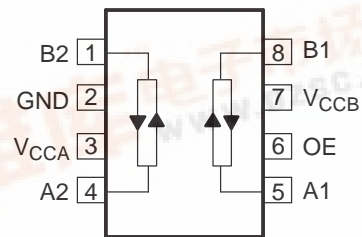


**FEATURES**

- Available in the Texas Instruments NanoFree™ Packages
- 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
    - 15-kV Human-Body Model (A114-B)
    - 200-V Machine Model (A115-A)
    - 1500-V Charged-Device Model (C101)

DCT OR DCU PACKAGE  
(TOP VIEW)



YZP PACKAGE  
(BOTTOM VIEW)



**DESCRIPTION/ORDERING INFORMATION**

This 2-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.

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.

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.

NanoFree™ package technology is a major breakthrough in IC packaging concepts, using the die as the package.

# TXB0102

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



SCES641 – MAY 2007

### ORDERING INFORMATION

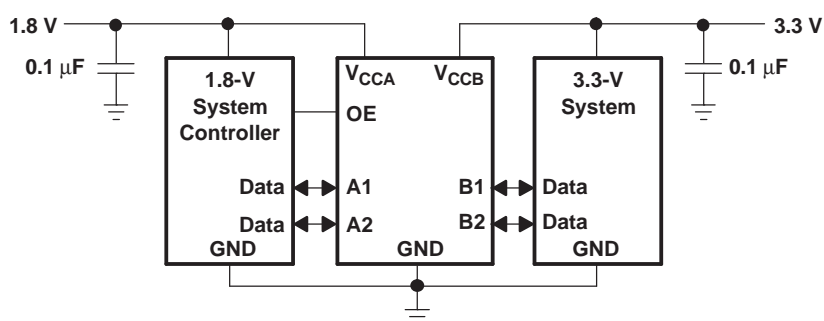
T <sub>A</sub>	PACKAGE <sup>(1)(2)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING <sup>(3)</sup>
-40°C to 85°C	NanoFree™ – WCSP (DSBGA) 0.23-mm Large Bump – YZP (Pb-free)	Reel of 3000	TXB0102YZPR	2E_
		Reel of 3000	TXB0102DCTR	NFD_
	SOT (SOT-23) – DCT	Reel of 250	TXB0102DCTT	
		SOT (SOT-70) – DCU	Reel of 3000	TXB0102DCUR
	Reel of 250		TXB0102DCUT	

- (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).
- (2) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at [www.ti.com](http://www.ti.com).
- (3) YZP: The actual top-side marking has three preceding characters to denote year, month, and sequence code, and one following character to designate the assembly/test site. Pin 1 identifier indicates solder-bump composition (1 = SnPb, • = Pb-free).

### PIN DESCRIPTION

PIN	NAME	FUNCTION
1	B2	Input/output B. Referenced to V <sub>CCB</sub> .
2	GND	Ground
3	V <sub>CCA</sub>	A port supply voltage. $1.2\text{ V} \leq V_{CCA} \leq 3.6\text{ V}$ and $V_{CCA} \leq V_{CCB}$
4	A2	Input/output A. Referenced to V <sub>CCA</sub> .
5	A1	Input/output A. Referenced to V <sub>CCA</sub> .
6	OE	3-State output. Pull OE low to place all outputs in 3-state mode. Referenced to V <sub>CCA</sub> .
7	V <sub>CCB</sub>	B port supply voltage. $1.65\text{ V} \leq V_{CCB} \leq 5.5\text{ V}$
8	B1	Input/output B. Referenced to V <sub>CCB</sub> .

### TYPICAL OPERATING CIRCUIT



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

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

		MIN	MAX	UNIT	
V <sub>CCA</sub>	Supply voltage range	-0.5	4.6	V	
V <sub>CCB</sub>	Supply voltage range	-0.5	6.5		
V <sub>I</sub>	Input voltage range <sup>(2)</sup>	A port	-0.5	4.6	V
		B port	-0.5	6.5	
V <sub>O</sub>	Voltage range applied to any output in the high-impedance or power-off state <sup>(2)</sup>	A port	-0.5	4.6	V
		B port	-0.5	6.5	
V <sub>O</sub>	Voltage range 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	mA
Continuous current through V <sub>CCA</sub> , V <sub>CCB</sub> , or GND				±100	mA
θ <sub>JA</sub>	Package thermal impedance <sup>(4)</sup>	DCT package		220	°C/W
		DCU package		227	
		YZP package		102	
T <sub>stg</sub>	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<sub>CCA</sub> and V<sub>CCB</sub> are provided in the recommended operating conditions table.
- (4) The package thermal impedance is calculated in accordance with JESD 51-7.

