

TXS0104E-Q1 适用于漏极开路 and 推挽应用的 4 位双向电压电平转换器 转换器

1 特性

- 汽车电子 应用认证末尾新增了一段内容
- 具有符合 AEC-Q100 标准的下列结果：
 - 器件温度 1 级：-40℃ 至 +125℃ 的环境运行温度范围
 - 器件人体放电模式 (HBM) 静电放电 (ESD) 分类等级 2
 - 器件组件充电模式 (CDM) ESD 分类等级 C6
- 无需方向控制信号
- 最大数据速率
 - 最大值 24Mbps (推挽)
 - 2Mbps (开漏)
- A 端口上 1.65V 至 3.6V, B 端口上 2.3V 至 5.5V ($V_{CCA} \leq V_{CCB}$)
- 无需电源序列 — V_{CCA} 或 V_{CCB} 均可优先斜升
- 静电放电 (ESD) 保护性能超过 JESD 22 规范要求
 - A 端口
 - 2000V 人体放电模式 (A114-B)
 - 1000V 组件充电模式 (C101)
 - B 端口
 - 15kV 人体放电模式 (A114-B)
 - 1000V 组件充电模式 (C101)
- IEC 61000-4-2 ESD (B 端口)
 - ±8kV 接触放电
 - ±10kV 空气间隙放电

2 应用范围

- 汽车用信息娱乐系统, 高级驾驶员辅助系统 (ADAS)
- 主处理器和外设模块间的隔离和电平转换
- I²C 或 1 线制电压电平转换

3 说明

由于电压不匹配, TXS0104E-Q1 器件连接芯片与芯片间的非兼容逻辑通信。这款自动导向转换器可方便地用来在无需主机方向控制的情况下缩小之间的差距。在无需主机干预的情况下, 每个通道可混合使用, 并且可以与不同的输出类型 (开漏或推挽) 和混合数据流 (发送或接收) 相匹配。这个 4 位非反向转换器使用两个独立的可配置电源轨。A 和 B 端口被设计用来分别跟踪 V_{CCA} 和 V_{CCB} 。 V_{CCB} 引脚在 V_{CCA} 引脚接受 1.65V 至 3.6V 之间的任一电源电压的同时, 接受 2.3V 至 5.5V 之间的任何电源电压, 这样的话, V_{CCA} 小于或等于 V_{CCB} 。这个跟踪功能可实现 1.8V, 2.5V, 3.3V 和 5V 电压节点之间的低电压双向转换。

当输出使能端 (OE) 输入为低电平时, 所有输出都被置于高阻抗状态。

TXS0104E-Q1 器件被设计成 OE 输入电路由 V_{CCA} 供电。

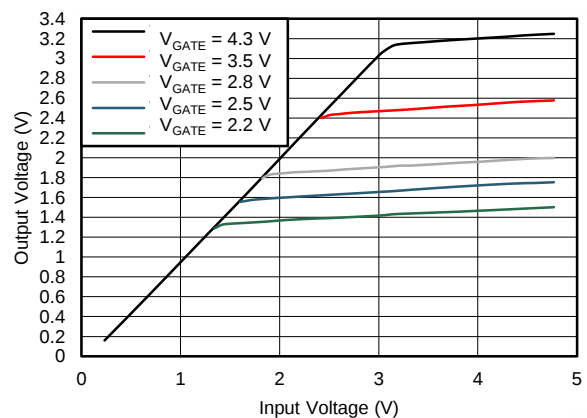
为了确保加电或断电期间的高阻抗状态, OE 引脚应该通过一个下拉电阻器接在 GND 引脚上; 此电阻器的最小值由驱动器的电流供源能力决定。

器件信息⁽¹⁾

器件型号	封装	封装尺寸 (标称值)
TXS0104E-Q1	薄型小外形尺寸封装 (TSSOP) (14)	5.00mm x 4.40mm

(1) 要了解所有可用封装, 请见数据表末尾的可订购产品附录。

N 通道晶体管的传输特征



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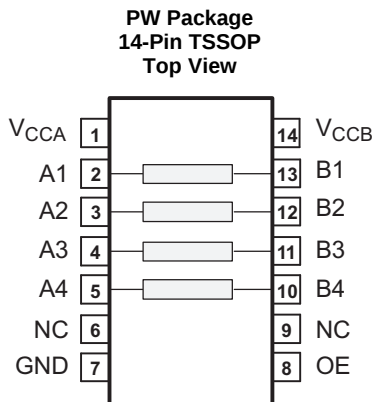
4 修订历史记录

注：之前版本的页码可能与当前版本有所不同。

Changes from Revision B (May 2014) to Revision C	Page
• Changed the type of the OE pin from output (O) to input (I) in the <i>Pin Functions</i> table	3
• Moved T_{stg} back to the <i>Absolute Maximum Ratings</i> table and changed the <i>Handling Ratings</i> table to <i>ESD Ratings</i>	4
• 已添加 文档支持，接收文档更新通知以及社区资源部分	20

Changes from Revision A (April 2014) to Revision B	Page
• 已更改 器件状态“产品预览”至“量产数据”	1

5 Pin Configuration and Functions



NC - No internal connection

Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
A1	2	I/O	Input-output 1 for the A port. This pin is referenced to V_{CCA} .
A2	3	I/O	Input-output 2 for the A port. This pin is referenced to V_{CCA} .
A3	4	I/O	Input-output 3 for the A port. This pin is referenced to V_{CCA} .
A4	5	I/O	Input-output 4 for the A port. This pin is referenced to V_{CCA} .
B1	13	I/O	Input-output 1 for the B port. This pin is referenced to V_{CCB} .
B2	12	I/O	Input-output 2 for the B port. This pin is referenced to V_{CCB} .
B3	11	I/O	Input-output 3 for the B port. This pin is referenced to V_{CCB} .
B4	10	I/O	Input-output 4 for the B port. This pin is referenced to V_{CCB} .
GND	7	—	Ground
NC	6	—	No connection
	9		
OE	8	I	Tri-state output-mode enable. Pull the OE pin low to place all outputs in tri-state mode. This pin is referenced to V_{CCA} .
V_{CCA}	1	I	A-port supply voltage. $1.65\text{ V} \leq V_{CCA} \leq 3.6\text{ V}$ and $V_{CCA} \leq V_{CCB}$.
V_{CCB}	14	I	B-port supply voltage. $2.3\text{ V} \leq V_{CCB} \leq 5.5\text{ V}$.

