

## 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<sub>CCA</sub>, V<sub>CCB0</sub>, and V<sub>CCB1</sub> 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)
- ±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.

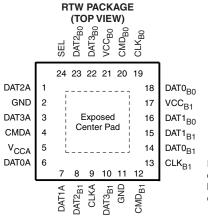
The select (SEL) input is used to choose between the B0 port and B1 port. When SEL = Low, B0 port is selected; when SEL = High, B1 port is selected. SEL is referenced to  $V_{CCA}$ . For the unselected B port, the clock output is held low, whereas the data and command I/Os are pulled high to their respective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

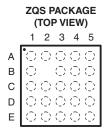
#### ORDERING INFORMATION(1)

T <sub>A</sub>	PACKAGE	(2)	ORDERABLE PART NUMBER	TOP-SIDE MARKING
-40°C to 85°C	MicroStar Junior™ BGA (VFBGA) – ZQS	Reel of 3000	TXS02612ZQSR	YJ612
10 0 10 00 0	QFN – RTW	Reel of 3000	TXS02612RTWR	YJ612

<sup>(1)</sup> 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.

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





For RTW, if the exposed center pad is used, it must be connected to ground or electrically open.

Table 1. ZQS PACKAGE TERMINAL ASSIGNMENTS

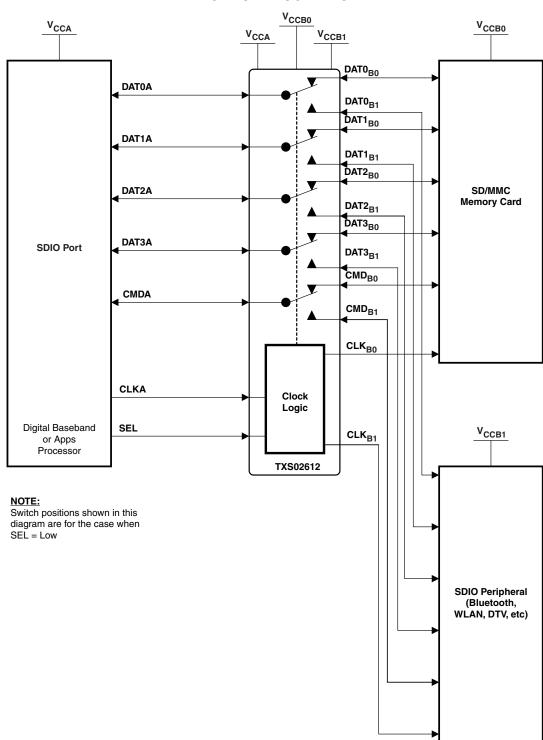
	1	2	3	4	5
Α	DAT2A	SEL	DAT3 <sub>B0</sub>	CMD <sub>B0</sub>	CLK <sub>B0</sub>
В	DAT3A		DAT2 <sub>B0</sub>	V <sub>CCB0</sub>	DAT0 <sub>B0</sub>
С	CMDA	$V_{CCA}$	GND	V <sub>CC B1</sub>	DAT1 <sub>B0</sub>
D	DAT0A	CLKA	GND	DAT1 <sub>B1</sub>	DAT0 <sub>B1</sub>
E	DAT1A	DAT2 <sub>B1</sub>	DAT3 <sub>B1</sub>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

