

TXS0101-Q1 Automotive 1-Bit Bidirectional Level-Shifting, Voltage-Level Translator With Auto-Direction-Sensing for Open-Drain and Push-Pull Applications

1 Features

- Qualified for automotive applications
- AEC-Q100 qualified with the following results
 - Device temperature grade 1: -40°C to +125°C ambient operating temperature range
- 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:
 - 50Mbps (push pull)
 - 2Mbps (open drain)
- 1.2V to 3.6V on A port and 1.65V to 5.5V on B port
- V_{CCA} may be greater than, less than, or equal to 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 1.2V to 3.6V. V_{CCA} may be greater than or equal to V_{CCB} as long as V_{CCA} is less than 3.6V. The B port is designed to track V_{CCB} . V_{CCB} accepts any supply voltage from 1.65V 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.

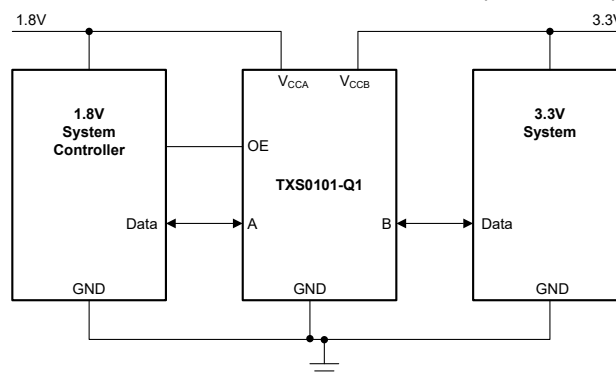
To put the device in the high-impedance state during power up or power down, tie OE to GND through a pull-down resistor; the current-sourcing capability of the driver determines the minimum value of the resistor.

Package Information

PART NUMBER	PACKAGE ⁽¹⁾	PACKAGE SIZE ⁽²⁾
TXS0101-Q1	DCK (SC70, 6)	2mm × 2.1mm
	DRL (SOT-5X3, 6)	1.6mm × 1.6mm

(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



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4 Pin Configuration and Functions

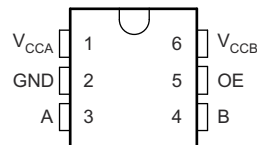


Figure 4-1. DCK and DRL Package, 6-Pin SC70, and SOT (Top View)

Table 4-1. Pin Functions

PIN		TYPE ⁽¹⁾	DESCRIPTION
NAME	NO.		
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. $1.2V \leq V_{CCA} \leq 3.6V$ and $V_{CCA} \leq V_{CCB}$
V_{CCB}	6	I	B-port supply voltage. $1.65V \leq V_{CCB} \leq 5.5V$

(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	
		I/O Ports (B Port)	-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) Operation outside the *Absolute Maximum Rating* may cause permanent device damage. *Absolute Maximum Rating* do not imply functional operation of the device at these or any other conditions beyond those listed under *Recommended Operating Condition*. If used outside the *Recommended Operating Condition* but within the *Absolute Maximum Rating*, the device may not be fully functional, and this may affect device reliability, functionality, performance, and shorten the device lifetime.
- (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 AEC Q100-002	A Port	±2500	V
			B Port	±8000	
		Charged device model (CDM), per AEC Q100-011	A Port	±1500	
			B Port	±1500	

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				1.2	3.6	V
V _{CCB}	Supply voltage B				1.65	5.5	V
V _{IH}	High-level input voltage	A-port I/O's	1.2V to 1.6V	1.65V to 5.5V	V _{CCI} - 0.2	V _{CCI}	V
			1.65V to 3.6V	2.3V to 5.5V	V _{CCI} - 0.4	V _{CCI}	
		B-port I/O's	1.2V to 3.6V	1.65V to 5.5V	V _{CCI} - 0.4	V _{CCI}	
		OE Input	1.2V to 3.6V	1.65V to 5.5V	V _{CCA} × 0.65	5.5	
V _{IL}	Low-level input voltage	A-port I/O's	1.2V to 3.6V	1.65V to 5.5V		0.15	V
			B-port I/O's	1.2V to 3.6V	1.65V to 5.5V		
		OE Input	1.2V to 3.6V	1.65V to 5.5V		V _{CCA} × 0.35	
Δt/Δv	Input transition rise and fall time	Push-Pull Driving	1.2V to 3.6V	1.65V to 5.5V		10	ns/V
T _A	Operating free-air temperature				-40	125	°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 *Electrical Characteristics*.

5.4 Thermal Information

THERMAL METRIC ⁽¹⁾		TXS0101-Q1		UNIT
		DCK	DRL	
		6 PINS	6 PINS	
R _{θJA}	Junction-to-ambient thermal resistance	222.9	207.5	°C/W
R _{θJC(top)}	Junction-to-case (top) thermal resistance	157.0	108.9	°C/W
R _{θJB}	Junction-to-board thermal resistance	77.4	88.5	°C/W
Y _{JT}	Junction-to-top characterization parameter	58.6	6.3	°C/W
Y _{JB}	Junction-to-board characterization parameter	77.1	88.1	°C/W
R _{θJC(bottom)}	Junction-to-case (bottom) thermal resistance	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 report.

