







TXU0204-Q1 SCES931B - APRIL 2021 - REVISED MARCH 2022

# TXU0204-Q1 Automotive 4-Bit Fixed Direction Voltage-Level Translator with Schmitt-**Trigger Inputs and 3-State Outputs**

#### 1 Features

- AEC-Q100 qualified for automotive applications
- Available in wettable flank QFN (WBQA) package
- Fully configurable dual-rail design allows each port to operate from 1.1 V to 5.5 V
- Up to 200 Mbps support for 3.3 V to 5.0 V
- Schmitt-trigger inputs allows for slow and noisy
- Inputs with integrated static pull-down resistors prevent channels from floating
- High drive strength (up to 12 mA at 5 V)
- Low power consumption
  - 3 µA maximum (25°C)
  - 6 μA maximum (–40°C to 125°C)
- V<sub>CC</sub> isolation and V<sub>CC</sub> disconnect (I<sub>off-float</sub>) feature
  - If either V<sub>CC</sub> input is <100 mV or disconnected, all outputs are disabled and become highimpedance
- I<sub>off</sub> supports partial-power-down mode operation
- Control logic (OE) with V<sub>CC(MIN)</sub> circuitry allows for control from either A or B port
- Pinout compatible with TXB family level shifters
- Available in other variants that support common applications: TXU0104-Q1, TXU0304-Q1
- Operating temperature from -40°C to +125°C
- Latch-up performance exceeds 100 mA per JESD 78. class II
- ESD protection exceeds JESD 22
  - 2500-V human-body model
  - 1500-V charged-device model

### 2 Applications

- Eliminate slow or noisy input signals
- Driving indicator LEDs or buzzers
- Debouncing a mechanical switch
- General purpose I/O level shifting
- Push-pull level shifting (UART, SPI, JTAG, and so forth)

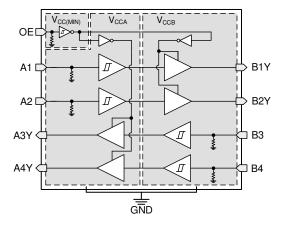
## 3 Description

TXU0204-Q1 is a 4-bit, dual-supply noninverting fixed direction voltage level translation device. Ax pins are referenced to V<sub>CCA</sub> logic level, OE pin can be referenced to either V<sub>CCA</sub> or V<sub>CCB</sub> logic levels, and Bx pins are referenced to  $V_{\text{CCB}}$  logic levels. The A port is able to accept input voltages ranging from 1.1 V to 5.5 V, while the B port can also accept input voltages from 1.1 V to 5.5 V. Fixed direction data transmission can occur from A to B or B to A when OE is set to high in reference to either supply. When OE is set to low, all output pins are in the high-impedance state. See Device Functional Modes for a summary of the operation of the control logic.

#### Device Information<sup>(1)</sup>

DEVICE NUMBER	PACKAGE	BODY SIZE (NOM)				
TXU0204-Q1WBQA	VQFN (14)	3.00 mm × 2.50 mm				
TXU0204-Q1PW	TSSOP (14)	5.00 mm × 4.40 mm				

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



**TXU0204-Q1 Functional Block Diagram** 



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## **4 Revision History**

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

Changes from Revision A (May 2021) to Revision B (March 2022)	Page
Added WBQA package and supporting information	1
Changes from Revision * (April 2021) to Revision A (May 2021)	Page
Changed the status of the data sheet from: advanced information to: production data.	a1

#### **5 Related Products**

TXU0x04-Q1 Automotive 4-Bit Unidirectional Voltage-Level Translators TXU0x04-Q1 are 4-bit, dual-supply noninverting fixed direction voltage level translators. These devices are compatible to the TXB0104-Q1 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-Q1 devices to be used for fixed direction, high drive applications which the TXB0104-Q1 is not recommended to support.

TXU0104-Q1

TXU0104-Q1 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.

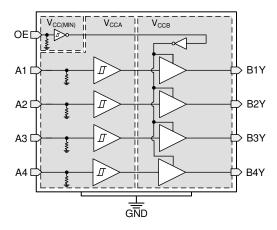


Figure 5-1. TXU0104-Q1 Functional Block Diagram

TXU0304-Q1 is a 4-bit, dual-supply noninverting fixed direction voltage level translators with 1 channel in the opposing direction commonly used for GPIO, SPI, and I2S translation.

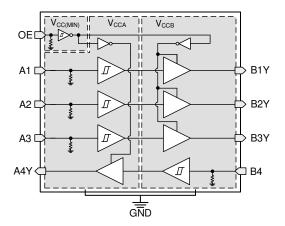


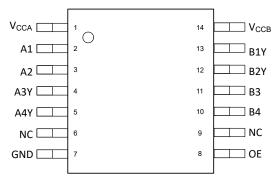
Figure 5-2. TXU0304-Q1 Functional Block Diagram

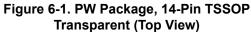
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## 6 Pin Configuration and Functions—TXU0204-Q1





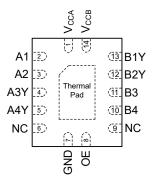


Figure 6-2. WBQA Package, 14-Pin VQFN Transparent (Top View)

Table 6-1. TXU0204-Q1 Pin Functions

F	PIN								
NAME	PW, WBQA	TYPE <sup>(1)</sup>	DESCRIPTION						
A1	2	I	Input A1. Referenced to V <sub>CCA</sub> .						
A2	3	I	Input A2. Referenced to V <sub>CCA</sub> .						
A3Y	4	0	Output A3. Referenced to V <sub>CCA</sub> .						
A4Y	5	0	Output A4. Referenced to V <sub>CCA</sub> .						
B1Y	13	0	Output B1. Referenced to V <sub>CCB</sub> .						
B2Y	12	0	out B2. Referenced to V <sub>CCB</sub> .						
B3	11	I	Input B3. Referenced to V <sub>CCB</sub> .						
B4	10	I	Input B4. Referenced to V <sub>CCB</sub> .						
GND	7	_	Ground						
NC	6, 9	_	No internal connection.						
OE	8	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 <sub>CCA</sub>	1	_	A-port supply voltage. 1.1 V ≤ V <sub>CCA</sub> ≤ 5.5 V						
V <sub>CCB</sub>	14	_	B-port supply voltage. 1.1 V ≤ V <sub>CCB</sub> ≤ 5.5 V						
Thermal Pad —		_	Thermal pad. May be left floating or grounded (recommended for best thermal and mechanical ntegrity).						