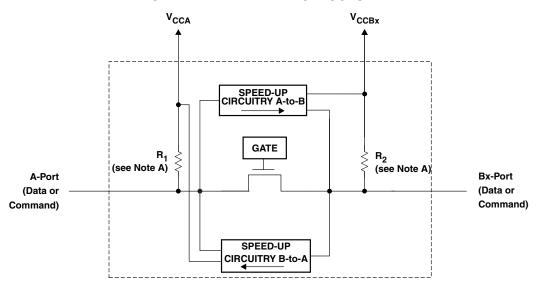


### **PIN ASSIGNMENTS**

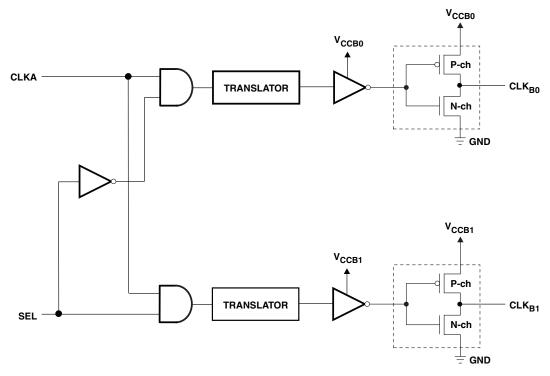
RTW PACKAGE PIN NO.	ZQS PACKAGE BALL NO.	NAME	FUNCTION	TYPE
1	A1	DAT2A	Data bit 2. Referenced to V <sub>CCA</sub> .	I/O
3	B1	DAT3A	Data bit 3. Referenced to V <sub>CCA</sub> .	I/O
4	C1	CMDA	Command bit. Referenced to V <sub>CCA</sub> .	I/O
6	D1	DAT0A	Data bit 0. Referenced to V <sub>CCA</sub> .	I/O
7	E1	DAT1A	Data bit 1. Referenced to V <sub>CCA</sub> .	I/O
24	A2	SEL	Select pin to choose between B0 and B1. Referenced to V <sub>CCA</sub> .	Input
	B2		Depopulated	
5	C2	$V_{CCA}$	A-port supply voltage. 1.1 $V \le V_{CCA} \le 3.6 V$ .	Power
9	D2	CLKA	Clock input A. Referenced to V <sub>CCA</sub> .	Input
8	E2	DAT2 <sub>B1</sub>	Data bit 2. Referenced to V <sub>CCB1</sub> .	I/O
22	A3	DAT3 <sub>B0</sub>	Data bit 3. Referenced to V <sub>CCB0</sub> .	I/O
23	В3	DAT2 <sub>B0</sub>	Data bit 2. Referenced to V <sub>CCB0</sub> .	I/O
2	C3	GND	Ground	
11	D3	GND	Ground	
10	E3	DAT3 <sub>B1</sub>	Data bit 3. Referenced to V <sub>CCB1</sub> .	I/O
20	A4	CMD <sub>B0</sub>	Command bit. Referenced to V <sub>CCB0</sub> .	I/O
21	B4	V <sub>CCB0</sub>	B0-port supply voltage. 1.1 V $\leq$ V <sub>CCB0</sub> $\leq$ 3.6 V.	Power
17	C4	V <sub>CCB1</sub>	B1-port supply voltage. 1.1 V $\leq$ V <sub>CCB1</sub> $\leq$ 3.6 V.	Power
15	D4	DAT1 <sub>B1</sub>	Data bit 1. Referenced to V <sub>CCB1</sub> .	I/O
12	E4	CMD <sub>B1</sub>	Command bit. Referenced to V <sub>CCB1</sub> .	I/O
19	A5	CLK <sub>B0</sub>	Clock output. Referenced to V <sub>CCB0</sub> .	Output
18	B5	DAT0 <sub>B0</sub>	Data bit 0. Referenced to V <sub>CCB0</sub> .	I/O
16	C5	DAT1 <sub>B0</sub>	Data bit 1. Referenced to V <sub>CCB0</sub> .	I/O
14	D5	DAT0 <sub>B1</sub>	Data bit 0. Referenced to V <sub>CCB1</sub> .	I/O
13	E5	CLK <sub>B1</sub>	Clock output. Referenced to V <sub>CCB1</sub> .	Output



#### SIMPLIFIED INTERNAL STRUCTURE



Simplified Architecture of Command and Each Data Path



Simplified Architecture of the Clock Path

- A. R<sub>1</sub> and R<sub>2</sub> 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  $k\Omega$  when a logic level low is applied to the A port or B port.
  - $R_1$  and  $R_2$  = 4  $k\Omega$  when a logic level high is applied to the A port or B port.
  - $R_1$  and  $R_2$  = 70 k $\Omega$  when the port is deselected.

#### **FUNCTION TABLE**

	Clock Channel											
SEL	CLKB0	CLKB1	OPERATION									
L	Active	Low	CLKA to CLKB0									
Н	Low	Active	CLKA to CLKB1									
	Da	ata 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									
Н	Disabled, pulled to $V_{CCB0}$ through 70 k $\Omega$	Active	DATxA to DATxB1, CMDA to CMDB1									

## ABSOLUTE MAXIMUM RATINGS(1) (2)

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

			MIN	MAX	UNIT
V <sub>CCA</sub> V <sub>CCB0</sub> V <sub>CCB1</sub>	Supply voltage range (2)		-0.5	4.6	٧
VI	Input voltage range	A port, B0 port, B1 port, control inputs	-0.5	V <sub>CCx</sub> + 0.5	V
Vo	Voltage range applied to any output in the high-impedance or power-off state	A port, B0 port, B1 port	-0.5	V <sub>CCx</sub> + 0.5	<b>V</b>
$I_{IK}$	Input clamp current	V <sub>I</sub> < 0		-50	mA
lok	Output clamp current	V <sub>O</sub> < 0		<b>-</b> 50	mA
I <sub>CC</sub> /	Continuous current through $V_{CCA}$ , $V_{CCB0}$ , $V_{CCB1}$ , or GND			±100	mA
T <sub>stg</sub>	Storage temperature range	·	-65	150	°C

<sup>(1)</sup> 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.

### PACKAGE THERMAL IMPEDANCE

	PARAMETER		UNIT	
0	Dealine at the armed improduces	RTW package	66	90.44
θЈА	Package thermal impedance	ZQS package	171.6	°C/W

<sup>(2)</sup> The input and output voltage ratings may be exceeded if the input and output clamp-current ratings are observed.



## 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
		A-port I/Os			V <sub>CCI</sub> - 0.2	$V_{CCI}$	
$V_{IH}$	High-level input voltage	B-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
		SEL, CLKA			$V_{CCA} \times 0.65 V$	3.6	
		A-port I/Os			0	0.15	
$V_{IL}$	Low-level input voltage	B-port I/Os	1.1 V to 3.6 V	1.1 V to 3.6 V	0	0.15	V
		SEL, CLKA			0	$V_{CCA} \times 0.35$	
Δt/Δν	Input transition rise or fall rate	CLK, SEL				10	ns/V
T <sub>A</sub>	Operating free-air temperature				-40	85	°C

<sup>(1)</sup>  $V_{CCBx}$  refers to  $V_{CCB0}$  and  $V_{CCB1}$ .

