

# TXB0604 345Mbps Auto-Bidirectional Level Translator for High-Speed Interfaces

## 1 Features

- 0.9V to 2V on A port and 1.65V to 3.6V on B port ( $V_{CCA} \leq V_{CCB}$ )
- Maximum data rates:
  - >345Mbps (15pF load)
  - >190Mbps (100pF load)
- Supports high-speed interfaces such as QSPI, OSPI, eSPI
- No direction control signal needed
- $V_{CC}$  isolation feature: if either  $V_{CC}$  input is at GND, all outputs are in the high-impedance state
- Schmitt-trigger inputs allow for slow or noisy inputs
- Output enable (OE) input circuit referenced to  $V_{CCA}$
- Latch-up Performance Exceeds 100mA Per JESD 78, Class II
- ESD Protection Exceeds JESD 22
  - A Port:
    - 2000V Human-Body Model (A114-B)
    - 1000V Charged-Device Model (C101)
  - B Port:
    - 2000V Human-Body Model (A114-B)
    - 1000V Charged-Device Model (C101)

## 2 Applications

- [Data Center and Enterprise Computing](#)
- [Desktop PC](#)
- [Personal Electronics](#)

## 3 Description

The TXB0604 is an 4-bit non-inverting auto-bidirectional translator that uses two separate configurable power-supply rails. This voltage translator/ line redriver can be used to remedy voltage domain mismatches in addition to signal boosting in long-cabling transmission applications.

The TXB0604 leverages a patented design to achieve high data throughput for memory-intensive interfaces like Quad-SPI between BMC and Flash devices without signal integrity losses associated with excessive output parasitic capacitance.

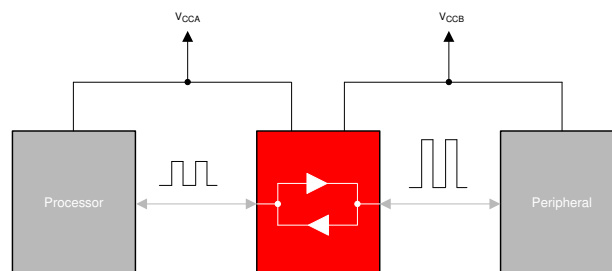
The A port is designed to track  $V_{CCA}$ .  $V_{CCA}$  accepts any supply voltage from 0.9V to 2V. The B port is designed to track  $V_{CCB}$ .  $V_{CCB}$  accepts any supply voltage from 1.65V to 3.6V.

When the OE input is low, all outputs are placed in the high-impedance state. To ensure the high-impedance state during power up or power down, OE must be tied to GND through a pulldown resistor. The current sourcing capability of the driver determines the minimum value of the resistor. The TXB0604 device is designed so the OE input circuit is supplied by  $V_{CCA}$ .

### Package Information

PART NUMBER	PACKAGE <sup>(1)</sup>	BODY SIZE (NOM)
TXB0604PW	TSSOP (14)	5.00mm × 4.40mm
TXB0604RGY	VQFN (14)	3.50mm x 3.50mm
TXB0604RWB	X2QFN (12)	1.6mm x 1.6mm
TXB0604RUT	UQFN (12)	2.00mm x 1.70mm
TXB0604DYY	SOT23-THN (14)	4.20mm × 3.26mm

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



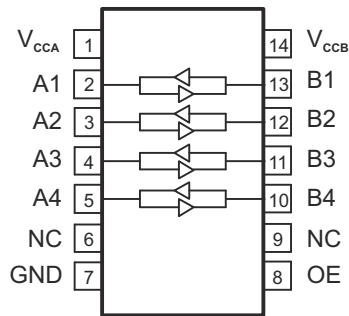
Typical Application Block Diagram for TXB0604



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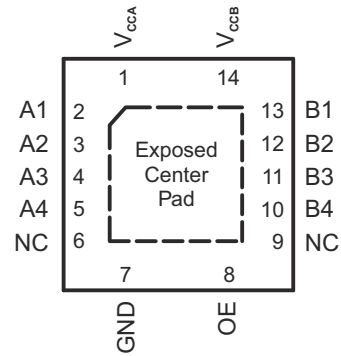
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### 4 Pin Configuration and Functions



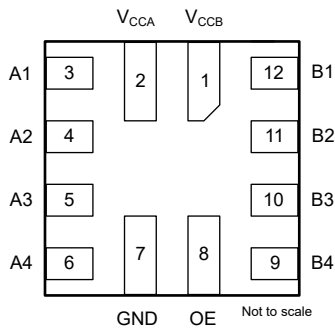
NC – No internal connection

**Figure 4-1. DYY or PW Package, 14-Pin SOT23-THN or TSSOP (Top View)**

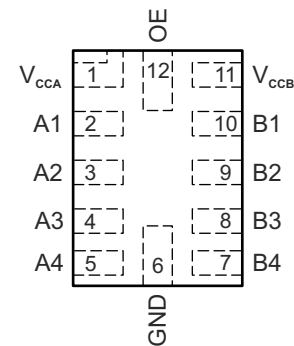


NC – No internal connection

**Figure 4-2. RGY Package, 14-Pin VQFN With Exposed Thermal Pad (Top View)**



**Figure 4-3. RWB Package, 12-Pin X2QFN (Top View)**



**Figure 4-4. RUT Package, 12-Pin UQFN (Top View)**

**ADVANCE INFORMATION**

Table 4-1. Pin Functions

NAME	PIN				I/O	DESCRIPTION
	DYY, PW	RGY	RUT	RWB		
A1	2	2	2	3	I/O	Input/output 1. Referenced to $V_{CCA}$ .
A2	3	3	3	4	I/O	Input/output 2. Referenced to $V_{CCA}$ .
A3	4	4	4	5	I/O	Input/output 3. Referenced to $V_{CCA}$ .
A4	5	5	5	6	I/O	Input/output 4. Referenced to $V_{CCA}$ .
B1	13	13	10	12	I/O	Input/output 1. Referenced to $V_{CCB}$ .
B2	12	12	9	11	I/O	Input/output 2. Referenced to $V_{CCB}$ .
B3	11	11	8	10	I/O	Input/output 3. Referenced to $V_{CCB}$ .
B4	10	10	7	9	I/O	Input/output 4. Referenced to $V_{CCB}$ .
GND	7	7	6	7	—	Ground
NC	6, 9	6,9	—	—	—	No connection. Not internally connected.
OE	8	8	12	8	I	Tri-state output-mode enable. Pull OE low to place all outputs in tri-state mode. Referenced to $V_{CCA}$ .
$V_{CCA}$	1	1	1	2	—	A-port supply voltage $0.9V \leq V_{CCA} \leq 2V$ and $V_{CCA} \leq V_{CCB}$ .
$V_{CCB}$	14	14	11	1	—	B-port supply voltage $1.65V \leq V_{CCB} \leq 3.6V$ .
Thermal pad	—		—	—	—	For the RGY package, the exposed center thermal pad must either be connected to Ground or left electrically open.

## 5 Specifications

### 5.1 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	2.5	V	
V <sub>CCB</sub>	Supply voltage B		-0.5	4.6	V	
V <sub>I</sub>	Input Voltage <sup>(2)</sup>	I/O Ports (A Port)	-0.5	2.5	V	
V <sub>I</sub>	Input Voltage <sup>(2)</sup>	I/O Ports (B Port)	-0.5	4.6	V	
V <sub>I</sub>	Input Voltage <sup>(2)</sup>	OE	-0.5	2.5	V	
V <sub>O</sub>	Voltage applied to any output in the high-impedance or power-off state <sup>(2)</sup>	A Port	-0.5	2.5	V	
		B Port	-0.5	4.6		
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		-50	mA	
I <sub>OK</sub>	Output clamp current	V <sub>O</sub> < 0		-50	mA	
I <sub>O</sub>	Continuous output current			-50	50	mA
	Continuous current through V <sub>CC</sub> or GND			-100	100	mA
T <sub>stg</sub>	Storage temperature			-65	150	°C
T <sub>J</sub>	Junction Temperature				150	°C

- (1) Stresses beyond those listed under [Section 5.1](#) 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 [Section 5.3](#) Exposure beyond the limits listed in [Section 5.3](#) 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 value of V<sub>CCA</sub> and V<sub>CCB</sub> are provided in the recommended operating conditions table.

### 5.2 ESD Ratings

			VALUE	UNIT	
V <sub>(ESD)</sub>	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001	A/B Port	±2	kV
		Charged device model (CDM), per JEDEC specification, JESD220C101	A/B Port	±1	kV

### 5.3 Recommended Operating Conditions

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

			V <sub>CCA</sub>	V <sub>CCB</sub>	MIN	MAX	UNIT
V <sub>CCA</sub>	Supply voltage A				0.9	2	V
V <sub>CCB</sub>	Supply voltage B				1.65	3.6	V
V <sub>I</sub>	Input voltage	A-port I/O's	0.9V to 2V	1.65V to 3.6V	0	V <sub>CCA</sub>	V
		B-port I/O's	0.9V to 2V	1.65V to 3.6V	0	V <sub>CCB</sub>	
		OE Input	0.9V to 2V	1.65V to 3.6V	0	2	
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 [Section 5.4](#)