6 Specifications

6.1 Absolute Maximum Ratings

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

			MIN	MAX	UNIT
Supply voltage	V_{CCA}		−0.5	4.6	V
	V_{CCB}		−0.5	6.5	
Input-output pin voltage, V_{IO} ⁽²⁾	A1, A2, A3, A4	A port	−0.5	4.6	V
	B1, B2, B3, B4	B port	−0.5	6.5	
Output voltage, V_O	Voltage range 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	
	Voltage range applied to any output in the high or low state ^{(2) (3)}	A port	−0.5	$V_{CCA} + 0.5$	V
		B port	−0.5	$V_{CCB} + 0.5$	
Input clamp current, I_{IK}		$V_I < 0$		−50	mA
Output clamp current, I_{OK}		$V_O < 0$		−50	mA
Continuous output current, I_O				±50	mA
Continuous current through each V_{CCA} , V_{CCB} , or GND				±100	mA
Storage temperature range, T_{stg}			−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.

6.2 ESD Ratings

		VALUE	UNIT
$V_{(ESD)}$ Electrostatic discharge	Human-body model (HBM), per AEC Q100-002 ⁽¹⁾	±2500	V
	Charged-device model (CDM), per AEC Q100-011	±1500	

- (1) AEC Q100-002 indicates that HBM stressing shall be in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

6.3 Recommended Operating Conditions

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

			V_{CCA}	V_{CCB}	MIN	MAX	UNIT
V_{CCA}	Supply voltage ⁽¹⁾				1.65	3.6	V
V_{CCB}	Supply voltage ⁽¹⁾				2.3	5.5	
$V_{IH(Ax)}$	High-level input voltage	A-port I/Os	1.65 to 1.95 V	2.3 to 5.5 V	$V_{CCA} - 0.2$	V_{CCA}	V
			2.3 to 3.6 V		$V_{CCA} - 0.4$	V_{CCA}	
$V_{IH(Bx)}$	High-level input voltage	B-port I/Os	1.65 to 3.6 V	2.3 to 5.5 V	$V_{CCB} - 0.4$	V_{CCB}	V
$V_{IH(OE)}$	High-level input voltage	OE input			$V_{CCA} \times 0.65$	5.5	
$V_{IL(Ax)}$	Low-level input voltage	A-port I/Os	1.65 to 3.6 V	2.3 to 5.5 V	0	0.15	V
$V_{IL(Bx)}$	Low-level input voltage	B-port I/Os			0	0.15	
$V_{IL(OE)}$	Low-level input voltage	OE input			0	$V_{CCA} \times 0.35$	
$\Delta t/\Delta V_{(Ax)}$	Input transition rise or fall rate	A-port I/Os, push-pull driving	1.65 to 3.6 V	2.3 to 5.5 V		10	ns/V
$\Delta t/\Delta V_{(Bx)}$	Input transition rise or fall rate	B-port I/Os, push-pull driving				10	
$\Delta t/\Delta V_{(OE)}$	Input transition rise or fall rate	OE input				10	
T_A	Operating free-air temperature				−40	125	°C

- (1) V_{CCA} must be less than or equal to V_{CCB} , and V_{CCA} must not exceed 3.6 V.

6.4 Thermal Information

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

THERMAL METRIC ⁽¹⁾		TXS0104E-Q1	UNIT
		PW (TSSOP)	
		14 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	120.1	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	49.1	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	61.8	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	6.2	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	61.2	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	—	°C/W

(1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC Package Thermal Metrics](#) application report (SPRA953).

6.5 Electrical Characteristics

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

PARAMETER	TEST CONDITIONS	V_{CCA}	V_{CCB}	MIN	TYP	MAX	UNIT
$V_{OH(Ax)}$	High-level output voltage, A port $I_{OH} = -20 \mu A$, $V_{I(Bx)} \geq V_{CCB} - 0.4 V$	1.65 to 3.6 V	2.3 to 5.5 V	$V_{CCA} \times 0.75$			V
$V_{OL(Ax)}$	Low-level output voltage, A port $I_{OL} = 1 mA$, $V_{I(Bx)} \leq 0.15 V$	1.65 to 3.6 V	2.3 to 5.5 V			0.4	V
$V_{OH(Bx)}$	High-level output voltage, B port $I_{OH} = -20 \mu A$, $V_{I(Ax)} \geq V_{CCA} - 0.2 V$	1.65 to 3.6 V	2.3 to 5.5 V	$V_{CCB} \times 0.75$			V
$V_{OL(Bx)}$	Low-level output voltage, B port $I_{OL} = 1 mA$, $V_{I(Ax)} \leq 0.15 V$	1.65 to 3.6 V	2.3 to 5.5 V			0.4	V
$I_{I(OE)}$	Input current, OE $V_I = V_{CCI}$ or GND, $T_A = 25^\circ C$	1.65 to 3.6 V	2.3 to 5.5 V			± 2	μA
						± 1	
I_{OZ}	Off-state output current, A or B port $OE = V_{IL}$, $T_A = 25^\circ C$	1.65 to 3.6 V	2.3 to 5.5 V			± 3	μA
						± 1	
I_{CCA}	Supply current, A port $V_I = V_O = \text{Open}$, $I_O = 0$	1.65 to V_{CCB}	2.3 to 5.5 V			4	μA
		3.6 V	0			2.2	
		0	5.5 V			-1	
I_{CCB}	Supply current, B port $V_I = V_O = \text{Open}$, $I_O = 0$	1.65 to V_{CCB}	2.3 to 5.5 V			21	μA
		3.6 V	0			-1	
		0	5.5 V			5	
$I_{CCA} + I_{CCB}$	Supply current, A port plus B port supply current $V_I = V_O = \text{Open}$, $I_O = 0$	1.65 V to V_{CCB}	2.3 to 5.5 V			25	μA
$C_{I(OE)}$	Input capacitance, OE $T_A = 25^\circ C$	3.3 V	3.3 V			4	pF
						2.5	
$C_{IO(Ax)}$	Input-output capacitance, A port $T_A = 25^\circ C$	3.3 V	3.3 V			6.5	pF
						5	
$C_{IO(Bx)}$	Input-output capacitance, B port $T_A = 25^\circ C$	3.3 V	3.3 V			16.5	pF
						12	

(1) V_{CCA} must be less than or equal to V_{CCB} , and V_{CCA} must not exceed 3.6 V.