### **ELECTRICAL CHARACTERISTICS**

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

DADAMETER	TEST CONDITIONS	V	V	$T_A = 25^{\circ}C$	$T_A = -40^{\circ}C$ to	85°C	UNIT
PARAMETER	TEST CONDITIONS	V <sub>CCA</sub>	V <sub>CCBx</sub>	TYP	MIN	MAX	UNII
		1.1 V	1.1 V		0.74		
$V_{OHA}$		1.4 V	1.4 V		V <sub>CCA</sub> × 0.67		
(DATA &	$I_{OH} = -20 \mu A,$ $V_{IBx} \ge V_{CCBx} - 0.2 V$	1.65 V	1.65 V		V <sub>CCA</sub> × 0.67		V
CMD)	VIBX = VCCBX U.2 V	2.3 V	2.3 V		V <sub>CCA</sub> × 0.67		
		3 V	3 V		V <sub>CCA</sub> × 0.67		
	$I_{OL} = 135 \mu A, V_{IBx} \le 0.15 V$	1.1 V	1.1 V			0.35	
$V_{OLA}$	$I_{OL} = 180 \mu A, V_{IBx} \le 0.15 V$	1.4 V	1.4 V			0.35	
(DATA &	I <sub>OL</sub> = 220 μA, V <sub>IBx</sub> ≤ 0.15 V	1.65 V	1.65 V			0.45	V
CMD)	I <sub>OL</sub> = 300 μA, V <sub>IBx</sub> ≤ 0.15 V	2.3 V	2.3 V			0.55	
	$I_{OL} = 620 \mu A, V_{IBx} \le 0.15 V$	3 V	3 V			0.70	
		1.1 V	1.1 V		0.74		
$V_{OHB}$		1.4 V	1.4 V		V <sub>CCBx</sub> × 0.67		
(DATA & $I_{OH} = -20 \mu A$ , $V_{IAx} \ge V_{CCAx} - 0.2 V$	$I_{OH} = -20 \mu A,$ $V_{IAX} \ge V_{CCAX} - 0.2 V$	1.65 V	1.65 V		$V_{CCBx} \times 0.67$		V
		2.3 V	2.3 V		$V_{CCBx} \times 0.67$		
		3 V	3 V		$V_{CCBx} \times 0.67$		
	$I_{OH} = -0.5 \text{ mA}$	1.1 V	1.1 V		0.74		
	I <sub>OH</sub> = - 1 mA	1.4 V	1.4 V		1.05		
V <sub>OHCLKB</sub>	I <sub>OH</sub> = - 2 mA	1.65 V	1.65 V		1.2		V
	I <sub>OH</sub> = - 4 mA	2.3 V	2.3 V		1.75		
	$I_{OH} = -8 \text{ mA}$	3 V	3 V		2.3		
	$I_{OL} = 135 \mu A, V_{IAx} \le 0.15 V$	1.1 V	1.1 V			0.35	
$V_{OLB}$	I <sub>OL</sub> = 180 μA, V <sub>IAx</sub> ≤ 0.15 V	1.4 V	1.4 V			0.35	
(DATA &	I <sub>OL</sub> = 220 μA, V <sub>IAx</sub> ≤ 0.15 V	1.65 V	1.65 V			0.45	V
CMD)	I <sub>OL</sub> = 300 μA, V <sub>IAx</sub> ≤ 0.15 V	2.3 V	2.3 V			0.55	
	$I_{OL} = 620 \mu A, V_{IAX} \le 0.15 V$	3 V	3 V			0.70	
	I <sub>OL</sub> = 0.5 mA	1.1 V	1.1 V			0.35	
	I <sub>OL</sub> = 1 mA	1.4 V	1.4 V			0.35	
/ <sub>OLCLKB</sub>	I <sub>OL</sub> = 2 mA	1.65 V 1.65 V 0.45			0.45		
	I <sub>OL</sub> = 4 mA	2.3 V	2.3 V			0.55	
	I <sub>OL</sub> = 8 mA	3 V	3 V			0.7	

## **ELECTRICAL CHARACTERISTICS (continued)**

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

DADAMETED	TEST COMPITIONS	V	V	T <sub>A</sub> = 25°C	$T_A = -40^{\circ}C$ to $85^{\circ}C$	LINUT
PARAMETER	TEST CONDITIONS	V <sub>CCA</sub>	V <sub>CCBx</sub>	TYP	MIN MAX	UNIT
	SEL, CLKA	1.1 V to 3.6 V	1.1 V to 3.6 V	±1	±2	^
11	DAT, CMD	1.1 V 10 3.6 V	1.1 V 10 3.6 V	±1	±2	μА
		1.1 V to 3.6 V	1.1 V to 3.6 V		12	
I <sub>CCA</sub>	$V_I = V_O = Open, I_O = 0,$ SEL, CLK = High or Low	3.6 V	0 V		12	μΑ
	oce, ocive riight of Low	0 V	3.6 V		-1	
		1.1 V to 3.6 V	1.1 V to 3.6 V		24	
I <sub>CCB0</sub> or I <sub>CCB1</sub>	$V_I = V_O = Open$ , $I_O = 0$ , $SEL$ , $CLK = High or Low$	3.6 V	0 V		-12	μΑ
ICCB1	OLL, OLK = High of Low	0 V	3.6 V		24	
C <sub>i</sub>	SEL, CLKA	3.3 V	3.3 V	2.5	3.5	pF
C	A port	221	221/	7	7.5	, r
C <sub>io</sub>	B port	3.3 V	3.3 V	9.5	10	pF