### 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 input	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 input	1.2 V to 3.6 V	1.65 V to 5.5 V	0	V <sub>CCA</sub> × 0.35	
V <sub>O</sub>	Voltage range applied to any output in the high-impedance or power-off state	A port	1.2 V to 3.6 V	1.65 V to 5.5 V	0	3.6	V
		B port			0	5.5	
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			ns/V
		B port inputs	1.2 V to 3.6 V	1.65 V to 1.95 V			
				4.5 V to 5.5 V			
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<sub>CCI</sub> or both at GND.
- (2) V<sub>CCA</sub> must be less than or equal to V<sub>CCB</sub> and must not exceed 3.6 V.
- (3) V<sub>CCI</sub> is the supply voltage associated with the input port.

# TXB0102

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



SCES641 – MAY 2007

### 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	V <sub>I</sub> = V <sub>CC1</sub> or GND	1.2 V to 3.6 V	1.65 V to 5.5 V	±1			±2	μA	
I <sub>off</sub>	A port	V <sub>I</sub> or V <sub>O</sub> = 0 to 3.6 V	0 V	0 V to 5.5 V	±1			±2	μA	
	B port	V <sub>I</sub> or V <sub>O</sub> = 0 to 5.5 V	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>CC1</sub> or GND, I <sub>O</sub> = 0	1.2 V	1.65 V to 5.5 V	0.06			3	μA	
			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 <sub>CCB</sub>		V <sub>I</sub> = V <sub>CC1</sub> or GND, I <sub>O</sub> = 0	1.2 V	1.65 V to 5.5 V	3.4			5	μA	
			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 <sub>CCA</sub> + I <sub>CCB</sub>		V <sub>I</sub> = V <sub>CC1</sub> or GND, I <sub>O</sub> = 0	1.2 V	1.65 V to 5.5 V	3.5			8	μA	
			1.4 V to 3.6 V	1.65 V to 5.5 V						
I <sub>CCZA</sub>		V <sub>I</sub> = V <sub>CC1</sub> or GND, I <sub>O</sub> = 0, OE = GND	1.2 V	1.65 V to 5.5 V	0.05			3	μA	
			1.4 V to 3.6 V	1.65 V to 5.5 V						
I <sub>CCZB</sub>		V <sub>I</sub> = V <sub>CC1</sub> or GND, I <sub>O</sub> = 0, OE = GND	1.2 V	1.65 V to 5.5 V	3.3			5	μA	
			1.4 V to 3.6 V	1.65 V to 5.5 V						
C <sub>i</sub>	OE		1.2 V to 3.6 V	1.65 V to 5.5 V	2.5			3	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<sub>CC1</sub> is the supply voltage associated with the input port.  
(2) V<sub>CC0</sub> is the supply voltage associated with the output port.

### Timing Requirements

T<sub>A</sub> = 25°C, V<sub>CCA</sub> = 1.2 V

			V <sub>CCB</sub> = 1.8 V	V <sub>CCB</sub> = 2.5 V	V <sub>CCB</sub> = 3.3 V	V <sub>CCB</sub> = 5 V	UNIT
			TYP	TYP	TYP	TYP	
Data rate			20	20	20	20	Mbps
t <sub>w</sub>	Pulse duration	Data inputs	50	50	50	50	ns

### Timing Requirements

over recommended operating free-air temperature range, V<sub>CCA</sub> = 1.5 V ± 0.1 V (unless otherwise noted)

			V <sub>CCB</sub> = 1.8 V ± 0.15 V		V <sub>CCB</sub> = 2.5 V ± 0.2 V		V <sub>CCB</sub> = 3.3 V ± 0.3 V		V <sub>CCB</sub> = 5 V ± 0.5 V		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
Data rate			40		40		40		40		Mbps

