

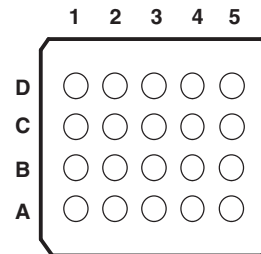
## 8-BIT BIDIRECTIONAL VOLTAGE-LEVEL TRANSLATOR FOR OPEN-DRAIN AND PUSH-PULL APPLICATIONS

### FEATURES

- No Direction-Control Signal Needed
- Max Data Rates
  - 60 Mbps (Push Pull)
  - 2 Mbps (Open Drain)
- 1.2 V to 3.6 V on A Port and 1.65 V to 5.5 V on B Port ( $V_{CCA} \leq V_{CCB}$ )
- No Power-Supply Sequencing Required – Either  $V_{CCA}$  or  $V_{CCB}$  Can Be Ramped First
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II
- ESD Protection Exceeds JESD 22 (A Port)
  - 2000-V Human-Body Model (A114-B)
  - 150-V Machine Model (A115-A)
  - 1000-V Charged-Device Model (C101)

- IEC 61000-4-2 ESD (B Port)
  - $\pm 8$ -kV Contact Discharge
  - $\pm 6$ -kV Air-Gap Discharge

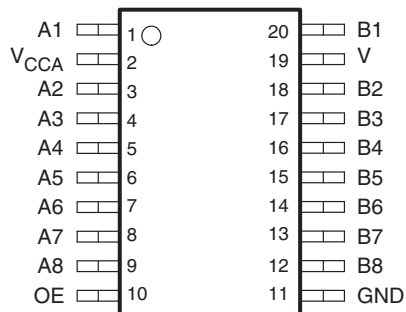
ZXY PACKAGE  
(BOTTOM VIEW)



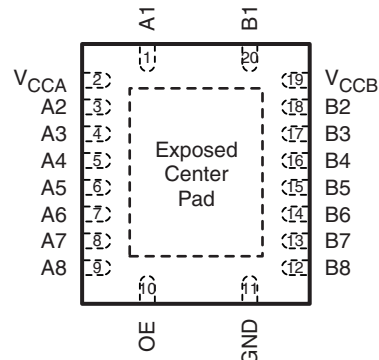
TERMINAL ASSIGNMENTS

	1	2	3	4	5
<b>D</b>	$V_{CCB}$	B2	B4	B6	B8
<b>C</b>	B1	B3	B5	B7	GND
<b>B</b>	A1	A3	A5	A7	OE
<b>A</b>	$V_{CCA}$	A2	A4	A6	A8

PW PACKAGE  
(TOP VIEW)



RGY PACKAGE  
(TOP VIEW)



The exposed center pad, if used, must be connected as a secondary ground or left electrically open.



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.

## DESCRIPTION/ORDERING INFORMATION

This 8-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 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.

When the output-enable (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 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.

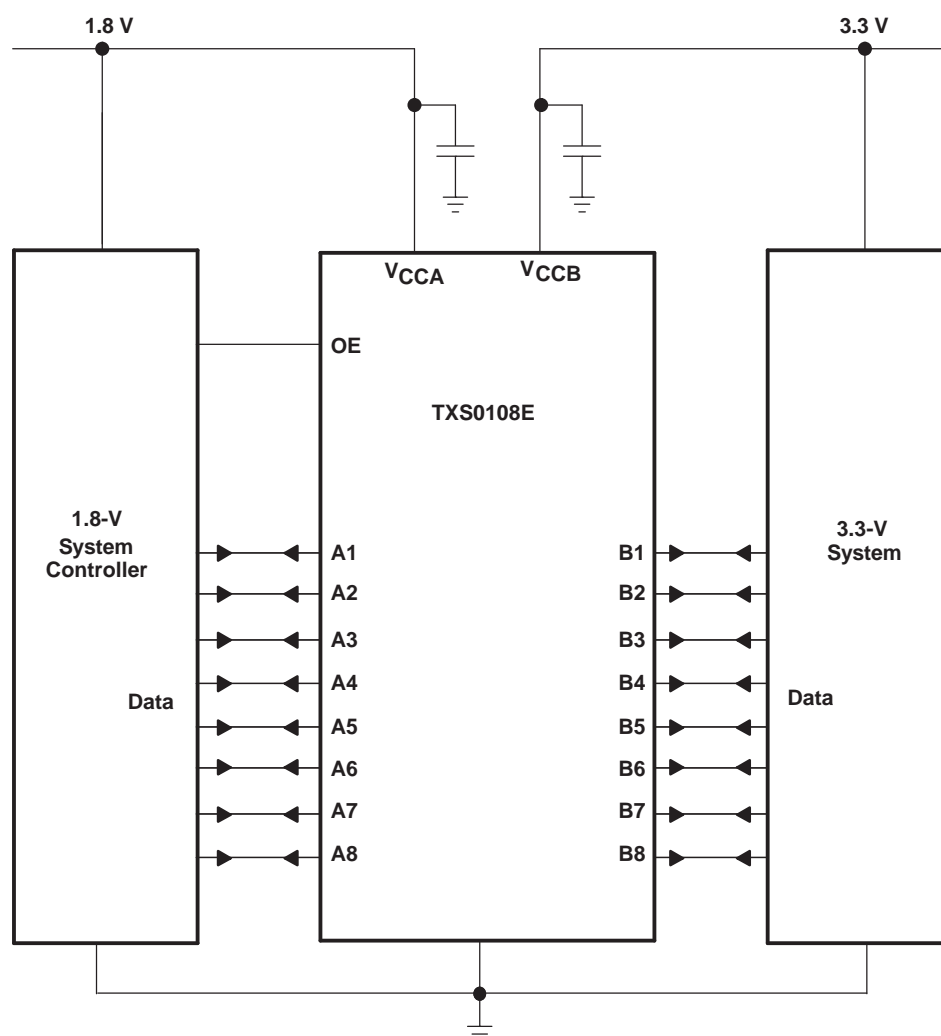
## ORDERING INFORMATION

$T_A$	PACKAGE <sup>(1)(2)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	QFN – RGY	Reel of 1000	TXS0108ERGYR	YF08E
	TSSOP – PW	Reel of 2000	TXS0108EPWR	YF08E
	UFBGA – ZXY	Reel of 2500	TXS0108EZXYR	YF08E

(1) Package drawings, thermal data, and symbolization are available at [www.ti.com/packaging](http://www.ti.com/packaging).

(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).

