

# TXU0304 4 ビット固定方向電圧レベル・トランスレータ、シュミット・トリガ入力、3 ステート出力

## 1 特長

- 完全に構成可能なデュアル・レール設計により、各ポートは 1.1V~5.5V で動作可能
- 3.3V~5.0V で最高 200Mbps をサポート
- シュミット・トリガ入力により低速またはノイズの多い入力に対応
- 入りに静的プルダウン抵抗を内蔵することで、チャンネルがフローティングになることを防止
- 高い駆動強度 (5V で最大 12mA)
- 低消費電力
  - 最大 2.5 $\mu$ A (25°C)
  - 最大 6 $\mu$ A (-40°C~125°C)
- V<sub>CC</sub> 絶縁および V<sub>CC</sub> 切断 (I<sub>off-float</sub>) 機能
  - どちらかの V<sub>CC</sub> 入力を 100mV 未満に下げる、または切り離すと、すべての出力が無効化され高インピーダンス化
- I<sub>off</sub> により部分的パワーダウン・モードでの動作をサポート
- 制御ロジック (OE) に V<sub>CC(MIN)</sub> 回路を備えているため、A ポートと B ポートのどちら側からも制御可能
- TXB ファミリのレベル・シフトとピン互換
- 一般的なアプリケーションをサポートする他のバリエーションで使用可能: TXU0104、TXU0204
- 動作温度範囲: -40°C~+125°C
- JESD 78、Class II 準拠で 100mA 超のラッチアップ性能
- JESD 22 を超える ESD 保護
  - 人体モデルで 2500V
  - 荷電デバイス・モデルで 1500V

## 2 アプリケーション

- 低速またはノイズの多い入力信号の除去
- インジケータ LED またはブザーの駆動
- メカニカル・スイッチのデバウンス
- 汎用 I/O レベル・シフト
- プッシュプル・レベル・シフト (UART、SPI、JTAG など)

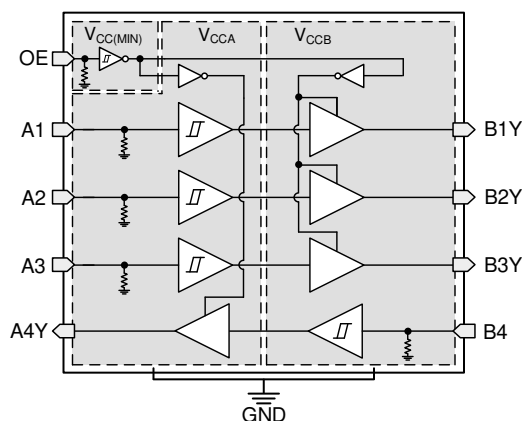
## 3 概要

TXU0304 は、4 ビット、2 電源の非反転固定方向電圧レベル変換デバイスです。Ax ピンは V<sub>CCA</sub> ロジック・レベルを基準にし、OE ピンは V<sub>CCA</sub> ロジック・レベルと V<sub>CCB</sub> ロジック・レベルのいずれかを基準にでき、Bx ピンは V<sub>CCB</sub> ロジック・レベルを基準にします。A ポートは 1.1V~5.5V の範囲の入力電圧を受け入れることができ、B ポートも 1.1V~5.5V の入力電圧を受け付けることができます。OE がどちらかの電源を基準として HIGH に設定されているとき、固定方向のデータ伝送が A から B、または B から A へ発生することがあります。OE を LOW に設定すると、すべての出力ピンは高インピーダンス状態になります。制御ロジックの動作の概要については、「デバイスの機能モード」を参照してください。

### 製品情報<sup>(1)</sup>

部品番号	パッケージ	本体サイズ (公称)
TXU0304BQA	VQFN (14)	3.00mm × 2.50mm
TXU0304PW	TSSOP (14)	5.00mm × 4.40mm
TXU0304RUT	UQFN (12)	2.00mm × 1.70mm
TXU0304DTR	X2SON (12)	1.70mm × 1.00mm

(1) 利用可能なすべてのパッケージについては、このデータシートの末尾にある注文情報を参照してください。



TXU0304 機能ブロック図



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## 4 Revision History

資料番号末尾の英字は改訂を表しています。その改訂履歴は英語版に準じています。

Changes from Revision * (May 2021) to Revision A (October 2021)	Page
• TXU0304BQA、TXU0304RUT、TXU0304DTR デバイスのステータスを製品プレビューから 量産データに変更 ....	1

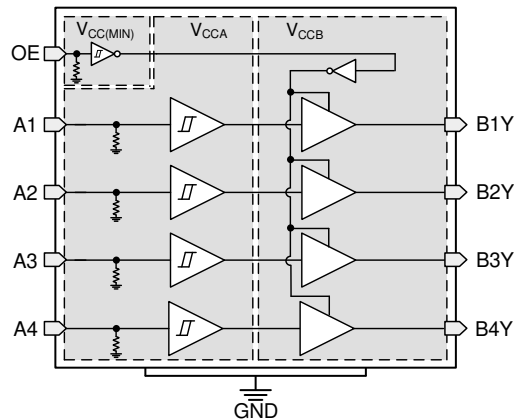
## 5 Related Products

### TXU0x04 4-Bit Unidirectional Voltage-Level Translators

TXU0x04 are 4-bit, dual-supply noninverting fixed direction voltage level translators. These devices are compatible to the TXB0104 with the same pinout allowing for a drop in replacement. The OE pin can be referenced to either  $V_{CCA}$  or  $V_{CCB}$  logic levels allowing for one of the TXU0x04 devices to be used for fixed direction, high drive applications which the TXB0104 is not recommended to support.

### TXU0104

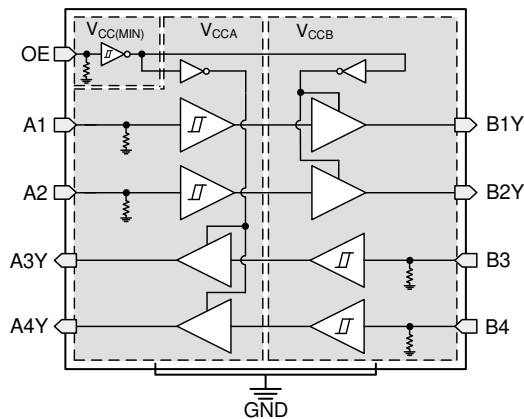
TXU0104 is a 4-bit, dual-supply noninverting fixed direction voltage level translators with all 4 channels in the same direction commonly used for GPIO translation.



5-1. TXU0104 Functional Block Diagram

### TXU0204

TXU0204 is a 4-bit, dual-supply noninverting fixed direction voltage level translators with 2 channels in the opposing direction commonly used for GPIO, UART, and JTAG translation.



5-2. TXU0204 Functional Block Diagram

## 6 Pin Configuration and Functions—TXU0304

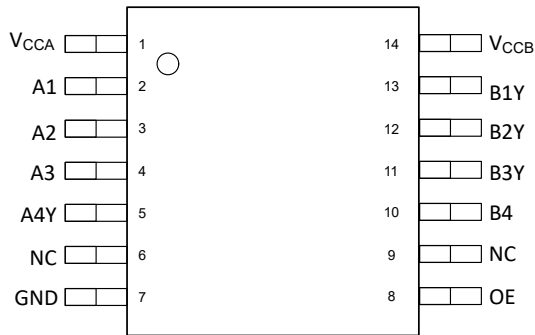


图 6-1. PW 14-Pin TSSOP Top View

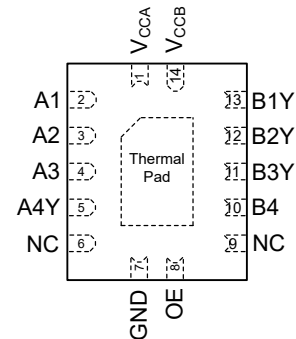


图 6-2. BQA Package 14-Pin VQFN Transparent Top View

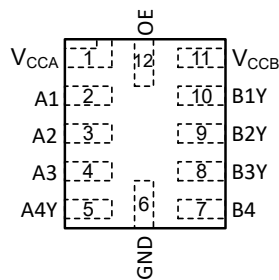


图 6-3. RUT Package 12-Pin UQFN Transparent Top View

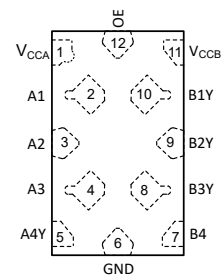


图 6-4. DTR Package 12-Pin X2SON Transparent Top View

表 6-1. TXU0304 Pin Functions

Name	PIN		I/O	DESCRIPTION
	PW, BQA	RUT, DTR		
A1	2	2	I	Input A1. Referenced to $V_{CCA}$ .
A2	3	3	I	Input A2. Referenced to $V_{CCA}$ .
A3	4	4	I	Input A3. Referenced to $V_{CCA}$ .
A4Y	5	5	O	Output A4. Referenced to $V_{CCA}$ .
B1Y	13	10	O	Output B1. Referenced to $V_{CCB}$ .
B2Y	12	9	O	Output B2. Referenced to $V_{CCB}$ .
B3Y	11	8	O	Output B3. Referenced to $V_{CCB}$ .
B4	10	7	I	Input B4. Referenced to $V_{CCB}$ .
GND	7	6	—	Ground
NC	6, 9		—	No internal connection.
OE	8	12	I	Output Enable. Pull to GND to place all outputs in high-impedance mode. Pull to $V_{CCA}$ or $V_{CCB}$ to enable all outputs.
$V_{CCA}$	1	1	—	A-port supply voltage. $1.1\text{ V} \leq V_{CCA} \leq 5.5\text{ V}$
$V_{CCB}$	14	11	—	B-port supply voltage. $1.1\text{ V} \leq V_{CCB} \leq 5.5\text{ V}$
PAD	—		—	Thermal pad. May be grounded (recommended) or left floating.

## 7 Specifications

### 7.1 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	6.5	V
V <sub>CCB</sub>	Supply voltage B		-0.5	6.5	V
V <sub>I</sub>	Input Voltage <sup>(2)</sup>	I/O Ports (A Port)	-0.5	6.5	V
		I/O Ports (B Port)	-0.5	6.5	
		OE	-0.5	6.5	
V <sub>O</sub>	Voltage applied to any output in the high-impedance or power-off state <sup>(2)</sup>	A Port	-0.5	6.5	V
		B Port	-0.5	6.5	
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> + 0.5	V
		B Port	-0.5	V <sub>CCB</sub> + 0.5	
I <sub>IK</sub>	Input clamp current	V <sub>I</sub> < 0	-20		mA
I <sub>OK</sub>	Output clamp current	V <sub>O</sub> < 0	-20		mA
I <sub>O</sub>	Continuous output current		-25	25	mA
	Continuous current through V <sub>CC</sub> or GND		-100	100	
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 beyond the limits listed in *Recommended Operating Conditions* 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 6.5 V maximum if the output current rating is observed.

### 7.2 ESD Ratings

			VALUE	UNIT
V <sub>(ESD)</sub>	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>	±2500	V
		Charged device model (CDM), per ANSI/ESDA/JEDEC JS-002 <sup>(2)</sup>	±1500	

- (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.