### Timing Requirements (continued)

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	
$t_w$	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	
$t_{rA}$	A port rise time		4.2	4.2	4.2	4.2	ns
$t_{fA}$	A port fall times		4.2	4.2	4.2	4.2	ns
$t_{rB}$	B port rise times		2.1	1.5	1.2	1.1	ns
$t_{fB}$	B port fall times		2.1	1.5	1.2	1.1	ns
$t_{sk(o)}$	Channel-to-channel		0.5	0.5	0.5	1.4	ns
Max data rate			20	20	20	20	Mbps

**TXB0102**  
**2-BIT BIDIRECTIONAL VOLTAGE-LEVEL TRANSLATOR**  
**WITH AUTO DIRECTION SENSING AND  $\pm 15$ -kV ESD PROTECTION**



SCES641 – MAY 2007

**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	
$t_{rA}$	A port rise times		1.4	5.1	1.4	5.1	1.4	5.1	1.4	5.1	ns
$t_{fA}$	A port fall times		1.4	5.1	1.4	5.1	1.4	5.1	1.4	5.1	ns
$t_{rB}$	B port rise times		0.9	4.5	0.6	3.2	0.5	2.8	0.4	2.7	ns
$t_{fB}$	B port 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			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	
$t_{rA}$	A port rise times		1	4.2	1.1	4.1	1.1	4.1	1.1	4.1	ns
$t_{fA}$	A port fall times		1	4.2	1.1	4.1	1.1	4.1	1.1	4.1	ns
$t_{rB}$	B port rise times		0.9	4.5	0.6	3.2	0.5	2.8	0.4	2.7	ns
$t_{fB}$	B port 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			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	
$t_{rA}$	A port rise times		0.8	3	0.8	3	0.8	3	ns
$t_{fA}$	A port fall times		0.8	3	0.8	3	0.8	3	ns
$t_{rB}$	B port rise times		0.7	3	0.5	2.8	0.4	2.7	ns
$t_{fB}$	B port fall times		0.7	3	0.5	2.8	0.4	2.7	ns
$t_{sk(o)}$	Channel-to-channel		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	4.5	
$t_{en}$	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	
$t_{rA}$	A port rise times		0.7	2.5	0.7	2.5	ns
$t_{fA}$	A port fall times		0.7	2.5	0.7	2.5	ns
$t_{rB}$	B port rise times		0.5	2.3	0.4	2.7	ns
$t_{fB}$	B port fall times		0.5	2.3	0.4	2.7	ns
$t_{sk(o)}$	Channel-to-channel		0.5		0.5		ns
Max data rate			100		100		Mbps

**TXB0102**  
**2-BIT BIDIRECTIONAL VOLTAGE-LEVEL TRANSLATOR**  
**WITH AUTO DIRECTION SENSING AND  $\pm 15$ -kV ESD PROTECTION**



SCE5641 – MAY 2007

**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	8	8	7	7	8	8	pF
	B port input, A port output		12	11	11	11	11	11	11	
$C_{pdB}$	A port input, B port output		38.1	29	29	29	29	30	30	
	B port input, A port output		25.4	19	18	18	18	21	21	
$C_{pdA}$	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	0.02	
	B port input, A port output		0.01	0.01	0.01	0.01	0.01	0.02	0.03	



