

# 4-BIT BIDIRECTIONAL VOLTAGE-LEVEL TRANSLATOR WITH AUTOMATIC DIRECTION SENSING

 Check for Samples: [TXB0304](#)

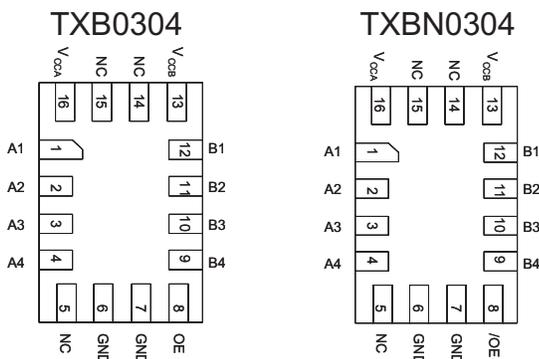
## FEATURES

- Fully Symmetric Supply Voltages. 0.9 V to 3.6 V on A Port and 0.9 V to 3.6 V
- $V_{CC}$  Isolation Feature – If Either  $V_{CC}$  Input Is at GND, All Outputs Are in the High-Impedance State
- OE Input Circuit Referenced to  $V_{CCA}$
- Low Power Consumption, 5- $\mu$ A Max ( $I_{CCA}$  or  $I_{CCB}$ )
- $I_{off}$  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 (A114-B)
  - 1000-V Charged-Device Model (C101)

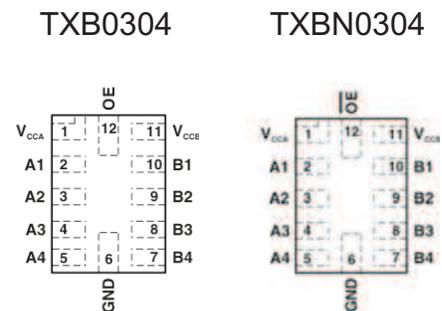
## DESCRIPTION

This 4-bit non-inverting translator uses two separate configurable power-supply rails. The A port is designed to track  $V_{CCA}$ .  $V_{CCA}$  accepts any supply voltage from 0.9 V to 3.6 V. The B port is designed to track  $V_{CCB}$ .  $V_{CCB}$  accepts any supply voltage from 0.9 V to 3.6 V. This allows for low-voltage bidirectional translation between 1-V, 1.2-V, 1.5-V, 1.8-V, 2.5-V and 3.3-V voltage nodes. For the TXB0304, when the output-enable (OE) input is low, all outputs are placed in the high-impedance state. To ensure the high-impedance state during power up or power down, OE should be tied to GND through a pulldown resistor; the minimum value of the resistor is determined by the current-sourcing capability of the driver. The TXB0304 is designed so that the OE input circuit is supplied by  $V_{CCA}$ . This device is fully specified for partial-power-down applications using  $I_{off}$ . The  $I_{off}$  circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down.

### RSV PACKAGE (TOP VIEW)



### RUT PACKAGE (TOP VIEW)



- Pull up resistors are not required on both sides for Logic I/O.
- If pull up or pull down resistors are needed, the resistor value must be over 20 k $\Omega$ .
- 20 k $\Omega$  is a safe recommended value, if the customer can accept higher  $V_{ol}$  or lower  $V_{oh}$ , smaller pull up or pull down resistor is allowed, the draft estimation is  $V_{ol} = V_{ccout} \times 1.5k / (1.5k + R_{pu})$  and  $V_{oh} = V_{ccout} \times R_{dw} / (1.5k + R_{dw})$ .
- If pull up resistors are needed, please refer to the TXS0104 or contact TI.
- For detailed information, please refer to application note [SCEA043](#).



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.



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.

### ORDERING INFORMATION<sup>(1)</sup>

T <sub>A</sub>	PACKAGE <sup>(2)</sup>	ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40 to 85°C	RUT – MicroQFN	TXB0304RUTR	73R
	RSV – QFN	TXB0304RSVR	ZTJ
	RUT – MicroQFN	TXBN0304RUTR	74R
	RSV – QFN	TXBN0304RSVR	ZTK

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at [www.ti.com](http://www.ti.com).

(2) Package drawings, thermal data, and symbolization are available at [www.ti.com](http://www.ti.com).

### DEVICE INFORMATION

**Table 1. SIGNAL DESCRIPTIONS**

PIN NO.		NAME		FUNCTION
RSV	RUT	TXB0304	TXBN0304	
16	1	V <sub>CCA</sub>		A-port supply voltage $0.9V \leq V_{CCA} \leq 3.6V$
1	2	A1		Input/output 1
2	3	A2		Input/output 2
3	4	A3		Input/output 3
4	5	A4		Input/output 4
5	–	NC		No connection; not internally connected
6,7	6	GND		Ground
8	12	OE	$\overline{OE}$	3-state output-mode enable. Pull $\overline{OE}$ (TXB0304) low to place all outputs in 3-state mode. 3-state output-mode enable. Pull $\overline{OE}$ (TXBN0304) high to place all outputs in 3-state mode. Referenced to V <sub>CCA</sub> .
9	7	B4		Input/output 1
10	8	B3		Input/output 2
11	9	B2		Input/output 3
12	10	B1		Input/output 4
13	11	V <sub>CCB</sub>		B-port supply voltage $0.9V \leq V_{CCB} \leq 3.6V$
14	–	NC		No connection; not internally connected
15	–	NC		No connection; not internally connected

## ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

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

			MIN	MAX	UNIT
V <sub>CCA</sub>	Supply voltage range		-0.5	4.6	V
V <sub>CCB</sub>			-0.5	4.6	
V <sub>I</sub>	Input voltage range	A port	-0.5	4.6	V
		B port	-0.5	4.6	
V <sub>O</sub>	Voltage range applied to any output in the high-impedance or power-off state	A port	-0.5	4.6	V
		B port	-0.5	4.6	
V <sub>O</sub>	Voltage range applied to any output in the high or low state <sup>(2)</sup>	A port	-0.5	V <sub>CCA</sub> + 0.5	V
		B port	-0.5	V <sub>CCB</sub> + 0.5	
I <sub>IK</sub>	Input clamp current	V <sub>I</sub> < 0		-50	mA
I <sub>OK</sub>	Output clamp current	V <sub>O</sub> < 0		-50	mA
I <sub>O</sub>	Continuous output current			±50	mA
	Continuous current through V <sub>CCA</sub> , V <sub>CCB</sub> , or GND			±100	mA
T <sub>stg</sub>	Storage temperature range		-65	150	°C

- (1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) The value of V<sub>CCA</sub> and V<sub>CCB</sub> are provided in the recommended operating conditions table.