(1) I = inpu, O = output



## 7 Specifications

## 7.1 Absolute Maximum Ratings

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

			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
		I/O Ports (A Port)	-0.5	6.5	
Vı	Input Voltage <sup>(2)</sup>	I/O Ports (B Port)	-0.5	6.5	V
		OE	-0.5	6.5	
V	Voltage applied to any output in the high-impedance or power-off	A Port	-0.5	6.5	V
Vo	o state <sup>(2)</sup>	B Port	-0.5	6.5	V
V	Voltage applied to any output in the high or law state(2) (3)	A Port	-0.5	V <sub>CCA</sub> + 0.5	V
Vo	Voltage applied to any output in the high or low state <sup>(2) (3)</sup>	B Port	-0.5	$V_{CCA} + 0.5$ $V_{CCB} + 0.5$	V
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
Io	Continuous output current		-25	25	mA
	Continuous current through V <sub>CC</sub> or GND		-100	100	mA
Tj	Junction Temperature			150	°C
T <sub>stg</sub>	Storage temperature		-65	150	°C

<sup>(1)</sup> 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	/(ESD)   Electrostatic discharge	Human body model (HBM), per AEC Q100-002 <sup>(1)</sup>	±2500	V
V <sub>(ESD)</sub>		Charged device model (CDM), per AEC Q100-011	±1500	v

(1) AEC Q100-002 indicates that HBM stressing shall be in accordance with the ANSI/ESDA/JEDEC JS-001 specification



#### 7.3 Recommended Operating Conditions

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

				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	
			V <sub>CCO</sub> = 1.1 V		-1.5		
			V <sub>CCO</sub> = 1.4 V		-3		
	High lovel output o	urront	V <sub>CCO</sub> = 1.65 V		-4.5	mA	
I <sub>OH</sub>	High-level output o	urrent	V <sub>CCO</sub> = 2.3 V		-8	IIIA	
			V <sub>CCO</sub> = 3 V		-10		
			V <sub>CCO</sub> = 4.5 V				
			V <sub>CCO</sub> = 1.1 V		1.5		
			V <sub>CCO</sub> = 1.4 V		3		
	L avy lavel autaut a	irrant	V <sub>CCO</sub> = 1.65 V		4.5	Λ	
l <sub>OL</sub>	Low-level output co	irrent	V <sub>CCO</sub> = 2.3 V		8	mA	
			V <sub>CCO</sub> = 3 V		10		
				12			
VI	Input voltage (3)		·	0	5.5	V	
V	Output valtage	Active State		0	V <sub>CCO</sub>	V	
Vo	Output voltage	Tri-State		0	5.5	, v	
T <sub>A</sub>	Operating free-air	emperature	-40	125	°C		

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

#### 7.4 Thermal Information

			7	XU0204		
	THERMAL METRIC(1)	PW (TSSOP)	BQA (WQFN)	RUT (UQFN)	DTR (X2SON)	UNIT
		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>0JC(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>0</sub> JC(bottom)	Junction-to-case (bottom) thermal resistance	N/A	33.0	N/A	N/A	°C/W

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

Product Folder Links: TXU0204-Q1

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

<sup>(3)</sup> 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*.



## 7.5 Electrical Characteristics

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

						0	peratir	ng free-	air temperat	ure (T	4)	
PA	ARAMETER	TEST CONDITIONS	V <sub>CCA</sub>	V <sub>CCB</sub>		25°C		–40°	C to 85°C	–40°	C to 125°C	UNIT
					MIN	TYP	MAX	MIN	TYP MAX	MIN	TYP MAX	
			1.1 V	1.1 V				0.44	0.88	0.44	0.88	
			1.4 V	1.4 V				0.60	0.98	0.60	0.98	
		Data Inputs	1.65 V	1.65 V				0.76	1.13	0.76	1.13	
		(Ax, Bx)	2.3 V	2.3 V				1.08	1.56	1.08	1.56	V
		(Referenced to V <sub>CCI</sub> )	3 V	3 V				1.48	1.92	1.48	1.92	
	Positive-		4.5 V	4.5 V				2.19	2.74	2.19	2.74	
going input-		5.5 V	5.5 V				2.65	3.33	2.65	3.33		
V <sub>T+</sub>	threshold		1.1 V	1.1 V				0.44	0.88	0.44	0.88	
	voltage		1.4 V	1.4 V				0.60	0.98	0.60	0.98	
		OE	1.65 V	1.65 V				0.76	1.13	0.76	1.13	
		(Referenced to V <sub>CCA</sub>	2.3 V	2.3 V				1.08	1.56	1.08	1.56	V
		or V <sub>CCB)</sub>	3 V	3 V				1.48	1.92	1.48	1.92	1
			4.5 V	4.5 V				2.19	2.74	2.19	2.74	1
			5.5 V	5.5 V				2.65	3.33	2.65	3.33	1
			1.1 V	1.1 V				0.17	0.48	0.17	0.48	
		1.4 V	1.4 V				0.28	0.59	0.28	0.59	1	
		Data Inputs (Ax, Bx) (Referenced to V <sub>CCI</sub> )	1.65 V	1.65 V				0.35	0.69	0.35	0.69	V
			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	
	Negative- going input-		5.5 V	5.5 V				1.88	2.4	1.88	2.4	
V <sub>T-</sub>	threshold	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	
	voltage		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	V
			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	
			1.1 V	1.1 V				0.2	0.4	0.2	0.4	
			1.4 V	1.4 V				0.25	0.5	0.25	0.5	1
		Data Inputs	1.65 V	1.65 V				0.3	0.55	0.3	0.55	1
		(Ax, Bx)	2.3 V	2.3 V				0.38	0.65	0.38	0.65	V
		(Referenced to V <sub>CCI</sub> )	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	
	Input- threshold		5.5 V	5.5 V				0.69	1.06	0.69	1.06	1
$\Delta V_{T}$	hysteresis		1.1 V	1.1 V				0.15	0.41	0.15	0.41	
	$(V_{T+} - V_{T-})$		1.4 V	1.4 V	1			0.2	0.5	0.2	0.5	-
		OE	1.65 V	1.65 V				0.23	0.55	0.23	0.55	-
		(Referenced to V <sub>CCA</sub>	2.3 V	2.3 V				0.32	0.65	0.32	0.65	V
		or V <sub>CCB)</sub>	3 V	3 V				0.39	0.72	0.39	0.72	
			4.5 V	4.5 V				0.57	0.97	0.57	0.72	
			5.5 V	5.5 V	1			0.69	1.18		1.18	-



