

## SDIO PORT EXPANDER WITH VOLTAGE-LEVEL TRANSLATION

### FEATURES

- 6-to-12 Demultiplexer/Multiplexer Allows SDIO Port Expansion
- Built-in Level Translator Eliminates Voltage Mismatch Between Baseband and SD Card or SDIO Peripheral
- $V_{CCA}$ ,  $V_{CCB0}$ , and  $V_{CCB1}$  Each Operate Over Full 1.1-V to 3.6-V Range
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II
- ESD Performance A Port
  - 2000-V Human-Body Model (A114-B)
  - 100-V Machine Model (A115-A)
  - 1500-V Charged-Device Model (C101)
- $\pm 8$ -kV Contact Discharge IEC 61000-4-2 ESD Performance (B Port)

### DESCRIPTION/ORDERING INFORMATION

The TXS02612 is designed to interface the cell phone baseband with external SDIO peripherals. The device includes a 6-channel SPDT switch with voltage-level translation capability. This allows a single SDIO port to be interfaced with two SDIO peripherals. The TXS02612 has three separate supply rails that operate over the full range of 1.1 V to 3.6 V. This allows the baseband and SDIO peripherals to operate at different supply voltages if required.

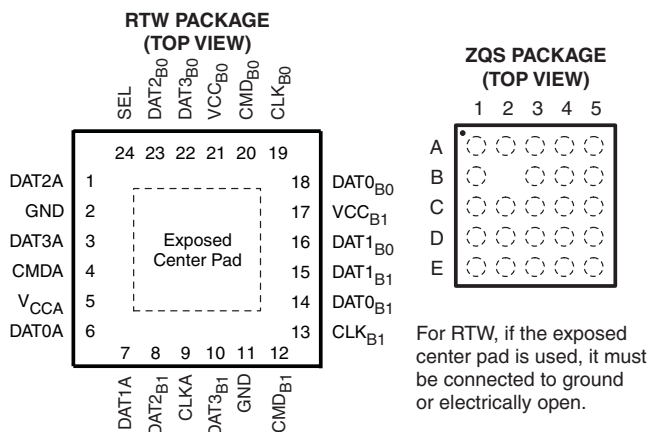
The select (SEL) input is used to choose between the B0 port and B1 port. When SEL = Low, B0 port is selected; when SEL = High, B1 port is selected. SEL is referenced to  $V_{CCA}$ . For the unselected B port, the clock output is held low, whereas the data and command I/Os are pulled high to their respective  $V_{CCB}$  through a 70-k $\Omega$  resistor ( $\pm 30\%$  tolerance).

#### ORDERING INFORMATION<sup>(1)</sup>

$T_A$	PACKAGE <sup>(2)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	MicroStar Junior™ BGA (VFBGA) – ZQS	Reel of 3000	TXS02612ZQSR	YJ612
	QFN – RTW	Reel of 3000	TXS02612RTWR	YJ612

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at [www.ti.com](http://www.ti.com).

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



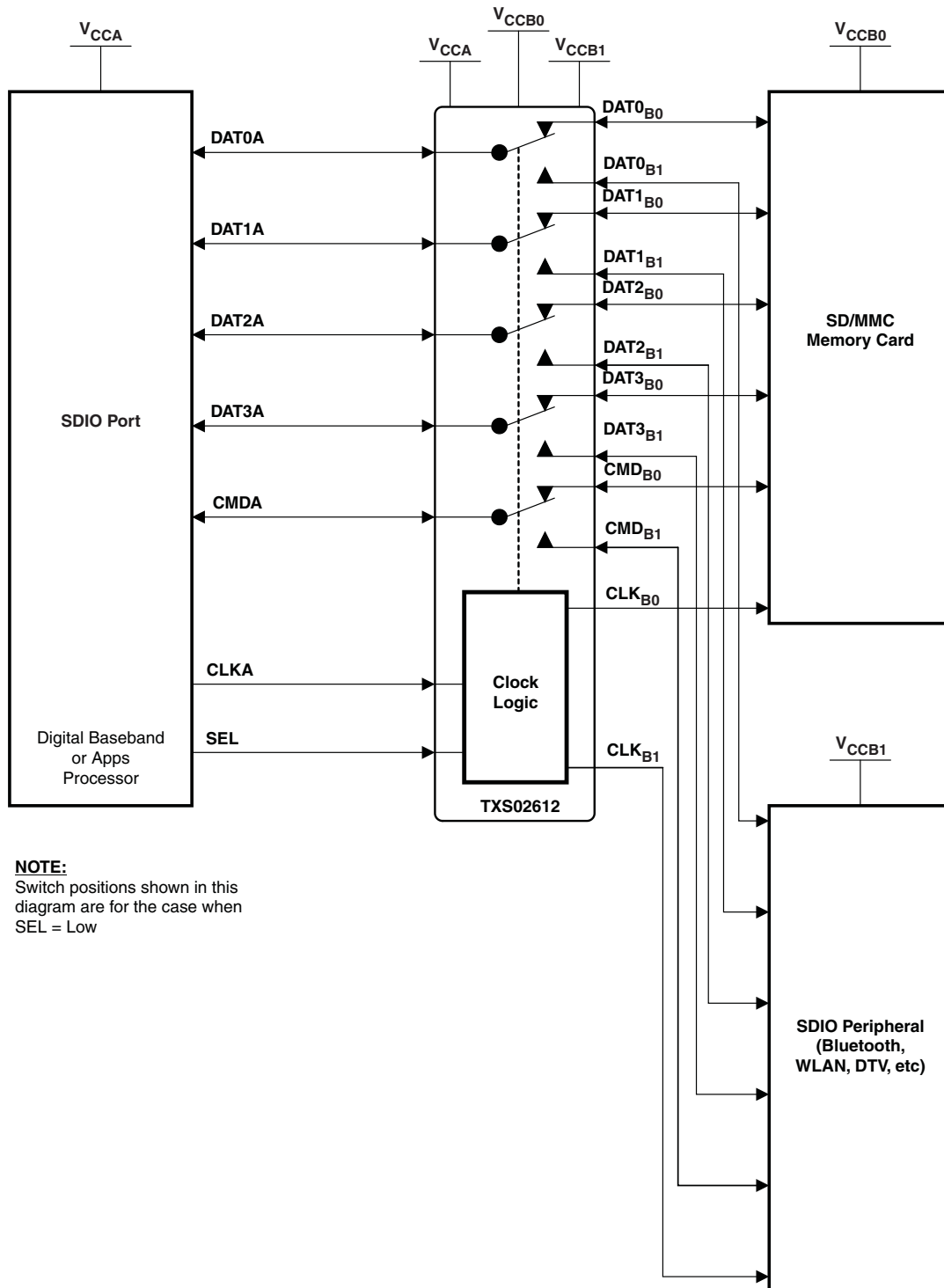
**Table 1. ZQS PACKAGE TERMINAL ASSIGNMENTS**

	1	2	3	4	5
A	DAT2A	SEL	DAT3 <sub>B0</sub>	CMD <sub>B0</sub>	CLK <sub>B0</sub>
B	DAT3A		DAT2 <sub>B0</sub>	$V_{CCB0}$	DAT0 <sub>B0</sub>
C	CMDA	$V_{CCA}$	GND	$V_{CC B1}$	DAT1 <sub>B0</sub>
D	DAT0A	CLKA	GND	DAT1 <sub>B1</sub>	DAT0 <sub>B1</sub>
E	DAT1A	DAT2 <sub>B1</sub>	DAT3 <sub>B1</sub>	CMD <sub>B1</sub>	CLK <sub>B1</sub>