### 5.4 Electrical Characteristics

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

ADVANCE INFORMATION

PARAMETER	TEST CONDITIONS	V <sub>CCA</sub>	V <sub>CCB</sub>	Operating free-air temperature (T <sub>A</sub> )						UNIT
				–40°C to 85°C			–40°C to 125°C			
				MIN	TYP	MAX	MIN	TYP	MAX	
V <sub>T+</sub>	Positive-going input-threshold voltage	Data Inputs (Ax) (Referenced to V <sub>CCI</sub> )	0.9V	1.65V	0.53	0.66	0.53	0.66	V	
			1.2V	1.8V	0.71	0.86	0.71	0.86		
			1.8V	2.5V	1.05	1.24	1.04	1.24		
			2V	3.6V	1.15	1.36	1.15	1.36		
	Positive-going input-threshold voltage	Data Inputs (Bx) (Referenced to V <sub>CCI</sub> )	0.9V	1.65V	0.86	1.16	0.84	1.16	V	
			1.2V	1.8V	0.93	1.24	0.91	1.24		
			1.8V	2.5V	1.23	1.56	1.23	1.56		
			2V	3.6V	1.72	2.11	1.72	2.11		
	Positive-going input-threshold voltage	OE (Referenced to V <sub>CCA</sub> )	0.9V	1.65V	0.53	0.66	0.52	0.66	V	
			1.2V	1.8V	0.69	0.85	0.68	0.85		
			1.8V	2.5V	0.97	1.17	0.96	1.17		
			2V	3.6V	1.05	1.26	1.05	1.26		
V <sub>T-</sub>	Negative-going input-threshold voltage	Data Inputs (Ax) (Referenced to V <sub>CCI</sub> )	0.9V	1.65V	0.29	0.40	0.29	0.41	V	
			1.2V	1.8V	0.39	0.51	0.39	0.52		
			1.8V	2.5V	0.59	0.74	0.59	0.75		
			2V	3.6V	0.67	0.82	0.67	0.83		
	Negative-going input-threshold voltage	Data Inputs (Bx) (Referenced to V <sub>CCI</sub> )	0.9V	1.65V	0.58	0.83	0.58	0.85	V	
			1.2V	1.8V	0.65	0.91	0.65	0.93		
			1.8V	2.5V	0.99	1.28	0.99	1.29		
			2V	3.6V	1.47	1.83	1.47	1.84		
	Negative-going input-threshold voltage	OE (Referenced to V <sub>CCA</sub> )	0.9V	1.65V	0.29	0.40	0.29	0.41	V	
			1.2V	1.8V	0.39	0.51	0.39	0.52		
			1.8V	2.5V	0.59	0.74	0.59	0.75		
			2V	3.6V	0.67	0.82	0.67	0.83		
ΔV <sub>T</sub>	Input-threshold hysteresis (V <sub>T+</sub> – V <sub>T-</sub> )	Data Inputs (Ax) (Referenced to V <sub>CCI</sub> )	0.9V	1.65V	0.22	0.30	0.21	0.30	V	
			1.2V	1.8V	0.30	0.38	0.28	0.38		
			1.8V	2.5V	0.41	0.54	0.39	0.54		
			2V	3.6V	0.44	0.58	0.42	0.58		
	Input-threshold hysteresis (V <sub>T+</sub> – V <sub>T-</sub> )	Data Inputs (Bx) (Referenced to V <sub>CCI</sub> )	0.9V	1.65V	0.19	0.44	0.17	0.44	V	
			1.2V	1.8V	0.19	0.43	0.17	0.43		
			1.8V	2.5V	0.19	0.38	0.18	0.38		
			2V	3.6V	0.22	0.32	0.21	0.32		
	Input-threshold hysteresis (V <sub>T+</sub> – V <sub>T-</sub> )	OE (Referenced to V <sub>CCA</sub> )	0.9V	1.65V	0.21	0.30	0.20	0.30	V	
			1.2V	1.8V	0.27	0.37	0.26	0.37		
			1.8V	2.5V	0.33	0.48	0.32	0.48		
			2V	3.6V	0.35	0.49	0.34	0.49		
V <sub>OHA</sub>	Port A output high voltage	I <sub>OH</sub> = –20uA	0.9V to 1.2V	1.65V to 3.6V	V <sub>CCA</sub> - 0.2		V <sub>CCA</sub> - 0.2		V	
			1.2V to 2V		V <sub>CCA</sub> - 0.4		V <sub>CCA</sub> - 0.4			
V <sub>OLA</sub>	Port A output low voltage	I <sub>OL</sub> = 20uA	0.9V to 2V	1.65V to 3.6V	0.2		0.25		V	
V <sub>OHB</sub>	Port B output high voltage	I <sub>OH</sub> = –20uA	0.9V to 1.2V	1.65V to 3.6V	V <sub>CCB</sub> - 0.2		V <sub>CCB</sub> - 0.2		V	
			1.2V to 2V		V <sub>CCB</sub> - 0.4		V <sub>CCB</sub> - 0.4			
V <sub>OLB</sub>	Port B output low voltage	I <sub>OL</sub> = 20uA	0.9V to 2V	1.65V to 3.6V	0.2		0.25		V	

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

PARAMETER		TEST CONDITIONS	V <sub>CCA</sub>	V <sub>CCB</sub>	Operating free-air temperature (T <sub>A</sub> )						UNIT
					–40°C to 85°C			–40°C to 125°C			
					MIN	TYP	MAX	MIN	TYP	MAX	
I <sub>I</sub>	Input leakage current	OE V <sub>I</sub> = V <sub>CC</sub> or GND	0.9V to 2V	1.65V to 3.6V			±1			±2	μA
I <sub>OZ</sub>	High-impedance state output current	OE = GND	0.9V to 2V	1.65V to 3.6V			±1			±3	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	0.9V	1.65V to 3.6V			6			17	μA
			1.2V to 2V	1.65V to 3.6V			9			24	
			2V	0V			4			19	
			0V	3.6V			±7.5			±8.5	
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	0.9V	1.65V to 3.6V			10			13	μA
			1.2V to 2V	1.65V to 3.6V			10			13	
			2V	0V			6			12	
			0V	3.6V			2			5	
I <sub>CCZA</sub>	High-impedance state V <sub>CCA</sub> supply current	V <sub>I</sub> = V <sub>CC1</sub> or GND I <sub>O</sub> = 0, OE = GND	0.9V to 2V	1.65V to 3.6V			6			21	μA
I <sub>CCZB</sub>	High-impedance state V <sub>CCB</sub> supply current	V <sub>I</sub> = V <sub>CC1</sub> or GND I <sub>O</sub> = 0, OE = GND	0.9V to 2V	1.65V to 3.6V			4			8	μA
C <sub>i</sub>	Control Input Capacitance	OE	0.9V to 2V	1.65V to 3.6V			3			3	pF
C <sub>io</sub>	Input-to-output internal capacitance	A port	0.9V to 2V	1.65V to 3.6V			5			7	pF
		B port	0.9V to 2V	1.65V to 3.6V			8			9	pF

- (1) V<sub>CC1</sub> is the V<sub>CC</sub> associated with the input port  
(2) V<sub>CC0</sub> is the V<sub>CC</sub> associated with the output port

### 5.5 Switching Characteristics, $V_{CCA} = 0.9V$

PARAMETER		FROM	TO	TEST CONDITIONS	LOAD	B-Port Supply Voltage ( $V_{CCB}$ )						UNIT			
						1.8 ± 0.15V			2.5 ± 0.2V				3.3 ± 0.3V		
						MIN	TYP	MAX	MIN	TYP	MAX		MIN	TYP	MAX
$t_{PHL}$	Propagation Delay (High-to-Low)	A	B	-40°C to 85°C	$C_L = 15pF$	5.1	13.0	4.4	9.2	4.1	9.4	ns			
				-40°C to 85°C	$C_L = 100pF$	6.6	17.6	5.6	12.1	6.2	11.7				
				-40°C to 125°C	$C_L = 15pF$	5.1	13.0	4.4	9.2	4.1	9.4	ns			
				-40°C to 125°C	$C_L = 100pF$	6.6	17.6	5.6	12.1	6.2	11.7				
$t_{PLH}$	Propagation Delay (Low-to-High)			A	B	-40°C to 85°C	$C_L = 15pF$	5.8	14.8	5.1	10.4	4.7	10.2	ns	
						-40°C to 85°C	$C_L = 100pF$	7.3	18.3	6.3	12.9	5.8	11.7		
						-40°C to 125°C	$C_L = 15pF$	5.8	14.8	5.1	10.4	4.7	10.2	ns	
						-40°C to 125°C	$C_L = 100pF$	7.3	18.3	6.3	12.9	5.8	11.7		
$t_{PHL}$	Propagation Delay (High-to-Low)	B	A			-40°C to 85°C	$C_L = 15pF$	4.0	9.6	3.6	8.3	3.4	7.8	ns	
						-40°C to 85°C	$C_L = 100pF$	5.1	12.0	4.7	10.8	4.6	10.4		
						-40°C to 125°C	$C_L = 15pF$	4.0	9.6	3.6	8.3	3.4	7.8	ns	
						-40°C to 125°C	$C_L = 100pF$	5.1	12.0	4.7	10.8	4.6	10.4		
$t_{PLH}$	Propagation Delay (Low-to-High)			B	A	-40°C to 85°C	$C_L = 15pF$	3.7	8.2	3.5	7.0	3.4	6.7	ns	
						-40°C to 85°C	$C_L = 100pF$	5.1	10.9	4.9	9.7	4.7	9.3		
						-40°C to 125°C	$C_L = 15pF$	3.7	8.2	3.5	7.0	3.4	6.7	ns	
						-40°C to 125°C	$C_L = 100pF$	5.1	10.9	4.9	9.7	4.7	9.3		
$t_{DCW}$	Direction Change Wait Time	A or B	B or A			-40°C to 125°C			40		35		35	ns	
$t_{en}$	Enable Time	OE	B			-40°C to 125°C			577		557		588	ns	
		OE	A						447		353		330		
$t_{dis}$	Disable Time	OE	B			-40°C to 125°C			87		87		86	ns	
		OE	A				95		95		96				
$t_{rA}, t_{fA}$	Output Rise/ Fall Time	B	A	-40°C to 85°C	$C_L = 15pF$		1		1		1	ns			
				-40°C to 85°C	$C_L = 100pF$		7.5		7.4		7.3	ns			
				-40°C to 125°C	$C_L = 15pF$		1		1		1	ns			
				-40°C to 125°C	$C_L = 100pF$		7.5		7.4		7.3	ns			
$t_{rB}, t_{fB}$	Output Rise/ Fall Time			A	B	-40°C to 85°C	$C_L = 15pF$		2.6		1.2		1	ns	
						-40°C to 85°C	$C_L = 100pF$		11.6		8.1		6.9	ns	
						-40°C to 125°C	$C_L = 15pF$		2.6		1.2		1	ns	
						-40°C to 125°C	$C_L = 100pF$		11.6		8.1		6.9	ns	

PARAMETER		FROM	TO	TEST CONDITIONS	LOAD	B-Port Supply Voltage (V <sub>CCB</sub> )									UNIT
						1.8 ± 0.15V			2.5 ± 0.2V			3.3 ± 0.3V			
						MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t <sub>sk(o)</sub>	Channel-to-channel skew	A or B	B or A	-40°C to 125°C	C <sub>L</sub> = 15pF	0.5			0.5			0.5			ns
Z <sub>OS,B</sub>	One-Shot Impedance	B	A	-40°C to 125°C		27.8			22.3			21			Ω
Data Rate	Maximum data rate	A or B	B or A	-40°C to 125°C	C <sub>L</sub> = 15pF <sup>(1)</sup>	85	142		129	180		128	166		Mbps
		A or B	B or A	-40°C to 125°C	C <sub>L</sub> = 100pF <sup>(1)</sup>	83	118		54	137		48	137		Mbps

(1) C<sub>L</sub> is given as a lumped capacitance at the output.

### 5.6 Switching Characteristics, V<sub>CCA</sub> = 1.2V

PARAMETER		FROM	TO	TEST CONDITIONS	LOAD	B-Port Supply Voltage (V <sub>CCB</sub> )									UNIT		
						1.8 ± 0.15V			2.5 ± 0.2V			3.3 ± 0.3V					
						MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX			
t <sub>PHL</sub>	Propagation Delay (High-to-Low)	A	B	-40°C to 85°C	C <sub>L</sub> = 15pF	4.2	12.0		3.5	7.9		3.1	6.6	ns			
				-40°C to 85°C	C <sub>L</sub> = 100pF	5.7	16.6		4.7	10.9		4.2	8.9				
				-40°C to 125°C	C <sub>L</sub> = 15pF	4.2	12.0		3.5	7.9		3.1	6.6	ns			
				-40°C to 125°C	C <sub>L</sub> = 100pF	5.7	16.6		4.7	10.9		4.2	8.9				
t <sub>PLH</sub>	Propagation Delay (Low-to-High)			A	B	-40°C to 85°C	C <sub>L</sub> = 15pF	4.5	13.3		3.8	8.9		3.4	7.4	ns	
						-40°C to 85°C	C <sub>L</sub> = 100pF	6.1	16.8		5.1	11.3		4.5	9.4		
						-40°C to 125°C	C <sub>L</sub> = 15pF	4.5	13.3		3.8	8.9		3.4	7.4	ns	
						-40°C to 125°C	C <sub>L</sub> = 100pF	6.1	16.8		5.1	11.3		4.5	9.4		
t <sub>PHL</sub>	Propagation Delay (High-to-Low)	B	A			-40°C to 85°C	C <sub>L</sub> = 15pF	2.8	6.9		2.5	5.4		2.3	4.8	ns	
						-40°C to 85°C	C <sub>L</sub> = 100pF	3.8	8.3		3.4	6.8		3.3	6.2		
						-40°C to 125°C	C <sub>L</sub> = 15pF	2.8	6.9		2.5	5.4		2.3	4.8	ns	
						-40°C to 125°C	C <sub>L</sub> = 100pF	3.8	8.3		3.4	6.8		3.3	6.2		
t <sub>PLH</sub>	Propagation Delay (Low-to-High)			B	A	-40°C to 85°C	C <sub>L</sub> = 15pF	2.7	6.3		2.4	5.0		2.2	4.5	ns	
						-40°C to 85°C	C <sub>L</sub> = 100pF	3.8	8.0		3.5	6.7		3.3	6.3		
						-40°C to 125°C	C <sub>L</sub> = 15pF	2.7	6.3		2.4	5.0		2.2	4.5	ns	
						-40°C to 125°C	C <sub>L</sub> = 100pF	3.8	8.0		3.5	6.7		3.3	6.3		
t <sub>DCW</sub>	Direction Change Wait Time	A or B	B or A			-40°C to 125°C		40			35			35			ns
t <sub>en</sub>	Enable Time	OE	B			-40°C to 125°C		463			433			429			ns
		OE	A					413			319			296			