## PRINCIPLES OF OPERATION

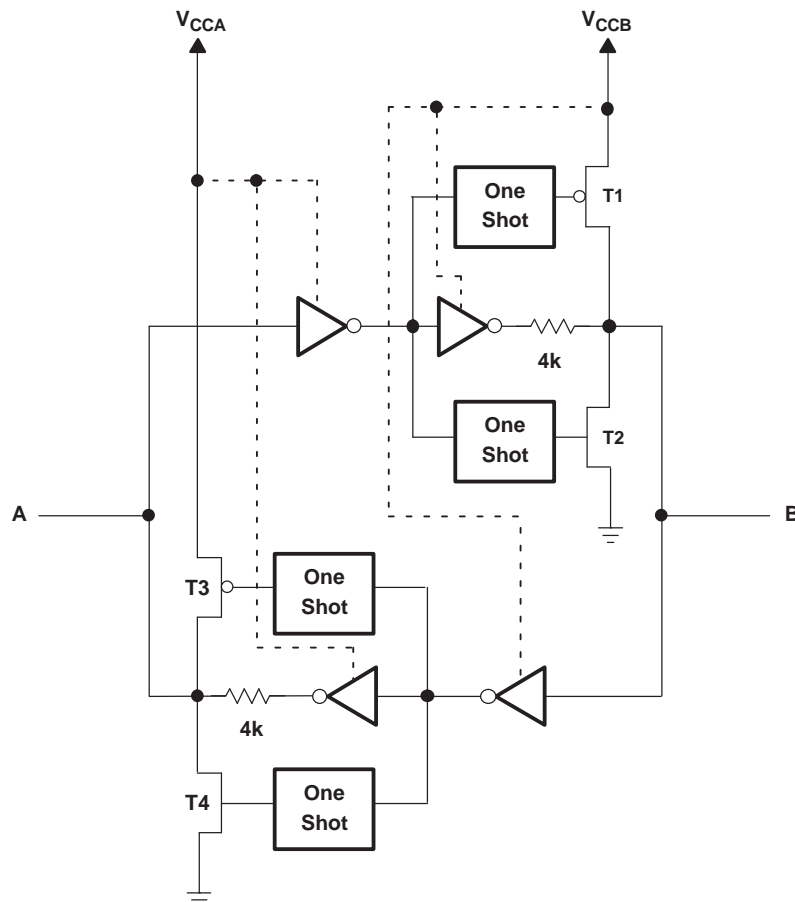
### Applications

The TXB0102 can be used in level-translation applications for interfacing devices or systems operating at different interface voltages with one another.

### Architecture

The TXB0102 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 TXB0102 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. The typical output impedance during output transition is  $70\ \Omega$  at  $V_{CC0} = 1.2\ \text{V}$  to  $1.8\ \text{V}$ ,  $50\ \Omega$  at  $V_{CC0} = 1.8\ \text{V}$  to  $3.3\ \text{V}$ , and  $40\ \Omega$  at  $V_{CC0} = 3.3\ \text{V}$  to  $5\ \text{V}$ .



**Figure 1. Architecture of TXB0102 I/O Cell**

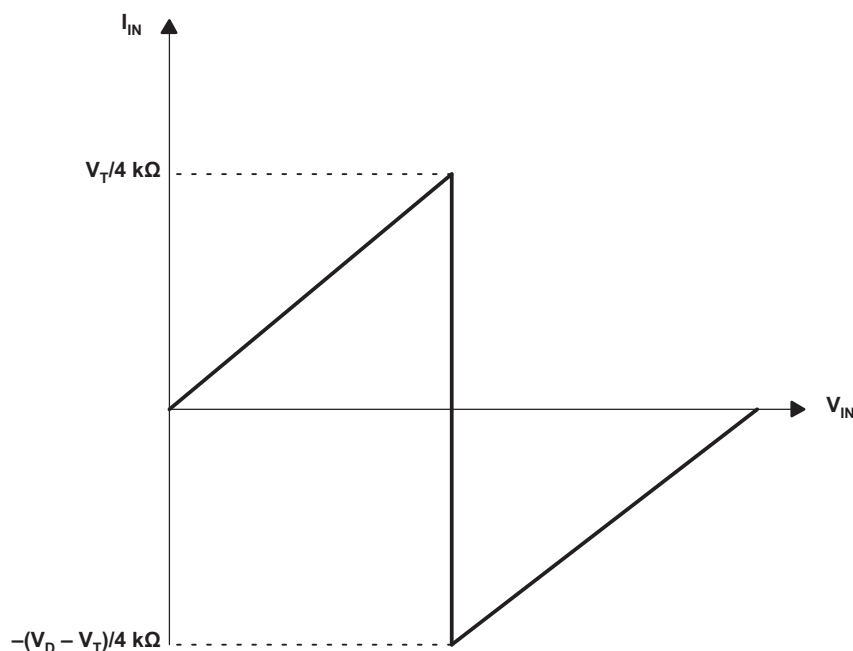
### Input Driver Requirements

Typical  $I_{IN}$  vs  $V_{IN}$  characteristics of the TXB0102 are shown in [Figure 2](#). For proper operation, the device driving the data I/Os of the TXB0102 must have drive strength of at least  $\pm 2\ \text{mA}$ .

**TXB0102**  
**2-BIT BIDIRECTIONAL VOLTAGE-LEVEL TRANSLATOR**  
**WITH AUTO DIRECTION SENSING AND  $\pm 15$ -kV ESD PROTECTION**

SCES641 – MAY 2007

**PRINCIPLES OF OPERATION (continued)**



- A.  $V_T$  is the input threshold voltage of the TXB0102 (typically  $V_{CC1}/2$ ).
- 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 TXB0102 has circuitry that disables all output ports when either  $V_{CC}$  is switched off ( $V_{CCA/B} = 0$  V).

