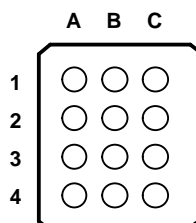


## FEATURES

- 1.2 V to 3.6 V on A Port and 1.65 V to 5.5 V on B Port ( $V_{CCA} \leq V_{CCB}$ )
- $V_{CC}$  Isolation Feature – If Either  $V_{CC}$  Input Is at GND, All Outputs Are in the High-Impedance State
- OE Input Circuit Referenced to  $V_{CCA}$
- Low Power Consumption, 4- $\mu$ A Max  $I_{CC}$
- $I_{off}$  Supports Partial-Power-Down Mode Operation
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II
- ESD Protection Exceeds JESD 22
  - A Port
    - 2500-V Human-Body Model (A114-B)
    - 200-V Machine Model (A115-A)
    - 1500-V Charged-Device Model (C101)
  - B Port
    - $\pm 15$ -kV Human-Body Model (A114-B)
    - 200-V Machine Model (A115-A)
    - 1500-V Charged-Device Model (C101)

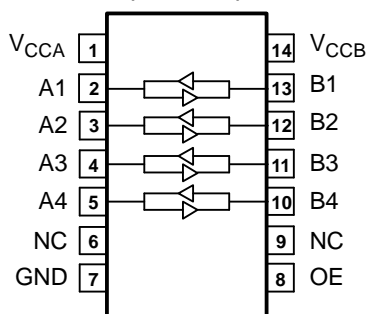
GXU OR ZXU PACKAGE  
(BOTTOM VIEW)



TERMINAL ASSIGNMENTS  
(GXU/ZXU Package)

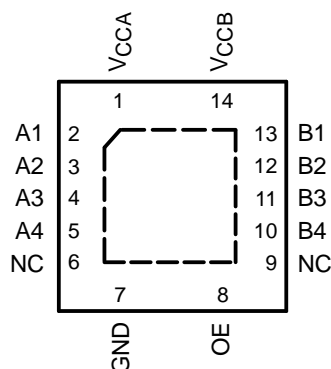
	A	B	C
1	A1	$V_{CCB}$	B1
2	A2	$V_{CCA}$	B2
3	A3	OE	B3
4	A4	GND	B4

D OR PW PACKAGE  
(TOP VIEW)



NC – No internal connection

RGY PACKAGE  
(TOP VIEW)



NC – No internal connection

## DESCRIPTION/ORDERING INFORMATION

This 4-bit noninverting translator uses two separate configurable power-supply rails. The A port is designed to track  $V_{CCA}$ .  $V_{CCA}$  accepts any supply voltage from 1.2 V to 3.6 V. The B port is designed to track  $V_{CCB}$ .  $V_{CCB}$  accepts any supply voltage from 1.65 V to 5.5 V. This allows for universal low-voltage bidirectional translation between any of the 1.2-V, 1.5-V, 1.8-V, 2.5-V, 3.3-V, and 5-V voltage nodes.  $V_{CCA}$  should not exceed  $V_{CCB}$ .

When the output-enable (OE) input is low, all outputs are placed in the high-impedance state.

The TXB0104 is designed so that the OE input circuit is supplied by  $V_{CCA}$ .

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



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

# TXB0104

## 4-BIT BIDIRECTIONAL VOLTAGE-LEVEL TRANSLATOR

### WITH AUTO DIRECTION SENSING AND $\pm 15$ -kV ESD PROTECTION

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## DESCRIPTION/ORDERING INFORMATION (CONTINUED)

To ensure the high-impedance state during power up or power down, OE should be tied to GND through a pulldown resistor; the minimum value of the resistor is determined by the current-sourcing capability of the driver.