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

**APPLICATION BLOCK DIAGRAM**

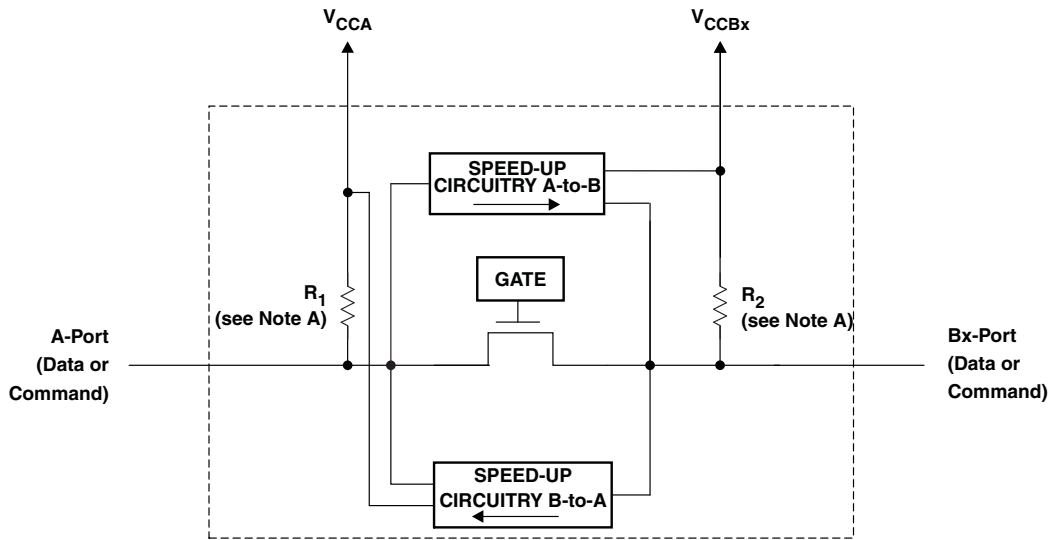


**NOTE:**  
Switch positions shown in this diagram are for the case when  $SEL = Low$

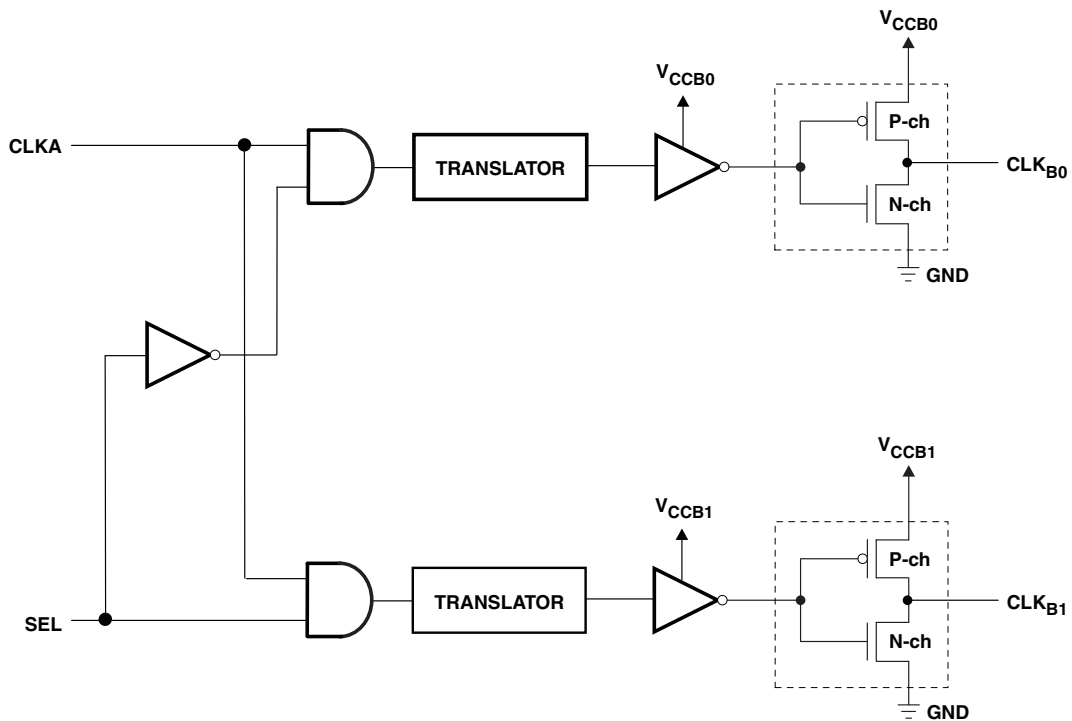
**PIN ASSIGNMENTS**

RTW PACKAGE PIN NO.	ZQS PACKAGE BALL NO.	NAME	FUNCTION	TYPE
1	A1	DAT2A	Data bit 2. Referenced to $V_{CCA}$ .	I/O
3	B1	DAT3A	Data bit 3. Referenced to $V_{CCA}$ .	I/O
4	C1	CMDA	Command bit. Referenced to $V_{CCA}$ .	I/O
6	D1	DAT0A	Data bit 0. Referenced to $V_{CCA}$ .	I/O
7	E1	DAT1A	Data bit 1. Referenced to $V_{CCA}$ .	I/O
24	A2	SEL	Select pin to choose between B0 and B1. Referenced to $V_{CCA}$ .	Input
	B2		Depopulated	
5	C2	$V_{CCA}$	A-port supply voltage. $1.1\text{ V} \leq V_{CCA} \leq 3.6\text{ V}$ .	Power
9	D2	CLKA	Clock input A. Referenced to $V_{CCA}$ .	Input
8	E2	DAT2 <sub>B1</sub>	Data bit 2. Referenced to $V_{CCB1}$ .	I/O
22	A3	DAT3 <sub>B0</sub>	Data bit 3. Referenced to $V_{CCB0}$ .	I/O
23	B3	DAT2 <sub>B0</sub>	Data bit 2. Referenced to $V_{CCB0}$ .	I/O
2	C3	GND	Ground	
11	D3	GND	Ground	
10	E3	DAT3 <sub>B1</sub>	Data bit 3. Referenced to $V_{CCB1}$ .	I/O
20	A4	CMD <sub>B0</sub>	Command bit. Referenced to $V_{CCB0}$ .	I/O
21	B4	$V_{CCB0}$	B0-port supply voltage. $1.1\text{ V} \leq V_{CCB0} \leq 3.6\text{ V}$ .	Power
17	C4	$V_{CCB1}$	B1-port supply voltage. $1.1\text{ V} \leq V_{CCB1} \leq 3.6\text{ V}$ .	Power
15	D4	DAT1 <sub>B1</sub>	Data bit 1. Referenced to $V_{CCB1}$ .	I/O
12	E4	CMD <sub>B1</sub>	Command bit. Referenced to $V_{CCB1}$ .	I/O
19	A5	CLK <sub>B0</sub>	Clock output. Referenced to $V_{CCB0}$ .	Output
18	B5	DAT0 <sub>B0</sub>	Data bit 0. Referenced to $V_{CCB0}$ .	I/O
16	C5	DAT1 <sub>B0</sub>	Data bit 1. Referenced to $V_{CCB0}$ .	I/O
14	D5	DAT0 <sub>B1</sub>	Data bit 0. Referenced to $V_{CCB1}$ .	I/O
13	E5	CLK <sub>B1</sub>	Clock output. Referenced to $V_{CCB1}$ .	Output

**SIMPLIFIED INTERNAL STRUCTURE**



Simplified Architecture of Command and Each Data Path



Simplified Architecture of the Clock Path

- A.  $R_1$  and  $R_2$  resistor values are determined based upon the logic level applied to the A port or B port, as follows:  
 $R_1$  and  $R_2 = 40\text{ k}\Omega$  when a logic level low is applied to the A port or B port.  
 $R_1$  and  $R_2 = 4\text{ k}\Omega$  when a logic level high is applied to the A port or B port.  
 $R_1$  and  $R_2 = 70\text{ k}\Omega$  when the port is deselected.