## 7.5 Electrical Characteristics (continued)

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

		ir temperature range					peratii	ng free	air tem	perat	ure (T <sub>A</sub>	.)		
PA	RAMETER	TEST CONDITIONS	V <sub>CCA</sub>	V <sub>CCB</sub>		25°C		-40°	C to 85	°C	-40°0	C to 12	5°C	UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
		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			
		$I_{OH} = -0.5 \text{ mA}$	1.1 V	1.1 V				0.82			0.82			
. ,	High-level	$I_{OH} = -3 \text{ mA}$	1.4 V	1.4 V				1			1			.,
$V_{OH}$	output voltage <sup>(3)</sup>	$I_{OH} = -4.5 \text{ mA}$	1.65 V	1.65 V				1.2			1.2			V
		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			
		I <sub>OL</sub> = 0.1 mA	1.1V – 5.5V	1.1V - 5.5V						0.1			0.1	
		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	
V <sub>OL</sub> Low-level output voltage (4)	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	V	
	I <sub>OL</sub> = 10 mA	3 V	3 V						8.0			0.8		
		I <sub>OL</sub> = 8 mA	4.5 V	4.5 V						0.55			0.55	
		I <sub>OL</sub> = 12 mA	4.5 V	4.5 V						0.8			0.8	
	I	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
l <sub>l</sub>	Input leakage current	Data Inputs (Ax, Bx) V <sub>I</sub> = V <sub>CCI</sub> or GND	1.1V – 5.5V	1.1V – 5.5V	-0.1		1.5	-0.1		1.5	-2		2	μA
		A Port or B Port	0 V	0 V - 5.5 V	-1.5		1.5	-2		2	-2.5		2.5	
l <sub>off</sub>	Partial power down current	$V_1 \text{ or } V_0 = 0 \text{ V} - 5.5 \text{ V}$	0 V - 5.5 V	0 V	-1.5		1.5	-2	-	2	-2.5		2.5	μA
	Floating		Floating <sup>(5)</sup>	0 V - 5.5 V	-1.5		1.5	-2		2	-2.5		2.5	
I <sub>off-float</sub>	supply Partial power down current	A Port or B Port $V_1$ or $V_0$ = GND	0 V - 5.5 V	Floating <sup>(5)</sup>	-1.5		1.5	-2		2	-2.5		2.5	μA
l <sub>oz</sub>	Tri-state output current	A or B Port: $V_I = V_{CCI}$ or GND $V_O = V_{CCO}$ or GND OE = GND	1.1V – 5.5V	1.1V – 5.5V	-0.3		0.3	-1		1	-2		2	μA
			1.1V – 5.5V	1.1V - 5.5V			1.5			2.5			6	
		$V_I = V_{CCI}$ or GND $I_O = 0$	0 V	5.5 V	-0.3			-1			-1			
$I_{CCA}$	V <sub>CCA</sub> supply current	10 - 0	5.5 V	0 V			1			1.5			3	μΑ
		V <sub>I</sub> = GND I <sub>O</sub> = 0	5.5 V	Floating <sup>(5)</sup>			1.5			7			15	
			1.1V – 5.5V	1.1V – 5.5V			1.5			2.5			6	
		$V_I = V_{CCI}$ or GND	0 V	5.5 V			1			1.5			3	
I <sub>CCB</sub>	V <sub>CCB</sub> supply current	I <sub>O</sub> = 0	5.5 V	0 V	-0.3			-1			-1			μΑ
		V <sub>I</sub> = GND I <sub>O</sub> = 0	Floating <sup>(5)</sup>	5.5 V			1.5			7			15	
I <sub>CCA</sub> +	Combined supply current	$V_I = V_{CCI}$ or GND $I_O = 0$	1.1V – 5.5V	1.1V – 5.5V			2.5			3			6	μA
Ci	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)(1) (2)

PARAMETER TEST CO			S V <sub>CCA</sub>	V <sub>CCB</sub>	Operating free-air temperature (T <sub>A</sub> )									
		TEST CONDITIONS			25°C		-40°C to 85°C		-40°C to 125°C		UNIT			
					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

- $V_{\text{CCI}}$  is the  $V_{\text{CC}}$  associated with the input port
- V<sub>CCO</sub> is the V<sub>CC</sub> associated with the output port (2)

- (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)

DADAMETED			.,	.,		Operating free-air temperature (T <sub>A</sub> )				
PARAMETER	TEST CON	DITIONS	V <sub>CCI</sub>	V <sub>cco</sub>	-40°	C to 12	5°C	UNIT		
					MIN	TYP	MAX			
			3.0 V - 3.6 V	4.5 V - 5.5 V	200					
			1.65 V - 1.95 V	4.5 V - 5.5 V	150					
		Un Translation	1.1 V - 1.3 V	4.5 V - 5.5 V	30					
T <sub>MAX</sub> - Maximum	50% Duty Cycle	Up Translation	1.65 V - 1.95 V	3.0 V - 3.6 V	100					
	Input One channel		1.1 V - 1.3 V	3.0 V - 3.6 V	30					
	switching		1.1 V - 1.3 V	1.65 V - 1.95 V	20			Mhaa		
Data Rate	20% of pulse >		4.5 V - 5.5 V	3.0 V - 3.6 V	125			Mbps		
	0.7*V <sub>CCO</sub> 20% of pulse <		4.5 V - 5.5 V	1.65 V - 1.95 V	50					
	0.3*V <sub>CCO</sub>	Down Translation	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					
			3.0 V - 3.6 V	4.5 V - 5.5 V			3	3		
			1.65 V - 1.95 V	4.5 V - 5.5 V			10			
		l	1.1 V - 1.3 V	4.5 V - 5.5 V			42			
		Up Translation	1.65 V - 1.95 V	3.0 V - 3.6 V			8			
	Timing skew		1.1 V - 1.3 V	3.0 V - 3.6 V			42			
t Output alcour	between any		1.1 V - 1.3 V	1.65 V - 1.95 V			45	20		
t <sub>sk</sub> - Output skew	switching outputs on the rising or falling		4.5 V - 5.5 V	3.0 V - 3.6 V			3	ns		
	edge		4.5 V - 5.5 V	1.65 V - 1.95 V			10			
		Davin Translation	4.5 V - 5.5 V	1.1 V - 1.3 V			42			
		Down Translation	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			

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

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.