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 125°C			
					MIN	TYP	MAX	
V _{OHA}	Port A output high voltage ⁽³⁾	I _{OH} = –20μA	1.2V to 3.6V	1.65V to 5.5V	V _{CCA} × 0.67			V
			1.65V to 3.6V	1.65V to 5.5V	V _{CCA} × 0.67			
V _{OLA}	Port A output low voltage ⁽⁴⁾	I _{OL} = 1mA	1.2V to 3.6V	1.65V to 5.5V	0.3			V
			1.65V to 3.6V	1.65V to 5.5V	0.3			
V _{OHB}	Port B output high voltage		1.2V to 3.6V	1.65V to 5.5V	V _{CCB} × 0.67			V
			1.65V to 3.6V	1.65V to 5.5V	V _{CCB} × 0.67			
V _{OLB}	Port B output low voltage ⁽⁴⁾		1.2V to 3.6V	1.65V to 5.5V	0.4			V
			1.65V to 3.6V	1.65V to 5.5V	0.4			
I _I	Input leakage current	OE V _I = V _{CC} or GND	1.2V to 3.6V	1.65V to 5.5V	–2	2	μA	
I _I	Input leakage current	OE V _I = V _{CC} or GND	1.2V 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	1.2V to 3.6V	1.65V to 5.5V	–3	3	μA	
I _{CCA}	V _{CCA} supply current	V _I = V _{CC1} or GND I _O = 0	1.2V to 3.6V	1.65V to 5.5V	5			μA
			0V	5.5V	–3			
			3.6V	0V	2.2			
I _{CCB}	V _{CCB} supply current	V _I = V _{CC1} or GND I _O = 0	1.2V to 3.6V	1.65V to 5.5V	21			μA
			0V	5.5V	8			
			3.6V	0V	–1			
I _{CCA} + I _{CCB}	Combined supply current	V _I = V _{CC1} or GND I _O = 0	1.2V to 3.6V	1.65V to 5.5V	25			μA
C _i	Input Capacitance	OE	3.3V	3.3V	3.5			pF
C _{io}	A or B port	OE = GND, V _O = 1.65V DC + 1MHz –16 dBm sine wave	3.3V	3.3V				pF
	A port		3.3V	3.3V	6			pF
	B port		3.3V	3.3V	7.5			pF

(1) V_{CC1} is the V_{CC} associated with the input port

- (2) V_{CC0} 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, $V_{CCA} = 1.2V$

PARAMETER	FROM	TO	Test Conditions	B-Port Supply Voltage (V_{CCB})												UNIT				
				1.8 ± 0.15V			2.5 ± 0.2V			3.3 ± 0.3V			5.0 ± 0.5V							
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX					
t_{PHL}	Propagation Delay (High-to-Low)	A	B	Push-Pull	-40°C to 125°C			10			10			12			12			ns
				Open-Drain	-40°C to 125°C			10			10			12			15			
t_{PLH}	Propagation Delay (Low-to-High)	A	B	Push-Pull	-40°C to 125°C			16.2			13.7			15			28.8			ns
				Open-Drain	-40°C to 125°C			60			46.7			42.2			49.4			
t_{PHL}	Propagation Delay (High-to-Low)	B	A	Push-Pull	-40°C to 125°C			10			10			12			12			ns
				Open-Drain	-40°C to 125°C			10			10			12			12			
t_{PLH}	Propagation Delay (Low-to-High)	B	A	Push-Pull	-40°C to 125°C			5.5			1.1			0.6			0			ns
				Open-Drain	-40°C to 125°C			4			1			0.5			0.5			
t_{en}	Enable Time	OE	A or B	Push-Pull	-40°C to 125°C			250			200			200			200			ns
t_{dis}	Disable Time				-40°C to 125°C			200			200			200			200			
t_{rA}	Input Rise Time	B	A	Push-Pull	-40°C to 125°C			25.2			21.8			20.1			18.1			ns
				Open-Drain	-40°C to 125°C			160			133.9			113			94.2			
t_{rB}	Input Rise Time	A	B	Push-Pull	-40°C to 125°C			20.5			16.8			16.5			28			ns
				Open-Drain	-40°C to 125°C			117			83.6			64.1			47.8			
t_{fA}	Input Fall Time	B	A	Push-Pull	-40°C to 125°C			10			10			12			12			ns
				Open-Drain	-40°C to 125°C			10			10			12			12			
t_{fB}	Input Fall Time	A	B	Push-Pull	-40°C to 125°C			14			16			18			24			ns
				Open-Drain	-40°C to 125°C			14			16.5			23			33			

5.7 Switching Characteristics, $V_{CCA} = 1.5 \pm 0.1V$

PARAMETER	FROM	TO	Test Conditions	B-Port Supply Voltage (V_{CCB})												UNIT				
				1.8 ± 0.15V			2.5 ± 0.2V			3.3 ± 0.3V			5.0 ± 0.5V							
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX					
t_{PHL}	Propagation Delay (High-to-Low)	A	B	Push-Pull	-40°C to 125°C			10			10			12			12			ns
				Open-Drain	-40°C to 125°C			10			10			12			12			
t_{PLH}	Propagation Delay (Low-to-High)	A	B	Push-Pull	-40°C to 125°C			10			7			6			6			ns
				Open-Drain	-40°C to 125°C			14			12			11			11			
t_{PHL}	Propagation Delay (High-to-Low)	B	A	Push-Pull	-40°C to 125°C			5			5			5			6			ns
				Open-Drain	-40°C to 125°C			5			5			8			8			
t_{PLH}	Propagation Delay (Low-to-High)	B	A	Push-Pull	-40°C to 125°C			8			1			1			1			ns
				Open-Drain	-40°C to 125°C			4			1			0.5			0.5			
t_{en}	Enable Time	OE	A or B	Push-Pull	-40°C to 125°C			200			200			200			200			ns
t_{dis}	Disable Time				-40°C to 125°C			200			200			200			200			
t_{rA}	Output Rise Time	B	A	Push-Pull	-40°C to 125°C			14			11			10			9			ns
				Open-Drain	-40°C to 125°C			120			90			75			53			
t_{rB}	Output Rise Time	A	B	Push-Pull	-40°C to 125°C			16			12			10			8			ns
				Open-Drain	-40°C to 125°C			105			75			55			31.5			
t_{fA}	Output Fall Time	B	A	Push-Pull	-40°C to 125°C			10			10			8			8			ns
				Open-Drain	-40°C to 125°C			10			10			8			8			
t_{fB}	Output Fall Time	A	B	Push-Pull	-40°C to 125°C			14			16			18			20			ns
				Open-Drain	-40°C to 125°C			14			16			18			20			