**Enable and Disable**

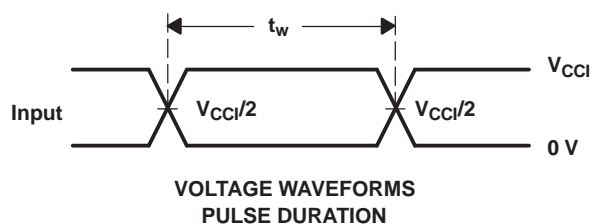
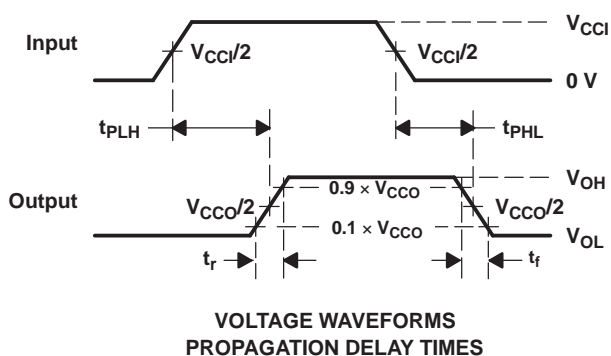
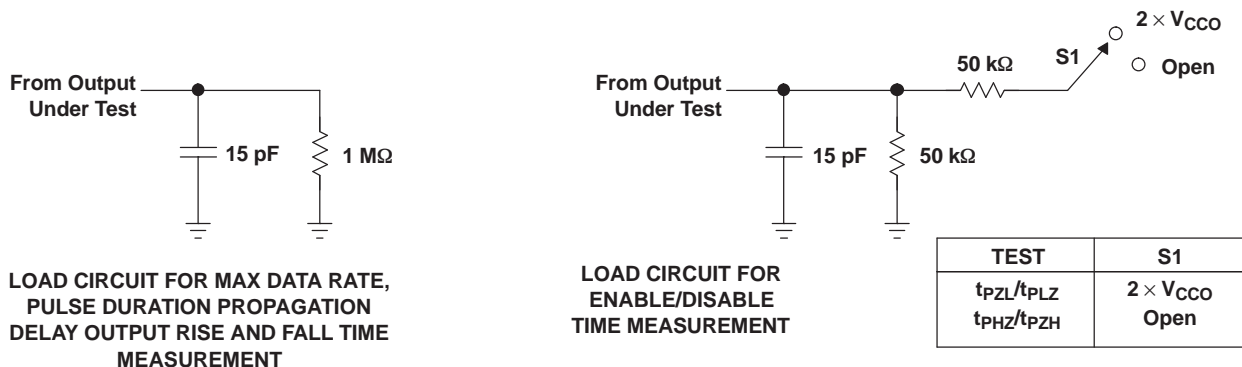
The TXB0102 has an OE input that is used to disable the device by setting OE = low, which places all I/Os in the high-impedance (Hi-Z) state. The disable time ( $t_{dis}$ ) indicates the delay between when OE goes low and when the outputs actually get disabled (Hi-Z). The enable time ( $t_{en}$ ) indicates 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 TXB0102 is designed to drive capacitive loads of up to 70 pF. The output drivers of the TXB0102 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 kΩ to ensure that they do not contend with the output drivers of the TXB0102.

For the same reason, the TXB0102 should not be used in applications such as I<sup>2</sup>C or 1-Wire where an open-drain driver is connected to 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.  $V_{CCI}$  is the  $V_{CC}$  associated with the input port.
- F.  $V_{CC0}$  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

PACKAGING INFORMATION

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
TXB0102DCUR	ACTIVE	US8	DCU	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TXB0102DCURG4	ACTIVE	US8	DCU	8	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TXB0102DCUT	ACTIVE	US8	DCU	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TXB0102DCUTG4	ACTIVE	US8	DCU	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TXB0102YZPR	ACTIVE	WCSP	YZP	8	3000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