PARAMETER		FROM	TO	TEST CONDITIONS	LOAD	B-Port Supply Voltage (V <sub>CCB</sub> )									UNIT			
						1.8 ± 0.15V			2.5 ± 0.2V			3.3 ± 0.3V						
						MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX				
t <sub>dis</sub>	Disable Time	OE	B	-40°C to 125°C					89			87			86			ns
		OE	A						95			95			95			
t <sub>rA</sub> , t <sub>fA</sub>	Output Rise/ Fall Time	B	A	-40°C to 85°C	C <sub>L</sub> = 15pF				0.8			0.8			0.8			ns
					C <sub>L</sub> = 100pF				6.1			6.1			6.2			
				-40°C to 125°C	C <sub>L</sub> = 15pF				0.8			0.8			0.8			
					C <sub>L</sub> = 100pF				6.1			6.1			6.2			
t <sub>rB</sub> , t <sub>fB</sub>	Output Rise/ Fall Time	A	B	-40°C to 85°C	C <sub>L</sub> = 15pF				2.6			1.3			1			ns
					C <sub>L</sub> = 100pF				11.6			8.1			6.9			
				-40°C to 125°C	C <sub>L</sub> = 15pF				2.6			1.3			1			
					C <sub>L</sub> = 100pF				11.6			8.1			6.9			
t <sub>sk(o)</sub>	Channel-to-channel skew	A or B	B or A	-40°C to 125°C	C <sub>L</sub> = 15pF				0.5			0.5			0.5			ns
Z <sub>OS,A</sub>	One-Shot Impedance	A or B	B or A			27.8			22.3			21						Ω
Data Rate	Maximum data rate	A or B	B or A		C <sub>L</sub> = 15pF <sup>(1)</sup>	142	211		208	292		229	309					Mbps
		A or B	B or A		C <sub>L</sub> = 100pF <sup>(1)</sup>	103	141		137	149		140	149					

(1) C<sub>L</sub> is given as a lumped capacitance at the output.

### 5.7 Switching Characteristics, V<sub>CCA</sub> = 1.5V ± 0.1V

PARAMETER		FROM	TO	TEST CONDITIONS	LOAD	B-Port Supply Voltage (V <sub>CCB</sub> )									UNIT		
						1.8 ± 0.15V			2.5 ± 0.2V			3.3 ± 0.3V					
						MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX			
t <sub>PHL</sub>	Propagation Delay (High-to-Low)	A	B	-40°C to 85°C	C <sub>L</sub> = 15pF	3.8	11.9		3.2	7.6		2.8	6.1		ns		
				-40°C to 85°C	C <sub>L</sub> = 100pF	5.2	16.7		4.3	10.7		3.8	8.5		ns		
				-40°C to 125°C	C <sub>L</sub> = 15pF	3.8	11.9		3.2	7.6		2.8	6.1		ns		
				-40°C to 125°C	C <sub>L</sub> = 100pF	5.2	16.7		4.3	10.7		3.8	8.5		ns		
t <sub>PLH</sub>	Propagation Delay (Low-to-High)	A	B	-40°C to 85°C	C <sub>L</sub> = 15pF	4.0	13.1		3.4	8.4		3.0	6.7		ns		
				-40°C to 85°C	C <sub>L</sub> = 100pF	5.5	16.7		4.5	11.0		4.0	8.9		ns		
				-40°C to 125°C	C <sub>L</sub> = 15pF	4.0	13.1		3.4	8.4		3.0	6.7		ns		
				-40°C to 125°C	C <sub>L</sub> = 100pF	5.5	16.7		4.5	11.0		4.0	8.9		ns		

PARAMETER		FROM	TO	TEST CONDITIONS	LOAD	B-Port Supply Voltage (V <sub>CCB</sub> )						UNIT					
						1.8 ± 0.15V			2.5 ± 0.2V				3.3 ± 0.3V				
						MIN	TYP	MAX	MIN	TYP	MAX		MIN	TYP	MAX		
t <sub>PHL</sub>	Propagation Delay (High-to-Low)	B	A	-40°C to 85°C	C <sub>L</sub> = 15pF	2.5		6.4	2.2		4.7	2.0		4.1	ns		
				-40°C to 85°C	C <sub>L</sub> = 100pF	3.4		7.7	3.0		6.1	2.9		5.4			
				-40°C to 125°C	C <sub>L</sub> = 15pF	2.5		6.4	2.2		4.7	2.0		4.1		ns	
				-40°C to 125°C	C <sub>L</sub> = 100pF	3.4		7.7	3.0		6.1	2.9		5.4			
t <sub>PLH</sub>	Propagation Delay (Low-to-High)			B	A	-40°C to 85°C	C <sub>L</sub> = 15pF	2.4		5.9	2.1		4.5	1.9		3.9	ns
						-40°C to 85°C	C <sub>L</sub> = 100pF	3.4		7.5	3.1		6.1	2.9		5.5	
						-40°C to 125°C	C <sub>L</sub> = 15pF	2.4		5.9	2.1		4.5	1.9		3.9	ns
						-40°C to 125°C	C <sub>L</sub> = 100pF	3.4		7.5	3.1		6.1	2.9		5.5	
t <sub>DCW</sub>	Direction Change Wait Time	A or B	B or A			-40°C to 125°C				40			35			35	ns
t <sub>en</sub>	Enable Time	OE	B			-40°C to 125°C				382			356			350	ns
			A			-40°C to 125°C			408			313			291		
t <sub>dis</sub>	Disable Time		B			-40°C to 125°C				89			88			87	
			A	-40°C to 125°C			95			95			95				
t <sub>rA</sub> , t <sub>fA</sub>	Output Rise/ Fall Time	B	A	-40°C to 85°C	C <sub>L</sub> = 15pF			0.8			0.8			0.8	ns		
				-40°C to 85°C	C <sub>L</sub> = 100pF			5.8			5.9			6			
				-40°C to 125°C	C <sub>L</sub> = 15pF			0.8			0.8			0.8			
				-40°C to 125°C	C <sub>L</sub> = 100pF			5.8			5.9			6			
t <sub>rB</sub> , t <sub>fB</sub>	Output Rise/ Fall Time			A	B	-40°C to 85°C	C <sub>L</sub> = 15pF			2.6			1.3			1	ns
						-40°C to 85°C	C <sub>L</sub> = 100pF			11.6			8.1			6.9	
						-40°C to 125°C	C <sub>L</sub> = 15pF			2.6			1.3			1	
						-40°C to 125°C	C <sub>L</sub> = 100pF			11.6			8.1			6.9	
t <sub>sk(o)</sub>	Channel-to-channel skew	A or B	B or A			-40°C to 125°C				0.5			0.5			0.5	ns
Z <sub>OS,A</sub>	One-Shot Impedance	A or B	A or B			-40°C to 125°C			27.8			22.3			21	Ω	
Data Rate	Maximum data rate	A or B	B or A			C <sub>L</sub> = 15pF <sup>(1)</sup>		154	237		244	372		308	378	Mbps	
		A or B	B or A			C <sub>L</sub> = 100pF <sup>(1)</sup>		104	145		151	199		147	221		

(1) C<sub>L</sub> is given as a lumped capacitance at the output.

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

PARAMETER		FROM	TO	TEST CONDITIONS	LOAD	B-Port Supply Voltage ( $V_{CCB}$ )						UNIT			
						1.8 ± 0.15V			2.5 ± 0.2V				3.3 ± 0.3V		
						MIN	TYP	MAX	MIN	TYP	MAX		MIN	TYP	MAX
$t_{PHL}$	Propagation Delay (Hight-to-Low)	A	B	-40°C to 85°C	$C_L = 15pF$	3.7	11.7	3.0	7.3	2.7	5.8	ns			
				-40°C to 85°C	$C_L = 100pF$	5.1	16.5	4.1	10.4	3.6	8.3				
				-40°C to 125°C	$C_L = 15pF$	3.7	11.7	3.0	7.3	2.7	5.8	ns			
				-40°C to 125°C	$C_L = 100pF$	5.1	16.5	4.1	10.4	3.6	8.3				
$t_{PLH}$	Propagation Delay (Low-to-High)			A	B	-40°C to 85°C	$C_L = 15pF$	3.9	12.8	3.2	8.0	2.8	6.4	ns	
						-40°C to 85°C	$C_L = 100pF$	5.4	16.4	4.4	10.6	3.9	8.5		
						-40°C to 125°C	$C_L = 15pF$	3.9	12.8	3.2	8.0	2.8	6.4	ns	
						-40°C to 125°C	$C_L = 100pF$	5.4	16.4	4.4	10.6	3.9	8.5		
$t_{PHL}$	Propagation Delay (Hight-to-Low)	B	A			-40°C to 85°C	$C_L = 15pF$	2.5	6.2	2.1	4.4	1.9	3.7	ns	
						-40°C to 85°C	$C_L = 100pF$	3.3	7.5	2.9	5.8	2.8	5.1		
						-40°C to 125°C	$C_L = 15pF$	2.5	6.2	2.1	4.4	1.9	3.7	ns	
						-40°C to 125°C	$C_L = 100pF$	3.3	7.5	2.9	5.8	2.8	5.1		
$t_{PLH}$	Propagation Delay (Low-to-High)			B	A	-40°C to 85°C	$C_L = 15pF$	2.3	5.7	2.0	4.2	1.8	3.6	ns	
						-40°C to 85°C	$C_L = 100pF$	3.3	7.3	3.0	5.8	2.8	5.2		
						-40°C to 125°C	$C_L = 15pF$	2.3	5.7	2.0	4.2	1.8	3.6	ns	
						-40°C to 125°C	$C_L = 100pF$	3.3	7.3	3.0	5.8	2.8	5.2		
$t_{DCW}$	Direction Change Wait Time	A or B	B or A			-40°C to 125°C		40		35		35	ns		
$t_{en}$	Enable Time	OE	A or B			-40°C to 125°C		348		320		315	ns		
			A or B			-40°C to 125°C		407		313		290			
$t_{dis}$	Disable Time		A or B			-40°C to 125°C		94		91		89			
			A or B	-40°C to 125°C		94		95		95					
$t_{rA}, t_{fA}$	Ouput Rise/ Fall Time	B	A	-40°C to 85°C	$C_L = 15pF$		0.8		0.8		0.8	ns			
				-40°C to 85°C	$C_L = 100pF$		5.8		5.8		5.9				
				-40°C to 125°C	$C_L = 15pF$		0.8		0.8		0.8				
				-40°C to 125°C	$C_L = 100pF$		5.8		5.8		5.9				
$t_{rB}, t_{fB}$	Ouput Rise/ Fall Time			A	B	-40°C to 85°C	$C_L = 15pF$		2.6		1.3		1	ns	
						-40°C to 85°C	$C_L = 100pF$		11.6		8.1		7		
						-40°C to 125°C	$C_L = 15pF$		2.6		1.3		1		
						-40°C to 125°C	$C_L = 100pF$		11.6		8.1		7		

PARAMETER		FROM	TO	TEST CONDITIONS	LOAD	B-Port Supply Voltage (V <sub>CCB</sub> )						UNIT			
						1.8 ± 0.15V			2.5 ± 0.2V				3.3 ± 0.3V		
						MIN	TYP	MAX	MIN	TYP	MAX		MIN	TYP	MAX
t <sub>sk(o)</sub>	Channel-to-channel skew	A or B	B or A	-40°C to 125°C	C <sub>L</sub> = 15pF	0.5			0.5			ns			
Z <sub>OS,A</sub>	One-Shot Impedance	A or B	A or B	-40°C to 125°C		27.8			22.3			Ω			
Data Rate	Maximum data rate	A or B	B or A	C <sub>L</sub> = 15pF <sup>(1)</sup>		158	260		269	402		345	449	Mbps	
		A or B	B or A	C <sub>L</sub> = 100pF <sup>(1)</sup>		107	150		156	213		190	236		

(1) C<sub>L</sub> is given as a lumped capacitance at the output.

