YZP Package 6-Pin DSBGA Bottom View**

**Table 5-1. Pin Functions**

PIN		I/O	DESCRIPTION
NAME	NO.		
A	3	I/O	Input/output A. Referenced to $V_{CCA}$
B	4	I/O	Input/output B. Referenced to $V_{CCB}$
DIR	5	I	Direction control signal. Referenced to $V_{CCA}$
GND	2	—	Ground
$V_{CCA}$	1	—	A-port supply voltage. $1.2\text{ V} \leq V_{CCA} \leq 3.6\text{ V}$
$V_{CCB}$	6	—	B-port supply voltage. $1.2\text{ V} \leq V_{CCB} \leq 3.6\text{ V}$

## 6 Specifications

### 6.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT
Supply voltage	$V_{CCA}$ and $V_{CCB}$	-0.5	4.6	V
Input voltage <sup>(2)</sup>	I/O ports (A port)	-0.5	4.6	V
	I/O ports (B port)	-0.5	4.6	
	Control inputs	-0.5	4.6	
Voltage applied to any output in the high-impedance or power-off state <sup>(2)</sup>	A port	-0.5	4.6	V
	B port	-0.5	4.6	
Voltage applied to any output in the high or low state <sup>(2) (3)</sup>	A port	-0.5	$V_{CCA} + 0.5$	V
	B port	-0.5	$V_{CCB} + 0.5$	
Input clamp current	$V_I < 0$		-50	mA
Output clamp current	$V_O < 0$		-50	mA
Continuous output current			±50	mA
Continuous through current	$V_{CCA}$ , $V_{CCB}$ , or GND		±100	mA
Junction temperature, $T_J$		-40	150	°C
Storage temperature, $T_{stg}$		-65	150	°C

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, 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 4.6V maximum if the output current rating is observed.

### 6.2 ESD Ratings

		VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>	±2000
		Charged-device model (CDM), per JEDEC specification JESD22-C101 <sup>(2)</sup>	±1000
		Machine model, per A115-A	±200

- (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

see (1) (2) (3) (4) (5)

		MIN	MAX	UNIT	
$V_{CCA}$	Supply voltage	1.2	3.6	V	
$V_{CCB}$	Supply voltage	1.2	3.6	V	
$V_{IH}$	High-level input voltage <sup>(1)</sup>	Data inputs <sup>(4)</sup>	$V_{CCI} = 1.2\text{ V to }1.95\text{ V}$	$V_{CCI} \times 0.65$	V
			$V_{CCI} = 1.95\text{ V to }2.7\text{ V}$	1.6	
			$V_{CCI} = 2.7\text{ V to }3.6\text{ V}$	2	
$V_{IL}$	Low-level input voltage <sup>(1)</sup>	Data inputs <sup>(4)</sup>	$V_{CCI} = 1.2\text{ V to }1.95\text{ V}$	$V_{CCI} \times 0.35$	V
			$V_{CCI} = 1.95\text{ V to }2.7\text{ V}$	0.7	
			$V_{CCI} = 2.7\text{ V to }3.6\text{ V}$	0.8	
$V_{IH}$	High-level input voltage	DIR (referenced to $V_{CCA}$ ) <sup>(5)</sup>	$V_{CCI} = 1.2\text{ V to }1.95\text{ V}$	$V_{CCA} \times 0.65$	V
			$V_{CCI} = 1.95\text{ V to }2.7\text{ V}$	1.6	
			$V_{CCI} = 2.7\text{ V to }3.6\text{ V}$	2	

### 6.3 Recommended Operating Conditions (continued)

see (1) (2) (3) (4) (5)

			MIN	MAX	UNIT
V <sub>IL</sub>	Low-level input voltage	DIR (referenced to V <sub>CCA</sub> ) <sup>(5)</sup>	V <sub>CCI</sub> = 1.2 V to 1.95 V	V <sub>CCA</sub> × 0.35	V
			V <sub>CCI</sub> = 1.95 V to 2.7 V	0.7	
			V <sub>CCI</sub> = 2.7 V to 3.6 V	0.8	
V <sub>I</sub>	Input voltage	Control Inputs <sup>(3)</sup>	0	3.6	V
V <sub>O</sub>	Output voltage <sup>(2)</sup>	Active state	0	V <sub>CCO</sub>	V
		3-state	0	3.6	
I <sub>OH</sub>	High-level output current		V <sub>CCO</sub> = 1.2 V	-3	mA
			V <sub>CCO</sub> = 1.4 V to 1.6 V	-6	
			V <sub>CCO</sub> = 1.65 V to 1.95 V	-8	
			V <sub>CCO</sub> = 2.3 V to 2.7 V	-9	
			V <sub>CCO</sub> = 3 V to 3.6 V	-12	
I <sub>OL</sub>	Low-level output current		V <sub>CCO</sub> = 1.2 V	3	mA
			V <sub>CCO</sub> = 1.4 V to 1.6 V	6	
			V <sub>CCO</sub> = 1.65 V to 1.95 V	8	
			V <sub>CCO</sub> = 2.3 V to 2.7 V	9	
			V <sub>CCO</sub> = 3 V to 3.6 V	12	
Δt/Δv	Input transition rise or fall rate			5	ns/V
T <sub>A</sub>	Operating free-air temperature		-40	85	°C

- (1) V<sub>CCI</sub> is the V<sub>CC</sub> associated with the input port.
- (2) V<sub>CCO</sub> is the V<sub>CC</sub> associated with the output port.
- (3) All unused control inputs of the device must be held at V<sub>CCI</sub> or GND for proper device operation.
- (4) For V<sub>CCI</sub> values not specified in the data sheet, V<sub>IH</sub> min = V<sub>CCI</sub> × 0.7V, V<sub>IL</sub> max = V<sub>CCI</sub> × 0.3V.
- (5) For V<sub>CCI</sub> values not specified in the data sheet, V<sub>IH</sub> min = V<sub>CCA</sub> × 0.7V, V<sub>IL</sub> max = V<sub>CCA</sub> × 0.3V.

### 6.4 Thermal Information

THERMAL METRIC <sup>(1)</sup>		SN74AVCH1T45			UNIT
		DBV (SOT-23)	DCK (SC70)	YZP (DSBGA)	
		6 PINS	6 PINS	6 PINS	
R <sub>θJA</sub>	Junction-to-ambient thermal resistance <sup>(2)</sup>	210.5	239.9	130	°C/W
R <sub>θJC(top)</sub>	Junction-to-case (top) thermal resistance	130.6	175.0	54	°C/W
R <sub>θJB</sub>	Junction-to-board thermal resistance	93.3	94.4	51	°C/W
ψ <sub>JT</sub>	Junction-to-top characterization parameter	69.0	75.6	1	°C/W
ψ <sub>JB</sub>	Junction-to-board characterization parameter	N/A	93.9	50	°C/W

- (1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC Package Thermal Metrics](#) application note.
- (2) The package thermal impedance is calculated in accordance with JESD 51-7.

## 6.5 Electrical Characteristics

All typical limits apply over  $T_A = 25^\circ\text{C}$ , and all maximum and minimum limits apply over  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$  (unless otherwise noted).<sup>(1) (2) (5) (6)</sup>

