

FEATURES

- Offers Bandwidth Allocation of PCI Express™ Signal Using Two-Lane 1:2 Multiplexer/Demultiplexer
- Vcc Operating Range From 1.7 V to 1.9 V
- Supports Data Rates of 2.5 Gbps
- Port-Port Crosstalk (–39 dB at 1.25 GHz)
- OFF Port Isolation (–38 dB at 1.25 GHz)
- Low ON-State Resistance (10 Ω Typ)
- Low Input/Output Capacitance (3.5 pF Typ)
- Excellent Differential Skew (5 ps Max)
- Minimal Propagation Delay
- ESD Performance Tested Per JESD 22
 - 2000-V Human-Body Model (A114-B, Class II)
 - 1000-V Charged-Device Model (C101)

DESCRIPTION/ORDERING INFORMATION

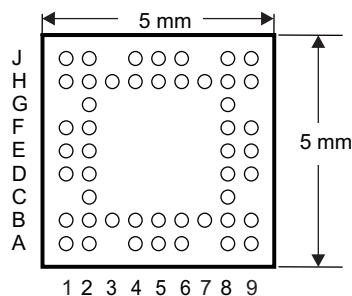
The TS2PCIE2212 can be used to muxitplex/demultiplex two PCI Express™ lanes, each representing differential pairs of receive (RX) and transmit (TX) signals. The switch operates at the PCI Express bandwidth standard of 2.5-Gbps signal-processing speed. The device is composed of two banks, with each bank accommodating two sources (source A and source B) and two destinations (destination A and destination B).

When a logic-level low is applied to the control (CTRL) pin, source A is connected to destination A and source B is connected to destination B. When a logic-level high is applied to CTRL, source A is connected to destination B, while source B and destination A are open.

ORDERING INFORMATION

T _A	PACKAGE		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 85°C	BGA – ZAH	Tape and reel	TS2PCIE2212ZAHR	

ZAH PACKAGE
(BOTTOM VIEW)



TERMINAL ASSIGNMENTS

	1	2	3	4	5	6	7	8	9
A	CTRL0	TxSB:0P		TxSA:0P	GND	TxDA:0P		TxDB:0P	NC
B	RxSA:0P	GND	TxSB:0N	TxSA:0N	VDD	TxDA:0N	TxDB:0N	GND	RxDA:0P
C		RxSA:0N						RxDA:0N	
D	RxSB:0P	RxSB:0N						RxDB:0N	RxDB:0P
E	GND	VDD						VDD	GND
F	TxSA:1P	TxSA:1N						TxDA:1N	TxDA:1P
G		TxSB:1N						TxDB:1N	
H	TxSB:1P	GND	RxSA:1N	RxSB:1N	VDD	RxDB:1N	RxDA:1N	GND	TxDB:1P
J	NC	RxSA:1P		RXSB:1P	GND	RXDB:1P		RxDA:1P	CTRL1



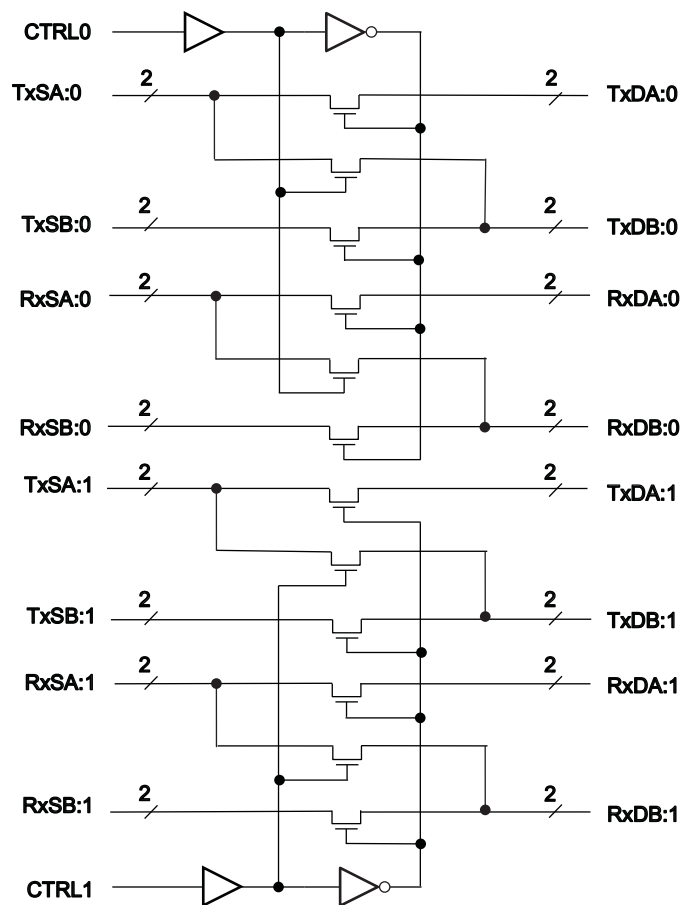
Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

PCI Express is a trademark of PCI-SIG.