**FUNCTION TABLE**

Clock Channel			
SEL	CLKB0	CLKB1	OPERATION
L	Active	Low	CLKA to CLKB0
H	Low	Active	CLKA to CLKB1
Data and Command Channel			
SEL	DATxB0 or CMDxB0	DATxB1 or CMDxB1	OPERATION
L	Active	Disabled, pulled to $V_{CCB1}$ through 70 k $\Omega$	DATxA to DATxB0, CMDA to CMDB0
H	Disabled, pulled to $V_{CCB0}$ through 70 k $\Omega$	Active	DATxA to DATxB1, CMDA to CMDB1

**ABSOLUTE MAXIMUM RATINGS<sup>(1) (2)</sup>**

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

		MIN	MAX	UNIT
$V_{CCA}$ $V_{CCB0}$ $V_{CCB1}$	Supply voltage range <sup>(2)</sup>	-0.5	4.6	V
$V_I$	Input voltage range	-0.5	$V_{CCx} + 0.5$	V
$V_O$	Voltage range applied to any output in the high-impedance or power-off state	-0.5	$V_{CCx} + 0.5$	V
$I_{IK}$	Input clamp current	$V_I < 0$	-50	mA
$I_{OK}$	Output clamp current	$V_O < 0$	-50	mA
$I_{CC}/$ $I_{GND}$	Continuous current through $V_{CCA}$ , $V_{CCB0}$ , $V_{CCB1}$ , or GND		$\pm 100$	mA
$T_{stg}$	Storage temperature range	-65	150	$^{\circ}\text{C}$

- (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 voltage ratings may be exceeded if the input and output clamp-current ratings are observed.

**PACKAGE THERMAL IMPEDANCE**

PARAMETER			UNIT
$\theta_{JA}$	Package thermal impedance	RTW package	66
		ZQS package	171.6

## RECOMMENDED OPERATING CONDITIONS

		V <sub>CCA</sub>	V <sub>CCBx</sub> <sup>(1)</sup>	MIN	MAX	UNIT	
V <sub>CCA</sub> V <sub>CCB0</sub> V <sub>CCB1</sub>	Supply voltage			1.1	3.6	V	
V <sub>IH</sub>	High-level input voltage	A-port I/Os	1.1 V to 3.6 V	1.1 V to 3.6 V	V <sub>CCI</sub> – 0.2	V <sub>CCI</sub>	V
		B-port I/Os			V <sub>CCI</sub> – 0.2	V <sub>CCI</sub>	
		SEL, CLKA			V <sub>CCA</sub> × 0.65 V	3.6	
V <sub>IL</sub>	Low-level input voltage	A-port I/Os	1.1 V to 3.6 V	1.1 V to 3.6 V	0	0.15	V
		B-port I/Os			0	0.15	
		SEL, CLKA			0	V <sub>CCA</sub> × 0.35	
Δt/Δv	Input transition rise or fall rate	CLK, SEL			10	ns/V	
T <sub>A</sub>	Operating free-air temperature			–40	85	°C	

(1) V<sub>CCBx</sub> refers to V<sub>CCB0</sub> and V<sub>CCB1</sub>.

## ELECTRICAL CHARACTERISTICS

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

PARAMETER	TEST CONDITIONS	V <sub>CCA</sub>	V <sub>CCBx</sub>	T <sub>A</sub> = 25°C	T <sub>A</sub> = –40°C to 85°C		UNIT
				TYP	MIN	MAX	
V <sub>OHA</sub> (DATA & CMD)	I <sub>OH</sub> = –20 μA, V <sub>IBx</sub> ≥ V <sub>CCBx</sub> – 0.2 V	1.1 V	1.1 V		0.74		V
		1.4 V	1.4 V		V <sub>CCA</sub> × 0.67		
		1.65 V	1.65 V		V <sub>CCA</sub> × 0.67		
		2.3 V	2.3 V		V <sub>CCA</sub> × 0.67		
		3 V	3 V		V <sub>CCA</sub> × 0.67		
V <sub>OLA</sub> (DATA & CMD)	I <sub>OL</sub> = 135 μA, V <sub>IBx</sub> ≤ 0.15 V	1.1 V	1.1 V		0.35		V
		1.4 V	1.4 V		0.35		
		1.65 V	1.65 V		0.45		
		2.3 V	2.3 V		0.55		
		3 V	3 V		0.70		
V <sub>OHB</sub> (DATA & CMD)	I <sub>OH</sub> = –20 μA, V <sub>IAX</sub> ≥ V <sub>CCAx</sub> – 0.2 V	1.1 V	1.1 V		0.74		V
		1.4 V	1.4 V		V <sub>CCBx</sub> × 0.67		
		1.65 V	1.65 V		V <sub>CCBx</sub> × 0.67		
		2.3 V	2.3 V		V <sub>CCBx</sub> × 0.67		
		3 V	3 V		V <sub>CCBx</sub> × 0.67		
V <sub>OHCLKB</sub>	I <sub>OH</sub> = –0.5 mA	1.1 V	1.1 V		0.74		V
		1.4 V	1.4 V		1.05		
		1.65 V	1.65 V		1.2		
		2.3 V	2.3 V		1.75		
		3 V	3 V		2.3		
V <sub>OLB</sub> (DATA & CMD)	I <sub>OL</sub> = 135 μA, V <sub>IAX</sub> ≤ 0.15 V	1.1 V	1.1 V		0.35		V
		1.4 V	1.4 V		0.35		
		1.65 V	1.65 V		0.45		
		2.3 V	2.3 V		0.55		
		3 V	3 V		0.70		
V <sub>OLCLKB</sub>	I <sub>OL</sub> = 0.5 mA	1.1 V	1.1 V		0.35		V
		1.4 V	1.4 V		0.35		
		1.65 V	1.65 V		0.45		
		2.3 V	2.3 V		0.55		
		3 V	3 V		0.7		

**ELECTRICAL CHARACTERISTICS (continued)**

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

PARAMETER	TEST CONDITIONS	V <sub>CCA</sub>	V <sub>CCBx</sub>	T <sub>A</sub> = 25°C	T <sub>A</sub> = -40°C to 85°C		UNIT
				TYP	MIN	MAX	
I <sub>I</sub>	SEL, CLKA	1.1 V to 3.6 V	1.1 V to 3.6 V	±1	±2		μA
	DAT, CMD			±1	±2		
I <sub>CCA</sub>	V <sub>I</sub> = V <sub>O</sub> = Open, I <sub>O</sub> = 0, SEL, CLK = High or Low	1.1 V to 3.6 V	1.1 V to 3.6 V		12		μA
		3.6 V	0 V		12		
		0 V	3.6 V		-1		
I <sub>CCB0</sub> or I <sub>CCB1</sub>	V <sub>I</sub> = V <sub>O</sub> = Open, I <sub>O</sub> = 0, SEL, CLK = High or Low	1.1 V to 3.6 V	1.1 V to 3.6 V		24		μA
		3.6 V	0 V		-12		
		0 V	3.6 V		24		
C <sub>i</sub>	SEL, CLKA	3.3 V	3.3 V	2.5	3.5		pF
C <sub>io</sub>	A port	3.3 V	3.3 V	7	7.5		pF
	B port			9.5	10		