## THERMAL IMPEDANCE RATINGS

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

			UNIT	
θ <sub>JA</sub>	Package thermal impedance	RUT package <sup>(1)</sup>	87	°C/W
		RSV package <sup>(2)</sup>	184	

- (1) The package thermal impedance is calculated in accordance with JESD 51-7
- (2) The package thermal impedance is calculated in accordance with JESD 51-5.

## RECOMMENDED OPERATING CONDITIONS<sup>(1)(2)</sup>

		V <sub>CCA</sub>	V <sub>CCB</sub>	MIN	MAX	UNIT	
V <sub>CCA</sub>	Supply voltage			0.9	3.6	V	
		V <sub>CCB</sub>		0.9	3.6		
V <sub>IH</sub>	High-level input voltage	Data inputs	0.9 V to 3.6 V	0.9 V to 3.6 V	V <sub>CCI</sub> × 0.65	V <sub>CCI</sub>	V
		OE	0.9 V to 3.6 V	0.9 V to 3.6 V	V <sub>CCA</sub> × 0.65	3.6	
V <sub>IL</sub>	Low-level input voltage	Data inputs	0.9 V to 3.6 V	0.9 V to 3.6 V	0	V <sub>CCI</sub> × 0.35	V
		OE	0.9 V to 3.6 V	0.9 V to 3.6 V	0	V <sub>CCA</sub> × 0.35	
V <sub>O</sub>	Voltage range applied to any output in the high-impedance or power-off state	A-port	0.9 V to 3.6 V	0.9 V to 3.6 V	0	3.6	V
		B-port	0.9 V to 3.6 V	0.9 V to 3.6 V	0	3.6	
Δt/Δv	Input transition rise or fall rate	A-port inputs	0.9 V to 3.6 V	0.9 V to 3.6 V		40	ns/V
		B-port inputs	0.9 V to 3.6 V	0.9 V to 3.6 V		40	
T <sub>A</sub>	Operating free-air temperature			-40	85	°C	

- (1) The A and B sides of an unused data I/O pair must be held in the same state, i.e., both at V<sub>CCI</sub> or both at GND.
- (2) V<sub>CCI</sub> is the supply voltage associated with the input port.

**ELECTRICAL CHARACTERISTICS**

PARAMETER	TEST CONDITIONS	V <sub>CCA</sub>	V <sub>CCB</sub>	T <sub>A</sub> = 25°C			–40°C to 85°C		UNIT
				MIN	TYP	MAX	MIN	MAX	
V <sub>OHA</sub>	I <sub>OH</sub> = –20 μA	0.9 V to 3.6 V				0.9 x V <sub>CCA</sub>			V
V <sub>OLA</sub>	I <sub>OL</sub> = 20 μA	0.9 V to 3.6 V					0.2		V
V <sub>OHB</sub>	I <sub>OH</sub> = –20 μA		0.9 V to 3.6 V			0.9 x V <sub>CCB</sub>			V
V <sub>OLB</sub>	I <sub>OL</sub> = 20 μA		0.9 V to 3.6 V				0.2		V
I <sub>I</sub>	OE	V <sub>I</sub> = V <sub>CCI</sub> or GND	0.9 V to 3.6 V	0.9 V to 3.6 V		±1		±2	μA
I <sub>off</sub>	A port	V <sub>I</sub> or V <sub>O</sub> = 0 to 3.6 V	0 V	0 V to 3.6 V		±1		±2	μA
	B port	V <sub>I</sub> or V <sub>O</sub> = 0 to 3.6 V	0.9 V to 3.6 V	0 V		±1		±2	
I <sub>OZ</sub>	A or B port	OE = GND	0.9 V to 3.6 V	0.9 V to 3.6 V		±1		±2	μA
I <sub>CCA</sub>		V <sub>I</sub> = V <sub>CCI</sub> or GND, I <sub>O</sub> = 0	0.9 V to 3.6 V	0.9 V to 3.6 V				5	μA
I <sub>CCB</sub>		V <sub>I</sub> = V <sub>CCB</sub> or GND, I <sub>O</sub> = 0	0.9 V to 3.6 V	0.9 V to 3.6 V				5	μA
I <sub>CCA</sub> + I <sub>CCB</sub>		V <sub>I</sub> = V <sub>CCI</sub> or GND, I <sub>O</sub> = 0	0.9 V to 3.6 V	0.9 V to 3.6 V				10	μA
I <sub>CCZA</sub>		V <sub>I</sub> = V <sub>CCI</sub> or GND, I <sub>O</sub> = 0, OE = GND	0.9 V to 3.6 V	0.9 V to 3.6 V				5	μA
I <sub>CCZB</sub>		V <sub>I</sub> = V <sub>CCB</sub> or GND, I <sub>O</sub> = 0, OE = GND	0.9 V to 3.6 V	0.9 V to 3.6 V				5	μA
C <sub>i</sub>	OE		0.9 V to 3.6 V	0.9 V to 3.6 V		3			pF
C <sub>io</sub>	A port		0.9 V to 3.6 V	0.9 V to 3.6 V		6.7			pF
	B port		0.9 V to 3.6 V	0.9 V to 3.6 V		6.7			