									B-P	ort Supply	Voltage	(V <sub>CCB</sub> )					
	PARAMETER	FROM	то	Test Conditions	1.2 ± 0.1	٧	1.5 ± 0.1	I V	1.8 ±	: 0.15 V	2.5	± 0.2 V	3.	3 ± 0.3 V	5.0	± 0.5 V	UNIT
					MIN TYP	MAX	MIN TYP	MAX	MIN T	YP MAX	MIN	TYP MAX	MIN	TYP MAX	MIN	TYP MAX	
		Α	В	-40°C to 85°C	3.3	96	0.5	43	0.5	37	0.5	32	0.5	30	0.5	31	
	Propagation			-40°C to 125°C	5.7	60	3.0	39	1.4	33	0.5	28	0.5	27	0.5	26	
t <sub>pd</sub>	delay	В	۸	-40°C to 85°C	3.3	95	1.9	80	0.5	75	0.5	70	0.5	69	0.5	69	ns
		В	Α	-40°C to 125°C	5.7	60	4.1	51	2.9	48	1.8	45	1.5	44	1.3	44	
		OE	Α	-40°C to 85°C	28.8	133	28.5	130	28.4	133	28.8	137	28.4	143	18.7	211	
	Disable time	OE	A	-40°C to 125°C	43.3	133	43.3	130	43.7	130	44.7	131	45.4	134	31.8	140	ns
t <sub>dis</sub>	Disable time	OE	В	-40°C to 85°C	32.5	150	27.6	117	25.8	110	22.5	104	22.1	112	20.1	181	
		OE .	Р	-40°C to 125°C	48.3	149	43.2	120	40.8	113	36.8	104	36.5	107	33.8	111	1
		OE	^	-40°C to 85°C	24.1	237	22.1	229	21.4	230	21.3	232	21.7	235	22.7	244	
	Enable time	OE	A	-40°C to 125°C	34.9	156	33.3	167	32.0	169	31.7	173	32.0	177	34.2	187	
t <sub>en</sub>	Enable time	OE	В	-40°C to 85°C	21.3	237	14.3	152	11.2	140	8.8	130	8.2	130	8.4	132	ns
		OL	0	-40°C to 125°C	29.8	143	23.0	116	18.6	107	15.4	97	14.5	97	14.8	103	1

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

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.

									В	-Port Sup	oply '	Voltage (	V <sub>CCB</sub> )						
	PARAMETER	FROM	то	Test Conditions	1.2 ± 0.	1 V	1.5	± 0.1 V	1.8	3 ± 0.15 V	<i>'</i>	2.5 ±	0.2 V	3.	3 ± 0.3 V	5	.0 ± 0.5	V	UNIT
					MIN TYP	MAX	MIN T	YP MAX	MIN	TYP M	ΙΑХ	MIN T	P MAX	MIN	TYP MAX	MIN	TYP	MAX	
		Α	В	-40°C to 85°C	1.9	80	0.5	31	0.5		25	0.5	19	0.5	17	0.5		15	
	Propagation			-40°C to 125°C	4.1	51	1.6	31	0.5		25	0.5	20	0.5	18	0.5		16	ns
t <sub>pd</sub>	delay	В	Α	-40°C to 85°C	0.5	43	0.5	31	0.5		28	0.5	26	0.5	25	0.5		24	115
		Ь	^	-40°C to 125°C	3.0	39	1.6	31	0.5		28	0.5	26	0.5	25	0.5		24	
		OE	Α	-40°C to 85°C	20.0	91	19.0	82	18.8		81	19.2	82	19.6	83	12.2		87	
	Disable time	OL	^	-40°C to 125°C	34.9	95	32.6	86	32.8		85	33.4	87	34.2	88	24.6		92	ns
t <sub>dis</sub>	Disable time	OE	В	-40°C to 85°C	27.4	127	21.7	91	19.9		82	16.3	71	15.9	7′	13.7		70	115
		OE		-40°C to 125°C	44.4	130	36.7	95	34.7		86	30.2	75	29.8	75	26.6		74	
		OE	_	-40°C to 85°C	14.9	102	14.4	86	13.5		88	12.7	90	12.6	92	13.2		97	
	Enable time	OE	A	-40°C to 125°C	25.5	102	25.2	89	24.1		91	22.8	93	22.8	96	23.5		100	200
t <sub>en</sub>	Lilable tille	OE		-40°C to 85°C	17.9	175	12.7	80	9.1		69	6.1	57	4.9	53	4.5		54	ns
		OL	D	-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 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.

										В	-Port S	Supply	Voltag	e (V <sub>CC</sub>	в)							
	PARAMETER	FROM	то	Test Conditions	1.2 :	± 0.1 V	1.	5 ± 0.1	٧	1.8	3 ± 0.15	5 V	2.	5 ± 0.2	: <b>V</b>	3.	3 ± 0.3	٧	5.	0 ± 0.5	V	UNIT
					MIN T	YP MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
		Α	В	-40°C to 85°C	0.5	75	0.5		28	0.5		22	0.5		17	0.5		14	0.5		12	
	Propagation			-40°C to 125°C	2.9	48	0.5		28	0.5		23	0.5		17	0.5		15	0.5		13	ns
t <sub>pd</sub>	delay	В	Α	-40°C to 85°C	0.5	37	0.5	,	25	0.5		22	0.5		19	0.5		19	0.5		18	1115
		В	^	-40°C to 125°C	1.4	33	0.5		25	0.5		23	0.5		20	0.5		19	0.5		19	
		OE	Α	-40°C to 85°C	17.2	79	14.7		67	14.5		65	14.3		65	14.4		66	8.5		68	
	Disable time	OE .	^	-40°C to 125°C	30.9	83	28.0		71	26.6		69	27.5		70	27.2		71	20.0		73	ns
t <sub>dis</sub>	Disable time	OE	В	-40°C to 85°C	25.4	121	18.7		81	16.5		71	12.8		60	12.5		58	9.8		55	
		OE .		-40°C to 125°C	41.7	123	34.0	,	86	30.3		76	26.2		64	25.3		62	21.8		59	
		OE	_	-40°C to 85°C	10.9	88	9.5		66	9.4		63	8.6		65	8.2		66	8.1		69	
	Enable time	OE .	A	-40°C to 125°C	20.3	87	19.0		69	18.9		67	17.6		68	17.1		70	17.1		73	
t <sub>en</sub>	Lilable tille	OE	В	-40°C to 85°C	16.7	177	10.4		75	8.1		58	4.9		46	3.3		42	2.2		39	ns
		OL		-40°C to 125°C	25.1	135	18.7		77	15.5		60	11.0		49	8.7		44	7.3		42	

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

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.

										В-	Port S	Supply	Voltag	e (V <sub>CC</sub>	в)							
	PARAMETER	FROM	то	Test Conditions	1.2 ± 0.4	I V	1.9	5 ± 0.1 V	/	1.8	± 0.15	5 V	2.	5 ± 0.2	V	3.	3 ± 0.3	٧	5.	0 ± 0.5	V	UNIT
					MIN TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
		Α	В	-40°C to 85°C	0.5	70	0.5		26	0.5		20	0.5		14	0.5		12	0.5		9	
	Propagation	^		-40°C to 125°C	1.8	45	0.5		26	0.5		20	0.5		14	0.5		12	0.5		10	ns
t <sub>pd</sub>	delay	В	Α	-40°C to 85°C	0.5	32	0.5		19	0.5		17	0.5		14	0.5		13	0.5		13	115
		В	A	-40°C to 125°C	0.5	28	0.5		20	0.5		17	0.5		14	0.5		13	0.5		13	
		OE	Α	-40°C to 85°C	12.9	65	10.5		51	9.0		51	8.1		43	8.4		44	5.0		45	
	Disable time	OL		-40°C to 125°C	24.9	68	21.8		55	19.7		50	18.2		47	18.6		48	15.0		49	ns
t <sub>dis</sub>	Disable time	OE	В	-40°C to 85°C	23.2	112	16.5		74	14.0		61	9.0		46	9.1		44	6.4		39	115
		OE	В	-40°C to 125°C	38.7	115	30.9		79	27.1		66	21.6		51	20.5		48	16.8		43	
		OE	^	-40°C to 85°C	7.9	80	5.9		50	5.1		44	4.7		39	4.4		40	3.7		41	
	Enable time	OE	A —	-40°C to 125°C	15.6	74	13.5		53	12.4		47	12.0		42	11.5		43	10.8		44	no
t <sub>en</sub>	Lilable tille	OE	В	-40°C to 85°C	16.3	183	9.2		74	6.0		54	4.0		36	2.1		31	0.5		27	ns
		OL	B	-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.