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

PARAMETER	FROM	TO	Test Conditions	B-Port Supply Voltage (V_{CCB})												UNIT				
				1.8 ± 0.15V			2.5 ± 0.2V			3.3 ± 0.3V			5.0 ± 0.5V							
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX					
t_{PHL}	Propagation Delay (High-to-Low)	A	B	Push-Pull	-40°C to 125°C			7			7			7			8			ns
				Open-Drain	-40°C to 125°C			7			7			7			8			
t_{PLH}	Propagation Delay (Low-to-High)	A	B	Push-Pull	-40°C to 125°C			9			7			6			6			ns
				Open-Drain	-40°C to 125°C			50			50			40			33			
t_{PHL}	Propagation Delay (High-to-Low)	B	A	Push-Pull	-40°C to 125°C			7			6			6			6			ns
				Open-Drain	-40°C to 125°C			7			6			6			6			
t_{PLH}	Propagation Delay (Low-to-High)	B	A	Push-Pull	-40°C to 125°C			10			2			2			1			ns
				Open-Drain	-40°C to 125°C			36			36			26			20			
t_{en}	Enable Time	OE	A or B	Push-Pull	-40°C to 125°C			200			200			250			275			ns
t_{dis}	Disable Time			Push-Pull	-40°C to 125°C			200			200			200			200			
t_{rA}	Output Rise Time	B	A	Push-Pull	-40°C to 125°C			13			9.5			9.3			7.6			ns
				Open-Drain	-40°C to 125°C			165			165			132			95			
t_{rB}	Output Rise Time	A	B	Push-Pull	-40°C to 125°C			14			10.8			9.1			7.6			ns
				Open-Drain	-40°C to 125°C			145			145			106			58			
t_{fA}	Output Fall Time	B	A	Push-Pull	-40°C to 125°C			8			5.9			6			13.3			ns
				Open-Drain	-40°C to 125°C			8			6.9			6.4			6.1			
t_{fB}	Output Fall Time	A	B	Push-Pull	-40°C to 125°C			10			13.8			16.2			16.2			ns
				Open-Drain	-40°C to 125°C			12			13.8			16.2			16.2			

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

PARAMETER	FROM	TO	Test Conditions	B-Port Supply Voltage (V_{CCB})												UNIT				
				1.8 ± 0.15V			2.5 ± 0.2V			3.3 ± 0.3V			5.0 ± 0.5V							
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX					
t_{PHL}	Propagation Delay (High-to-Low)	A	B	Push-Pull	-40°C to 125°C			6			3.2			3.7			3.8			ns
				Open-Drain	-40°C to 125°C			7			6.3			6			5.8			
t_{PLH}	Propagation Delay (Low-to-High)	A	B	Push-Pull	-40°C to 125°C			3			3.5			4.1			4.4			ns
				Open-Drain	-40°C to 125°C			250			250			206			190			
t_{PHL}	Propagation Delay (High-to-Low)	B	A	Push-Pull	-40°C to 125°C			5			3			3.6			4.3			ns
				Open-Drain	-40°C to 125°C			6			4.7			4.2			4			
t_{PLH}	Propagation Delay (Low-to-High)	B	A	Push-Pull	-40°C to 125°C			10			2.5			1.6			1			ns
				Open-Drain	-40°C to 125°C			170			170			140			103			
t_{en}	Enable Time	OE	A or B	Push-Pull	-40°C to 125°C			250			200			200			250			ns
t_{dis}	Disable Time			Push-Pull	-40°C to 125°C			250			200			200			200			
t_{rA}	Output Rise Time	B	A	Push-Pull	-40°C to 125°C			13			7.8			6.6			6.0			ns
				Open-Drain	-40°C to 125°C			150			149			121			89			
t_{rB}	Output Rise Time	A	B	Push-Pull	-40°C to 125°C			13			8.3			7.2			6.1			ns
				Open-Drain	-40°C to 125°C			160			151			112			64			
t_{fA}	Output Fall Time	B	A	Push-Pull	-40°C to 125°C			7			5.7			5.5			5.3			ns
				Open-Drain	-40°C to 125°C			9			6.9			6.2			5.8			
t_{fB}	Output Fall Time	A	B	Push-Pull	-40°C to 125°C			10			7.8			6.7			6.6			ns
				Open-Drain	-40°C to 125°C			9			8.8			9.4			10.4			

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

PARAMETER		FROM	TO	Test Conditions		B-Port Supply Voltage (V_{CCB})								UNIT				
						1.8 ± 0.15V			2.5 ± 0.2V			3.3 ± 0.3V			5.0 ± 0.5V			
						MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP		MAX	MIN	TYP	MAX
t _{PHL}	Propagation Delay (High-to-Low)	A	B	Push-Pull	-40°C to 125°C	6			5			2.4			3.1			ns
				Open-Drain	-40°C to 125°C	6			5			4.2			4.6			
t _{PLH}	Propagation Delay (Low-to-High)	A	B	Push-Pull	-40°C to 125°C	4			4			4.2			4.4			ns
				Open-Drain	-40°C to 125°C	210			210			204			165			
t _{PHL}	Propagation Delay (High-to-Low)	B	A	Push-Pull	-40°C to 125°C	5			4			2.5			3.3			ns
				Open-Drain	-40°C to 125°C	130			130			124			97			
t _{PLH}	Propagation Delay (Low-to-High)	B	A	Push-Pull	-40°C to 125°C	12			6			2.5			2.6			ns
				Open-Drain	-40°C to 125°C	150			150			139			105			
t _{en}	Enable Time	OE	A or B	Push-Pull	-40°C to 125°C	250			250			200			250			ns
t _{dis}	Disable Time				-40°C to 125°C	200			200			200			200			
t _{rA}	Output Rise Time	B	A	Push-Pull	-40°C to 125°C	14			13			6.1			5.5			ns
				Open-Drain	-40°C to 125°C	120			120			116			85			
t _{rB}	Output Rise Time	A	B	Push-Pull	-40°C to 125°C	12			9			6.4			7.4			ns
				Open-Drain	-40°C to 125°C	120			120			116			72			
t _{fA}	Output Fall Time	B	A	Push-Pull	-40°C to 125°C	8			6			5.4			5			ns
				Open-Drain	-40°C to 125°C	9			7			6.1			5.7			
t _{fB}	Output Fall Time	A	B	Push-Pull	-40°C to 125°C	8			8			7.4			7.6			ns
				Open-Drain	-40°C to 125°C	8			7			7.6			8.3			