### 7.3 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	1.08	5.5	V	
V <sub>CCB</sub>	Supply voltage B	1.08	5.5	V	
I <sub>OH</sub>	High-level output current	V <sub>CCO</sub> = 1.1 V	-1.5	mA	
		V <sub>CCO</sub> = 1.4 V	-3		
		V <sub>CCO</sub> = 1.65 V	-4.5		
		V <sub>CCO</sub> = 2.3 V	-8		
		V <sub>CCO</sub> = 3 V	-10		
		V <sub>CCO</sub> = 4.5 V	-12		
I <sub>OL</sub>	Low-level output current	V <sub>CCO</sub> = 1.1 V	1.5	mA	
		V <sub>CCO</sub> = 1.4 V	3		
		V <sub>CCO</sub> = 1.65 V	4.5		
		V <sub>CCO</sub> = 2.3 V	8		
		V <sub>CCO</sub> = 3 V	10		
		V <sub>CCO</sub> = 4.5 V	12		
V <sub>I</sub>	Input voltage <sup>(3)</sup>	0	5.5	V	
V <sub>O</sub>	Output voltage	Active State	0	V <sub>CCO</sub>	V
		Tri-State	0	5.5	
T <sub>A</sub>	Operating free-air temperature	-40	125	°C	

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

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

(3) All control inputs and data I/Os of this device have weak pulldowns to ensure the line is not floating when undefined external to the device. The input leakage from these weak pulldowns is defined by the I<sub>I</sub> specification indicated under [Electrical Characteristics](#).

### 7.4 Thermal Information

THERMAL METRIC <sup>(1)</sup>		TXU0304				UNIT
		PW (TSSOP)	BQA (WQFN)	RUT (UQFN)	DTR (X2SON)	
		14 PINS	14 PINS	12 PINS	12 PINS	
R <sub>θJA</sub>	Junction-to-ambient thermal resistance	135.8	87.2	171.9	176.6	°C/W
R <sub>θJC(top)</sub>	Junction-to-case (top) thermal resistance	65.0	90.0	100.4	84.1	°C/W
R <sub>θJB</sub>	Junction-to-board thermal resistance	78.8	56.0	97.1	99.1	°C/W
Y <sub>JT</sub>	Junction-to-top characterization parameter	15.6	9.8	10.9	2.6	°C/W
Y <sub>JB</sub>	Junction-to-board characterization parameter	78.2	56.0	95.5	98.9	°C/W
R <sub>θJC(bottom)</sub>	Junction-to-case (bottom) thermal resistance	N/A	33.0	N/A	N/A	°C/W

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

## 7.5 Electrical Characteristics

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

PARAMETER	TEST CONDITIONS	V <sub>CCA</sub>	V <sub>CCB</sub>	Operating free-air temperature (T <sub>A</sub> )						UNIT	
				25°C			–40°C to 85°C		–40°C to 125°C		
				MIN	TYP	MAX	MIN	TYP	MAX		MIN
V <sub>T+</sub>	Positive-going input-threshold voltage	Data Inputs (Ax, Bx) (Referenced to V <sub>CCI</sub> )	1.1 V	1.1 V		0.44	0.88	0.44	0.88	V	
			1.4 V	1.4 V		0.60	0.98	0.60	0.98		
			1.65 V	1.65 V		0.76	1.13	0.76	1.13		
			2.3 V	2.3 V		1.08	1.56	1.08	1.56		
			3 V	3 V		1.48	1.92	1.48	1.92		
			4.5 V	4.5 V		2.19	2.74	2.19	2.74		
			5.5 V	5.5 V		2.65	3.33	2.65	3.33		
		OE (Referenced to V <sub>CCA</sub> or V <sub>CCB</sub> )	1.1 V	1.1 V		0.44	0.88	0.44	0.88	V	
			1.4 V	1.4 V		0.60	0.98	0.60	0.98		
			1.65 V	1.65 V		0.76	1.13	0.76	1.13		
			2.3 V	2.3 V		1.08	1.56	1.08	1.56		
			3 V	3 V		1.48	1.92	1.48	1.92		
			4.5 V	4.5 V		2.19	2.74	2.19	2.74		
			5.5 V	5.5 V		2.65	3.33	2.65	3.33		
V <sub>T-</sub>	Negative-going input-threshold voltage	Data Inputs (Ax, Bx) (Referenced to V <sub>CCI</sub> )	1.1 V	1.1 V		0.17	0.48	0.17	0.48	V	
			1.4 V	1.4 V		0.28	0.59	0.28	0.59		
			1.65 V	1.65 V		0.35	0.69	0.35	0.69		
			2.3 V	2.3 V		0.56	0.97	0.56	0.97		
			3 V	3 V		0.89	1.5	0.89	1.5		
			4.5 V	4.5 V		1.51	1.97	1.51	1.97		
			5.5 V	5.5 V		1.88	2.4	1.88	2.4		
		OE (Referenced to V <sub>CCA</sub> or V <sub>CCB</sub> )	1.1 V	1.1 V		0.17	0.48	0.17	0.48	V	
			1.4 V	1.4 V		0.28	0.59	0.28	0.59		
			1.65 V	1.65 V		0.35	0.69	0.35	0.69		
			2.3 V	2.3 V		0.56	0.97	0.56	0.97		
			3 V	3 V		0.89	1.5	0.89	1.5		
			4.5 V	4.5 V		1.51	1.97	1.51	1.97		
			5.5 V	5.5 V		1.88	2.46	1.88	2.46		
ΔV <sub>T</sub>	Input-threshold hysteresis (V <sub>T+</sub> – V <sub>T-</sub> )	Data Inputs (Ax, Bx) (Referenced to V <sub>CCI</sub> )	1.1 V	1.1 V		0.2	0.4	0.2	0.4	V	
			1.4 V	1.4 V		0.25	0.5	0.25	0.5		
			1.65 V	1.65 V		0.3	0.55	0.3	0.55		
			2.3 V	2.3 V		0.38	0.65	0.38	0.65		
			3 V	3 V		0.46	0.72	0.46	0.72		
			4.5 V	4.5 V		0.58	0.93	0.58	0.93		
			5.5 V	5.5 V		0.69	1.06	0.69	1.06		
		OE (Referenced to V <sub>CCA</sub> or V <sub>CCB</sub> )	1.1 V	1.1 V		0.15	0.41	0.15	0.41	V	
			1.4 V	1.4 V		0.2	0.5	0.2	0.5		
			1.65 V	1.65 V		0.23	0.55	0.23	0.55		
			2.3 V	2.3 V		0.32	0.65	0.32	0.65		
			3 V	3 V		0.39	0.72	0.39	0.72		
			4.5 V	4.5 V		0.57	0.97	0.57	0.97		
			5.5 V	5.5 V		0.69	1.18	0.69	1.18		

## 7.5 Electrical Characteristics (continued)

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

PARAMETER	TEST CONDITIONS	V <sub>CCA</sub>	V <sub>CCB</sub>	Operating free-air temperature (T <sub>A</sub> )									UNIT
				25°C			-40°C to 85°C			-40°C to 125°C			
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V <sub>OH</sub>	High-level output voltage <sup>(3)</sup>	I <sub>OH</sub> = -0.1 mA	1.1V – 5.5V	1.1V – 5.5V				V <sub>CCO</sub> - 0.1			V <sub>CCO</sub> - 0.1	V	
		I <sub>OH</sub> = -0.5 mA	1.1 V	1.1 V				0.82			0.82		
		I <sub>OH</sub> = -3 mA	1.4 V	1.4 V				1			1		
		I <sub>OH</sub> = -4.5 mA	1.65 V	1.65 V				1.2			1.2		
		I <sub>OH</sub> = -8 mA	2.3 V	2.3 V				1.7			1.7		
		I <sub>OH</sub> = -10 mA	3 V	3 V				2.2			2.2		
		I <sub>OH</sub> = -12 mA	4.5 V	4.5 V				3.7			3.7		
V <sub>OL</sub>	Low-level output voltage <sup>(4)</sup>	I <sub>OL</sub> = 0.1 mA	1.1V – 5.5V	1.1V – 5.5V					0.1		0.1	V	
		I <sub>OL</sub> = 0.5 mA	1.1 V	1.1 V					0.27		0.27		
		I <sub>OL</sub> = 3 mA	1.4 V	1.4 V					0.35		0.35		
		I <sub>OL</sub> = 4.5 mA	1.65 V	1.65 V					0.45		0.45		
		I <sub>OL</sub> = 8 mA	2.3 V	2.3 V					0.7		0.7		
		I <sub>OL</sub> = 10 mA	3 V	3 V					0.8		0.8		
		I <sub>OL</sub> = 12 mA	4.5 V	4.5 V					0.8		0.8		
I <sub>I</sub>	Input leakage current	OE V <sub>I</sub> = V <sub>CC</sub> or GND	1.1V – 5.5V	1.1V – 5.5V	-0.1	1.5	-0.1	1.5	-0.1	2	μA		
		Data Inputs (A <sub>x</sub> , B <sub>x</sub> ) V <sub>I</sub> = V <sub>CC1</sub> or GND	1.1V – 5.5V	1.1V – 5.5V	-0.1	1.5	-0.1	1.5	-2	2	μA		
I <sub>off</sub>	Partial power down current	A Port or B Port V <sub>I</sub> or V <sub>O</sub> = 0 V - 5.5 V	0 V	0 V - 5.5 V	-1.5	1.5	-2	2	-2.5	2.5	μA		
			0 V - 5.5 V	0 V	-1.5	1.5	-2	2	-2.5	2.5			
I <sub>off-float</sub>	Floating supply Partial power down current	A Port or B Port V <sub>I</sub> or V <sub>O</sub> = GND	Floating <sup>(5)</sup>	0 V - 5.5 V	-1.5	1.5	-2	2	-2.5	2.5	μA		
			0 V - 5.5 V	Floating <sup>(5)</sup>	-1.5	1.5	-2	2	-2.5	2.5			
I <sub>OZ</sub>	Tri-state output current	A or B Port: V <sub>I</sub> = V <sub>CC1</sub> or GND V <sub>O</sub> = V <sub>CCO</sub> or GND OE = GND	1.1V – 5.5V	1.1V – 5.5V	-0.3	0.3	-1	1	-2	2	μA		
I <sub>CCA</sub>	V <sub>CCA</sub> supply current	V <sub>I</sub> = V <sub>CC1</sub> or GND I <sub>O</sub> = 0	1.1V – 5.5V	1.1V – 5.5V		1.5		2.5		6	μA		
			0 V	5.5 V	-0.3		-1		-1				
			5.5 V	0 V		1		1.5		3			
I <sub>CCB</sub>	V <sub>CCB</sub> supply current	V <sub>I</sub> = V <sub>CC1</sub> or GND I <sub>O</sub> = 0	1.1V – 5.5V	1.1V – 5.5V		1.5		2.5		6	μA		
			0 V	5.5 V		1		1.5		3			
			5.5 V	0 V	-0.3		-1		-1				
I <sub>CCA</sub> + I <sub>CCB</sub>	Combined supply current	V <sub>I</sub> = V <sub>CC1</sub> or GND I <sub>O</sub> = 0	1.1V – 5.5V	1.1V – 5.5V		2.5		3		6	μA		
			Floating <sup>(5)</sup>	5.5 V		1.5		7		15			
C <sub>i</sub>	Control Input Capacitance	V <sub>I</sub> = 3.3 V or GND	3.3 V	3.3 V		2.75		3		3.5	pF		



## 7.5 Electrical Characteristics (continued)

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

PARAMETER	TEST CONDITIONS	V <sub>CCA</sub>	V <sub>CCB</sub>	Operating free-air temperature (T <sub>A</sub> )									UNIT	
				25°C			-40°C to 85°C			-40°C to 125°C				
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX		
C <sub>io</sub>	Data I/O Capacitance	OE = GND, V <sub>O</sub> = 1.65V DC +1 MHz -16 dBm sine wave	3.3 V	3.3 V	3			4			4			pF

- (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) Tested at V<sub>I</sub> = V<sub>T+(MAX)</sub>
- (4) Tested at V<sub>I</sub> = V<sub>T-(MIN)</sub>
- (5) Floating is defined as a node that is both not actively driven by an external device and has leakage not exceeding 10nA

