

TXS0101 1-Bit Bidirectional Level-Shifting, Voltage-Level Translator With Auto-Direction-Sensing for Open-Drain and Push-Pull Applications

1 Features

- Latch-up performance exceeds 100mA per JESD 78, class II
- ESD protection exceeds JESD 22:
 - A Port:
 - 2500V Human-Body Model (A114-B)
 - 200V Machine Model (A115-A)
 - 1500V Charged-Device Model (C101)
 - B port:
 - 8kV Human-Body Model (A114-B)
 - 200V Machine Model (A115-A)
 - 1500V Charged-Device Model (C101)
- No direction-control signal needed
- Maximum data rates:
 - 24Mbps (push pull)
 - 2Mbps (open drain)
- Available in the Texas Instruments NanoFree™ package
- 1.65V to 3.6V on A port and 2.3V to 5.5V on B port ($V_{CCA} \leq V_{CCB}$)
- V_{CC} isolation feature – if either V_{CC} input is at GND, both ports are in the high-impedance state
- No power-supply sequencing required – either V_{CCA} or V_{CCB} can be ramped first
- I_{off} supports partial-power-down mode operation

2 Applications

- Handsets
- [Smartphones](#)
- [Tablets](#)
- [Desktop PCs](#)

3 Description

This one-bit non-inverting translator uses two separate configurable power-supply rails. The A port is designed to track V_{CCA} . V_{CCA} accepts any supply voltage from 1.65V to 3.6V. V_{CCA} must be less than or equal to V_{CCB} . The B port is designed to track V_{CCB} . V_{CCB} accepts any supply voltage from 2.3V to 5.5V. This allows for low voltage bidirectional translation between any of the 1.8V, 2.5V, 3.3V, and 5V voltage nodes.

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

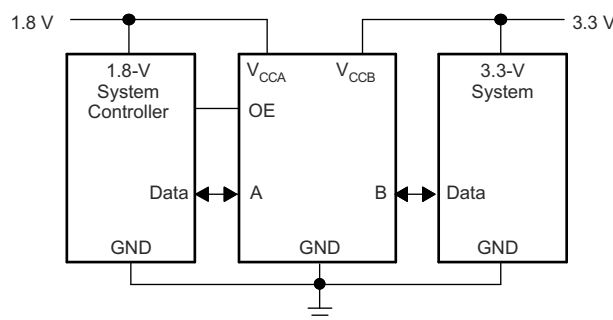
To put the device in the high-impedance state during power up or power down, tie OE to GND through a pull-down resistor; the current-sourcing capability of the driver determines the minimum value of the resistor.

Package Information

PART NUMBER	PACKAGE ⁽¹⁾	PACKAGE SIZE ⁽²⁾
TXS0101	DBV (SOT-23, 6)	2.9mm × 2.8mm
	DCK (SC70, 6)	2mm × 2.1mm
	DRL (SOT-5X3, 6)	1.6mm × 1.6mm
	DRY (SON, 6)	1.45mm x 1mm

(1) For more information, see [Section 11](#).

(2) The package size (length × width) is a nominal value and includes pins, where applicable.



Typical Operating Circuit



Table of Contents

1 Features	1	7.1 Overview.....	12
2 Applications	1	7.2 Functional Block Diagram.....	12
3 Description	1	7.3 Feature Description.....	13
4 Pin Configuration and Functions	3	7.4 Device Functional Modes.....	13
5 Specifications	4	8 Application and Implementation	14
5.1 Absolute Maximum Ratings.....	4	8.1 Application Information.....	14
5.2 ESD Ratings.....	4	8.2 Typical Application.....	14
5.3 Recommended Operating Conditions.....	4	8.3 Power Supply Recommendations.....	15
5.4 Thermal Information.....	5	8.4 Layout.....	16
5.5 Electrical Characteristics.....	5	9 Device and Documentation Support	17
5.6 Switching Characteristics, $V_{CCA} = 1.8 \pm 0.15V$	6	9.1 Device Support.....	17
5.7 Switching Characteristics, $V_{CCA} = 2.5 \pm 0.2V$	6	9.2 Receiving Notification of Documentation Updates....	17
5.8 Switching Characteristics, $V_{CCA} = 3.3 \pm 0.3V$	7	9.3 Support Resources.....	17
5.9 Switching Characteristics: T_{sk} , T_{MAX}	8	9.4 Trademarks.....	17
5.10 Typical Characteristics.....	9	9.5 Electrostatic Discharge Caution.....	17
6 Parameter Measurement Information	10	9.6 Glossary.....	17
6.1 Load Circuits.....	10	10 Revision History	17
6.2 Voltage Waveforms.....	11	11 Mechanical, Packaging, and Orderable Information	18
7 Detailed Description	12		

4 Pin Configuration and Functions

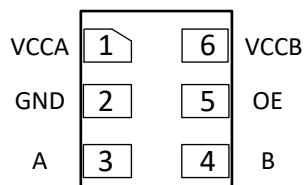


Figure 4-1. DRY Package

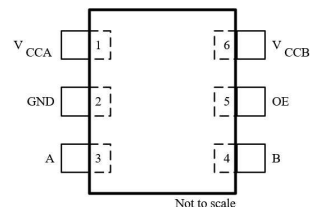


Figure 4-2. DBV, DCK, and DRL Package

Table 4-1. Pin Functions

PIN		TYPE ⁽¹⁾	DESCRIPTION
NAME	DBV, DCK, DRL, DRY		
A	3	I/O	Input/output A. Referenced to V _{CCA}
B	4	I/O	Input/output B. Referenced to V _{CCB}
GND	2	G	Ground
OE	5	I	Output enable. Pull OE low to place all outputs in 3-state mode. Referenced to V _{CCA} .
V _{CCA}	1	I	A-port supply voltage. 1.65V ≤ V _{CCA} ≤ 3.6V and V _{CCA} ≤ V _{CCB}
V _{CCB}	6	I	B-port supply voltage. 2.3V ≤ V _{CCB} ≤ 5.5V

(1) I = input, O = output, G = ground

5 Specifications

5.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)⁽¹⁾

			MIN	MAX	UNIT
V_{CCA}	Supply voltage A		-0.5	4.6	V
V_{CCB}	Supply voltage B		-0.5	6.5	V
V_I	Input Voltage ⁽²⁾	I/O Ports (A Port)	-0.5	4.6	V
V_I	Input Voltage ⁽²⁾	I/O Ports (B Port), OE	-0.5	6.5	
V_O	Voltage applied to any output in the high-impedance or power-off state ⁽²⁾	A Port	-0.5	4.6	V
		B Port	-0.5	6.5	
V_O	Voltage 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	$V_I < 0$		-50	mA
I_{OK}	Output clamp current	$V_O < 0$		-50	mA
I_O	Continuous output current			±50	mA
	Continuous current through V_{CC} or GND			±100	mA
T_j	Junction Temperature			150	°C
T_{stg}	Storage temperature		-65	150	°C

(1) Stresses beyond those listed under [Section 5.1](#) may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under [Section 5.3](#) Exposure beyond the limits listed in [Section 5.3](#) may affect device reliability.

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

(3) The output positive-voltage rating may be exceeded up to 6.5V maximum if the output current rating is observed.

5.2 ESD Ratings

				VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	A Port	±2500	V
			B Port	±8000	
		Charged device model (CDM), per ANSI/ESDA/JEDEC JS-002 ⁽²⁾	B Port	±1500	
			A Port	±200	

(1) JEDEC document JEP155 states that 500V HBM allows safe manufacturing with a standard ESD control process.

(2) JEDEC document JEP157 states that 250V CDM allows safe manufacturing with a standard ESD control process.

5.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted) ^{(1) (2) (3)}

			V_{CCA}	V_{CCB}	MIN	MAX	UNIT
V_{CCA}	Supply voltage A				1.65	3.6	V
V_{CCB}	Supply voltage B				2.3	5.5	V
V_{IH}	High-level input voltage	A-port I/O's	1.65V to 1.95V	2.3V to 5.5V	$V_{CCI} - 0.2$	V_{CCI}	V
			2.3V to 3.6V		$V_{CCI} - 0.4$	V_{CCI}	
		B-port I/O's	1.65V to 3.6V	2.3V to 5.5V	$V_{CCI} - 0.4$	V_{CCI}	
		OE Input			$V_{CCA} \times 0.65$	5.5	
V_{IL}	Low-level input voltage	A-port I/O's	1.65V to 3.6V	2.3V to 5.5V	0	0.15	V
		B-port I/O's			0	0.15	
		OE Input			0	$V_{CCA} \times 0.35$	
$\Delta t/\Delta v$	Input transition rise and fall time	A/B Port I/Os, Push-Pull Driving	1.65V to 3.6V	2.3V to 5.5V		10	ns/V
T_A	Operating free-air temperature				-40	85	°C

(1) V_{CCI} is the V_{CC} associated with the input port.

(2) V_{CCO} is the V_{CC} associated with the output port.

- (3) All control inputs and data I/Os of this device have weak pulldowns to ensure the line is not floating when undefined external to the device. The input leakage from these weak pulldowns is defined by the I_I specification indicated under [Section 5.5](#).

5.4 Thermal Information

THERMAL METRIC ⁽¹⁾		TXS0101				UNIT
		DCK	DRY	DRL	DBV	
		6 PINS	6 PINS	6 PINS	6 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	222.9	277.6	207.5	195.3	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	157.0	163.1	108.9	114.5	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	77.4	158.9	88.5	76.0	°C/W
Y_{JT}	Junction-to-top characterization parameter	58.6	29.3	6.3	51.7	°C/W
Y_{JB}	Junction-to-board characterization parameter	77.1	158.2	88.1	75.7	°C/W
$R_{\theta JC(bottom)}$	Junction-to-case (bottom) thermal resistance	N/A	N/A	N/A	N/A	°C/W

- (1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC Package Thermal Metrics](#) application note.