## TYPICAL OPERATING CIRCUIT



## 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	5.5	V
$V_I$	Input voltage range <sup>(2)</sup>	A port	–0.5	4.6	V
		B port	–0.5	6.5	
$V_O$	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	
$V_O$	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			±50	mA
	Continuous current through $V_{CCA}$ , $V_{CCB}$ , or GND			±100	mA
$T_{stg}$	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.

## THERMAL IMPEDANCE RATINGS

			UNIT
$\theta_{JA}$	Package thermal impedance	PW package <sup>(1)</sup>	70
		RGY package <sup>(2)</sup>	80.9
		ZXY package <sup>(1)</sup>	47

- (1) The package thermal impedance is calculated in accordance with JESD 51-5.
- (2) The package thermal impedance is calculated in accordance with JESD 51-7.

**RECOMMENDED OPERATING CONDITIONS<sup>(1)(2)</sup>**

			$V_{CCA}$	$V_{CCB}$	MIN	MAX	UNIT
$V_{CCA}$	Supply voltage <sup>(3)</sup>				1.2	3.6	V
$V_{CCB}$					1.65	5.5	
$V_{IH}$	High-level input voltage	A-Port I/Os	1.2 V to 1.95 V	1.65 V to 5.5 V	$V_{CCI} - 0.2$	$V_{CCI}$	V
			1.95 V to 3.6 V		$V_{CCI} - 0.4$	$V_{CCI}$	
		B-Port I/Os	1.2 V to 3.6 V	1.65 V to 5.5 V	$V_{CCI} - 0.4$	$V_{CCI}$	
		OE			$V_{CCA} \times 0.65$	5.5	
$V_{IL}$	Low-level input voltage	A-Port I/Os	1.2 V to 1.95 V	1.65 V to 5.5 V	0	0.15	V
			1.95 V to 3.6 V		0	0.15	
		B-Port I/Os	1.2 V to 3.6 V	1.65 V to 5.5 V	0	0.15	
		OE			0	$V_{CCA} \times 0.35$	
$\Delta t/\Delta v$	Input transition rise or fall rate	A-Port I/Os push-pull driving	1.2 V to 3.6 V	1.65 V to 5.5 V	10		ns/V
		B-Port I/Os push-pull driving					
		Control input					
$T_A$	Operating free-air temperature				–40	85	°C

(1)  $V_{CCI}$  is the  $V_{CC}$  associated with the data input port.(2)  $V_{CCO}$  is the  $V_{CC}$  associated with the output port.(3)  $V_{CCA}$  must be less than or equal to  $V_{CCB}$ , and  $V_{CCA}$  must not exceed 3.6 V.

**ELECTRICAL CHARACTERISTICS<sup>(1)(2)(3)</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, V <sub>IB</sub> ≥ V <sub>CCB</sub> – 0.4 V	1.2 V 1.4 V to 3.6 V	1.65 V to 5.5 V	V <sub>CCA</sub> × 0.67			V <sub>CCA</sub> × 0.67		V
V <sub>OLA</sub>		I <sub>OL</sub> = 135 μA, V <sub>IB</sub> ≤ 0.15 V	1.2 V	1.65 V to 5.5 V	0.25					V
		I <sub>OL</sub> = 180 μA, V <sub>IB</sub> ≤ 0.15 V	1.4 V					0.4		
		I <sub>OL</sub> = 220 μA, V <sub>IB</sub> ≤ 0.15 V	1.65 V					0.4		
		I <sub>OL</sub> = 300 μA, V <sub>IB</sub> ≤ 0.15 V	2.3 V					0.4		
		I <sub>OL</sub> = 400 μA, V <sub>IB</sub> ≤ 0.15 V	3 V					0.55		
V <sub>OHB</sub>		I <sub>OH</sub> = –20 μA, V <sub>IA</sub> ≥ V <sub>CCA</sub> – 0.2 V	1.2 V 1.4 V to 3.6 V	1.65 V to 5.5 V				V <sub>CCB</sub> × 0.67		V
V <sub>OLB</sub>		I <sub>OL</sub> = 220 μA, V <sub>IA</sub> ≤ 0.15 V	1.2 V to 3.6 V	1.65 V				0.4		V
		I <sub>OL</sub> = 300 μA, V <sub>IA</sub> ≤ 0.15 V		2.3 V				0.4		
		I <sub>OL</sub> = 400 μA, V <sub>IA</sub> ≤ 0.15 V		3 V				0.55		
		I <sub>OL</sub> = 620 μA, V <sub>IA</sub> ≤ 0.15 V		4.5 V				0.55		
I <sub>I</sub>	OE	V <sub>I</sub> = V <sub>CCI</sub> or GND	1.2 V	1.65 V to 5.5 V	±1			2		μA
I <sub>OZ</sub>	A or B port		1.2 V	1.65 V to 5.5 V	±1			±2		μA
I <sub>CCA</sub>		V <sub>I</sub> = V <sub>O</sub> = Open, I <sub>O</sub> = 0	1.2 V	1.65 V to 5.5 V	1.5			±2		μA
			1.4 V to 3.6 V	2.3 V to 5.5 V				2		
			3.6 V	0 V				2		
			0 V	5.5 V				–1		
I <sub>CCB</sub>		V <sub>I</sub> = V <sub>O</sub> = Open, I <sub>O</sub> = 0	1.2 V	1.65 V to 5.5 V	1.5					μA
			1.4 V to 3.6 V	2.3 V to 5.5 V				6		
			3.6 V	0 V				–1		
			0 V	5.5 V				1		
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 1.4 V to 3.6 V	2.3 V to 5.5 V	3			8		μA
I <sub>CCZA</sub>		V <sub>I</sub> = V <sub>O</sub> = Open, 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					2		
I <sub>CCZB</sub>		V <sub>I</sub> = V <sub>O</sub> = Open, I <sub>O</sub> = 0, OE = GND	1.2 V	1.65 V to 5.5 V	4					μA
			1.4 V to 3.6 V					6		
C <sub>i</sub>	OE		3.3 V	3.3 V	4.5			5.5		pF
C <sub>io</sub>	A port		3.3 V	3.3 V	6			7		pF
	B port				5.5			6		

- (1) V<sub>CCO</sub> is the V<sub>CC</sub> associated with the output port.
- (2) V<sub>CCI</sub> is the V<sub>CC</sub> associated with the input port.
- (3) V<sub>CCA</sub> must be less than or equal to V<sub>CCB</sub>, and V<sub>CCA</sub> must not exceed 3.6 V.