## 7.6 Switching Characteristics: T<sub>sk</sub>, T<sub>MAX</sub>

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

PARAMETER	TEST CONDITIONS	V <sub>CCI</sub>	V <sub>CCO</sub>	Operating free-air temperature (T <sub>A</sub> )			UNIT	
				-40°C to 125°C				
				MIN	TYP	MAX		
T <sub>MAX</sub> - Maximum Data Rate	50% Duty Cycle Input One channel switching 20% of pulse > 0.7*V <sub>CCO</sub> 20% of pulse < 0.3*V <sub>CCO</sub>	Up Translation	3.0 V - 3.6 V	4.5 V - 5.5 V	200			Mbps
			1.65 V - 1.95 V	4.5 V - 5.5 V	150			
			1.1 V - 1.3 V	4.5 V - 5.5 V	30			
			1.65 V - 1.95 V	3.0 V - 3.6 V	100			
			1.1 V - 1.3 V	3.0 V - 3.6 V	30			
			1.1 V - 1.3 V	1.65 V - 1.95 V	20			
		Down Translation	4.5 V - 5.5 V	3.0 V - 3.6 V	125			
			4.5 V - 5.5 V	1.65 V - 1.95 V	50			
			4.5 V - 5.5 V	1.1 V - 1.3 V	10			
			3.0 V - 3.6 V	1.65 V - 1.95 V	50			
			3.0 V - 3.6 V	1.1 V - 1.3 V	10			
			1.65 V - 1.95 V	1.1 V - 1.3 V	10			
t <sub>sk</sub> - Output skew	Timing skew between any switching outputs on the rising or falling edge	Up Translation	3.0 V - 3.6 V	4.5 V - 5.5 V	3			ns
			1.65 V - 1.95 V	4.5 V - 5.5 V	10			
			1.1 V - 1.3 V	4.5 V - 5.5 V	42			
			1.65 V - 1.95 V	3.0 V - 3.6 V	8			
			1.1 V - 1.3 V	3.0 V - 3.6 V	42			
			1.1 V - 1.3 V	1.65 V - 1.95 V	45			
		Down Translation	4.5 V - 5.5 V	3.0 V - 3.6 V	3			
			4.5 V - 5.5 V	1.65 V - 1.95 V	10			
			4.5 V - 5.5 V	1.1 V - 1.3 V	42			
			3.0 V - 3.6 V	1.65 V - 1.95 V	8			
			3.0 V - 3.6 V	1.1 V - 1.3 V	42			
			1.65 V - 1.95 V	1.1 V - 1.3 V	45			

## 7.7 Switching Characteristics, $V_{CCA} = 1.2 \pm 0.1 \text{ V}$

See [图 8-1](#) and [表 8-1](#) for test circuit and loading. See [图 8-2](#), [图 8-3](#), and [图 8-4](#) for measurement waveforms.

PARAMETER	FROM	TO	Test Conditions	B-Port Supply Voltage ( $V_{CCB}$ )												UNIT						
				$1.2 \pm 0.1 \text{ V}$			$1.5 \pm 0.1 \text{ V}$			$1.8 \pm 0.15 \text{ V}$			$2.5 \pm 0.2 \text{ V}$				$3.3 \pm 0.3 \text{ V}$			$5.0 \pm 0.5 \text{ V}$		
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX		MIN	TYP	MAX	MIN	TYP	MAX
$t_{pd}$	Propagation delay	A	B	-40°C to 85°C	3.3	96	0.5	43	0.5	37	0.5	32	0.5	30	0.5	31	ns					
				-40°C to 125°C	5.7	60	3.0	39	1.4	33	0.5	28	0.5	27	0.5	26						
		B	A	-40°C to 85°C	3.3	95	1.9	80	0.5	75	0.5	70	0.5	69	0.5	69						
				-40°C to 125°C	5.7	60	4.1	51	2.9	48	1.8	45	1.5	44	1.3	44						
$t_{dis}$	Disable time	OE	A	-40°C to 85°C	28.8	133	28.5	130	28.4	133	28.8	137	28.4	143	18.7	211	ns					
				-40°C to 125°C	43.3	133	43.3	130	43.7	130	44.7	131	45.4	134	31.8	140						
		OE	B	-40°C to 85°C	32.5	150	27.6	117	25.8	110	22.5	104	22.1	112	20.1	181						
				-40°C to 125°C	48.3	149	43.2	120	40.8	113	36.8	104	36.5	107	33.8	111						
$t_{en}$	Enable time	OE	A	-40°C to 85°C	24.1	237	22.1	229	21.4	230	21.3	232	21.7	235	22.7	244	ns					
				-40°C to 125°C	34.9	156	33.3	167	32.0	169	31.7	173	32.0	177	34.2	187						
		OE	B	-40°C to 85°C	21.3	237	14.3	152	11.2	140	8.8	130	8.2	130	8.4	132						
				-40°C to 125°C	29.8	143	23.0	116	18.6	107	15.4	97	14.5	97	14.8	103						

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

See [图 8-1](#) and [表 8-1](#) for test circuit and loading. See [图 8-2](#), [图 8-3](#), and [图 8-4](#) for measurement waveforms.

PARAMETER	FROM	TO	Test Conditions	B-Port Supply Voltage ( $V_{CCB}$ )												UNIT						
				$1.2 \pm 0.1 \text{ V}$			$1.5 \pm 0.1 \text{ V}$			$1.8 \pm 0.15 \text{ V}$			$2.5 \pm 0.2 \text{ V}$				$3.3 \pm 0.3 \text{ V}$			$5.0 \pm 0.5 \text{ V}$		
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX		MIN	TYP	MAX	MIN	TYP	MAX
$t_{pd}$	Propagation delay	A	B	-40°C to 85°C	1.9	80	0.5	31	0.5	25	0.5	19	0.5	17	0.5	15	ns					
				-40°C to 125°C	4.1	51	1.6	31	0.5	25	0.5	20	0.5	18	0.5	16						
		B	A	-40°C to 85°C	0.5	43	0.5	31	0.5	28	0.5	26	0.5	25	0.5	24						
				-40°C to 125°C	3.0	39	1.6	31	0.5	28	0.5	26	0.5	25	0.5	24						
$t_{dis}$	Disable time	OE	A	-40°C to 85°C	20.0	91	19.0	82	18.8	81	19.2	82	19.6	83	12.2	87	ns					
				-40°C to 125°C	34.9	95	32.6	86	32.8	85	33.4	87	34.2	88	24.6	92						
		OE	B	-40°C to 85°C	27.4	127	21.7	91	19.9	82	16.3	71	15.9	71	13.7	70						
				-40°C to 125°C	44.4	130	36.7	95	34.7	86	30.2	75	29.8	75	26.6	74						
$t_{en}$	Enable time	OE	A	-40°C to 85°C	14.9	102	14.4	86	13.5	88	12.7	90	12.6	92	13.2	97	ns					
				-40°C to 125°C	25.5	102	25.2	89	24.1	91	22.8	93	22.8	96	23.5	100						
		OE	B	-40°C to 85°C	17.9	175	12.7	80	9.1	69	6.1	57	4.9	53	4.5	54						
				-40°C to 125°C	26.6	135	21.0	81	16.8	71	12.5	60	10.8	56	10.4	57						

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

See [图 8-1](#) and [表 8-1](#) for test circuit and loading. See [图 8-2](#), [图 8-3](#), and [图 8-4](#) for measurement waveforms.

PARAMETER	FROM	TO	Test Conditions	B-Port Supply Voltage ( $V_{CCB}$ )												UNIT						
				$1.2 \pm 0.1 \text{ V}$			$1.5 \pm 0.1 \text{ V}$			$1.8 \pm 0.15 \text{ V}$			$2.5 \pm 0.2 \text{ V}$				$3.3 \pm 0.3 \text{ V}$			$5.0 \pm 0.5 \text{ V}$		
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX		MIN	TYP	MAX	MIN	TYP	MAX
$t_{pd}$	Propagation delay	A	B	-40°C to 85°C	0.5	75	0.5	28	0.5	22	0.5	17	0.5	14	0.5	12	ns					
				-40°C to 125°C	2.9	48	0.5	28	0.5	23	0.5	17	0.5	15	0.5	13						
		B	A	-40°C to 85°C	0.5	37	0.5	25	0.5	22	0.5	19	0.5	19	0.5	18						
				-40°C to 125°C	1.4	33	0.5	25	0.5	23	0.5	20	0.5	19	0.5	19						
$t_{dis}$	Disable time	OE	A	-40°C to 85°C	17.2	79	14.7	67	14.5	65	14.3	65	14.4	66	8.5	68	ns					
				-40°C to 125°C	30.9	83	28.0	71	26.6	69	27.5	70	27.2	71	20.0	73						
		OE	B	-40°C to 85°C	25.4	121	18.7	81	16.5	71	12.8	60	12.5	58	9.8	55						
				-40°C to 125°C	41.7	123	34.0	86	30.3	76	26.2	64	25.3	62	21.8	59						
$t_{en}$	Enable time	OE	A	-40°C to 85°C	10.9	88	9.5	66	9.4	63	8.6	65	8.2	66	8.1	69	ns					
				-40°C to 125°C	20.3	87	19.0	69	18.9	67	17.6	68	17.1	70	17.1	73						
		OE	B	-40°C to 85°C	16.7	177	10.4	75	8.1	58	4.9	46	3.3	42	2.2	39						
				-40°C to 125°C	25.1	135	18.7	77	15.5	60	11.0	49	8.7	44	7.3	42						

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

See [图 8-1](#) and [表 8-1](#) for test circuit and loading. See [图 8-2](#), [图 8-3](#), and [图 8-4](#) for measurement waveforms.

PARAMETER	FROM	TO	Test Conditions	B-Port Supply Voltage ( $V_{CCB}$ )												UNIT						
				$1.2 \pm 0.1 \text{ V}$			$1.5 \pm 0.1 \text{ V}$			$1.8 \pm 0.15 \text{ V}$			$2.5 \pm 0.2 \text{ V}$				$3.3 \pm 0.3 \text{ V}$			$5.0 \pm 0.5 \text{ V}$		
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX		MIN	TYP	MAX	MIN	TYP	MAX
$t_{pd}$	Propagation delay	A	B	-40°C to 85°C	0.5	70	0.5	26	0.5	20	0.5	14	0.5	12	0.5	9	ns					
				-40°C to 125°C	1.8	45	0.5	26	0.5	20	0.5	14	0.5	12	0.5	10						
		B	A	-40°C to 85°C	0.5	32	0.5	19	0.5	17	0.5	14	0.5	13	0.5	13						
				-40°C to 125°C	0.5	28	0.5	20	0.5	17	0.5	14	0.5	13	0.5	13						
$t_{dis}$	Disable time	OE	A	-40°C to 85°C	12.9	65	10.5	51	9.0	51	8.1	43	8.4	44	5.0	45	ns					
				-40°C to 125°C	24.9	68	21.8	55	19.7	50	18.2	47	18.6	48	15.0	49						
		OE	B	-40°C to 85°C	23.2	112	16.5	74	14.0	61	9.0	46	9.1	44	6.4	39						
				-40°C to 125°C	38.7	115	30.9	79	27.1	66	21.6	51	20.5	48	16.8	43						
$t_{en}$	Enable time	OE	A	-40°C to 85°C	7.9	80	5.9	50	5.1	44	4.7	39	4.4	40	3.7	41	ns					
				-40°C to 125°C	15.6	74	13.5	53	12.4	47	12.0	42	11.5	43	10.8	44						
		OE	B	-40°C to 85°C	16.3	183	9.2	74	6.0	54	4.0	36	2.1	31	0.5	27						
				-40°C to 125°C	24.4	139	17.2	76	13.0	57	9.8	38	7.1	33	4.7	29						

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

See [Figure 8-1](#) and [Table 8-1](#) for test circuit and loading. See [Figure 8-2](#), [Figure 8-3](#), and [Figure 8-4](#) for measurement waveforms.