## **TIMING REQUIREMENTS**

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

	/ COA			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	LINIT	
				TYP	TYP	TYP	TYP	TYP	UNIT	
Data rate Clock		Push-pull dri	ving	60	80	120	120	120	N.41	
	Command	Open-drain driving		2	2	2	2	2	Mbps	
	Clock	Push-pull driving		30	40	60	60	60	MHz	
	Data	Push-pull driving		60	80	120	120	120	Mbps	
		Push-pull driving	CLK	17	13	8	8	8		
t <sub>w</sub>	Pulse duration	Open-drain driving	CMD	500	500	500	500	500	ns	
		Push-pull	Data	17	13	8	8	8		
		driving	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 <sub>CCB</sub> = 1.2 V	V <sub>CCB</sub> = ± 0.7		V <sub>CCB</sub> = 1.8 V ± 0.15 V		V <sub>CCB</sub> = 2.5 V ± 0.2 V		V <sub>CCB</sub> = 3.3 V ± 0.3 V		UNIT
				TYP	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
	Command	Push-pull dri	ving	60		80		120		120		120	Mhna
Data	Command	Open-drain o	Iriving	2		2		2		2		2	Mbps
rate	Clock	Push-pull dri	ving	30		40		60		60		60	MHz
	Data	Push-pull driving		60		80		120		120		120	Mbps
	1	Push-pull driving	CLK	17	13		8		8		8		
T T	Pulse duration	Open-drain driving	CMD	500	500		500		500		500		ns
		Push-pull	Data	17	13		8		8		8		
		driving	CMD	17	13		8		8		8		

## **TIMING REQUIREMENTS**

over recommended operating free-air temperature range, V<sub>CCA</sub> = 1.8 V ± 0.15 V (unless otherwise noted)

				V <sub>CCB</sub> = 1.2 V	V <sub>CCB</sub> = ± 0.7		V <sub>CCB</sub> = 1.8 V ± 0.15 V		V <sub>CCB</sub> = 2.5 V ± 0.2 V		V <sub>CCB</sub> = 3.3 V ± 0.3 V		UNIT
				TYP	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
	0	Push-pull dri	ving	60		80		120		120		120	Maria
Data	Command	Open-drain driving		2		2		2		2		2	Mbps
rate	Clock	Push-pull driving		30		40		60		60		60	MHz
	Data	Push-pull driving		60		80		120		120		120	Mbps
		Push-pull driving	CLK	17	13		8		8		8		
t <sub>w</sub>	Pulse duration	Open-drain driving	CMD	500	500		500		500		500		ns
		Push-pull	Data	17	13		8		8		8		
		driving	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 <sub>CCB</sub> = 1.2 V	V <sub>CCB</sub> = ± 0.1		V <sub>CCB</sub> = ± 0.1		V <sub>CCB</sub> = ± 0.2		V <sub>CCB</sub> = ± 0.3		UNIT
				TYP	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
	Command	Push-pull dri	ving	60		80		120		120		120	Mbps
Data	Command	Open-drain o	driving	2		2		2		2		2	Minhs
rate	Clock	Push-pull dri	ving	30		40		60		60		60	MHz
	Data	Push-pull dri	ving	60		80		120		120		120	Mbps
		Push-pull driving	CLK	17	13		8		8		8		
t <sub>w</sub>	Pulse duration	Open-drain driving	CMD	500	500		500		500		500		ns
		Push-pull	Data	17	13		8		8		8		
		driving	CMD	17	13		8		8		8		

## **TIMING REQUIREMENTS**

over recommended operating free-air temperature range, V<sub>CCA</sub> = 3.3 V ± 0.3 V (unless otherwise noted)

				V <sub>CCB</sub> = 1.2 V	V <sub>CCB</sub> = ± 0.7		V <sub>CCB</sub> = ± 0.1		V <sub>CCB</sub> = ± 0.2		V <sub>CCB</sub> = ± 0.3		UNIT
				TYP	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
	C	Push-pull dri	ving	60		80		120		120		120	Mha
Data	Command	Open-drain o	driving	2		2		2		2		2	Mbps
rate	Clock	Push-pull dri	ving	30		40		60		60		60	MHz
	Data	Push-pull dri	ving	60		80		120		120		120	Mbps
		Push-pull driving	CLK	17	13		8		8		8		
t <sub>w</sub>	Pulse duration	Open-drain driving	CMD	500	500		500		500		500		ns
		Push-pull	Data	17	13		8		8		8		
		driving	CMD	17	13		8		8		8		