										В	-Port S	Supply	Voltag	e (V <sub>CC</sub>	в)							
	PARAMETER	FROM	то	Test Conditions	1.2	± 0.1 V	1.	5 ± 0.1	٧	1.8	3 ± 0.15	5 V	2.	5 ± 0.2	: <b>V</b>	3.	3 ± 0.3	٧	5.	0 ± 0.5	V	UNIT
					MIN T	YP MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
		Α	В	-40°C to 85°C	0.5	69	0.5		25	0.5		19	0.5		13	0.5		11	0.5		8	
	Propagation	^		-40°C to 125°C	1.5	44	0.5		25	0.5		19	0.5		13	0.5		11	0.5		9	ns
t <sub>pd</sub>	delay	В	Α	-40°C to 85°C	0.5	30	0.5	,	17	0.5		14	0.5		12	0.5		11	0.5		10	1115
		В	A	-40°C to 125°C	0.5	27	0.5		18	0.5		15	0.5		12	0.5		11	0.5		10	
		OE	Α	-40°C to 85°C	12.9	62	10.1		47	8.7		42	6.9		39	6.6		39	6.9		40	
	Disable time	OE	A	-40°C to 125°C	24.0	65	20.6		51	18.4		46	15.7		40	15.3		39	15.9		40	ns
t <sub>dis</sub>	Disable time	OE	В	-40°C to 85°C	22.7	109	15.7		71	13.2		59	8.5		42	7.6		38	4.7		34	1115
		OE	В	-40°C to 125°C	37.6	111	29.5	,	75	25.4		63	19.2		46	18.5		42	14.2		36	
		OE	^	-40°C to 85°C	6.6	85	4.2		45	3.0		37	2.4		31	2.2		30	1.7		30	
	Enable time	OE	A	-40°C to 125°C	13.6	72	10.9		47	9.3		40	8.2		33	8.1		32	7.5		33	
t <sub>en</sub>	Enable time	OE	В	-40°C to 85°C	16.3	192	8.9		76	5.4		55	2.6		34	1.8		27	0.5		22	ns
		OE	В	-40°C to 125°C	24.3	144	16.7		78	12.2		57	8.0		36	6.6		29	3.7		24	

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

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.

									E	3-Port S	Supply	Voltag	e (V <sub>CC</sub>	в)							
	PARAMETER	FROM	то	Test Conditions	1.2 ± 0.	1 V	1.5	5 ± 0.1 V	1.	8 ± 0.15	5 V	2.	5 ± 0.2	٧	3.	3 ± 0.3	٧	5.0	0 ± 0.5	٧	UNIT
					MIN TYP	MAX	MIN	TYP MA	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
		Α	В	-40°C to 85°C	0.5	69	0.5	2	4 0.5		18	0.5		13	0.5		10	0.5		8	
	Propagation	^		-40°C to 125°C	1.3	44	0.5	2	4 0.5		19	0.5		13	0.5		11	0.5		8	ns
t <sub>pd</sub>	delay	В	Α	-40°C to 85°C	0.5	31	0.5	1	0.5		12	0.5	,	9	0.5		8	0.5		8	115
		В	A	-40°C to 125°C	0.5	26	0.5	1	0.5		13	0.5		10	0.5		9	0.5		8	
		OE	Α	-40°C to 85°C	10.8	58	7.7	4	2 5.9		36	4.2		31	3.4		30	2.8		26	
	Disable time	OL		-40°C to 125°C	20.8	61	17.0	4	3 14.5		40	11.8		33	10.4		31	9.6		29	ns
t <sub>dis</sub>	Disable time	OE	В	-40°C to 85°C	9.7	109	5.9	6	13.2		56	8.4		40	6.9		36	3.7		29	115
		OE	В	-40°C to 125°C	37.4	111	29.2	7	3 24.6		60	18.1	,	43	16.4		39	12.2		31	
		OE	^	-40°C to 85°C	6.0	102	2.8	4	1.2		33	0.5		25	0.5		22	0.5		21	
	Enable time	OE	A	-40°C to 125°C	12.4	81	8.8	4	6.5		36	4.7		27	4.2		24	4.4		23	
t <sub>en</sub>	Lilable tille	OE	В	-40°C to 85°C	16.7	212	8.8	8	2 4.8		58	1.6		35	0.5		26	0.5		19	ns
		OL	B	-40°C to 125°C	24.8	158	16.7	8	3 11.7		60	6.9		37	4.7		28	3.5		21	



## 7.13 Operating Characteristics

 $T_A = 25^{\circ}C^{(1)}$ 

				Su	pply Voltage	(V <sub>CCB</sub> = V <sub>CC</sub>	;A)		
	PARAMETER	Test Conditions	1.2 ± 0.1V	1.5 ± 0.1V	1.8 ± 0.15V	2.5 ± 0.2V	3.3 ± 0.3V	5.0 ± 0.5V	UNIT
			TYP	TYP	TYP	TYP	TYP	TYP	
	A to B: outputs enabled	A Port	2	2	2	2	2	3	
C <sub>pdA</sub> (2)	A to B: outputs disabled	CL = 0, RL = Open	2	2	2	2	2	3	pF
OpdA V	B to A: outputs enabled	f = 10 MHz	12	12	12	13	13	16	ρι
	B to A: outputs disabled	t <sub>rise</sub> = t <sub>fall</sub> = 1 ns	2	2	2	2	2	3	
	A to B: outputs enabled	B Port	12	12	12	13	13	16	
C <sub>pdB</sub> (3)	A to B: outputs disabled	CL = 0, RL = Open	2	2	2	2	2	3	pF
pdB (	B to A: outputs enabled	f = 10 MHz	2	2	2	2	2	3	ρι
	B to A: outputs disabled	t <sub>rise</sub> = t <sub>fall</sub> = 1 ns	2	2	2	2	2	3	

<sup>(1)</sup> See the CMOS Power Consumption and C<sub>pd</sub> Calculation application report for additional information about how power dissipation capacitance affects power consumption.