**TIMING REQUIREMENTS**

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

			V <sub>CCB</sub> = 1.2 V	V <sub>CCB</sub> = 1.5 V	V <sub>CCB</sub> = 1.8 V	V <sub>CCB</sub> = 2.5 V	V <sub>CCB</sub> = 3.3 V	UNIT	
			TYP	TYP	TYP	TYP	TYP		
Data rate	Command	Push-pull driving	60	80	120	120	120	Mbps	
		Open-drain driving	2	2	2	2	2		
	Clock	Push-pull driving	30	40	60	60	60	MHz	
	Data	Push-pull driving	60	80	120	120	120	Mbps	
t <sub>w</sub>	Pulse duration	Push-pull driving	CLK	17	13	8	8	8	ns
		Open-drain driving	CMD	500	500	500	500	500	
	Push-pull driving	Data	17	13	8	8	8		
		CMD	17	13	8	8	8		

## TIMING REQUIREMENTS

over recommended operating free-air temperature range,  $V_{CCA} = 1.5 \text{ V} \pm 0.1 \text{ V}$  (unless otherwise noted)

			$V_{CCB} = 1.2 \text{ V}$	$V_{CCB} = 1.5 \text{ V} \pm 0.1 \text{ V}$		$V_{CCB} = 1.8 \text{ V} \pm 0.15 \text{ V}$		$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		UNIT
			TYP	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
Data rate	Command	Push-pull driving	60	80		120		120		120		Mbps
		Open-drain driving	2	2		2		2		2		
	Data	Push-pull driving	30	40		60		60		60		MHz
		Push-pull driving	60	80		120		120		120		
$t_w$	Pulse duration	Push-pull driving	17	13	8		8		8		ns	
		Open-drain driving	500	500	500		500		500			
		Push-pull driving	Data	17	13	8		8		8		
			CMD	17	13	8		8		8		

## TIMING REQUIREMENTS

over recommended operating free-air temperature range,  $V_{CCA} = 1.8 \text{ V} \pm 0.15 \text{ V}$  (unless otherwise noted)

			$V_{CCB} = 1.2 \text{ V}$	$V_{CCB} = 1.5 \text{ V} \pm 0.1 \text{ V}$		$V_{CCB} = 1.8 \text{ V} \pm 0.15 \text{ V}$		$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		UNIT
			TYP	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
Data rate	Command	Push-pull driving	60	80		120		120		120		Mbps
		Open-drain driving	2	2		2		2		2		
	Data	Push-pull driving	30	40		60		60		60		MHz
		Push-pull driving	60	80		120		120		120		
$t_w$	Pulse duration	Push-pull driving	17	13	8		8		8		ns	
		Open-drain driving	500	500	500		500		500			
		Push-pull driving	Data	17	13	8		8		8		
			CMD	17	13	8		8		8		



## TIMING REQUIREMENTS

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

			$V_{CCB} = 1.2 \text{ V}$	$V_{CCB} = 1.5 \text{ V} \pm 0.1 \text{ V}$		$V_{CCB} = 1.8 \text{ V} \pm 0.15 \text{ V}$		$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		UNIT
			TYP	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
Data rate	Command	Push-pull driving	60	80		120		120		120		Mbps
		Open-drain driving	2	2		2		2		2		
	Data	Push-pull driving	30	40		60		60		60		MHz
		Push-pull driving	60	80		120		120		120		
$t_w$	Pulse duration	Push-pull driving	17	13	8		8		8		ns	
		Open-drain driving	500	500	500		500		500			
		Push-pull driving	Data	17	13	8		8		8		
			CMD	17	13	8		8		8		

## TIMING REQUIREMENTS

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

			$V_{CCB} = 1.2 \text{ V}$	$V_{CCB} = 1.5 \text{ V} \pm 0.1 \text{ V}$		$V_{CCB} = 1.8 \text{ V} \pm 0.15 \text{ V}$		$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		UNIT
			TYP	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
Data rate	Command	Push-pull driving	60	80		120		120		120		Mbps
		Open-drain driving	2	2		2		2		2		
	Data	Push-pull driving	30	40		60		60		60		MHz
		Push-pull driving	60	80		120		120		120		
$t_w$	Pulse duration	Push-pull driving	17	13	8		8		8		ns	
		Open-drain driving	500	500	500		500		500			
		Push-pull driving	Data	17	13	8		8		8		
			CMD	17	13	8		8		8		

## SWITCHING CHARACTERISTICS

 $T_A = 25^\circ\text{C}$ ,  $V_{CCA} = 1.2\text{ V}$ 

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	$V_{CCB} = 1.2\text{ V}$	$V_{CCB} = 1.5\text{ V}$	$V_{CCB} = 1.8\text{ V}$	$V_{CCB} = 2.5\text{ V}$	$V_{CCB} = 3.3\text{ V}$	UNIT
				TYP	TYP	TYP	TYP	TYP	
$t_{PD}$	CMDA	CMDB	Push-pull driving	5.9	4.8	4.4	4	4.46	ns
			Open-drain driving	238	214	192	159	140	
	CMDB	CMDA	Push-pull driving	5.6	4.8	4.4	4.1	4	
			Open-drain driving	227	201	176	137	114	
	CLKA	CLKB	Push-pull driving	5.5	4.1	3.6	3.2	3	
	DATA	DATB	Push-pull driving	5.8	4.8	4.4	4.2	6.8	
	DATB	DATA		5.6	4.8	4.4	4.1	4	
SEL	B-Port	Push-pull driving	13	11	10	9.4	9.1		
$t_{rA}$	A-port rise time		Push-pull driving	4.8	5.1	5.1	5.3	5.7	ns
$t_{rB}$	B-port rise time		Push-pull driving	6.1	3.8	2.9	1.9	1.5	
$t_{rB}$	CLKA	CLKB	Push-pull driving	5.2	3.4	2.6	1.7	1.3	
$t_{fA}$	A-port fall time		Push-pull driving	3.4	2.8	2.6	2.6	2.6	
$t_{fB}$	B-port fall time		Push-pull driving	4.2	3	2.3	1.7	1.5	
$t_{fB}$	CLKA	CLKB	Push-pull driving	3.1	2.1	1.6	1.2	1	
$t_{sk(O)}$	ChA-to-ChB skew		Push-pull driving	0.4	0.4	0.3	0.4	0.4	ns
	ChB-to-ChA skew		Push-pull driving	0.3	0.3	0.3	0.3	0.4	
	Channel-to-Clock skew		Push-pull driving	1.68	1.5	1.5	1.5	1.7	
Max data rate	Command		Push-pull driving	60	80	120	120	120	Mbps
			Open-drain driving	2	2	2	2	2	
	Clock		Push-pull driving	30	40	60	60	60	MHz
	Data		Push-pull driving	60	80	120	120	120	Mbps