### ORDERING INFORMATION

T <sub>A</sub>	PACKAGE <sup>(1)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	UFBGA – GXU	Tape and reel	TXB0104GXUR	— — — —
	UFBGA – ZXU (Pb-Free)		TXB0104ZXUR	
	QFN – RGY	Tape and reel	TXB0104RGYR	
	SOIC – D	Tape and reel	TXB0104DR	
	TSSOP – PW	Tape and reel	TXB0104PWR	

(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).

### PIN DESCRIPTION

D, PW, OR RGY PIN NO.	GXU OR ZXU BALL NO.	NAME	FUNCTION
1	B2	V <sub>CCA</sub>	A-port supply voltage $1.2\text{ V} \leq V_{CCA} \leq 3.6\text{ V}$ and $V_{CCA} \leq V_{CCB}$ .
2	A1	A1	Input/output 1. Referenced to V <sub>CCA</sub> .
3	A2	A2	Input/output 2. Referenced to V <sub>CCA</sub> .
4	A3	A3	Input/output 3. Referenced to V <sub>CCA</sub> .
5	A4	A4	Input/output 4. Referenced to V <sub>CCA</sub> .
6		NC	No connection. Not internally connected.
7	B4	GND	Ground
8	B3	OE	3-state output-mode enable. Pull OE low to place all outputs in 3-state mode. Referenced to V <sub>CCA</sub> .
9		NC	No connection. Not internally connected.
10	C4	B4	Input/output 4. Referenced to V <sub>CCB</sub> .
11	C3	B3	Input/output 3. Referenced to V <sub>CCB</sub> .
12	C2	B2	Input/output 2. Referenced to V <sub>CCB</sub> .
13	C1	B1	Input/output 1. Referenced to V <sub>CCB</sub> .
14	B1	V <sub>CCB</sub>	B-port supply voltage $1.65\text{ V} \leq V_{CCB} \leq 5.5\text{ V}$ .

## Absolute Maximum Ratings<sup>(1)</sup>

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

			MIN	MAX	UNIT
$V_{CCA}$	Supply voltage range		–0.5	4.6	V
$V_{CCB}$			–0.5	6.5	
$V_I$	Input voltage range <sup>(2)</sup>		–0.5	6.5	V
$V_O$	Voltage range applied to any output in the high-impedance or power-off state <sup>(2)</sup>		–0.5	6.5	V
$V_O$	Voltage range applied to any output in the high or low state <sup>(2)(3)</sup>	A port	–0.5	$V_{CCA} + 0.5$	V
		B port	–0.5	$V_{CCB} + 0.5$	
$I_{IK}$	Input clamp current	$V_I < 0$		–50	mA
$I_{OK}$	Output clamp current	$V_O < 0$		–50	mA
$I_O$	Continuous output current			$\pm 50$	mA
	Continuous current through $V_{CCA}$ , $V_{CCB}$ , or GND			$\pm 100$	mA
$\theta_{JA}$	Package thermal impedance	D package <sup>(4)</sup>		86	$^{\circ}\text{C/W}$
		GXU/ZXU package <sup>(4)</sup>		TBD	
		PW package <sup>(4)</sup>		113	
		RGY package <sup>(5)</sup>		47	
$T_{stg}$	Storage temperature range		–65	150	$^{\circ}\text{C}$

(1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

(2) The input and output negative-voltage ratings may be exceeded if the input and output current ratings are observed.

(3) The value of  $V_{CCA}$  and  $V_{CCB}$  are provided in the recommended operating conditions table.