## 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	Push-pull driving		20	20	20	20	Mbps
	Open-drain driving		2	2	2	2	
$t_w$ Pulse duration	Data inputs	Push-pull driving	50	50	50	50	ns
		Open-drain driving	500	500	500	500	

## 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		Push-pull driving		40		60		60		50		Mbps	
		Open-drain driving		2		2		2		2			
t <sub>w</sub>	Pulse duration	Push-pull driving		Data inputs	25		16.7		16.7		20		ns
		Open-drain driving			500		500		500		500		

## TIMING REQUIREMENTS

 over recommended operating free-air temperature range,  $V_{CCA} = 1.8\text{ V} \pm 0.15\text{ V}$  (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	
Data rate		Push-pull driving		40	60	60	60	Mbps
		Open-drain driving		2	2	2	2	
t <sub>w</sub>	Pulse duration	Push-pull driving	Data inputs	25	16.7	16.7	16.7	ns
		Open-drain driving		500	500	500	500	

## TIMING REQUIREMENTS

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

				$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$		$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$		$V_{CC} = 5\text{ V} \pm 0.5\text{ V}$		UNIT	
				MIN	MAX	MIN	MAX	MIN	MAX		
Data rate	Push-pull driving			60		60		60		Mbps	
	Open-drain driving			2		2		2			
$t_w$	Pulse duration	Push-pull driving		Data inputs	16.7		16.7		16.7		ns
		Open-drain driving			500		500		500		

## TIMING REQUIREMENTS

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

			$V_{CCB} = 3.3\text{ V}$ $\pm 0.3\text{ V}$		$V_{CC} = 5\text{ V}$ $\pm 0.5\text{ V}$		UNIT
			MIN	MAX	MIN	MAX	
Data rate	Push-pull driving		60		60		Mbps
	Open-drain driving		2		2		
t <sub>w</sub> Pulse duration	Push-pull driving	Data inputs	16.7		16.7		ns
	Open-drain driving		500		500		

## SWITCHING CHARACTERISTICS

over recommended operating free-air temperature range,  $V_{CCA} = 1.2\text{ V}$  (unless otherwise noted)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	$V_{CCB} = 1.8\text{ V}$ $\pm 0.15\text{ V}$	$V_{CCB} = 2.5\text{ V}$ $\pm 0.2\text{ V}$	$V_{CCB} = 3.3\text{ V}$ $\pm 0.3\text{ V}$	$V_{CCB} = 5\text{ V}$ $\pm 0.5\text{ V}$	UNIT
				TYP	TYP	TYP	TYP	
$t_{PHL}$	A	B	Push-pull driving	6.5	5.9	5.7	5.5	ns
			Open-drain driving	11.9	11.1	11.0	11.1	
$t_{PLH}$			Push-pull driving	7.1	6.3	6.2	6.6	
			Open-drain driving	293	236	197	152	
$t_{PHL}$	B	A	Push-pull driving	6.4	6	5.8	5.6	ns
			Open-drain driving	8.5	6.8	6.2	5.9	
$t_{PLH}$			Push-pull driving	5.6	4.1	3.6	3.2	
			Open-drain driving	312	248	192	132	
$t_{en}$	OE	A or B	Push-pull driving	200	200	200	200	ns
$t_{dis}$	OE	A or B		16.8	13.9	13.2	13.5	ns
$t_{rA}$	A-port rise time		Push-pull driving	7.9	6.7	6.5	6.4	ns
			Open-drain driving	296	238	185	127	
$t_{rB}$	B-port rise time		Push-pull driving	6.3	3.3	1.8	1.5	ns
			Open-drain driving	236	164	115	60	
$t_{fA}$	A-port fall time		Push-pull driving	5.8	4.8	4.3	3.8	ns
			Open-drain driving	5.9	4.7	4.1	3.5	
$t_{fB}$	B-port fall time		Push-pull driving	4.6	2.8	2.2	1.9	
			Open-drain driving	4.5	2.7	2.2	1.9	
$t_{SK(O)}$	Channel-to-channel skew		Push-pull driving	1	1	1	1	ns
Max data rate	A or B		Push-pull driving	20	20	20	20	Mbps
			Open-drain driving	2	2	2	2	

## 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)	TEST CONDITIONS	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	
t <sub>PHL</sub>	A	B	Push-pull driving		11		9.2		8.6		8.6	ns
			Open-drain driving	4	14.4	3.6	12.8	3.5	12.2	3.5	12	
t <sub>PLH</sub>			Push-pull driving		12		10		9.8		9.7	
			Open-drain driving	182	720	143	554	114	473	81	384	
t <sub>PHL</sub>	B	A	Push-pull driving		12.7		11.1		11		12	ns
			Open-drain driving	3.4	13.2	3.1	9.6	2.8	8.5	2.5	7.5	
t <sub>PLH</sub>			Push-pull driving		9.5		6.2		5.1		1.6	
			Open-drain driving	186	745	147	603	118	519	84	407	
t <sub>en</sub>	OE	A or B	Push-pull driving		200		200		200		200	ns
t <sub>dis</sub>	OE	A or B			28.1		22		20.1		19.6	ns
t <sub>rA</sub>	A-port rise time		Push-pull driving	3.5	13.1	3	9.8	3.1	9	3.2	8.3	ns
			Open-drain driving	147	982	115	716	92	592	66	481	
t <sub>rB</sub>	B-port rise time		Push-pull driving	2.9	11.4	1.9	7.4	0.9	4.7	0.7	2.6	ns
			Open-drain driving	135	1020	91	756	58	653	20	370	
t <sub>fA</sub>	A-port fall time		Push-pull driving	2.3	9.9	1.7	7.7	1.6	6.8	1.7	6	ns
			Open-drain driving	2.4	10	2.1	7.9	1.7	7	1.5	6.2	
t <sub>fB</sub>	B-port fall time		Push-pull driving	2	8.7	1.3	5.5	0.9	3.8	0.8	3.1	
			Open-drain driving	1.2	11.5	1.3	8.6	1	9.6	0.5	7.7	
t <sub>SK(O)</sub>	Channel-to-channel skew		Push-pull driving		1	1	1		1.1		1	ns
Max data rate	A or B		Push-pull driving	40		60		60		50		Mbps
			Open-drain driving	2		2		2		2		