## SWITCHING CHARACTERISTICS

 over operating free-air temperature range,  $V_{CCA} = 1.5 \text{ V} \pm 0.1 \text{ V}$  (unless otherwise noted)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	$V_{CCB} = 1.2 \text{ V}$		$V_{CCB} = 1.5 \text{ V} \pm 0.1 \text{ V}$		$V_{CCB} = 1.8 \text{ V} \pm 0.15 \text{ V}$		$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		UNIT
				TYP	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX		
$t_{PD}$	CMDA	CMDB	Push-pull driving	5.1		13		9		8		7.5	ns	
			Open-drain driving	210		777		756		684		758		
	CMDB	CMDA	Push-pull driving	4.5		10.6		9.2		8.5		8.2		
			Open-drain driving	200		616		560		433		375		
	CLKA	CLKB	Push-pull driving	4.7		13.1		9.8		6		5.2		
	DATA	DATB	Push-pull driving	5.1		13		9		8		7.8		
	DATB	DATA		4.5		11		9.3		8.8		8.4		
SEL	B-Port	Push-pull driving	9.5		26		21		19		18			
$t_{rA}$	A-port rise time		Push-pull driving	2.7	1.5	5.8	1.7	5.9	1.7	6	1.8	6.1	ns	
$t_{rB}$	B-port rise time		Push-pull driving	3.3	1.7	8.2	1.3	6.6	1	4.3	0.8	2.9		
$t_{rB}$	CLKA	CLKB	Push-pull driving	5.2	1.7	6.4	1.3	4.9	0.9	3.2	0.8	2.5	ns	
$t_{fA}$	A-port fall time		Push-pull driving	2.4	1	3.9	0.9	3.4	0.9	3.2	1.3	3.3		
$t_{fB}$	B-port fall time		Push-pull driving	3.7	1.1	6.3	0.9	5.2	0.6	3.9	0.6	3.2	ns	
$t_{fB}$	CLKA	CLKB	Push-pull driving	3.1	0.9	4.1	0.8	3.2	0.5	2.2	0.5	1.9		
$t_{sk(O)}$	ChA-to-ChB skew		Push-pull driving	0.32		0.47		0.58		0.63		0.63	ns	
	ChB-to-ChA skew		Push-pull driving	0.27		0.24		0.23		0.22		0.22		
	Channel-to-Clock skew		Push-pull driving	1.47		1.66		1.68		1.82		1.77		
Max data rate	Command		Push-pull driving	60		80		120		120		120	Mbps	
			Open-drain driving	2		2		2		2		2		
	Clock		Push-pull driving	30		40		60		60		60	MHz	
	Data		Push-pull driving	60		80		120		120		120	Mbps	

## SWITCHING CHARACTERISTICS

over operating free-air temperature range,  $V_{CCA} = 1.8 \text{ V} \pm 0.15 \text{ V}$  (unless otherwise noted)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	$V_{CCB} = 1.2 \text{ V}$		$V_{CCB} = 1.5 \text{ V} \pm 0.1 \text{ V}$		$V_{CCB} = 1.8 \text{ V} \pm 0.15 \text{ V}$		$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		UNIT
				TYP	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX		
$t_{PD}$	CMDA	CMDB	Push-pull driving	4.8		12		8		6		5.7	ns	
			Open-drain driving	183		726		715		686		780		
	CMDB	CMDA	Push-pull driving	4		9		7		6.4		6		
			Open-drain driving	175		565		563		441		392		
	CLKA	CLKB	Push-pull driving	4.5		13		9		5.4		4.5		
	DATA	DATB	Push-pull driving	4.7		12		8.4		6		5.8		
	DATB	DATA		4.1		9		7.5		6.4		6.3		
SEL	B-Port	Push-pull driving	8.2		22		17		14.8		14			
$t_{rA}$	A-port rise time		Push-pull driving	2	1.1	4	1.1	4.3	1.2	4.5	1.3	4.6	ns	
$t_{rB}$	B-port rise time		Push-pull driving	6.2	1.7	7.9	1.2	6.2	1	4.3	0.8	3.1		
$t_{rB}$	CLKA	CLKB	Push-pull driving	5.2	1.7	6.4	1.3	4.9	0.9	3.2	0.8	2.5	ns	
$t_{fA}$	A-port fall time		Push-pull driving	1.8	0.8	3.2	0.7	2.8	0.7	1.7	0.7	2.6		
$t_{fB}$	B-port fall time		Push-pull driving	3.5	1	5.6	0.9	3.5	0.6	1.9	0.6	3	ns	
$t_{fB}$	CLKA	CLKB	Push-pull driving	3.1	0.9	4.1	0.8	3.2	0.5	2.2	0.5	1.9		
$t_{sk(O)}$	ChA-to-ChB skew		Push-pull driving	0.33		0.45		0.48		0.53		0.67	ns	
	ChB-to-ChA skew		Push-pull driving	0.28		0.24		0.23		0.23		0.22		
	Channel-to-Clock skew		Push-pull driving	1.51		1.58		1.46		1.56		1.48		
Max data rate	Command		Push-pull driving	60		80		120		120		120	Mbps	
			Open-drain driving	2		2		2		2		2		
	Clock		Push-pull driving	30		40		60		60		60	MHz	
	Data		Push-pull driving	60		80		120		120		120	Mbps	

## SWITCHING CHARACTERISTICS

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	$V_{CCB} = 1.2 \text{ V}$		$V_{CCB} = 1.5 \text{ V} \pm 0.1 \text{ V}$		$V_{CCB} = 1.8 \text{ V} \pm 0.15 \text{ V}$		$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		UNIT
				TYP	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX		
$t_{PD}$	CMDA	CMDB	Push-pull driving	4.4		11		7.4		4.4		3.8	ns	
			Open-drain driving	143		544		596		605		669		
	CMDB	CMDA	Push-pull driving	3.8		7.6		5.5		4.2		3.7		
			Open-drain driving	137		434		444		414		372		
	CLKA	CLKB	Push-pull driving	4.1		12		8		4.8		3.8		
	DATA	DATB	Push-pull driving	4.4		11		7		4.5		3.8		
	DATB	DATA		4.4		8		5.5		4.1		3.7		
SEL	B-Port	Push-pull driving	7		18		13		10.5		9			
$t_{rA}$	A-port rise time		Push-pull driving	1.4	0.75	2.2	0.74	2.2	1.06	2.6	0.7	2.8	ns	
$t_{rB}$	B-port rise time		Push-pull driving	6.3	1.91	7.7	1.34	6.1	0.95	4.2	0.83	3.2		
$t_{rB}$	CLKA	CLKB	Push-pull driving	5.2	1.67	6.4	1.27	4.9	0.9	3.2	0.76	2.6	ns	
$t_{fA}$	A-port fall time		Push-pull driving	1.1	0.58	1.9	0.58	2	0.61	1.9	0.57	1.9		
$t_{fB}$	B-port fall time		Push-pull driving	3.6	1.04	5.4	0.87	4.3	0.66	3.4	0.57	3	ns	
$t_{fB}$	CLKA	CLKB	Push-pull driving	3.1	0.92	4.2	0.79	3.2	0.56	2.2	0.49	1.9		
$t_{sk(O)}$	ChA-to-ChB skew		Push-pull driving	0.41		0.43		0.39		0.59		0.68	ns	
	ChB-to-ChA skew		Push-pull driving	0.41		0.24		0.2		0.19		0.18		
	Channel-to-Clock skew		Push-pull driving	2.11		1.47		1.3		1.25		1.21		
Max data rate	Command		Push-pull driving	60		80		120		120		120	Mbps	
			Open-drain driving	2		2		2		2		2		
	Clock		Push-pull driving	30		40		60		60		60	MHz	
	Data		Push-pull driving	60		80		120		120		120	Mbps	