PARAMETER		FROM	TO	Test Conditions	B-Port Supply Voltage ( $V_{CCB}$ )												UNIT						
					$1.2 \pm 0.1 \text{ V}$			$1.5 \pm 0.1 \text{ V}$			$1.8 \pm 0.15 \text{ V}$			$2.5 \pm 0.2 \text{ V}$				$3.3 \pm 0.3 \text{ V}$			$5.0 \pm 0.5 \text{ V}$		
					MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX		MIN	TYP	MAX	MIN	TYP	MAX
$t_{pd}$	Propagation delay	A	B	-40°C to 85°C	0.5	69	0.5	25	0.5	19	0.5	13	0.5	11	0.5	8	ns						
				-40°C to 125°C	1.5	44	0.5	25	0.5	19	0.5	13	0.5	11	0.5	9							
		B	A	-40°C to 85°C	0.5	30	0.5	17	0.5	14	0.5	12	0.5	11	0.5	10							
				-40°C to 125°C	0.5	27	0.5	18	0.5	15	0.5	12	0.5	11	0.5	10							
$t_{dis}$	Disable time	OE	A	-40°C to 85°C	12.9	62	10.1	47	8.7	42	6.9	39	6.6	39	6.9	40	ns						
				-40°C to 125°C	24.0	65	20.6	51	18.4	46	15.7	40	15.3	39	15.9	40							
		OE	B	-40°C to 85°C	22.7	109	15.7	71	13.2	59	8.5	42	7.6	38	4.7	34							
				-40°C to 125°C	37.6	111	29.5	75	25.4	63	19.2	46	18.5	42	14.2	36							
$t_{en}$	Enable time	OE	A	-40°C to 85°C	6.6	85	4.2	45	3.0	37	2.4	31	2.2	30	1.7	30	ns						
				-40°C to 125°C	13.6	72	10.9	47	9.3	40	8.2	33	8.1	32	7.5	33							
		OE	B	-40°C to 85°C	16.3	192	8.9	76	5.4	55	2.6	34	1.8	27	0.5	22							
				-40°C to 125°C	24.3	144	16.7	78	12.2	57	8.0	36	6.6	29	3.7	24							

## 7.12 Switching Characteristics, $V_{CCA} = 5.0 \pm 0.5 \text{ V}$

See [图 8-1](#) and [表 8-1](#) for test circuit and loading. See [图 8-2](#), [图 8-3](#), and [图 8-4](#) for measurement waveforms.

PARAMETER	FROM	TO	Test Conditions	B-Port Supply Voltage ( $V_{CCB}$ )												UNIT						
				1.2 ± 0.1 V			1.5 ± 0.1 V			1.8 ± 0.15 V			2.5 ± 0.2 V				3.3 ± 0.3 V			5.0 ± 0.5 V		
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX		MIN	TYP	MAX	MIN	TYP	MAX
$t_{pd}$	Propagation delay	A	B	-40°C to 85°C	0.5	69	0.5	24	0.5	18	0.5	13	0.5	10	0.5	8	ns					
				-40°C to 125°C	1.3	44	0.5	24	0.5	19	0.5	13	0.5	11	0.5	8						
		B	A	-40°C to 85°C	0.5	31	0.5	15	0.5	12	0.5	9	0.5	8	0.5	8						
				-40°C to 125°C	0.5	26	0.5	16	0.5	13	0.5	10	0.5	9	0.5	8						
$t_{dis}$	Disable time	OE	A	-40°C to 85°C	10.8	58	7.7	42	5.9	36	4.2	31	3.4	30	2.8	26	ns					
				-40°C to 125°C	20.8	61	17.0	46	14.5	40	11.8	33	10.4	31	9.6	29						
		OE	B	-40°C to 85°C	9.7	109	5.9	69	13.2	56	8.4	40	6.9	36	3.7	29						
				-40°C to 125°C	37.4	111	29.2	73	24.6	60	18.1	43	16.4	39	12.2	31						
$t_{en}$	Enable time	OE	A	-40°C to 85°C	6.0	102	2.8	44	1.2	33	0.5	25	0.5	22	0.5	21	ns					
				-40°C to 125°C	12.4	81	8.8	46	6.5	36	4.7	27	4.2	24	4.4	23						
		OE	B	-40°C to 85°C	16.7	212	8.8	82	4.8	58	1.6	35	0.5	26	0.5	19						
				-40°C to 125°C	24.8	158	16.7	83	11.7	60	6.9	37	4.7	28	3.5	21						

## 7.13 Operating Characteristics

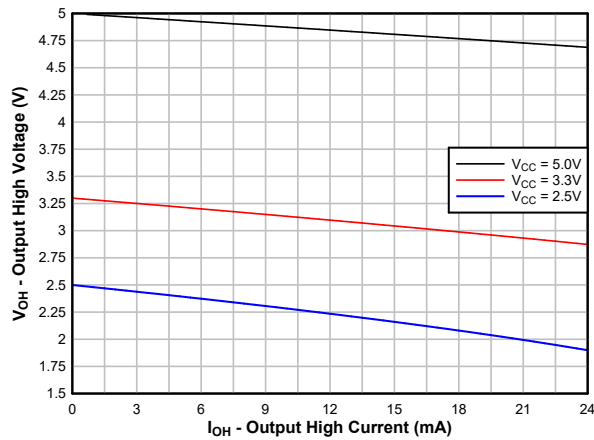
 $T_A = 25^\circ\text{C}$  <sup>(1)</sup>

PARAMETER		Test Conditions	Supply Voltage ( $V_{CCB} = V_{CCA}$ )						UNIT
			1.2 ± 0.1V	1.5 ± 0.1V	1.8 ± 0.15V	2.5 ± 0.2V	3.3 ± 0.3V	5.0 ± 0.5V	
			TYP	TYP	TYP	TYP	TYP	TYP	
$C_{pdA}$ <sup>(2)</sup>	A to B: outputs enabled	A Port CL = 0, RL = Open f = 10 MHz $t_{rise} = t_{fall} = 1$ ns	2	2	2	2	2	3	pF
	A to B: outputs disabled		2	2	2	2	2	3	
	B to A: outputs enabled		12	12	12	13	13	16	
	B to A: outputs disabled		2	2	2	2	2	3	
$C_{pdB}$ <sup>(3)</sup>	A to B: outputs enabled	B Port CL = 0, RL = Open f = 10 MHz $t_{rise} = t_{fall} = 1$ ns	12	12	12	13	13	16	pF
	A to B: outputs disabled		2	2	2	2	2	3	
	B to A: outputs enabled		2	2	2	2	2	3	
	B to A: outputs disabled		2	2	2	2	2	3	

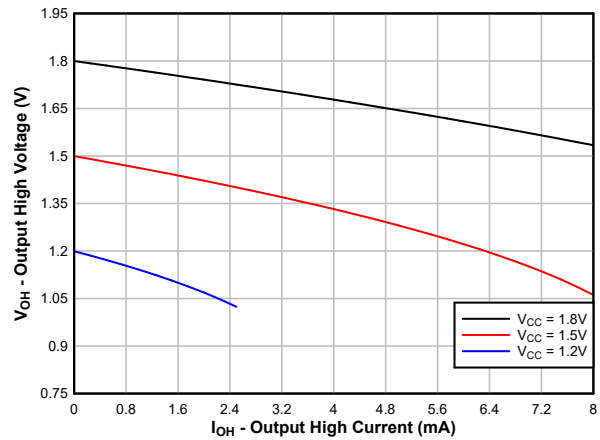
- (1) See the [CMOS Power Consumption and  \$C\_{pd}\$  Calculation](#) application report for additional information about how power dissipation capacitance affects power consumption.
- (2) A-Port power dissipation capacitance per transceiver.
- (3) B-Port power dissipation capacitance per transceiver.



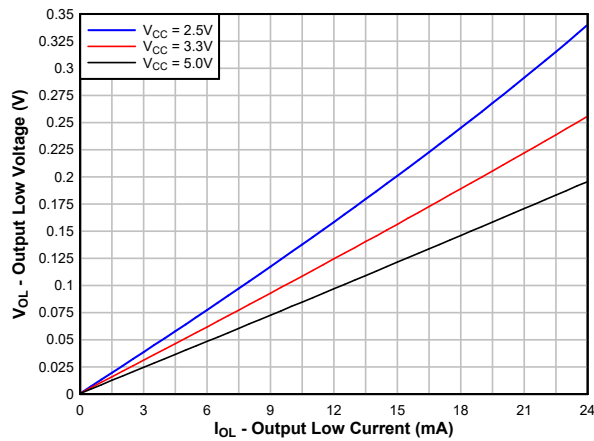
## 7.14 Typical Characteristics



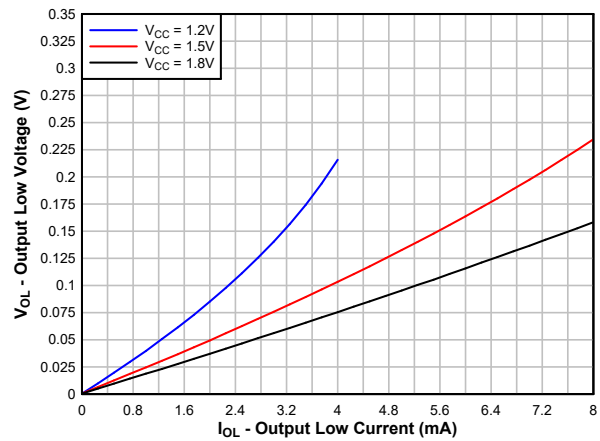
7-1. Typical ( $T_A=25^\circ C$ ) Output High Voltage ( $V_{OH}$ ) vs Source Current ( $I_{OH}$ )



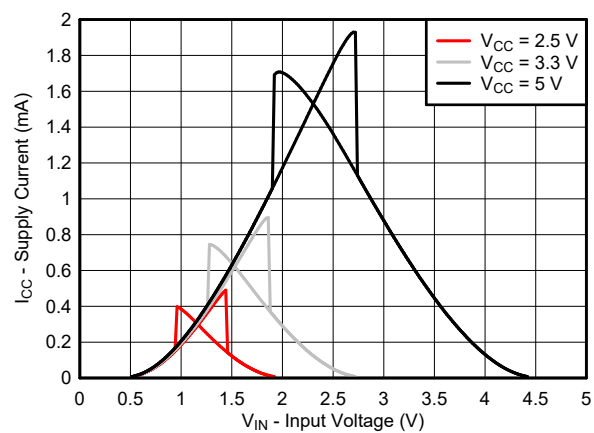
7-2. Typical ( $T_A=25^\circ C$ ) Output High Voltage ( $V_{OH}$ ) vs Source Current ( $I_{OH}$ )



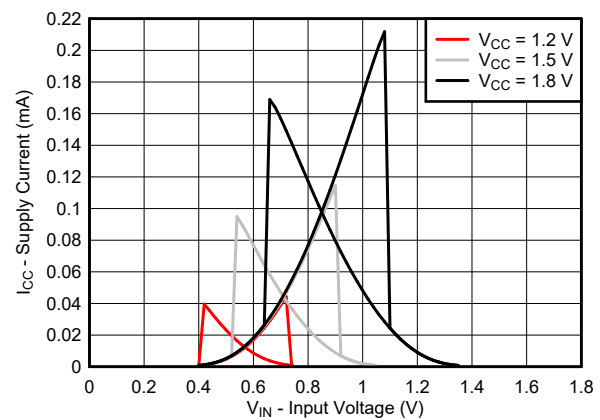
7-3. Typical ( $T_A=25^\circ C$ ) Output Low Voltage ( $V_{OL}$ ) vs Sink Current ( $I_{OL}$ )