6.6 Timing Requirements— $V_{CCA} = 1.8\text{ V} \pm 0.15\text{ V}$

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

			MIN	MAX	UNIT
Data rate	Push-pull driving	$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$		18	Mbps
		$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$		21	
		$V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$		23	
	Open-drain driving	$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$		2	
		$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$		2	
		$V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$		2	
t_w Pulse duration, data inputs See Figure 7	Push-pull driving	$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$	55		ns
		$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$	47		
		$V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$	43		
	Open-drain driving	$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$	500		
		$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$	500		
		$V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$	500		

6.7 Timing Requirements— $V_{CCA} = 2.5\text{ V} \pm 0.2\text{ V}$

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

			MIN	MAX	UNIT
Data rate	Push-pull driving	$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$		20	Mbps
		$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$		22	
		$V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$		24	
	Open-drain driving	$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$		2	
		$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$		2	
		$V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$		2	
t_w Pulse duration, data inputs See Figure 7	Push-pull driving	$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$	50		ns
		$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$	45		
		$V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$	41		
	Open-drain driving	$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$	500		
		$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$	500		
		$V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$	500		

6.8 Timing Requirements— $V_{CCA} = 3.3\text{ V} \pm 0.3\text{ V}$

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

			MIN	MAX	UNIT
Data rate	Push-pull driving	$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$		22	Mbps
		$V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$		24	
	Open-drain driving	$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$		2	
		$V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$		2	
t_w Pulse duration, Data inputs See Figure 7	Push-pull driving	$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$	45		ns
		$V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$	41		
	Open-drain driving	$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$	500		
		$V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$	500		

6.9 Switching Characteristics— $V_{CCB} = 1.8 \text{ V} \pm 0.15 \text{ V}$

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

PARAMETER		TEST CONDITIONS		MIN	MAX	UNIT
$t_{PHL(A-B)}$	Propagation delay time (high to low), from A (input) to B (output) See Figure 8	Push-pull driving	$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		6	ns
			$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		5.8	
			$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		5.8	
	Open-drain driving		$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		8.8	
			$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		9.6	
			$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		10	
$t_{PHL(B-A)}$	Propagation delay time (high to low), from B (input) to A (output) See Figure 8	Push-pull driving	$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		4.4	ns
			$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		4.5	
			$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		4.7	
	Open-drain driving		$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		5.3	
			$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		4.4	
			$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		4	
$t_{PLH(A-B)}$	Propagation delay time (low to high), from A (input) to B (output) See Figure 8	Push-pull driving	$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		7.7	ns
			$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		6.8	
			$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		7	
	Open-drain driving		$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		50	
			$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		26	
			$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		33	
$t_{PLH(B-A)}$	Propagation delay time (low to high), from B (input) to A (output) See Figure 8	Push-pull driving	$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		5.3	ns
			$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		4.5	
			$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		0.5	
	Open-drain driving		$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		36	
			$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		16	
			$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		20	
$t_{en(OE-A)}$ $t_{en(OE-B)}$	Enable time, from OE (input) to A or B (output)	$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$			200	ns
		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$			200	
		$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$			200	
$t_{dis(OE-A)}$ $t_{dis(OE-B)}$	Disable time, from OE (input) to A or B (output)	$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$			200	ns
		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$			200	
		$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$			200	
$t_{r(Ax)}$	Rise time, A port	Push-pull driving	$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		9.5	ns
			$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		9.3	
			$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		15	
	Open-drain driving		$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$	38	199	
			$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$	30	150	
			$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$	22	109	
$t_{r(Bx)}$	Rise time, B port	Push-pull driving	$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		10.8	ns
			$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		9.1	
			$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		7.6	
	Open-drain driving		$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$	34	186	
			$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$	23	112	
			$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$	10	58	

Switching Characteristics— $V_{CCA} = 1.8 \text{ V} \pm 0.15 \text{ V}$ (continued)

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

PARAMETER	TEST CONDITIONS		MIN	MAX	UNIT
$t_{f(Ax)}$ Fall time, A port	Push-pull driving	$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		5.9	ns
		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		6	
		$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		13.3	
	Open-drain driving	$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		6.9	
		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		6.4	
		$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		6.1	
$t_{f(Bx)}$ Fall time, B port	Push-pull driving	$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		7.6	
		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		7.5	
		$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		8.8	
	Open-drain driving	$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		13.8	
		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		16.2	
		$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		16.2	
t_{sk} Channel-to-channel skew	$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$			1	ns
	$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$			1	
	$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$			1	
Maximum data rate	Push-pull driving	$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		18	Mbps
		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		21	
		$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		23	
	Open-drain driving	$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		2	
		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		2	
		$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		2	

6.10 Switching Characteristics— $V_{CCA} = 2.5 \text{ V} \pm 0.2 \text{ V}$

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

PARAMETER	TEST CONDITIONS		MIN	MAX	UNIT
$t_{PHL(A-B)}$ Propagation delay time (high to low), from A (input) to B (output) See Figure 8	Push-pull driving	$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		3.2	ns
		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		3.3	
		$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		3.4	
	Open-drain driving	$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		6.3	
		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		6	
		$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		5.8	
$t_{PHL(B-A)}$ Propagation delay time (high to low), from B (input) to A (output) See Figure 8	Push-pull driving	$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		3	
		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		3.6	
		$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		4.3	
	Open-drain driving	$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		4.7	
		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		4.2	
		$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		4	
$t_{PLH(A-B)}$ Propagation delay time (low to high), from A (input) to B (output) See Figure 8	Push-pull driving	$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		3.5	ns
		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		4.1	
		$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		4.4	
	Open-drain driving	$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		3.5	
		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		4.1	
		$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		4.4	
$t_{PLH(B-A)}$ Propagation delay time (low to high), from B (input) to A (output) See Figure 8	Push-pull driving	$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		2.5	
		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		1.6	
		$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		0.7	
	Open-drain driving	$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		2.5	
		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		1.6	
		$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		1	

Switching Characteristics— $V_{CCA} = 2.5\text{ V} \pm 0.2\text{ V}$ (continued)