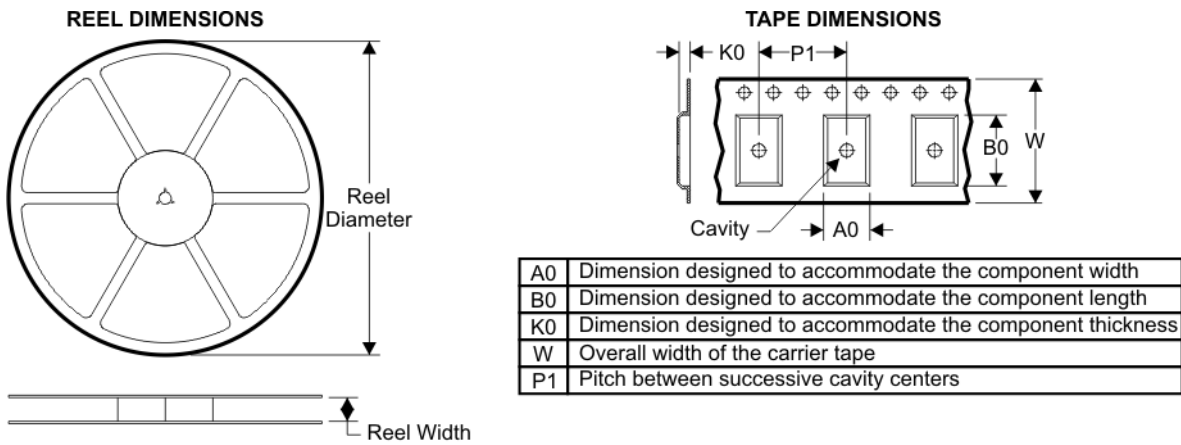
**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

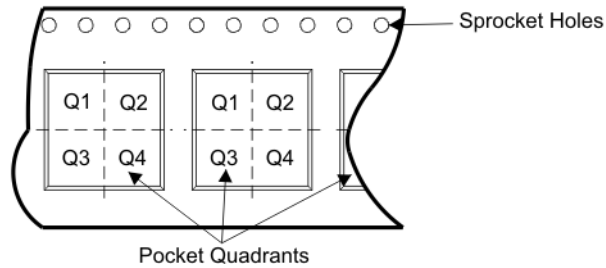
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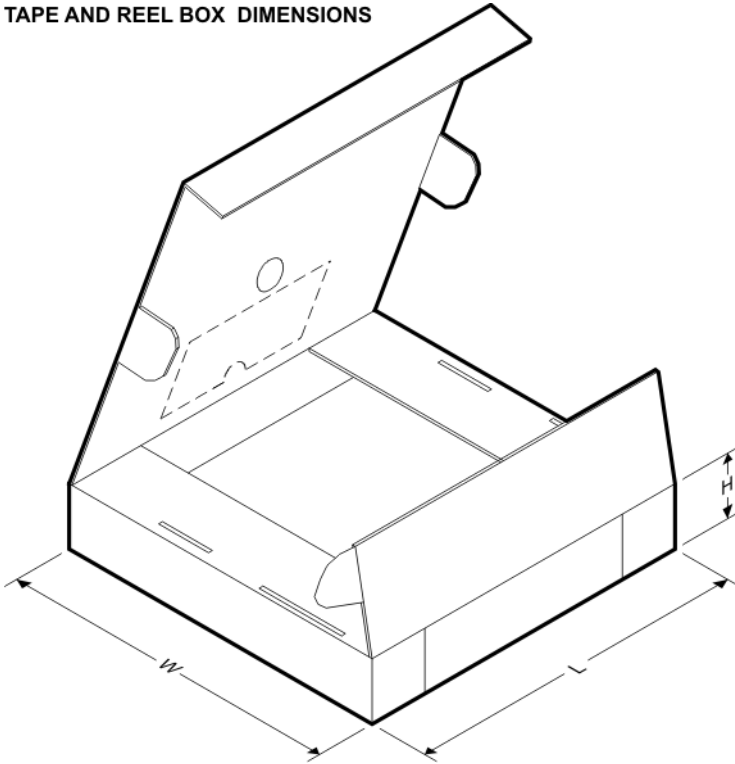


**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**



Device	Package	Pins	Site	Reel Diameter (mm)	Reel Width (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TXB0102YZPR	YZP	8	SITE 12	180	8	1.1	2.1	0.56	4	8	Q1