PARAMETER	TEST CONDITIONS		MIN	TYP	MAX	UNIT	
$V_{OH}$	High-level output voltage <sup>(1)</sup>	$I_{OH} = -100\ \mu\text{A}$ , $V_I = V_{IH}$	$V_{CCA} = V_{CCB} = 1.2\ \text{V to } 3.6\ \text{V}$	$V_{CCO} - 0.2\ \text{V}$		V	
		$I_{OH} = -3\ \text{mA}$ , $V_I = V_{IH}$	$V_{CCA} = V_{CCB} = 1.2\ \text{V}$	0.95			
		$I_{OH} = -6\ \text{mA}$ , $V_I = V_{IH}$	$V_{CCA} = V_{CCB} = 1.4\ \text{V}$	1.05			
		$I_{OH} = -8\ \text{mA}$ , $V_I = V_{IH}$	$V_{CCA} = V_{CCB} = 1.65\ \text{V}$	1.2			
		$I_{OH} = -9\ \text{mA}$ , $V_I = V_{IH}$	$V_{CCA} = V_{CCB} = 2.3\ \text{V}$	1.75			
		$I_{OH} = -12\ \text{mA}$ , $V_I = V_{IH}$	$V_{CCA} = V_{CCB} = 3\ \text{V}$	2.3			
$V_{OL}$	Low-level output voltage	$I_{OL} = 100\ \mu\text{A}$ , $V_I = V_{IL}$	$V_{CCA} = V_{CCB} = 1.2\ \text{V to } 3.6\ \text{V}$	0.2		V	
		$I_{OL} = 3\ \text{mA}$ , $V_I = V_{IL}$	$V_{CCA} = V_{CCB} = 1.2\ \text{V}$	0.15			
		$I_{OL} = 6\ \text{mA}$ , $V_I = V_{IL}$	$V_{CCA} = V_{CCB} = 1.4\ \text{V}$	0.35			
		$I_{OL} = 8\ \text{mA}$ , $V_I = V_{IL}$	$V_{CCA} = V_{CCB} = 1.65\ \text{V}$	0.45			
		$I_{OL} = 9\ \text{mA}$ , $V_I = V_{IL}$	$V_{CCA} = V_{CCB} = 2.3\ \text{V}$	0.55			
		$I_{OL} = 12\ \text{mA}$ , $V_I = V_{IL}$	$V_{CCA} = V_{CCB} = 3\ \text{V}$	0.7			
$I_I$	Control Input (DIR)	$V_I = V_{CCA}$ or GND	$V_{CCA} = V_{CCB} = 1.2\ \text{V to } 3.6\ \text{V}$	$\pm 0.025$	$\pm 1$	$\mu\text{A}$	
$I_{BHL}$	Bus-hold low sustaining current <sup>(3)</sup>	$V_I = 0.42\ \text{V}$	$V_{CCA} = V_{CCB} = 1.2\ \text{V}$	25		$\mu\text{A}$	
		$V_I = 0.49\ \text{V}$	$V_{CCA} = V_{CCB} = 1.4\ \text{V}$	15			
		$V_I = 0.58\ \text{V}$	$V_{CCA} = V_{CCB} = 1.65\ \text{V}$	25			
		$V_I = 0.7\ \text{V}$	$V_{CCA} = V_{CCB} = 2.3\ \text{V}$	45			
		$V_I = 0.8\ \text{V}$	$V_{CCA} = V_{CCB} = 3.3\ \text{V}$	100			
$I_{BHH}$	Bus-hold high sustaining current <sup>(4)</sup>	$V_I = 0.78\ \text{V}$	$V_{CCA} = V_{CCB} = 1.2\ \text{V}$	-25		$\mu\text{A}$	
		$V_I = 0.91\ \text{V}$	$V_{CCA} = V_{CCB} = 1.4\ \text{V}$	-15			
		$V_I = 1.07\ \text{V}$	$V_{CCA} = V_{CCB} = 1.65\ \text{V}$	-25			
		$V_I = 1.6\ \text{V}$	$V_{CCA} = V_{CCB} = 2.3\ \text{V}$	-45			
		$V_I = 2\ \text{V}$	$V_{CCA} = V_{CCB} = 3.3\ \text{V}$	-100			
$I_{BHLO}$	Bus-hold low overdrive current <sup>(5)</sup>	$V_I = 0\ \text{to } V_{CC}$	$V_{CCA} = V_{CCB} = 1.2\ \text{V}$	50		$\mu\text{A}$	
			$V_{CCA} = V_{CCB} = 1.6\ \text{V}$	125			
			$V_{CCA} = V_{CCB} = 1.95\ \text{V}$	200			
			$V_{CCA} = V_{CCB} = 2.7\ \text{V}$	300			
			$V_{CCA} = V_{CCB} = 3.6\ \text{V}$	500			
$I_{BHHO}$	Bus-hold high overdrive current <sup>(6)</sup>	$V_I = 0\ \text{to } V_{CC}$	$V_{CCA} = V_{CCB} = 1.2\ \text{V}$	-50		$\mu\text{A}$	
			$V_{CCA} = V_{CCB} = 1.6\ \text{V}$	-125			
			$V_{CCA} = V_{CCB} = 1.95\ \text{V}$	-200			
			$V_{CCA} = V_{CCB} = 2.7\ \text{V}$	-300			
			$V_{CCA} = V_{CCB} = 3.6\ \text{V}$	-500			
$I_{off}$	Input and output Power-off leakage current	$V_I = 0\ \text{V to } 3.6\ \text{V}$ , $V_O = 0\ \text{V to } 3.6\ \text{V}$	$V_{CCA} = 0\ \text{V}$ , $V_{CCB} = 0\ \text{V to } 3.6\ \text{V}$	A Port	$\pm 0.1$	$\pm 5$	$\mu\text{A}$
			$V_{CCA} = 0\ \text{V to } 3.6\ \text{V}$ , $V_{CCB} = 0\ \text{V}$	B Port	$\pm 0.1$	$\pm 5$	
$I_{OZ}$	Off-state output current <sup>(7)</sup>	$V_I = V_{CCI}$ or GND, $V_O = V_{CCO}$ or GND	$V_{CCA} = 0\ \text{V}$ , $V_{CCB} = 3.6\ \text{V}$	A Port	$\pm 0.5$	$\pm 5$	$\mu\text{A}$
			$V_{CCA} = 3.6\ \text{V}$ , $V_{CCB} = 0\ \text{V}$	B port	$\pm 0.5$	$\pm 5$	
$I_{CCA}$	Supply current A port	$V_I = V_{CCI}$ or GND, $I_O = 0$	$V_{CCA} = V_{CCB} = 1.2\ \text{V to } 3.6\ \text{V}$		10		$\mu\text{A}$
			$V_{CCA} = 0\ \text{V}$ , $V_{CCB} = 3.6\ \text{V}$		-2		
			$V_{CCA} = 3.6\ \text{V}$ , $V_{CCB} = 0\ \text{V}$		10		

## 6.5 Electrical Characteristics (continued)

All typical limits apply over  $T_A = 25^\circ\text{C}$ , and all maximum and minimum limits apply over  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$  (unless otherwise noted).<sup>(1) (2) (5) (6)</sup>

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$I_{CCB}$	Supply current B port	$V_I = V_{CCI}$ or GND, $I_O = 0$	$V_{CCA} = V_{CCB} = 1.2\text{ V to }3.6\text{ V}$			10	$\mu\text{A}$
			$V_{CCA} = 0\text{ V}, V_{CCB} = 3.6\text{ V}$			10	
			$V_{CCA} = 3.6\text{ V}, V_{CCB} = 0\text{ V}$			-2	
$I_{CCA} + I_{CCB}$	Combined supply current	$V_I = V_{CCI}$ or GND, $I_O = 0$	$V_{CCA} = V_{CCB} = 1.2\text{ V to }3.6\text{ V}$			20	$\mu\text{A}$
$C_i$	Input capacitance control pin (DIR)	$V_I = 3.3\text{ V}$ or GND	$V_{CCA} = V_{CCB} = 3.3\text{ V}$		2.5		pF
$C_{io}$	Input and output capacitance A or B port	$V_O = 3.3\text{ V}$ or GND	$V_{CCA} = V_{CCB} = 3.3\text{ V}$		6		pF

- (1)  $V_{CCO}$  is the  $V_{CC}$  associated with the output port.
- (2)  $V_{CCI}$  is the  $V_{CC}$  associated with the input port.
- (3) The bus-hold circuit can sink at least the minimum low sustaining current at  $V_{IL}$  max. Measure  $I_{BHL}$  after lowering  $V_{IN}$  to GND and then raising it to  $V_{IL}$  max.
- (4) The bus-hold circuit can source at least the minimum high sustaining current at  $V_{IH}$  min. Measure  $I_{BHH}$  after raising  $V_{IN}$  to  $V_{CC}$  and then lowering it to  $V_{IH}$  min.
- (5) An external driver must source at least  $I_{BHLO}$  to switch this node from low to high.
- (6) An external driver must sink at least  $I_{BHHO}$  to switch this node from high to low.
- (7) For I/O ports, the parameter  $I_{OZ}$  includes the input leakage current.

## 6.6 Switching Characteristics, $V_{CCA} = 1.2V$

$T_A = 25^\circ C$  (see Figure 7-1).

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{PLH}$ , $t_{PHL}$	A	B	$V_{CCB} = 1.2 V$		3.3		ns
			$V_{CCB} = 1.5 V$		2.7		
			$V_{CCB} = 1.8 V$		2.4		
			$V_{CCB} = 2.5 V$		2.3		
			$V_{CCB} = 3.3 V$		2.4		
$t_{PLH}$ , $t_{PHL}$	B	A	$V_{CCB} = 1.2 V$		3.3		ns
			$V_{CCB} = 1.5 V$		3.1		
			$V_{CCB} = 1.8 V$		2.9		
			$V_{CCB} = 2.5 V$		2.8		
			$V_{CCB} = 3.3 V$		2.7		
$t_{PZH}$ , $t_{PZL}$	DIR	A	$V_{CCB} = 1.2 V$		5.1		ns
			$V_{CCB} = 1.5 V$		5.2		
			$V_{CCB} = 1.8 V$		5.3		
			$V_{CCB} = 2.5 V$		5.2		
			$V_{CCB} = 3.3 V$		3.7		
$t_{PZH}$ , $t_{PZL}$	DIR	B	$V_{CCB} = 1.2 V$		5.3		ns
			$V_{CCB} = 1.5 V$		4.3		
			$V_{CCB} = 1.8 V$		4		
			$V_{CCB} = 2.5 V$		3.3		
			$V_{CCB} = 3.3 V$		3.7		
$t_{PHZ}$ , $t_{PLZ}$	DIR	A	$V_{CCB} = 1.2 V$		8.5		ns
			$V_{CCB} = 1.5 V$		6.9		
			$V_{CCB} = 1.8 V$		6.4		
			$V_{CCB} = 2.5 V$		5.5		
			$V_{CCB} = 3.3 V$		6.1		
$t_{PHZ}$ , $t_{PLZ}$	DIR	B	$V_{CCB} = 1.2 V$		8.3		ns
			$V_{CCB} = 1.5 V$		7.8		
			$V_{CCB} = 1.8 V$		7.7		
			$V_{CCB} = 2.5 V$		7.5		
			$V_{CCB} = 3.3 V$		5.9		

(1) The enable time is a calculated value, derived using the formula shown in [Enable Times](#).

## 6.7 Switching Characteristics, $V_{CCA} = 1.5V \pm 0.1V$

All typical limits apply over  $T_A = 25^\circ C$ , and all maximum and minimum limits apply over  $T_A = -40^\circ C$  to  $85^\circ C$  (unless otherwise noted) (see [Figure 7-1](#)).

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{PLH}$ , $t_{PHL}$	A	B	$V_{CCB} = 1.2 V$		2.9		ns
			$V_{CCB} = 1.5 V \pm 0.1 V$	0.7		5.6	
			$V_{CCB} = 1.8 V \pm 0.15 V$	0.6		4.2	
			$V_{CCB} = 2.5 V \pm 0.2 V$	0.5		4.2	
			$V_{CCB} = 3.3 V \pm 0.3 V$	0.5		3.8	
$t_{PLH}$ , $t_{PHL}$	B	A	$V_{CCB} = 1.2 V$		2.6		ns
			$V_{CCB} = 1.5 V \pm 0.1 V$	0.6		5.5	
			$V_{CCB} = 1.8 V \pm 0.15 V$	0.4		5.3	
			$V_{CCB} = 2.5 V \pm 0.2 V$	0.3		4.9	
			$V_{CCB} = 3.3 V \pm 0.3 V$	0.3		4.8	
$t_{PZH}$ , $t_{PZL}$	DIR	A	$V_{CCB} = 1.2 V$		3.8		ns
			$V_{CCB} = 1.5 V \pm 0.1 V$	1.6		6.7	
			$V_{CCB} = 1.8 V \pm 0.15 V$	1.5		6.8	
			$V_{CCB} = 2.5 V \pm 0.2 V$	0.3		6.9	
			$V_{CCB} = 3.3 V \pm 0.3 V$	0.9		6.9	
$t_{PZH}$ , $t_{PZL}$	DIR	B	$V_{CCB} = 1.2 V$		5.1		ns
			$V_{CCB} = 1.5 V \pm 0.1 V$	1.8		8.1	
			$V_{CCB} = 1.8 V \pm 0.15 V$	1.6		7.1	
			$V_{CCB} = 2.5 V \pm 0.2 V$	1.1		4.7	
			$V_{CCB} = 3.3 V \pm 0.3 V$	1.4		4.5	
$t_{PHZ}$ , $t_{PLZ}$	DIR	A	$V_{CCB} = 1.2 V$		7.7		ns
			$V_{CCB} = 1.5 V \pm 0.1 V$			13.6	
			$V_{CCB} = 1.8 V \pm 0.15 V$			12.4	
			$V_{CCB} = 2.5 V \pm 0.2 V$			9.6	
			$V_{CCB} = 3.3 V \pm 0.3 V$			9.3	
$t_{PHZ}$ , $t_{PLZ}$	DIR	B	$V_{CCB} = 1.2 V$		6.7		ns
			$V_{CCB} = 1.5 V \pm 0.1 V$			12.3	
			$V_{CCB} = 1.8 V \pm 0.15 V$			12	
			$V_{CCB} = 2.5 V \pm 0.2 V$			11.1	
			$V_{CCB} = 3.3 V \pm 0.3 V$			10.7	

(1) The enable time is a calculated value, derived using the formula shown in [Enable Times](#).