## 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)	TEST CONDITIONS	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	
t <sub>PHL</sub>	A	B	Push-pull driving		8.2		6.4		5.7		5.6	ns
t <sub>PLH</sub>			Open-drain driving	3.6	11.4	3.2	9.9	3.1	9.3	3.1	8.9	
			Push-pull driving		9		2.1		6.5		6.3	
			Open-drain driving	194	729	155	584	126	466	90	346	
t <sub>PHL</sub>	B	A	Push-pull driving		9.8		8		7.4		7	ns
t <sub>PLH</sub>			Open-drain driving	3.4	12.1	2.8	8.5	2.5	7.3	2.1	6.2	
			Push-pull driving		10.2		7		5.8		5	
			Open-drain driving	197	733	159	578	129	459	93	323	
t <sub>en</sub>	OE	A or B	Push-pull driving		200		200		200		200	ns
t <sub>dis</sub>	OE	A or B			25.1		18.8		16.5		15.3	ns
t <sub>rA</sub>	A-port rise time		Push-pull driving	3.1	11.9	2.6	8.6	2.7	7.8	2.8	7.2	ns
			Open-drain driving	155	996	124	691	100	508	72	350	
t <sub>rB</sub>	B-port rise time		Push-pull driving	2.8	10.5	1.8	7.2	1.2	5.2	0.7	2.7	ns
			Open-drain driving	132	1001	106	677	73	546	32	323	
t <sub>fA</sub>	A-port fall time		Push-pull driving	2.1	8.8	1.6	6.6	1.4	5.7	1.4	4.9	ns
			Open-drain driving	2.2	9	1.7	6.7	1.4	5.8	1.2	5.2	
t <sub>fB</sub>	B-port fall time		Push-pull driving	2	8.3	1.3	5.4	0.9	3.9	0.7	3	
			Open-drain driving	0.8	10.5	0.7	10.7	1	9.6	0.6	7.8	
t <sub>SK(O)</sub>	Channel-to-channel skew		Push-pull driving		1		1		1		1	ns
Max data rate	A or B		Push-pull driving	40		60		60		60		Mbps
			Open-drain driving	2		2		2		2		

## 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)	TEST CONDITIONS	$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		UNIT
				MIN	MAX	MIN	MAX	MIN	MAX	
$t_{PHL}$	A	B	Push-pull driving		5		4		3.7	ns
			Open-drain driving	2.4	6.9	2.3	6.3	2.2	5.8	
$t_{PLH}$			Push-pull driving		5.2		4.3		3.9	
			Open-drain driving	149	592	125	488	93	368	
$t_{PHL}$	B	A	Push-pull driving		5.4		4.7		4.2	ns
			Open-drain driving	2.5	7.3	2.2	6	1.8	4.9	
$t_{PLH}$			Push-pull driving		5.9		4.4		3.5	
			Open-drain driving	150	595	126	481	94	345	
$t_{en}$	OE	A or B	Push-pull driving		200		200		200	ns
$t_{dis}$	OE	A or B			15.7		12.9		11.2	ns
$t_{rA}$	A-port rise time		Push-pull driving	2	7.3	2.1	6.4	2.2	5.8	ns
			Open-drain driving	110	692	93	529	68	369	
$t_{rB}$	B-port rise time		Push-pull driving	1.8	6.5	1.3	5.1	0.7	3.4	ns
			Open-drain driving	107	693	79	483	41	304	
$t_{fA}$	A-port fall time		Push-pull driving	1.5	5.7	1.2	4.7	1.3	3.8	ns
			Open-drain driving	1.5	5.6	1.2	4.7	1.1	4	
$t_{fB}$	B-port fall time		Push-pull driving	1.4	5.4	0.9	4.1	0.7	3	
			Open-drain driving	0.4	14.2	0.5	19.4	0.4	3	
$t_{SK(O)}$	Channel-to-channel skew		Push-pull driving		1		1.2		1	ns
Max data rate	A or B		Push-pull driving		60		60		60	Mbps
			Open-drain driving		2		2		2	

## 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)	TEST CONDITIONS	$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		UNIT
				MIN	MAX	MIN	MAX	
$t_{PHL}$	A	B	Push-pull driving		3.8		3.1	ns
			Open-drain driving	2	5.3	1.9	4.8	
$t_{PLH}$			Push-pull driving		3.9		3.5	
			Open-drain driving	111	439	87	352	
$t_{PHL}$	B	A	Push-pull driving		4.2		3.8	ns
			Open-drain driving	2.1	5.5	1.7	4.5	
$t_{PLH}$			Push-pull driving		3.8		4.3	
			Open-drain driving	112	449	86	339	
$t_{en}$	OE	A or B	Push-pull driving		200		200	ns
$t_{dis}$	OE	A or B			11.9		9.8	ns
$t_{rA}$	A-port rise time		Push-pull driving	1.8	5.7	1.9	5	ns
			Open-drain driving	75	446	57	337	
$t_{rB}$	B-port rise time		Push-pull driving	1.5	5	1	3.6	ns
			Open-drain driving	72	427	40	290	
$t_{fA}$	A-port fall time		Push-pull driving	1.2	4.5	1.1	3.5	ns
			Open-drain driving	1.1	4.4	1	3.7	
$t_{fB}$	B-port fall time		Push-pull driving	1.1	4.2	0.8	3.1	
			Open-drain driving	1	4.2	0.8	3.1	
$t_{SK(O)}$	Channel-to-channel skew		Push-pull driving		1		1	ns
Max data rate	A or B		Push-pull driving	60		60		Mbps
			Open-drain driving	2		2		

## 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> = 1ns, OE = V <sub>CCA</sub> (outputs enabled)	5.9	5.7	5.9	5.9	6.7	6.9	8	pF	
	B-port input, A-port output		10.2	10.3	9.9	9.7	9.7	9.4	9.8		
C <sub>pdB</sub>	A-port input, B-port output		29.9	22.2	21.5	20.8	21	23.4	23		
	B-port input, A-port output		22.9	16.7	16.7	16.8	17.8	20.8	20.9		
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> = 1ns, 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		0.06	0.01	0.01	0.01	0.01	0.01	0.01		
C <sub>pdB</sub>	A-port input, B-port output		0.06	0.01	0.01	0.01	0.01	0.03	0.02		
	B-port input, A-port output		0.06	0.01	0.01	0.01	0.01	0.03	0.02		