**TIMING REQUIREMENTS**

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

			V <sub>CCA</sub>	V <sub>CCB</sub>	MIN	MAX	UNIT
Data rate		C <sub>L</sub> = 15 pF	0.9 to 3.6 V	0.9 to 3.6 V		50	Mbps
		C <sub>L</sub> = 15 pF	1.2 to 3.6 V	1.2 to 3.6 V		100	Mbps
		C <sub>L</sub> = 15 pF	1.8 to 3.6 V	1.8 to 3.6 V		140	Mbps
		C <sub>L</sub> = 30 pF	0.9 to 3.6 V	0.9 to 3.6 V		40	Mbps
		C <sub>L</sub> = 30 pF	1.2 to 3.6 V	1.2 to 3.6 V		90	Mbps
		C <sub>L</sub> = 30 pF	1.8 to 3.6 V	1.8 to 3.6 V		130	Mbps
		C <sub>L</sub> = 50 pF	1.2 to 3.6 V	1.2 to 3.6 V		80	Mbps
		C <sub>L</sub> = 50 pF	1.8 to 3.6 V	1.8 to 3.6 V		120	Mbps
		C <sub>L</sub> = 100 pF	1.2 to 3.6 V	1.2 to 3.6 V		70	Mbps
	C <sub>L</sub> = 100 pF	1.8 to 3.6 V	1.8 to 3.6 V		100	Mbps	

## SWITCHING CHARACTERISTICS

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)		VCCA	VCCB	MIN	TYP T <sub>A</sub> = 25°C	MAX	UNIT
t <sub>pd</sub>	A	B	C <sub>L</sub> = 15	0.9-3.6	0.9-3.6		18.9	30	ns
	A	B	C <sub>L</sub> = 15	1.2-3.6	1.2-3.6		7.5	11.5	
	A	B	C <sub>L</sub> = 15	1.8-3.6	1.8-3.6		3.7	4.8	
	A	B	C <sub>L</sub> = 30	0.9-3.6	0.9-3.6		19.5	34	
	A	B	C <sub>L</sub> = 30	1.2-3.6	1.2-3.6		7.8	11.9	
	A	B	C <sub>L</sub> = 30	1.8-3.6	1.8-3.6		3.8	5.2	
	A	B	C <sub>L</sub> = 50	1.2-3.6	1.2-3.6		8	12.3	
	A	B	C <sub>L</sub> = 50	1.8-3.6	1.8-3.6		4	5.4	
	A	B	C <sub>L</sub> = 100	1.2-3.6	1.2-3.6		8.6	13.5	
	A	B	C <sub>L</sub> = 100	1.8-3.6	1.8-3.6		4.5	6	
	B	A	C <sub>L</sub> = 15	0.9-3.6	0.9-3.6		18.9	30	ns
	B	A	C <sub>L</sub> = 15	1.2-3.6	1.2-3.6		7.5	11.5	
	B	A	C <sub>L</sub> = 15	1.8-3.6	1.8-3.6		3.7	5	
	B	A	C <sub>L</sub> = 30	0.9-3.6	0.9-3.6		19.5	34	
	B	A	C <sub>L</sub> = 30	1.2-3.6	1.2-3.6		7.8	11.9	
	B	A	C <sub>L</sub> = 30	1.8-3.6	1.8-3.6		3.8	5.2	
	B	A	C <sub>L</sub> = 50	1.2-3.6	1.2-3.6		8	12.3	
	B	A	C <sub>L</sub> = 50	1.8-3.6	1.8-3.6		4	5.4	
B	A	C <sub>L</sub> = 100	1.2-3.6	1.2-3.6		8.6	13.5		
B	A	C <sub>L</sub> = 100	1.8-3.6	1.8-3.6		4.5	6		
t <sub>en</sub>	OE	A	C <sub>L</sub> = 15	0.9-3.6	0.9-3.6			173	ns
		B	C <sub>L</sub> = 15	0.9-3.6	0.9-3.6			213	
t <sub>dis</sub>	OE	A	C <sub>L</sub> = 15	0.9-3.6	0.9-3.6			172	ns
		B	C <sub>L</sub> = 15	0.9-3.6	0.9-3.6			169	ns
t <sub>rB</sub> , t <sub>fB</sub>	B-port rise and fall times		C <sub>L</sub> = 15	0.9-3.6	0.9-3.6		2.95		ns
t <sub>s</sub> , t <sub>f</sub>	A-port rise and fall times		C <sub>L</sub> = 15	0.9-3.6	0.9-3.6		3.1		ns
t <sub>SK(O)</sub>	Channel-to-channel skew		C <sub>L</sub> = 15	0.9-3.6	0.9-3.6			0.15	ns

## OPERATING CHARACTERISTICS

 T<sub>A</sub> = 25°C

PARAMETER		TEST CONDITIONS	V <sub>CCA</sub> , V <sub>CCB</sub> 0.9 V to 3.6 V	UNIT
			TYP	
C <sub>pdA</sub>	A-port input, B-port output	C <sub>L</sub> = 0, f = 10 MHz, t <sub>r</sub> = t <sub>f</sub> = 1 ns, OE = V <sub>CCA</sub> (outputs enabled)	34	pF
	B-port input, A-port output		34	
C <sub>pdB</sub>	A-port input, B-port output		34	pF
	B-port input, A-port output		34	
C <sub>pdA</sub>	A-port input, B-port output	C <sub>L</sub> = 0, f = 10 MHz, t <sub>r</sub> = t <sub>f</sub> = 1 ns, OE = GND (outputs disabled)	0.01	pF
	B-port input, A-port output		0.01	
C <sub>pdB</sub>	A-port input, B-port output		0.01	pF
	B-port input, A-port output		0.01	