### 5.9 Switching Characteristics: T<sub>sk</sub>, T<sub>MAX</sub> (-40°C to 125°C)

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

PARAMETER	TEST CONDITIONS	V <sub>CC1</sub>	V <sub>CC0</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>CC0</sub> 20% of pulse < 0.3*V <sub>CC0</sub>	TX Line: 20inch + 50pF Clod	0.9V - 2V	1.8V - 2V	70	99	Mbps
T <sub>MAX</sub> - Maximum Data Rate	50% Duty Cycle Input One channel switching 20% of pulse > 0.7*V <sub>CC0</sub> 20% of pulse < 0.3*V <sub>CC0</sub>	TX Line: 20inch + 50pF Clod	1.2V - 2V	1.8V - 2V	80	111	Mbps
T <sub>MAX</sub> - Maximum Data Rate	50% Duty Cycle Input One channel switching 20% of pulse > 0.7*V <sub>CC0</sub> 20% of pulse < 0.3*V <sub>CC0</sub>	TX Line: 20inch + 50pF Clod	1.65V - 2V	1.8V - 2V	80	115	Mbps
T <sub>MAX</sub> - Maximum Data Rate	50% Duty Cycle Input One channel switching 20% of pulse > 0.7*V <sub>CC0</sub> 20% of pulse < 0.3*V <sub>CC0</sub>	TX Line: 20inch + 50pF Clod	0.9V - 2V	3.6V	82	120	Mbps
T <sub>MAX</sub> - Maximum Data Rate	50% Duty Cycle Input One channel switching 20% of pulse > 0.7*V <sub>CC0</sub> 20% of pulse < 0.3*V <sub>CC0</sub>	TX Line: 20inch + 50pF Clod	1.2V - 2V	3.6V	132	170	Mbps
T <sub>MAX</sub> - Maximum Data Rate	50% Duty Cycle Input One channel switching 20% of pulse > 0.7*V <sub>CC0</sub> 20% of pulse < 0.3*V <sub>CC0</sub>	TX Line: 20inch + 50pF Clod	1.65V - 2V	3.6V	142	187	Mbps

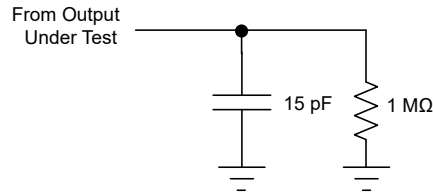
## 6 Parameter Measurement Information

Unless otherwise noted, all input pulses are supplied by generators that have the following characteristics:

- PRR 10MHz
- $Z_O = 50\Omega$
- $dv/dt \geq 1V/ns$

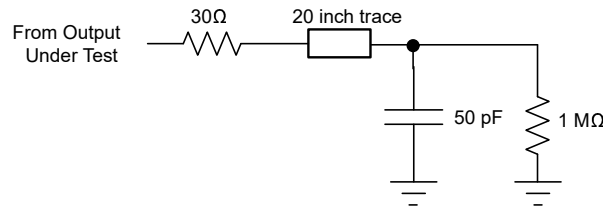
### Note

All parameters and waveforms are not applicable to all devices.



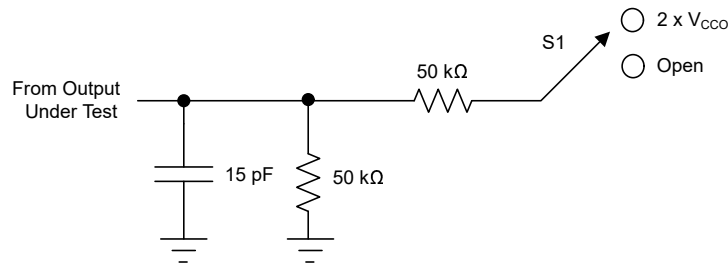
- A. The outputs are measured one at a time, with one transition per measurement.

**Figure 6-1. Lumped Capacitive Load Circuit For Maximum Data Rate & Propagation Delay, Output Rise, And Fall Time Measurement**



- A. The outputs are measured one at a time, with one transition per measurement.

**Figure 6-2. Long Trace + Capacitive Load Circuit For Maximum Data Rate**



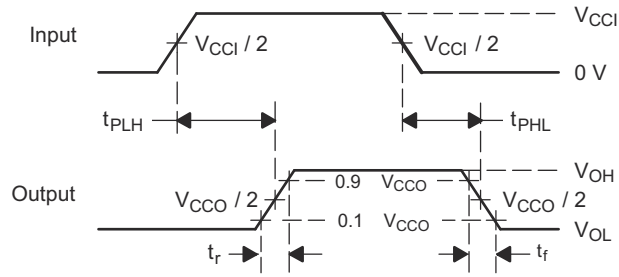
- A. The outputs are measured one at a time, with one transition per measurement.

**Figure 6-3. Load Circuit For Enable and Disable Time Measurement**

**Table 6-1. Switch Position For Enable and Disable Time Measurement**

TEST <sup>(1)</sup>	S1
$t_{PZL}$ , $t_{PLZ}$	$2 \times V_{CC0}$
$t_{PHZ}$ , $t_{PZH}$	Open

(1) See [Figure 6-3](#)



- A.  $V_{CCI}$  is the  $V_{CC}$  associated with the input port.
- B.  $V_{CCO}$  is the  $V_{CC}$  associated with the output port.
- C.  $t_{PLH}$  and  $t_{PHL}$  are the same as  $t_{pd}$ .
- D. The outputs are measured one at a time, with one transition per measurement.

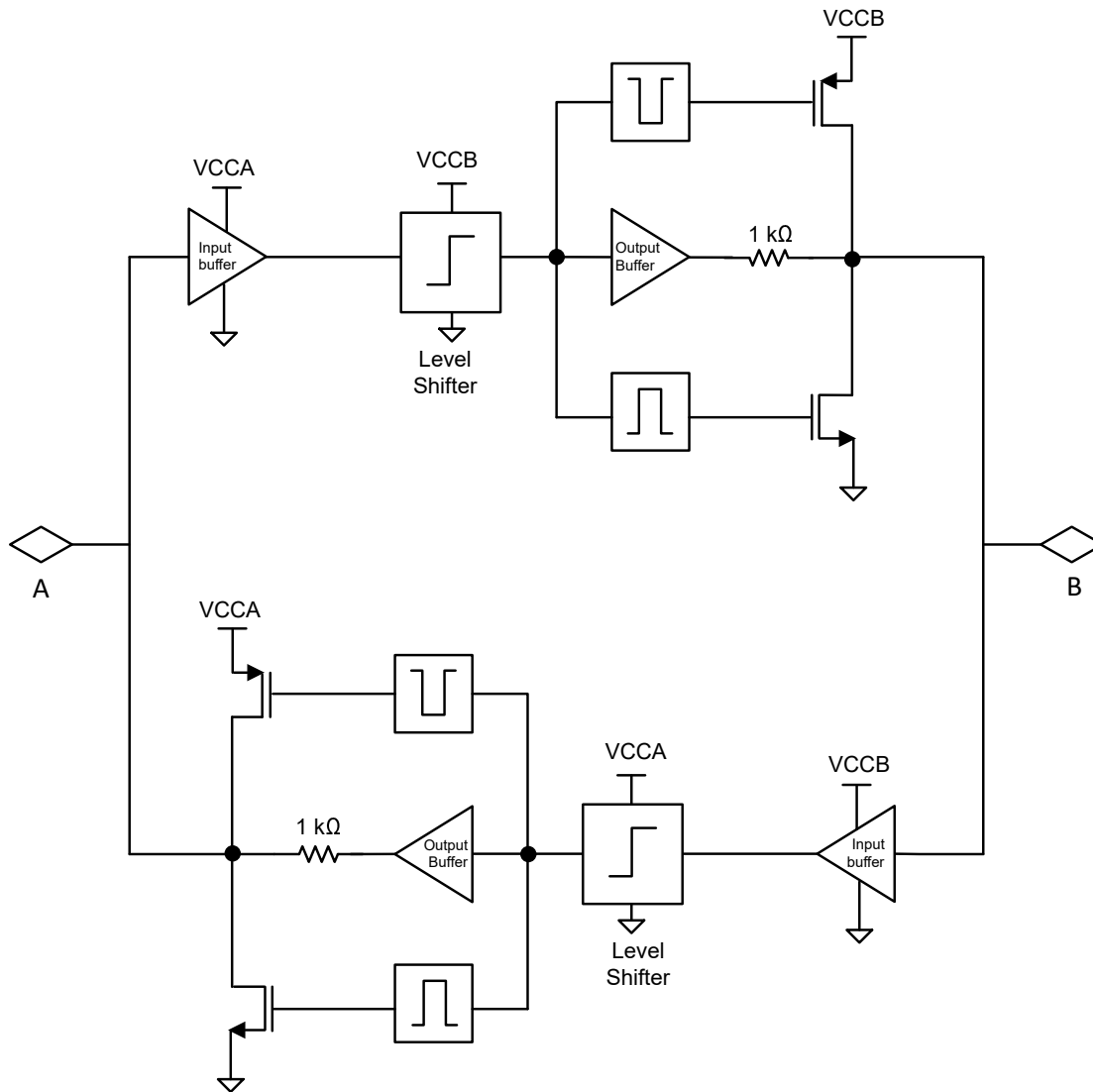
**Figure 6-4. Voltage Waveforms Propagation Delay Times**

## 7 Detailed Description

### 7.1 Overview

The TXB0604 device is a 4-bit, bidirectional voltage-level translator with auto-direction sensing specifically designed for translating logic voltage levels. The A port is able to accept I/O voltages ranging from 0.9V to 2V, while the B port can accept I/O voltages from 1.65V to 3.6V. The device is a buffered architecture with edge-rate accelerators (one-shots) to improve the overall data rate. This device can only translate push-pull CMOS logic outputs. If for open-drain signal translation, please refer to TI's TXS010X products.