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

PARAMETER		TEST CONDITIONS		MIN	MAX	UNIT
$t_{\text{en}}(\text{OE-A})$ $t_{\text{en}}(\text{OE-B})$	Enable time, from OE (input) to A or B (output)	$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$			200	ns
		$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$			200	
		$V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$			200	
$t_{\text{dis}}(\text{OE-A})$ $t_{\text{dis}}(\text{OE-B})$	Disable time, from OE (input) to A or B (output)	$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$			200	ns
		$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$			200	
		$V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$			200	
$t_{\text{r(Ax)}}$	Rise time, A port	Push-pull driving	$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$		7.4	ns
			$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$		6.6	
			$V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$		5.6	
		Open-drain driving	$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$	34	180	
			$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$	28	150	
			$V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$	24	105	
$t_{\text{r(Bx)}}$	Rise time, B port	Push-pull driving	$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$		8.3	ns
			$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$		7.2	
			$V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$		6.1	
		Open-drain driving	$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$	35	170	
			$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$	24	120	
			$V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$	12	64	
$t_{\text{f(Ax)}}$	Fall time, A port	Push-pull driving	$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$		5.7	ns
			$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$		5.5	
			$V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$		5.3	
		Open-drain driving	$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$			
			$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$			
			$V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$		5.8	
$t_{\text{f(Bx)}}$	Fall time, B port	Push-pull driving	$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$		7.8	ns
			$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$		6.7	
			$V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$		6.6	
		Open-drain driving	$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$		8.8	
			$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$		9.4	
			$V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$		10.4	
t_{sk}	Channel-to-channel skew	$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$			1	ns
		$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$			1	
		$V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$			1	
Maximum data rate	Push-pull driving	$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$		20		Mbps
		$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$		22		
		$V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$		24		
	Open-drain driving	$V_{CCB} = 2.5\text{ V} \pm 0.2\text{ V}$		2		
		$V_{CCB} = 3.3\text{ V} \pm 0.3\text{ V}$		2		
		$V_{CCB} = 5\text{ V} \pm 0.5\text{ V}$		2		

6.11 Switching Characteristics— $V_{CCA} = 3.3 \text{ V} \pm 0.3 \text{ V}$

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

PARAMETER		TEST CONDITIONS		MIN	MAX	UNIT
$t_{PHL(A-B)}$	Propagation delay time (high to low), from A (input) to B (output) See Figure 8	Push-pull driving	$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		2.4	ns
			$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		3.1	
		Open-drain driving	$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		4.2	
			$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		4.6	
$t_{PHL(B-A)}$	Propagation delay time (high to low), from B (input) to A (output) See Figure 8	Push-pull driving	$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		2.5	ns
			$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		3.3	
		Open-drain driving	$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		124	
			$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		97	
$t_{PLH(A-B)}$	Propagation delay time (low to high), from A (input) to B (output) See Figure 8	Push-pull driving	$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		4.2	ns
			$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		4.4	
		Open-drain driving	$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		4.2	
			$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		4.4	
$t_{PLH(B-A)}$	Propagation delay time (low to high), from B (input) to A (output) See Figure 8	Push-pull driving	$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		2.5	ns
			$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		2.6	
		Open-drain driving	$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		2.5	
			$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		3.3	
$t_{en(OE-A)}$ $t_{en(OE-B)}$	Enable time, from OE (input) to A or B (output)	$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$			200	ns
		$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$			200	
$t_{dis(OE-A)}$ $t_{dis(OE-B)}$	Disable time, from OE (input) to A or B (output)	$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$			200	ns
		$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$			200	
$t_{r(Ax)}$	Rise time, A port	Push-pull driving	$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		5.6	ns
			$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		5	
		Open-drain driving	$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$	25	140	
			$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$	19	102	
$t_{r(Bx)}$	Rise time, B port	Push-pull driving	$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		6.4	ns
			$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		7.4	
		Open-drain driving	$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$	26	130	
			$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$	14	75	
$t_{f(Ax)}$	Fall time, A port	Push-pull driving	$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		5.4	ns
			$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		5	
		Open-drain driving	$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		6.1	
			$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		5.7	
$t_{f(Bx)}$	Fall time, B port	Push-pull driving	$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		7.4	ns
			$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		7.6	
		Open-drain driving	$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		7.6	
			$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		8.3	
t_{sk}	Channel-to-channel skew	$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$			1	ns
		$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$			1	
Maximum data rate	Push-pull driving	$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		22		Mbps
		$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		24		
	Open-drain driving	$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		2		
		$V_{CCB} = 5 \text{ V} \pm 0.5 \text{ V}$		2		

6.12 Typical Characteristics

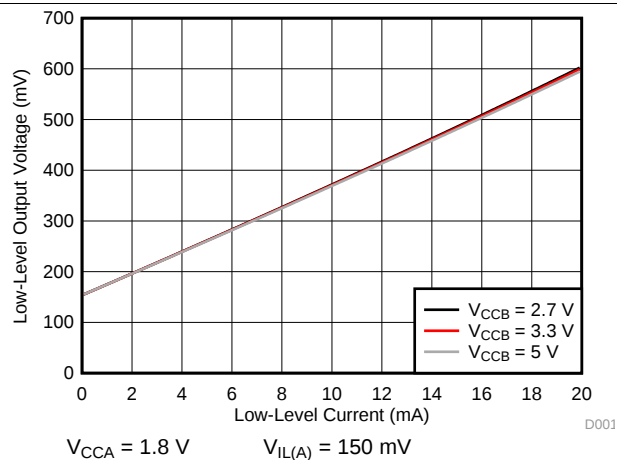


Figure 1. Low-Level Output Voltage ($V_{OL(Ax)}$) vs Low-Level Current ($I_{OL(Ax)}$)

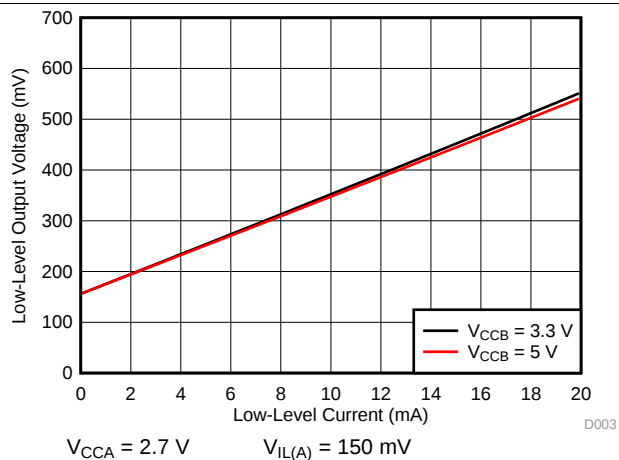


Figure 2. Low-Level Output Voltage ($V_{OL(Ax)}$) vs Low-Level Current ($I_{OL(Ax)}$)