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<sup>2)</sup> A-Port power dissipation capacitance per transceiver.

<sup>(3)</sup> B-Port power dissipation capacitance per transceiver.

#### 7.14 Typical Characteristics

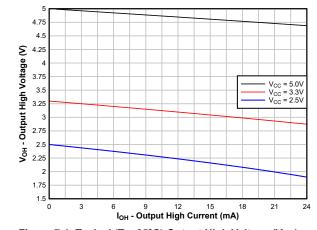


Figure 7-1. Typical ( $T_A$ =25°C) Output High Voltage ( $V_{OH}$ ) vs Source Current ( $I_{OH}$ )

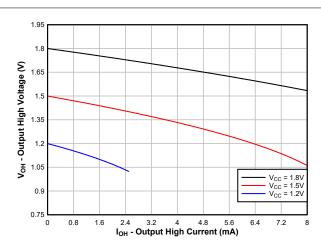


Figure 7-2. Typical ( $T_A$ =25°C) Output High Voltage ( $V_{OH}$ ) vs Source Current ( $I_{OH}$ )

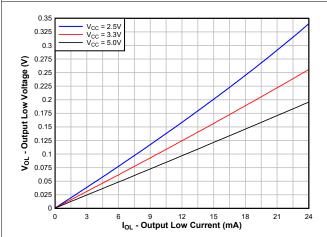


Figure 7-3. Typical ( $T_A$ =25°C) Output Low Voltage ( $V_{OL}$ ) vs Sink Current ( $I_{OL}$ )

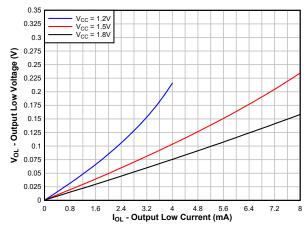


Figure 7-4. Typical ( $T_A$ =25°C) Output Low Voltage ( $V_{OL}$ ) vs Sink Current ( $I_{OL}$ )

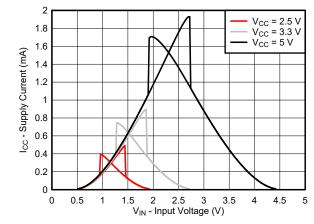


Figure 7-5. Typical ( $T_A$ =25°C) Supply Current ( $I_{CC}$ ) vs Input Voltage ( $V_{IN}$ )

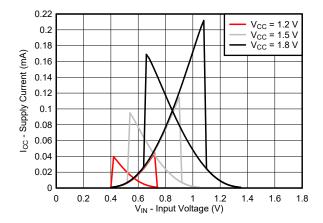


Figure 7-6. Typical ( $T_A$ =25°C) Supply Current ( $I_{CC}$ ) vs Input Voltage ( $V_{IN}$ )

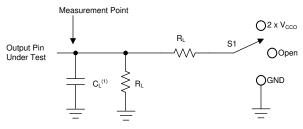


#### **8 Parameter Measurement Information**

## 8.1 Load Circuit and Voltage Waveforms

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

- f = 1 MHz
- Z<sub>O</sub> = 50 Ω
- Δt/ΔV ≤ 1 ns/V

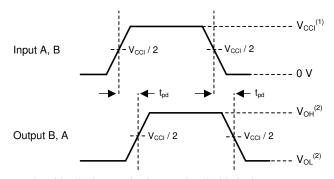


C<sub>L</sub> includes probe and jig capacitance.

Figure 8-1. Load Circuit

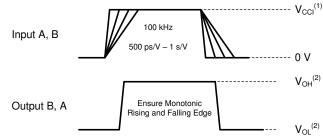
**Table 8-1. Load Circuit Conditions** 

	Parameter	V <sub>cco</sub>	R <sub>L</sub>	CL	S <sub>1</sub>	V <sub>TP</sub>
t <sub>pd</sub>	Propagation (delay) time	1.1 V – 5.5 V	10 kΩ	5 pF	Open	N/A
		1.1 V – 1.6 V	10 kΩ	5 pF	2 × V <sub>CCO</sub>	0.1 V
t <sub>en</sub> , t <sub>dis</sub>	Enable time, disable time	1.65 V – 2.7 V	10 kΩ	5 pF	2 × V <sub>CCO</sub>	0.15 V
		3.0 V – 5.5 V	10 kΩ	5 pF	2 × V <sub>CCO</sub>	0.3 V
		1.1 V – 1.6 V	10 kΩ	5 pF	GND	0.1 V
t <sub>en</sub> , t <sub>dis</sub>	Enable time, disable time	1.65 V – 2.7 V	10 kΩ	5 pF	GND	0.15 V
		3.0 V – 5.5 V	10 kΩ	5 pF	GND	0.3 V



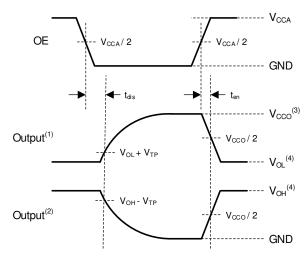
- 1.  $V_{\text{CCI}}$  is the supply pin associated with the input port.
- V<sub>OH</sub> and V<sub>OL</sub> are typical output voltage levels that occur with specified R<sub>L</sub>, C<sub>L</sub>, and S<sub>1</sub>

Figure 8-2. Propagation Delay



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

Figure 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<sub>CCO</sub> 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  $S_1.$

Figure 8-4. Enable Time And Disable Time

## 9 Detailed Description

### 9.1 Overview

The TXU0204-Q1 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  $V_{CCB}$ .

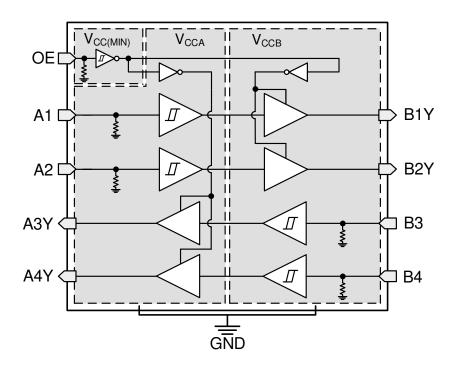
The TXU0204-Q1 device is designed for asynchronous communication between data buses, and transmits data with fixed direction from the A bus to the B bus on some channels and from the B bus to the A bus on the remaining channels. The output-enable input (OE) is used to disable the outputs so the buses are effectively isolated. The output-enable pin of the TXU0204-Q1 (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<sub>off</sub> current. The I<sub>off</sub> 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<sub>off-float</sub> 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<sub>CC(MIN)</sub> 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-Q1 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 (Ioff)

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<sub>off</sub> 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<sub>CC</sub> 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<sub>CCx(floating)</sub> in the *Electrical Characteristics* specifies the maximum supply current. The I<sub>off(float)</sub> in the *Electrical Characteristics* specifies the maximum leakage into or out of any input or output pin on the device.