## 6.8 Switching Characteristics, $V_{CCA} = 1.8V \pm 0.15V$

All typical limits apply over  $T_A = 25^\circ\text{C}$ , and all maximum and minimum limits apply over  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$  (unless otherwise noted) (see [Figure 7-1](#)).

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{PLH}$ , $t_{PHL}$	A	B	$V_{CCB} = 1.2\text{ V}$		2.8		ns
			$V_{CCB} = 1.5\text{ V} \pm 0.1\text{ V}$	0.6		5.3	
			$V_{CCB} = 1.8\text{ V} \pm 0.15\text{ V}$	0.5		5	
			$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$	0.4		3.9	
			$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$	0.4		3.4	
$t_{PLH}$ , $t_{PHL}$	B	A	$V_{CCB} = 1.2\text{ V}$		2.3		ns
			$V_{CCB} = 1.5\text{ V} \pm 0.1\text{ V}$	0.5		5.2	
			$V_{CCB} = 1.8\text{ V} \pm 0.15\text{ V}$	0.4		5	
			$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$	0.3		4.6	
			$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$	0.2		4.4	
$t_{PZH}$ , $t_{PZL}$	DIR	A	$V_{CCB} = 1.2\text{ V}$		3.8		ns
			$V_{CCB} = 1.5\text{ V} \pm 0.1\text{ V}$	1.6		5.9	
			$V_{CCB} = 1.8\text{ V} \pm 0.15\text{ V}$	1.6		5.9	
			$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$	1.6		5.9	
			$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$	0.5		6	
$t_{PZH}$ , $t_{PZL}$	DIR	B	$V_{CCB} = 1.2\text{ V}$		5		ns
			$V_{CCB} = 1.5\text{ V} \pm 0.1\text{ V}$	1.8		7.7	
			$V_{CCB} = 1.8\text{ V} \pm 0.15\text{ V}$	1.4		6.8	
			$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$	1		4.4	
			$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$	1.4		4.3	
$t_{PHZ}$ , $t_{PLZ}$	DIR	A	$V_{CCB} = 1.2\text{ V}$		7.3		ns
			$V_{CCB} = 1.5\text{ V} \pm 0.1\text{ V}$			12.9	
			$V_{CCB} = 1.8\text{ V} \pm 0.15\text{ V}$			11.8	
			$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$			9	
			$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$			8.7	
$t_{PHZ}$ , $t_{PLZ}$	DIR	B	$V_{CCB} = 1.2\text{ V}$		6.5		ns
			$V_{CCB} = 1.5\text{ V} \pm 0.1\text{ V}$			11.2	
			$V_{CCB} = 1.8\text{ V} \pm 0.15\text{ V}$			10.9	
			$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$			9.8	
			$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$			9.4	

(1) The enable time is a calculated value, derived using the formula shown in [Enable Times](#).

## 6.9 Switching Characteristics, $V_{CCA} = 2.5V \pm 0.2V$

All typical limits apply over  $T_A = 25^\circ C$ , and all maximum and minimum limits apply over  $T_A = -40^\circ C$  to  $85^\circ C$  (unless otherwise noted) (see [Figure 7-1](#)).

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{PLH}$ , $t_{PHL}$ Propagation delay time: low-to-high-level output and high-to-low level output	A	B	$V_{CCB} = 1.2 V$		2.6		ns
			$V_{CCB} = 1.5 V \pm 0.1 V$	0.5		4.9	
			$V_{CCB} = 1.8 V \pm 0.15 V$	0.4		4.6	
			$V_{CCB} = 2.5 V \pm 0.2 V$	0.3		3.4	
			$V_{CCB} = 3.3 V \pm 0.3 V$	0.3		3	
$t_{PLH}$ , $t_{PHL}$ Propagation delay time: low-to-high-level output and high-to-low level output	B	A	$V_{CCB} = 1.2 V$		2.2		ns
			$V_{CCB} = 1.5 V \pm 0.1 V$	0.4		4.2	
			$V_{CCB} = 1.8 V \pm 0.15 V$	0.3		3.8	
			$V_{CCB} = 2.5 V \pm 0.2 V$	0.2		3.4	
			$V_{CCB} = 3.3 V \pm 0.3 V$	0.2		3.3	
$t_{PZH}$ , $t_{PZL}$ Enable time: to high level <sup>(1)</sup> and to low level <sup>(1)</sup>	DIR	A	$V_{CCB} = 1.2 V$		2.8		ns
			$V_{CCB} = 1.5 V \pm 0.1 V$	0.3		3.8	
			$V_{CCB} = 1.8 V \pm 0.15 V$	0.8		3.8	
			$V_{CCB} = 2.5 V \pm 0.2 V$	0.4		3.8	
			$V_{CCB} = 3.3 V \pm 0.3 V$	0.5		3.8	
$t_{PZH}$ , $t_{PZL}$ Enable time: to high level <sup>(1)</sup> and to low level <sup>(1)</sup>	DIR	B	$V_{CCB} = 1.2 V$		4.9		ns
			$V_{CCB} = 1.5 V \pm 0.1 V$	2		7.6	
			$V_{CCB} = 1.8 V \pm 0.15 V$	1.5		6.5	
			$V_{CCB} = 2.5 V \pm 0.2 V$	0.6		4.1	
			$V_{CCB} = 3.3 V \pm 0.3 V$	1		4	
$t_{PHZ}$ , $t_{PLZ}$ Disable time: from high level and from low level	DIR	A	$V_{CCB} = 1.2 V$		7.1		ns
			$V_{CCB} = 1.5 V \pm 0.1 V$			11.8	
			$V_{CCB} = 1.8 V \pm 0.15 V$			10.3	
			$V_{CCB} = 2.5 V \pm 0.2 V$			7.5	
			$V_{CCB} = 3.3 V \pm 0.3 V$			7.3	
$t_{PHZ}$ , $t_{PLZ}$ Disable time: from high level and from low level	DIR	B	$V_{CCB} = 1.2 V$		5.4		ns
			$V_{CCB} = 1.5 V \pm 0.1 V$			8.6	
			$V_{CCB} = 1.8 V \pm 0.15 V$			8.1	
			$V_{CCB} = 2.5 V \pm 0.2 V$			7	
			$V_{CCB} = 3.3 V \pm 0.3 V$			6.6	

(1) The enable time is a calculated value, derived using the formula shown in [Enable Times](#).

## 6.10 Switching Characteristics, $V_{CCA} = 3.3V \pm 0.3V$

All typical limits apply over  $T_A = 25^\circ\text{C}$ , and all maximum and minimum limits apply over  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$  (unless otherwise noted) (see [Figure 7-1](#)).

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{PLH}$ , $t_{PHL}$	A	B	$V_{CCB} = 1.2\text{ V}$		2.6		ns
			$V_{CCB} = 1.5\text{ V} \pm 0.1\text{ V}$	0.4		4.7	
			$V_{CCB} = 1.8\text{ V} \pm 0.15\text{ V}$	0.3		4.4	
			$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$	0.2		3.3	
			$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$	0.2		2.8	
$t_{PLH}$ , $t_{PHL}$	B	A	$V_{CCB} = 1.2\text{ V}$		2.2		ns
			$V_{CCB} = 1.5\text{ V} \pm 0.1\text{ V}$	0.4		3.8	
			$V_{CCB} = 1.8\text{ V} \pm 0.15\text{ V}$	0.3		3.4	
			$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$	0.2		3	
			$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$	0.1		2.8	
$t_{PZH}$ , $t_{PZL}$	DIR	A	$V_{CCB} = 1.2\text{ V}$		3.1		ns
			$V_{CCB} = 1.5\text{ V} \pm 0.1\text{ V}$	1.3		4.3	
			$V_{CCB} = 1.8\text{ V} \pm 0.15\text{ V}$	1.3		4.3	
			$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$	1.3		4.3	
			$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$	1.3		4.3	
$t_{PZH}$ , $t_{PZL}$	DIR	B	$V_{CCB} = 1.2\text{ V}$		4		ns
			$V_{CCB} = 1.5\text{ V} \pm 0.1\text{ V}$	0.7		7.4	
			$V_{CCB} = 1.8\text{ V} \pm 0.15\text{ V}$	0.6		6.5	
			$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$	0.7		4	
			$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$	1.5		3.9	
$t_{PHZ}$ , $t_{PLZ}$	DIR	A	$V_{CCB} = 1.2\text{ V}$		6.2		ns
			$V_{CCB} = 1.5\text{ V} \pm 0.1\text{ V}$			11.2	
			$V_{CCB} = 1.8\text{ V} \pm 0.15\text{ V}$			9.9	
			$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$			7	
			$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$			6.7	
$t_{PHZ}$ , $t_{PLZ}$	DIR	B	$V_{CCB} = 1.2\text{ V}$		5.7		ns
			$V_{CCB} = 1.5\text{ V} \pm 0.1\text{ V}$			8.9	
			$V_{CCB} = 1.8\text{ V} \pm 0.15\text{ V}$			8.5	
			$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$			7.2	
			$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$			6.8	

(1) The enable time is a calculated value, derived using the formula shown in [Enable Times](#).