### 7.2 Functional Block Diagram

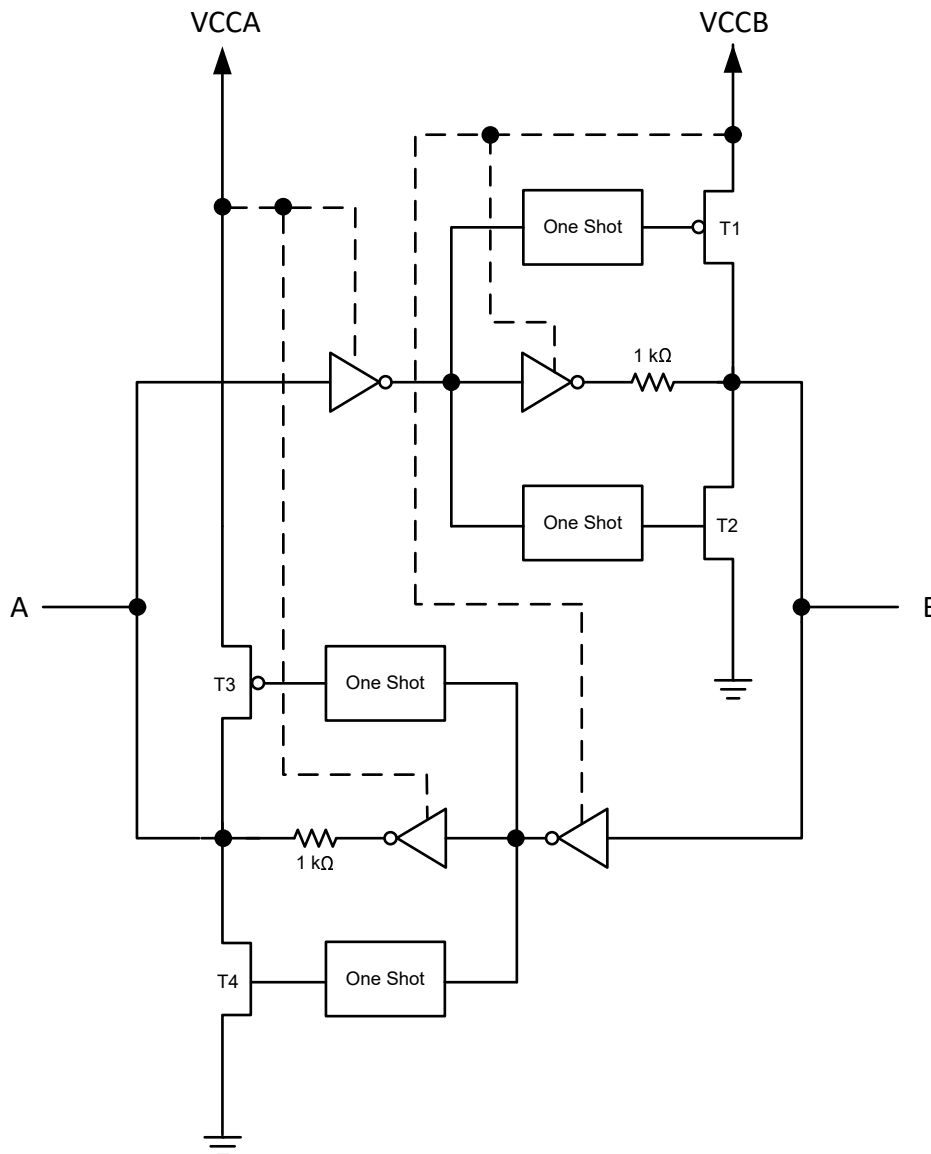


## 7.3 Feature Description

### 7.3.1 Architecture

The TXB0604 device architecture (see [Figure 7-1](#)) does not require a direction-control signal to control the direction of data flow from A to B or from B to A. In a DC state, the output drivers of the device maintain a high or low, but are designed to be weak, so the output drivers can be overdriven by an external driver when data on the bus flows the opposite direction.

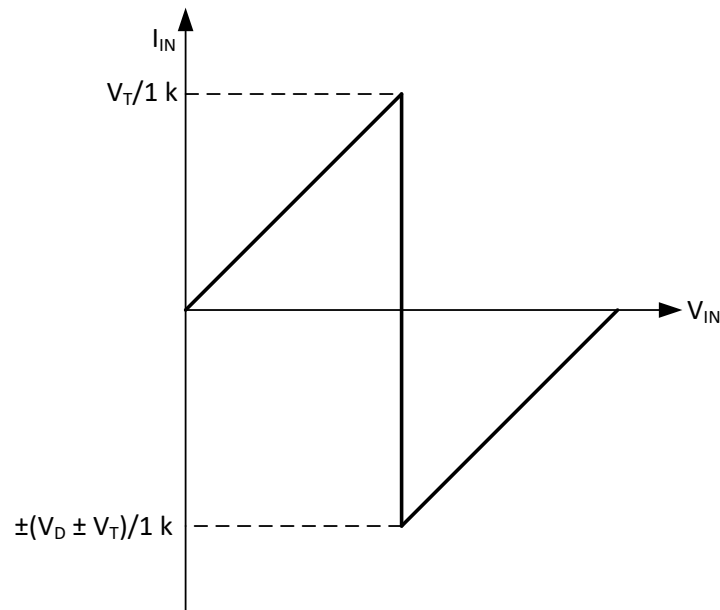
The output one-shots detect rising or falling edges on the A or B ports. During a rising edge, the one-shot turns on the PMOS transistors (T1, T3) for a short duration, which speeds up the low-to-high transition. Similarly, during a falling edge, the one-shot turns on the NMOS transistors (T2, T4) for a short duration, which speeds up the high-to-low transition. The typical output impedance during output transition is approximately  $28\Omega$  at  $V_{CCO} = 1.8V$ , approximately  $22\Omega$  at  $V_{CCO} = 2.5V$ , and  $21\Omega$  at  $V_{CCO} = 3.3V$ .



**Figure 7-1. Architecture of TXB0604 Device I/O Cell**

### 7.3.2 Input Driver Requirements

Typical  $I_{IN}$  vs  $V_{IN}$  characteristics of the device are shown in Figure 7-2. For proper operation, the device driving the data I/Os of the TXB0604 device must have drive strength of at least  $\pm 3\text{mA}$ .



- A.  $V_T$  is the input threshold of the TXB0604 device, (typically  $V_{CC} / 2$ ).
- B.  $V_D$  is the supply voltage of the external driver.

Figure 7-2. Typical  $I_{IN}$  vs  $V_{IN}$  Curve

### 7.3.3 Output Load Considerations

TI recommends following careful PCB layout practices to minimize signal distortion and ringing. Impedance matching techniques should be implemented to reduce output oscillations and ensure signal integrity. Series termination resistors are recommended at the device outputs to match the total output impedance to the transmission line.

For example, given that the device output impedance is  $21\Omega$  ( $V_{CCA} = 0.9$  to  $2\text{V}$  and  $V_{CCB} = 3.3\text{V}$ ), adding a series resistor value of  $30\Omega$  provides an effective source impedance close to  $50\Omega$ , matching a typical controlled-impedance trace or cable.

### 7.3.4 Enable and Disable

The TXB0604 has an OE input that is used to disable the device by setting OE = low, which places all I/Os in the high-impedance (Hi-Z) state. The disable time ( $t_{dis}$ ) indicates the delay between when OE goes low and when the outputs actually get disabled (Hi-Z). The enable time ( $t_{en}$ ) indicates the amount of time the user must allow for the one-shot circuitry to become operational after OE is taken high.

### 7.3.5 Pullup or Pulldown Resistors on I/O Lines

The device is designed to support high-drive applications with either a lumped capacitive load of up to  $100\text{pF}$  or a signal trace length of up to 20 inches with a  $50\text{pF}$  load. The output drivers of the TXB0604 device have low DC drive strength. If pullup or pulldown resistors are connected externally to the data I/Os, their values must be kept higher than  $20\text{k}\Omega$  to ensure that they do not contend with the output drivers of the TXB0604 device.

For the same reason, the TXB0604 device must not be used in applications such as I<sup>2</sup>C or 1-Wire where an open-drain driver is connected on the bidirectional data I/O. For these applications, use a device from the TI TXS series of level translators.

### 7.3.6 Dummy Cycles

When TXB0604 is used in Quad-SPI (QSPI) interfaces between a microcontroller and serial flash memory, the direction of the data flow can change dynamically between the controller and the memory device. Given the TXB0604 features automatic direction sensing, a minimum turn-around time of 40ns is required for the device to transition from one direction to the other. This is shown under the Switching Characteristics table as  $t_{DCW}$  - Direction Change Wait Time.

To ensure proper bus timing, the QSPI controller must insert sufficient dummy clock cycles after the command and address phase before data is sampled from the flash memory. The total dummy period must be greater or equal to the TXB0604 turn-around time of 40ns.

As an example, at a QSPI clock frequency of 104MHz:

$$1/104MHz = 9.6ns \tag{1}$$

$$40ns/9.6ns = 4.16ns \rightarrow 5 \text{ dummy cycles} \tag{2}$$

Many flash devices, such as the ISSI IS25LQ040B, specify 8 dummy cycles at 104MHz frequency, which satisfies the TXB0604 requirement and provides additional margin.

### 7.4 Device Functional Modes

The device has two functional modes, enabled and disabled. To disable the device, set the OE input to low, which places all I/Os in a high impedance state. Setting the OE input to high will enable the device.

## 8 Application and Implementation

### Note

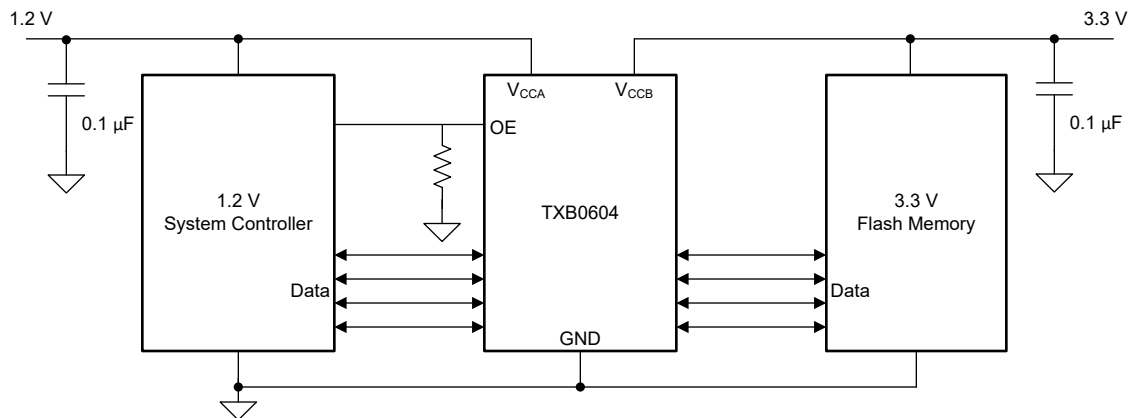
Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes, as well as validating and testing their design implementation to confirm system functionality.

### 8.1 Application Information

The TXB0604 device can be used in level-translation applications for interfacing devices or systems operating at different interface voltages with one another. It can only translate push-pull CMOS logic outputs. If for open-drain signal translation, please refer to TI TXS010X products. Any external pulldown or pullup resistors are recommended larger than 20kΩ.

The device features enhanced output drive strength for use in high-speed interfaces such as QSPI, OSPI, eSPI, etc. The device is designed to support high-drive applications with either a lumped capacitive load of up to 100pF at 190Mbps or a signal trace length of up to 20 inches with a 50pF load at 142Mbps.

### 8.2 Typical Application



#### 8.2.1 Design Requirements

For this design example, use the parameters listed in [Table 8-1](#). And make sure the  $V_{CCA} \leq V_{CCB}$ .