PIN DESCRIPTION

NAME	FUNCTION
TxSA:nP, TxSA:nN	Source A transmit pair
RxSA:nP, RxSA:nN	Source A receive pair
TxSB:nP, TxSB:nN	Source B transmit pair
RxSB:nP, RxSB:nN	Source B receive pair
TxDA:nP, TxDA:nN	Destination A transmit pair
RxDA:nP, RxDA:nN	Destination A receive pair
TxDB:nP, TxDB:nN	Destination B transmit pair
RxDB:nP, RxDB:nN	Destination B receive pair
CTRL0	Control signal for bank 0
CTRL1	Control signal for bank 1
V _{DD}	Positive supply voltage
GND	Ground (0 V)
NC	No internal connection

LOGIC DIAGRAM



FUNCTION TABLE

CTRLn	FUNCTION
L	SA:n = DA:n, SB:n = DB:n
H	SA:n = DB:n, DA:n = open, SBin = open

Absolute Maximum Ratings⁽¹⁾

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

		MIN	MAX	UNIT
V _{DD}	Supply voltage range	-0.5	2.5	V
V _{IN}	Control input voltage range ⁽²⁾⁽³⁾	-0.5	2.5	V
V _{I/O}	Switch I/O voltage range ⁽²⁾⁽³⁾⁽⁴⁾	-0.5	2.5	V
I _{IK}	Control input clamp current	V _{IN} < 0 and V _{I/O} < 0		50 mA
I _{I/O} K	I/O port clamp current	V _{IN} < 0 and V _{I/O} < 0		50 mA
I _{I/O}	ON-state switch current ⁽⁵⁾		±100	mA
	Continuous current through V _{DD} or GND		±100	mA
θ _{JA}	Package thermal impedance ⁽⁶⁾		TBD	°C/W
T _{stg}	Storage temperature range	-65	150	°C

- (1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltages are with respect to ground, unless otherwise specified.
- (3) The input and output voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
- (4) V_I and V_O are used to denote specific conditions for V_{I/O}.
- (5) I_I and I_O are used to denote specific conditions for I_{I/O}.
- (6) The package thermal impedance is calculated in accordance with JESD 51-7.

Recommended Operating Conditions

		MIN	TYP	MAX	UNIT
V _{DD}	Supply voltage	1.7	1.8	1.9	V
V _{IH}	High-level control input voltage	CTRL		0.65 V _{DD}	V
V _{IL}	Low-level control input voltage	CTRL		0.35 V _{DD}	V
V _{IO}	Data input/output voltage	0		V _{DD}	V
T _A	Operating free-air temperature	0		85	°C

Electrical Characteristics

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

PARAMETER		TEST CONDITIONS		T _A = 0°C to 85°C			UNIT
				MIN	TYP	MAX	
V _{IK}	Control inputs	V _{DD} = 1.7 V,	I _{IN} = -18 mA			-1.8	V
I _{IN}	Control inputs	V _{DD} = 1.9 V,	V _{IN} = V _{DD} or GND			±1	μA
I _{OZ}		V _{DD} = 1.9 V,	V _O = 0 to 1.9 V, V _I = 0, Switch OFF			±5	μA
I _{CC}		V _{DD} = 1.9 V, V _{IN} = V _{DD} or GND,	I _{I/O} = 0, Switch ON or OFF	160	300		μA
C _{in}	Control inputs	V _{DD} = 1.9 V,	V _{IN} = V _{DD} or GND	0.5	1.0		pF
C _{IO(OFF)}	SB or DA port	V _{I/O} = 0 V,	Switch OFF	1.4	1.5		pF
C _{IO(ON)}		V _{I/O} = 0 V,	Switch ON	3.5	4		pF
r _{on}		V _{DD} = 1.7 V,	V _I = 0 V, I _O = 10 mA	10	14		Ω
		V _{DD} = 1.7 V,	V _I = 1.5 V, I _O = -10 mA	12	17		
Δr _{on(flat)}		V _{DD} = 1.7 V,	I _O = 10 mA, V _I = 1.5 V ± 0.4 V	2.5	5		Ω