## 6.11 Operating Characteristics

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	TYP	UNIT	
$C_{pdA}$ Power dissipation capacitance per transceiver <sup>(1)</sup> port A	A	B	$C_L = 0\text{ pF}$ , $f = 10\text{ MHz}$ , $t_r = t_f = 1\text{ ns}$	$V_{CCA} = V_{CCB} = 1.2\text{ V}$	3	pF
				$V_{CCA} = V_{CCB} = 1.5\text{ V}$	3	
				$V_{CCA} = V_{CCB} = 1.8\text{ V}$	3	
				$V_{CCA} = V_{CCB} = 2.5\text{ V}$	3	
				$V_{CCA} = V_{CCB} = 3.3\text{ V}$	4	
	B	A	$C_L = 0\text{ pF}$ , $f = 10\text{ MHz}$ , $t_r = t_f = 1\text{ ns}$	$V_{CCA} = V_{CCB} = 1.2\text{ V}$	14	pF
				$V_{CCA} = V_{CCB} = 1.5\text{ V}$	14	
				$V_{CCA} = V_{CCB} = 1.8\text{ V}$	14	
				$V_{CCA} = V_{CCB} = 2.5\text{ V}$	15	
				$V_{CCA} = V_{CCB} = 3.3\text{ V}$	16	
$C_{pdB}$ Power dissipation capacitance per transceiver <sup>(1)</sup> port B	A	B	$C_L = 0\text{ pF}$ , $f = 10\text{ MHz}$ , $t_r = t_f = 1\text{ ns}$	$V_{CCA} = V_{CCB} = 1.2\text{ V}$	14	pF
				$V_{CCA} = V_{CCB} = 1.5\text{ V}$	14	
				$V_{CCA} = V_{CCB} = 1.8\text{ V}$	14	
				$V_{CCA} = V_{CCB} = 2.5\text{ V}$	15	
				$V_{CCA} = V_{CCB} = 3.3\text{ V}$	16	
	B	A	$C_L = 0\text{ pF}$ , $f = 10\text{ MHz}$ , $t_r = t_f = 1\text{ ns}$	$V_{CCA} = V_{CCB} = 1.2\text{ V}$	3	pF
				$V_{CCA} = V_{CCB} = 1.5\text{ V}$	3	
				$V_{CCA} = V_{CCB} = 1.8\text{ V}$	3	
				$V_{CCA} = V_{CCB} = 2.5\text{ V}$	3	
				$V_{CCA} = V_{CCB} = 3.3\text{ V}$	4	

(1) See [CMOS Power Consumption and Cpd Calculation](#).

## 6.12 Typical Characteristics

T<sub>A</sub> = 25°C

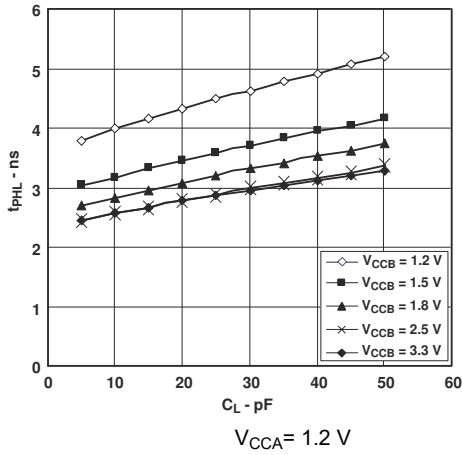


Figure 6-1. Typical Propagation Delay (A to B) vs Load Capacitance

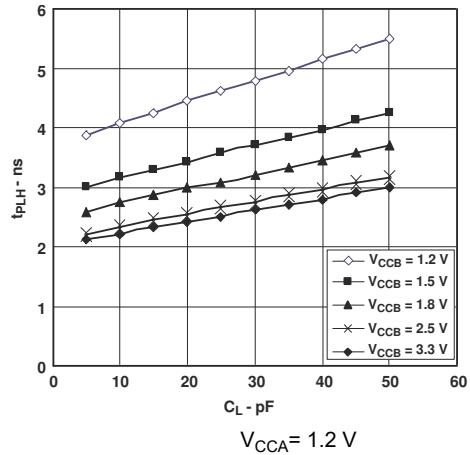


Figure 6-2. Typical Propagation Delay (A to B) vs Load Capacitance

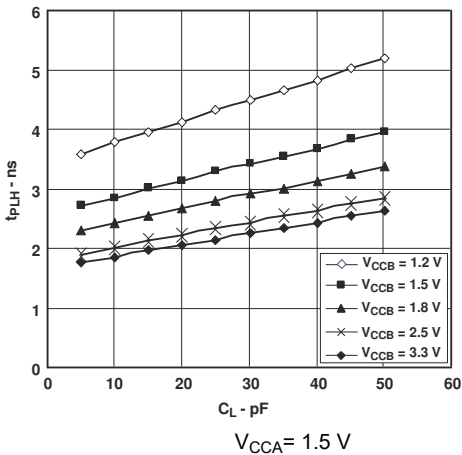


Figure 6-3. Typical Propagation Delay (A to B) vs Load Capacitance

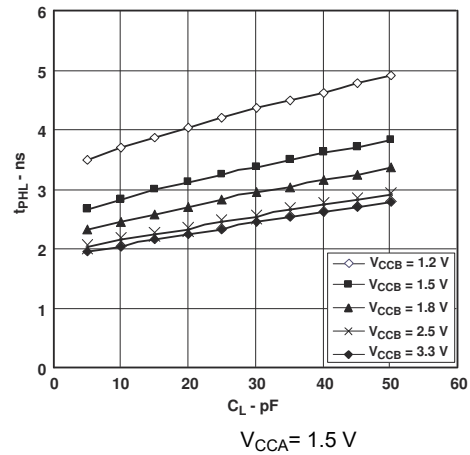


Figure 6-4. Typical Propagation Delay (A to B) vs Load Capacitance

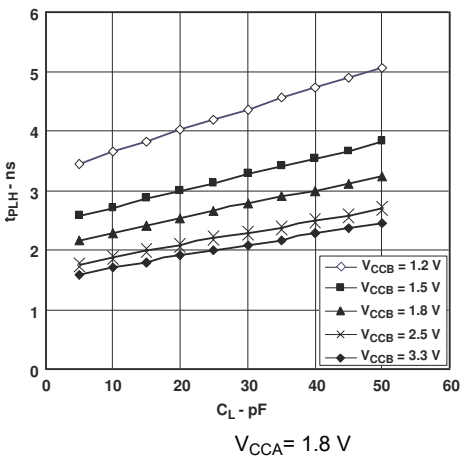


Figure 6-5. Typical Propagation Delay (A to B) vs Load Capacitance

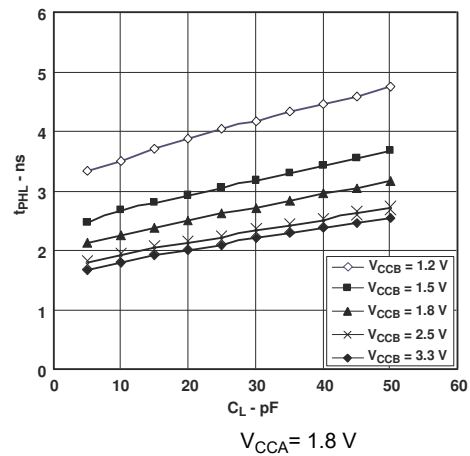


Figure 6-6. Typical Propagation Delay (A to B) vs Load Capacitance

### 6.12 Typical Characteristics (continued)

T<sub>A</sub> = 25°C

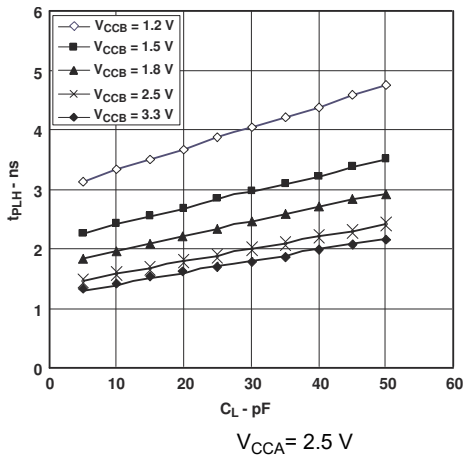


Figure 6-7. Typical Propagation Delay (A to B) vs Load Capacitance

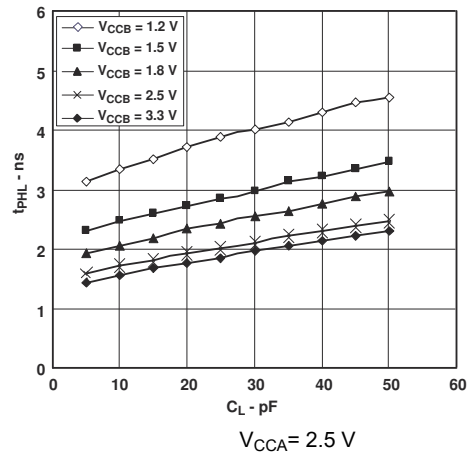


Figure 6-8. Typical Propagation Delay (A to B) vs Load Capacitance

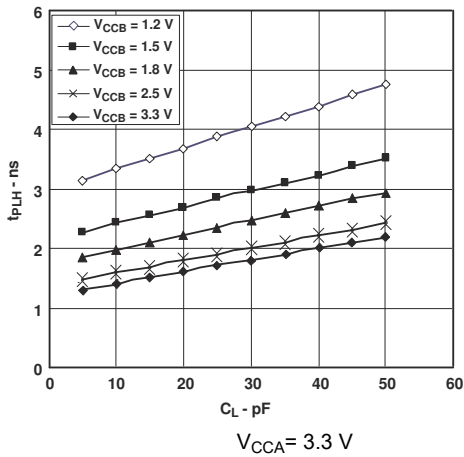


Figure 6-9. Typical Propagation Delay (A to B) vs Load Capacitance

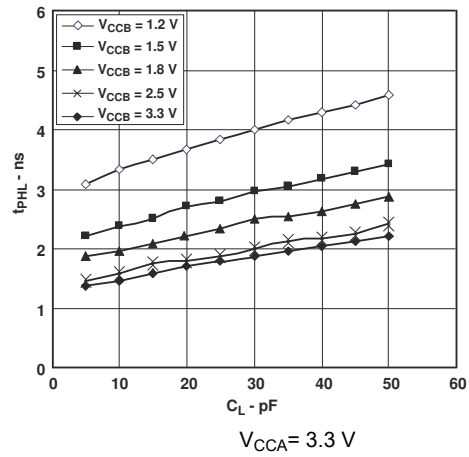
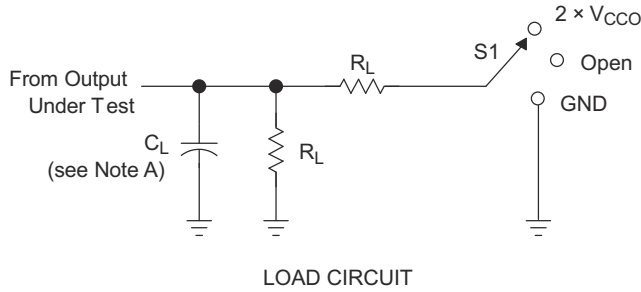