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

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

## Recommended Operating Conditions<sup>(1)(2)</sup>

			V <sub>CCA</sub>	V <sub>CCB</sub>	MIN	MAX	UNIT
V <sub>CCA</sub>	Supply voltage				1.2	3.6	V
V <sub>CCB</sub>					1.65	5.5	
V <sub>IH</sub>	High-level input voltage	Data inputs	1.2 V to 3.6 V	1.65 V to 5.5 V	V <sub>CCI</sub> × 0.65 <sup>(3)</sup>	V <sub>CCI</sub>	V
		OE	1.2 V to 3.6 V	1.65 V to 5.5 V	V <sub>CCA</sub> × 0.65	5.5	
V <sub>IL</sub>	Low-level input voltage	Data inputs	1.2 V to 5.5 V	1.65 V to 5.5 V	0	V <sub>CCI</sub> × 0.35 <sup>(3)</sup>	V
		OE	1.2 V to 3.6 V	1.65 V to 5.5 V	0	V <sub>CCA</sub> × 0.35	
Δt/Δv	Input transition rise or fall rate	A-port inputs	1.2 V to 3.6 V	1.65 V to 5.5 V		40	ns/V
		B-port inputs	1.2 V to 3.6 V	1.65 V to 3.6 V		40	
				4.5 V to 5.5 V		30	
T <sub>A</sub>	Operating free-air temperature				−40	85	°C

(1) The A and B sides of an unused data I/O pair must be held in the same state, i.e., both at  $V_{CCI}$  or both at GND.

(2)  $V_{CCA}$  must be less than or equal to  $V_{CCB}$  and must not exceed 3.6 V.

(3)  $V_{CCI}$  is the supply voltage associated with the input port.

**TXB0104**  
**4-BIT BIDIRECTIONAL VOLTAGE-LEVEL TRANSLATOR**  
**WITH AUTO DIRECTION SENSING AND  $\pm 15$ -kV ESD PROTECTION**

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**Electrical Characteristics**<sup>(1)(2)</sup>

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

PARAMETER		TEST CONDITIONS	V <sub>CCA</sub>	V <sub>CCB</sub>	T <sub>A</sub> = 25°C			−40°C to 85°C		UNIT
					MIN	TYP	MAX	MIN	MAX	
V <sub>OHA</sub>		I <sub>OH</sub> = −20 μA	1.2 V		1.1			V <sub>CCA</sub> − 0.4		V
			1.4 V to 3.6 V							
V <sub>OLA</sub>		I <sub>OL</sub> = 20 μA	1.2 V		0.9			0.4		V
			1.4 V to 3.6 V							
V <sub>OHB</sub>		I <sub>OH</sub> = −20 μA		1.65 V to 5.5 V				V <sub>CCB</sub> − 0.4		V
V <sub>OLB</sub>		I <sub>OL</sub> = 20 μA		1.65 V to 5.5 V				0.4		V
I <sub>I</sub>	OE		1.2 V to 3.6 V	1.65 V to 5.5 V	±1			±2		μA
I <sub>off</sub>	A port		0 V	0 V to 5.5 V	±1			±2		μA
	B port		0 V to 3.6 V	0 V	±1			±2		
I <sub>OZ</sub>	A or B port	OE = GND	1.2 V to 3.6 V	1.65 V to 5.5 V	±1			±2		μA
I <sub>CCA</sub>		V <sub>I</sub> = V <sub>CCI</sub> or GND, I <sub>O</sub> = 0	1.2 V	1.65 V to 5.5 V	0.06					μA
			1.4 V to 3.6 V	1.65 V to 5.5 V				5		
			3.6 V	0 V				2		
			0 V	5.5 V				-2		
I <sub>CCB</sub>		V <sub>I</sub> = V <sub>CCI</sub> or GND, I <sub>O</sub> = 0	1.2 V	1.65 V to 5.5 V	3.4					μA
			1.4 V to 3.6 V	1.65 V to 5.5 V				5		
			3.6 V	0 V				-2		
			0 V	5.5 V				2		
I <sub>CCA</sub> + I <sub>CCB</sub>		V <sub>I</sub> = V <sub>CCI</sub> or GND, I <sub>O</sub> = 0	1.2 V	1.65 V to 5.5 V	3.5					μA
			1.4 V to 3.6 V	1.65 V to 5.5 V				10		
I <sub>CCZA</sub>		V <sub>I</sub> = V <sub>CCI</sub> or GND, I <sub>O</sub> = 0, OE = GND	1.2 V	1.65 V to 5.5 V	0.05					μA
			1.4 V to 3.6 V	1.65 V to 5.5 V				5		
I <sub>CCZB</sub>		V <sub>I</sub> = V <sub>CCI</sub> or GND, I <sub>O</sub> = 0, OE = GND	1.2 V	1.65 V to 5.5 V	3.3					μA
			1.4 V to 3.6 V	1.65 V to 5.5 V				5		
C <sub>i</sub>	OE		1.2 V to 3.6 V	1.65 V to 5.5 V	3			4		pF
C <sub>io</sub>	A port		1.2 V to 3.6 V	1.65 V to 5.5 V	5			6		pF
	B port				11			14		

