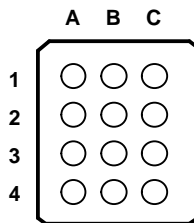


FEATURES

- 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- μ 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
 - ± 15 -kV Human-Body Model (A114-B)
 - 200-V Machine Model (A115-A)
 - 1500-V Charged-Device Model (C101)

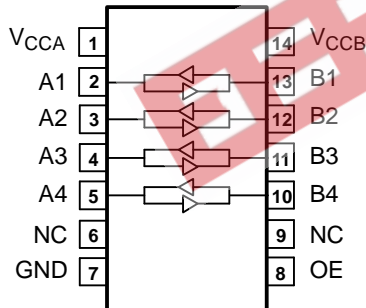
**GXU OR ZXU PACKAGE
(BOTTOM VIEW)**



**TERMINAL ASSIGNMENTS
(GXU/ZXU Package)**

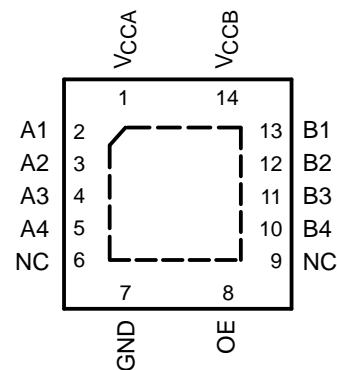
	A	B	C
1	A1	V_{CCB}	B1
2	A2	V_{CCA}	B2
3	A3	OE	B3
4	A4	GND	B4

**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 ± 15 -kV ESD PROTECTION



SCES650–APRIL 2006

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 _A	PACKAGE ⁽¹⁾		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.

PIN DESCRIPTION

D, PW, OR RGY PIN NO.	GXU OR ZXU BALL NO.	NAME	FUNCTION
1	B2	V _{CCA}	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 _{CCA} .
3	A2	A2	Input/output 2. Referenced to V _{CCA} .
4	A3	A3	Input/output 3. Referenced to V _{CCA} .
5	A4	A4	Input/output 4. Referenced to V _{CCA} .
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 _{CCA} .
9		NC	No connection. Not internally connected.
10	C4	B4	Input/output 4. Referenced to V _{CCB} .
11	C3	B3	Input/output 3. Referenced to V _{CCB} .
12	C2	B2	Input/output 2. Referenced to V _{CCB} .
13	C1	B1	Input/output 1. Referenced to V _{CCB} .
14	B1	V _{CCB}	B-port supply voltage $1.65\text{ V} \leq V_{CCB} \leq 5.5\text{ V}$.

Absolute Maximum Ratings⁽¹⁾

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 ⁽²⁾	–0.5	6.5	V	
V _O	Voltage range applied to any output in the high-impedance or power-off state ⁽²⁾	–0.5	6.5	V	
V _O	Voltage range applied to any output in the high or low state ⁽²⁾⁽³⁾	A port	–0.5	V _{CCA} + 0.5	V
		B port	–0.5	V _{CCB} + 0.5	
I _{IK}	Input clamp current		–50	mA	
I _{OK}	Output clamp current		–50	mA	
I _O	Continuous output current		±50	mA	
	Continuous current through V _{CCA} , V _{CCB} , or GND		±100	mA	
θ _{JA}	Package thermal impedance	D package ⁽⁴⁾		86	°C/W
		GXU/ZXU package ⁽⁴⁾		TBD	
		PW package ⁽⁴⁾		113	
		RGY package ⁽⁵⁾		47	
T _{stg}	Storage temperature range	–65	150	°C	

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

(2) The 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⁽¹⁾⁽²⁾

		V _{CCA}	V _{CCB}	MIN	MAX	UNIT	
V _{CCA}	Supply voltage			1.2	3.6	V	
V _{CCB}				1.65	5.5		
V _{IH}	High-level input voltage	Data inputs	1.2 V to 3.6 V	1.65 V to 5.5 V	V _{CCI} × 0.65 ⁽³⁾	V _{CCI}	V
		OE	1.2 V to 3.6 V	1.65 V to 5.5 V	V _{CCA} × 0.65	5.5	
V _{IL}	Low-level input voltage	Data inputs	1.2 V to 5.5 V	1.65 V to 5.5 V	0	V _{CCI} × 0.35 ⁽³⁾	V
		OE	1.2 V to 3.6 V	1.65 V to 5.5 V	0	V _{CCA} × 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 _A	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 ± 15 -kV ESD PROTECTION