## SWITCHING CHARACTERISTICS

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	$V_{CCB} = 1.2 \text{ V}$		$V_{CCB} = 1.5 \text{ V} \pm 0.1 \text{ V}$		$V_{CCB} = 1.8 \text{ V} \pm 0.15 \text{ V}$		$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		UNIT
				TYP	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	
$t_{PD}$	CMDA	CMDB	Push-pull driving	4.4		11			7		4.1		3.3	ns
			Open-drain driving	116		432			477		506		533	
	CMDB	CMDA	Push-pull driving	4.2		7.5			5.4		3.8		3	
			Open-drain driving	112		349			363		347		324	
	CLKA	CLKB	Push-pull driving	4.1		12			7.8		4.4		3.5	
	DATA	DATB	Push-pull driving	4.3		11			6.8		4		3.8	
	DATB	DATA		7.9		7.8			5.4		3.4		3	
SEL	B-Port	Push-pull driving	6.4		16			11.5		8.8		7.6		
$t_{rA}$	A-port rise time		Push-pull driving	1.1	0.57	1.7	0.57	1.8	0.56	1.7	0.53	1.8	ns	
$t_{rB}$	B-port rise time		Push-pull driving	6.2	1.96	7.7	1.43	6.1	0.95	4.2	0.71	3.1		
$t_{fB}$	CLKA	CLKB	Push-pull driving	5.2	1.67	6.4	1.26	4.9	0.91	3.3	0.76	2.5	ns	
$t_{fA}$	A-port fall time		Push-pull driving	1	0.53	1.6	0.52	1.6	0.53	1.6	0.56	1.6		
$t_{fB}$	B-port fall time		Push-pull driving	3.4	0.95	5.2	0.8	4.1	0.63	3.2	0.58	2.9	ns	
$t_{fB}$	CLKA	CLKB	Push-pull driving	3.1	0.92	4.1	0.79	3.2	0.56	2.2	0.49	1.9		
$t_{sk(O)}$	ChA-to-ChB skew		Push-pull driving	0.39		0.36		0.39		0.57		0.65	ns	
	ChB-to-ChA skew		Push-pull driving	0.45		0.3		0.19		0.19		0.18		
	Channel-to-Clock skew		Push-pull driving	1.7		1.61		1.34		1.22		1.14		
Max data rate	Command		Push-pull driving	60		80		120		120		120	Mbps	
			Open-drain driving	2		2		2		2		2		
	Clock		Push-pull driving	30		40		60		60		60	MHz	
	Data		Push-pull driving	60		80		120		120		120	Mbps	

## OPERATING CHARACTERISTICS

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

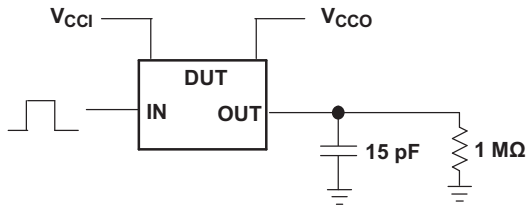
PARAMETER			TEST CONDITIONS	$V_{CCA}$					UNIT
				1.2 V	1.5 V	1.8 V	2.5 V	3.3 V	
				$V_{CCB}$					
				1.2 V	1.5 V	1.8 V	2.5 V	3.3 V	
				TYP	TYP	TYP	TYP	TYP	
Data and CMD	$C_{pdA}$	A-port input, B-port output	$C_L = 0$ , $f = 10 \text{ MHz}$ , $t_r = t_f = 1 \text{ ns}$ , OE = outputs enabled	14.5	12.9	12.1	13.4	15	pF
		B-port input, A-port output		20.7	20.7	21	22	23.2	
	$C_{pdB}$	A-port input, B-port output		23.2	23.4	23.6	24.5	25.5	
		B-port input, A-port output		14.1	12.2	11.5	12.9	14.4	
		A-port input, B-port output		0.1	0.1	0.1	0.1	0.1	
Clock	$C_{pdA}$	A-port input, B-port output	$C_L = 0$ , $f = 10 \text{ MHz}$ , $t_r = t_f = 1 \text{ ns}$ , OE = outputs enabled	0.4	0.4	0.4	0.5	0.7	pF
	$C_{pdB}$	B-port input, A-port output		14	13.9	13.8	13.8	13.7	

## POWER-UP CONSIDERATIONS

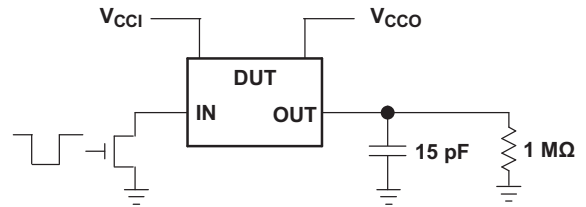
The following power-up sequence for this TXS02612 SDIO port expander with voltage-level translator should be followed to ensure proper operation and to avoid any unnecessary excessive supply current, bus contention, oscillations, or other anomalies caused by improperly biased device pins. The following power-up sequence should be used to safe-guard against these problems:

1. Connect the ground pin of the device first before any power-supply voltage is applied.
2. Connect and power up  $V_{CCA}$ , which internally powers up the SEL control logic of the TXS02612.
3. Depending on the port to be chosen, the SEL pin can be high or low. If SEL high is needed (i.e., A port to B<sub>1</sub> port), ramp the SEL pin with the  $V_{CCA}$  power supply. Otherwise, keep SEL Low.
4. Apply  $V_{CCB0}$  and  $V_{CCB1}$  only after the  $V_{CCA}$  power supply is applied.

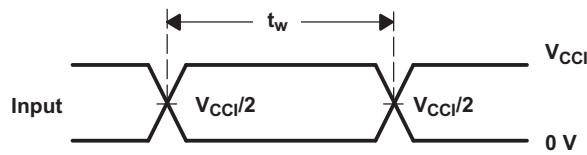
**PARAMETER MEASUREMENT INFORMATION**



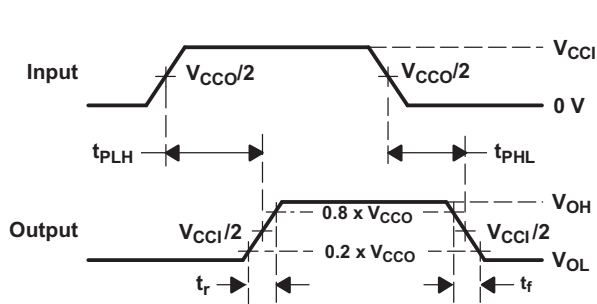
**DATA RATE, PULSE DURATION, PROPAGATION DELAY, ENABLE/DISABLE OUTPUT RISE AND FALL TIME MEASUREMENT USING A PUSH-PULL DRIVER**



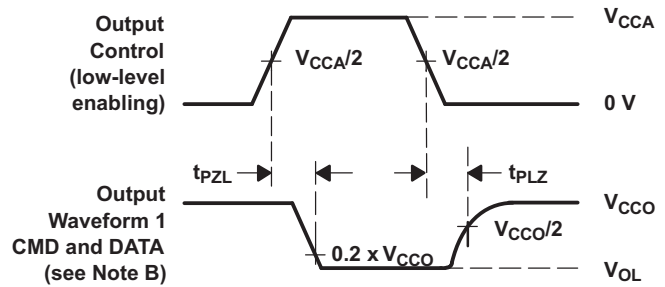
**DATA RATE, PULSE DURATION, PROPAGATION DELAY, OUTPUT RISE AND FALL TIME MEASUREMENT USING AN OPEN-DRAIN DRIVER**



**VOLTAGE WAVEFORMS PULSE DURATION**



**VOLTAGE WAVEFORMS PROPAGATION DELAY TIMES**



**VOLTAGE WAVEFORMS ENABLE AND DISABLE TIMES**

- NOTES:
- A.  $C_L$  includes probe and jig capacitance.
  - B. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high, except when disabled by the output control.
  - C. All input pulses are supplied by generators having the following characteristics: PRR = 10 MHz,  $Z_O = 50\Omega$ ,  $dv/dt \geq 1$  V/ns.
  - D. The outputs are measured one at a time, with one transition per measurement.
  - E.  $t_{pLZ}$  and  $t_{pHZ}$  are the same as  $t_{dis}$ .
  - F.  $t_{pZL}$  and  $t_{pZH}$  are the same as  $t_{en}$ .
  - G.  $t_{pLH}$  and  $t_{pHL}$  are the same as  $t_{cd}$ .
  - H.  $V_{CCI}$  is the  $V_{CC}$  associated with the input port.
  - I.  $V_{CCO}$  is the  $V_{CC}$  associated with the output port.
  - J. All parameters and waveforms are not applicable to all devices.