5.11 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	1.2V ± 0.1V	1.8 ± 0.15V			24	Mbps
				2.5V ± 0.2V			24	
				3.3V ± 0.3V			24	
				5V ± 0.5V			24	
			1.5V ± 0.1V	1.8 ± 0.15V			24	
				2.5V ± 0.2V			24	
				3.3V ± 0.3V			24	
				5V ± 0.5V			24	
			1.8 ± 0.15V	1.8 ± 0.15V			50	
				2.5V ± 0.2V			50	
				3.3V ± 0.3V			50	
				5V ± 0.5V			50	
		2.5V ± 0.2V	1.8 ± 0.15V			24		
			2.5V ± 0.2V			50		
			3.3V ± 0.3V			50		
			5V ± 0.5V			50		
		3.3V ± 0.3V	1.8 ± 0.15V			24		
			2.5V ± 0.2V			24		
			3.3V ± 0.3V			50		
			5V ± 0.5V			50		
		Open-Drain Driving	1.2V ± 0.1V	1.8 ± 0.15V			2	
				2.5V ± 0.2V			2	
				3.3V ± 0.3V			2	
				5V ± 0.5V			2	
			1.5V ± 0.1V	1.8 ± 0.15V			2	
				2.5V ± 0.2V			2	
				3.3V ± 0.3V			2	
				5V ± 0.5V			2	
			1.8 ± 0.15V	1.8 ± 0.15V			2	
				2.5V ± 0.2V			2	
				3.3V ± 0.3V			2	
				5V ± 0.5V			2	
		2.5V ± 0.2V	1.8 ± 0.15V			2		
			2.5V ± 0.2V			2		
			3.3V ± 0.3V			2		
			5V ± 0.5V			2		
3.3V ± 0.3V	1.8 ± 0.15V			2				
	2.5V ± 0.2V			2				
	3.3V ± 0.3V			2				
	5V ± 0.5V			2				
t_w	Pulse Duration, Data Inputs	Push-Pull Driving	1.2V ± 0.1V to 3.3V ± 0.3V	1.8V ± 0.15V to 5.5V ± 0.5V	20	ns		
		Open-Drain Driving	1.2V ± 0.1V to 3.3V ± 0.3V	1.8V ± 0.15V to 5.5V ± 0.5V	500			
t_{sk} - Output skew	Skew between any two outputs of the same package switching in the same direction	Push-Pull Driving	1.2V ± 0.1V to 3.3V ± 0.3V	1.8V ± 0.15V to 5.5V ± 0.5V	1	ns		
		Open-Drain Driving	1.2V ± 0.1V to 3.3V ± 0.3V	1.8V ± 0.15V to 5.5V ± 0.5V	1			

5.12 Typical Characteristics

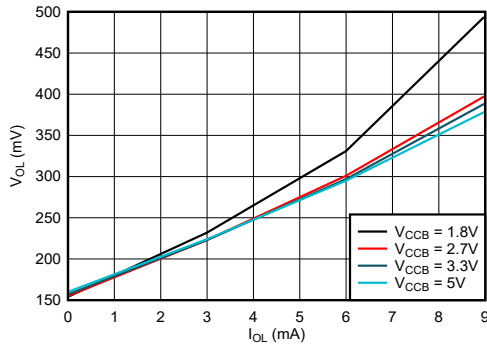


Figure 5-1. Low-Level Output Voltage ($V_{OL(Bx)}$) vs Low-Level Current ($I_{OL(Bx)}$)

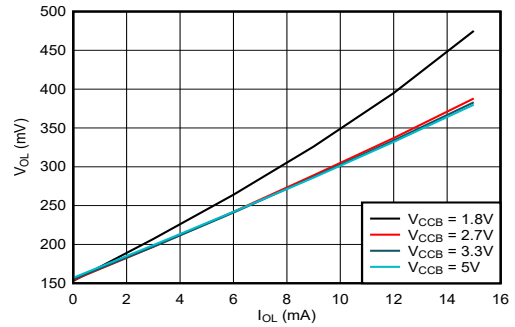


Figure 5-2. Low-Level Output Voltage ($V_{OL(Bx)}$) vs Low-Level Current ($I_{OL(Bx)}$)

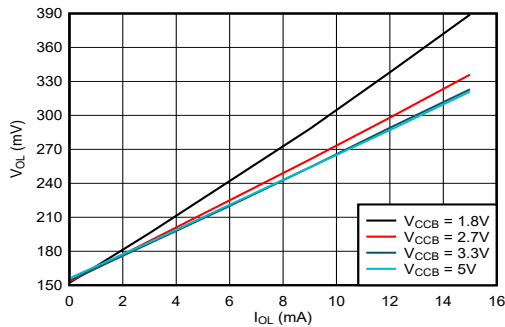


Figure 5-3. Low-Level Output Voltage ($V_{OL(Bx)}$) vs Low-Level Current ($I_{OL(Bx)}$)

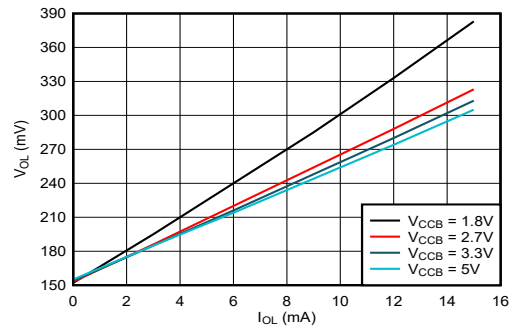


Figure 5-4. Low-Level Output Voltage ($V_{OL(Bx)}$) vs Low-Level Current ($I_{OL(Bx)}$)

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.

