

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

### DESCRIPTION/ORDERING INFORMATION

The TXS02612 is designed to interface the cellphone 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.

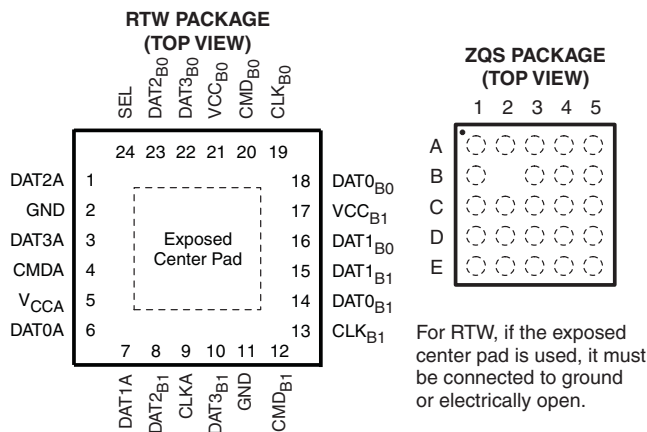
The select (SEL) input is used to choose between the B0 port and B1 port. When SEL = Low, B0 port is selected; when SEL = High, B1 port is selected. SEL is referenced to  $V_{CCA}$ . For the unselected B port, the clock output is held low, whereas the data and command I/Os are pulled high to their respective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

### ORDERING INFORMATION

$T_A$	PACKAGE <sup>(1)(2)</sup>	ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	MicroStar Junior™ BGA (VFBGA) – ZQS	Reel of 3000	TXS02612ZQSR
	QFN – RTW	Reel of 3000	TXS02612RTWR

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

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



### ZQS PACKAGE TERMINAL ASSIGNMENTS

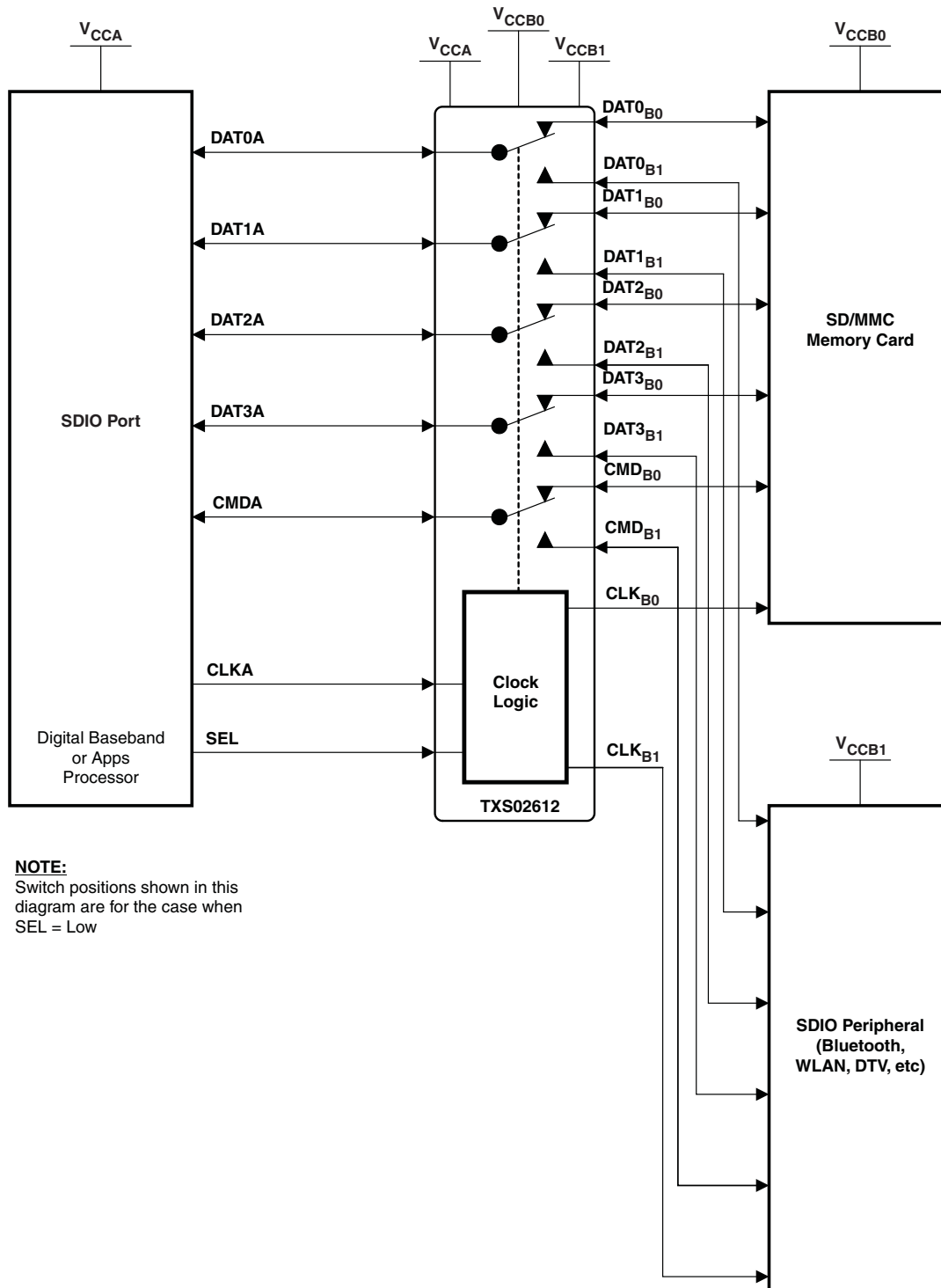
	1	2	3	4	5
<b>A</b>	DAT2A	SEL	DAT3B0	CMD_B0	CLK_B0
<b>B</b>	DAT3A		DAT2B0	VCCB0	DAT0B0
<b>C</b>	CMDA	VCCA	GND	VCCB1	DAT1B0
<b>D</b>	DAT0A	CLKA	GND	DAT1B1	DAT0B1
<b>E</b>	DAT1A	DAT2B1	DAT3B1	CMD_B1	CLK_B1