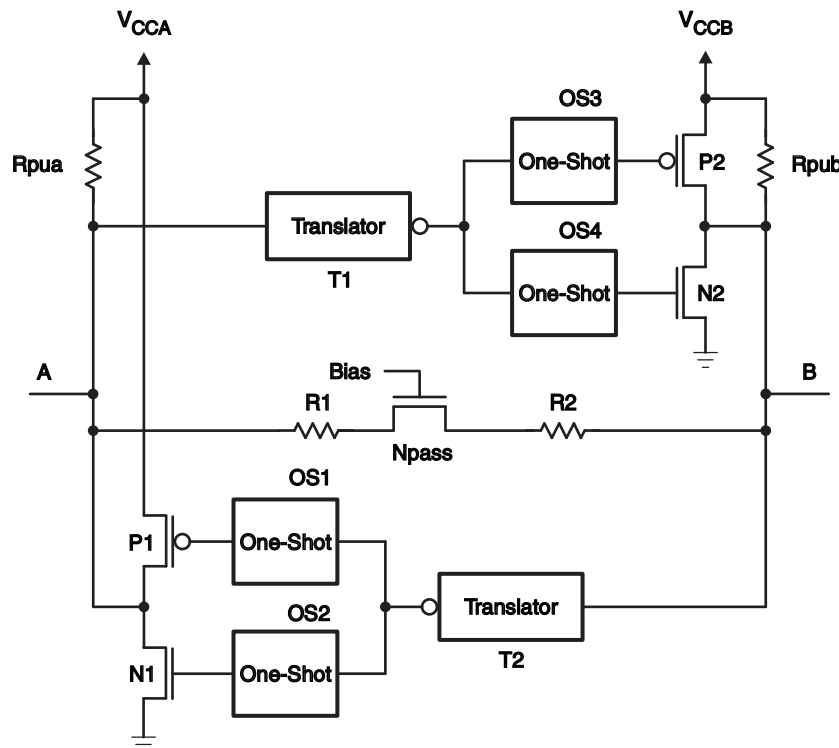
## PRINCIPLES OF OPERATION

### Applications

The TXS0108E can be used in level-translation applications for interfacing devices or systems operating at different interface voltages with one another. The TXS0108E is ideal for use in applications where an open-drain driver is connected to the data I/Os. The TXS0108E can also be used in applications where a push-pull driver is connected to the data I/Os, but the TXB0104 might be a better option for such push-pull applications. The TXS0108E device is a semi-buffered auto-direction-sensing voltage translator design is optimized for translation applications (e.g. MMC Card Interfaces) that require the system to start out in a low-speed open-drain mode and then switch to a higher speed push-pull mode.

### Architecture

To address these application requirements, a semi-buffered architecture design is used and is illustrated below (see [Figure 1](#)). Edge-rate accelerator circuitry (for both the high-to-low and low-to-high edges), a High-Ron n-channel pass-gate transistor (on the order of 300  $\Omega$  to 500  $\Omega$ ) and pull-up resistors (to provide DC-bias and drive capabilities) are included to realize this solution. A direction-control signal (to control the direction of data flow from A to B or from B to A) is not needed. The resulting implementation supports both low-speed open-drain operation as well as high-speed push-pull operation.



**Figure 1. Architecture of a TXS01xx Cell**

When transmitting data from A to B ports, during a rising edge the One-Shot (OS3) turns on the PMOS transistor (P2) for a short-duration and this speeds up the low-to-high transition. Similarly, during a falling edge, when transmitting data from A to B, the One-Shot (OS4) turns on NMOS transistor (N2) for a short-duration and this speeds up the high-to-low transition. The B-port edge-rate accelerator consists of one-shots OS3 and OS4, Transistors P2 and N2 and serves to rapidly force the B port high or low when a corresponding transition is detected on the A port.

When transmitting data from B to A ports, during a rising edge the One-Shot (OS1) turns on the PMOS transistor

(P1) for a short-duration and this speeds up the low-to-high transition. Similarly, during a falling edge, when transmitting data from B to A, the One-Shot (OS2) turns on NMOS transistor (N1) for a short-duration and this speeds up the high-to-low transition. The A-port edge-rate accelerator consists of one-shots OS1 and OS2, Transistors P1 and N1 components and form the edge-rate accelerator and serves to rapidly force the A port high or low when a corresponding transition is detected on the B port.