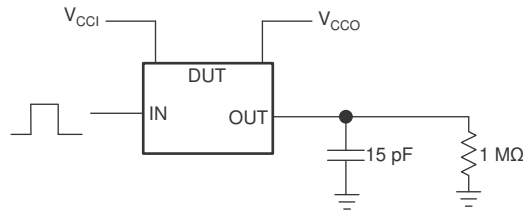


Figure 6-1. Data Rate, Pulse Duration, Propagation Delay, Output Rise-Time and Fall-Time Measurement Using a Push-Pull Driver

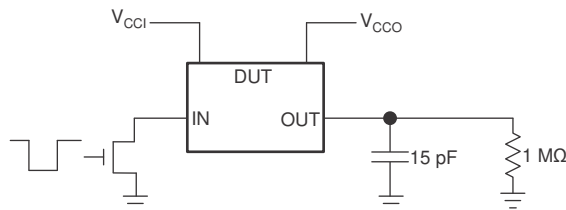


Figure 6-2. Data Rate, Pulse Duration, Propagation Delay, Output Rise-Time and Fall-Time Measurement Using an Open-Drain Driver

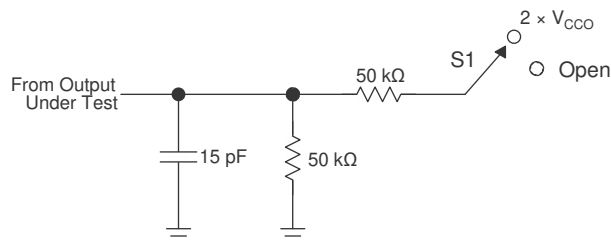


Figure 6-3. Load Circuit for Enable-Time and Disable-Time Measurement

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

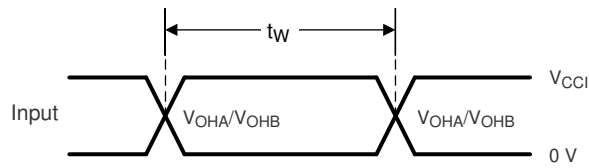


Figure 6-4. Pulse Duration (Push-Pull)

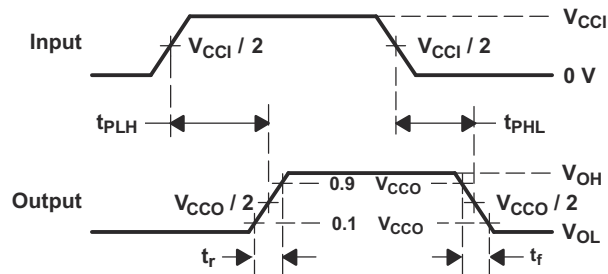
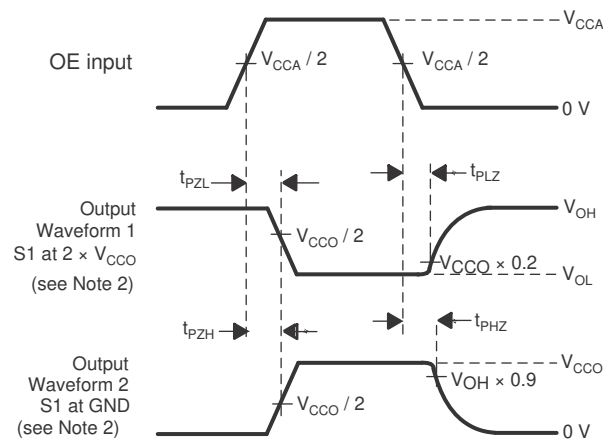


Figure 6-5. Propagation Delay Times



- 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.

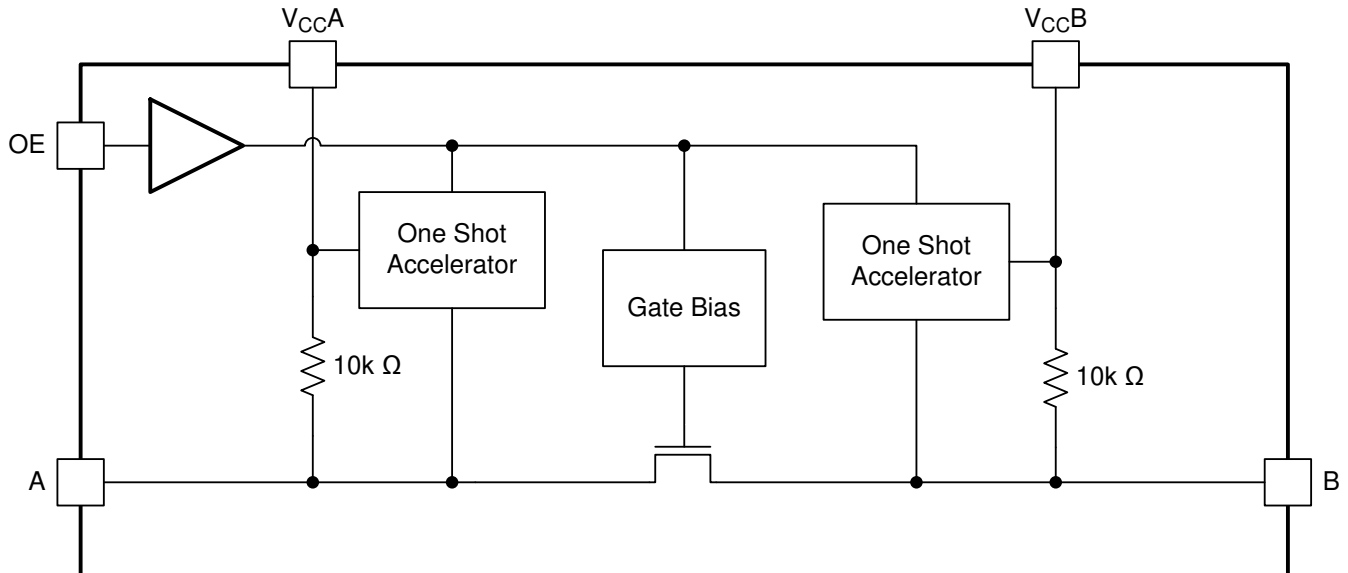
Figure 6-6. Enable and Disable Times

7 Detailed Description

7.1 Overview

The TXS0101-Q1 device is a directionless voltage-level translator specifically designed for translating logic voltage levels. The A port can accept I/O voltages ranging from 1.2V to 3.6V, while the B port can accept I/O voltages from 1.65V 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-Q1 architecture does not require a direction-control signal to control the direction of data flow from A to B or from B to A.