7-4. Typical ( $T_A=25^\circ C$ ) Output Low Voltage ( $V_{OL}$ ) vs Sink Current ( $I_{OL}$ )



7-5. Typical ( $T_A=25^\circ C$ ) Supply Current ( $I_{CC}$ ) vs Input Voltage ( $V_{IN}$ )



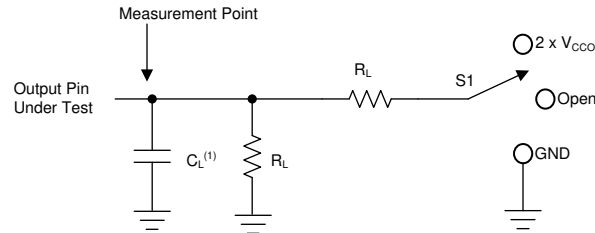
7-6. Typical ( $T_A=25^\circ C$ ) Supply Current ( $I_{CC}$ ) vs Input Voltage ( $V_{IN}$ )

## 8 Parameter Measurement Information

### 8.1 Load Circuit and Voltage Waveforms

Unless otherwise noted, generators supply all input pulses that have the following characteristics:

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

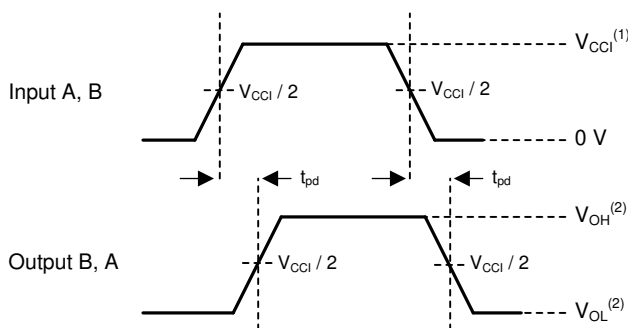


A.  $C_L$  includes probe and jig capacitance.

图 8-1. Load Circuit

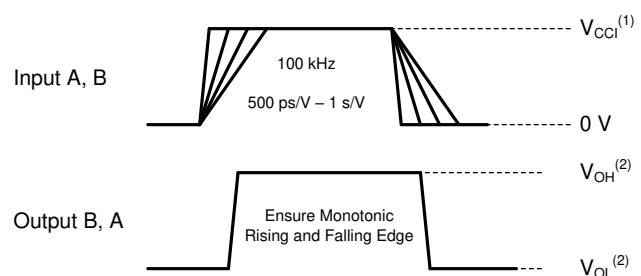
表 8-1. Load Circuit Conditions

Parameter	$V_{CCO}$	$R_L$	$C_L$	$S_1$	$V_{TP}$
$t_{pd}$ Propagation (delay) time	1.1 V – 5.5 V	10 k $\Omega$	5 pF	Open	N/A
$t_{en}, t_{dis}$ Enable time, disable time	1.1 V – 1.6 V	10 k $\Omega$	5 pF	$2 \times V_{CCO}$	0.1 V
	1.65 V – 2.7 V	10 k $\Omega$	5 pF	$2 \times V_{CCO}$	0.15 V
	3.0 V – 5.5 V	10 k $\Omega$	5 pF	$2 \times V_{CCO}$	0.3 V
$t_{en}, t_{dis}$ Enable time, disable time	1.1 V – 1.6 V	10 k $\Omega$	5 pF	GND	0.1 V
	1.65 V – 2.7 V	10 k $\Omega$	5 pF	GND	0.15 V
	3.0 V – 5.5 V	10 k $\Omega$	5 pF	GND	0.3 V



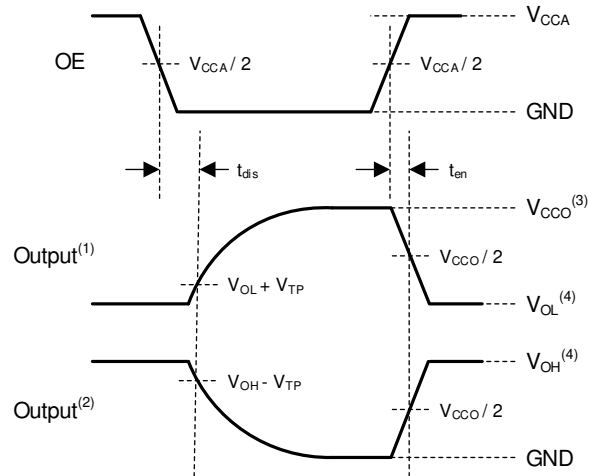
1.  $V_{CCI}$  is the supply pin associated with the input port.
2.  $V_{OH}$  and  $V_{OL}$  are typical output voltage levels that occur with specified  $R_L$ ,  $C_L$ , and  $S_1$

图 8-2. Propagation Delay



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

图 8-3. Input Transition Rise and Fall Rate



1. Output waveform on the condition that input is driven to a valid Logic Low.
2. Output waveform on the condition that input is driven to a valid Logic High.
3.  $V_{CC0}$  is the supply pin associated with the output port.
4.  $V_{OH}$  and  $V_{OL}$  are typical output voltage levels with specified  $R_L$ ,  $C_L$ , and  $S_1$ .

**8-4. Enable Time And Disable Time**

## 9 Detailed Description

### 9.1 Overview

The TXU0304 is a 4-bit translating transceiver that uses two individually configurable power-supply rails. The device is operational with  $V_{CCA}$  and  $V_{CCB}$  supplies as low as 1.1 V and as high as 5.5 V. Additionally, the device can be operated with  $V_{CCA} = V_{CCB}$ . The A port is designed to track  $V_{CCA}$ , and the B port is designed to track  $V_{CCB}$ .

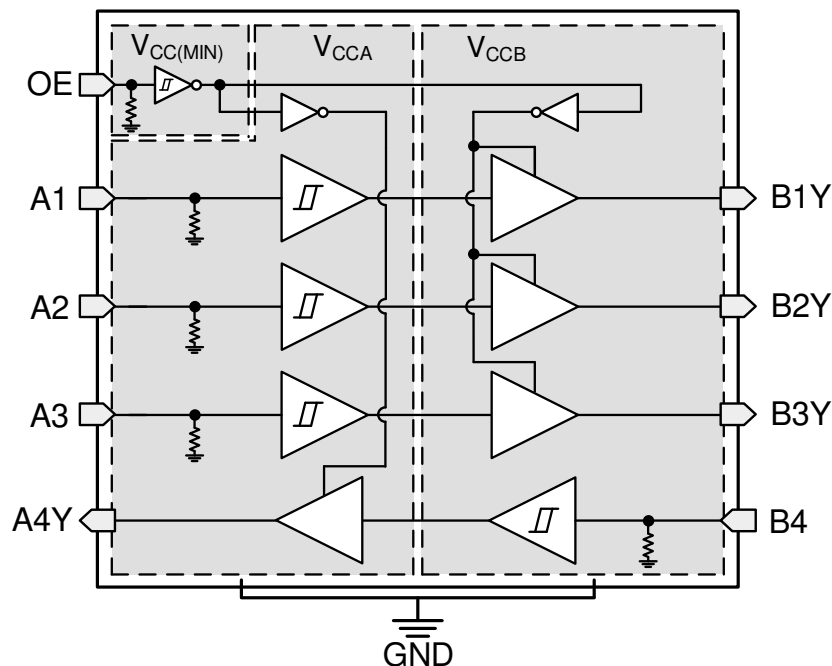
The TXU0304 device is designed for asynchronous communication between data buses, and transmits data with fixed direction from the A bus to the B bus on some channels and from the B bus to the A bus on the remaining channels. The output-enable input (OE) is used to disable the outputs so the buses are effectively isolated. The output-enable pin of the TXU0304 (OE) can be referenced to either  $V_{CCA}$  or  $V_{CCB}$ . The OE pin can be left floating or externally pulled down to ground to ensure the high-impedance state of the level shifter outputs during power up or power down.

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

The VCC isolation or VCC disconnect feature ensures that if either VCC is less than 100 mV or disconnected with the complementary supply within recommended operating conditions, outputs are disabled and set to the high-impedance state while the supply current is maintained. The  $I_{off\_float}$  circuitry ensures that no excessive current is drawn from or sourced into an input or output while the supply is floating.

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

### 9.2 Functional Block Diagram



## 9.3 Feature Description

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

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

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

#### 9.3.1.1 Inputs with Integrated Static Pull-Down Resistors

This device has 5 M $\Omega$  typical integrated weak pull-downs for each input. This feature allows all inputs to be left floating without the concern for unstable outputs or increased current consumption. This also helps to reduce external component count for applications where not all channels are used or need to be fixed low. If an external pull-up is required, it should be no larger than 1 M $\Omega$  to avoid contention with the 5 M $\Omega$  internal pull-down.

### 9.3.2 Control Logic (OE) with $V_{CC(MIN)}$ Circuitry

The output-enable input (OE) is used to disable the outputs so the buses are effectively isolated. The output-enable pin of the TXU0x04 has  $V_{CC(MIN)}$  circuitry, which allows the OE pin to operate with the lower supply voltage. The [Over-Voltage Tolerant Inputs](#) feature allows the OE pin to operate with the higher supply voltage. This combination means that the enable pin can be referenced to either  $V_{CCA}$  or  $V_{CCB}$  supply. Multiple permutations of each device are possible since the controller can be placed on either the A or B port and can still control the enable pin.

### 9.3.3 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. [Absolute Maximum Ratings](#) defines the electrical and thermal limits that must be followed at all times.

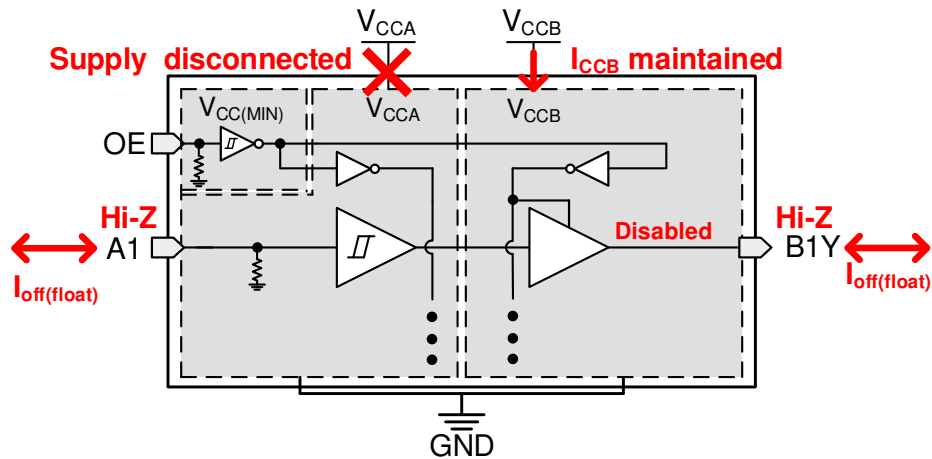
### 9.3.4 Partial Power Down ( $I_{off}$ )

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  $I_{off}$  in the [Electrical Characteristics](#) specifies the maximum leakage into or out of any input or output pin on the device.

### 9.3.5 VCC Isolation and $V_{CC}$ Disconnect

The outputs for this device are disabled and enter a high-impedance state when either supply is <100 mV or left floating (disconnected), with the complementary supply within recommended operating conditions. It is recommended that the inputs are kept low before floating (disconnecting) either supply.