5.5 Electrical Characteristics

over operating free-air temperature range (unless otherwise noted)⁽¹⁾ (2)

PARAMETER		TEST CONDITIONS	V _{CCA}	V _{CCB}	Operating free-air temperature (T _A)			UNIT
					-40°C to 85°C			
					MIN	TYP	MAX	
V _{OHA}	Port A output high voltage ⁽³⁾	I _{OH} = -20uA, V _{IB} ≥ V _{CCB} - 0.4V	1.65V to 3.6V	2.3V to 5.5V	V _{CCA} x 0.67			V
V _{OLA}	Port A output low voltage ⁽⁴⁾	I _{OL} = 1mA, V _{IB} ≤ 0.15V	1.65V to 3.6V	2.3V to 5.5V	0.4			V
V _{OHB}	Port B output high voltage	I _{OH} = -20uA, V _{IA} ≥ V _{CCA} - 0.2V	1.65V to 3.6V	2.3V to 5.5V	V _{CCB} x 0.67			V
V _{OLB}	Port B output low voltage ⁽⁴⁾	I _{OL} = 1mA, V _{IA} ≤ 0.15V	1.65V to 3.6V	1.65V to 5.5V	0.4			V
I _I	Input leakage current	OE V _I = V _{CC} or GND, T _A = 25°C	1.65V to 3.6V	1.65V to 5.5V	-1	1	μA	
I _I	Input leakage current	OE V _I = V _{CC} or GND, -40°C- 85°C	1.65V to 3.6V	1.65V to 5.5V	-2	2	μA	
I _{off}	Partial power down current	A port	0V	0V to 5.5V	-2	2	μA	
		B port	0V to 3.6V	0V	-2	2	μA	
I _{OZ}	Tri-state output current	A or B Port: V _I = V _{CC1} or GND V _O = V _{CC0} or GND OE = GND	1.65V to 3.6V	2.3V to 5.5V	-2	2	μA	
I _{CCA}	V _{CCA} supply current	V _I = V _{CC1} or GND I _O = 0	1.65V to V _{CCB}	2.3V to 5.5V	2.4			μA
			3.6V	0V	2.2			
			0V	5.5V	-1			
I _{CCB}	V _{CCB} supply current	V _I = V _{CC1} or GND I _O = 0	1.65V to V _{CCB}	2.3V to 5.5V	12			μA
			3.6V	0V	-1			
			0V	5.5V	1			
I _{CCA} + I _{CCB}	Combined supply current	V _I = V _{CC1} or GND I _O = 0	1.65V to V _{CCB}	2.3V to 5.5V	14.4			μA
C _i	Input Capacitance	OE	3.3V	3.3V	3.5			pF
C _{io}	A port	T _A = 25°C	3.3V	3.3V	5			pF
		-40°C - 85°C			6			

over operating free-air temperature range (unless otherwise noted)^{(1) (2)}

PARAMETER		TEST CONDITIONS	V _{CCA}	V _{CCB}	Operating free-air temperature (T _A)			UNIT
					−40°C to 85°C			
					MIN	TYP	MAX	
C _{io}	B port	T _A = 25°C	3.3V	3.3V	6			pF
		−40°C - 85°C			7.5			

(1) V_{CCI} is the V_{CC} associated with the input port

(2) V_{CCO} is the V_{CC} associated with the output port

(3) Tested at $V_I = V_{T+(MAX)}$

(4) Tested at $V_I = V_{T-(MIN)}$

5.6 Switching Characteristics, $V_{CCA} = 1.8 \pm 0.15\text{V}$

PARAMETER		FROM	TO	Test Conditions	B-Port Supply Voltage (V _{CCB})									UNIT
					2.5 ± 0.2V			3.3 ± 0.3V			5.0 ± 0.5V			
					MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t _{PHL}	Propagation Delay (Hight-to-Low)	A	B	Push-Pull			5.3			5.4			6.8	ns
				Open-Drain	2.3		8.8	2.4		9.6	2.6		10	
t _{PLH}	Propagation Delay (Low-to-High)	A	B	Push-Pull			6.8			7.1			7.5	ns
				Open-Drain	45		260	36		208	27		198	
t _{PHL}	Propagation Delay (Hight-to-Low)	B	A	Push-Pull			4.4			4.5			4.7	ns
				Open-Drain	1.9		5.3	1.1		4.4	1.2		4	
t _{PLH}	Propagation Delay (Low-to-High)	B	A	Push-Pull			5.3			4.5			0.5	ns
				Open-Drain	45		175	36		140	27		102	
t _{en}	Enable Time	OE	A or B	Push-Pull			200			200			200	ns
t _{dis}	Disable Time						200			200			200	
t _{rA}	Ouput Rise Time	B	A	Push-Pull	3.2		9.5	2.3		9.3	2		7.6	ns
				Open-Drain	38		165	30		132	22		95	
t _{rB}	Ouput Rise Time	A	B	Push-Pull	1.1		10.8	1		9.1	1		7.6	ns
				Open-Drain	34		145	23		106	10		76	
t _{fA}	Output Fall Time	B	A	Push-Pull	1.9		5.9	1.9		6	1.4		13.3	ns
				Open-Drain	4.4		6.9	4.3		6.4	4.2		6.1	
t _{fB}	Output Fall Time	A	B	Push-Pull	2.2		13.8	2.2		16.2	2.6		16.2	ns
				Open-Drain	6.9		13.8	7.5		16.2	7		16.2	

5.7 Switching Characteristics, $V_{CCA} = 2.5 \pm 0.2\text{V}$

PARAMETER		FROM	TO	Test Conditions	B-Port Supply Voltage (V _{CCB})									UNIT
					2.5 ± 0.2V			3.3 ± 0.3V			5.0 ± 0.5V			
					MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t _{PHL}	Propagation Delay (Hight-to-Low)	A	B	Push-Pull			3.2			3.7			3.8	ns
				Open-Drain	1.7		6.3	2		6	2.1		5.8	
t _{PLH}	Propagation Delay (Low-to-High)	A	B	Push-Pull			3.5			4.1			4.4	ns
				Open-Drain	43		250	36		206	27		190	
t _{PHL}	Propagation Delay (Hight-to-Low)	B	A	Push-Pull			3			3.6			4.3	ns
				Open-Drain	1.8		4.7	1.6		4.2	1.2		4	
t _{PLH}	Propagation Delay (Low-to-High)	B	A	Push-Pull			2.5			1.6			1	ns
				Open-Drain	44		170	37		140	27		103	
t _{en}	Enable Time	OE	A or B	Push-Pull			200			200			200	ns
t _{dis}	Disable Time						200			200			200	
t _{rA}	Ouput Rise Time	B	A	Push-Pull	2.8		7.4	2.1		6.6	0.9		5.6	ns
				Open-Drain	34		149	28		121	24		89	

PARAMETER		FROM	TO	Test Conditions	B-Port Supply Voltage (V _{CCB})									UNIT
					2.5 ± 0.2V			3.3 ± 0.3V			5.0 ± 0.5V			
					MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t _{rB}	Ouput Rise Time	A	B	Push-Pull	1.3		8.3	0.9		7.2	0.4		6.1	ns
				Open-Drain	35		151	24		112	12		81	
t _{fA}	Output Fall Time	B	A	Push-Pull	1.9		5.7	1.4		5.5	0.8		5.3	ns
				Open-Drain	4.4		6.9	4.3		6.2	4.2		5.8	
t _{fB}	Output Fall Time	A	B	Push-Pull	2.2		7.8	2.4		6.7	2.6		6.6	ns
				Open-Drain	5.1		8.8	5.4		9.4	5.4		10.4	

5.8 Switching Characteristics, $V_{CCA} = 3.3 \pm 0.3V$

PARAMETER		FROM	TO	Test Conditions	B-Port Supply Voltage (V _{CCB})						UNIT
					3.3 ± 0.3V			5.0 ± 0.5V			
					MIN	TYP	MAX	MIN	TYP	MAX	
t _{PHL}	Propagation Delay (Hight-to-Low)	A	B	Push-Pull	2.4			3.1			ns
				Open-Drain	1.3		4.2	1.4		4.6	
t _{PLH}	Propagation Delay (Low-to-High)	A	B	Push-Pull	4.2			4.4			ns
				Open-Drain	36		204	28		165	
t _{PHL}	Propagation Delay (Hight-to-Low)	B	A	Push-Pull	2.5			3.3			ns
				Open-Drain	1		124	1		97	
t _{PLH}	Propagation Delay (Low-to-High)	B	A	Push-Pull	2.5			2.6			ns
				Open-Drain	3		139	3		105	
t _{en}	Enable Time	OE	A or B	Push-Pull	200			200			ns
t _{dis}	Disable Time				200			200			
t _{rA}	Ouput Rise Time	B	A	Push-Pull	2.3		5.6	1.9		4.8	ns
				Open-Drain	25		116	19		85	
t _{rB}	Ouput Rise Time	A	B	Push-Pull	1.6		6.4	0.6		7.4	ns
				Open-Drain	26		116	14		72	
t _{fA}	Output Fall Time	B	A	Push-Pull	1.4		5.4	1		5	ns
				Open-Drain	4.3		6.1	4.2		5.7	
t _{fB}	Output Fall Time	A	B	Push-Pull	2.3		7.4	2.4		7.6	ns
				Open-Drain	5		7.6	4.8		8.3	