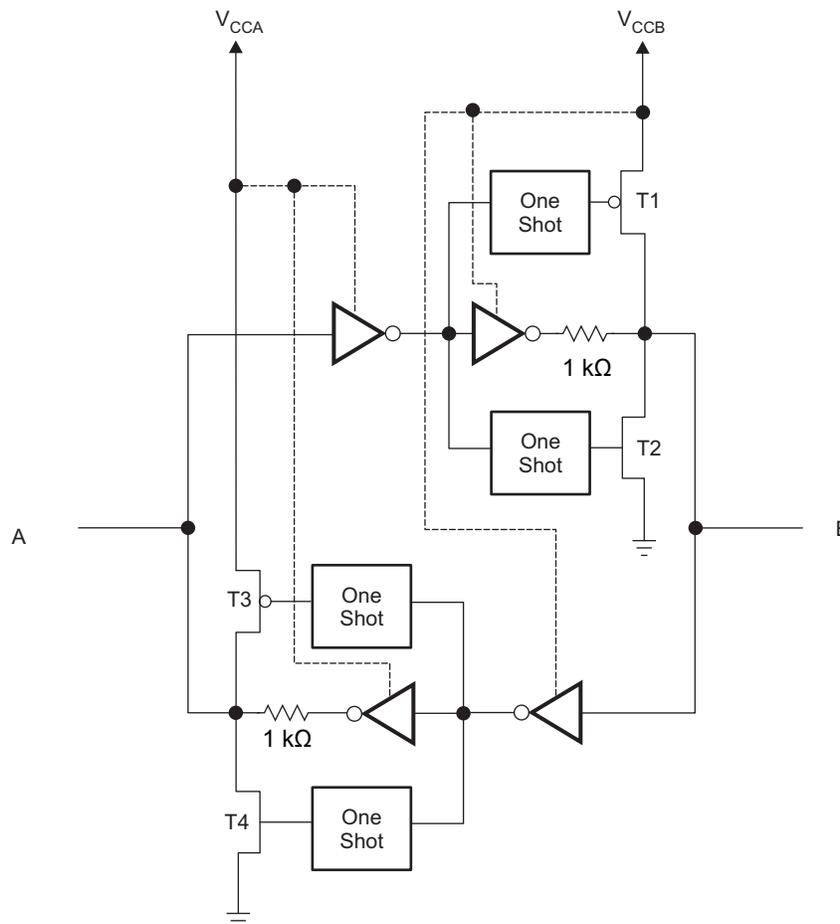
## PRINCIPLES OF OPERATION

### Applications

The TXB0304 can be used in level-translation applications for interfacing devices or systems operating at different interface voltages with one another.

### Architecture

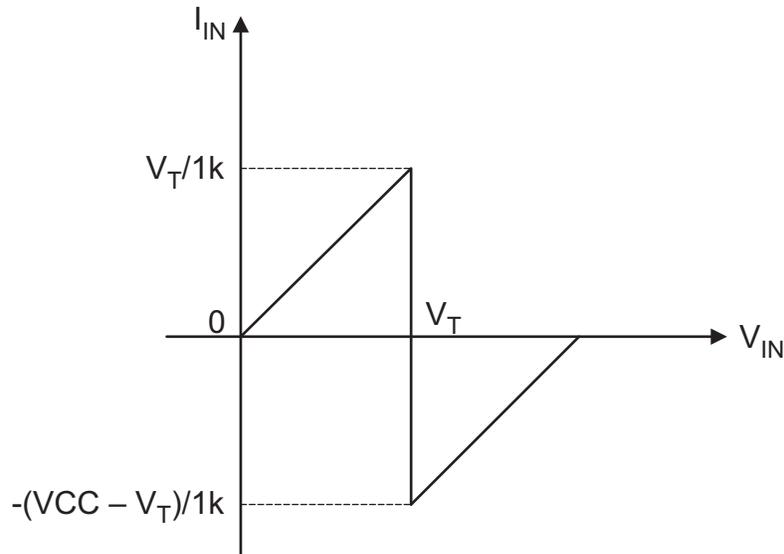
The TXB0304 architecture (see [Figure 1](#)) does not require a direction-control signal to control the direction of data flow from A to B or from B to A. In a dc state, the output drivers of the TXB0304 can maintain a high or low, but are designed to be weak, so that they can be overdriven by an external driver when data on the bus starts flowing the opposite direction. The output one shots detect rising or falling edges on the A or B ports. During a rising edge, the one shot turns on the PMOS transistors (T1, T3) for a short duration, which speeds up the low-to-high transition. Similarly, during a falling edge, the one shot turns on the NMOS transistors (T2, T4) for a short duration, which speeds up the high-to-low transition. The typical output impedance during output transition is 30  $\Omega$  at  $V_{CCO} = 0.9$  V to 1 V, 10  $\Omega$  at  $V_{CCO} = 1.1$  V to 1.7 V, and 5  $\Omega$  at  $V_{CCO} = 1.8$  V to 3.3 V.



**Figure 1. Architecture of TXB0302 I/O Cell**

### Input Driver Requirements

Typical  $I_{IN}$  vs  $V_{IN}$  characteristics of the TXB0304 are shown in [Figure 2](#). For proper operation, the device driving the data I/Os of the TXB0304 must have drive strength of at least  $\pm 3$  mA.



- (1)  $V_{CC}$  is power supply of TXB0304.
- (2)  $V_T$  is the input threshold voltage of TXB0304 (typically it is  $V_{CC}/2$ ).

**Figure 2. Typical  $I_{IN}$  vs  $V_{IN}$  Curve**

## Power Up

There is no requirement for the power sequence. During operation, TXB0304 can work at both  $V_{CCA} \leq V_{CCB}$  and  $V_{CCA} \geq V_{CCB}$ . During power-up sequencing, any power supply can be ramped up first. The TXB0304 has circuitry that disables all output ports when either  $V_{CC}$  is switched off ( $V_{CCA/B} = 0$  V).

## Enable and Disable

The TXB0304 has an OE input that is used to disable the device by setting OE = low, which places all I/Os in the high-impedance (Hi-Z) state. The disable time ( $t_{dis}$ ) indicates the delay between when OE goes low and when the outputs actually get disabled (Hi-Z). The enable time ( $t_{en}$ ) indicates the amount of time the user must allow for the one-shot circuitry to become operational after OE is taken high.

## Pullup or Pulldown Resistor on I/O Lines

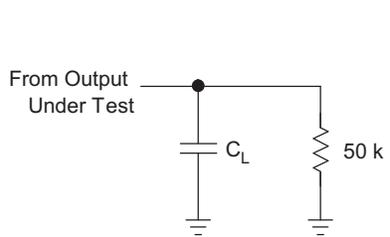
The TXB0304 is designed to drive capacitive loads of up to 100 pF. The output drivers of the TXB0304 have low dc drive strength. If pullup or pulldown resistors are connected externally to the data I/Os, their values must be kept higher than 20 k $\Omega$  to ensure that they do not contend with the output drivers of the TXB0304. but if the receiver is integrated with the smaller pull down or pull up resistor, below formula can be used for estimation to evaluate the  $V_{oh}$  and  $V_{ol}$ .

$$V_{ol} = V_{CCout} \times \frac{1.5k\Omega}{1.5k\Omega + R_{pu}} \quad (1)$$

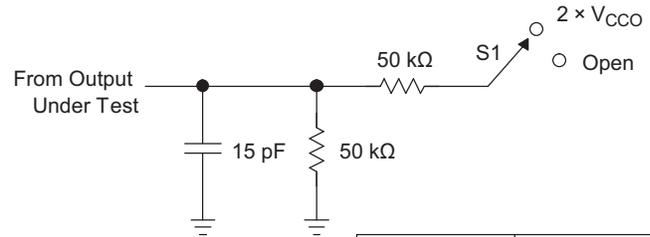
$$V_{oh} = V_{CCout} \times \frac{R_{pd}}{1.5k\Omega + R_{pd}} \quad (2)$$

For the same reason, the TXB0304 should not be used in applications such as I<sup>2</sup>C or 1-Wire where an open-drain driver is connected on the bidirectional data I/O. For these applications, use a device from the TI TXS01xx series of level translators.