**Figure 1. Load Circuit and Voltage Waveforms**



**PACKAGING INFORMATION**

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
TXS02612RTWR	ACTIVE	WQFN	RTW	24	3000	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	YJ612	Samples

(1) The marketing status values are defined as follows:

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

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

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

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

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

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices 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.

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**TAPE AND REEL INFORMATION**

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


\*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
TXS02612RTWR	WQFN	RTW	24	3000	330.0	12.4	4.25	4.25	1.15	8.0	12.0	Q2

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TXS02612RTWR	WQFN	RTW	24	3000	356.0	356.0	35.0

## GENERIC PACKAGE VIEW

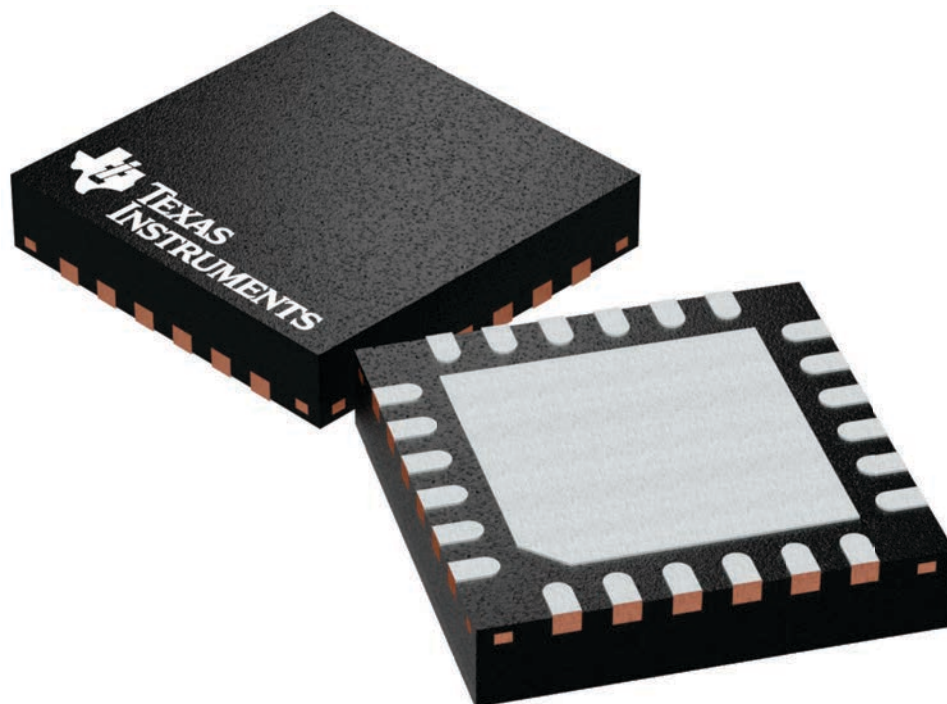
**RTW 24**

**WQFN - 0.8 mm max height**

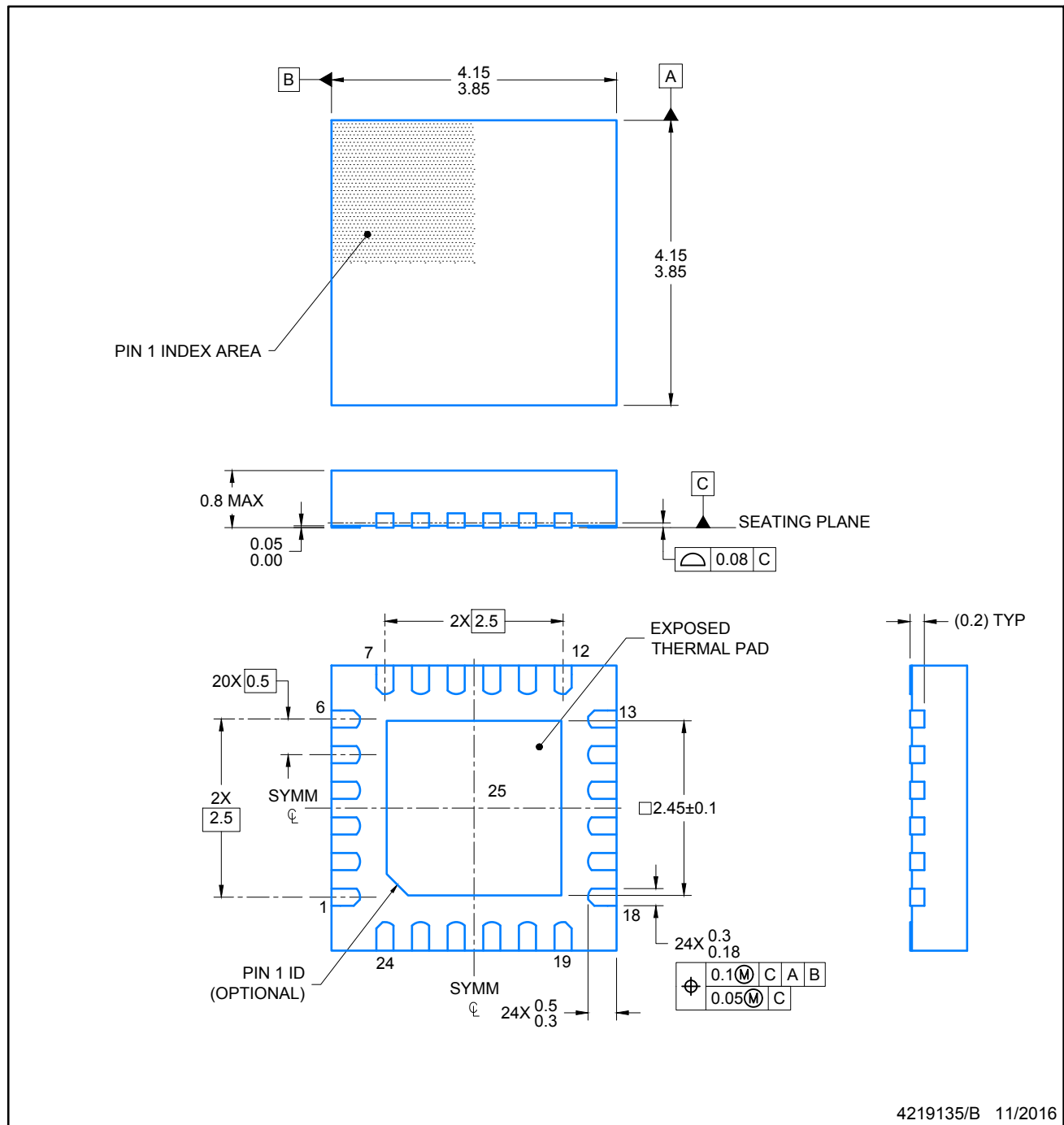
4 x 4, 0.5 mm pitch

PLASTIC QUAD FLATPACK - NO LEAD

This image is a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.