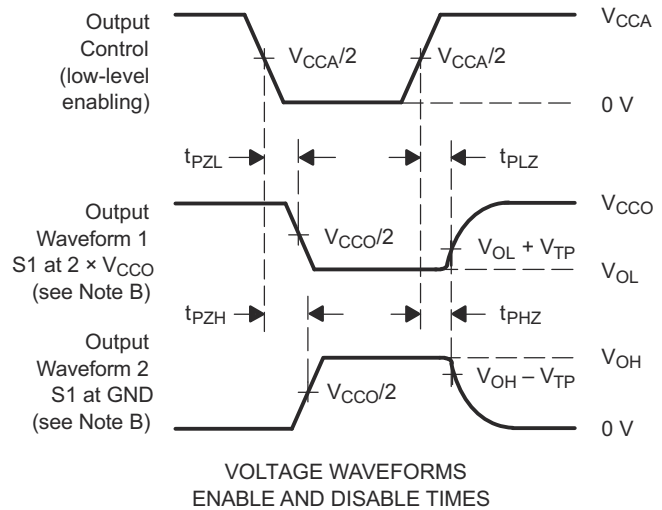
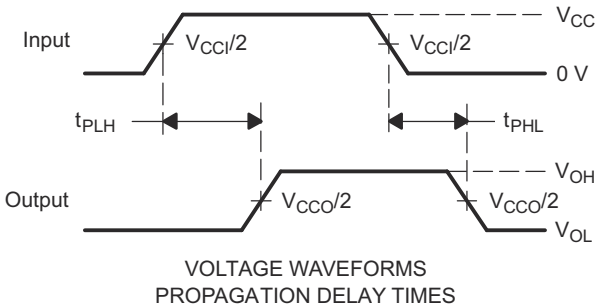
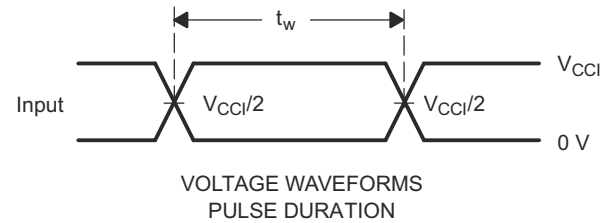
Figure 6-10. Typical Propagation Delay (A to B) vs Load Capacitance

## 7 Parameter Measurement Information



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

$V_{CCO}$	$C_L$	$R_L$	$V_{TP}$
1.2 V	15 pF	2 kW	0.1 V
$1.5 \text{ V} \pm 0.1 \text{ V}$	15 pF	2 kW	0.1 V
$1.8 \text{ V} \pm 0.15 \text{ V}$	15 pF	2 kW	0.15 V
$2.5 \text{ V} \pm 0.2 \text{ V}$	15 pF	2 kW	0.15 V
$3.3 \text{ V} \pm 0.3 \text{ V}$	15 pF	2 kW	0.3 V



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

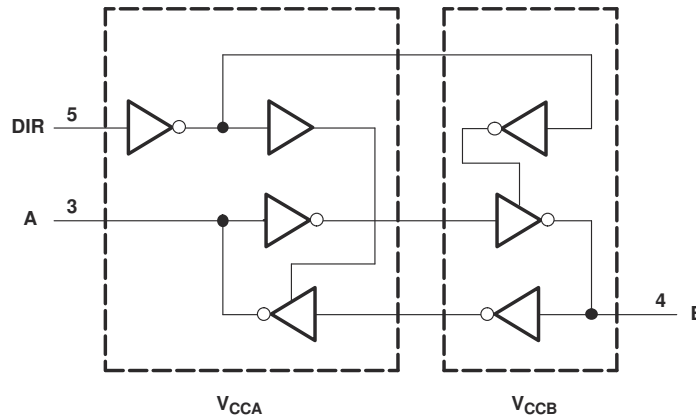
Figure 7-1. Load Circuit and Voltage Waveforms

## 8 Detailed Description

### 8.1 Overview

The SN74AVCH1T45 is a single-bit, dual-supply, noninverting voltage level translator. Pins A and DIR are referenced to  $V_{CCA}$ , while pin B is referenced to  $V_{CCB}$ . Both the A port and B port can accept I/O voltages ranging from 1.2V to 3.6V. The high on DIR allows data transmission from Port A to Port B and a low on DIR allows data transmission from Port B to Port A. See application report, [AVC Logic Family Technology and Applications](#), for more information.

### 8.2 Functional Block Diagram



### 8.3 Feature Description

#### 8.3.1 Fully Configurable Dual-Rail Design

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

#### 8.3.2 Supports High-Speed Translation

SN74AVCH1T45 can support high data rate applications, which can be calculated from the maximum propagation delay. This support is dependent on output load. For example, a 1.8V to 3.3V conversion yields a maximum data rate of 500Mbps.

#### 8.3.3 Partial-Power-Down Mode Operation

$I_{off}$  circuitry disables the outputs, preventing damaging current backflow through the SN74AVCH1T45 when the device is powered down. This event can occur in applications where subsections of a system are powered down (partial-power-down) to reduce power consumption.

#### 8.3.4 Active Bus-Hold Circuitry

Active bus-hold circuitry holds unused or undriven data inputs at a valid logic state, which helps with board space savings and reduced component costs. TI does not recommend using pullup or pulldown resistors with bus-hold circuitry. See applications report, [Bus-Hold Circuit](#), for more information.

#### 8.3.5 $V_{CC}$ Isolation

The  $V_{CC}$  isolation feature places both ports in a high-impedance state ( $I_{OZ}$  as shown in [Electrical Characteristics](#)) if either  $V_{CCA}$  or  $V_{CCB}$  are at GND (or < 0.4V). This feature prevents false logic levels from being presented to either bus.

## 8.4 Device Functional Modes

Table 8-1 lists the functional modes of the SN74AVCH1T45.

**Table 8-1. Function Table**

DIR	OPERATION
L	B data to A bus
H	A data to B bus

## 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 SN74AVCH1T45 device can be used in level-translation applications for interfacing devices or systems operating at different interface voltages with one another. The maximum data rate can be up to 500Mbps when the device translate signal is from 1.8V to 3.3V.

### 9.2 Typical Applications

#### 9.2.1 Unidirectional Logic Level-Shifting Application

Figure 9-1 shows an example of the SN74AVCH1T45 being used in a unidirectional logic level-shifting application.

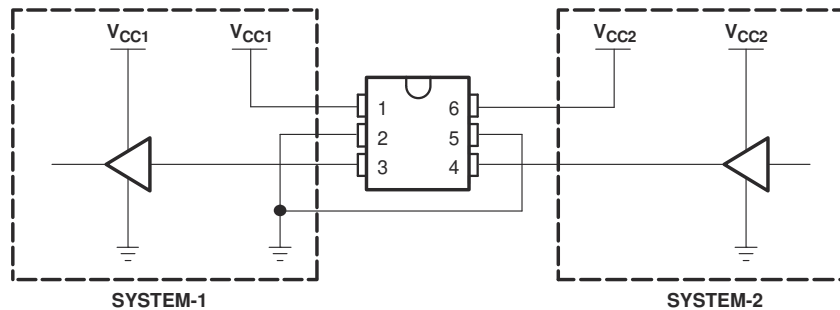


Figure 9-1. Unidirectional Logic Level-Shifting Application Diagram

Table 9-1. Data Transmission: SYSTEM-1 and SYSTEM-2

PIN	NAME	FUNCTION	DESCRIPTION
1	V <sub>CCA</sub>	V <sub>CC1</sub>	SYSTEM-1 supply voltage (1.2V to 3.6V)
2	GND	GND	Device GND
3	A	OUT	Output level depends on V <sub>CC1</sub> voltage.
4	B	IN	Input threshold value depends on V <sub>CC2</sub> voltage.
5	DIR	DIR	GND (low level) determines B-port to A-port direction.
6	V <sub>CCB</sub>	V <sub>CC2</sub>	SYSTEM-2 supply voltage (1.2V to 3.6V)

### 9.2.1.1 Design Requirements

For this design example, use the parameters listed in [Table 9-2](#).

**Table 9-2. Design Parameters**

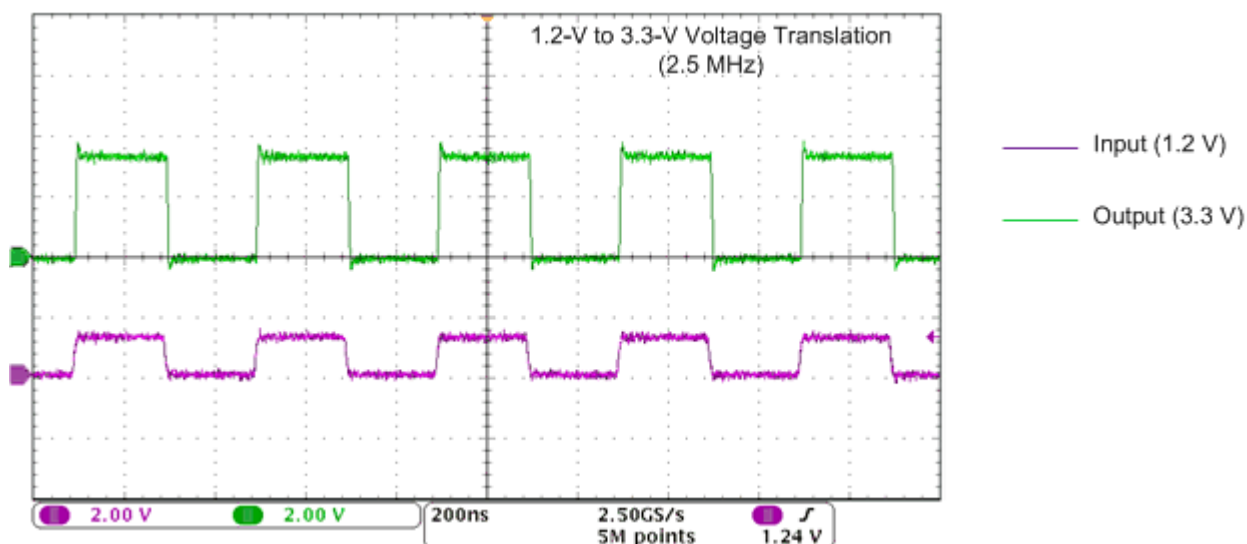
DESIGN PARAMETERS	EXAMPLE VALUES
Input voltage	1.2V to 3.6V
Output voltage	1.2V to 3.6V

### 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 SN74AVCH1T45 device to determine the input voltage range. For a valid logic-high, the value must exceed the  $V_{IH}$  of the input port. For a valid logic low, the value must be less than the  $V_{IL}$  of the input port.
- Output voltage range
  - Use the supply voltage of the device that the SN74AVCH1T45 device is driving to determine the output voltage range.