5.9 Switching Characteristics: T_{sk} , T_{MAX}

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

PARAMETER	TEST CONDITIONS		V _{CCA}	V _{CCB}	Operating free-air temperature (T _A)			UNIT
					-40°C to 125°C			
					MIN	TYP	MAX	
T _{MAX} - Maximum Data Rate	50% Duty Cycle Input One channel switching	Push-Pull Driving	1.8 ± 0.15V	2.5V ± 0.2V	21			Mbps
				3.3V ± 0.3V	22			
				5V ± 0.5V	24			
			2.5V ± 0.2V	2.5V ± 0.2V	20			
				3.3V ± 0.3V	22			
				5V ± 0.5V	24			
			3.3V ± 0.3V	3.3V ± 0.3V	23			
				5V ± 0.5V	24			
				Open-Drain Driving	1.8 ± 0.15V	2.5V ± 0.2V	2	
		3.3V ± 0.3V	2					
		5V ± 0.5V	2					
		2.5V ± 0.2V	2.5V ± 0.2V		2			
			3.3V ± 0.3V		2			
			5V ± 0.5V		1			
		3.3V ± 0.3V	3.3V ± 0.3V		2			
			5V ± 0.5V	2				
t _w	Pulse Duration, Data Inputs	Push-Pull Driving	1.8V ± 0.15V to 3.3V ± 0.3V	2.5V ± 0.2V to 5.5V ± 0.5V	41			ns
		Open-Drain Driving	1.8V ± 0.15V to 3.3V ± 0.3V	2.5V ± 0.2V to 5.5V ± 0.5V	500			

5.10 Typical Characteristics

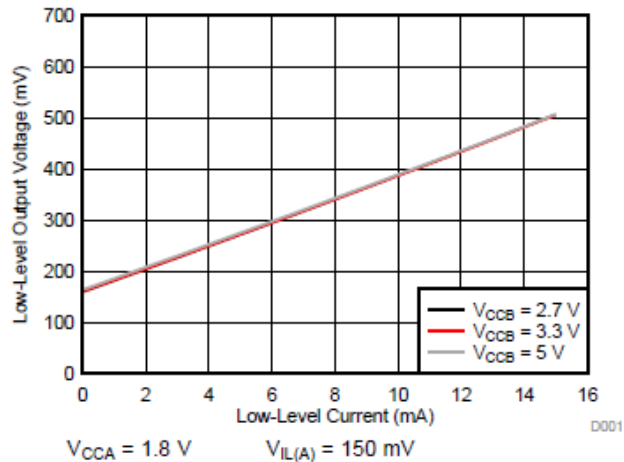


Figure 5-1. Low-Level Output Voltage ($V_{OL(Bx)}$) vs Low-Level Current ($I_{OL(Bx)}$)

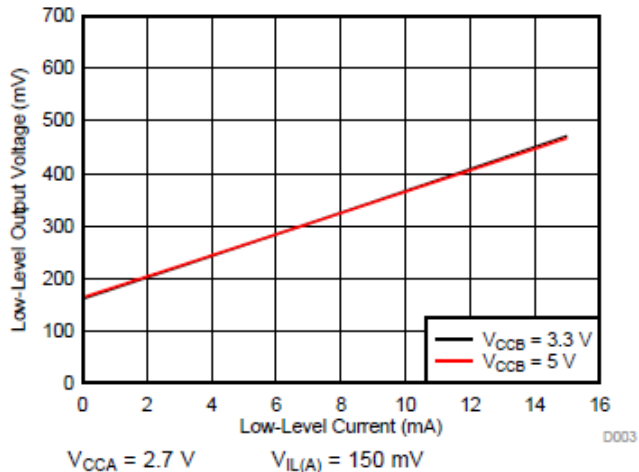


Figure 5-2. Low-Level Output Voltage ($V_{OL(Bx)}$) vs Low-Level Current ($I_{OL(Bx)}$)

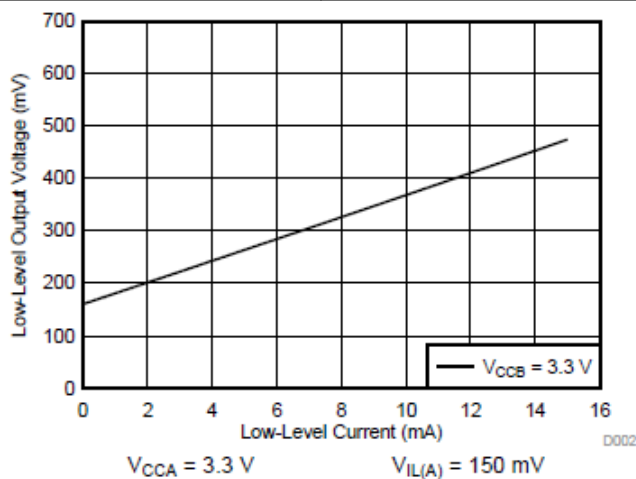


Figure 5-3. Low-Level Output Voltage ($V_{OL(Bx)}$) vs Low-Level Current ($I_{OL(Bx)}$)

6 Parameter Measurement Information

6.1 Load Circuits

Figure 6-1 shows the push-pull driver circuit used for measuring data rate, pulse duration, propagation delay, output rise-time and fall-time. Figure 6-2 shows the open-drain driver circuit used for measuring data rate, pulse duration, propagation delay, output rise-time and fall-time.

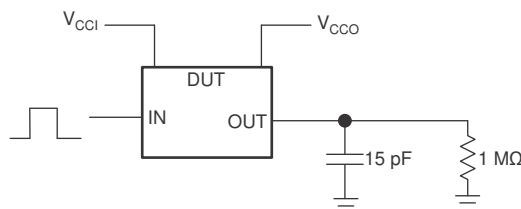


Figure 6-1. Data Rate, Pulse Duration, Propagation Delay, Output Rise-Time and Fall-Time Measurement Using a Push-Pull Driver

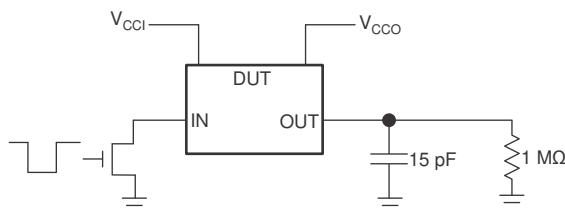


Figure 6-2. Data Rate, Pulse Duration, Propagation Delay, Output Rise-Time and Fall-Time Measurement Using an Open-Drain Driver

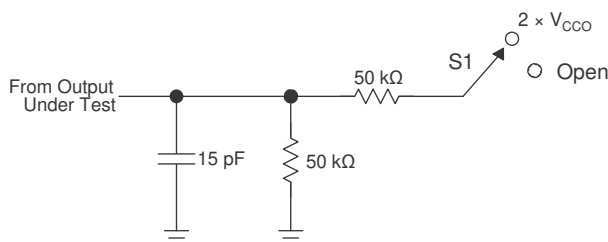


Figure 6-3. Load Circuit for Enable-Time and Disable-Time Measurement

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

1. t_{PLZ} and t_{PHZ} are the same as t_{dis} .
2. t_{PZL} and t_{PZH} are the same as t_{en} .
3. V_{CCI} is the V_{CC} associated with the input port.
4. V_{CCO} is the V_{CC} associated with the output port.

6.2 Voltage Waveforms

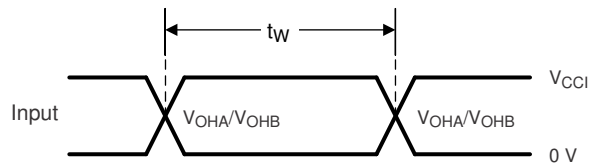


Figure 6-4. Pulse Duration (Push-Pull)

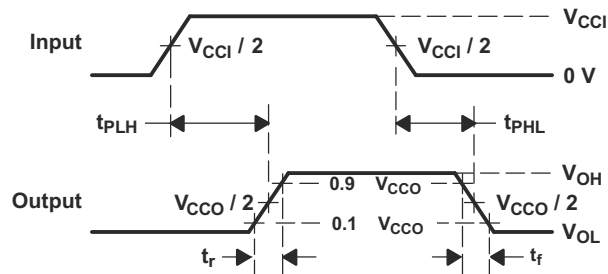
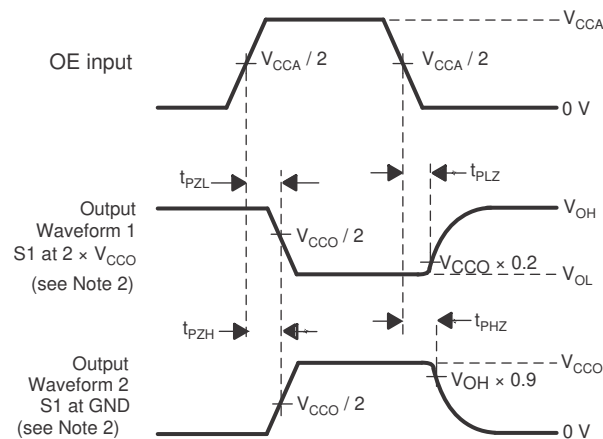


Figure 6-5. Propagation Delay Times



- C_L includes probe and jig capacitance.
- Waveform 1 in Figure 6-6 is for an output with internal such that the output is high, except when OE is high (see Figure 6-3). Waveform 2 in Figure 6-6 is for an output with conditions such that the output is low, except when OE is high.
- All input pulses are supplied by generators having the following characteristics: $PRR \leq 10\text{MHz}$, $Z_O = 50\Omega$, $dv/dt \geq 1\text{V/ns}$.
- 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.