(1)  $V_{CCI}$  is the supply voltage associated with the input port.

(2)  $V_{CCO}$  is the supply voltage associated with the output port.

**Timing Requirements**

$T_A = 25^\circ\text{C}$ ,  $V_{CCA} = 1.2\ \text{V}$

			$V_{CCB} = 1.8\ \text{V}$	$V_{CCB} = 2.5\ \text{V}$	$V_{CCB} = 3.3\ \text{V}$	$V_{CCB} = 5\ \text{V}$	UNIT
			TYP	TYP	TYP	TYP	
Data rate			20	20	20	20	Mbps
$t_w$	Pulse duration	Data inputs	50	50	50	50	ns

**Timing Requirements**

over recommended operating free-air temperature range,  $V_{CCA} = 1.5\ \text{V} \pm 0.1\ \text{V}$  (unless otherwise noted)

			$V_{CCB} = 1.8\ \text{V} \pm 0.15\ \text{V}$		$V_{CCB} = 2.5\ \text{V} \pm 0.2\ \text{V}$		$V_{CCB} = 3.3\ \text{V} \pm 0.3\ \text{V}$		$V_{CCB} = 5\ \text{V} \pm 0.5\ \text{V}$		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
Data rate			40		40		40		40		Mbps
$t_w$	Pulse duration	Data inputs	25		25		25		25		ns

## Timing Requirements

over recommended operating free-air temperature range,  $V_{CCA} = 1.8 \text{ V} \pm 0.15 \text{ V}$  (unless otherwise noted)

			$V_{CCB} = 1.8 \text{ V} \pm 0.15 \text{ V}$		$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
Data rate			60		60		60		60		Mbps
$t_w$	Pulse duration	Data inputs	17		17		17		17		ns

## Timing Requirements

over recommended operating free-air temperature range,  $V_{CCA} = 2.5 \text{ V} \pm 0.2 \text{ V}$  (unless otherwise noted)

			$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
Data rate			100		100		100		Mbps
$t_w$	Pulse duration	Data inputs	10		10		10		ns

## Timing Requirements

over recommended operating free-air temperature range,  $V_{CCA} = 3.3 \text{ V} \pm 0.3 \text{ V}$  (unless otherwise noted)

			$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		UNIT
			MIN	MAX	MIN	MAX	
Data rate			100		100		Mbps
$t_w$	Pulse duration	Data inputs	10		10		ns

## Switching Characteristics

$T_A = 25^\circ\text{C}$ ,  $V_{CCA} = 1.2 \text{ V}$

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CCB} = 1.8 \text{ V}$	$V_{CCB} = 2.5 \text{ V}$	$V_{CCB} = 3.3 \text{ V}$	$V_{CCB} = 5 \text{ V}$	UNIT
			TYP	TYP	TYP	TYP	
$t_{pd}$	A	B	6.9	5.7	5.3	5.5	ns
	B	A	7.4	6.4	6	5.8	
$t_{en}$	OE	A	1	1	1	1	$\mu\text{s}$
		B	1	1	1	1	
$t_{dis}$	OE	A	18	15	14	14	ns
		B	20	17	16	16	
$t_{rA}$ , $t_{fA}$	A-port rise and fall times		4.2	4.2	4.2	4.2	ns
$t_{rB}$ , $t_{fB}$	B-port rise and fall times		2.1	1.5	1.2	1.1	ns
$t_{SK(O)}$	Channel-to-channel skew		0.4	0.5	0.5	1.4	ns
Max data rate			20	20	20	20	Mbps