## **SWITCHING CHARACTERISTICS**

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

PARAMETER	FROM	то	TEST	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
PARAMETER	(INPUT)	(OUTPUT)	CONDITIONS	TYP	TYP	TYP	TYP	TYP	UNII
	CMDA	CMDB	Push-pull driving	5.9	4.8	4.4	4	4.46	
	CIVIDA	CIVIDB	Open-drain driving	238	214	192	159	140	
	CMDB	CMDA	Push-pull driving	5.6	4.8	4.4	4.1	4	
	CIVIDB	CIVIDA	Open-drain driving	227	201	176	137	114	no
t <sub>PD</sub>	CLKA	CLKB	Push-pull driving	5.5	4.1	3.6	3.2	3	ns
	DATA	DATB	Push-pull driving	5.8	4.8	4.4	4.2	6.8	
	DATB	DATA	Push-pull driving	5.6	4.8	4.4	4.1	4	
	SEL	B-Port	Push-pull driving	13	11	10	9.4	9.1	
t <sub>rA</sub>	A-port	rise time	Push-pull driving	4.8	5.1	5.1	5.3	5.7	
t <sub>rB</sub>	B-port	rise time	Push-pull driving	6.1	3.8	2.9	1.9	1.5	
t <sub>rB</sub>	CLKA	CLKB	Push-pull driving	5.2	3.4	2.6	1.7	1.3	
t <sub>fA</sub>	A-port	fall time	Push-pull driving	3.4	2.8	2.6	2.6	2.6	ns
t <sub>fB</sub>	B-port	fall time	Push-pull driving	4.2	3	2.3	1.7	1.5	
t <sub>fB</sub>	CLKA	CLKB	Push-pull driving	3.1	2.1	1.6	1.2	1	
	ChA-to-	ChB skew	Push-pull driving	0.4	0.4	0.3	0.4	0.4	
tura	ChB-to-	ChA skew	Push-pull driving	0.3	0.3	0.3	0.3	0.4	ns
t <sub>sk(O)</sub>		el-to-Clock kew	Push-pull driving	1.68	1.5	1.5	1.5	1.7	113
			Push-pull driving	60	80	120	120	120	
Marrialata wata	Con	nmand	Open-drain driving	2	2	2	2	2	Mbps
Max data rate	С	lock	Push-pull driving	30	40	60	60	60	MHz
	D	ata	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 <sub>CCB</sub> = 1.2 V	V <sub>CCB</sub> = ± 0.1	1.5 V V	V <sub>CCB</sub> = 1 ± 0.15		V <sub>CCB</sub> = ± 0.2		V <sub>CCB</sub> = ± 0.3		UNIT
	(INFUI)	(OUTPUT)	CONDITIONS	TYP	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
	CMDA	CMDB	Push-pull driving	5.1		13		9		8		7.5	
	CIVIDA	CIVIDB	Open-drain driving	210		777		756		684		758	
	CMDB	CMDA	Push-pull driving	4.5		10.6		9.2		8.5		8.2	
	CIVIDB	CIVIDA	Open-drain driving	200		616		560		433		375	ns
t <sub>PD</sub>	CLKA	CLKB	Push-pull driving	4.7		13.1		9.8		6		5.2	115
	DATA	DATB	Push-pull driving	5.1		13		9		8		7.8	
	DATB	DATA	Push-pull driving	4.5		11		9.3		8.8		8.4	
	SEL	B-Port	Push-pull driving	9.5		26		21		19		18	
t <sub>rA</sub>	A-port	rise time	Push-pull driving	2.7	1.5	5.8	1.7	5.9	1.7	6	1.8	6.1	
t <sub>rB</sub>	B-port	rise time	Push-pull driving	3.3	1.7	8.2	1.3	6.6	1	4.3	0.8	2.9	ns
t <sub>rB</sub>	CLKA	CLKB	Push-pull driving	5.2	1.7	6.4	1.3	4.9	0.9	3.2	0.8	2.5	
t <sub>fA</sub>	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 <sub>fB</sub>	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 <sub>fB</sub>	CLKA	CLKB	Push-pull driving	3.1	0.9	4.1	0.8	3.2	0.5	2.2	0.5	1.9	
	ChA-to-	ChB skew	Push-pull driving	0.32		0.47		0.58		0.63		0.63	
t <sub>sk(O)</sub>	ChB-to-	ChA skew	Push-pull driving	0.27		0.24		0.23		0.22		0.22	ns
*SK(O)		el-to-Clock kew	Push-pull driving	1.47		1.66		1.68		1.82		1.77	
	0		Push-pull driving	60		80		120		120		120	Maria
May data rat-	Con	nmand	Open-drain driving	2		2		2		2		2	Mbps
Max data rate	С	lock	Push-pull driving	30		40		60		60		60	MHz
	D	ata	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 <sub>CCB</sub> = 1.2 V	V <sub>CCB</sub> = ± 0.1	1.5 V V	V <sub>CCB</sub> = ± 0.15		V <sub>CCB</sub> = : ± 0.2	2.5 V V	V <sub>CCB</sub> = ± 0.3		UNIT
	(INPUT)	(001701)	CONDITIONS	TYP	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
	CMDA	CMDB	Push-pull driving	4.8		12		8		6		5.7	
	CIVIDA	CIVIDB	Open-drain driving	183		726		715		686		780	
	CMDB	CMDA	Push-pull driving	4		9		7		6.4		6	
	CIVIDB	CIVIDA	Open-drain driving	175		565		563		441		392	
t <sub>PD</sub>	CLKA	CLKB	Push-pull driving	4.5		13		9		5.4		4.5	ns
	DATA	DATB	Decelor and definition	4.7		12		8.4		6		5.8	
	DATB	DATA	Push-pull driving	4.1		9		7.5		6.4		6.3	
	SEL	B-Port	Push-pull driving	8.2		22		17		14.8		14	
t <sub>rA</sub>	A-port	rise time	Push-pull driving	2	1.1	4	1.1	4.3	1.2	4.5	1.3	4.6	
t <sub>rB</sub>	B-port	rise time	Push-pull driving	6.2	1.7	7.9	1.2	6.2	1	4.3	8.0	3.1	ns
t <sub>rB</sub>	CLKA	CLKB	Push-pull driving	5.2	1.7	6.4	1.3	4.9	0.9	3.2	8.0	2.5	
t <sub>fA</sub>	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	
	ChA-to-	ChB skew	Push-pull driving	0.33		0.45		0.48		0.53		0.67	
t <sub>sk(O)</sub>	ChB-to-	ChA skew	Push-pull driving	0.28		0.24		0.23		0.23		0.22	ns
*SK(O)		el-to-Clock kew	Push-pull driving	1.51		1.58		1.46		1.56		1.48	110
	0	d	Push-pull driving	60		80		120		120		120	Misses
NA	Con	nmand	Open-drain driving	2		2		2		2		2	Mbps
Max data rate	С	lock	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 <sub>CCB</sub> = 1.2 V	V <sub>CCB</sub> = ± 0.1		V <sub>CCB</sub> = ± 0.15		V <sub>CCB</sub> = ± 0.2	2.5 V ! V	V <sub>CCB</sub> = ± 0.3		UNIT
	(INPUT)	(OUTPUT)	CONDITIONS	TYP	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
	CMDA	CMDB	Push-pull driving	4.4		11		7.4		4.4		3.8	
	CIVIDA	CIVIDB	Open-drain driving	143		544		596		605		669	
	CMDB	CMDA	Push-pull driving	3.8		7.6		5.5		4.2		3.7	
	CIVIDB	CIVIDA	Open-drain driving	137		434		444		414		372	20
t <sub>PD</sub>	CLKA	CLKB	Push-pull driving	4.1		12		8		4.8		3.8	ns
	DATA	DATB	Duck pull deising	4.4		11		7		4.5		3.8	
	DATB	DATA	Push-pull driving	4.4		8		5.5		4.1		3.7	
	SEL	B-Port	Push-pull driving	7		18		13		10.5		9	
t <sub>rA</sub>	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	
t <sub>rB</sub>	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	ns
t <sub>rB</sub>	CLKA	CLKB	Push-pull driving	5.2	1.67	6.4	1.27	4.9	0.9	3.2	0.76	2.6	
t <sub>fA</sub>	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 <sub>fB</sub>	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	
	ChA-to-	ChB skew	Push-pull driving	0.41		0.43		0.39		0.59		0.68	
t <sub>sk(O)</sub>	ChB-to-	ChA skew	Push-pull driving	0.41		0.24		0.2		0.19		0.18	ns
*SK(O)		el-to-Clock kew	Push-pull driving	2.11		1.47		1.3		1.25		1.21	110
	0		Push-pull driving	60		80		120		120		120	Misse
Man data as	Con	nmand	Open-drain driving	2		2		2		2		2	Mbps
Max data rate	С	lock	Push-pull driving	30		40		60		60		60	MHz
		ata	Push-pull driving	60		80		120		120		120	Mbps