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APPLICATION BLOCK DIAGRAM

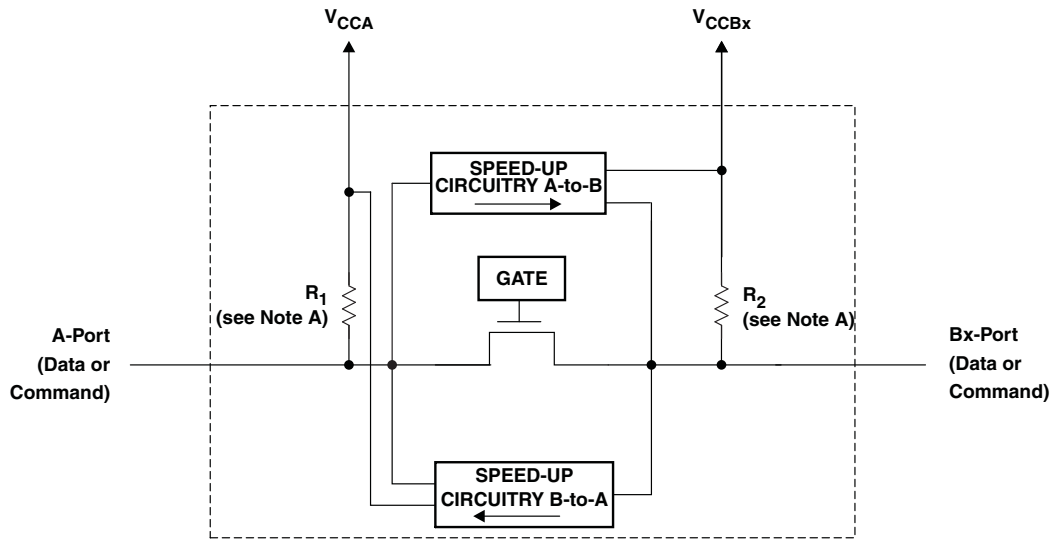


**NOTE:**  
Switch positions shown in this diagram are for the case when  $SEL = Low$

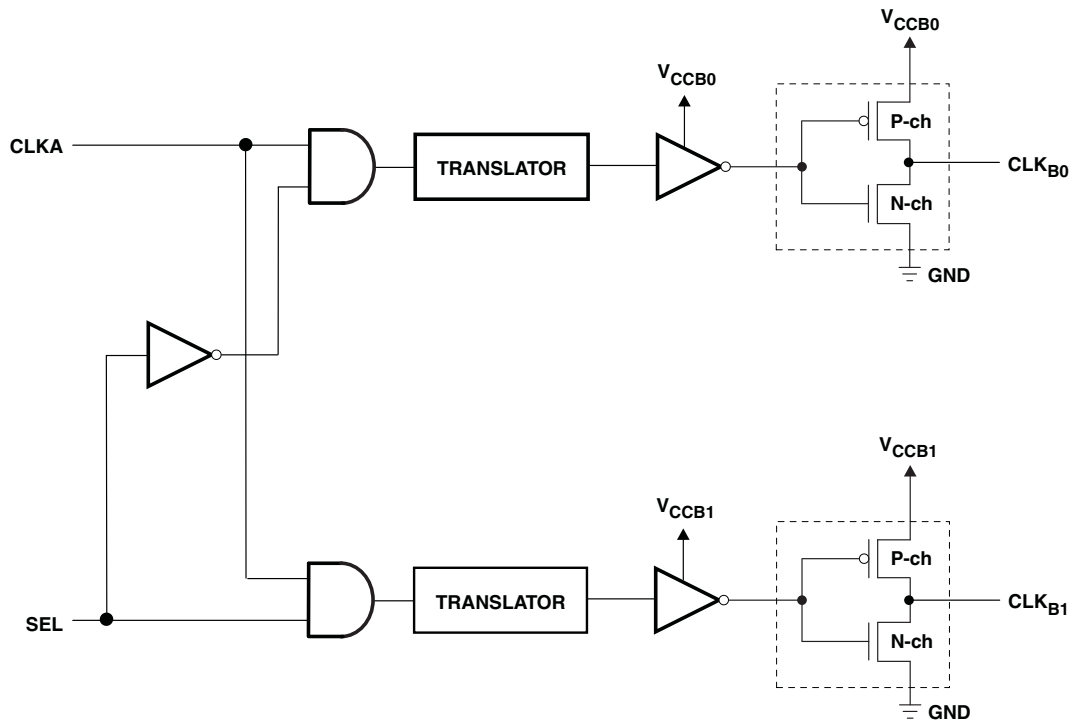
**PIN ASSIGNMENTS**

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	A port, B0 port, B1 port, control inputs	-0.5	$V_{CCx} + 0.5$	V
$V_O$	Voltage range applied to any output in the high-impedance or power-off state	A port, B0 port, B1 port	-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		$^{\circ}\text{C}/\text{W}$
		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 B-port I/Os SEL, CLKA	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
					V <sub>CCA</sub> × 0.65 V	3.6	
V <sub>IL</sub>	Low-level input voltage	A-port I/Os B-port I/Os SEL, CLKA	1.1 V to 3.6 V	1.1 V to 3.6 V	0	0.15	V
					0	0.15	
					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 I <sub>OH</sub> = –1 mA I <sub>OH</sub> = –2 mA I <sub>OH</sub> = –4 mA I <sub>OH</sub> = –8 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 I <sub>OL</sub> = 180 μA, V <sub>IAx</sub> ≤ 0.15 V I <sub>OL</sub> = 220 μA, V <sub>IAx</sub> ≤ 0.15 V I <sub>OL</sub> = 300 μA, V <sub>IAx</sub> ≤ 0.15 V I <sub>OL</sub> = 620 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 I <sub>OL</sub> = 1 mA I <sub>OL</sub> = 2 mA I <sub>OL</sub> = 4 mA I <sub>OL</sub> = 8 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	MIN	
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	
	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	
				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	
$t_{fB}$	CLKA	CLKB	Push-pull driving	3.1	0.9	4.1	0.8	3.2	0.5	2.2	0.5	1.9	ns
$t_{sk(O)}$	ChA-to-ChB skew		Push-pull driving	0.33		0.45		0.48		0.53		0.67	
	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)