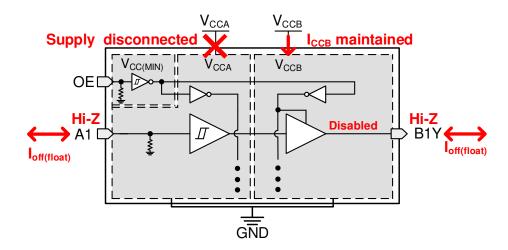


Figure 9-1. V<sub>CC</sub> Disconnect Feature

### 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 VCC when it should be held low or vice versa). Glitches of this nature can be misinterpreted by a peripheral as a valid data bit, which could trigger a false device reset of the peripheral, a false device configuration of the peripheral, or even a false data initialization by the peripheral.

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### 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 *Absoulte 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.

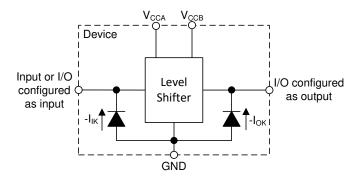


Figure 9-2. Electrical Placement of Clamping Diodes for Each Input and Output

### 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 TXU0204-Q1 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.



#### 9.3.11 Wettable Flanks

This device includes wettable flanks for at least one package. See the *Features* section on the front page of the data sheet for which packages include this feature.

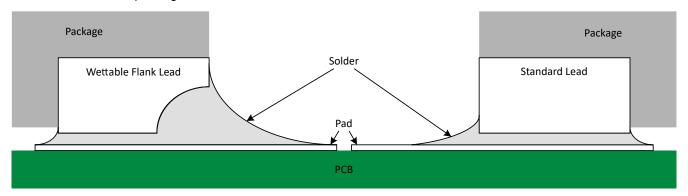


Figure 9-3. Simplified Cutaway View of Wettable-Flank QFN Package and Standard QFN Package After Soldering

Wettable flanks help improve side wetting after soldering, which makes QFN packages easier to inspect with automatic optical inspection (AOI). A wettable flank can be dimpled or step-cut to provide additional surface area for solder adhesion which assists in reliably creating a side fillet as shown in Figure 9-3. Please see the mechanical drawing for additional details.

#### 9.4 Device Functional Modes

**Table 9-1. Function Table** 

CONTROL INPUTS	Port St	atus	OPERATION
OE	Input	Output	OFERATION
Н	L	L	Unidirectional non-inverting voltage translation
Н	Н	Н	Unidirectional non-inverting voltage translation
L	Х	Hi-Z	Isolation

Product Folder Links: TXU0204-Q1

## 10 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.

#### 10.1 Application Information

The TXU0204-Q1 device can be used in level-translation applications for interfacing devices or systems operating at different interface voltages with one another. The TXU0204-Q1 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 the device translates a signal from 3.3 V to 5.0 V.

#### 10.2 Typical Application

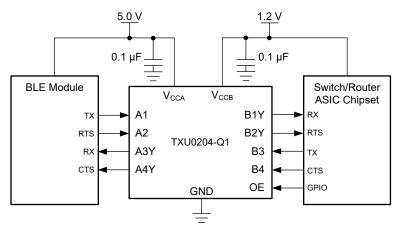


Figure 10-1. TXU0204-Q1 UART Interface Application

#### 10.2.1 Design Requirements

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

Table 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 TXU0204-Q1 device to determine the input voltage range. For a valid logic-high, the value must exceed the positive-going input-threshold voltage (V<sub>T+</sub>) of the input port. For a valid logic low the value must be less than the negative-going input-threshold voltage (V<sub>T-</sub>) of the input port.
- Output voltage range
  - Use the supply voltage of the device that the TXU0204-Q1 device is driving to determine the output voltage range.

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### 10.2.3 Application Curve

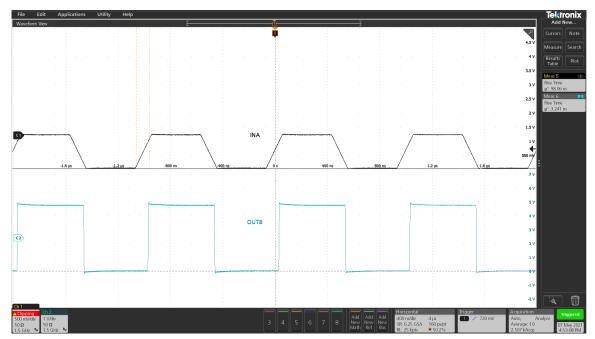


Figure 10-2. Up Translation at 1 MHz (1.2 V to 5 V)

## 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, it is recommended to follow common printed-circuit board layout guidelines:

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

## 12.2 Layout Example

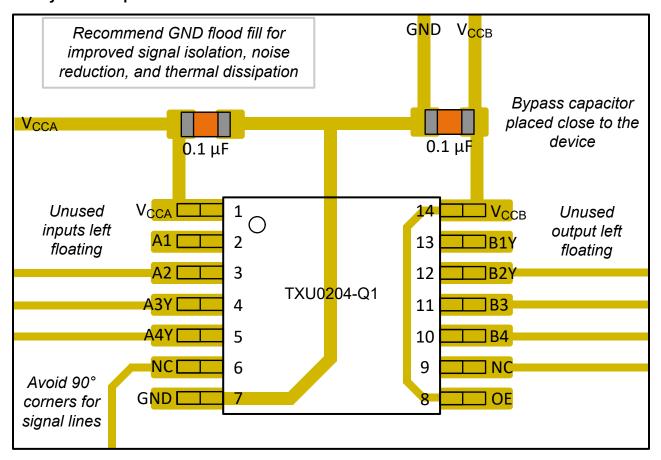


Figure 12-1. Layout Example - TXU0204-Q1



## 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 Cod 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. 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 Support Resources

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

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

#### 13.5 Trademarks

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#### 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.

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www.ti.com 1-May-2025

#### PACKAGING INFORMATION

Orderable part number	Status	Material type	Package   Pins	Package qty   Carrier	RoHS	Lead finish/ Ball material	MSL rating/ Peak reflow	Op temp (°C)	Part marking (6)
						(4)	(5)		
TXU0204QPWRQ1	Active	Production	TSSOP (PW)   14	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	TXU204Q
TXU0204QWBQARQ1	Active	Production	WQFN (BQA)   14	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	TX0204

<sup>(1)</sup> Status: For more details on status, see our product life cycle.