**Table 8-1. Design Parameters**

DESIGN PARAMETERS	EXAMPLE VALUE
Input voltage range	0.9V to 2V
Output voltage range	1.65V to 3.6V

### 8.2.2 Detailed Design Procedure

To begin the design process, determine the following:

- Series resistor at the device outputs
  - Series resistors must be placed at the device outputs to improve signal integrity and to match the total output impedance to the external transmission path. For example, given that the device output impedance is 21Ω, a 30Ω series resistor provides an effective source impedance close to 50Ω, matching a typical controlled-impedance PCB trace or cable connection.
- Input voltage range
  - Use the supply voltage of the device that is driving the TXB0604 device to determine the input voltage range. For a valid logic high, the value must exceed the  $V_{IH}$  of the input port. For a valid logic low, the value must be less than the  $V_{IL}$  of the input port.
- An external pulldown or pullup resistor decreases the output  $V_{OH}$  and  $V_{OL}$ . Use the below equations to draft estimate the  $V_{OH}$  and  $V_{OL}$  as a result of an external pulldown and pullup resistor.

$$V_{OH} = V_{CCx} \times R_{PD} / (R_{PD} + 1.5k\Omega) \quad (3)$$

$$V_{OL} = V_{CCx} \times 1.5k\Omega / (R_{PU} + 1.5k\Omega) \quad (4)$$

Where

- $V_{CCx}$  is the output port supply voltage on either  $V_{CCA}$  or  $V_{CCB}$
- $R_{PD}$  is the value of the external pull down resistor
- $R_{PU}$  is the value of the external pull up resistor
- 1.5kΩ is the counting the variation of the serial resistor 1kΩ in the I/O line.

## 9 Power Supply Recommendations

During operation, ensure that  $V_{CCA} \leq V_{CCB}$  at all times. During power-up sequencing,  $V_{CCA} \geq V_{CCB}$  does not damage the device, so any power supply can be ramped up first. Please ensure that  $V_{CCA/B}$  is powered on before the I/O ports.

The output-enable (OE) input circuit is designed so that it is supplied by  $V_{CCA}$  and when the (OE) input is low, all outputs are placed in the high-impedance state. To ensure the high-impedance state of the outputs during power up or power down, the OE input pin must be tied to GND through a pull-down resistor and must not be enabled until  $V_{CCA}$  and  $V_{CCB}$  are fully ramped and stable. The minimum value of the pull-down resistor to ground is determined by the current-sourcing capability of the driver.

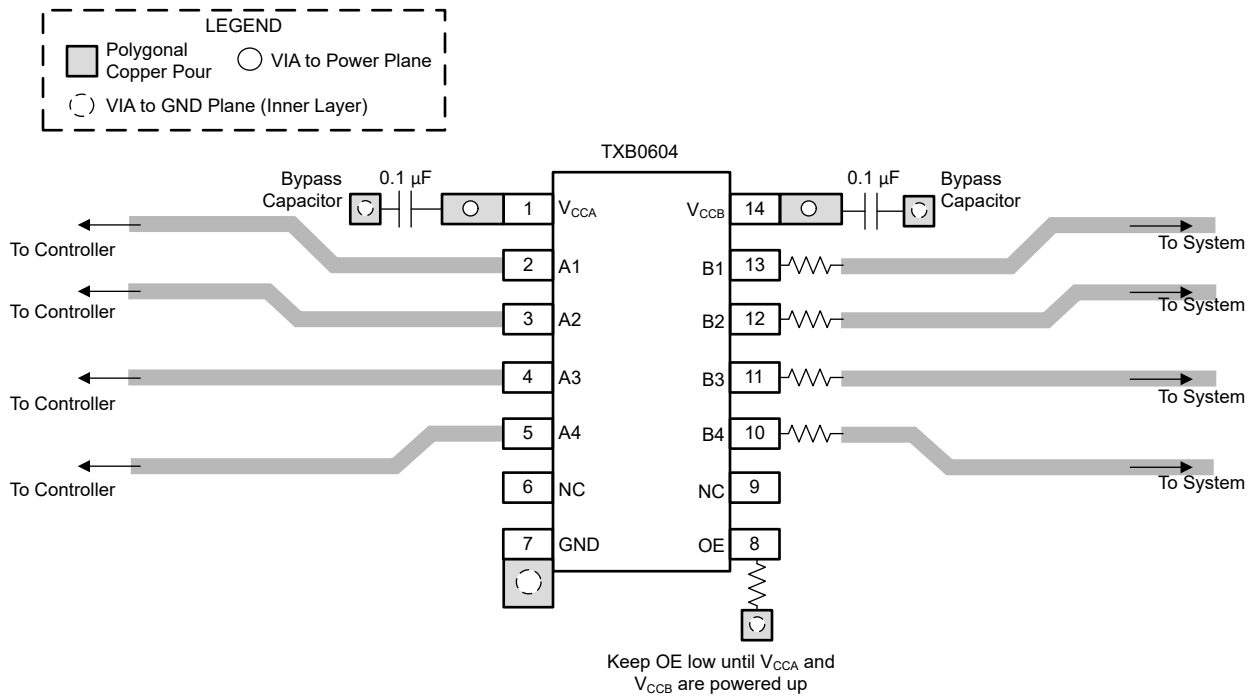
## 10 Layout

### 10.1 Layout Guidelines

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

- Bypass capacitors must be used on power supplies, and must be placed as close as possible to the  $V_{CCA}$ ,  $V_{CCB}$  pin and GND pin.
- Series resistors must be placed at the device outputs to improve signal integrity and match the total output impedance to the external transmission path. For example, given that the device output impedance is  $21\Omega$ , a  $30\Omega$  series resistor provides an effective source impedance close to  $50\Omega$ , matching a typical controlled-impedance PCB trace or cable connection.
- During operation, the data direction changes dynamically between the host and the target device. A direction-change delay ( $t_{DCW}$ ) must be provided before the bus switches direction between the host and target device. Ensure that the delay between direction changes meets the  $t_{DCW}$  requirement listed in the Switching Characteristics table. In QSPI applications, this delay corresponds to dummy clock cycles inserted between the command/address and data phases to satisfy the required turn-around time.

### 10.2 Layout Example



## 11 Device and Documentation Support

### 11.1 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on [ti.com](http://ti.com). Click on *Notifications* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

### 11.2 Support Resources

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

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

### 11.3 Trademarks

TI E2E™ is a trademark of Texas Instruments.  
All trademarks are the property of their respective owners.

### 11.4 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.

### 11.5 Glossary

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

## 12 Revision History

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

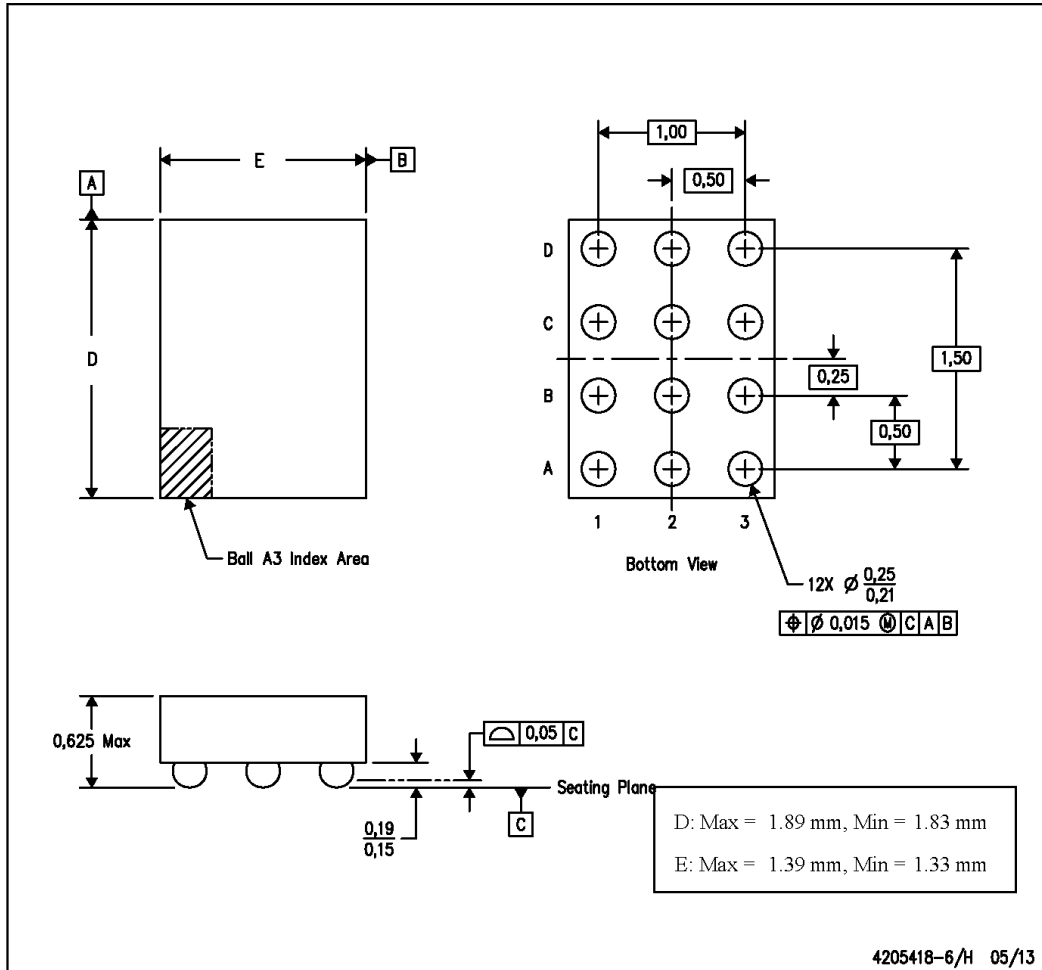
DATE	REVISION	NOTES
October 2025	*	Initial Release

## 13 Mechanical, Packaging, and Orderable Information

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

**MECHANICAL DATA**

YZT (R-XBGA-N12) (CUSTOM) DIE-SIZE BALL GRID ARRAY



- NOTES:
- All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
  - This drawing is subject to change without notice.
  - NanoFree™ package configuration.

NanoFree is a trademark of Texas Instruments.

**PACKAGING INFORMATION**

Orderable part number	Status (1)	Material type (2)	Package   Pins	Package qty   Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
<a href="#">PTXB0604DYR</a>	Active	Preproduction	SOT-23-THIN (DYY)   14	3000   LARGE T&R	-	Call TI	Call TI	-40 to 125	
<a href="#">PTXB0604PWR</a>	Active	Preproduction	TSSOP (PW)   14	3000   LARGE T&R	-	Call TI	Call TI	-40 to 125	
<a href="#">PTXB0604RUTR</a>	Active	Preproduction	UQFN (RUT)   12	3000   LARGE T&R	-	Call TI	Call TI	-40 to 125	

(1) **Status:** For more details on status, see our [product life cycle](#).

(2) **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.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

(4) **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.

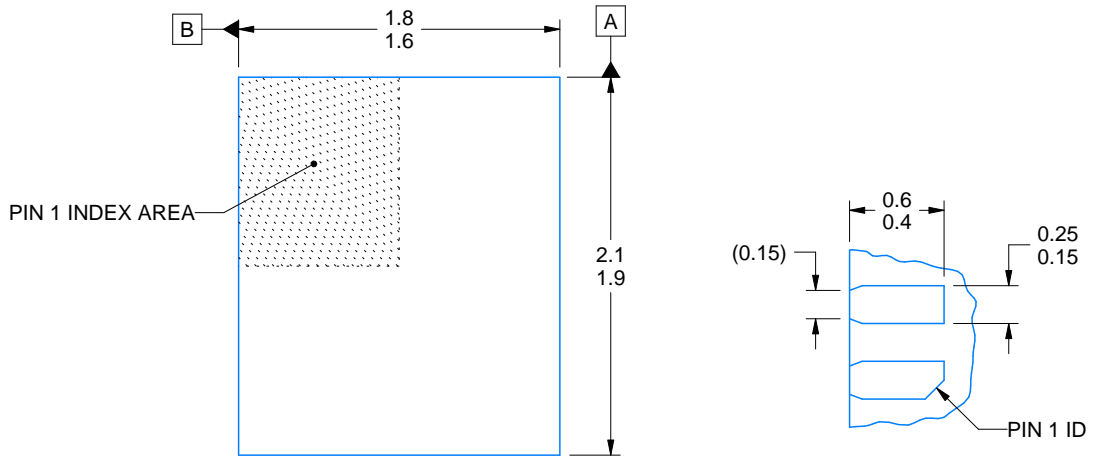
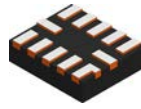
(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will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

(6) **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.