SCES650–APRIL 2006

Electrical Characteristics⁽¹⁾⁽²⁾

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

PARAMETER	TEST CONDITIONS	V _{CCA}	V _{CCB}	T _A = 25°C			–40°C to 85°C		UNIT	
				MIN	TYP	MAX	MIN	MAX		
V _{OHA}	I _{OH} = –20 μ A	1.2 V		1.1			V _{CCA} – 0.4		V	
		1.4 V to 3.6 V								
V _{OLA}	I _{OL} = 20 μ A	1.2 V		0.9			0.4		V	
		1.4 V to 3.6 V								
V _{OHB}	I _{OH} = –20 μ A		1.65 V to 5.5 V				V _{CCB} – 0.4		V	
V _{OLB}	I _{OL} = 20 μ A		1.65 V to 5.5 V				0.4		V	
I _I	OE	1.2 V to 3.6 V	1.65 V to 5.5 V				± 1	± 2	μ A	
I _{off}	A port	0 V	0 V to 5.5 V				± 1	± 2	μ A	
	B port	0 V to 3.6 V	0 V				± 1	± 2		
I _{OZ}	A or B port	OE = GND	1.2 V to 3.6 V	1.65 V to 5.5 V				± 1	± 2	μ A
I _{CCA}	V _I = V _{CC1} or GND, I _O = 0	1.2 V	1.65 V to 5.5 V	0.06			5		μ A	
		1.4 V to 3.6 V	1.65 V to 5.5 V							
		3.6 V	0 V							2
		0 V	5.5 V							–2
I _{CCB}	V _I = V _{CC1} or GND, I _O = 0	1.2 V	1.65 V to 5.5 V	3.4			5		μ A	
		1.4 V to 3.6 V	1.65 V to 5.5 V							
		3.6 V	0 V							–2
		0 V	5.5 V							2
I _{CCA} + I _{CCB}	V _I = V _{CC1} or GND, I _O = 0	1.2 V	1.65 V to 5.5 V	3.5			10		μ A	
		1.4 V to 3.6 V	1.65 V to 5.5 V							
I _{CCZA}	V _I = V _{CC1} or GND, I _O = 0, OE = GND	1.2 V	1.65 V to 5.5 V	0.05			5		μ A	
		1.4 V to 3.6 V	1.65 V to 5.5 V							
I _{CCZB}	V _I = V _{CC1} or GND, I _O = 0, OE = GND	1.2 V	1.65 V to 5.5 V	3.3			5		μ A	
		1.4 V to 3.6 V	1.65 V to 5.5 V							
C _i	OE	1.2 V to 3.6 V	1.65 V to 5.5 V	3			4		pF	
C _{io}	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_{CC1} is the supply voltage associated with the input port.
(2) V_{CC0} is the supply voltage associated with the output port.

Timing Requirements

T_A = 25°C, V_{CCA} = 1.2 V

		V _{CCB} = 1.8 V	V _{CCB} = 2.5 V	V _{CCB} = 3.3 V	V _{CCB} = 5 V	UNIT
		TYP	TYP	TYP	TYP	
Data rate		20	20	20	20	Mbps
t _w	Pulse duration	Data inputs	50	50	50	ns

Timing Requirements

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

		V _{CCB} = 1.8 V ± 0.15 V		V _{CCB} = 2.5 V ± 0.2 V		V _{CCB} = 3.3 V ± 0.3 V		V _{CCB} = 5 V ± 0.5 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	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	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	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	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	μs
		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

TXB0104
4-BIT BIDIRECTIONAL VOLTAGE-LEVEL TRANSLATOR
WITH AUTO DIRECTION SENSING AND ± 15 -kV ESD PROTECTION



SCES650–APRIL 2006

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	μs
		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	μs
		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	μs
		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	μs
		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 ± 15 -kV ESD PROTECTION

SCES650–APRIL 2006

Operating Characteristics

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

PARAMETER		TEST CONDITIONS	V_{CCA}							UNIT
			1.2 V	1.2 V	1.5 V	1.8 V	2.5 V	2.5 V	3.3 V	
			V_{CCB}							
			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_{pdA}	A-port input, B-port output	$C_L = 0$, $f = 10$ MHz, $t_r = t_f = 1$ ns, $OE = V_{CCA}$ (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_{pdB}	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_{pdA}	A-port input, B-port output	$C_L = 0$, $f = 10$ MHz, $t_r = t_f = 1$ ns, $OE = \text{GND}$ (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_{pdB}	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	

EEPW.com.cn 电子产品世界

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.