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**4-BIT BIDIRECTIONAL VOLTAGE-LEVEL TRANSLATOR**  
**WITH AUTO DIRECTION SENSING AND  $\pm 15$ -kV ESD PROTECTION**

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## Switching Characteristics

over recommended operating free-air temperature range,  $V_{CCA} = 1.5 \text{ V} \pm 0.1 \text{ V}$  (unless otherwise noted)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CCB} = 1.8 \text{ V} \pm 0.15 \text{ V}$		$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
$t_{pd}$	A	B	1.4	12.9	1.2	10.1	1.1	10	0.8	9.9	ns
	B	A	0.9	14.2	0.7	12	0.4	11.7	0.3	13.7	
$t_{en}$	OE	A		1		1		1		1	$\mu\text{s}$
		B		1		1		1		1	
$t_{dis}$	OE	A	5.9	31	5.7	25.9	5.6	23	5.7	22.4	ns
		B	5.4	30.3	4.9	22.8	4.8	20	4.9	19.5	
$t_{rA}, t_{fA}$	A-port rise and fall times		1.4	5.1	1.4	5.1	1.4	5.1	1.4	5.1	ns
$t_{rB}, t_{fB}$	B-port rise and fall times		0.9	4.5	0.6	3.2	0.5	2.8	0.4	2.7	ns
$t_{SK(O)}$	Channel-to-channel skew			0.5		0.5		0.5		0.5	ns
Max data rate			40		40		40		40		Mbps

## Switching Characteristics

over recommended operating free-air temperature range,  $V_{CCA} = 1.8 \text{ V} \pm 0.15 \text{ V}$  (unless otherwise noted)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CCB} = 1.8 \text{ V} \pm 0.15 \text{ V}$		$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
$t_{pd}$	A	B	1.6	11	1.4	7.7	1.3	6.8	1.2	6.5	ns
	B	A	1.5	12	1.3	8.4	1	7.6	0.9	7.1	
$t_{en}$	OE	A		1		1		1		1	$\mu\text{s}$
		B		1		1		1		1	
$t_{dis}$	OE	A	5.9	31	5.1	21.3	5	19.3	5	17.4	ns
		B	5.4	30.3	4.4	20.8	4.2	17.9	4.3	16.3	
$t_{rA}, t_{fA}$	A-port rise and fall times		1	4.2	1.1	4.1	1.1	4.1	1.1	4.1	ns
$t_{rB}, t_{fB}$	B-port rise and fall times		0.9	3.8	0.6	3.2	0.5	2.8	0.4	2.7	ns
$t_{SK(O)}$	Channel-to-channel skew			0.5		0.5		0.5		0.5	ns
Max data rate			60		60		60		60		Mbps

## Switching Characteristics

over recommended operating free-air temperature range,  $V_{CCA} = 2.5 \text{ V} \pm 0.2 \text{ V}$  (unless otherwise noted)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
$t_{pd}$	A	B	1.1	6.3	1	5.2	0.9	4.7	ns
	B	A	1.2	6.6	1.1	5.1	0.9	4.4	
$t_{en}$	OE	A		1		1		1	$\mu\text{s}$
		B		1		1		1	
$t_{dis}$	OE	A	5.1	21.3	4.6	15.2	4.6	13.2	ns
		B	4.4	20.8	3.8	16	3.9	13.9	
$t_{rA}, t_{fA}$	A-port rise and fall times		0.8	3	0.8	3	0.8	3	ns
$t_{rB}, t_{fB}$	B-port rise and fall times		0.7	2.6	0.5	2.8	0.4	2.7	ns
$t_{SK(O)}$	Channel-to-channel skew			0.5		0.5		0.5	ns
Max data rate			100		100		100		Mbps