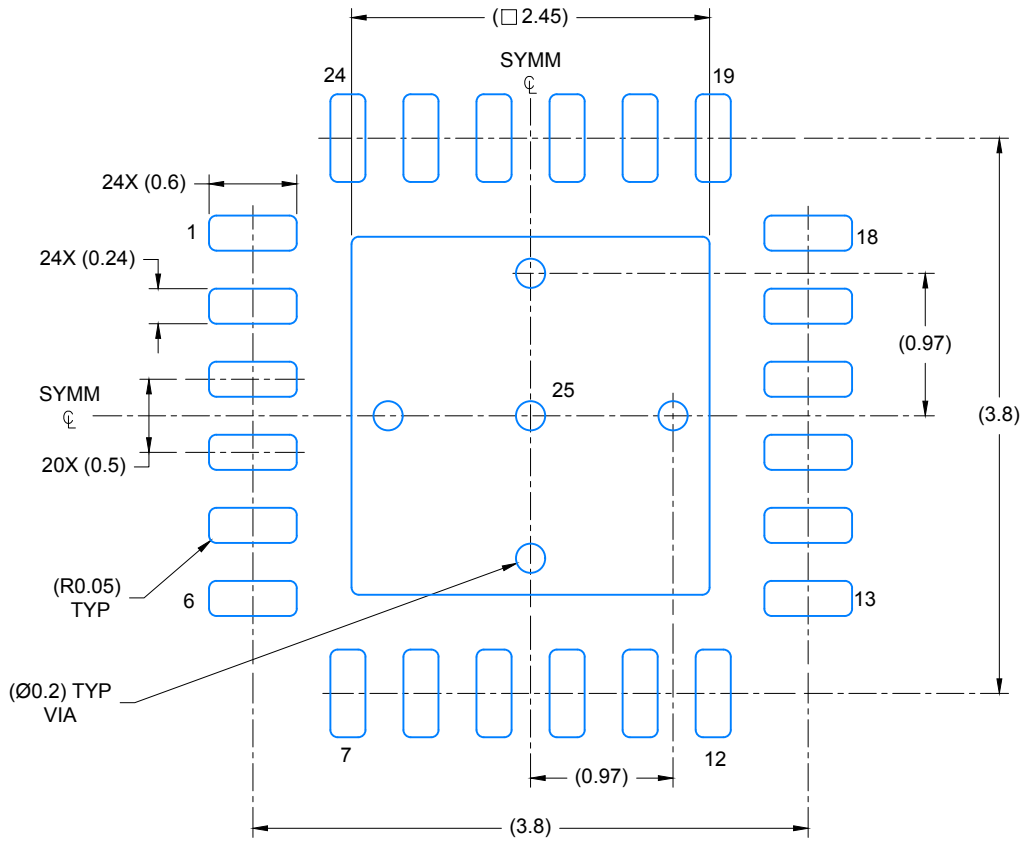


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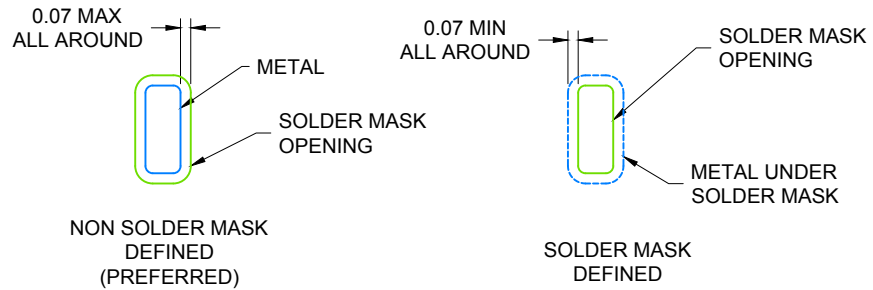


NOTES:

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.



LAND PATTERN EXAMPLE  
SCALE: 20X

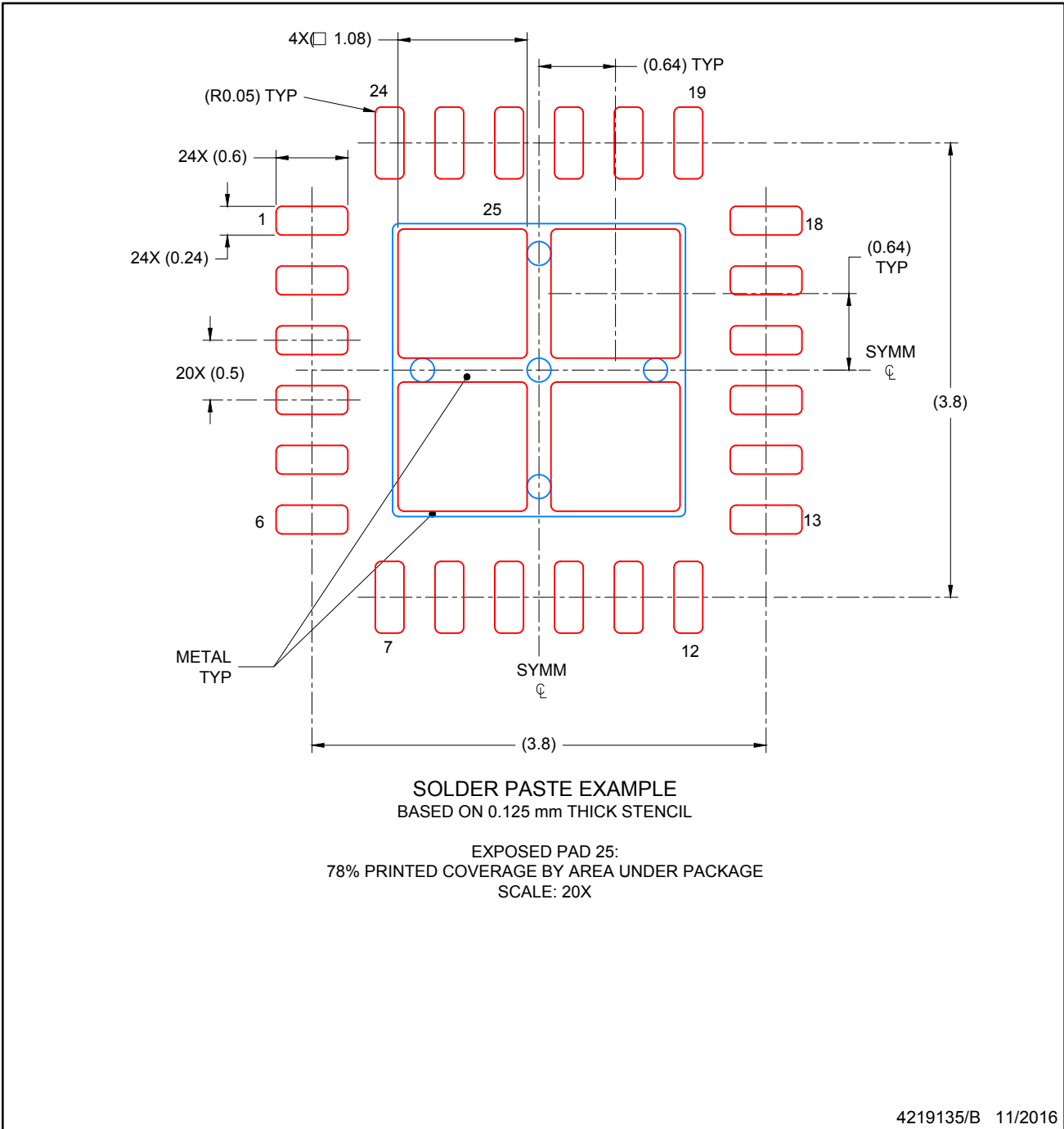


SOLDER MASK DETAILS

4219135/B 11/2016

NOTES: (continued)

- For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/sluea271](http://www.ti.com/lit/sluea271)).



NOTES: (continued)

4. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

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