### **SWITCHING CHARACTERISTICS**

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

PARAMETER	FROM	TO (OUTPUT)	TEST	V <sub>CCB</sub> = 1.2 V	V <sub>CCB</sub> = ± 0.1	1.5 V V	V <sub>CCB</sub> = ± 0.15		V <sub>CCB</sub> = ± 0.2		V <sub>CCB</sub> = ± 0.3		UNIT
	(INPUT)	(OUTPUT)	CONDITIONS	TYP	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
	CMDA	CMDB	Push-pull driving	4.4		11		7		4.1		3.3	
	CIVIDA	CIVIDB	Open-drain driving	116		432		477		506		533	
	CMDB	CMDA	Push-pull driving	4.2		7.5		5.4		3.8		3	
•	CIVIDB	CIVIDA	Open-drain driving	112		349		363		347		324	ns
t <sub>PD</sub>	CLKA	CLKB	Push-pull driving	4.1		12		7.8		4.4		3.5	115
	DATA	DATB	Push-pull driving	4.3		11		6.8		4		3.8	
	DATB	DATA	r usii-puii uiiviiig	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 <sub>rA</sub>	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	
t <sub>rB</sub>	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	ns
t <sub>rB</sub>	CLKA	CLKB	Push-pull driving	5.2	1.67	6.4	1.26	4.9	0.91	3.3	0.76	2.5	
t <sub>fA</sub>	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 <sub>fB</sub>	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 <sub>fB</sub>	CLKA	CLKB	Push-pull driving	3.1	0.92	4.1	0.79	3.2	0.56	2.2	0.49	1.9	
	ChA-to-	ChB skew	Push-pull driving	0.39		0.36		0.39		0.57		0.65	
t <sub>sk(O)</sub>	ChB-to-	ChA skew	Push-pull driving	0.45		0.3		0.19		0.19		0.18	ns
*SK(O)		el-to-Clock kew	Push-pull driving	1.7		1.61		1.34		1.22		1.14	
	0		Push-pull driving	60		80		120		120		120	Misses
May data rata	Con	nmand	Open-drain driving	2		2		2		2		2	Mbps
Max data rate	С	lock	Push-pull driving	30		40		60		60		60	MHz
	D	ata	Push-pull driving	60		80		120		120		120	Mbps