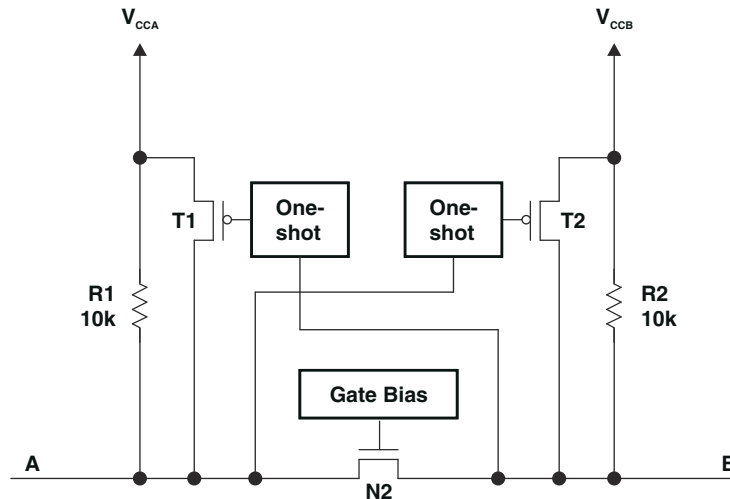


Figure 7-1. Architecture of a TXS01xx Cell

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-Q1. 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 Enable and Disable

The TXS0101-Q1 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.

7.3.4 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-Q1 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-Q1 can be used in level-translation applications for interfacing devices or systems operating at different interface voltages with one another. The TXS0101-Q1 is an excellent choice for use in applications where an open-drain driver is connected to the data I/Os. The TXS0101-Q1 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

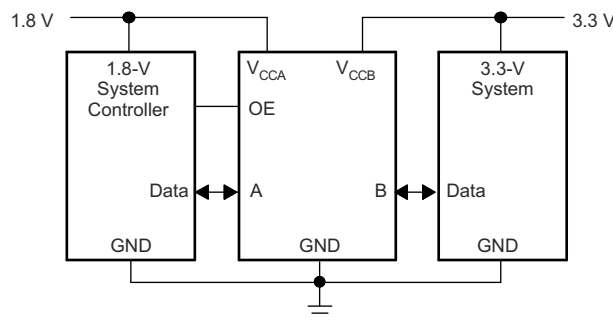


Figure 8-1. Typical Application Schematic

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	1.2 to 3.6V
Output voltage range	1.65 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-Q1 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-Q1 device is driving to determine the output voltage range.
 - The TXS0101-Q1 device has 10k Ω 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

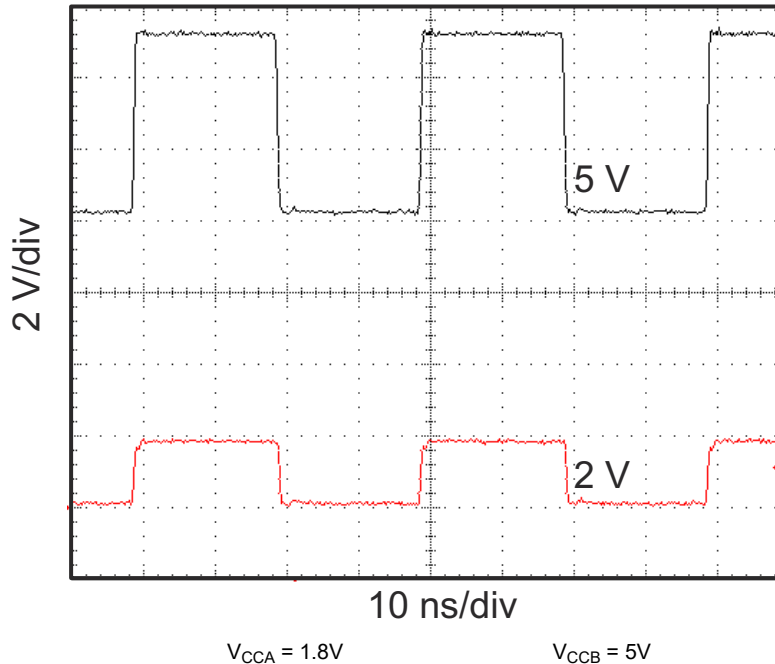


Figure 8-2. Level-Translation of a 2.5MHz Signal

8.3 Power Supply Recommendations

The TXS0101-Q1 device uses two separate configurable power-supply rails, V_{CCA} and V_{CCB} . V_{CCB} accepts any supply voltage from 1.65V to 5.5V and V_{CCA} accepts any supply voltage from 1.2V 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-Q1 device does not require power sequencing between V_{CCA} and V_{CCB} during power-up so the power-supply 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, and during operation, V_{CCA} may be greater than or equal to V_{CCB} ($V_{CCA} \leq V_{CCB}$).

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

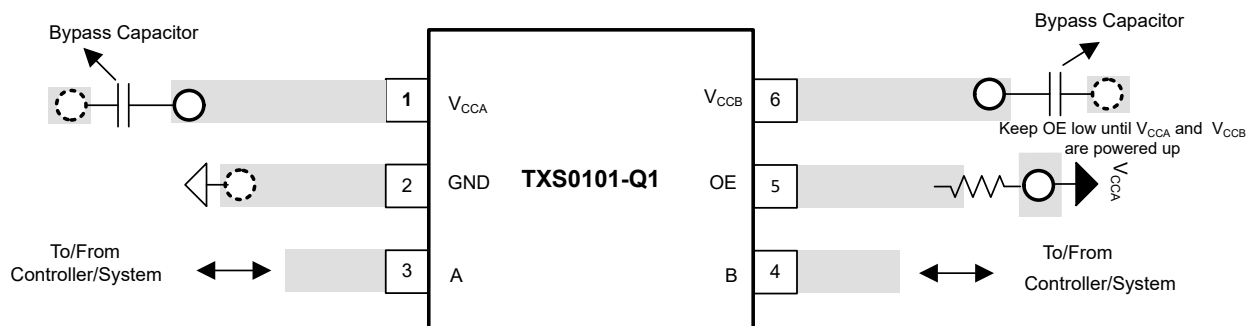
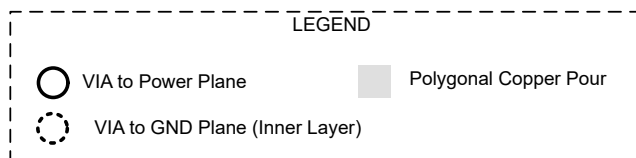


Figure 8-3. Typical Layout of TXS0101-Q1

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.