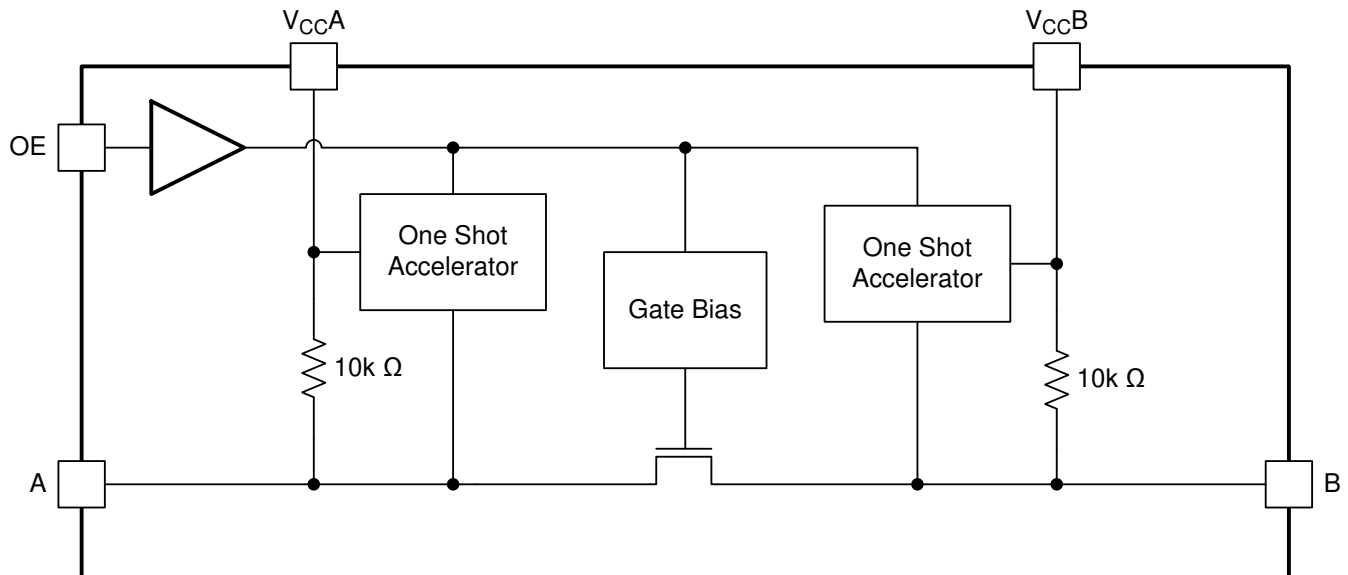
Figure 6-6. Enable and Disable Times

7 Detailed Description

7.1 Overview

The TXS0101 device is a directionless voltage-level translator specifically designed for translating logic voltage levels. The A port can accept I/O voltages ranging from 1.65V to 3.6V, while the B port can accept I/O voltages from 2.3V to 5.5V. The device is a pass gate architecture with edge rate accelerators (one shots) to improve the overall data rate. 10k Ω pullup resistors, commonly used in open drain applications, have been conveniently integrated so that an external resistor is not needed. While this device is designed for open drain applications, the device can also translate push-pull CMOS logic outputs.

7.2 Functional Block Diagram



7.3 Feature Description

7.3.1 Architecture

As shown in [Figure 7-1](#), the TXS0101 architecture does not require a direction-control signal to control the direction of data flow from A to B or from B to A.

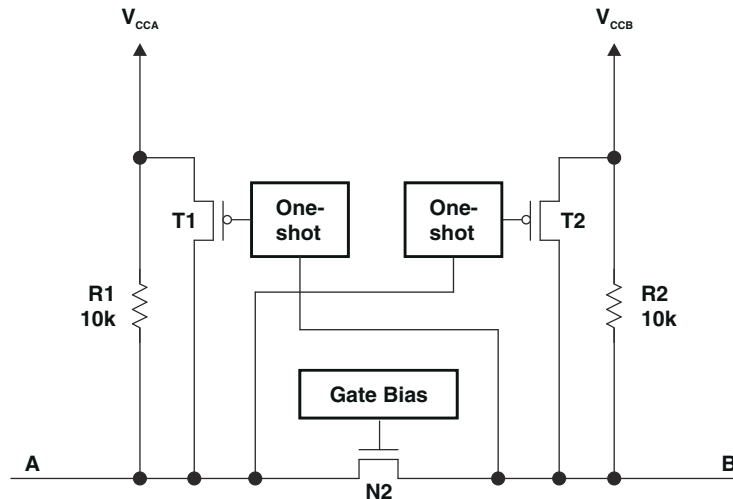


Figure 7-1. Architecture of a TXS01xx Cell

Each A-port I/O has an internal 10kΩ pullup resistor to V_{CCA} , and each B-port I/O has an internal 10kΩ pullup resistor to V_{CCB} . The output one-shots detect rising edges on the A or B ports. During a rising edge, the one-shot turns on the PMOS transistors (T1 and T2) for a short duration, which speeds up the low-to-high transition.

7.3.2 Input Driver Requirements

The fall time (t_{fA} and t_{fB}) of a signal depends on the output impedance of the external device driving the data I/Os of the TXS0101. Similarly, the t_{PHL} and maximum data rates also depend on the output impedance of the external driver. The values for t_{fA} , t_{fB} , t_{PHL} , and maximum data rates in the data sheet assume that the output impedance of the external driver is less than 50Ω.

7.3.3 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.

7.3.4 Enable and Disable

The TXS0101 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.

7.3.5 Pullup or Pulldown Resistors on I/O Lines

Each A-port I/O has an internal 10kΩ pullup resistor to V_{CCA} , and each B-port I/O has an internal 10kΩ pullup resistor to V_{CCB} . If a smaller value of pullup resistor is required, an external resistor must be added from the I/O to V_{CCA} or V_{CCB} (in parallel with the internal 10kΩ resistors).

7.4 Device Functional Modes

The TXS0101 device has two functional modes, enabled and disabled. To disable the device set the OE input low, which places all I/Os in a high impedance state. Setting the OE input high will enable the device.

8 Application and Implementation

Note

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

8.1 Application Information

The TXS0101 can be used in level-translation applications for interfacing devices or systems operating at different interface voltages with one another. The TXS0101 is an excellent choice for use in applications where an open-drain driver is connected to the data I/Os. The TXS0101 can also be used in applications where a push-pull driver is connected to the data I/Os, but the TXB0102 might be a better option for such push-pull applications.

8.2 Typical Application

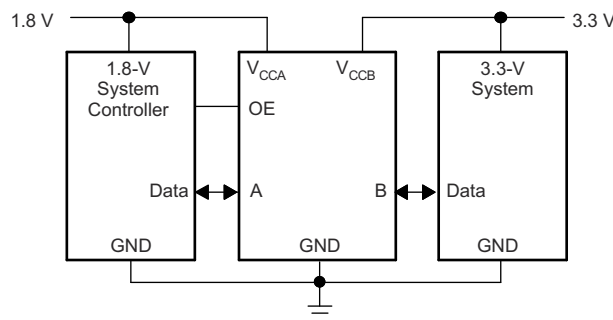


Figure 8-1. Typical Application Schematic

8.2.1 Design Requirements

For this design example, use the parameters listed in [Table 8-1](#).

Table 8-1. Design Parameters

DESIGN PARAMETER	EXAMPLE VALUE
Input voltage range	1.65 to 3.6V
Output voltage range	2.3 to 5.5V

8.2.2 Detailed Design Procedure

To begin the design process, determine the following:

- Input voltage range:
 - Use the supply voltage of the device that is driving the TXS0101 device to determine the input voltage range. For a valid logic high the value must exceed the V_{IH} of the input port. For a valid logic low the value must be less than the V_{IL} of the input port.
- Output voltage range:
 - Use the supply voltage of the device that the TXS0101 device is driving to determine the output voltage range.
 - The TXS0101 device has 10kΩ internal pullup resistors. External pullup resistors can be added to reduce the total RC of a signal trace if necessary.

- An external pull down resistor decreases the output V_{OH} and V_{OL} . Use [Equation 1](#) to calculate the V_{OH} as a result of an external pull down resistor.

$$V_{OH} = V_{CCx} \times R_{PD} / (R_{PD} + 10k\Omega) \quad (1)$$

where

- V_{CCx} is the supply voltage on either V_{CCA} or V_{CCB}
- R_{PD} is the value of the external pull down resistor

8.2.3 Application Curve

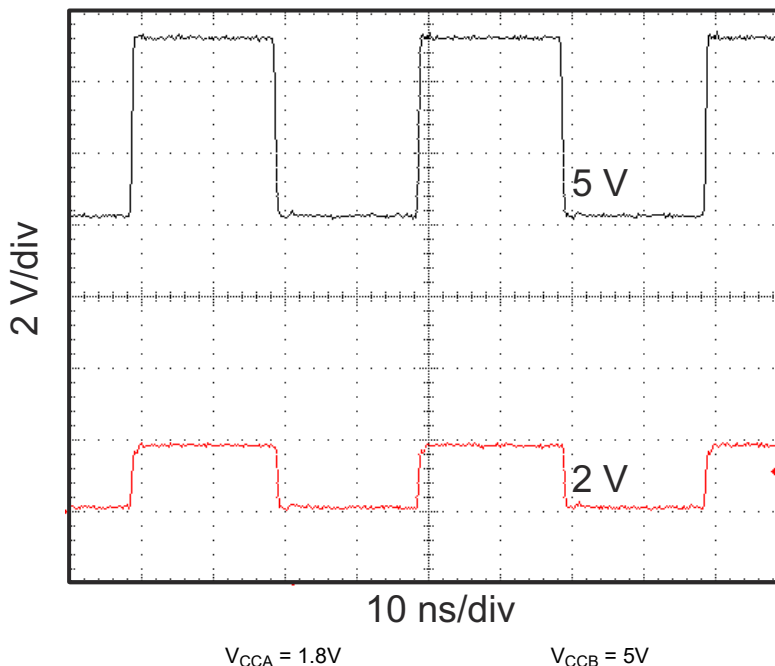


Figure 8-2. Level-Translation of a 2.5MHz Signal

8.3 Power Supply Recommendations

The TXS0101 device uses two separate configurable power-supply rails, V_{CCA} and V_{CCB} . V_{CCB} accepts any supply voltage from 2.3V to 5.5V and V_{CCA} accepts any supply voltage from 1.65V to 3.6V. The A port and B port are designed to track V_{CCA} and V_{CCB} respectively allowing for low voltage bidirectional translation between any of the 1.8V, 2.5V, 3.3V, and 5V voltage nodes.

The TXS0101 device does not require power sequencing between V_{CCA} and V_{CCB} during power-up so the powersupply rails can be ramped in any order. A V_{CCA} value greater than or equal to V_{CCB} ($V_{CCA} \geq V_{CCB}$) does not damage the device, but during operation, V_{CCA} must be less than or equal to V_{CCB} ($V_{CCA} \leq V_{CCB}$) at all times.