**PARAMETER MEASUREMENT INFORMATION**

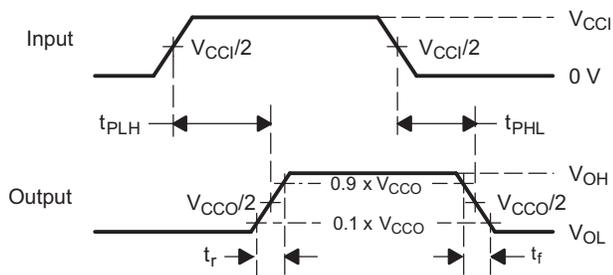


LOAD CIRCUIT FOR MAX DATA RATE, PULSE DURATION PROPAGATION DELAY OUTPUT RISE AND FALL TIME MEASUREMENT

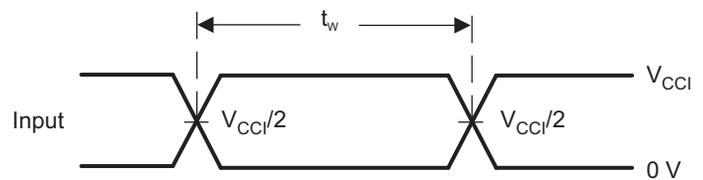


LOAD CIRCUIT FOR ENABLE/DISABLE TIME MEASUREMENT

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



VOLTAGE WAVEFORMS PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS PULSE DURATION

- A.  $C_L$  includes probe and jig capacitance.
- B. All input pulses are supplied by generators having the following characteristics: PRR 10 MHz,  $Z_0 = 50 \Omega$ ,  $dv/dt \geq 1 \text{ V/ns}$ .
- C. The outputs are measured one at a time, with one transition per measurement.
- D.  $t_{PLH}$  and  $t_{PHL}$  are the same as  $t_{pd}$ .
- E.  $V_{CCI}$  is the  $V_{CC}$  associated with the input port.
- F.  $V_{CCO}$  is the  $V_{CC}$  associated with the output port.
- G. All parameters and waveforms are not applicable to all devices.

**Figure 3. Load Circuits and Voltage Waveforms**

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**REVISION HISTORY**

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**Changes from Revision B (September 2011) to Revision C** **Page**

- Added package pin out diagram notes. .... **1**
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**Changes from Revision C (May 2012) to Revision D** **Page**

- Added Application Information Section ..... **6**
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**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TXB0304RSVR	ACTIVE	UQFN	RSV	16	3000	Green (RoHS & no Sb/Br)	CU NIPDAUAG	Level-1-260C-UNLIM	-40 to 85	ZTJ	<a href="#">Samples</a>
TXB0304RUTR	ACTIVE	UQFN	RUT	12	3000	Green (RoHS & no Sb/Br)	CU NIPDAU   CU NIPDAUAG	Level-1-260C-UNLIM	-40 to 85	(737 ~ 73R)	<a href="#">Samples</a>
TXBN0304RSVR	ACTIVE	UQFN	RSV	16	3000	Green (RoHS & no Sb/Br)	CU NIPDAU   CU NIPDAUAG	Level-1-260C-UNLIM	-40 to 85	ZTK	<a href="#">Samples</a>
TXBN0304RUTR	ACTIVE	UQFN	RUT	12	3000	Green (RoHS & no Sb/Br)	CU NIPDAUAG	Level-1-260C-UNLIM	-40 to 85	74R	<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.

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

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

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

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

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

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

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

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

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

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

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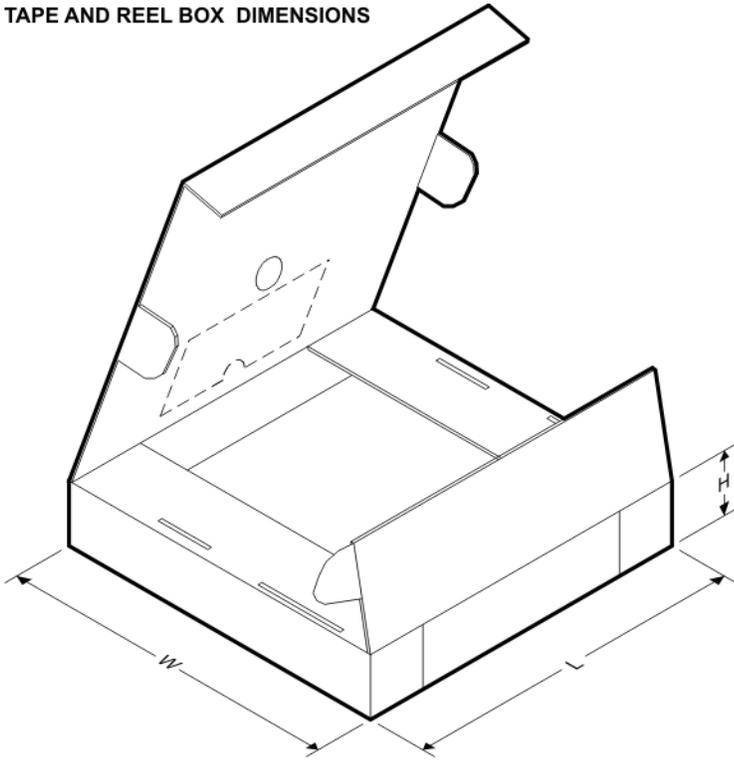
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**TAPE AND REEL INFORMATION**