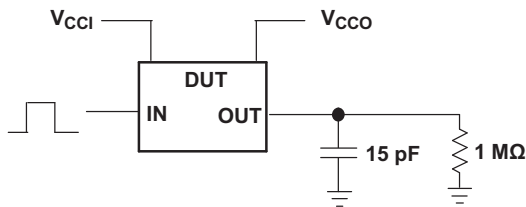
PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	$V_{CCB} = 1.2 \text{ V}$	$V_{CCB} = 1.5 \text{ V} \pm 0.1 \text{ V}$		$V_{CCB} = 1.8 \text{ V} \pm 0.15 \text{ V}$		$V_{CCB} = 2.5 \text{ V} \pm 0.2 \text{ V}$		$V_{CCB} = 3.3 \text{ V} \pm 0.3 \text{ V}$		UNIT	
				TYP	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX		
$t_{PD}$	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
					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		
$t_{rB}$	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

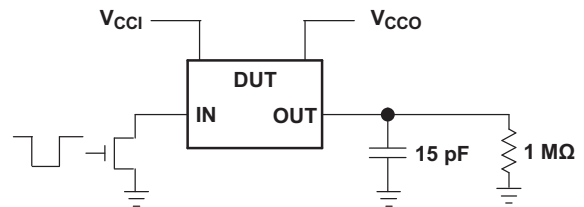
over operating free-air temperature range (unless otherwise noted)

	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 & 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	
Data & CMD	$C_{pdB}$	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	pF
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
	$C_{pdB}$	B-port input, A-port output	14		13.9	13.8	13.8	13.7	

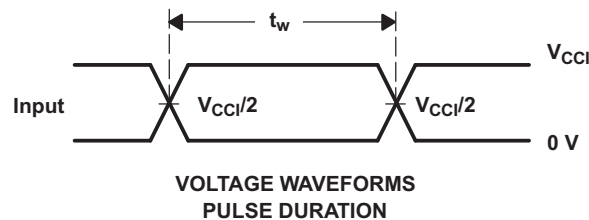
PARAMETER MEASUREMENT INFORMATION



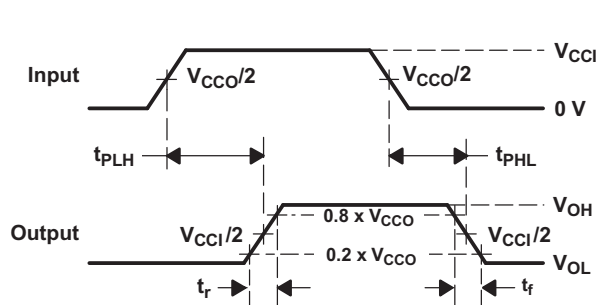
DATA RATE, PULSE DURATION, PROPAGATION DELAY, ENABLE/DISABLE OUTPUT RISE AND FALL TIME MEASUREMENT USING A PUSH-PULL DRIVER



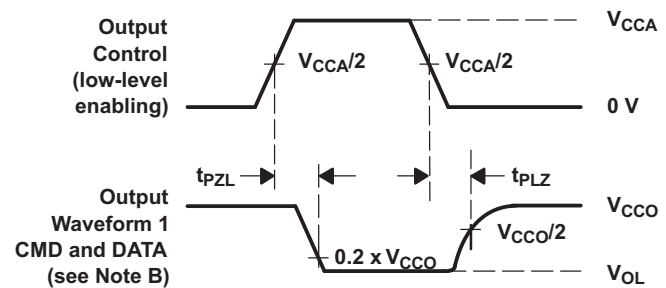
DATA RATE, PULSE DURATION, PROPAGATION DELAY, OUTPUT RISE AND FALL TIME MEASUREMENT USING AN OPEN-DRAIN DRIVER