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

8.4 Layout

8.4.1 Layout Guidelines

For device reliability, TI recommends following common printed-circuit board layout guidelines such as follows:

- Bypass capacitors should be used on power supplies.
- Short trace lengths should be used to avoid excessive loading.
- PCB signal trace-lengths must be kept short enough so that the round-trip delay of any reflection is less than the one shot duration, approximately 30ns, causing any reflection to encounter low impedance at the source driver.
- Placing pads on the signal paths for loading capacitors or pullup resistors to help adjust rise and fall times of signals depending on the system requirements

8.4.2 Layout Example

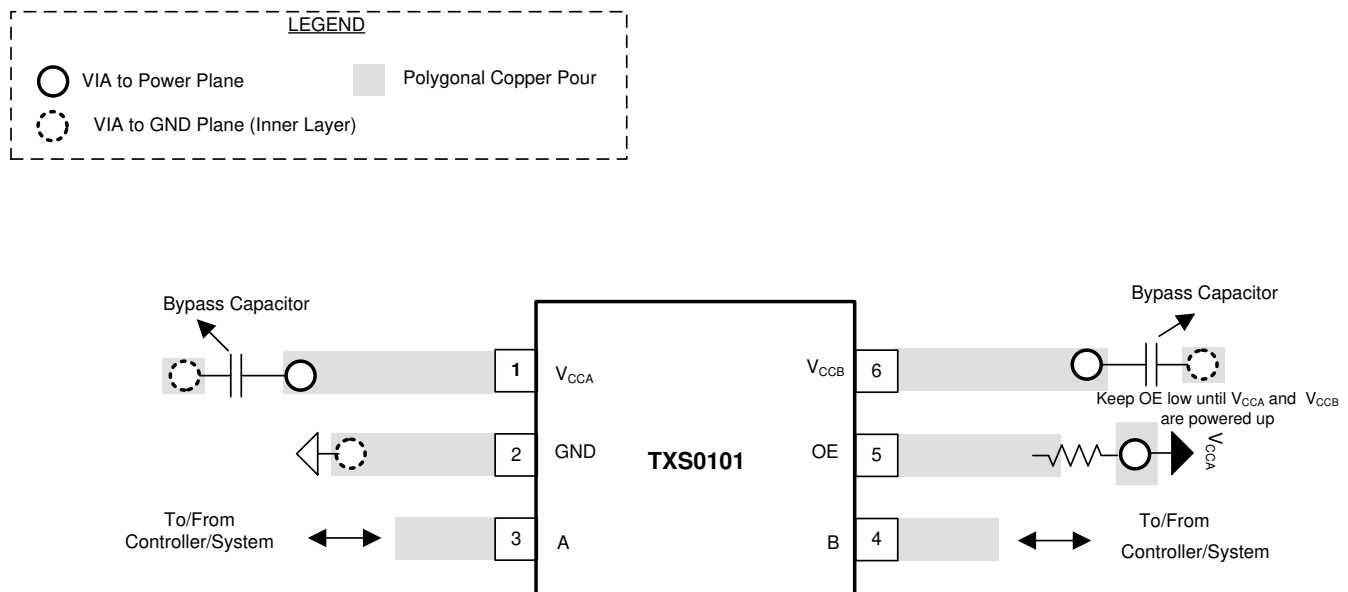


Figure 8-3. Typical Layout of TXS0101

9 Device and Documentation Support

9.1 Device Support

9.1.1 Related Documentation

For related documentation, see the following:

- Texas Instruments, [A Guide to Voltage Translation With TXS-Type Translators](#)
- Texas Instruments, [Introduction to Logic](#)

9.2 Receiving Notification of Documentation Updates

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

9.3 Support Resources

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

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

9.4 Trademarks

NanoFree™ and TI E2E™ are trademarks of Texas Instruments.
All trademarks are the property of their respective owners.

9.5 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

9.6 Glossary

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

10 Revision History

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

Changes from Revision E (October 2024) to Revision F (Sep 2025)	Page
• Updated disable times (max conditions).....	6
• Updated disable times (max conditions).....	6
• Updated disable times (max conditions).....	7

Changes from Revision D (June 2017) to Revision E (October 2024)	Page
• Added DRY pinout diagram.....	3

Changes from Revision C (December 2015) to Revision D (June 2017)	Page
• Changed YZP package pinout diagram with new image and added YZP pin assignments in <i>Pin Functions</i> table.....	3

11 Mechanical, Packaging, and Orderable Information

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

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package Pins	Package qty Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
TXS0101DBVR	Active	Production	SOT-23 (DBV) 6	3000 LARGE T&R	Yes	NIPDAU SN	Level-1-260C-UNLIM	-40 to 85	(35WH, NFFF, NFFR)
TXS0101DBVR.A	Active	Production	SOT-23 (DBV) 6	3000 LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 85	(35WH, NFFF, NFFR)
TXS0101DBVR.B	Active	Production	SOT-23 (DBV) 6	3000 LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 85	(35WH, NFFF, NFFR)
TXS0101DBVRG4	Active	Production	SOT-23 (DBV) 6	3000 LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 85	(35WH, NFFF, NFFR)
TXS0101DBVT	Active	Production	SOT-23 (DBV) 6	250 SMALL T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	NFFR
TXS0101DBVT.B	Active	Production	SOT-23 (DBV) 6	250 SMALL T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	NFFR
TXS0101DBVTG4	Active	Production	SOT-23 (DBV) 6	250 SMALL T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	NFFR
TXS0101DBVTG4.B	Active	Production	SOT-23 (DBV) 6	250 SMALL T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	NFFR
TXS0101DCKR	Active	Production	SC70 (DCK) 6	3000 LARGE T&R	Yes	Call TI Sn Nipdau	Level-1-260C-UNLIM	-40 to 85	(1PR, 2GO)
TXS0101DCKR.A	Active	Production	SC70 (DCK) 6	3000 LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 85	(1PR, 2GO)
TXS0101DCKR.B	Active	Production	SC70 (DCK) 6	3000 LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 85	(1PR, 2GO)
TXS0101DCKRG4.A	Active	Production	SC70 (DCK) 6	3000 LARGE T&R	-	Call TI	Call TI	-40 to 85	
TXS0101DCKRG4.B	Active	Production	SC70 (DCK) 6	3000 LARGE T&R	-	Call TI	Call TI	-40 to 85	
TXS0101DCKT	Active	Production	SC70 (DCK) 6	250 SMALL T&R	Yes	Call TI Sn Nipdau	Level-1-260C-UNLIM	-40 to 85	(1PR, 2GO)
TXS0101DCKT.A	Active	Production	SC70 (DCK) 6	250 SMALL T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 85	(1PR, 2GO)
TXS0101DCKT.B	Active	Production	SC70 (DCK) 6	250 SMALL T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 85	(1PR, 2GO)
TXS0101DRLR	Active	Production	SOT-5X3 (DRL) 6	4000 LARGE T&R	Yes	NIPDAUAG	Level-1-260C-UNLIM	-40 to 85	2GR
TXS0101DRLR.A	Active	Production	SOT-5X3 (DRL) 6	4000 LARGE T&R	Yes	NIPDAUAG	Level-1-260C-UNLIM	-40 to 85	2GR
TXS0101DRLR.B	Active	Production	SOT-5X3 (DRL) 6	4000 LARGE T&R	Yes	NIPDAUAG	Level-1-260C-UNLIM	-40 to 85	2GR
TXS0101DRYR	Active	Production	SON (DRY) 6	5000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	Q9
TXS0101DRYR.A	Active	Production	SON (DRY) 6	5000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	Q9
TXS0101YZPR	Active	Production	DSBGA (YZP) 6	3000 LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	2GN
TXS0101YZPR.B	Active	Production	DSBGA (YZP) 6	3000 LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	2GN

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

(2) Material type: When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

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

(4) Lead finish/Ball material: Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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

(6) Part marking: There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

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

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

OTHER QUALIFIED VERSIONS OF TXS0101 :

- Automotive : [TXS0101-Q1](#)

NOTE: Qualified Version Definitions:

- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

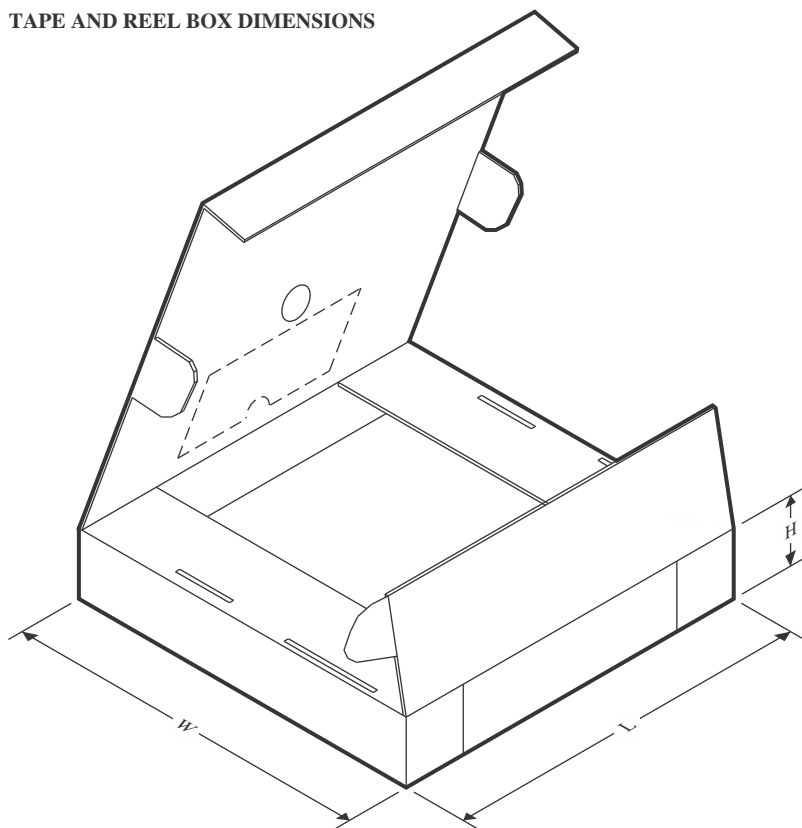
TAPE AND REEL INFORMATION



*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
TXS0101DBVR	SOT-23	DBV	6	3000	180.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
TXS0101DBVR	SOT-23	DBV	6	3000	180.0	8.4	3.23	3.17	1.37	4.0	8.0	Q3
TXS0101DBVT	SOT-23	DBV	6	250	180.0	8.4	3.23	3.17	1.37	4.0	8.0	Q3
TXS0101DBVTG4	SOT-23	DBV	6	250	180.0	8.4	3.23	3.17	1.37	4.0	8.0	Q3
TXS0101DCKR	SC70	DCK	6	3000	180.0	8.4	2.3	2.5	1.2	4.0	8.0	Q3
TXS0101DCKR	SC70	DCK	6	3000	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3
TXS0101DCKT	SC70	DCK	6	250	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3
TXS0101DRLR	SOT-5X3	DRL	6	4000	180.0	8.4	1.98	1.78	0.69	4.0	8.0	Q3
TXS0101DRYR	SON	DRY	6	5000	180.0	8.4	1.2	1.65	0.63	4.0	8.0	Q1
TXS0101YZPR	DSBGA	YZP	6	3000	178.0	9.2	1.02	1.52	0.63	4.0	8.0	Q1

TAPE AND REEL BOX DIMENSIONS



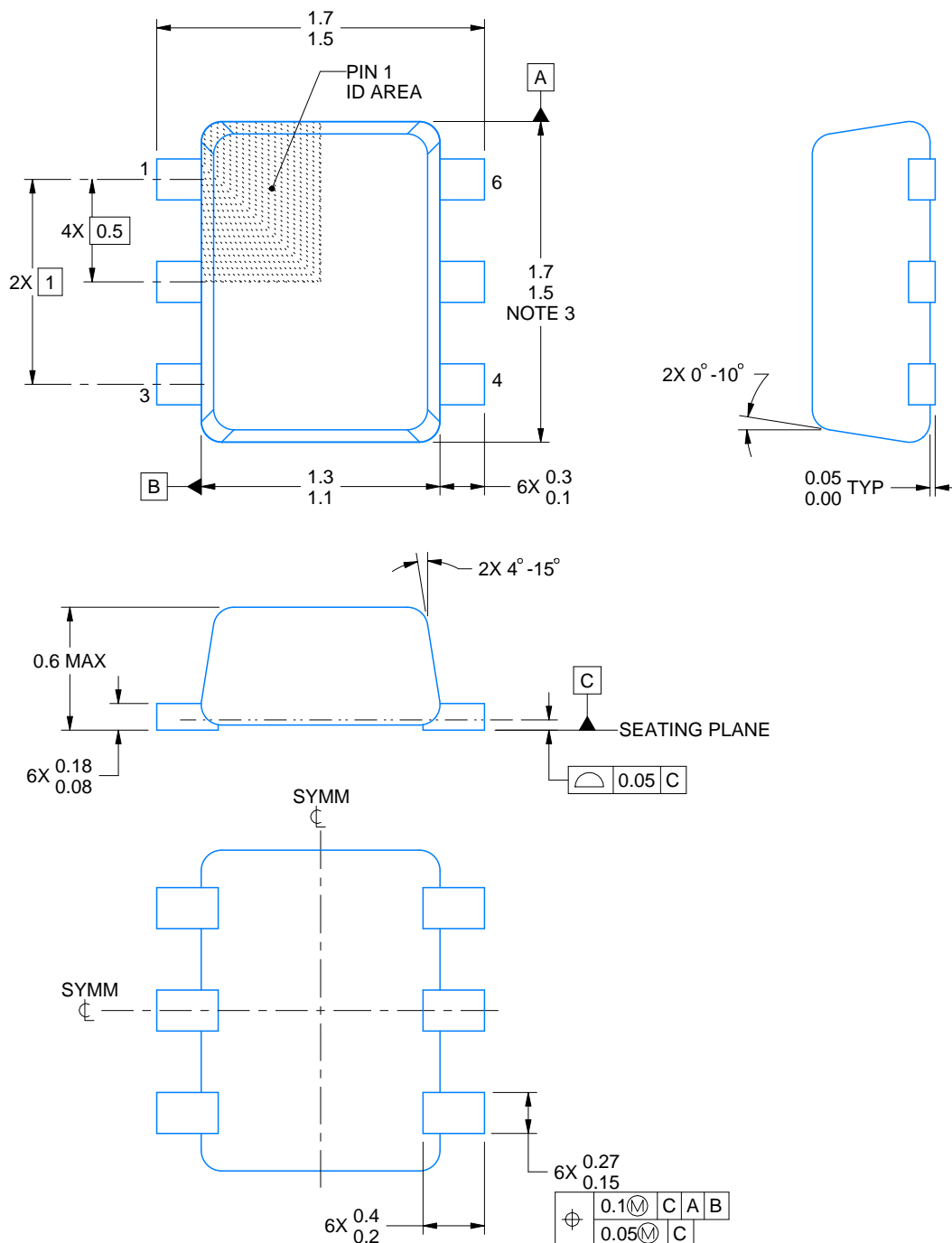
*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TXS0101DBVR	SOT-23	DBV	6	3000	210.0	185.0	35.0
TXS0101DBVR	SOT-23	DBV	6	3000	202.0	201.0	28.0
TXS0101DBVT	SOT-23	DBV	6	250	202.0	201.0	28.0
TXS0101DBVTG4	SOT-23	DBV	6	250	202.0	201.0	28.0
TXS0101DCKR	SC70	DCK	6	3000	210.0	185.0	35.0
TXS0101DCKR	SC70	DCK	6	3000	200.0	183.0	25.0
TXS0101DCKT	SC70	DCK	6	250	200.0	183.0	25.0
TXS0101DRLR	SOT-5X3	DRL	6	4000	202.0	201.0	28.0
TXS0101DRYR	SON	DRY	6	5000	210.0	185.0	35.0
TXS0101YZPR	DSBGA	YZP	6	3000	220.0	220.0	35.0



SOT - 0.6 mm max height

PLASTIC SMALL OUTLINE



4223266/F 11/2024

NOTES:

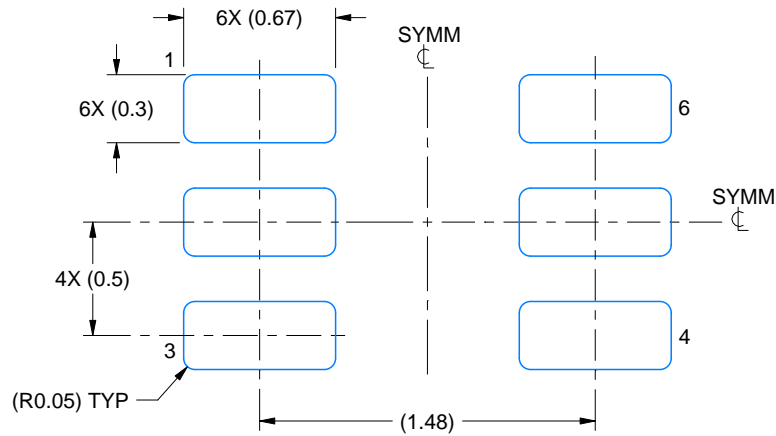
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. Reference JEDEC registration MO-293 Variation UAAD

EXAMPLE BOARD LAYOUT

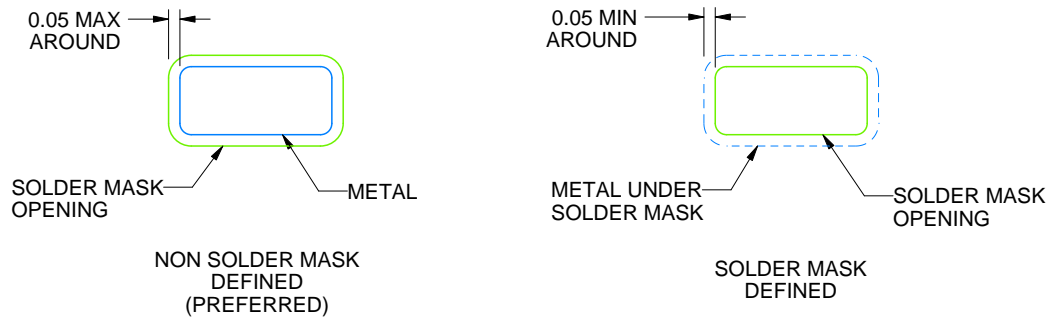
DRL0006A

SOT - 0.6 mm max height

PLASTIC SMALL OUTLINE



LAND PATTERN EXAMPLE
SCALE:30X



SOLDERMASK DETAILS

4223266/F 11/2024

NOTES: (continued)

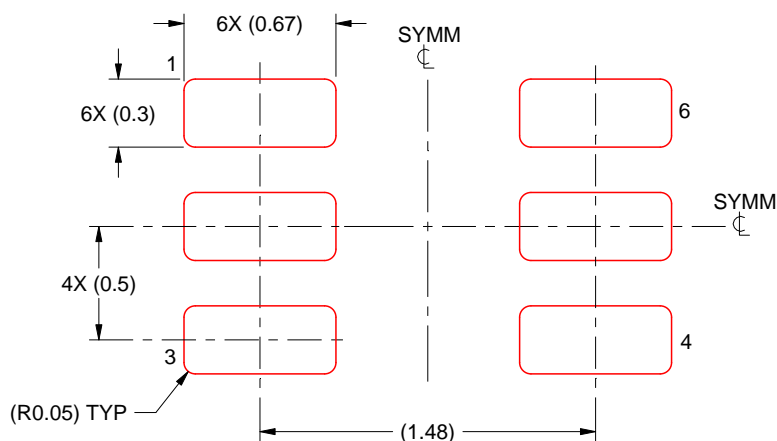
5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.
7. Land pattern design aligns to IPC-610, Bottom Termination Component (BTC) solder joint inspection criteria.