**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
TXB0304RSVR	UQFN	RSV	16	3000	177.8	12.4	2.0	2.8	0.7	4.0	12.0	Q1
TXB0304RUTR	UQFN	RUT	12	3000	180.0	9.5	1.9	2.3	0.75	4.0	8.0	Q1
TXBN0304RSVR	UQFN	RSV	16	3000	330.0	12.4	2.1	2.9	0.75	4.0	12.0	Q1
TXBN0304RSVR	UQFN	RSV	16	3000	177.8	12.4	2.0	2.8	0.7	4.0	12.0	Q1
TXBN0304RUTR	UQFN	RUT	12	3000	180.0	8.4	1.95	2.3	0.75	4.0	8.0	Q1

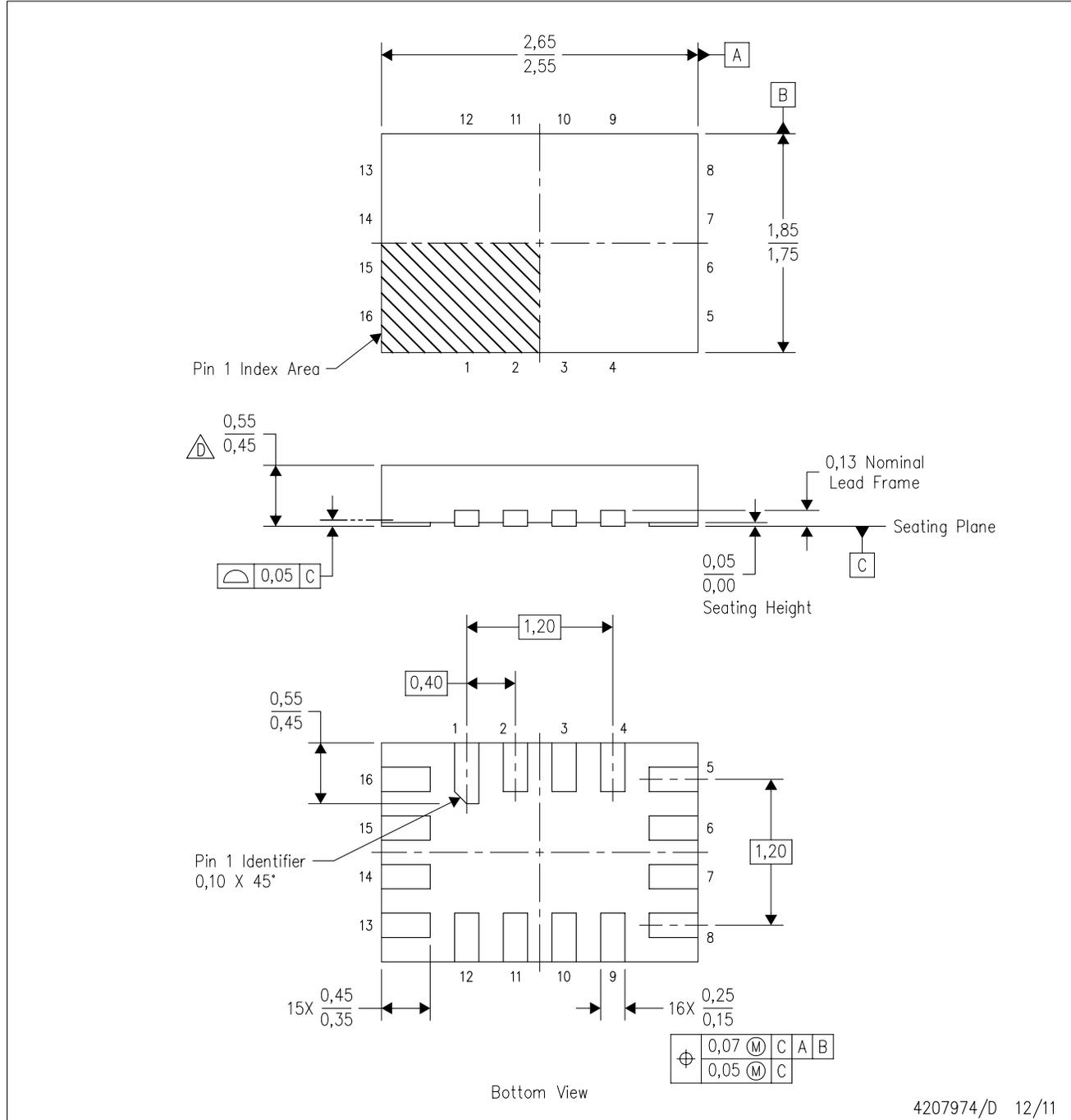
**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TXB0304RSVR	UQFN	RSV	16	3000	202.0	201.0	28.0
TXB0304RUTR	UQFN	RUT	12	3000	184.0	184.0	19.0
TXBN0304RSVR	UQFN	RSV	16	3000	184.0	184.0	19.0
TXBN0304RSVR	UQFN	RSV	16	3000	202.0	201.0	28.0
TXBN0304RUTR	UQFN	RUT	12	3000	202.0	201.0	28.0

RSV (R-PUQFN-N16)