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 <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
TXS02612RTWR	ACTIVE	QFN	RTW	24	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
TXS02612ZQSR	ACTIVE	BGA MI CROSTA R JUNI OR	ZQS	24	2500	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM

<sup>(1)</sup> The marketing status values are defined as follows:

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

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

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

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

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

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

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**TAPE AND REEL INFORMATION**



**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	QFN	RTW	24	3000	330.0	12.4	4.3	4.3	1.5	8.0	12.0	Q2
TXS02612ZQSR	BGA MICROSTAR JUNIOR	ZQS	24	2500	330.0	12.4	3.3	3.3	1.6	8.0	12.0	Q1

**TAPE AND REEL BOX DIMENSIONS**

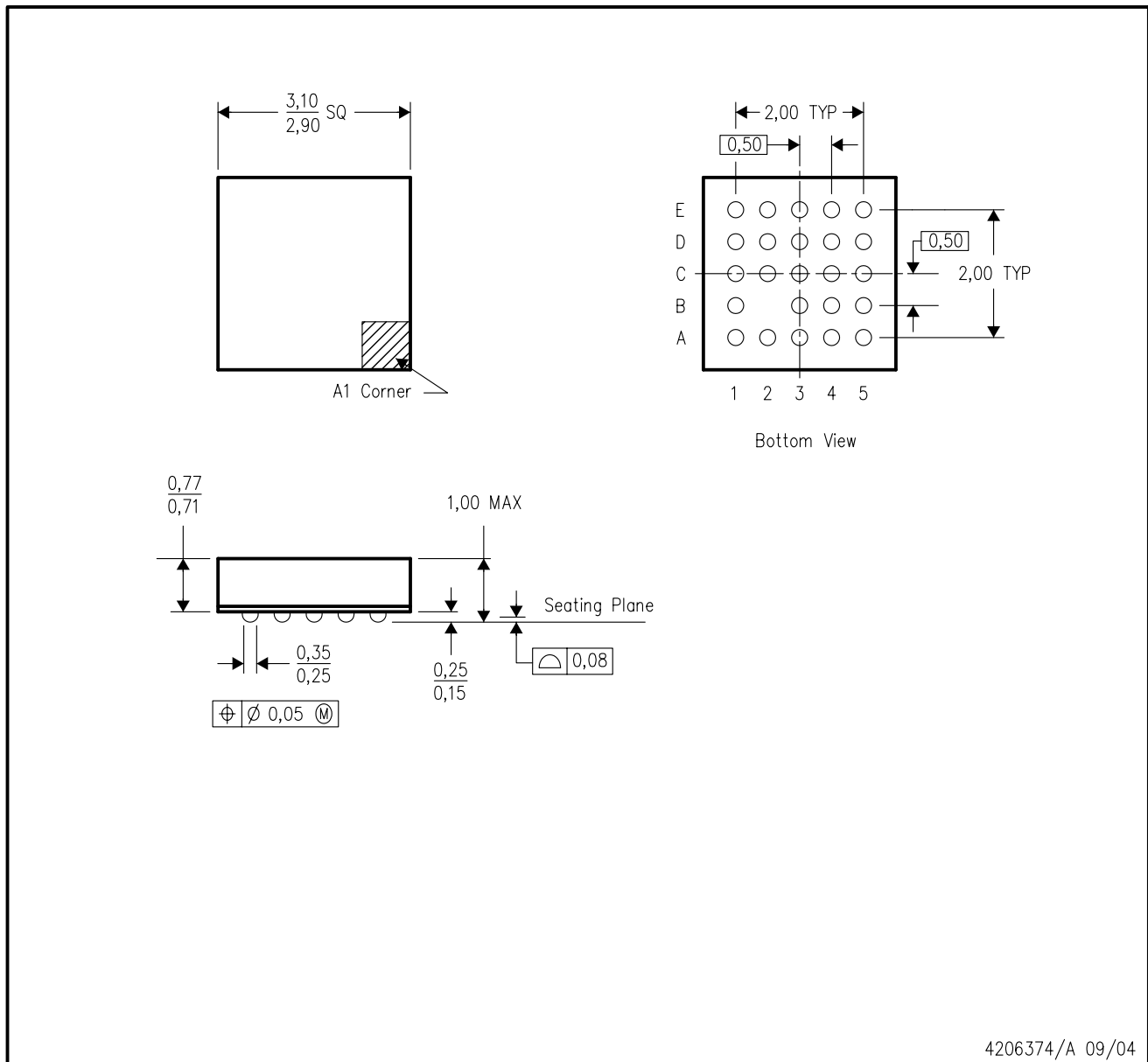


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TXS02612RTWR	QFN	RTW	24	3000	346.0	346.0	29.0
TXS02612ZQSR	BGA MICROSTAR JUNIOR	ZQS	24	2500	340.5	338.1	20.6

ZQS (S-PBGA-N24)