The  $I_{CCx(floating)}$  in the [Electrical Characteristics](#) specifies the maximum supply current. The  $I_{off(float)}$  in the [Electrical Characteristics](#) specifies the maximum leakage into or out of any input or output pin on the device.



☒ 9-1.  $V_{CC}$  Disconnect Feature

### 9.3.6 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](#).

### 9.3.7 Glitch-Free Power Supply Sequencing

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

### 9.3.8 Negative Clamping Diodes

Figure 9-2 depicts the inputs and outputs to this device that have negative clamping diodes.

**CAUTION**

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

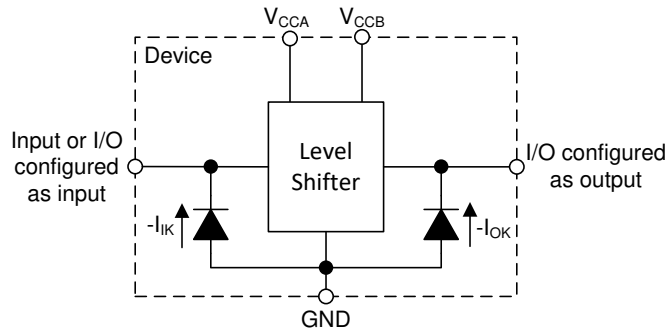


Figure 9-2. Electrical Placement of Clamping Diodes for Each Input and Output

### 9.3.9 Fully Configurable Dual-Rail Design

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

### 9.3.10 Supports High-Speed Translation

The TXU0304 device can support high data-rate applications. The translated signal data rate can be up to 200 Mbps when the signal is translated from 3.3 V to 5.0 V.

## 9.4 Device Functional Modes

Table 9-1. Function Table

CONTROL INPUTS	Port Status		OPERATION
	Input	Output	
H	L	L	Unidirectional non-inverting voltage translation
H	H	H	Unidirectional non-inverting voltage translation
L	X	Hi-Z	Isolation

## 10 Application and Implementation

### Note

以下のアプリケーション情報は、TI の製品仕様に含まれるものではなく、TI ではその正確性または完全性を保証いたしません。個々の目的に対する製品の適合性については、お客様の責任で判断していただくこととなります。お客様は自身の設計実装を検証しテストすることで、システムの機能を確認する必要があります。

### 10.1 Application Information

The TXU0304 device can be used in level-translation applications for interfacing devices or systems operating at different interface voltages with one another. The TXU0304 device is ideal for use in applications where a push-pull driver is connected to the data inputs. The maximum data rate can be up to 200 Mbps when device translates a signal from 3.3 V to 5.0 V.

### 10.2 Typical Application

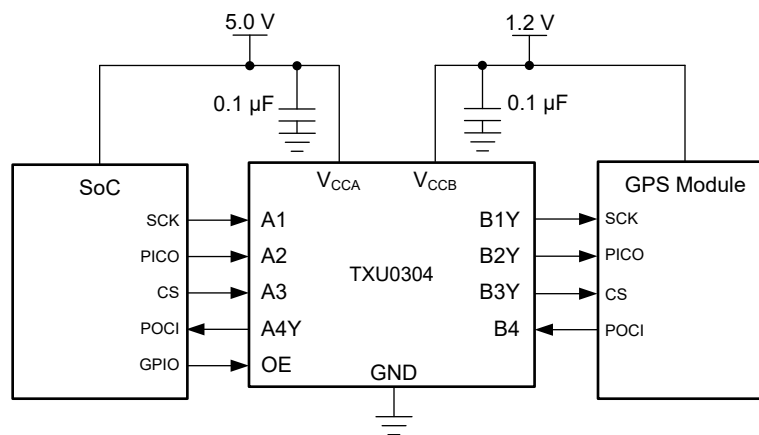


図 10-1. TXU0304 SPI Interface Application

#### 10.2.1 Design Requirements

Use the parameters listed in 表 10-1 for this design example.

表 10-1. Design Parameters

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

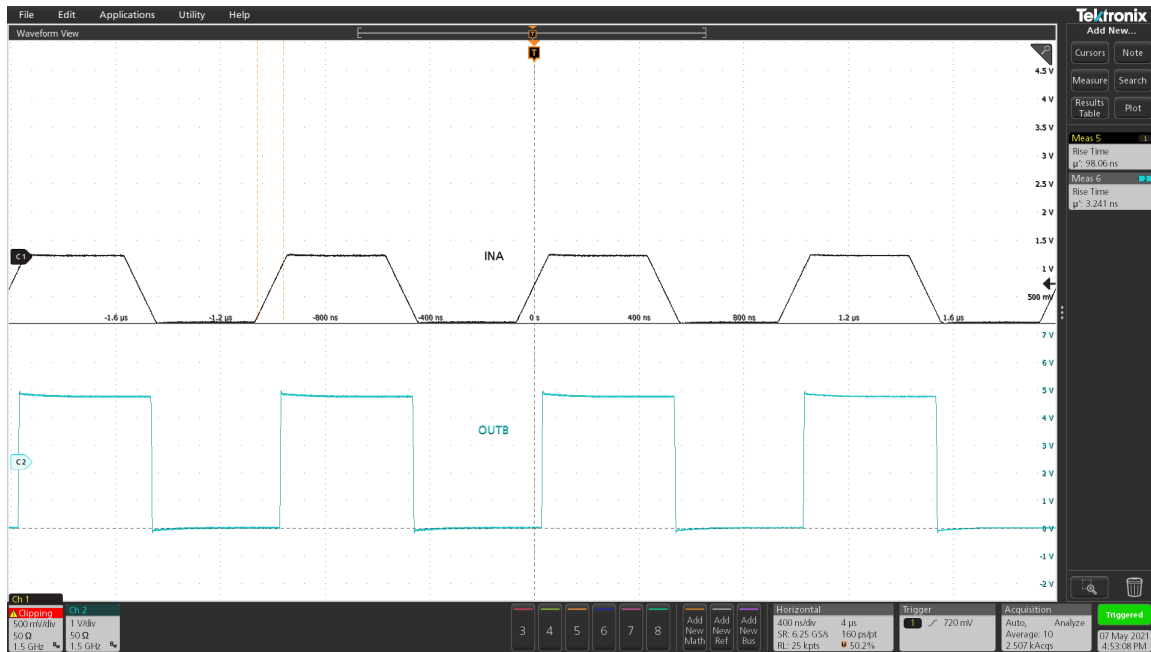
#### 10.2.2 Detailed Design Procedure

To begin the design process, determine the following:

- Input voltage range
  - Use the supply voltage of the device that is driving the TXU0304 device to determine the input voltage range. For a valid logic-high, the value must exceed the positive-going input-threshold voltage ( $V_{T+}$ ) of the input port. For a valid logic low the value must be less than the negative-going input-threshold voltage ( $V_{T-}$ ) of the input port.
- Output voltage range
  - Use the supply voltage of the device that the TXU0304 device is driving to determine the output voltage range.



## 10.2.3 Application Curve



**10-2. Up Translation at 1 MHz (1.2 V to 5 V)**

## 11 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.

[Glitch-Free Power Supply Sequencing](#) describes how this device was designed with various power supply sequencing methods in mind to help prevent unintended triggering of downstream devices.

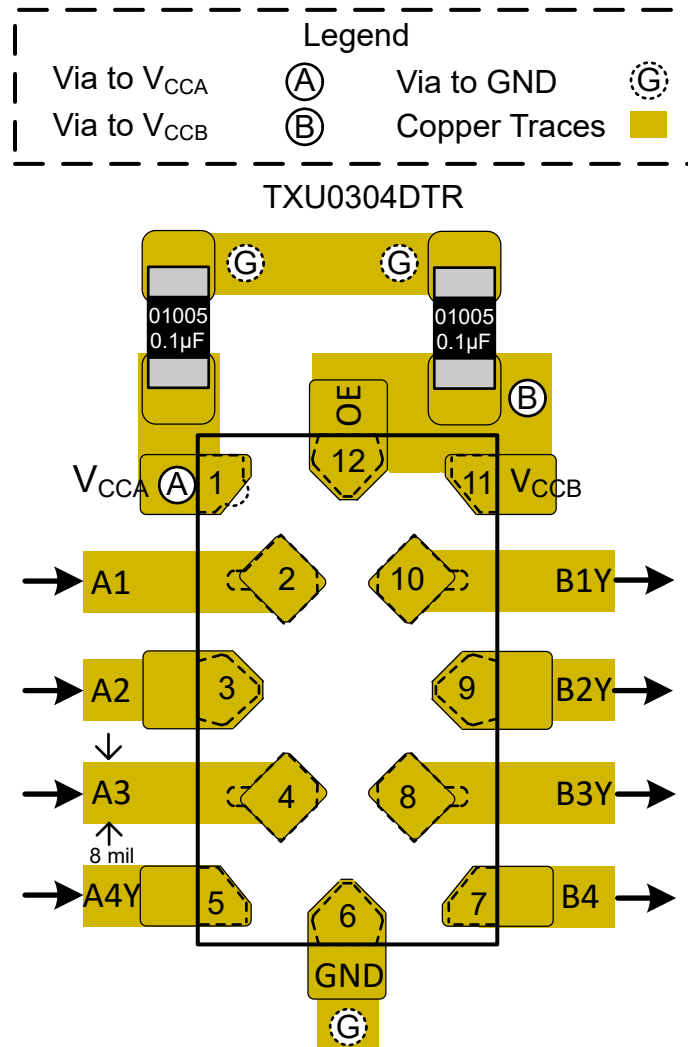
## 12 Layout

### 12.1 Layout Guidelines

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

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

## 12.2 Layout Example



12-1. Layout Example – TXU0304

## 13 Device and Documentation Support

### 13.1 Device Support

#### 13.1.1 Regulatory Requirements

No statutory or regulatory requirements apply to this device.

There are no special characteristics for this product.

### 13.2 Documentation Support

#### 13.2.1 Related Documentation

- Texas Instruments, [Understanding Schmitt Triggers application report](#)
- Texas Instruments, [CMOS Power Consumption and  \$C\_{pd}\$  Calculation application report](#)

### 13.3 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on [ti.com](https://www.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.

### 13.4 サポート・リソース

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### 13.5 Trademarks

TI E2E™ is a trademark of Texas Instruments.

すべての商標は、それぞれの所有者に帰属します。

### 13.6 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.

### 13.7 Glossary

[TI Glossary](#) This glossary lists and explains terms, acronyms, and definitions.

## 14 Mechanical, Packaging, and Orderable Information

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

**PACKAGING INFORMATION**

Orderable Device	Status (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
TXU0304BQAR	ACTIVE	WQFN	BQA	14	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	TX0304	<a href="#">Samples</a>
TXU0304DTRR	ACTIVE	X2QFN	DTR	12	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	1KL	<a href="#">Samples</a>
TXU0304PWR	ACTIVE	TSSOP	PW	14	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	TXU0304	<a href="#">Samples</a>
TXU0304RUTR	ACTIVE	UQFN	RUT	12	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	1J6	<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) **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.