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

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#### OTHER QUALIFIED VERSIONS OF TXU0204-Q1:

Catalog: TXU0204

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

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

<sup>(4)</sup> Lead finish/Ball material: Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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

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



# **PACKAGE OPTION ADDENDUM**

www.ti.com 1-May-2025

NOTE: Qualified Version Definitions:

• Catalog - TI's standard catalog product

# **PACKAGE MATERIALS INFORMATION**

www.ti.com 3-Jun-2022

### TAPE AND REEL INFORMATION





A0	Dimension designed to accommodate the component width
В0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

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



#### \*All dimensions are nominal

Device	Package Type	Package Drawing		SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TXU0204QPWRQ1	TSSOP	PW	14	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
TXU0204QWBQARQ1	WQFN	BQA	14	3000	180.0	12.4	2.8	3.3	1.1	4.0	12.0	Q1

# **PACKAGE MATERIALS INFORMATION**

www.ti.com 3-Jun-2022



### \*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TXU0204QPWRQ1	TSSOP	PW	14	2000	356.0	356.0	35.0
TXU0204QWBQARQ1	WQFN	BQA	14	3000	210.0	185.0	35.0

2.5 x 3, 0.5 mm pitch

PLASTIC QUAD FLATPACK - NO LEAD

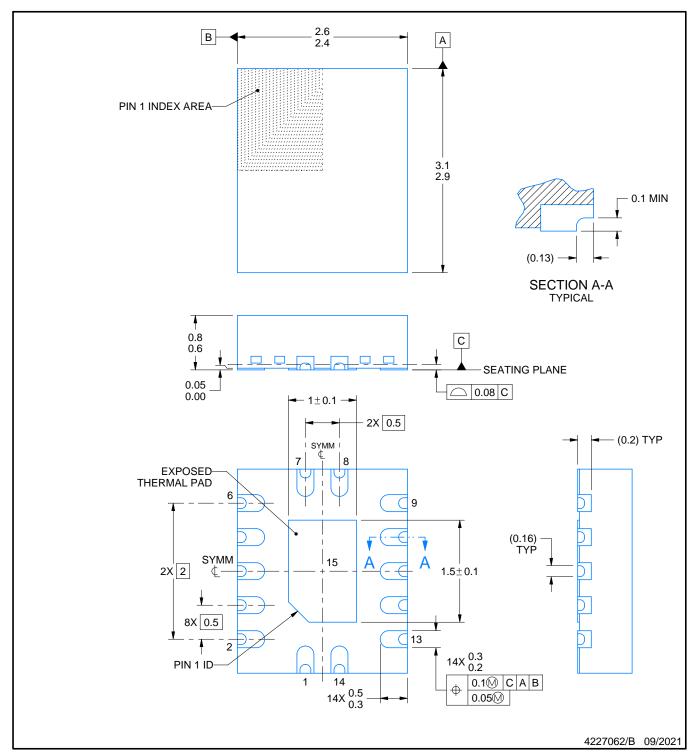
This image is a representation of the package family, actual package may vary. Refer to the product data sheet for package details.



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PLASTIC QUAD FLATPACK - NO LEAD

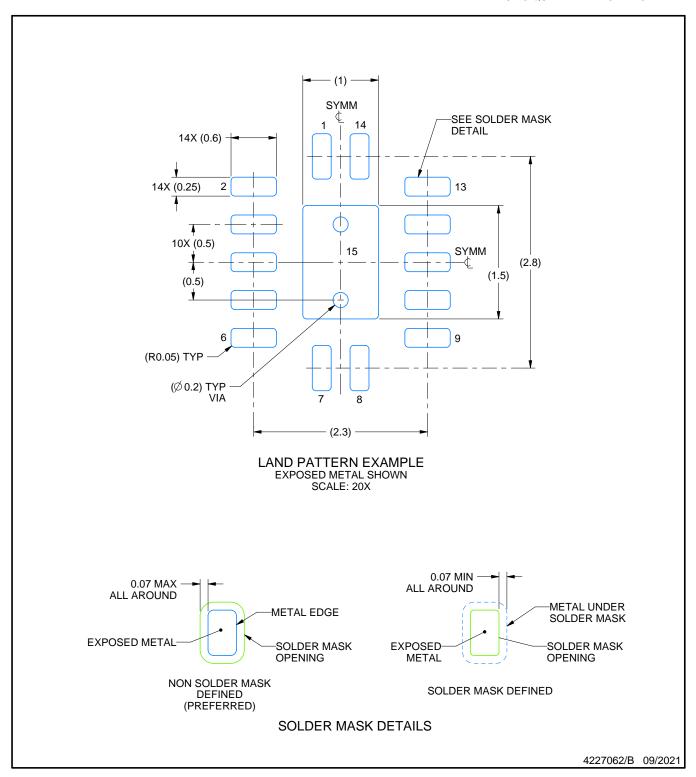


#### NOTES:

- 1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
  2. This drawing is subject to change without notice.
- 3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.



PLASTIC QUAD FLATPACK - NO LEAD

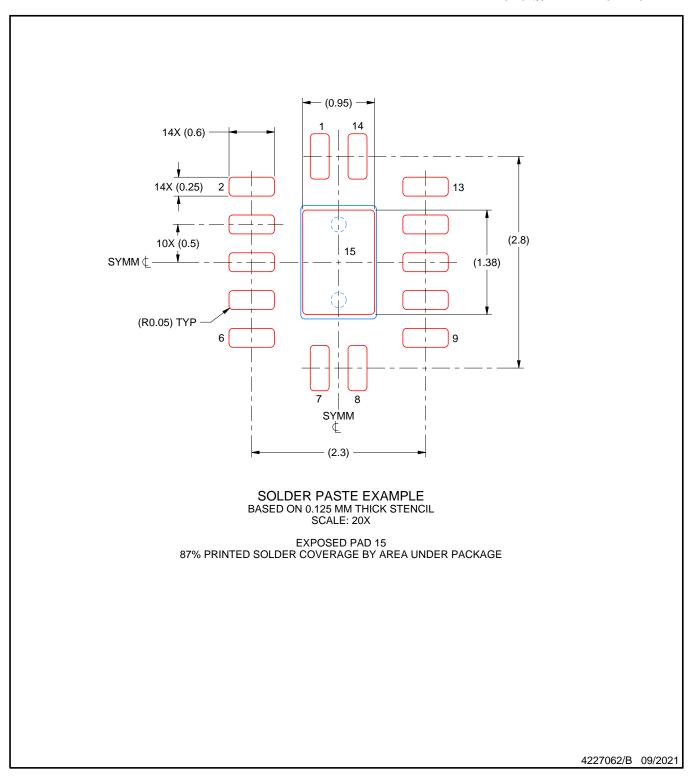


NOTES: (continued)

- 4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
- 5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.



PLASTIC QUAD FLATPACK - NO LEAD



NOTES: (continued)

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





SMALL OUTLINE PACKAGE



#### NOTES:

- 1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.

  2. This drawing is subject to change without notice.

  3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not
- exceed 0.15 mm per side.
- 4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
- 5. Reference JEDEC registration MO-153.



SMALL OUTLINE PACKAGE



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.



SMALL OUTLINE PACKAGE



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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