### **OPERATING CHARACTERISTICS**

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

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

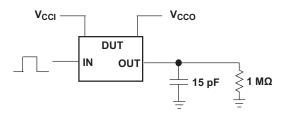
#### **POWER-UP CONSIDERATIONS**

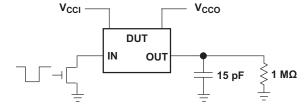
The following power-up sequence for this TXS02612 SDIO port expander with voltage-level translator should be followed to ensure proper operation and to avoid any unnecessary excessive supply current, bus contention, oscillations, or other anomalies caused by improperly biased device pins. The following 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<sub>CCA</sub>, 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  $B_1$  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



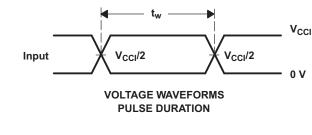


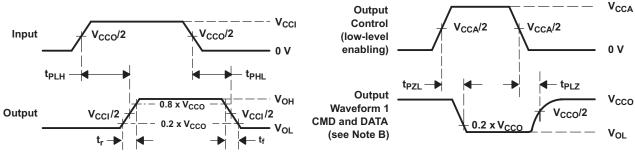
DATA RATE, PULSE DURATION, PROPAGATION DELAY, ENABLE/DISABLE
OUTPUT RISE AND FALL TIME MEASUREMENT USING
A PUSH-PULL DRIVER

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

**VOLTAGE WAVEFORMS** 

**ENABLE AND DISABLE TIMES** 





NOTES:

- : A. C<sub>L</sub> includes probe and jig capacitance.
  - B. Waveform 1 is for an output with internal conditions such that the output is lowexcept when disabled by the output control. Waveform2 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  $_{\rm O}=50\Omega$ , dv/dt $\geq$  1 V/ns.
  - D. The outputs are measured one at a time, with one transition per measurement.
  - E.  $t_{PLZ}$  and  $t_{HZ}$  are the same as  $t_{is}$ .
  - F.  $t_{PZL}$  and  $t_{PZH}$  are the same as  $t_{PL}$ .
  - G. t<sub>PLH</sub> and t<sub>HL</sub> are the same as t<sub>d</sub>.
  - H.  $V_{CCI}$  is the  $V_{CC}$  associated with the input port.
  - I.  $V_{CCO}$  is the  $V_{CC}$  associated with the output port.

**VOLTAGE WAVEFORMS** 

PROPAGATION DELAY TIMES

J. All parameters and waveforms are not applicable to all devices.

Figure 1. Load Circuit and Voltage Waveforms

#### PACKAGE OPTION ADDENDUM

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#### **PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins I	Package Qty	e 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

(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) 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)

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

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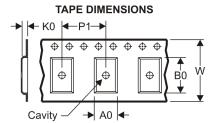
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## PACKAGE MATERIALS INFORMATION

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## TAPE AND REEL INFORMATION





A0	Dimension designed to accommodate the component width
В0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

## QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



#### \*All dimensions are nominal

Device	Package Type	Package Drawing		SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TXS02612ZQSR	BGA MI CROSTA R JUNI OR	ZQS	24	2500	330.0	12.4	3.3	3.3	1.6	8.0	12.0	Q1

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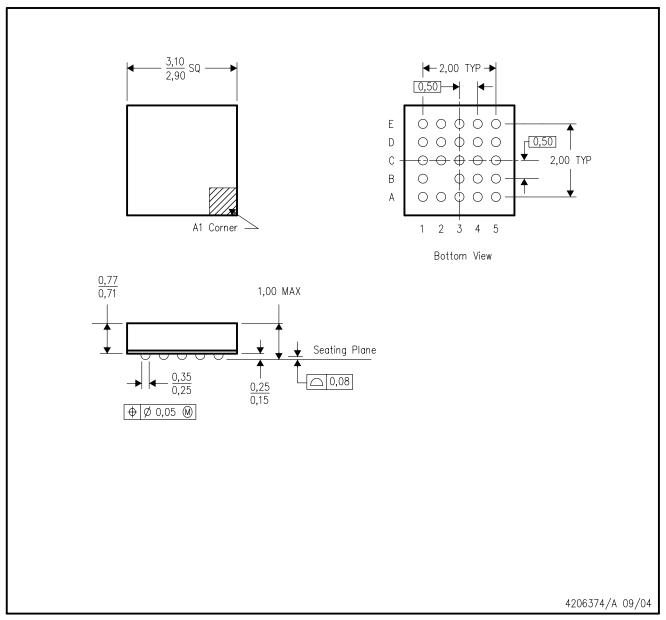