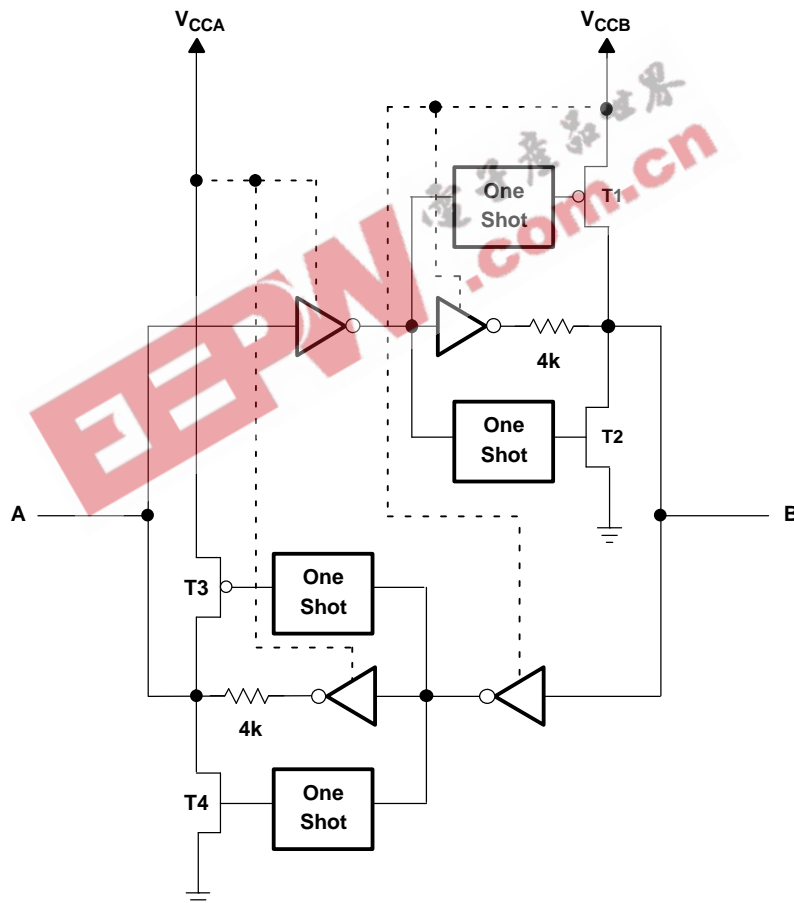


Figure 1. Architecture of TXB0104 I/O Cell

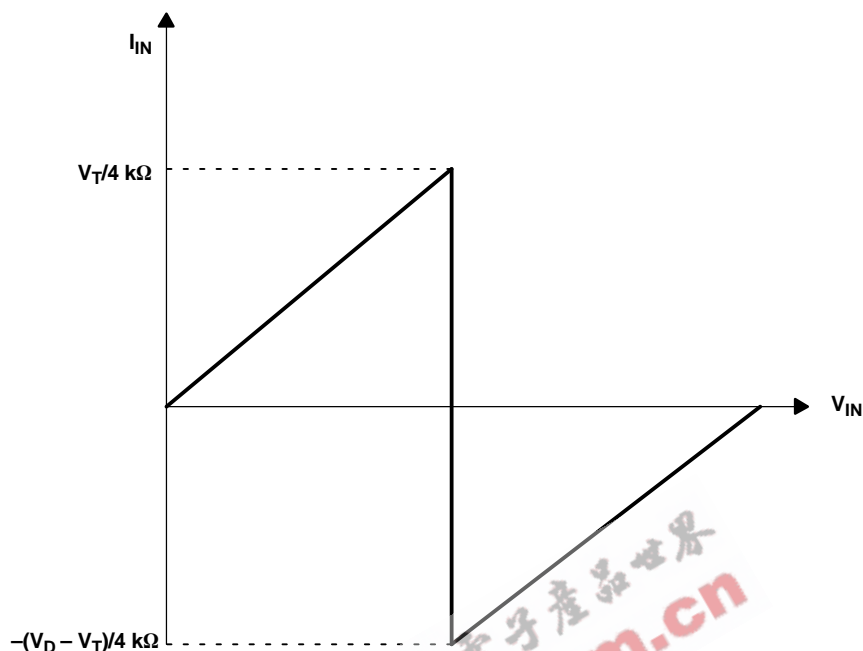
Input Driver Requirements

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 ± 2 mA.