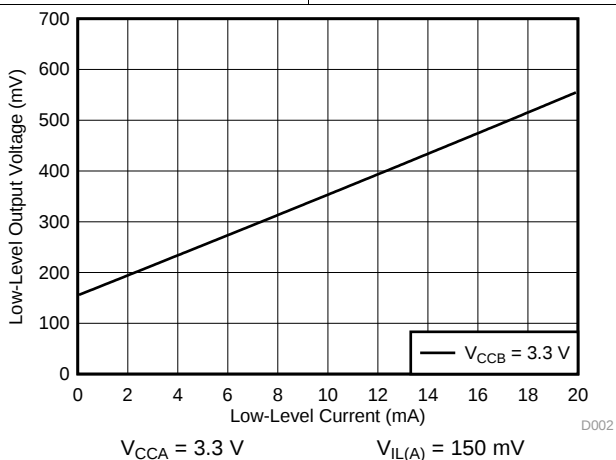


Figure 3. Low-Level Output Voltage ($V_{OL(Ax)}$) vs Low-Level Current ($I_{OL(Ax)}$)

7 Parameter Measurement Information

7.1 Load Circuits

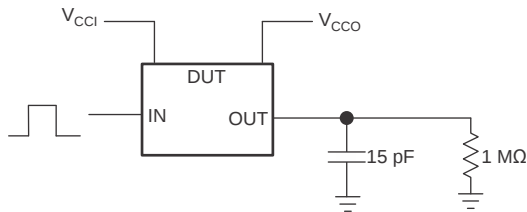


Figure 4. Data Rate, Pulse Duration, Propagation Delay, Output Rise-Time and Fall-Time Measurement Using a Push-Pull Driver

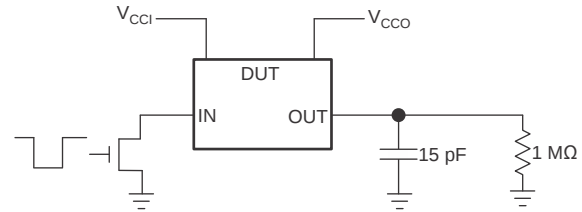
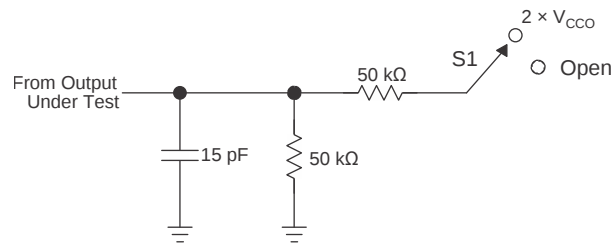


Figure 5. Data Rate, Pulse Duration, Propagation Delay, Output Rise-Time and Fall-Time Measurement Using an Open-Drain Driver



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

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

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.

7.2 Voltage Waveforms

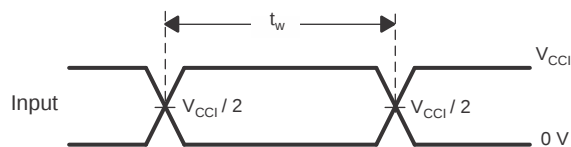


Figure 7. Pulse Duration

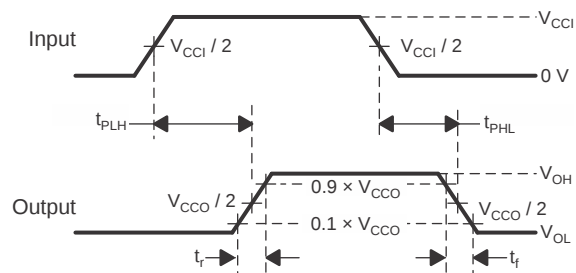


Figure 8. Propagation Delay Times

1. C_L includes probe and jig capacitance.
2. Waveform 1 in Figure 9 is for an output with internal such that the output is high, except when OE is high (see Figure 6). Waveform 2 in Figure 9 is for an output with conditions such that the output is low, except when OE is high.
3. 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.
4. The outputs are measured one at a time, with one transition per measurement.
5. t_{PLZ} and t_{PHZ} are the same as t_{dis} .
6. t_{PZL} and t_{PZH} are the same as t_{en} .
7. t_{PLH} and t_{PHL} are the same as t_{pd} .
8. V_{CCI} is the V_{CC} associated with the input port.
9. V_{CCO} is the V_{CC} associated with the output port.