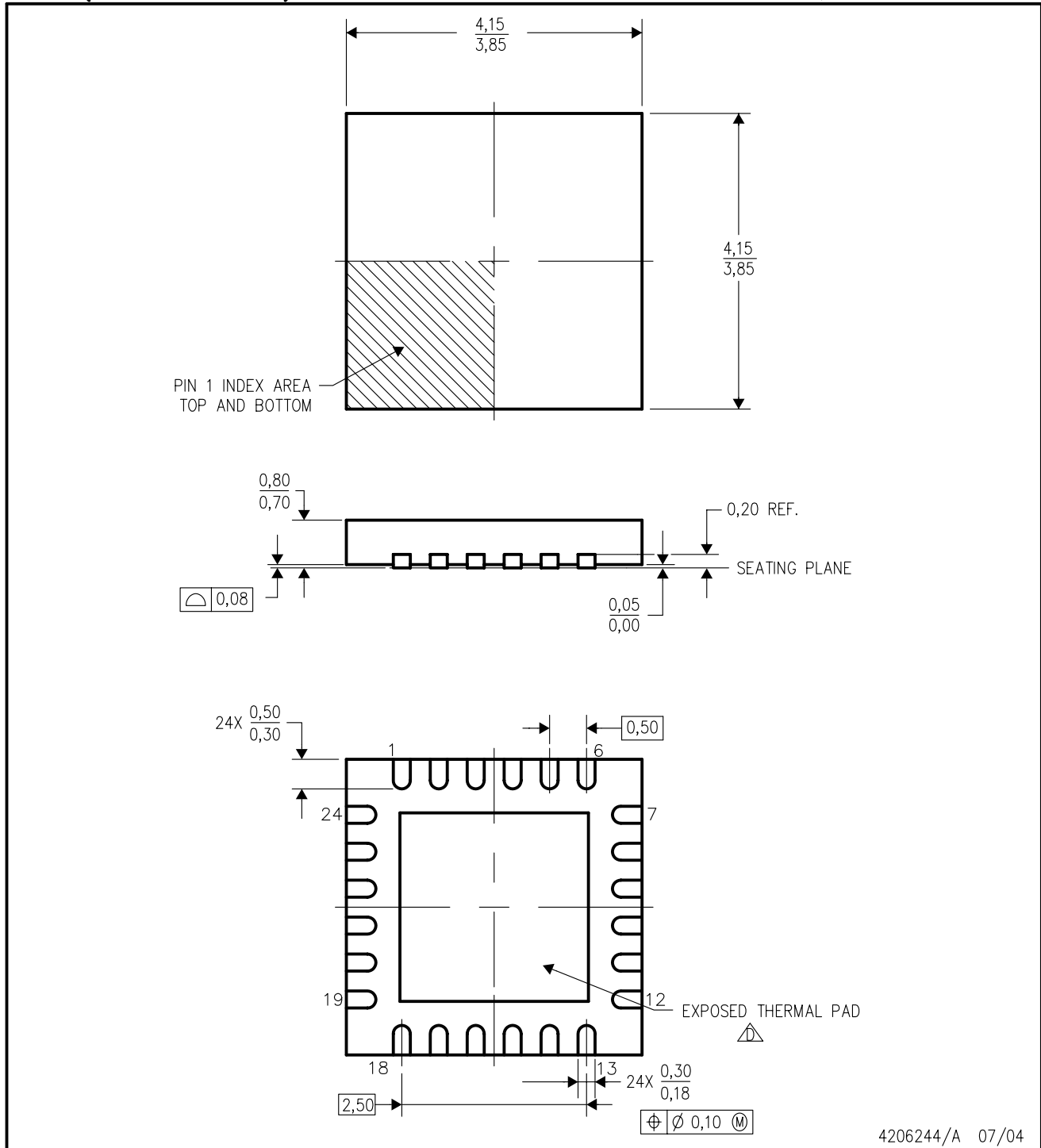
PLASTIC BALL GRID ARRAY



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Falls within JEDEC MO-225
  - D. This package is lead-free.

RTW (S-PQFP-N24)

PLASTIC QUAD FLATPACK



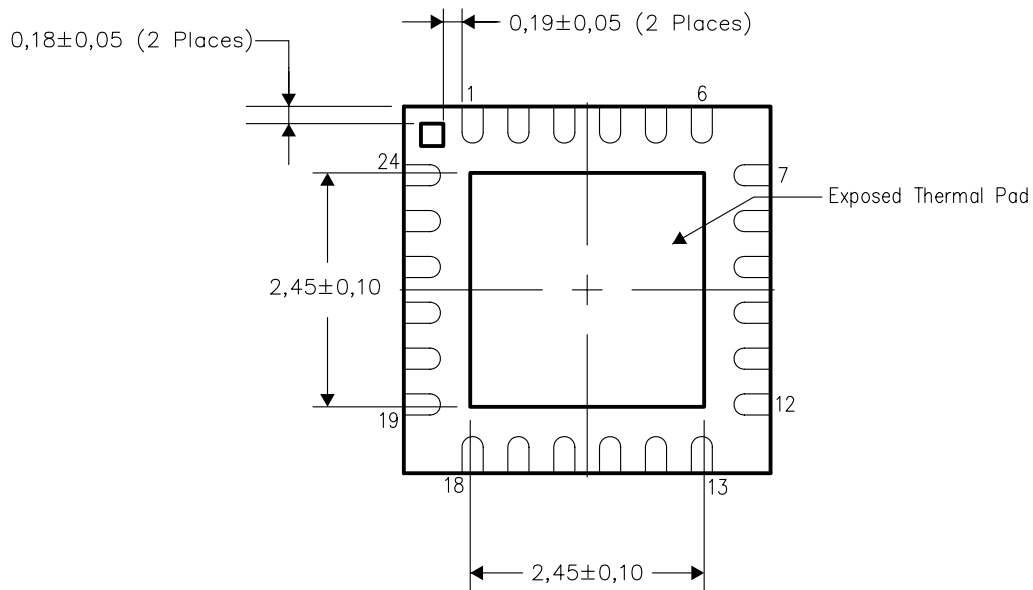
- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5-1994.
  - B. This drawing is subject to change without notice.
  - C. Quad Flatpack, No-Leads (QFN) package configuration.
  - △ The package thermal pad must be soldered to the board for thermal and mechanical performance. See the Product Data Sheet for details regarding the exposed thermal pad dimensions.
  - E. Falls within JEDEC MO-220.

THERMAL INFORMATION

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

For information on the Quad Flatpack No-Lead (QFN) package and its advantages, refer to Application Report, Quad Flatpack No-Lead Logic Packages, Texas Instruments Literature No. SCBA017. This document is available at [www.ti.com](http://www.ti.com).

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



Bottom View

NOTE: All linear dimensions are in millimeters

Exposed Thermal Pad Dimensions

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