## Switching Characteristics

over recommended operating free-air temperature range,  $V_{CCA} = 3.3 \text{ V} \pm 0.3 \text{ V}$  (unless otherwise noted)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		UNIT
			MIN	MAX	MIN	MAX	
$t_{pd}$	A	B	0.9	4.7	0.8	4	ns
	B	A	1	4.9	0.9	3.8	
$t_{en}$	OE	A		1		1	$\mu\text{s}$
		B		1		1	
$t_{dis}$	OE	A	4.6	15.2	4.3	12.1	ns
		B	3.8	16	3.4	13.2	
$t_{rA}, t_{fA}$	A-port rise and fall times		0.7	2.5	0.7	2.5	ns
$t_{rB}, t_{fB}$	B-port rise and fall times		0.5	2.1	0.4	2.7	ns
$t_{SK(O)}$	Channel-to-channel skew			0.5		0.5	ns
Max data rate			100		100		Mbps

**TXB0104**  
**4-BIT BIDIRECTIONAL VOLTAGE-LEVEL TRANSLATOR**  
**WITH AUTO DIRECTION SENSING AND  $\pm 15$ -kV ESD PROTECTION**

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**Operating Characteristics**

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

PARAMETER		TEST CONDITIONS	V <sub>CCA</sub>							UNIT
			1.2 V	1.2 V	1.5 V	1.8 V	2.5 V	2.5 V	3.3 V	
			V <sub>CCB</sub>							
			5 V	1.8 V	1.8 V	1.8 V	2.5 V	5 V	3.3 V to 5 V	
			TYP	TYP	TYP	TYP	TYP	TYP	TYP	
C <sub>pdA</sub>	A-port input, B-port output	C <sub>L</sub> = 0, f = 10 MHz, t <sub>r</sub> = t <sub>f</sub> = 1 ns, OE = V <sub>CCA</sub> (outputs enabled)	7.8	10	9	8	8	8	9	pF
	B-port input, A-port output		12	11	11	11	11	11	11	
C <sub>pdB</sub>	A-port input, B-port output		38.1	28	28	28	29	29	29	
	B-port input, A-port output		25.4	19	18	18	19	21	22	
C <sub>pdA</sub>	A-port input, B-port output	C <sub>L</sub> = 0, f = 10 MHz, t <sub>r</sub> = t <sub>f</sub> = 1 ns, OE = GND (outputs disabled)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	pF
	B-port input, A-port output		0.01	0.01	0.01	0.01	0.01	0.01	0.01	
C <sub>pdB</sub>	A-port input, B-port output		0.01	0.01	0.01	0.01	0.01	0.01	0.03	
	B-port input, A-port output		0.01	0.01	0.01	0.01	0.01	0.01	0.04	



## PRINCIPLES OF OPERATION

### Applications

The TXB0104 can be used in level-translation applications for interfacing devices or systems operating at different interface voltages with one another.

### Architecture

The TXB0104 architecture (see [Figure 1](#)) does not require a direction-control signal to control the direction of data flow from A to B or from B to A. In a dc state, the output drivers of the TXB0104 can maintain a high or low, but are designed to be weak, so that they can be overdriven by an external driver when data on the bus starts flowing the opposite direction.

The output one shots detect rising or falling edges on the A or B ports. During a rising edge, the one shot turns on the PMOS transistors (T1, T3) for a short duration, which speeds up the low-to-high transition. Similarly, during a falling edge, the one shot turns on the NMOS transistors (T2, T4) for a short duration, which speeds up the high-to-low transition.