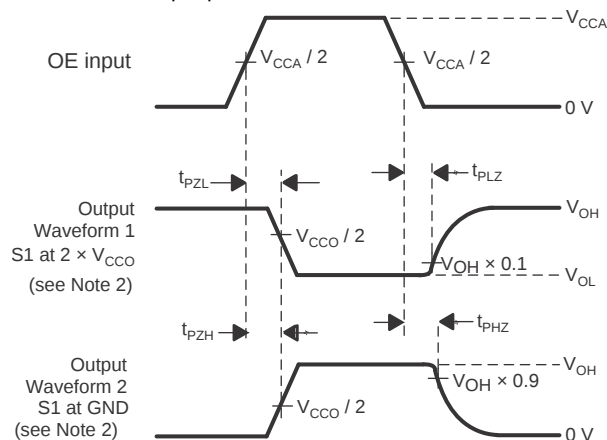


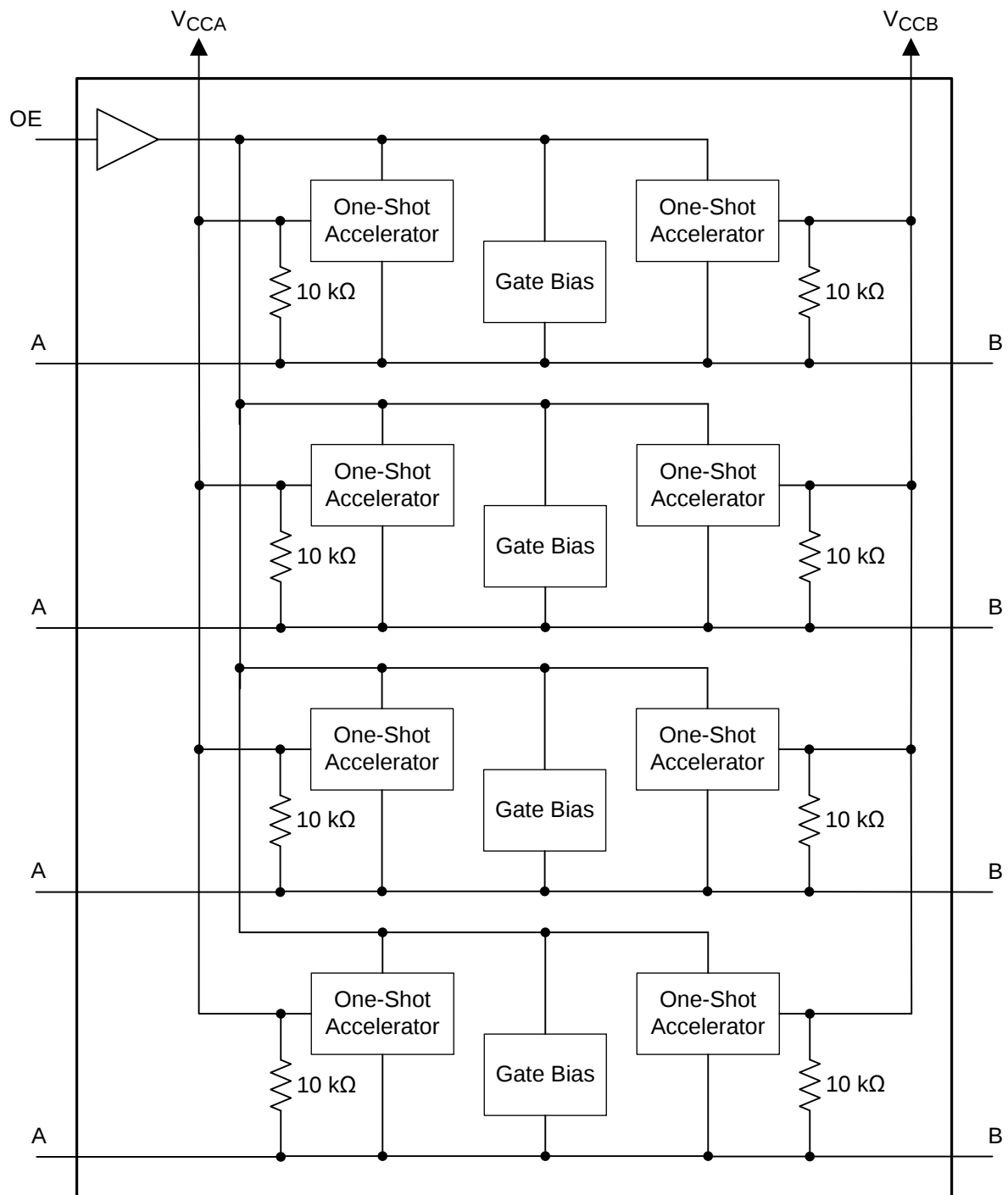
Figure 9. Enable and Disable Times

8 Detailed Description

8.1 Overview

The TXS0104E-Q1 device is a directionless voltage-level translator specifically designed for translating logic voltage levels. The A port is able to accept I/O voltages ranging from 1.65 V to 3.6 V, while the B port can accept I/O voltages from 2.3 V to 5.5 V. The device is a pass gate architecture with edge rate accelerators (one shots) to improve the overall data rate. 10-k 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.

8.2 Functional Block Diagram



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8.3 Feature Description

8.3.1 Architecture

The TXS0104E-Q1 architecture (see [Figure 10](#)) does not require a direction-control signal in order to control the direction of data flow from A to B or from B to A.

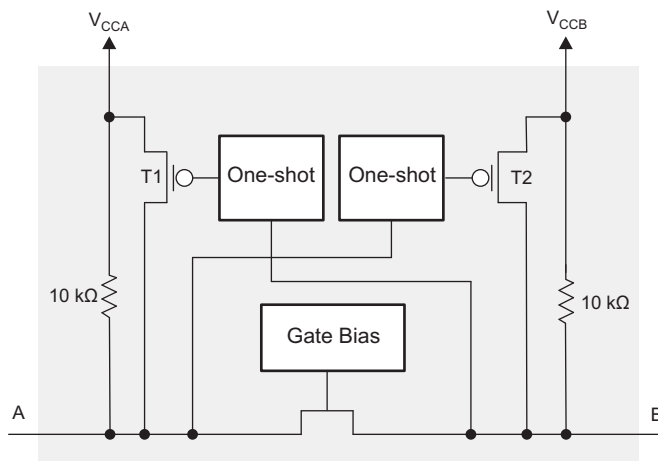


Figure 10. Architecture of a TXS01xx Cell

Each A-port I/O has an internal 10-kΩ pullup resistor to V_{CCA} , and each B-port I/O has an internal 10-kΩ 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, T2) for a short duration which speeds up the low-to-high transition.

8.3.2 Input Driver Requirements

The fall time (t_{fA} , t_{fB}) of a signal depends on the output impedance of the external device driving the data I/Os of the TXS0104E-Q1 device. 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 50 Ω.

8.3.3 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.

8.3.4 Enable and Disable

The TXS0104E-Q1 device has an OE input that disables the device by setting OE low, which places all I/Os in the high-impedance state. The disable time (t_{dis}) indicates the delay between the time when the OE pin goes low and when the outputs actually enter the high-impedance state. The enable time (t_{en}) indicates the amount of time the user must allow for the one-shot circuitry to become operational after the OE pin is taken high.

8.3.5 Pullup and Pulldown Resistors on I/O Lines

Each A-port I/O has an internal 10-kΩ pullup resistor to V_{CCA} , and each B-port I/O has an internal 10-kΩ 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 10-kΩ resistors).