### 9.2.1.3 Application Curve



**Figure 9-2. Translation Up (1.2V to 3.3V) at 2.5MHz**

## 9.2.2 Bidirectional Logic Level-Shifting Application

Figure 9-3 shows the SN74AVCH1T45 being used in a bidirectional logic level-shifting application. Take precautions to avoid bus contention between SYSTEM-1 and SYSTEM-2 when changing directions because the SN74AVCH1T45 does not have an output-enable (OE) pin.

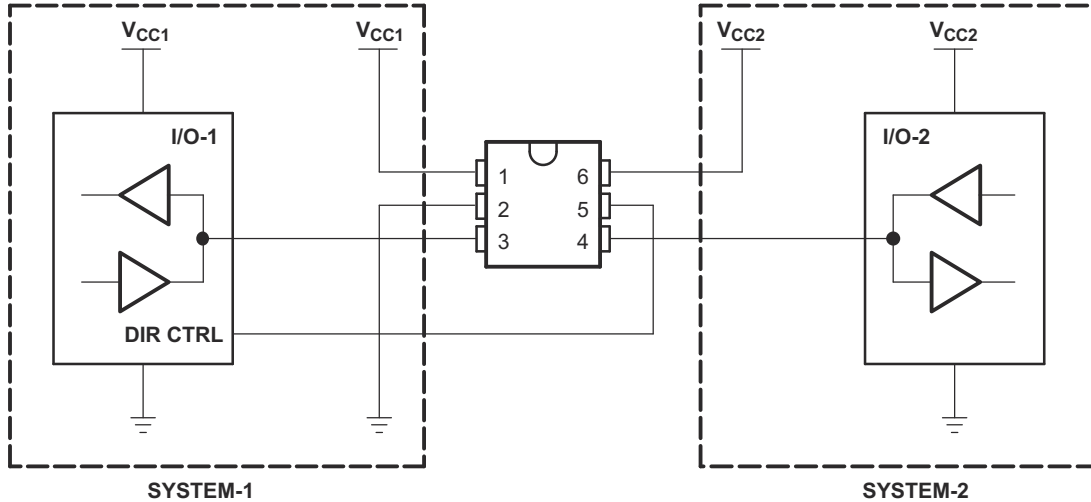


Figure 9-3. Bidirectional Logic Level-Shifting Application Diagram

The following table shows data transmission from SYSTEM-1 to SYSTEM-2 and then from SYSTEM-2 to SYSTEM-1.

Table 9-3. Data Transmission: SYSTEM-1 and SYSTEM-2

STATE	DIR CTRL	I/O-1	I/O-2	DESCRIPTION
1	H	Out	In	SYSTEM-1 data to SYSTEM-2
2	H	Hi-Z	Hi-Z	SYSTEM-2 is getting ready to send data to SYSTEM-1. I/O-1 and I/O-2 are disabled.
3	L	Hi-Z	Hi-Z	DIR bit is flipped. I/O-1 and I/O-2 still are disabled.
4	L	In	Out	SYSTEM-2 data to SYSTEM-1

### 9.2.2.1 Design Requirements

Refer to [Design Requirements](#) found in [Unidirectional Logic Level-Shifting Application](#).

### 9.2.2.2 Detailed Design Procedure

#### 9.2.2.2.1 Enable Times

Calculate the enable times for the SN74AVCH1T45 using the following formulas:

- $t_{PZH}(\text{DIR to A}) = t_{PLZ}(\text{DIR to B}) + t_{PLH}(\text{B to A})$
- $t_{PZL}(\text{DIR to A}) = t_{PHZ}(\text{DIR to B}) + t_{PHL}(\text{B to A})$
- $t_{PZH}(\text{DIR to B}) = t_{PLZ}(\text{DIR to A}) + t_{PLH}(\text{A to B})$
- $t_{PZL}(\text{DIR to B}) = t_{PHZ}(\text{DIR to A}) + t_{PHL}(\text{A to B})$

In a bidirectional application, these enable times provide the maximum delay from the time the DIR bit is switched until an output is expected. For example, if the SN74AVCH1T45 initially is transmitting from A to B, then the DIR bit is switched; the B port of the device must be disabled before presenting it with an input. After the B port has been disabled, an input signal applied to it appears on the corresponding A port after the specified propagation delay.

### 9.2.2.3 Application Curve

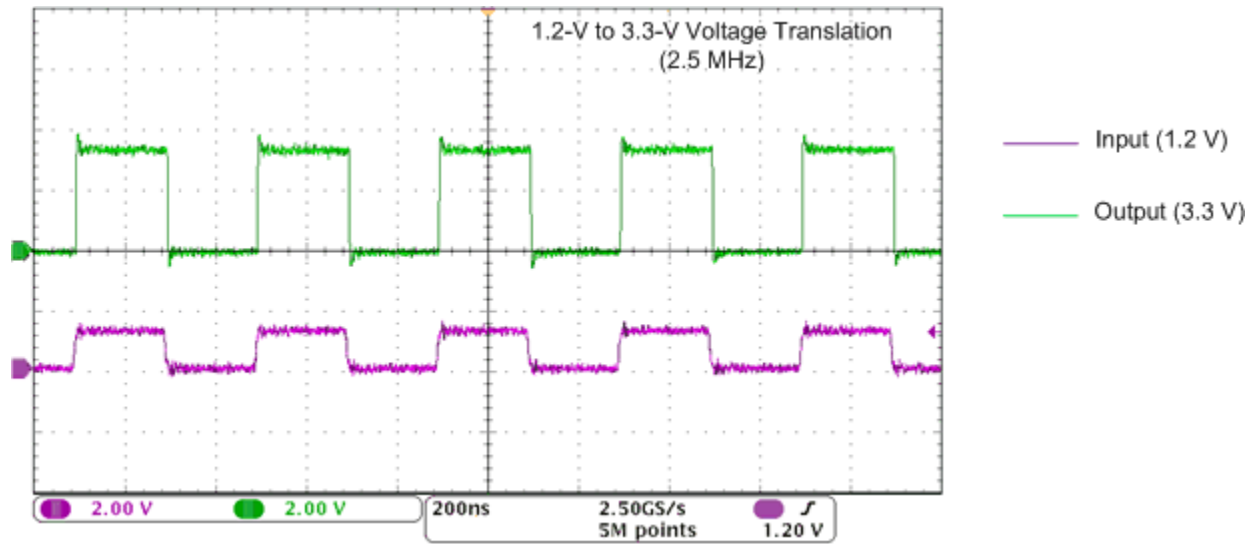


Figure 9-4. Translation Up (1.2V to 3.3V) at 2.5MHz

## 10 Power Supply Recommendations

A proper power-up sequence must be followed to avoid excessive supply current, bus contention, oscillations, or other anomalies. To guard against such power-up problems, take the following precautions:

1. Connect ground before any supply voltage is applied.
2. Power up  $V_{CCA}$ .
3.  $V_{CCB}$  can be ramped up along with or after  $V_{CCA}$ .

**Table 10-1. Typical Total Static Power Consumption ( $I_{CCA} + I_{CCB}$ )**

$V_{CCB}$	$V_{CCA}$						UNIT
	0V	1.2V	1.5V	1.8V	2.5V	3.3V	
0V	0	<0.5	<0.5	<0.5	<0.5	<0.5	$\mu\text{A}$
1.2V	<0.5	<1	<1	<1	<1	1	
1.5V	<0.5	<1	<1	<1	<1	1	
1.8V	<0.5	<1	<1	<1	<1	<1	
2.5V	<0.5	1	<1	<1	<1	<1	
3.3V	<0.5	1	<1	<1	<1	<1	

## 11 Layout

### 11.1 Layout Guidelines

TI recommends following common printed-circuit board layout guidelines for better device reliability.

- Use bypass capacitors on power supplies.
- Use short trace lengths to avoid excessive loading.
- Place pads on the signal paths for loading capacitors, or pullup resistors, to help adjust rise and fall times of signals depending on the system requirements.

### 11.2 Layout Example

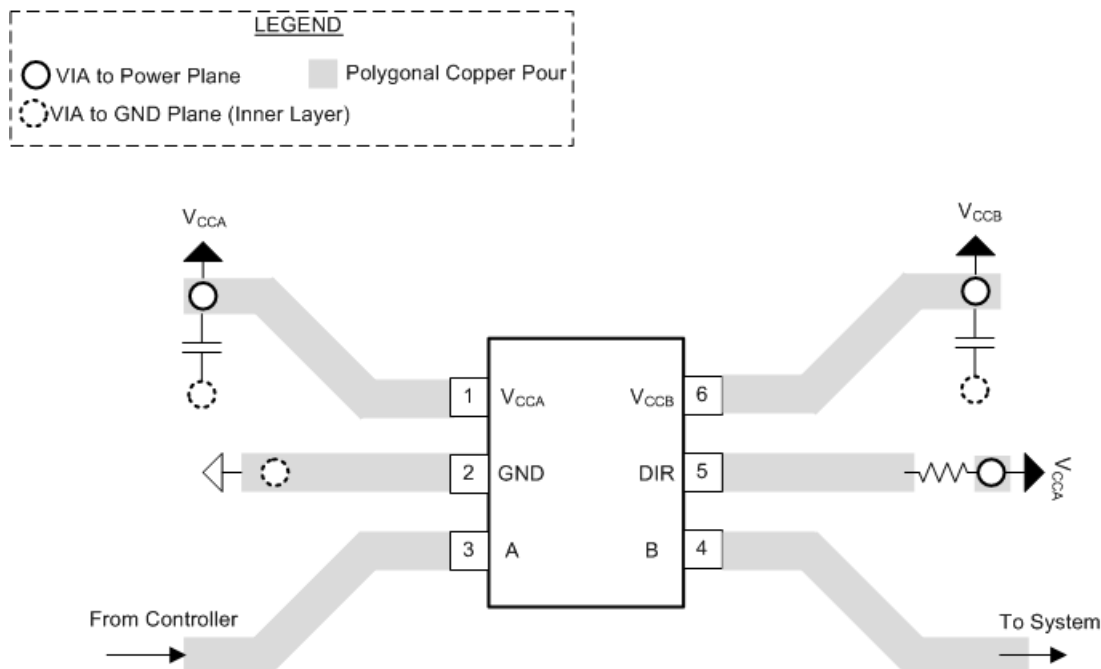


Figure 11-1. PCB Layout Example

## 12 Device and Documentation Support

### 12.1 Documentation Support

#### 12.1.1 Related Documentation

For related documentation see the following:

- [Designing with SN74LVCXT245 and SN74LVCHXT245 Family of Direction Controlled Voltage Translators/Level-Shifters](#), application report
- [Bus-Hold Circuit](#), application report
- [AVC Logic Family Technology and Applications](#)

#### 12.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on [ti.com](http://ti.com). Click on *Notifications* 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.