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9.4 Trademarks

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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

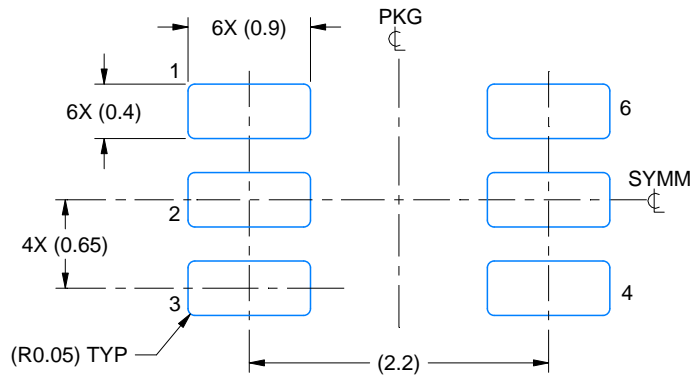
[TI Glossary](#) This glossary lists and explains terms, acronyms, and definitions.

10 Revision History

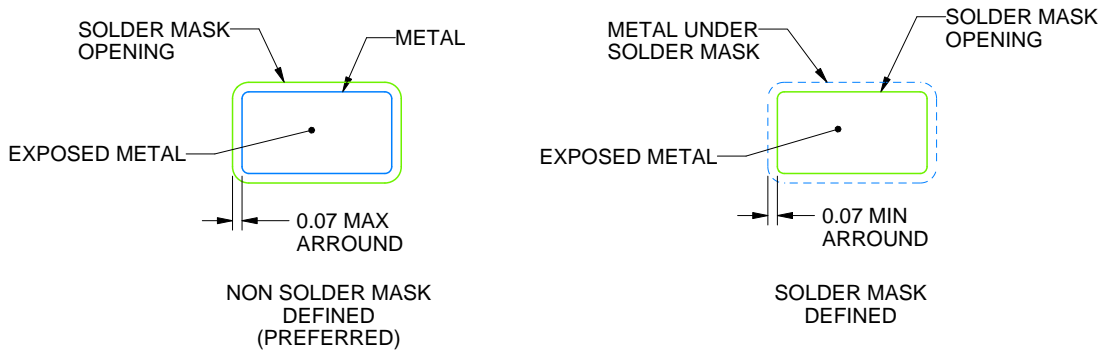
DATE	REVISION	NOTES
June 2024	*	Initial Release

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.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:18X

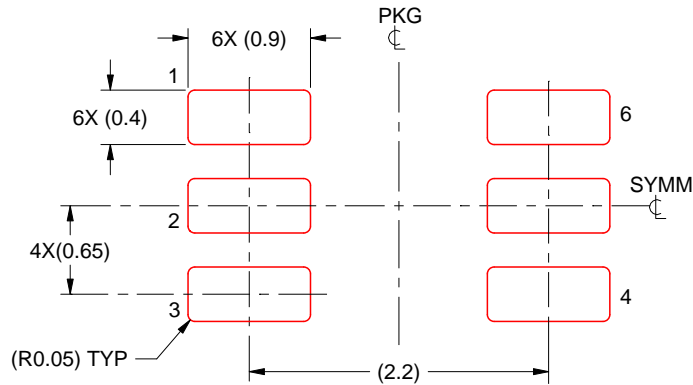


SOLDER MASK DETAILS

4214835/B 04/2024

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/B 04/2024

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.