EXAMPLE STENCIL DESIGN

DRL0006A

SOT - 0.6 mm max height

PLASTIC SMALL OUTLINE



SOLDER PASTE EXAMPLE
BASED ON 0.1 mm THICK STENCIL
SCALE:30X

4223266/F 11/2024

NOTES: (continued)

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



SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



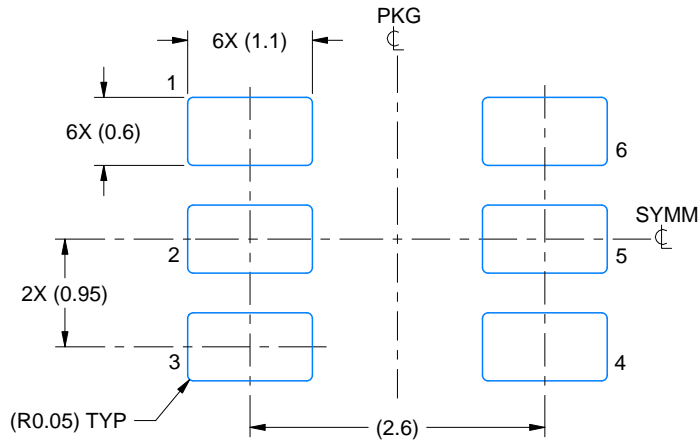
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.25 per side.
4. Leads 1,2,3 may be wider than leads 4,5,6 for package orientation.
5. Reference JEDEC MO-178.

EXAMPLE BOARD LAYOUT

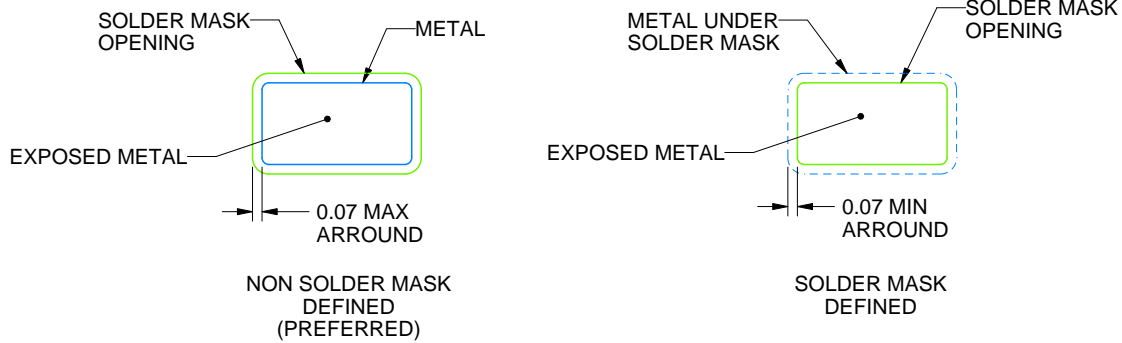
DBV0006A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:15X



SOLDER MASK DETAILS

4214840/G 08/2024

NOTES: (continued)

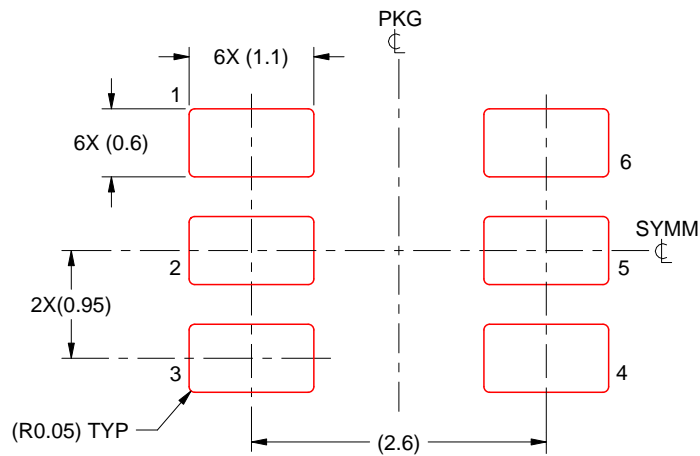
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DBV0006A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:15X

4214840/G 08/2024

NOTES: (continued)

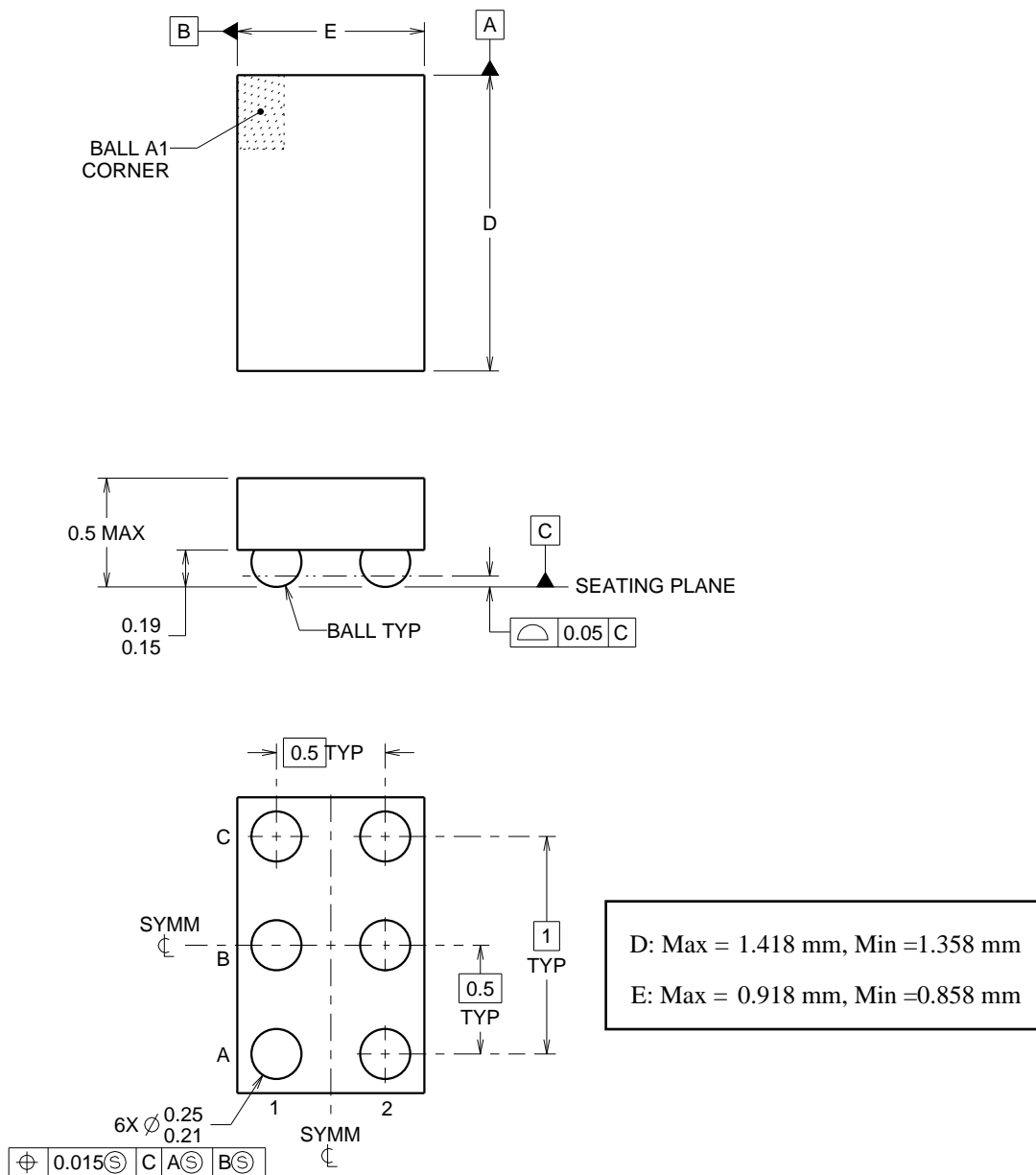
8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.



PACKAGE OUTLINE

DSBGA - 0.5 mm max height

DIE SIZE BALL GRID ARRAY



4219524/A 06/2014

NOTES:

NanoFree Is a trademark of Texas Instruments.

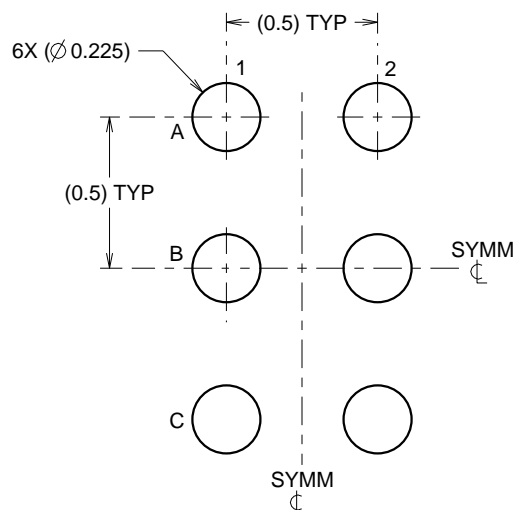
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. NanoFree™ package configuration.