## 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.

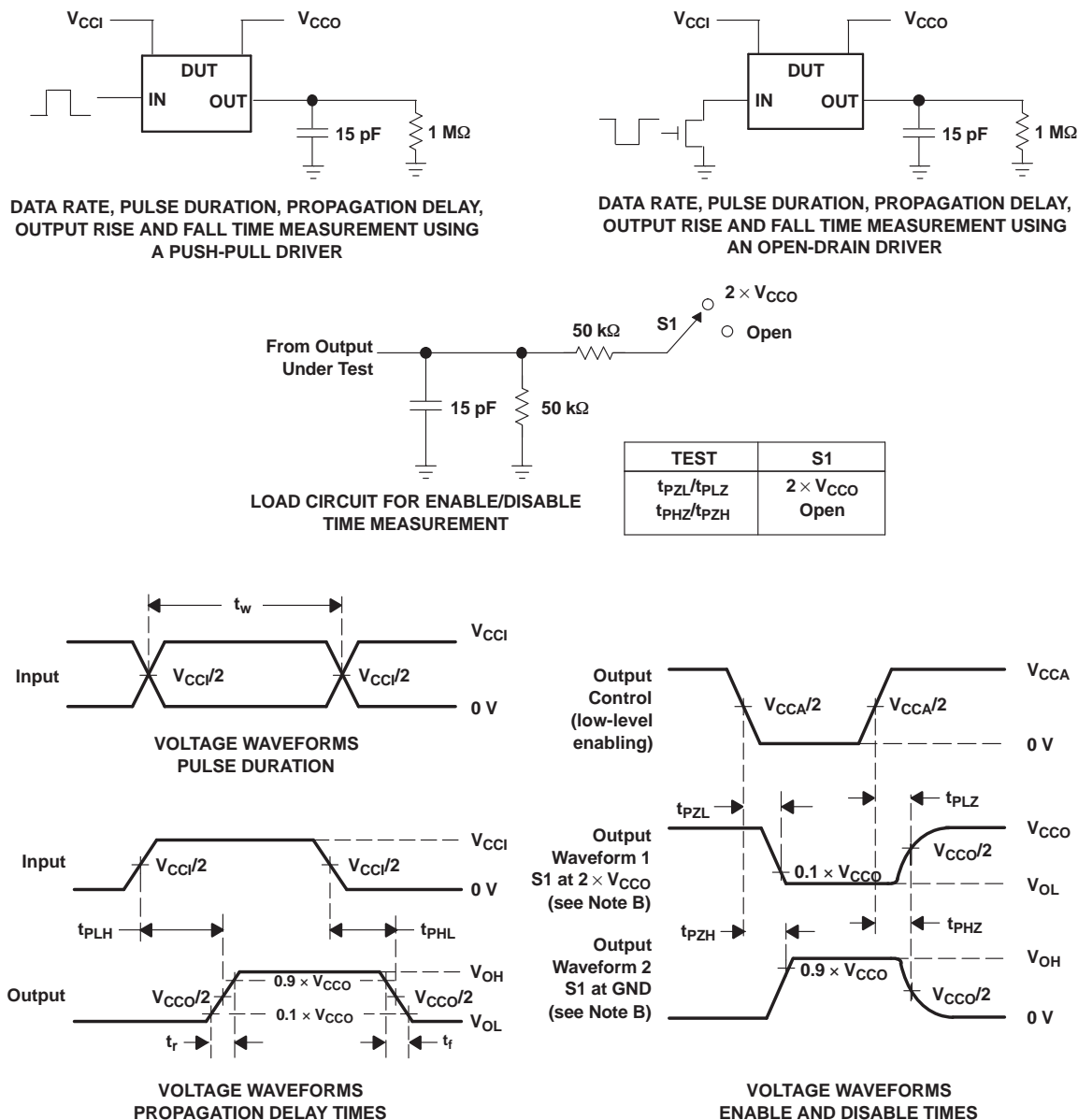
## Enable and Disable

The TXS0108E has an OE input that is used to disable the device by setting OE low, which places all I/Os in the Hi-Z state. The disable time ( $t_{dis}$ ) indicates the delay between the time 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

Each A-port I/O has a pull-up resistor ( $R_{pua}$ ) to  $V_{CCA}$  and each B-port I/O has a pull-up resistor ( $R_{pub}$ ) to  $V_{CCB}$ .  $R_{pua}$  and  $R_{pub}$  have a value of 40 k $\Omega$  when the output is driving low.  $R_{pua}$  and  $R_{pub}$  have a value of 4 k $\Omega$  when the output is driving high.  $R_{pua}$  and  $R_{pub}$  are disabled when OE = Low.

## PARAMETER MEASUREMENT INFORMATION



- $C_L$  includes probe and jig capacitance.
- Waveform 1 is for an output with internal conditions such that the output is low, except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high, except when disabled by the output control.
- 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.
- The outputs are measured one at a time, with one transition per measurement.
- $t_{PLZ}$  and  $t_{PHZ}$  are the same as  $t_{dis}$ .
- $t_{PZL}$  and  $t_{PZH}$  are the same as  $t_{en}$ .
- $t_{PLH}$  and  $t_{PHL}$  are the same as  $t_{pd}$ .
- $V_{CCI}$  is the  $V_{CC}$  associated with the input port.
- $V_{CCO}$  is the  $V_{CC}$  associated with the output port.
- All parameters and waveforms are not applicable to all devices.

**Figure 2. Load Circuit 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>
TXS0108EPWR	ACTIVE	TSSOP	PW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TXS0108EPWRG4	ACTIVE	TSSOP	PW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TXS0108ERGYR	ACTIVE	VQFN	RGY	20	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
TXS0108EZXYR	ACTIVE	BGA MI CROSTA R JUNI OR	ZXY	20	2500	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.

**OBSELETE:** 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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**TAPE AND REEL INFORMATION**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TXS0108EPWR	TSSOP	PW	20	2000	330.0	16.4	6.95	7.1	1.6	8.0	16.0	Q1
TXS0108ERGYR	VQFN	RGY	20	3000	330.0	12.4	3.8	4.8	1.6	8.0	12.0	Q1
TXS0108EZXYR	BGA MICROSTAR JUNIOR	ZXY	20	2500	330.0	12.4	2.8	3.3	1.0	4.0	12.0	Q2