8.4 Device Functional Modes

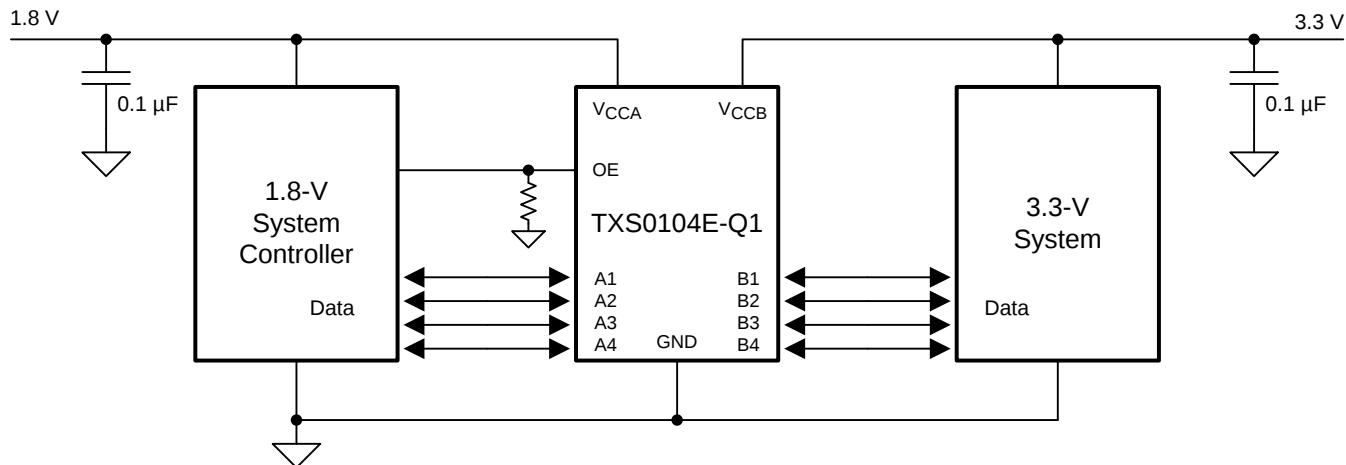
The TXS0104E-Q1 device has two functional modes, enabled and disabled. To disable the device set the OE input low, which places all I/Os in a high impedance state. Setting the OE input high will enable the device.

9 Application and Implementation

9.1 Application Information

The TXS0104E-Q1 device can be used in level-translation applications for interfacing devices or systems operating at different interface voltages with one another. The TXS0104E-Q1 device is ideal for use in applications where an open-drain driver is connected to the data I/Os. The TXS0104E-Q1 device can also be used in applications where a push-pull driver is connected to the data I/Os, but the TXB0104-Q1 device might be a better option for such push-pull applications.

9.2 Typical Application



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Figure 11. Application Schematic

9.2.1 Design Requirements

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

Table 1. Design Parameters

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

9.2.2 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 TXS0104E-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 TXS0104E-Q1 device is driving to determine the output voltage range.
 - The TXS0104E-Q1 device has 10-k Ω internal pullup resistors. External pullup resistors can be added to reduce the total RC of a signal trace if necessary.

- An external pulldown 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.

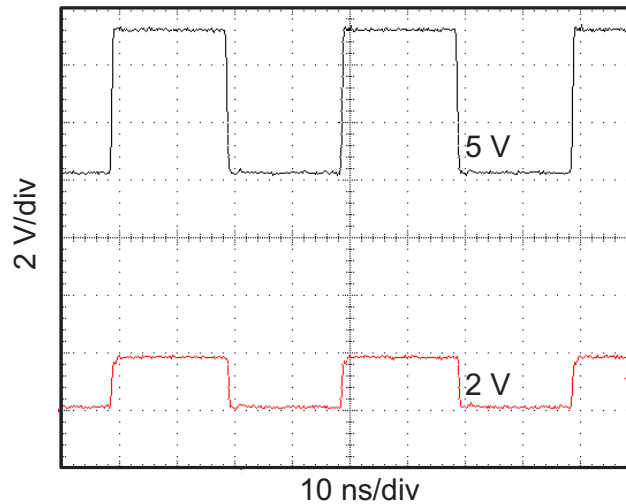
$$V_{OH} = V_{CCX} \times R_{PD} / (R_{PD} + 10 \text{ k}\Omega)$$

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

(1)

9.2.3 Application Curve



$$V_{CCA} = 1.8 \text{ V}$$

$$V_{CCB} = 5 \text{ V}$$

Figure 12. Level-Translation of a 2.5-MHz Signal

10 Power Supply Recommendations

The TXS0104E-Q1 device uses two separate configurable power-supply rails, V_{CCA} and V_{CCB} . V_{CCB} accepts any supply voltage from 2.3 V to 5.5 V and V_{CCA} accepts any supply voltage from 1.65 V to 3.6 V as long as V_S is less than or equal to V_{CCB} . 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 1.8-V, 2.5-V, 3.3-V, and 5-V voltage nodes.

The TXS0104E-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, 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 ensure the high-impedance state of the outputs 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 minimum value of the pulldown resistor to ground is determined by the current-sourcing capability of the driver.

11 Layout

11.1 Layout Guidelines

To ensure reliability of the device, following common printed-circuit board layout guidelines is recommended.

- 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 30 ns, ensuring that any reflection encounters 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