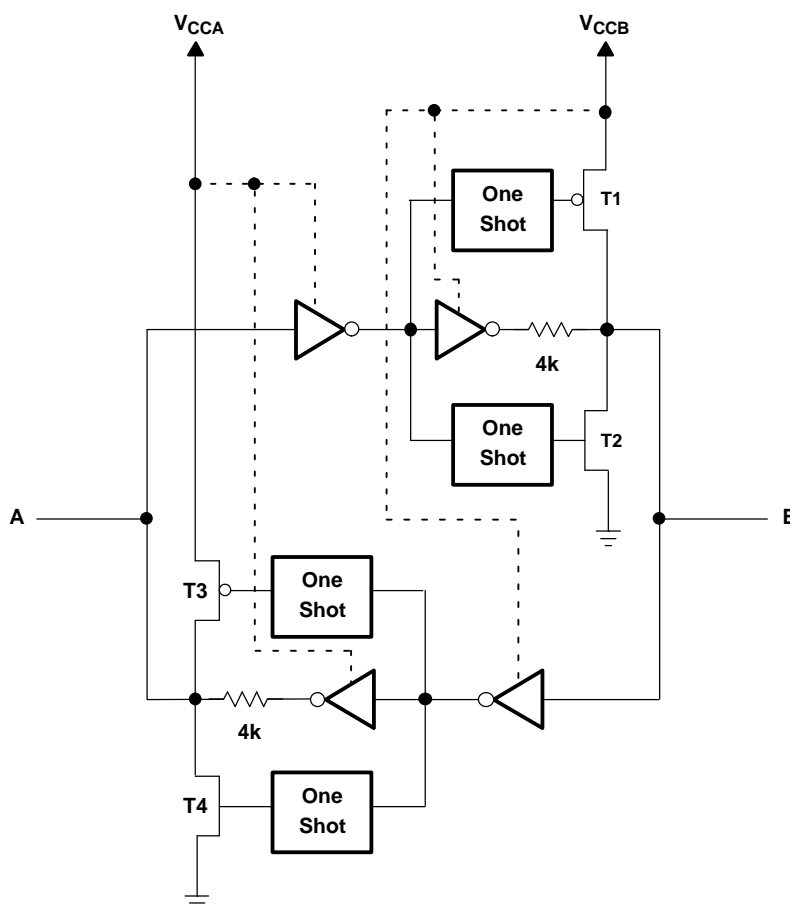
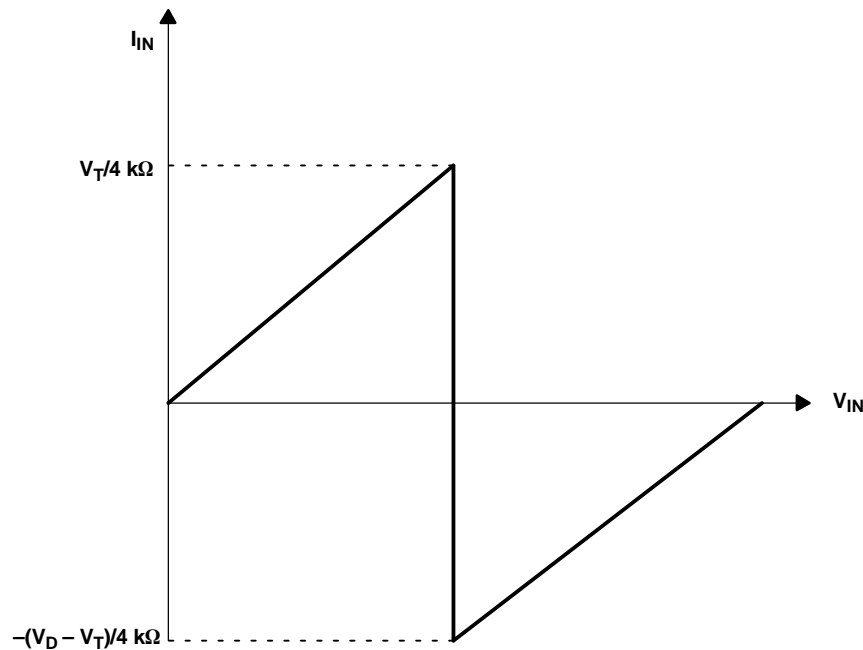


Figure 1. Architecture of TXB0104 I/O Cell

### Input Driver Requirements

Typical  $I_{IN}$  vs  $V_{IN}$  characteristics of the TXB0104 are shown in [Figure 2](#). For proper operation, the device driving the data I/Os of the TXB0104 must have drive strength of at least  $\pm 2$  mA.