**TAPE AND REEL BOX DIMENSIONS**



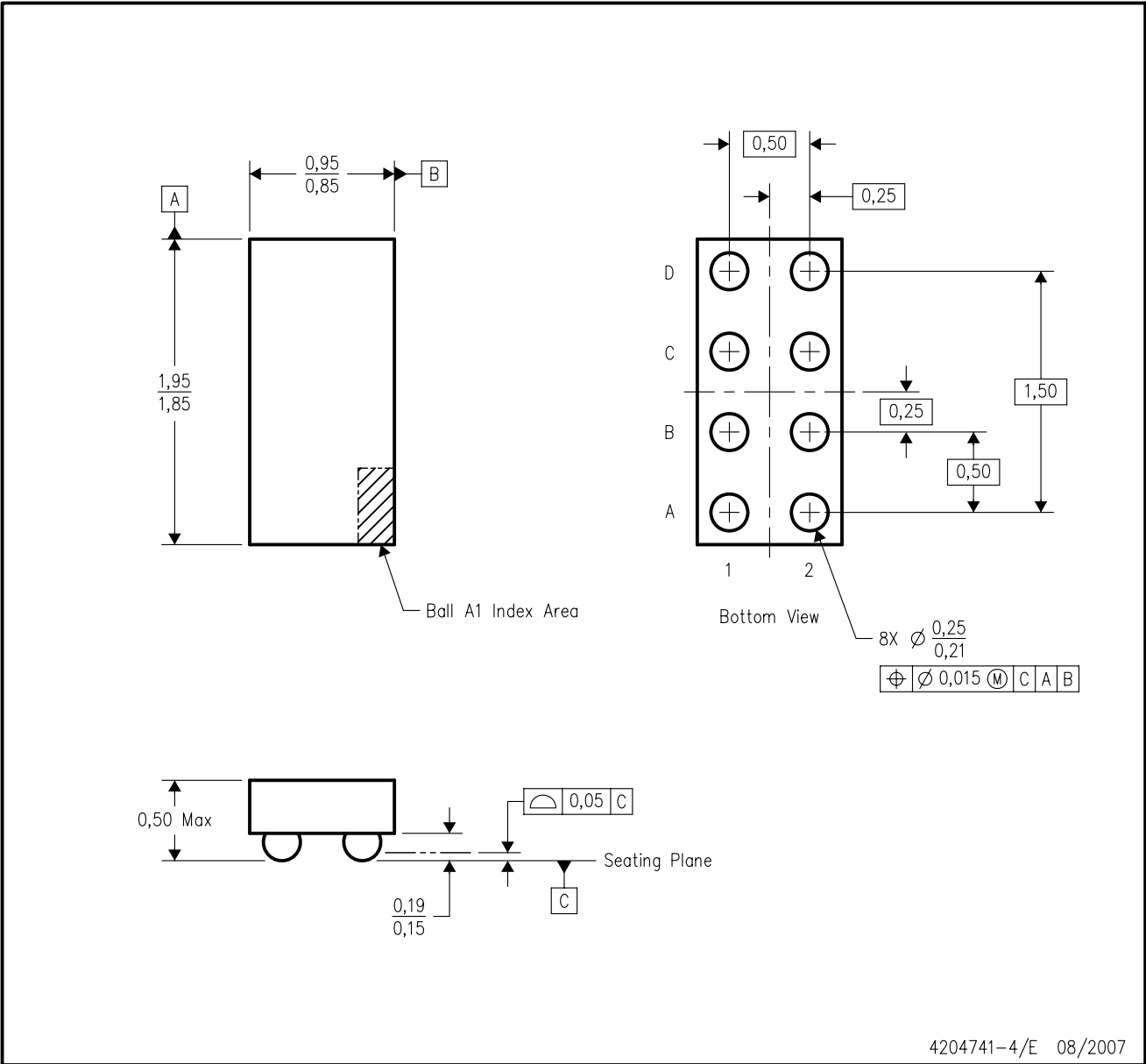
Device	Package	Pins	Site	Length (mm)	Width (mm)	Height (mm)
TXB0102YZPR	YZP	8	SITE 12	220.0	220.0	0.0



MECHANICAL DATA

YZP (R-XBGA-N8)

DIE-SIZE BALL GRID ARRAY



- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
  - B. This drawing is subject to change without notice.
  - C. NanoFree™ package configuration.
  - D. This package is lead-free. Refer to the 8 YEP package (drawing 4204725) for tin-lead (SnPb).



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