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#### 12.4 Trademarks

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#### 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 Revision History

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

<b>Changes from Revision E (March 2016) to Revision F (March 2024)</b>	<b>Page</b>
• Updated the numbering format for tables, figures, and cross-references throughout the document.....	1
• Updated DBV and DCK thermal information.....	5

<b>Changes from Revision D (January 2008) to Revision E (March 2016)</b>	<b>Page</b>
• Added <i>ESD Ratings</i> table, <i>Feature Description</i> section, <i>Device Functional Modes, Application and Implementation</i> section, <i>Power Supply Recommendations</i> section, <i>Layout</i> section, <i>Device and Documentation Support</i> section, and <i>Mechanical, Packaging, and Orderable Information</i> section.....	1

## 14 Mechanical, Packaging, and Orderable Information

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

**PACKAGING INFORMATION**

Orderable Device	Status (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
74AVCH1T45DBVRE4	ACTIVE	SOT-23	DBV	6	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(ET1F, ET1R)	<a href="#">Samples</a>
74AVCH1T45DBVRG4	ACTIVE	SOT-23	DBV	6	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(ET1F, ET1R)	<a href="#">Samples</a>
74AVCH1T45DCKRE4	ACTIVE	SC70	DCK	6	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(TFF, TFR)	<a href="#">Samples</a>
74AVCH1T45DCKRG4	ACTIVE	SC70	DCK	6	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(TFF, TFR)	<a href="#">Samples</a>
SN74AVCH1T45DBVR	ACTIVE	SOT-23	DBV	6	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(ET1F, ET1R)	<a href="#">Samples</a>
SN74AVCH1T45DBVT	ACTIVE	SOT-23	DBV	6	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(ET1F, ET1R)	<a href="#">Samples</a>
SN74AVCH1T45DCKR	ACTIVE	SC70	DCK	6	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(TFF, TFR)	<a href="#">Samples</a>
SN74AVCH1T45DCKT	ACTIVE	SC70	DCK	6	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(TFF, TFR)	<a href="#">Samples</a>
SN74AVCH1T45YZPR	ACTIVE	DSBGA	YZP	6	3000	RoHS & Green	SNAGCU	Level-1-260C-UNLIM	-40 to 85	(TE2, TEN)	<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.

<sup>(5)</sup> 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.

<sup>(6)</sup> 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
SN74AVCH1T45DBVR	SOT-23	DBV	6	3000	180.0	8.4	3.23	3.17	1.37	4.0	8.0	Q3
SN74AVCH1T45DBVT	SOT-23	DBV	6	250	180.0	8.4	3.23	3.17	1.37	4.0	8.0	Q3
SN74AVCH1T45DCKR	SC70	DCK	6	3000	180.0	8.4	2.41	2.41	1.2	4.0	8.0	Q3
SN74AVCH1T45DCKT	SC70	DCK	6	250	180.0	8.4	2.41	2.41	1.2	4.0	8.0	Q3
SN74AVCH1T45YZPR	DSBGA	YZP	6	3000	178.0	9.2	1.02	1.52	0.63	4.0	8.0	Q1

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74AVCH1T45DBVR	SOT-23	DBV	6	3000	202.0	201.0	28.0
SN74AVCH1T45DBVT	SOT-23	DBV	6	250	202.0	201.0	28.0
SN74AVCH1T45DCKR	SC70	DCK	6	3000	202.0	201.0	28.0
SN74AVCH1T45DCKT	SC70	DCK	6	250	202.0	201.0	28.0
SN74AVCH1T45YZPR	DSBGA	YZP	6	3000	220.0	220.0	35.0

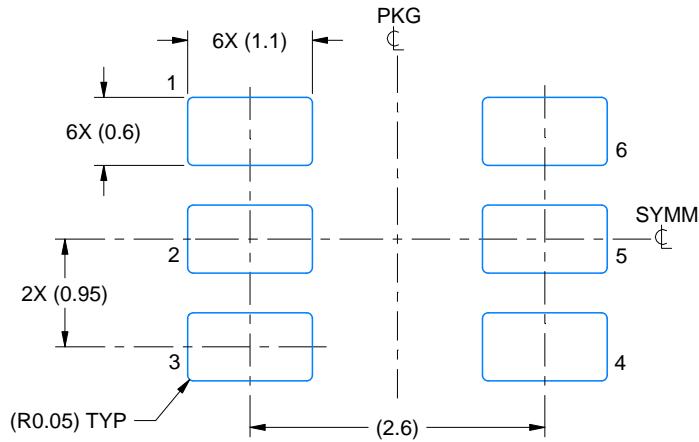


# EXAMPLE BOARD LAYOUT

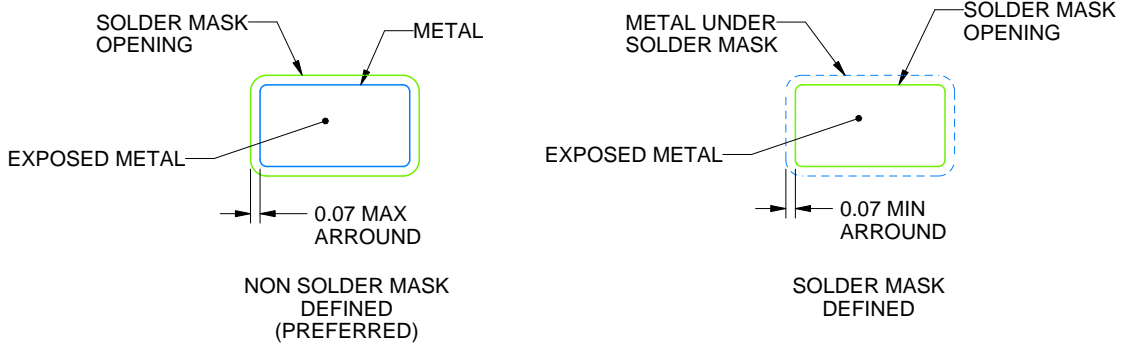
DBV0006A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:15X



SOLDER MASK DETAILS

4214840/E 02/2024

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

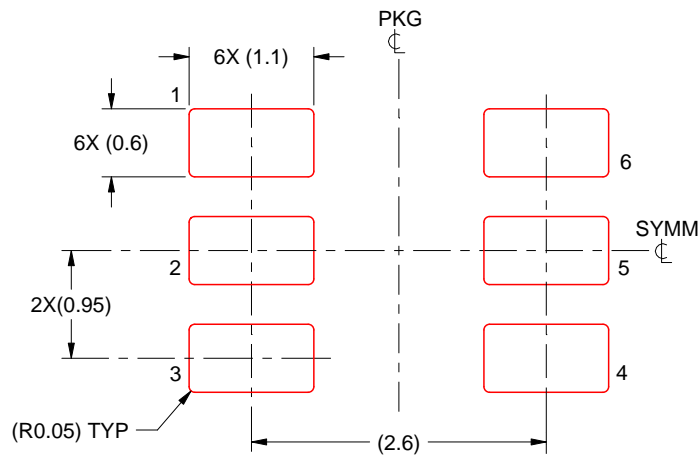
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

DBV0006A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



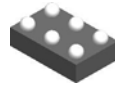
SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE:15X

4214840/E 02/2024

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.

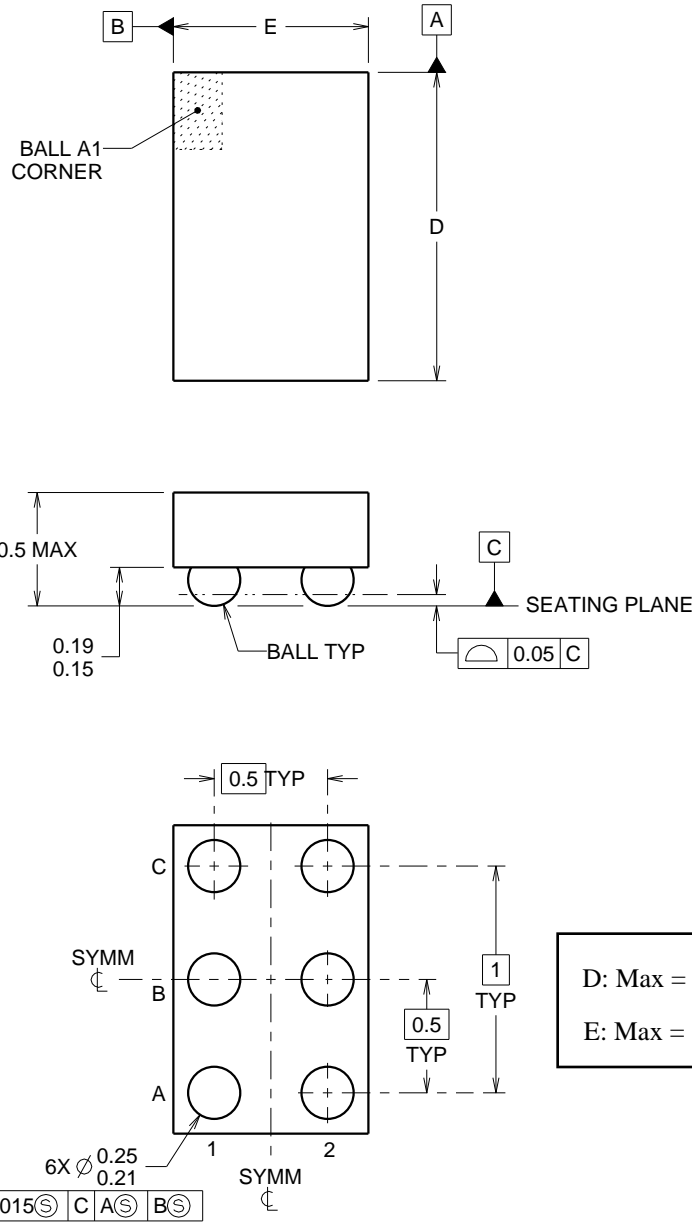
YZP0006



PACKAGE OUTLINE

DSBGA - 0.5 mm max height

DIE SIZE BALL GRID ARRAY



D: Max = 1.418 mm, Min = 1.358 mm  
 E: Max = 0.918 mm, Min = 0.858 mm

4219524/A 06/2014

NOTES:

NanoFree Is a trademark of Texas Instruments.