#### \*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TXS02612ZQSR	BGA MICROSTAR JUNIOR	ZQS	24	2500	340.5	338.1	20.6

# ZQS (S-PBGA-N24)

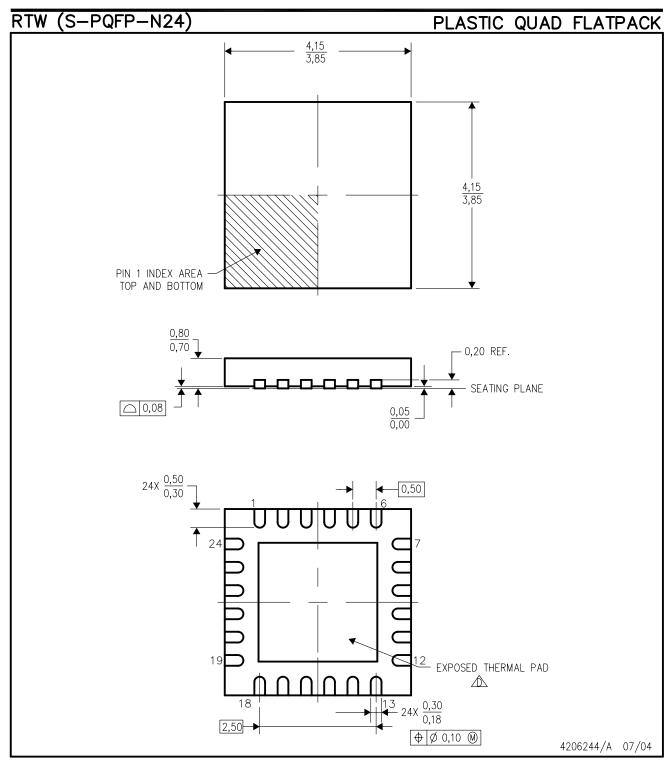
## PLASTIC BALL GRID ARRAY



NOTES: All linear dimensions are in millimeters.

- This drawing is subject to change without notice.
- C. Falls within JEDEC MO-225
- D. This package is lead-free.





- 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.

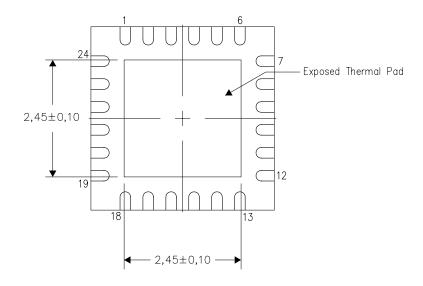


#### THERMAL INFORMATION

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, QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271. This document is available at www.ti.com.

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



Bottom View

Exposed Thermal Pad Dimensions

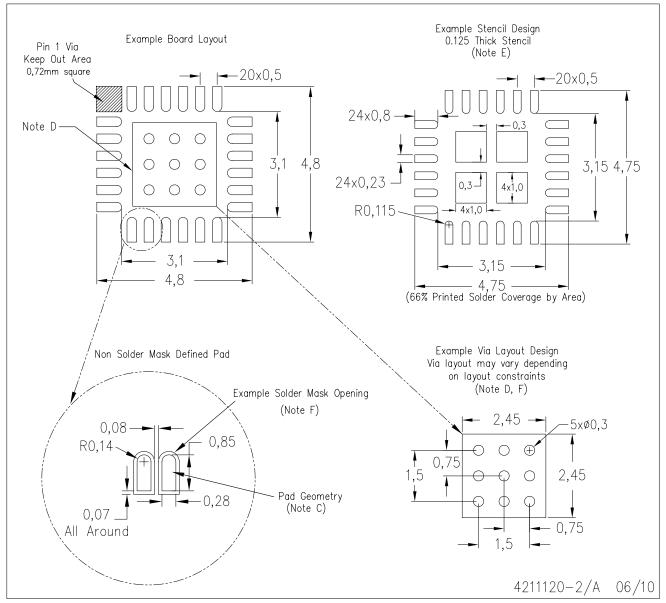
#### NOTES:

1) All linear dimensions are in millimeters



## RTW (S-PWQFN-N24)

## PLASTIC QUAD FLATPACK NO-LEAD



NOTES:

- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. Publication IPC-7351 is recommended for alternate designs.
- D. This package is designed to be soldered to a thermal pad on the board. Refer to Application Note, Quad Flat—Pack Packages, Texas Instruments Literature No. SLUA271, and also the Product Data Sheets for specific thermal information, via requirements, and recommended board layout. These documents are available at www.ti.com <a href="http://www.ti.com">www.ti.com</a>.
- E. 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 stencil design considerations.
- F. Customers should contact their board fabrication site for recommended solder mask tolerances and via tenting recommendations for vias placed in the thermal pad.



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