TXB0104 4-BIT BIDIRECTIONAL VOLTAGE-LEVEL TRANSLATOR WITH AUTO DIRECTION SENSING AND ± 15 -kV ESD PROTECTION

SCES650–APRIL 2006

PRINCIPLES OF OPERATION (continued)



- A. V_T is the input threshold voltage of the TXB0104 (typically $V_{CC}/2$).
- 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

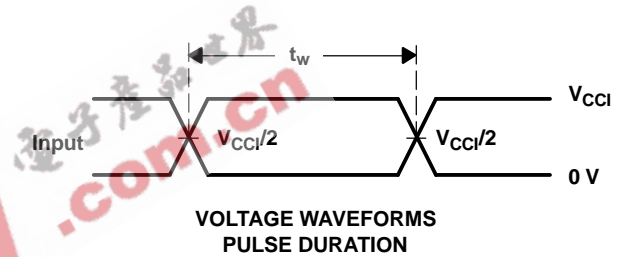
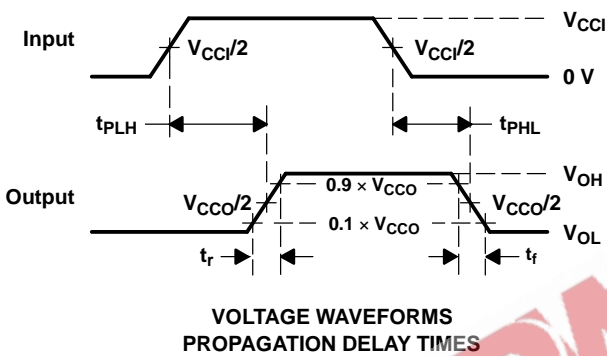
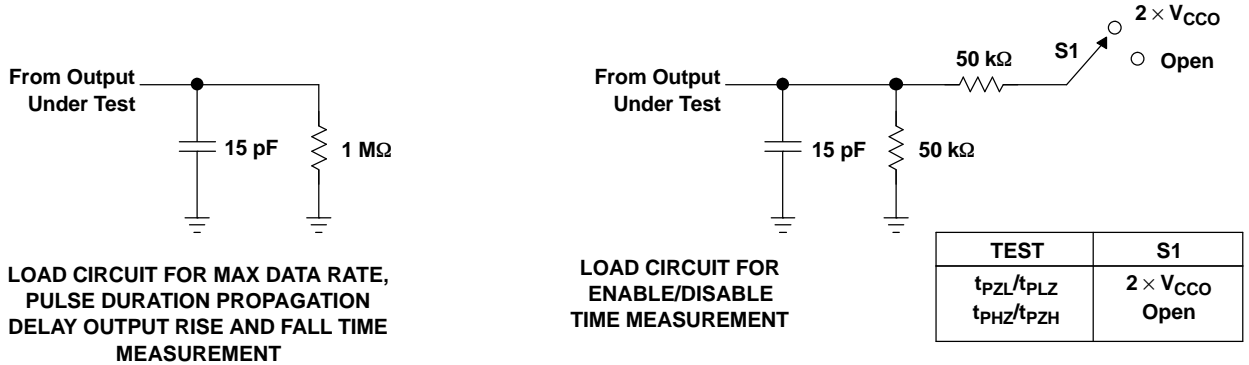
The TXB0104 has an OE input that is used to disable the device by setting OE = low, which places all I/Os in the high-impedance (Hi-Z) state. The disable time (t_{dis}) indicates the delay between when OE goes low and when the outputs actually get disabled (Hi-Z). The enable time (t_{en}) indicates the 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 Ω 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 I²C, 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



- 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_{CC1} 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

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		Applications	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DSP	dsp.ti.com	Broadband	www.ti.com/broadband
Interface	interface.ti.com	Digital Control	www.ti.com/digitalcontrol
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
Low Power Wireless	www.ti.com/lpw	Telephony	www.ti.com/telephony
		Video & Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments
Post Office Box 655303 Dallas, Texas 75265