PLASTIC QUAD FLATPACK NO-LEAD

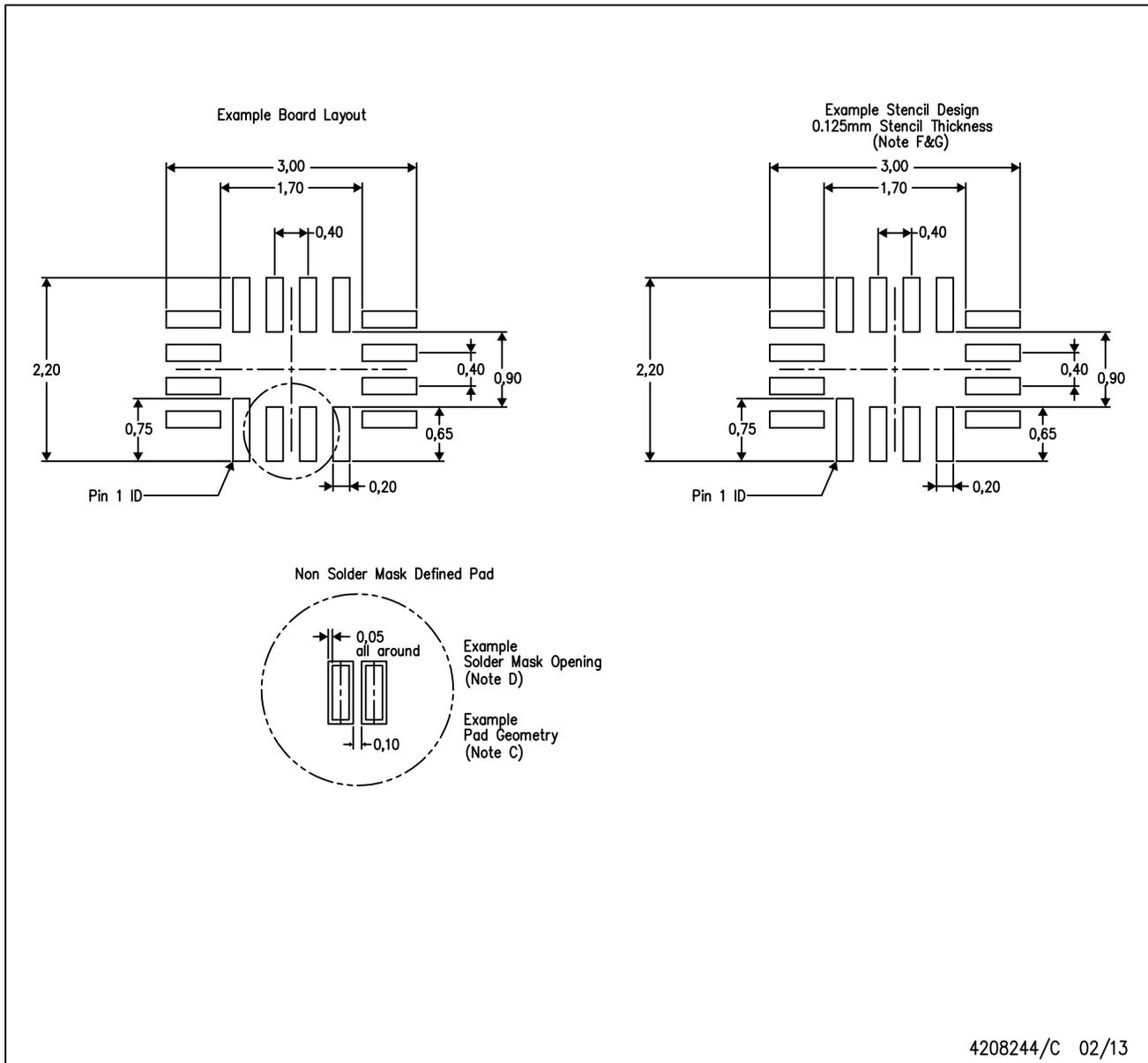


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- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
  - B. This drawing is subject to change without notice.
  - C. QFN (Quad Flatpack No-Lead) package configuration.
  -  This package complies to JEDEC MO-288 variation UFHE, except minimum package thickness.

RSV (R-PUQFN-N16)