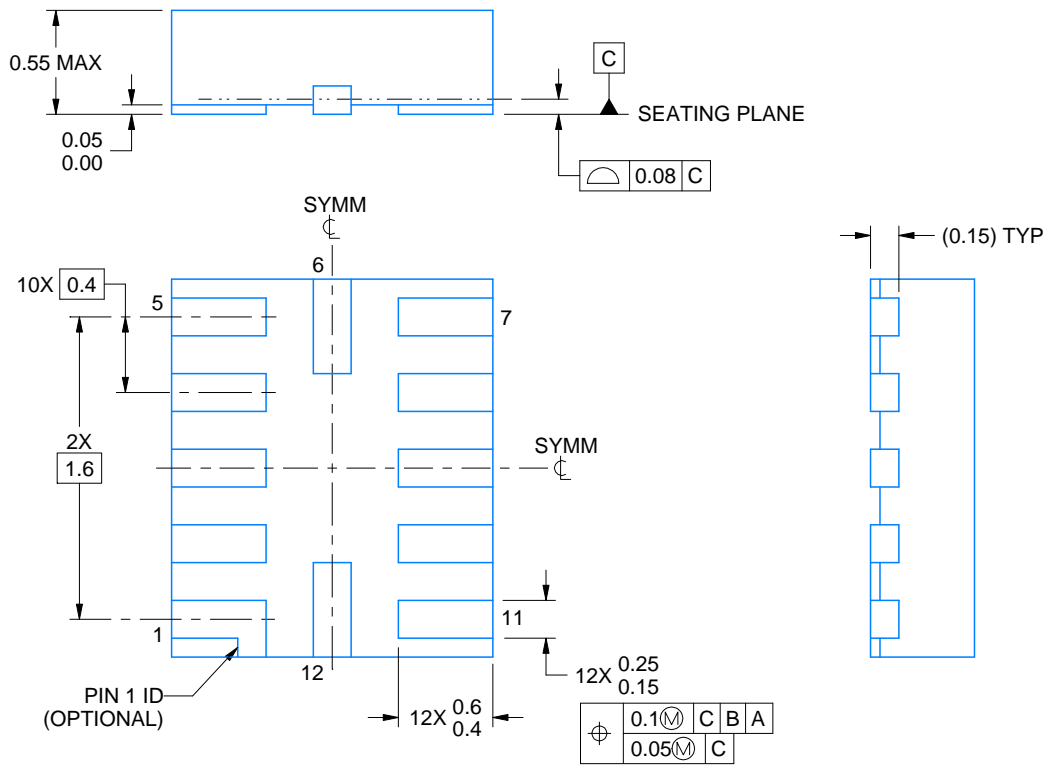
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "-" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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OPTIONAL TERMINAL & PIN 1 ID



4220310/A 11/2016

NOTES:

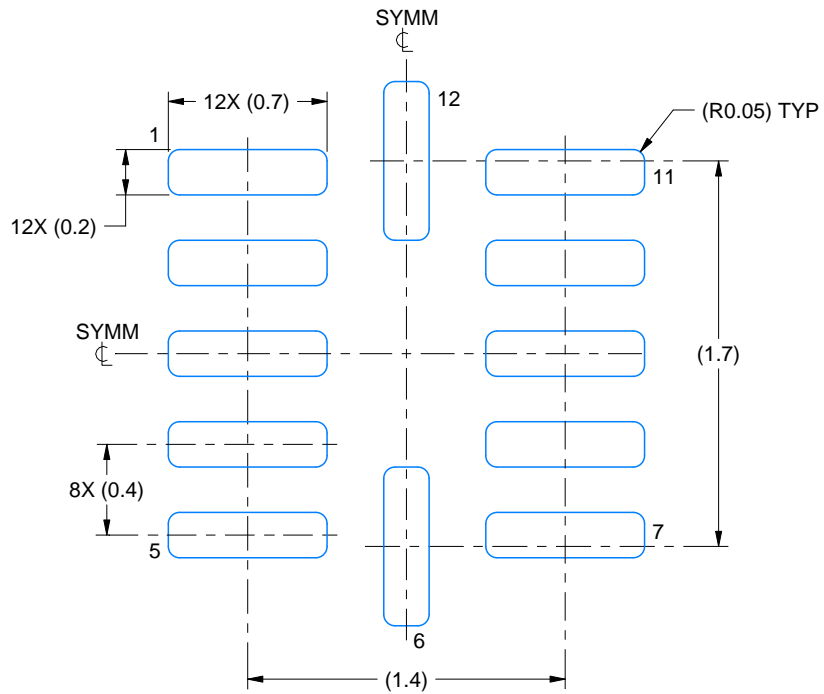
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

# EXAMPLE BOARD LAYOUT

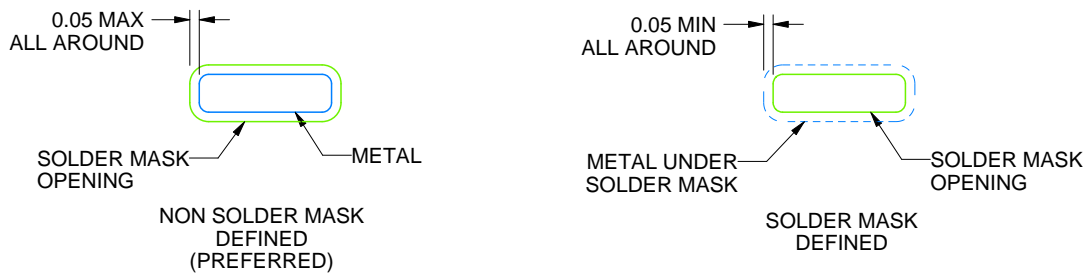
RUT0012A

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)

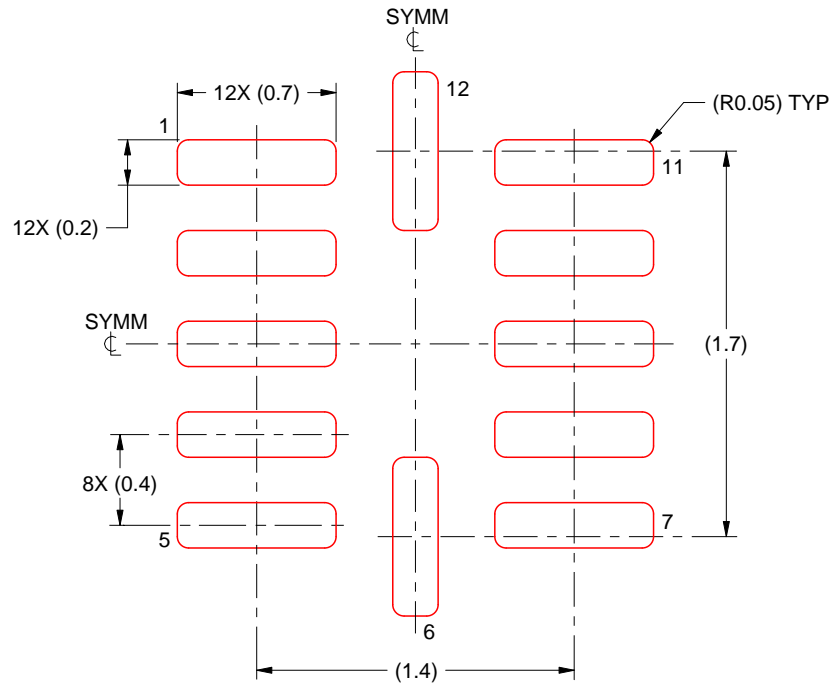
3. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/slue271](http://www.ti.com/lit/slue271)).

# 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)

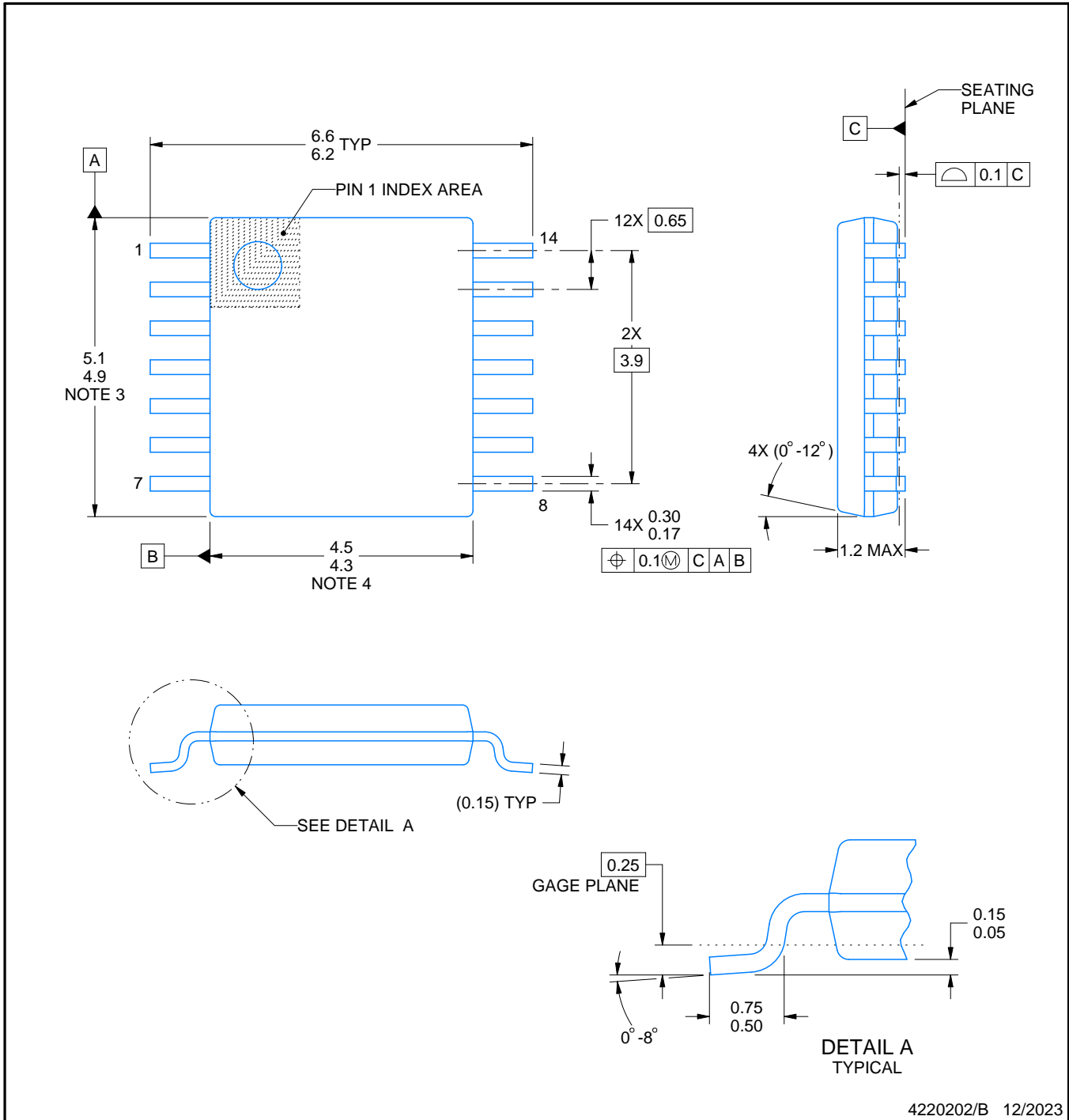
4. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