EXAMPLE BOARD LAYOUT

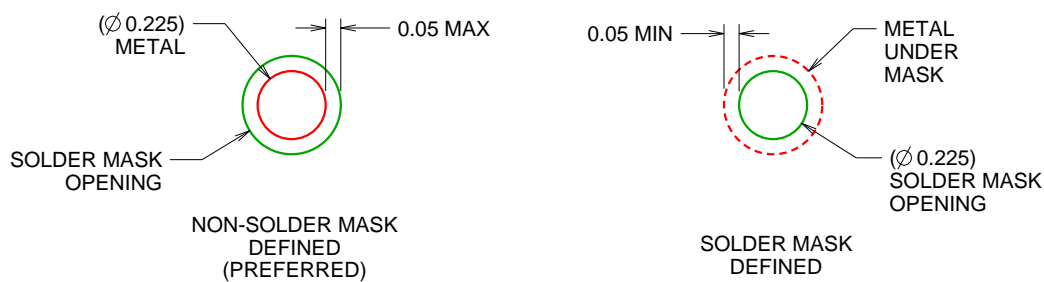
YZP0006

DSBGA - 0.5 mm max height

DIE SIZE BALL GRID ARRAY



LAND PATTERN EXAMPLE
SCALE:40X



SOLDER MASK DETAILS
NOT TO SCALE

4219524/A 06/2014

NOTES: (continued)

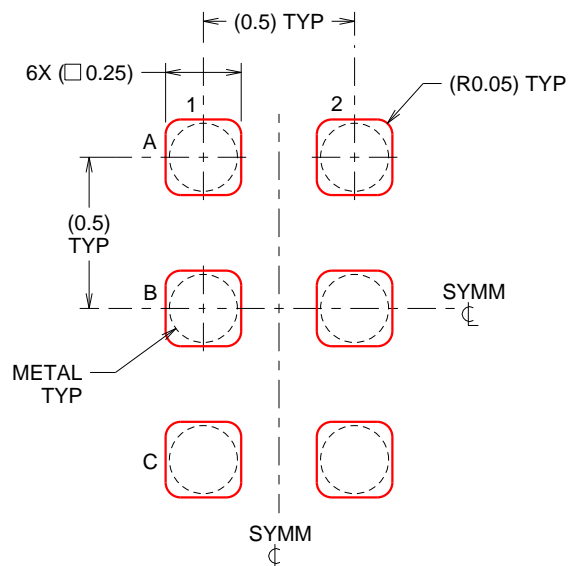
- Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints. For more information, see Texas Instruments literature number SBVA017 (www.ti.com/lit/sbva017).

EXAMPLE STENCIL DESIGN

YZP0006

DSBGA - 0.5 mm max height

DIE SIZE BALL GRID ARRAY



SOLDER PASTE EXAMPLE
BASED ON 0.1 mm THICK STENCIL
SCALE:40X

4219524/A 06/2014

NOTES: (continued)

5. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release.

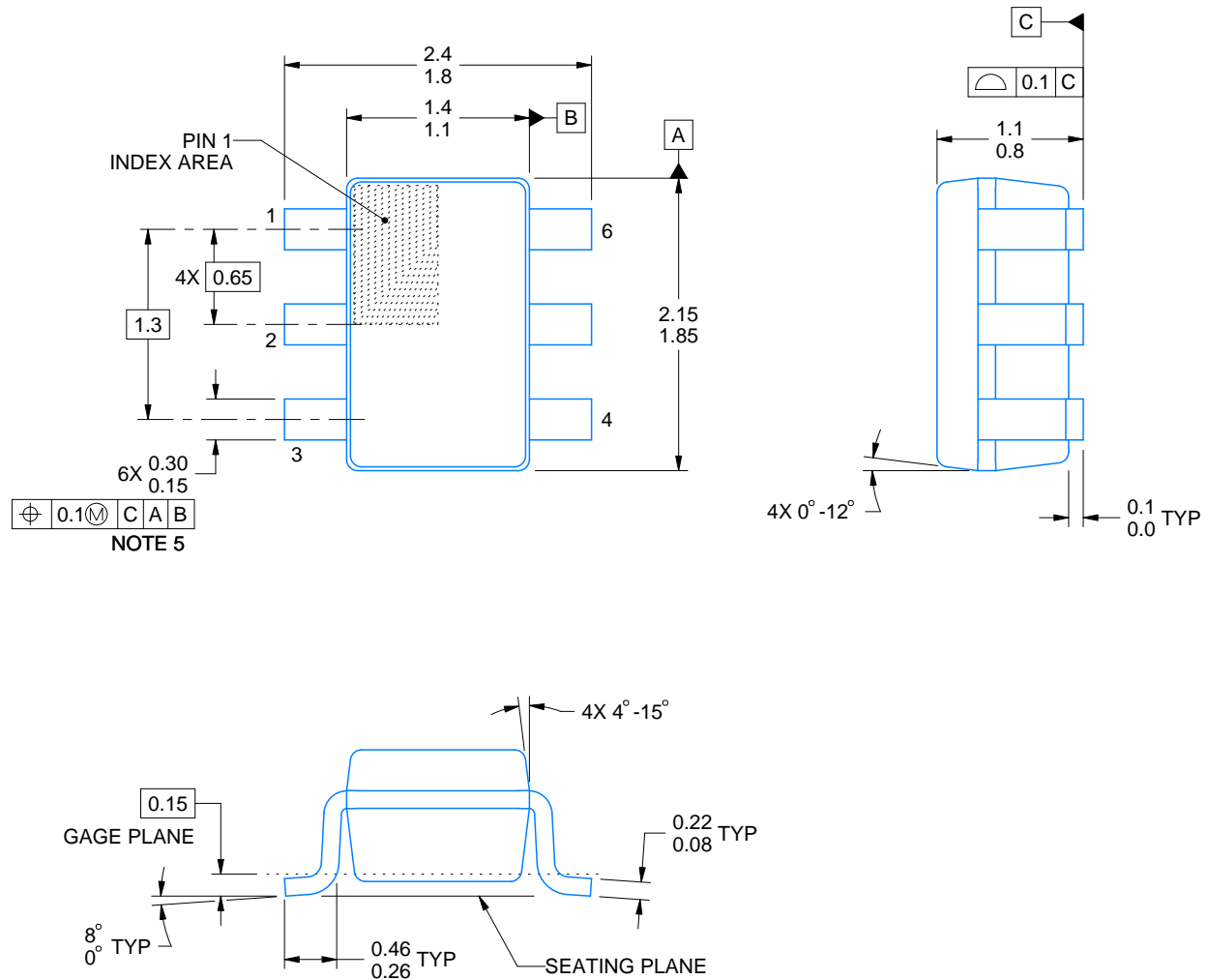
DCK0006A



PACKAGE OUTLINE

SOT - 1.1 max height

SMALL OUTLINE TRANSISTOR



4214835/D 11/2024

NOTES:

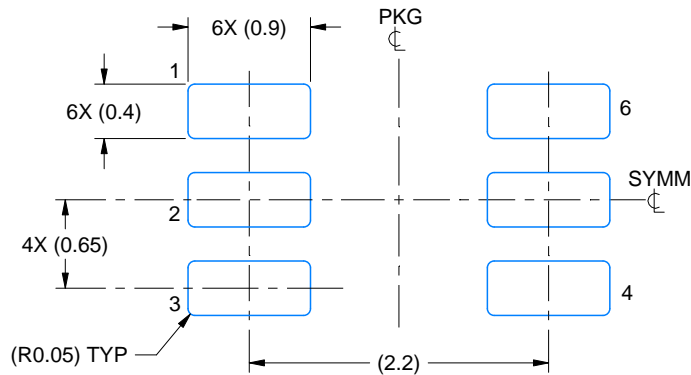
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
4. Falls within JEDEC MO-203 variation AB.

EXAMPLE BOARD LAYOUT

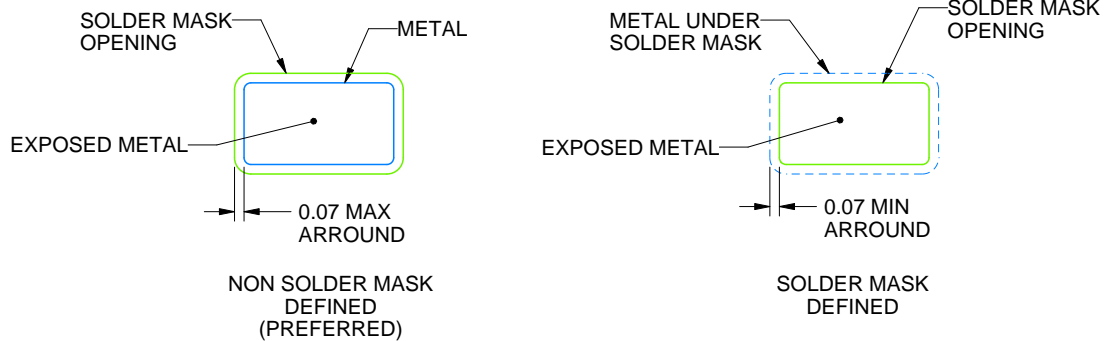
DCK0006A

SOT - 1.1 max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:18X

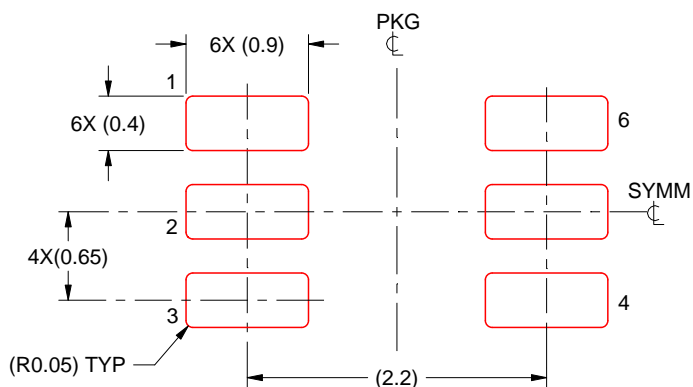


SOLDER MASK DETAILS

4214835/D 11/2024

NOTES: (continued)

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



SOLDER PASTE EXAMPLE
 BASED ON 0.125 THICK STENCIL
 SCALE:18X

4214835/D 11/2024

NOTES: (continued)

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

GENERIC PACKAGE VIEW

DRY 6

USON - 0.6 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

4207181/G

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to [TI's Terms of Sale](#) or other applicable terms available either on [ti.com](https://www.ti.com) or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2025, Texas Instruments Incorporated