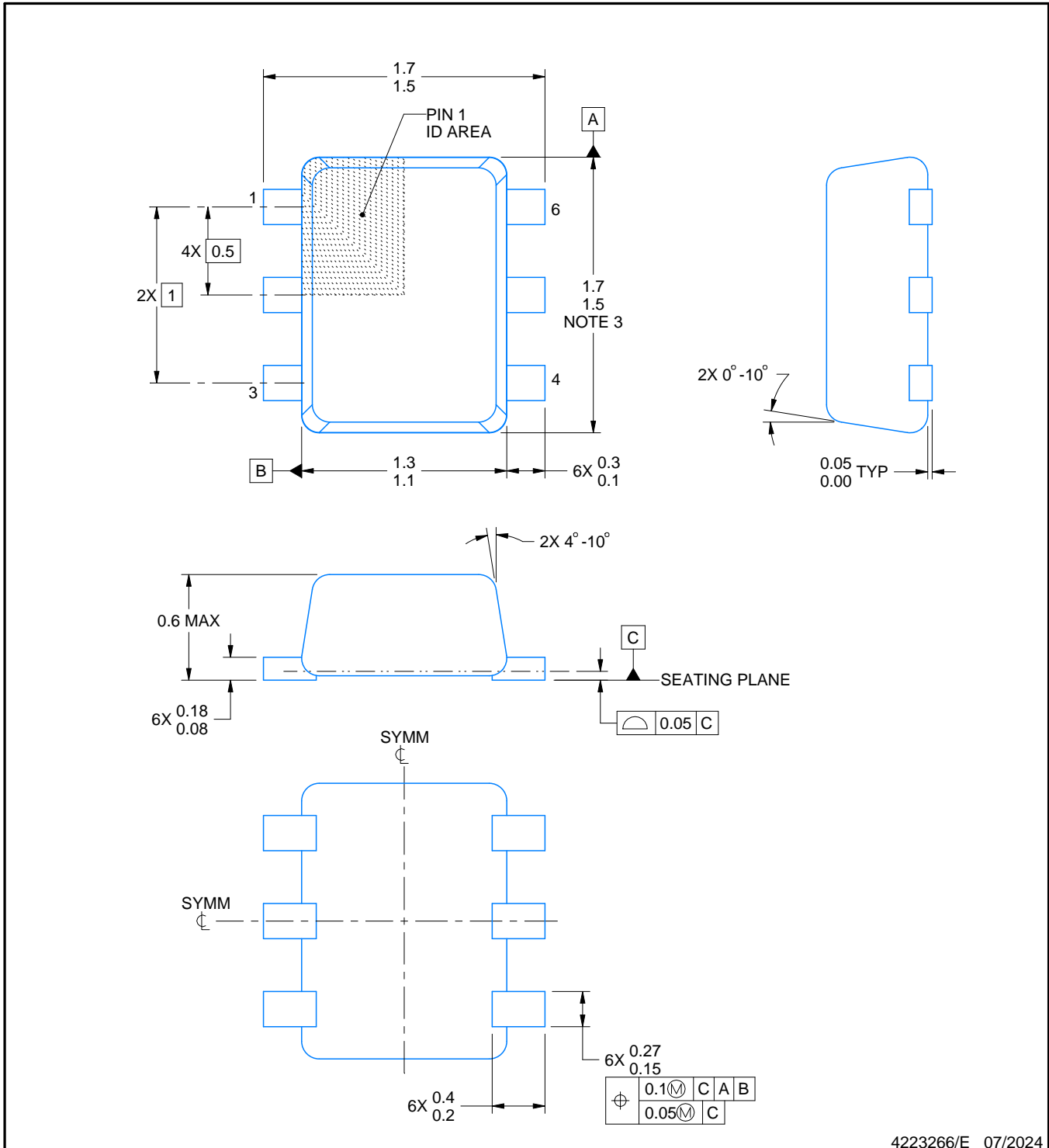
DRL0006A



PACKAGE OUTLINE

SOT - 0.6 mm max height

PLASTIC SMALL OUTLINE



4223266/E 07/2024

NOTES:

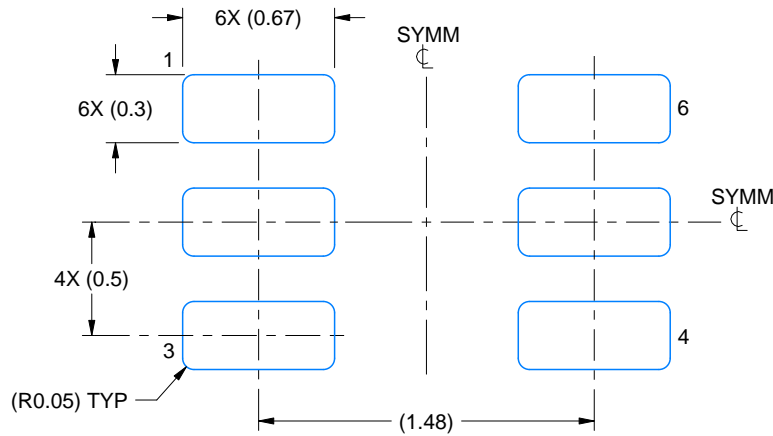
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or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

EXAMPLE BOARD LAYOUT

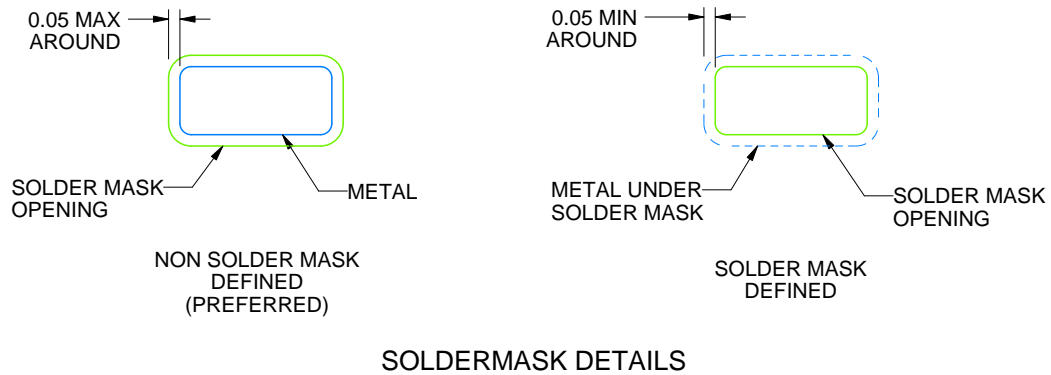
DRL0006A

SOT - 0.6 mm max height

PLASTIC SMALL OUTLINE



LAND PATTERN EXAMPLE
SCALE:30X



SOLDERMASK DETAILS

4223266/E 07/2024

NOTES: (continued)

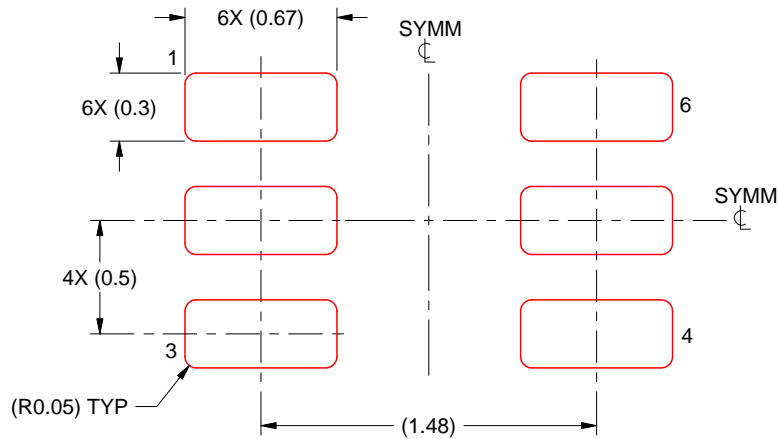
5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.
7. Land pattern design aligns to IPC-610, Bottom Termination Component (BTC) solder joint inspection criteria.

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/E 07/2024

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.

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