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

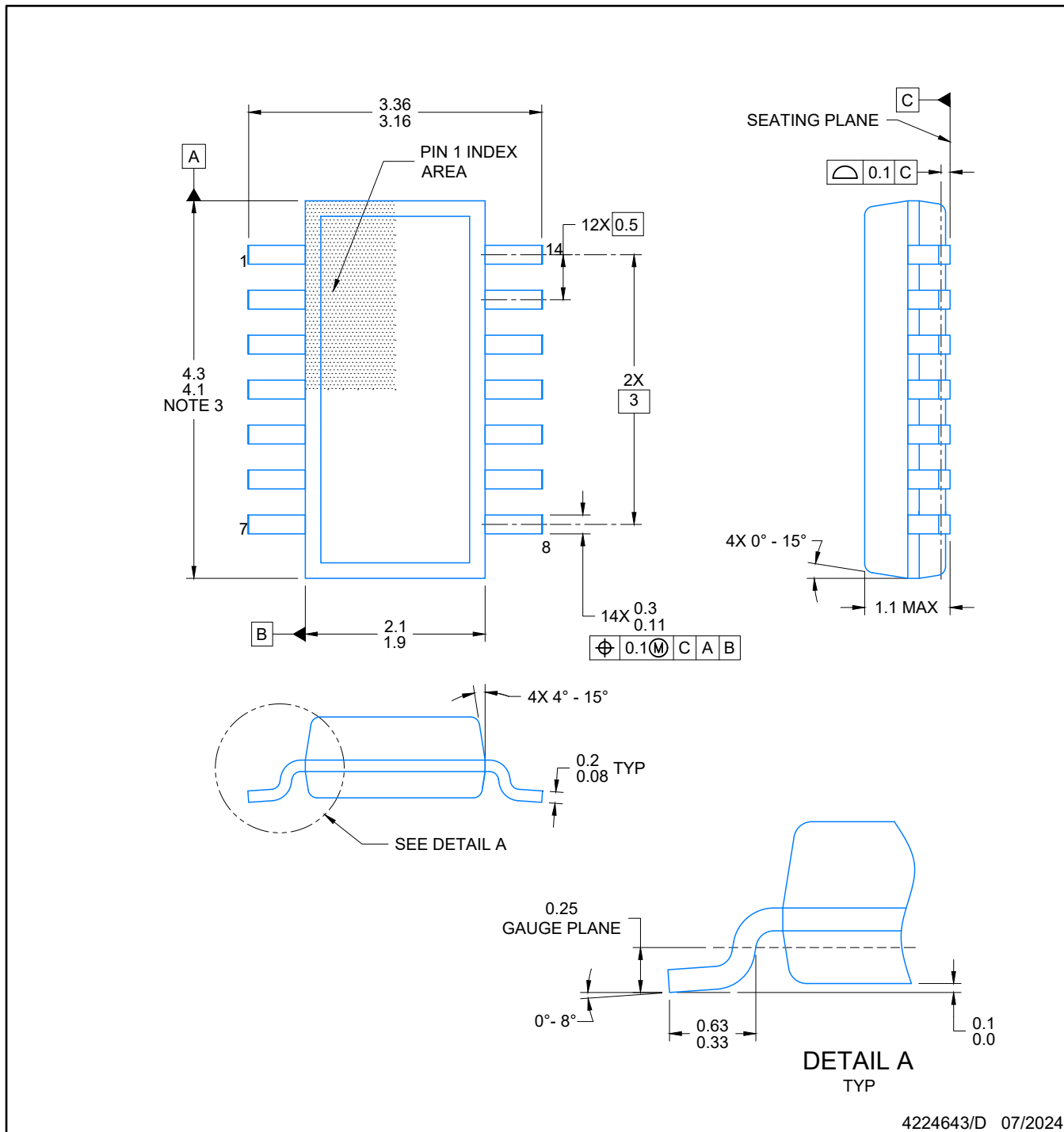


SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE: 10X

4220202/B 12/2023

NOTES: (continued)

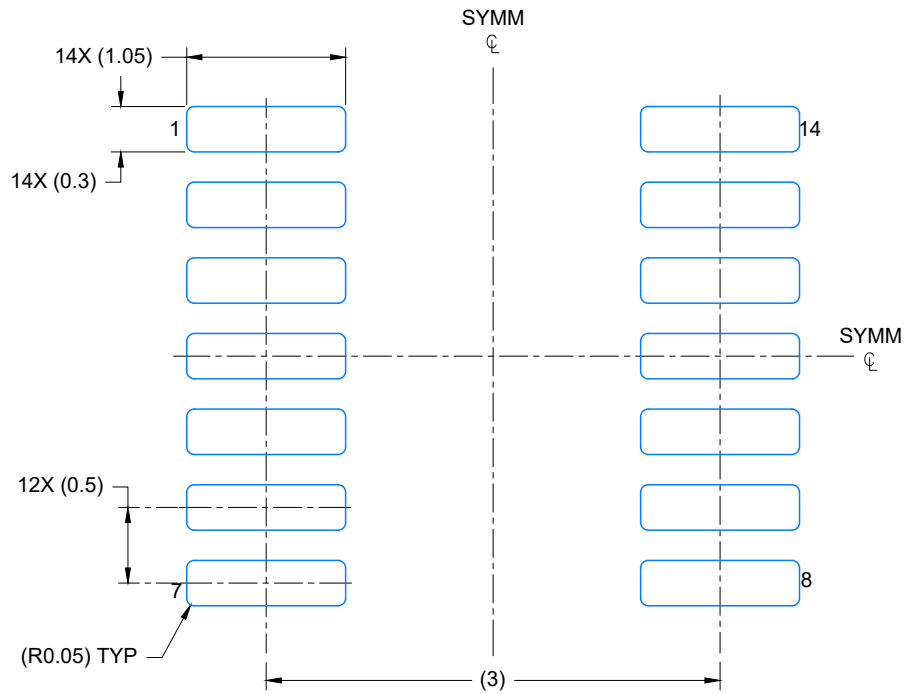
8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.



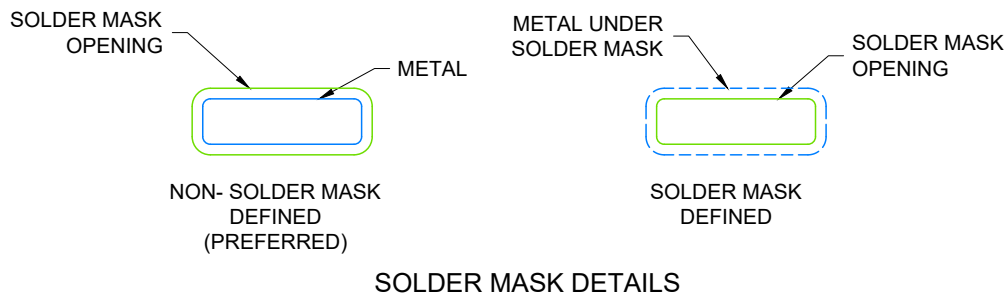
4224643/D 07/2024

NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.50 per side.
5. Reference JEDEC Registration MO-345, Variation AB



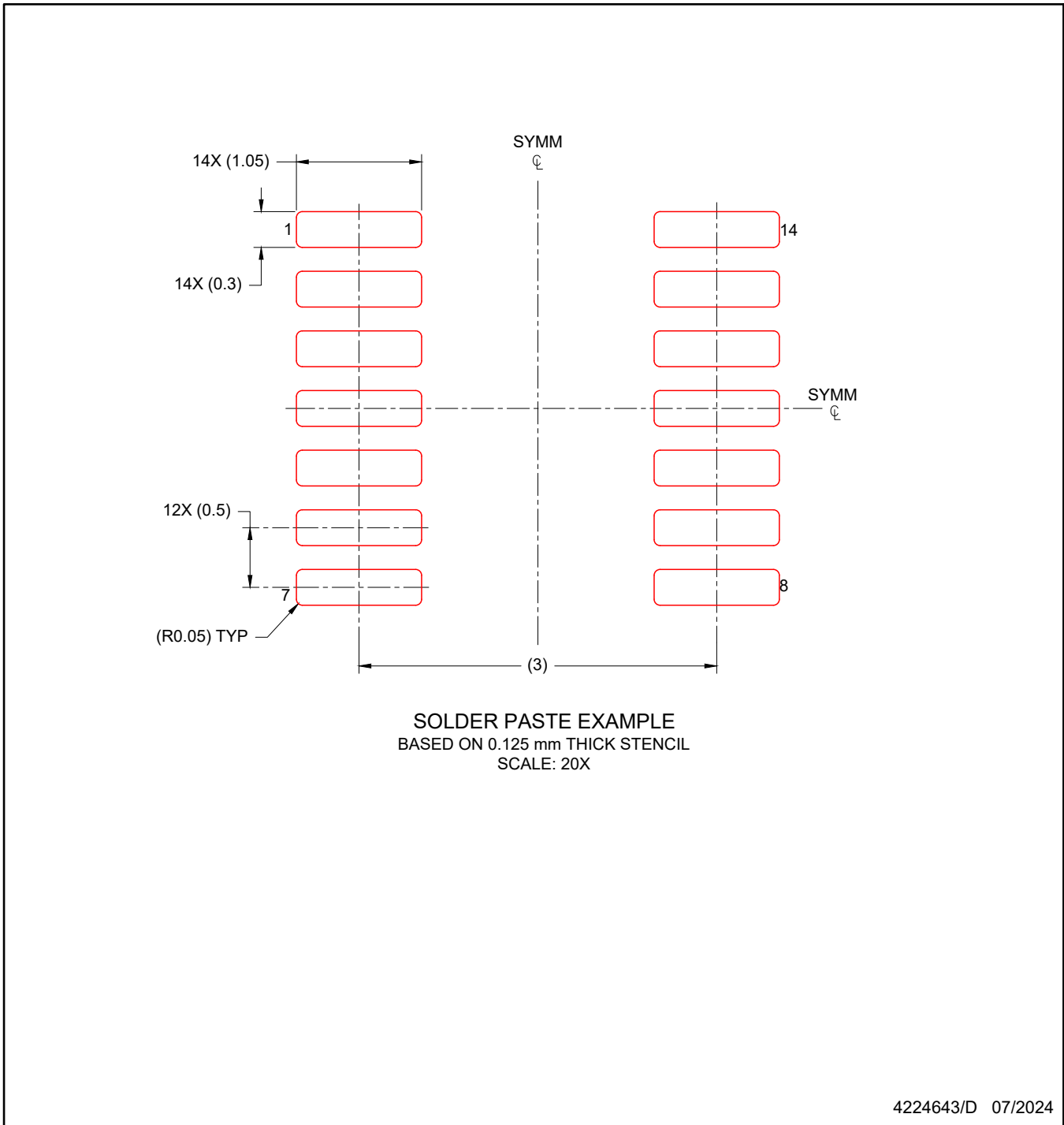
LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE: 20X



4224643/D 07/2024

NOTES: (continued)

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



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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Last updated 10/2025