11.2 Layout Example

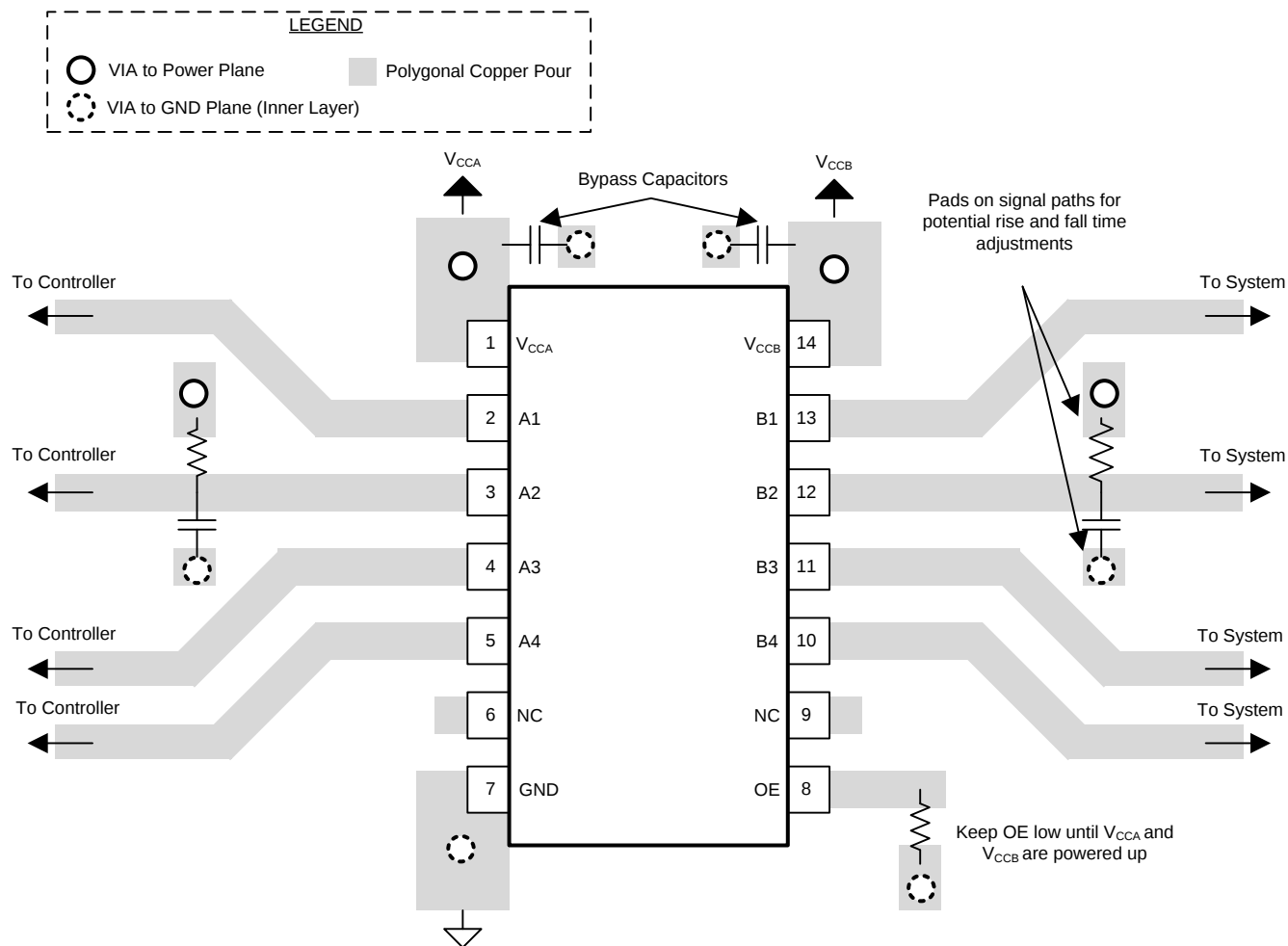


Figure 13. TXS0104E-Q1 Layout Example

12 器件和文档支持

12.1 文档支持

12.1.1 相关文档

相关文档如下：

[《逻辑器件简介》](#)

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12.6 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

13 机械、封装和可订购信息

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Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TXS0104EQPWRQ1	ACTIVE	TSSOP	PW	14	2000	RoHS & Green	NIPDAU	Level-3-260C-168 HR	-40 to 125	04EQ1	Samples

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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
TXS0104EQPWRQ1	TSSOP	PW	14	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS

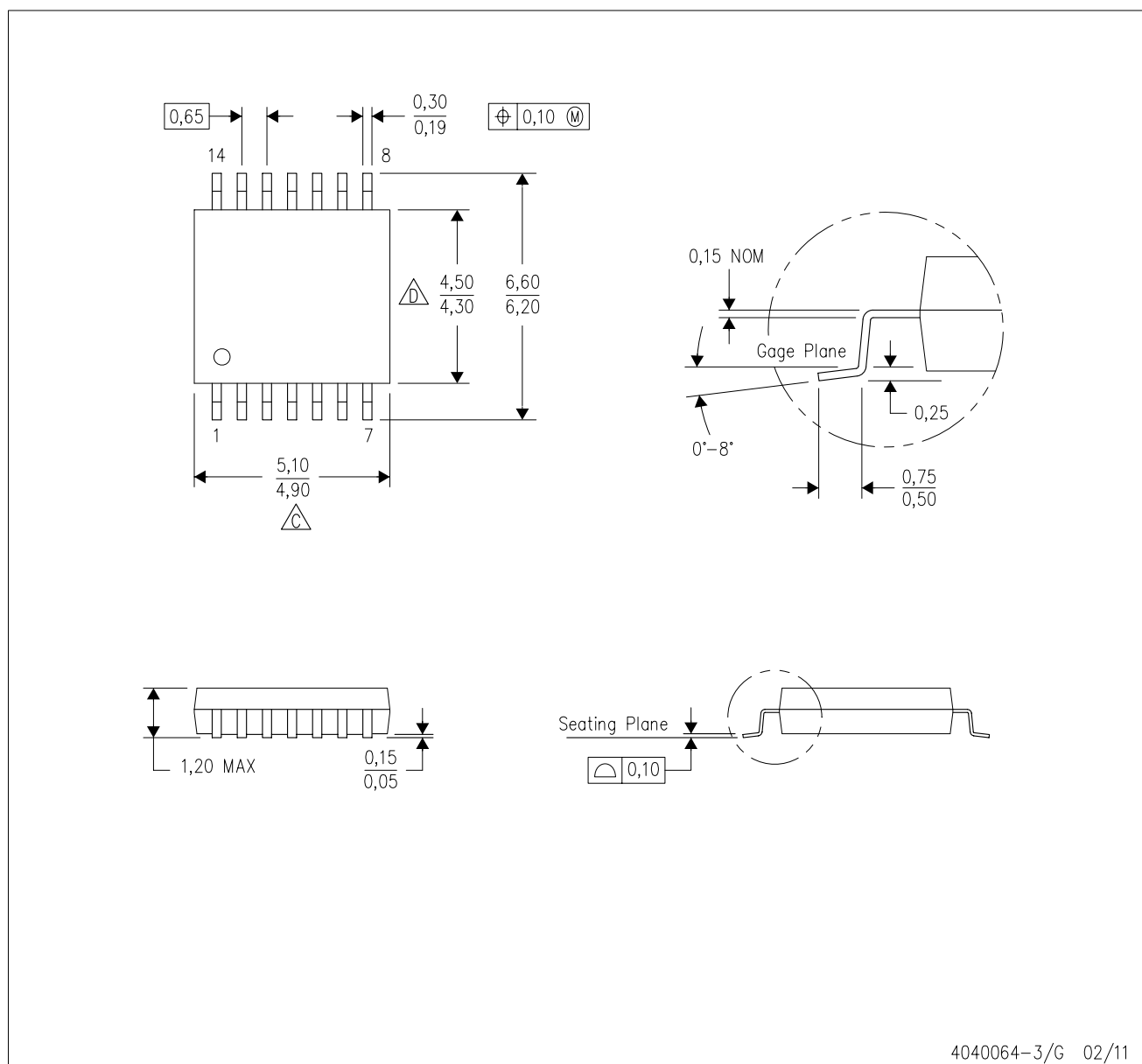


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TXS0104EQPWRQ1	TSSOP	PW	14	2000	853.0	449.0	35.0

PW (R-PDSO-G14)

PLASTIC SMALL OUTLINE



4040064-3/G 02/11

- 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.
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 - E. Falls within JEDEC MO-153

PW (R-PDSO-G14)

PLASTIC SMALL OUTLINE



- NOTES:
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 - This drawing is subject to change without notice.
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 - 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 other stencil recommendations.
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