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. NanoFree™ package configuration.

# EXAMPLE BOARD LAYOUT

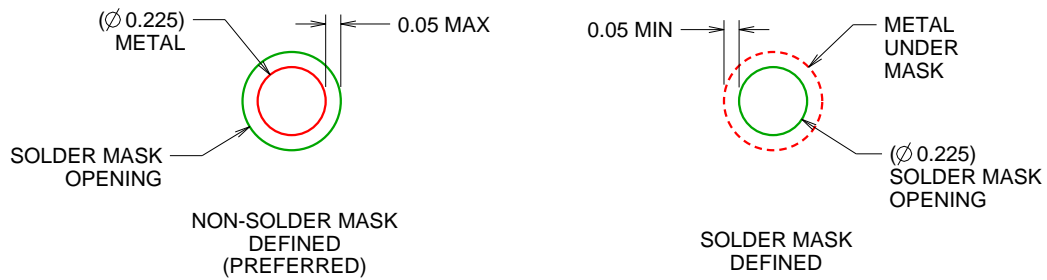
YZP0006

DSBGA - 0.5 mm max height

DIE SIZE BALL GRID ARRAY



LAND PATTERN EXAMPLE  
SCALE:40X



SOLDER MASK DETAILS  
NOT TO SCALE

4219524/A 06/2014

NOTES: (continued)

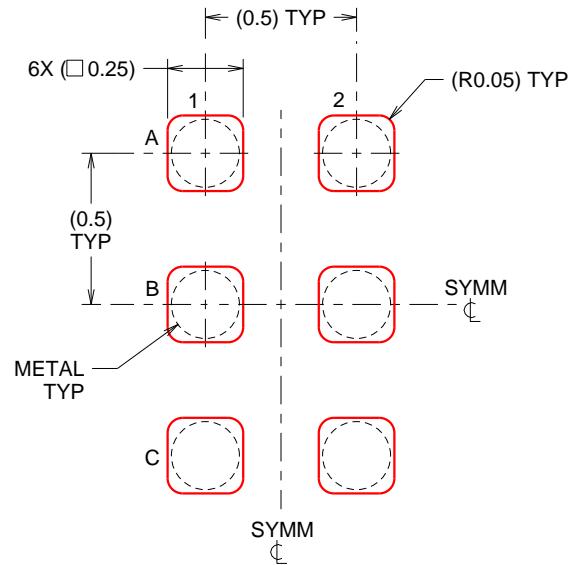
- Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints. For more information, see Texas Instruments literature number SBVA017 ([www.ti.com/lit/sbva017](http://www.ti.com/lit/sbva017)).

# EXAMPLE STENCIL DESIGN

YZP0006

DSBGA - 0.5 mm max height

DIE SIZE BALL GRID ARRAY



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

4219524/A 06/2014

NOTES: (continued)

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

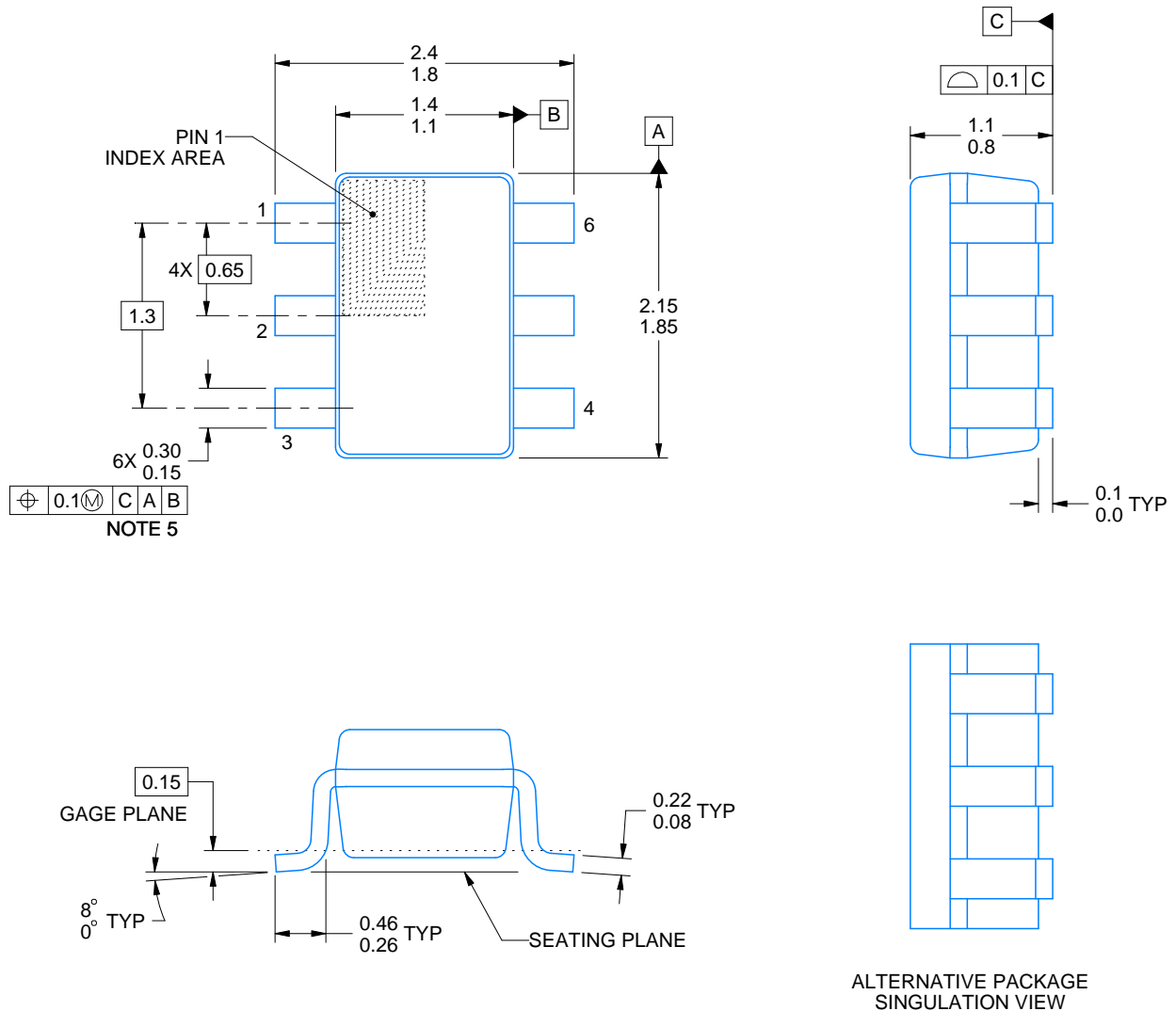
# DCK0006A



# PACKAGE OUTLINE

SOT - 1.1 max height

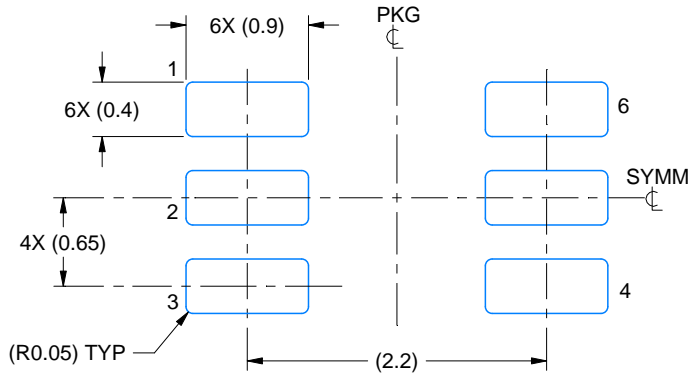
SMALL OUTLINE TRANSISTOR



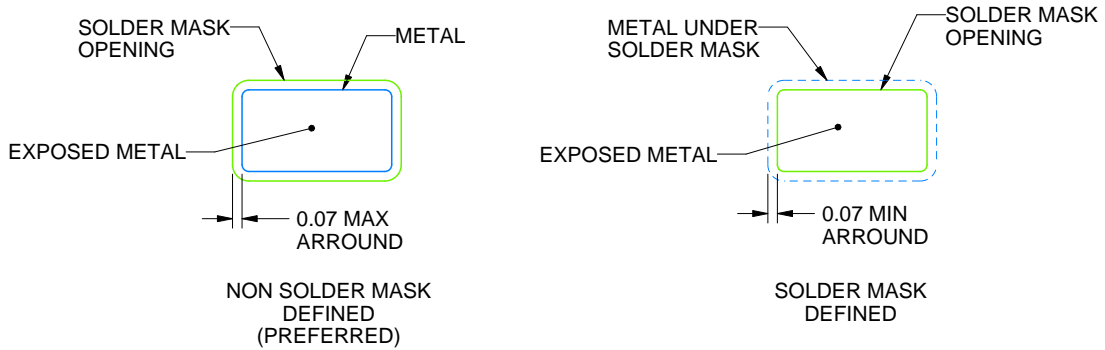
4214835/B 04/2024

**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 0.15 per side.
4. Falls within JEDEC MO-203 variation AB.



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:18X

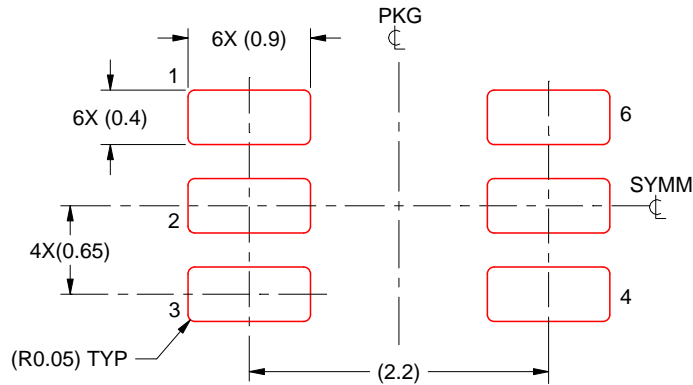


SOLDER MASK DETAILS

4214835/B 04/2024

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.



SOLDER PASTE EXAMPLE  
BASED ON 0.125 THICK STENCIL  
SCALE:18X

4214835/B 04/2024

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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 [Texas Instruments](#) Information

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-  Obsolete Management
-  Cost Control Management
-  Shortage Management
-  Alternative Solution
-  Excess Inventory Management