## PRINCIPLES OF OPERATION (continued)



- A.  $V_T$  is the input threshold voltage of the TXB0104 (typically  $V_{CCI}/2$ ).  
B.  $V_D$  is the supply voltage of the external driver.

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

### Power Up

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. The TXB0104 has circuitry that disables all output ports when either  $V_{CC}$  is switched off ( $V_{CCA/B} = 0$  V).

### Enable and Disable

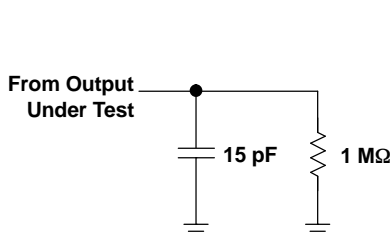
The TXB0104 has an OE input that is used to disable the device by setting OE = low, which places all I/Os in the high-impedance (Hi-Z) state. The disable time ( $t_{dis}$ ) indicates the delay between when OE goes low and when the outputs actually get disabled (Hi-Z). The enable time ( $t_{en}$ ) indicates the amount of time the user must allow for the one-shot circuitry to become operational after OE is taken high.

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

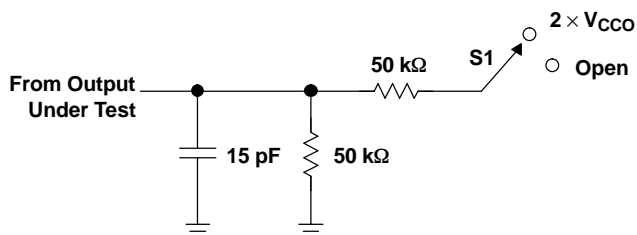
The TXB0104 is designed to drive capacitive loads of up to 70 pF. The output drivers of the TXB0104 have low dc drive strength. If pullup or pulldown resistors are connected externally to the data I/Os, their values must be kept higher than 50 k $\Omega$  to ensure that they do not contend with the output drivers of the TXB0104.

For the same reason, the TXB0104 should not be used in applications such as I<sup>2</sup>C, 1-Wire, or an MMC card interface where an open-drain driver is connected on the bidirectional data I/O. For these applications, use a device from the TI TXS01xx series of level translators.

## PARAMETER MEASUREMENT INFORMATION

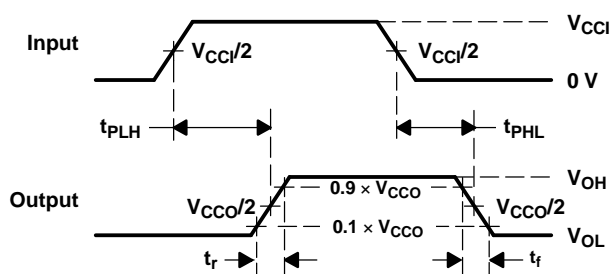


LOAD CIRCUIT FOR MAX DATA RATE,  
PULSE DURATION PROPAGATION  
DELAY OUTPUT RISE AND FALL TIME  
MEASUREMENT

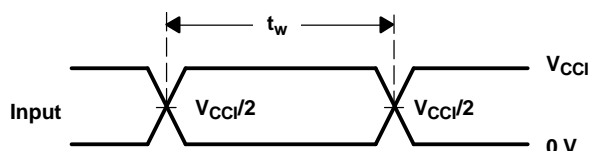


LOAD CIRCUIT FOR  
ENABLE/DISABLE  
TIME MEASUREMENT

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



VOLTAGE WAVEFORMS  
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS  
PULSE DURATION

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

Figure 3. Load Circuits and Voltage Waveforms

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