## TAPE AND REEL BOX DIMENSIONS

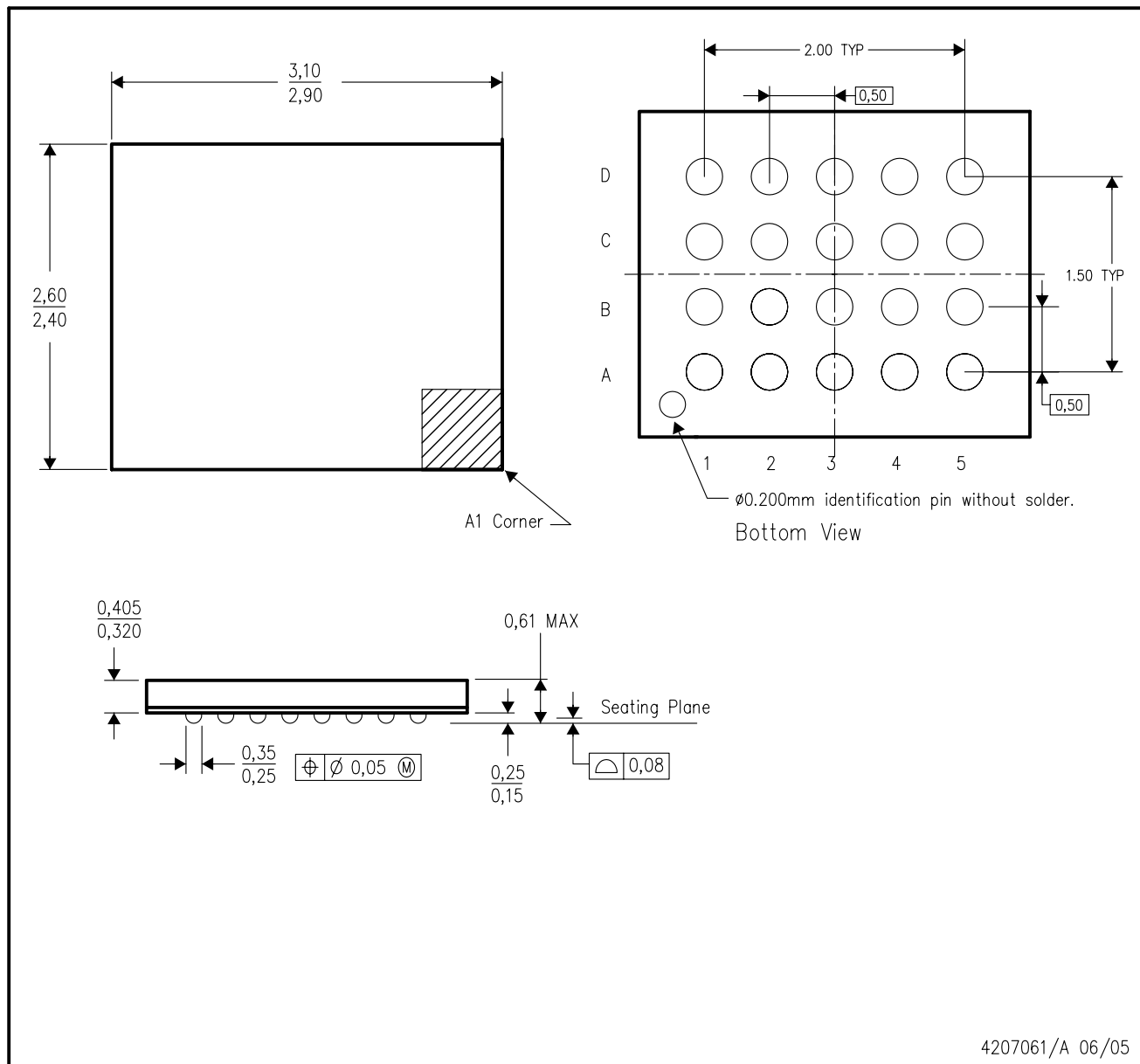


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TXS0108EPWR	TSSOP	PW	20	2000	346.0	346.0	33.0
TXS0108ERGYR	VQFN	RGY	20	3000	346.0	346.0	29.0
TXS0108EZXYR	BGA MICROSTAR JUNIOR	ZXY	20	2500	340.5	338.1	20.6

## ZXY (S-PBGA-N20)

## PLASTIC BALL GRID ARRAY



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. This package is a lead-free solder ball design.

PW (R-PDSO-G20)

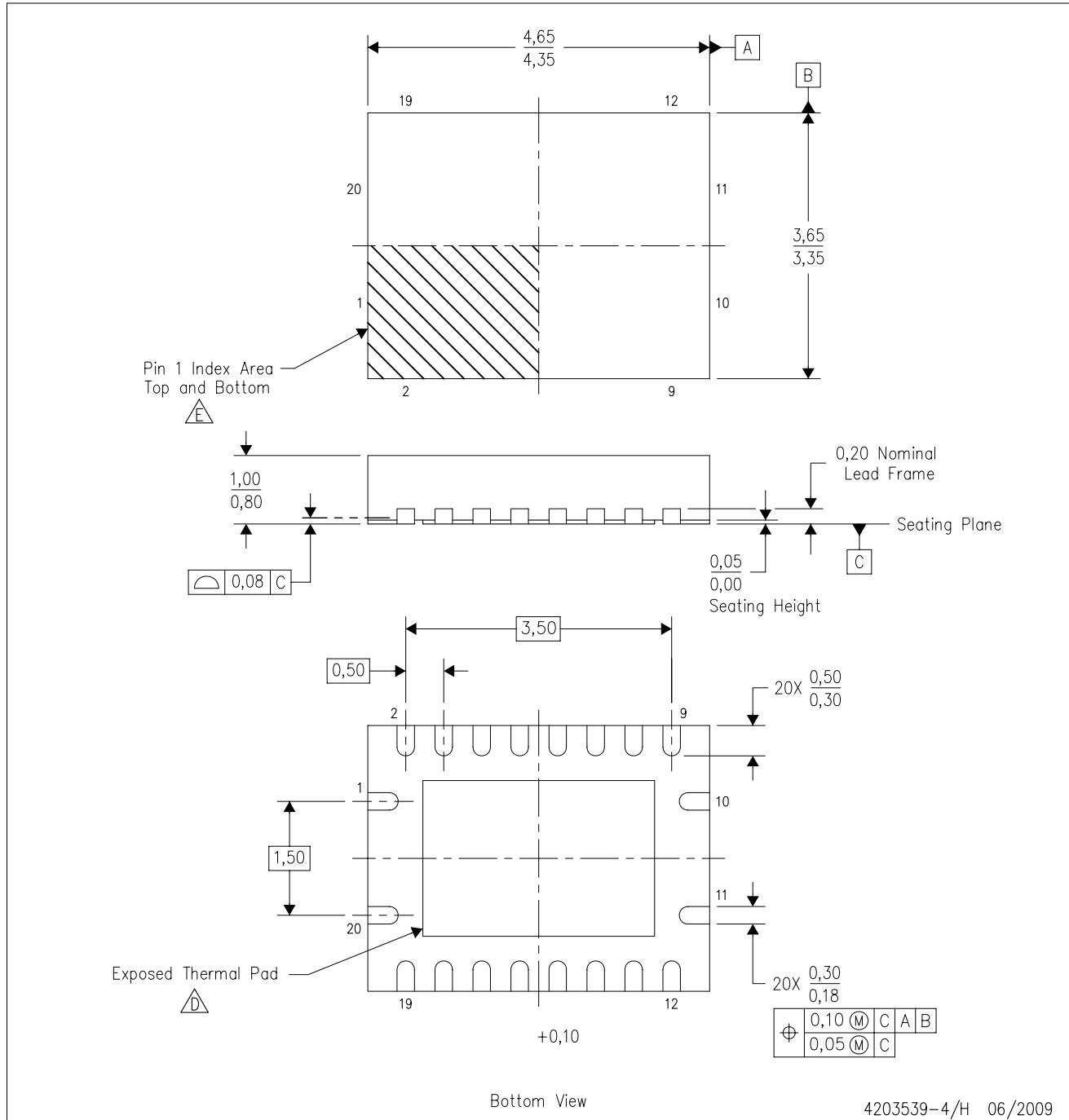
PLASTIC SMALL OUTLINE



- 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. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
  - D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
  - E. Falls within JEDEC MO-153

RGY (R-PVQFN-N20)

PLASTIC QUAD FLATPACK NO-LEAD



4203539-4/H 06/2009

- 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. QFN (Quad Flatpack No-Lead) package configuration.
  - (D) The package thermal pad must be soldered to the board for thermal and mechanical performance. See the Product Data Sheet for details regarding the exposed thermal pad dimensions.
  - (E) Pin 1 identifiers are located on both top and bottom of the package and within the zone indicated. The Pin 1 identifiers are either a molded, marked, or metal feature.
  - F. Package complies to JEDEC MO-241 variation BC.