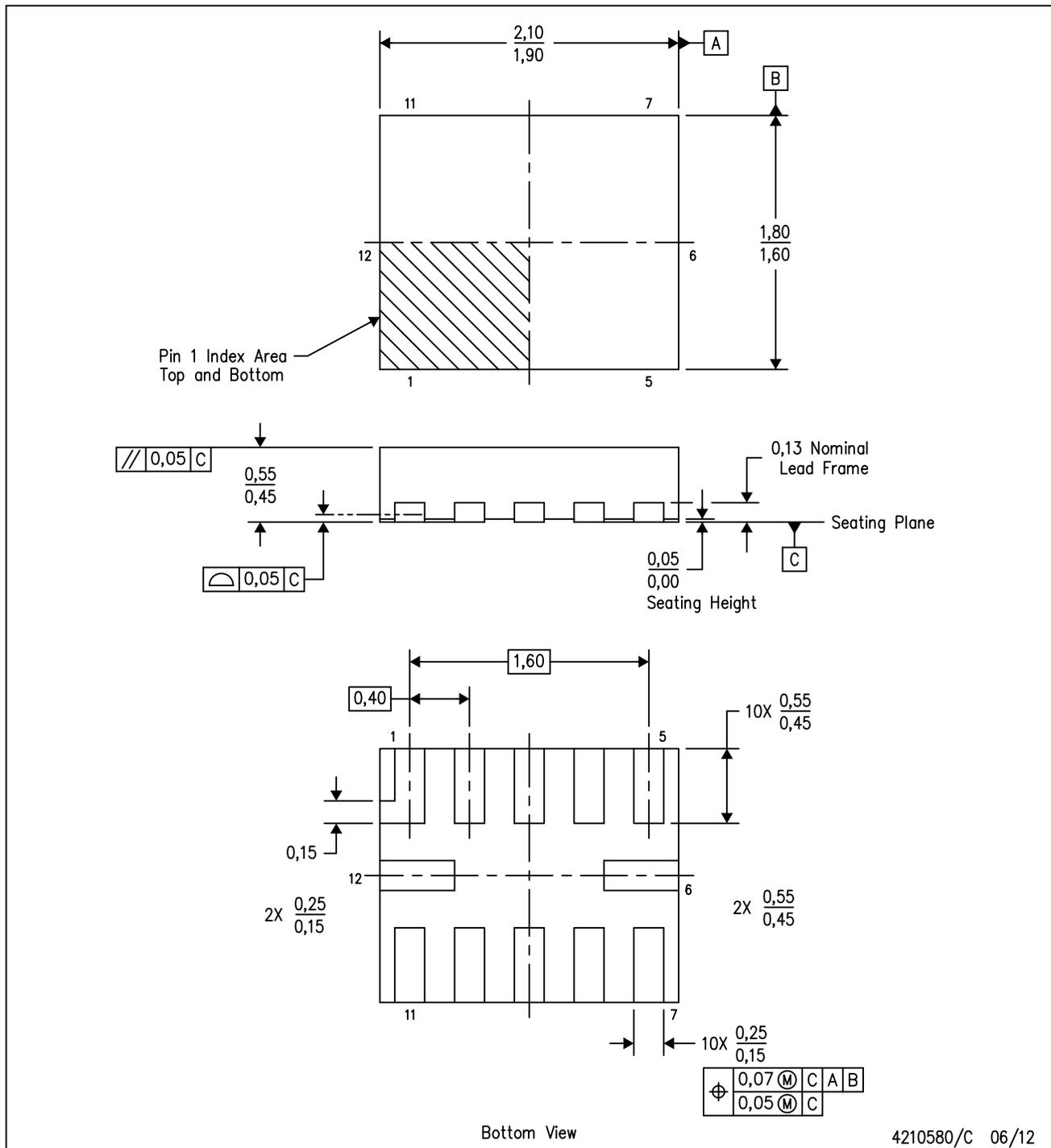
PLASTIC QUAD FLATPACK NO-LEAD



- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Publication IPC-7351 is recommended for alternate designs.
  - Customers should contact their board fabrication site for minimum solder mask web tolerances between signal pads.
  - Maximum stencil thickness 0,127 mm (5 mils). All linear dimensions are in millimeters.
  - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC 7525 for stencil design considerations.
  - Side aperture dimensions over-print land for acceptable area ratio > 0.66. Customer may reduce side aperture dimensions if stencil manufacturing process allows for sufficient release at smaller opening.

RUT (R-PUQFN-N12)

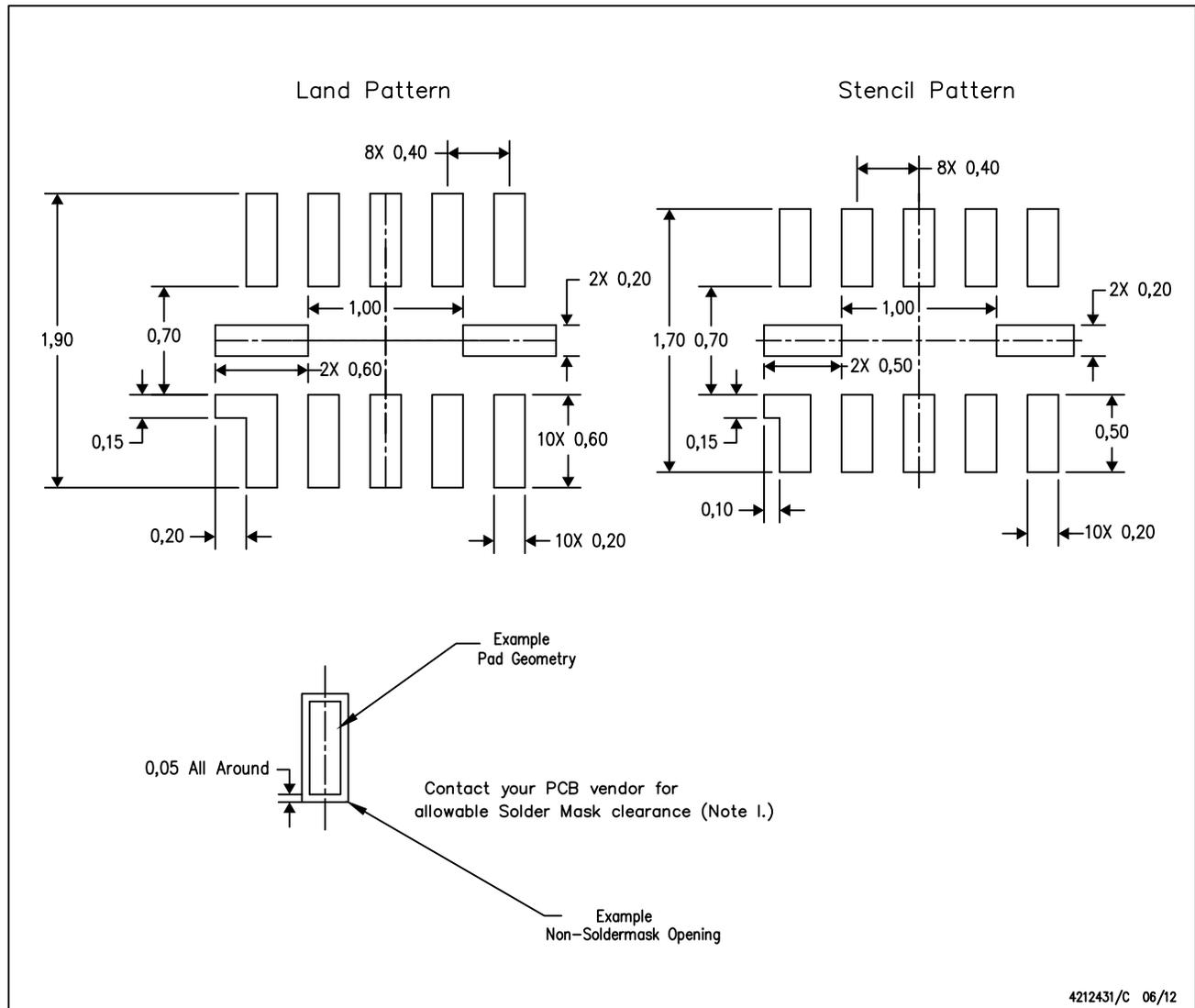
PLASTIC QUAD FLATPACK NO-LEAD



- NOTES:
- All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
  - This drawing is subject to change without notice.
  - QFN (Quad Flatpack No-Lead) package configuration.

RUT (R-PUQFN-N12)

PLASTIC QUAD FLATPACK NO-LEAD



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Publication IPC-7351 is recommended for alternate designs.
  - D. Customers should contact their board fabrication site for minimum solder mask web tolerances between signal pads.
  - E. Maximum stencil thickness 0,1016 mm (4 mils). All linear dimensions are in millimeters.
  - F. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC 7525 for stencil design considerations.
  - G. Over-printing land for larger area ratio is not advised due to land width and bridging potential. Exercise extreme caution.
  - H. Suggest stencils cut with lasers such as Fiber Laser that produce the greatest positional accuracy.
  - I. Component placement force should be minimized to prevent excessive paste block deformation.

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