**Important Information and Disclaimer:**The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and

continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

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

**OTHER QUALIFIED VERSIONS OF TXU0304 :**

- Automotive : [TXU0304-Q1](#)

NOTE: Qualified Version Definitions:

- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

**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
TXU0304BQAR	WQFN	BQA	14	3000	180.0	12.4	2.8	3.3	1.1	4.0	12.0	Q1
TXU0304DTRR	X2QFN	DTR	12	3000	180.0	9.5	1.18	1.88	0.53	4.0	8.0	Q1
TXU0304PWR	TSSOP	PW	14	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
TXU0304RUTR	UQFN	RUT	12	3000	180.0	9.5	1.9	2.2	0.7	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)
TXU0304BQAR	WQFN	BQA	14	3000	210.0	185.0	35.0
TXU0304DTRR	X2QFN	DTR	12	3000	189.0	185.0	36.0
TXU0304PWR	TSSOP	PW	14	2000	356.0	356.0	35.0
TXU0304RUTR	UQFN	RUT	12	3000	189.0	185.0	36.0

## GENERIC PACKAGE VIEW

**BQA 14**

**WQFN - 0.8 mm max height**

2.5 x 3, 0.5 mm pitch

PLASTIC QUAD FLATPACK - NO LEAD

This image is a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.



4227145/A





4224636/A 11/2018

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 pad must be soldered to the printed circuit board for optimal thermal and mechanical performance.



**EXAMPLE STENCIL DESIGN**

**BQA0014A**

**WQFN - 0.8 mm max height**

PLASTIC QUAD FLAT PACK-NO LEAD



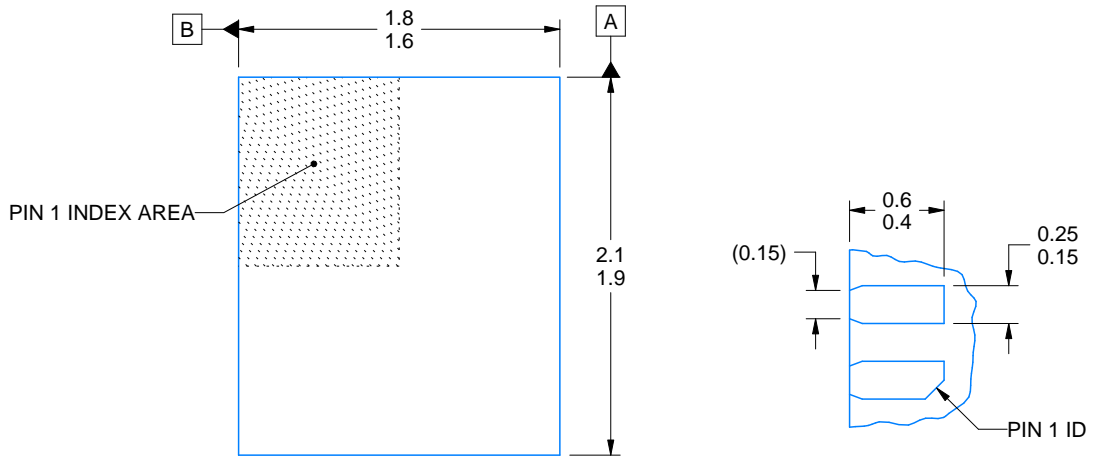
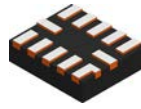
**SOLDER PASTE EXAMPLE**  
 BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD  
 88% PRINTED COVERAGE BY AREA  
 SCALE: 20X

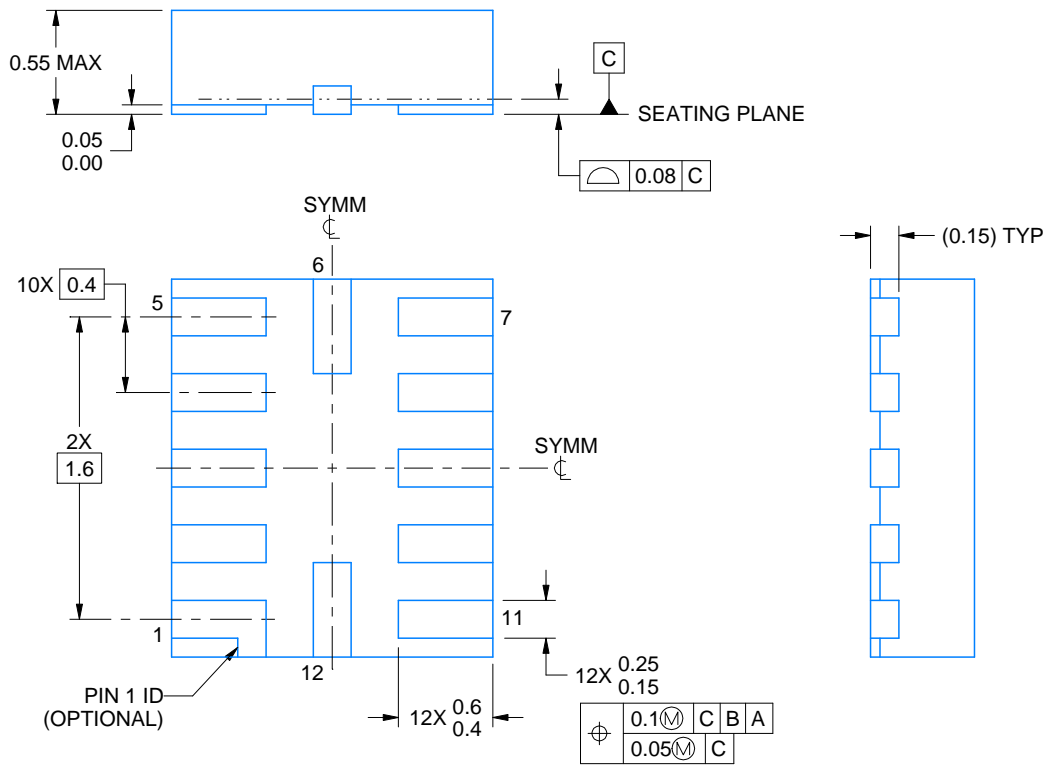
4224636/A 11/2018

NOTES: (continued)

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



OPTIONAL TERMINAL & PIN 1 ID



4220310/A 11/2016

NOTES:

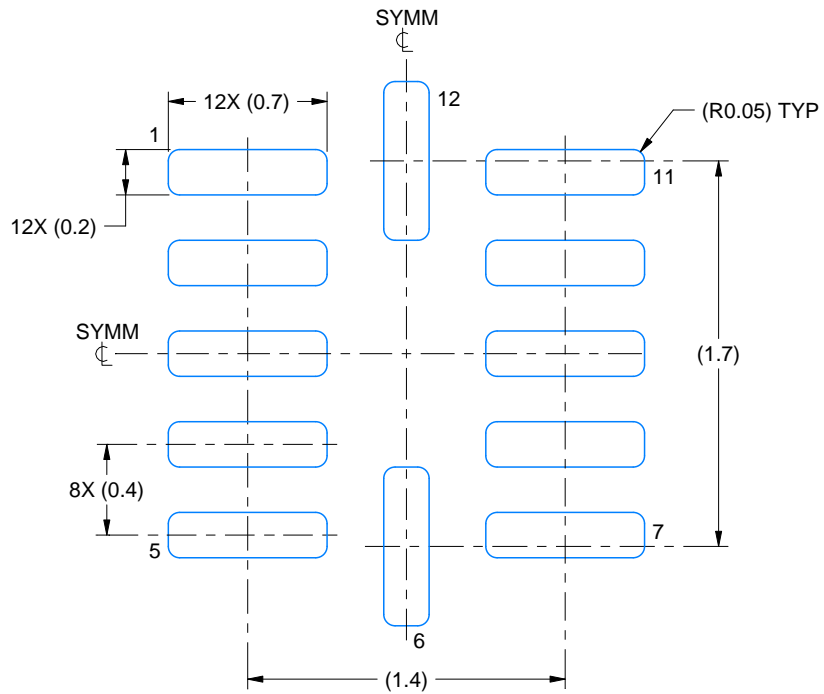
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

# EXAMPLE BOARD LAYOUT

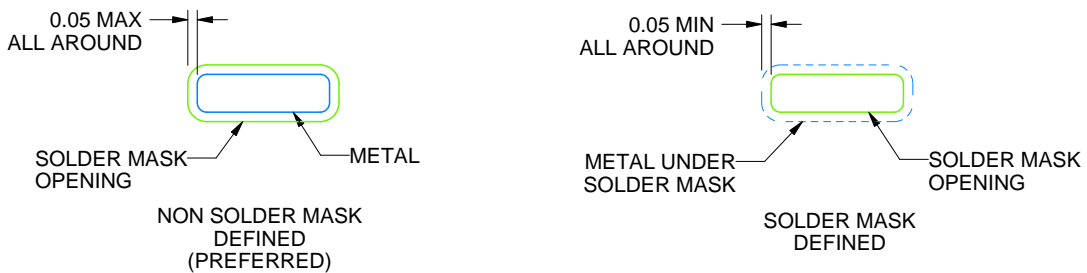
RUT0012A

UQFN - 0.55 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



LAND PATTERN EXAMPLE  
SCALE:30X



SOLDER MASK DETAILS

4220310/A 11/2016

NOTES: (continued)

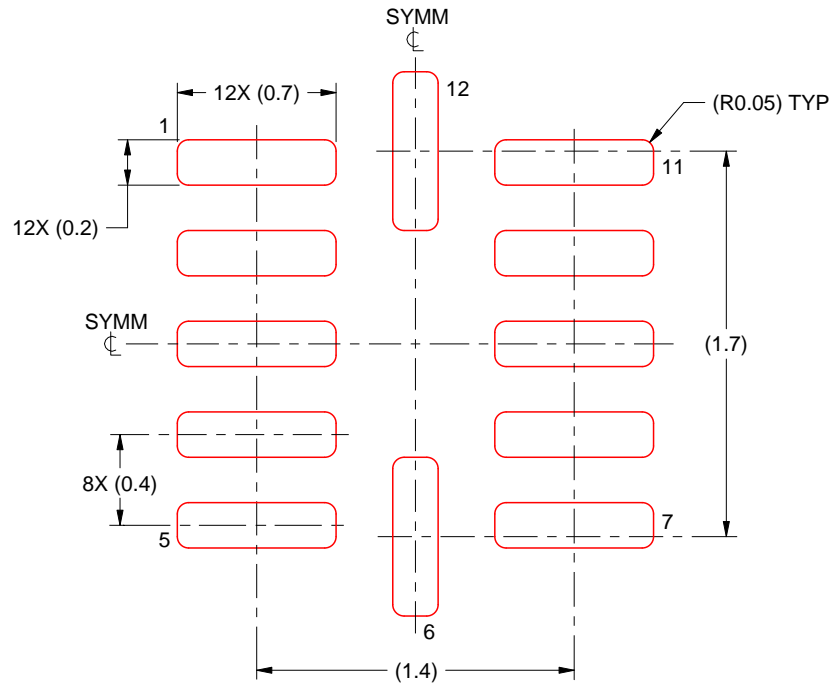
3. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/sluea271](http://www.ti.com/lit/sluea271)).