RGY (R-PVQFN-N20)

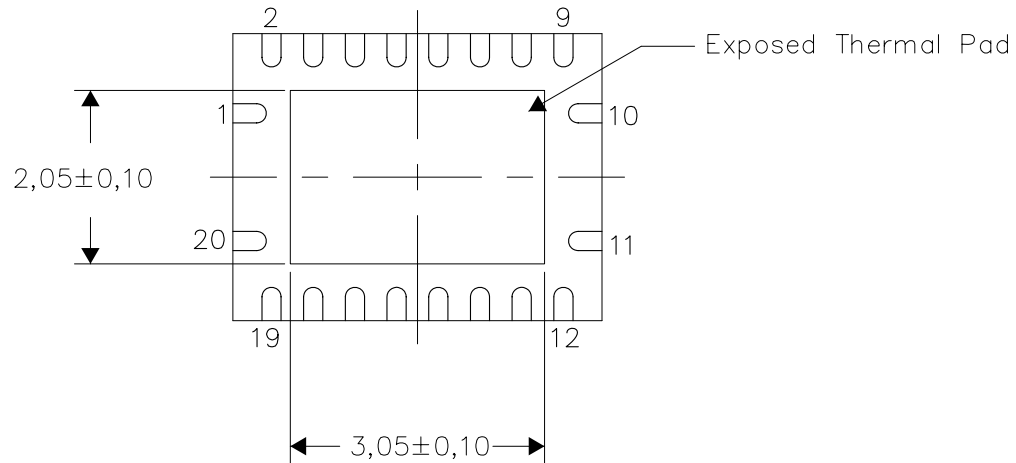
PLASTIC QUAD FLATPACK NO-LEAD

## THERMAL INFORMATION

This package incorporates an exposed thermal pad that is designed to be attached directly to an external heatsink. The thermal pad must be soldered directly to the printed circuit board (PCB). After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For information on the Quad Flatpack No-Lead (QFN) package and its advantages, refer to Application Report, QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271. This document is available at [www.ti.com](http://www.ti.com).

The exposed thermal pad dimensions for this package are shown in the following illustration.



Bottom View

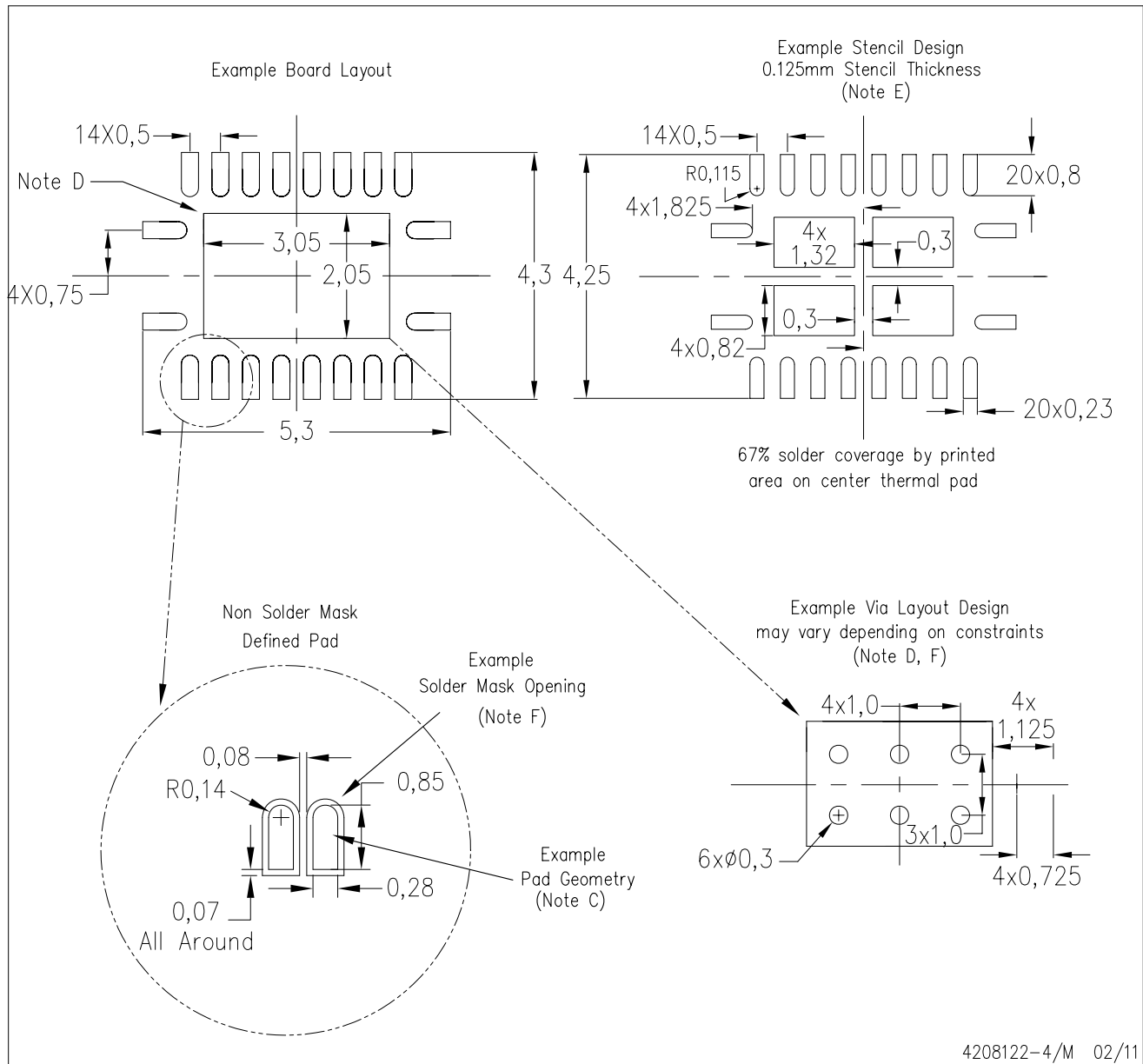
Exposed Thermal Pad Dimensions

4206353-4/M 02/11

NOTE: A. All linear dimensions are in millimeters

RGY (R-PVQFN-N20)

PLASTIC QUAD FLATPACK NO-LEAD



- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Publication IPC-7351 is recommended for alternate designs.
  - This package is designed to be soldered to a thermal pad on the board. Refer to Application Note, Quad Flat-Pack QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271, and also the Product Data Sheets for specific thermal information, via requirements, and recommended board layout. These documents are available at [www.ti.com](http://www.ti.com) <<http://www.ti.com>>.
  - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC 7525 for stencil design considerations.
  - Customers should contact their board fabrication site for minimum solder mask web tolerances between signal pads.

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