# EXAMPLE STENCIL DESIGN

RUT0012A

UQFN - 0.55 mm max height

PLASTIC QUAD FLATPACK - NO LEAD

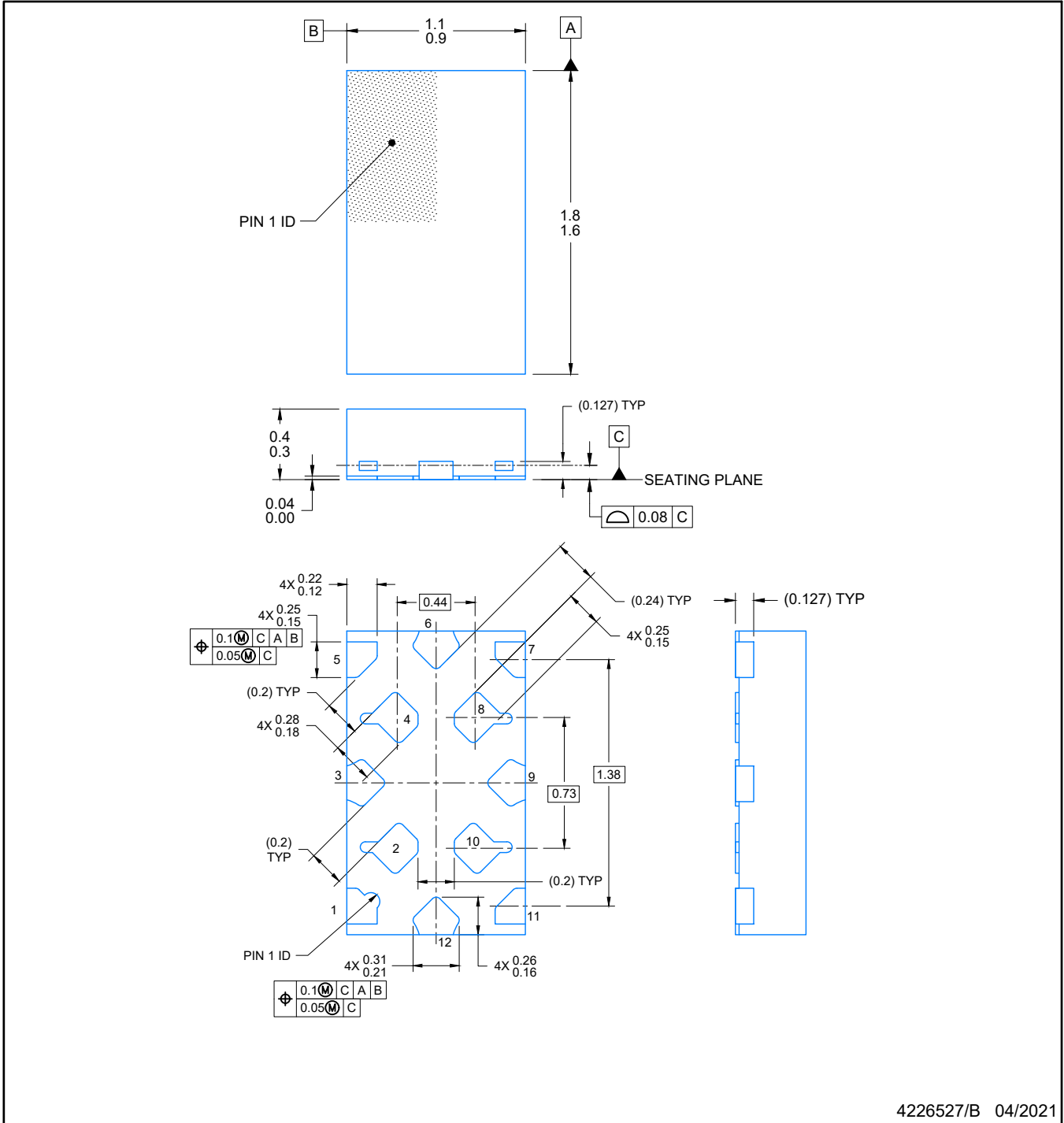


SOLDER PASTE EXAMPLE  
BASED ON 0.1 mm THICK STENCIL  
SCALE: 30X

4220310/A 11/2016

NOTES: (continued)

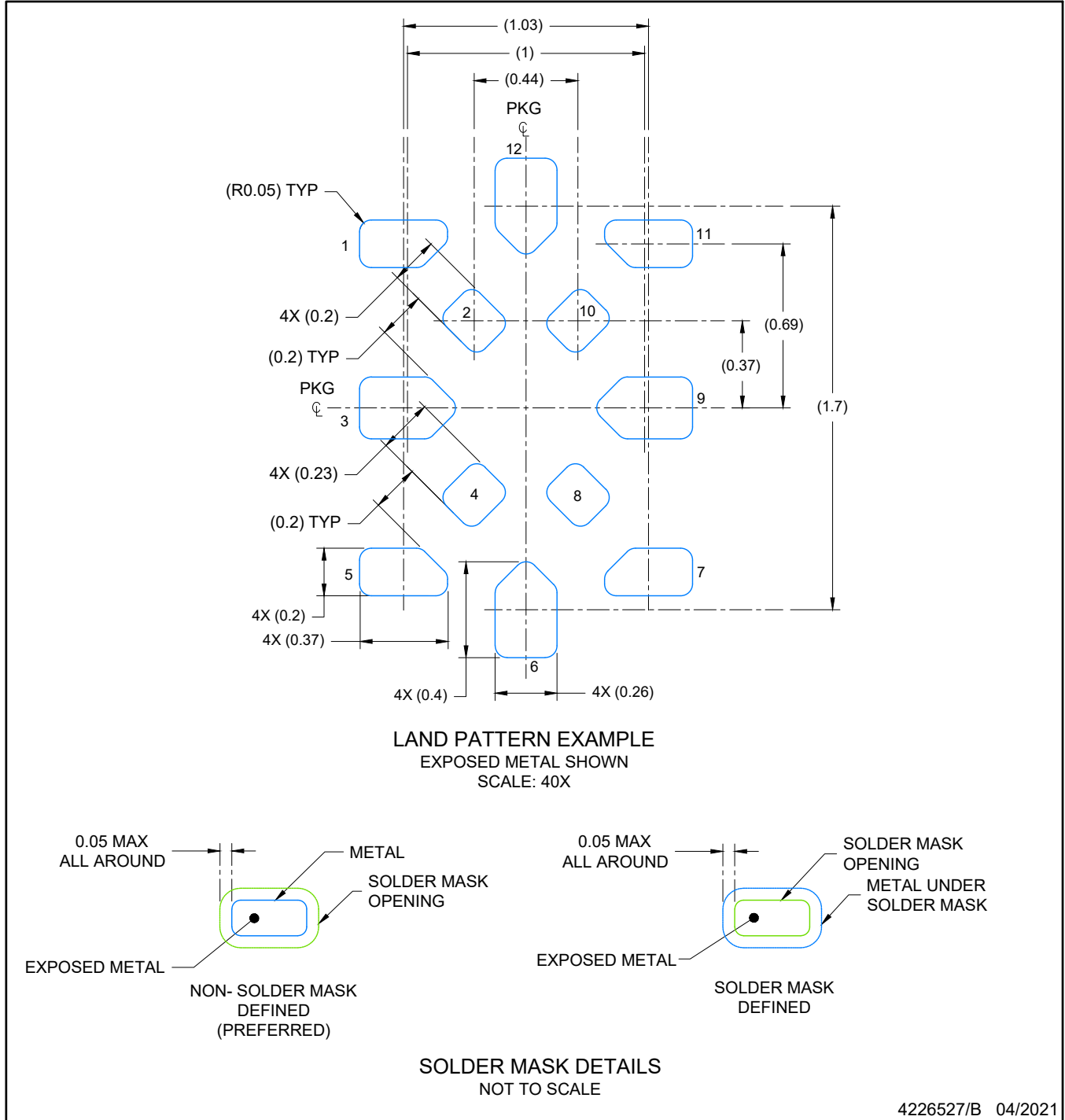
4. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.



4226527/B 04/2021

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.



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NOTES: (continued)

3. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/sluea271](http://www.ti.com/lit/sluea271)).
4. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

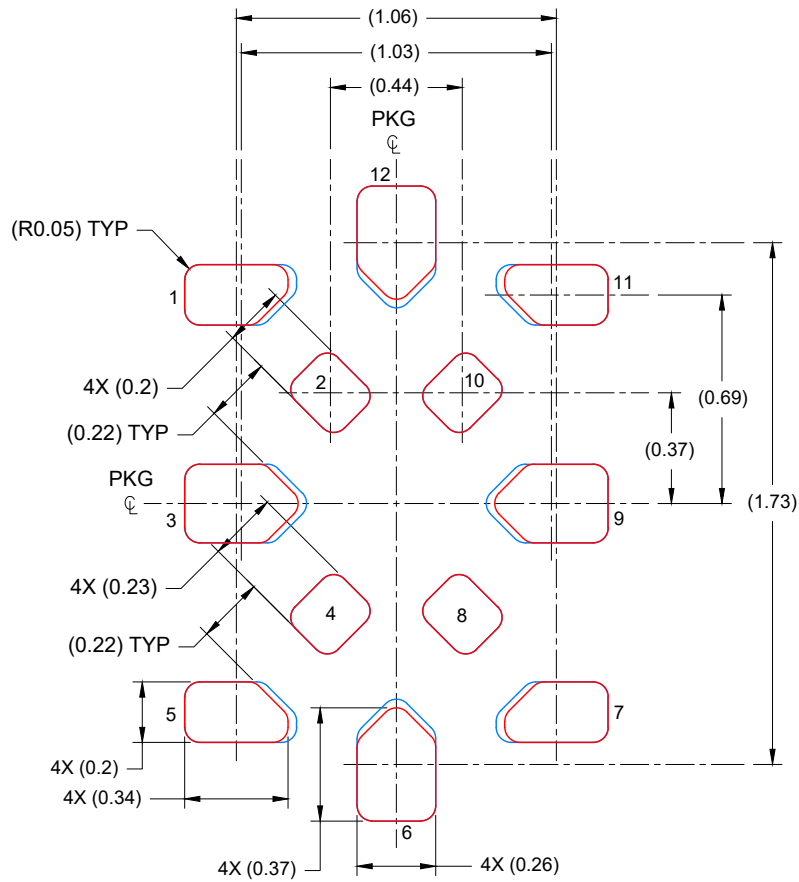


# EXAMPLE STENCIL DESIGN

DTR0012A

X2QFN - 0.4 mm max height

PLASTIC QUAD FLATPACK-NO LEAD



SOLDER PASTE EXAMPLE  
BASED ON 0.1 mm THICK STENCIL

SCALE: 40X

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NOTES: (continued)

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

PW0014A



**PACKAGE OUTLINE**  
**TSSOP - 1.2 mm max height**

SMALL OUTLINE PACKAGE



4220202/B 12/2023

**NOTES:**

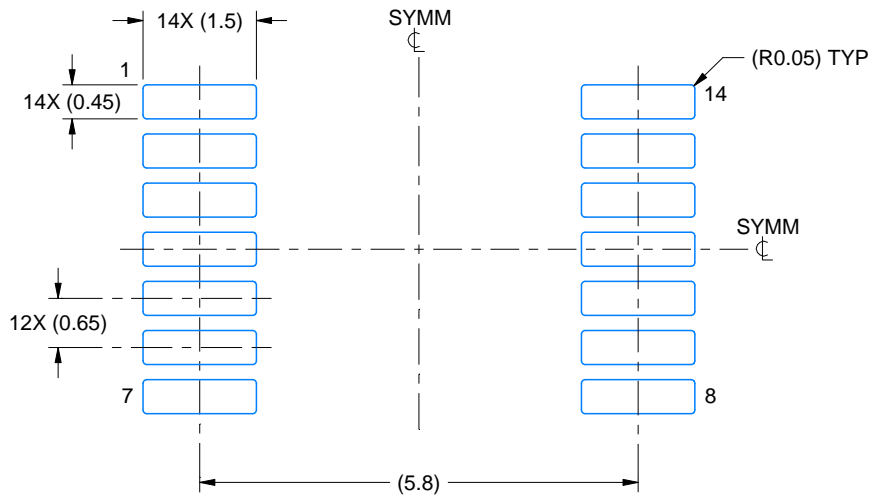
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153.

# EXAMPLE BOARD LAYOUT

PW0014A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE: 10X



4220202/B 12/2023

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

PW0014A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE: 10X

4220202/B 12/2023

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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