Switching Characteristics

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

PARAMETER	DESCRIPTION	TEST CONDITIONS	T _A = 0°C to 85°C			UNIT
			MIN	TYP	MAX	
DR	Data rate per TX or RX pair			2.5		Gbps
t _{pd}	Propagation delay, Sx to Dx	See Figure 7		250		ps
t _{sk}	Intra-pair skew	f = 1.25 GHz, See Figure 7			5	ps
t _{en} (t _{PZL} , t _{PZH})	Switch turn-on delay, CTRL to DA	See Figure 6			5	ns
t _{dis} (t _{PLZ} , t _{PHZ})	Switch turn-off delay, CTRL to DA	See Figure 6			2.5	ns
I _{LOSS}	Differential insertion loss	f = 1.25 GHz, R _{LOAD} = 50 Ω, See Figure 1		-2.5	-3.2	dB
R _{LOSS}	Differential return loss	f = 1.25 GHz, R _{LOAD} = 50 Ω, See Figure 2	-7.2	-9.5		dB
I _{LOSS(CM)}	Common-mode insertion loss	f = 1.25 GHz, R _{LOAD} = 50 Ω, See Figure 3		-2		dB
O _{IFF}	Differential OFF isolation	f = 1.25 GHz, R _{LOAD} = 50 Ω, See Figure 4	-33	-38		dB
X _{TALK}	Differential crosstalk	f = 1.25 GHz, R _{LOAD} = 50 Ω, See Figure 5	-33	-39		dB

OPERATING CHARACTERISTICS

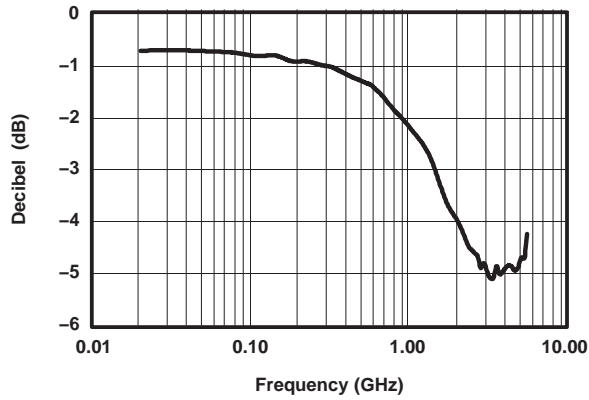


Figure 1. Differential Insertion Loss vs Frequency

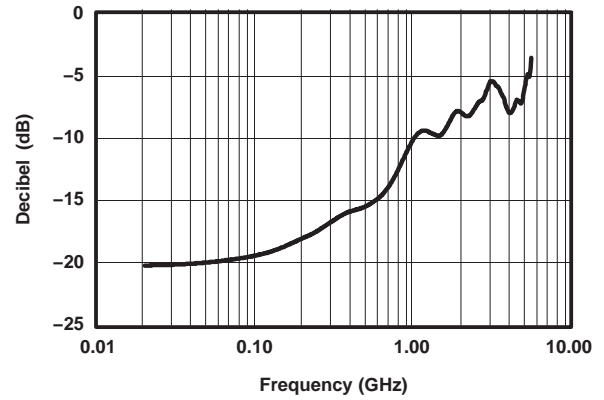


Figure 2. Differential Return Loss vs Frequency

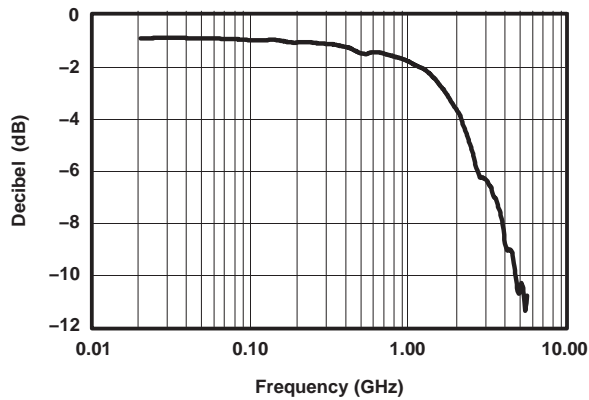


Figure 3. Common-Mode Insertion Loss vs Frequency

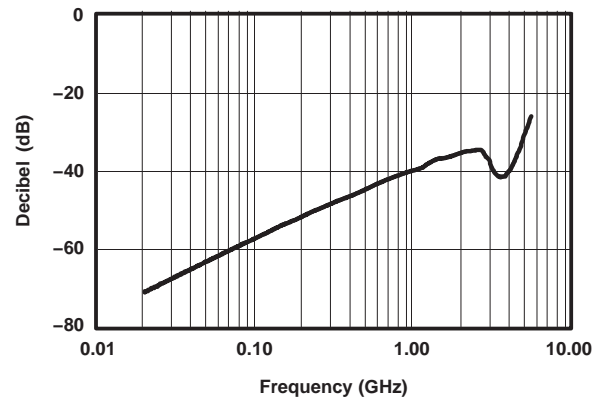


Figure 4. Differential OFF Isolation vs Frequency

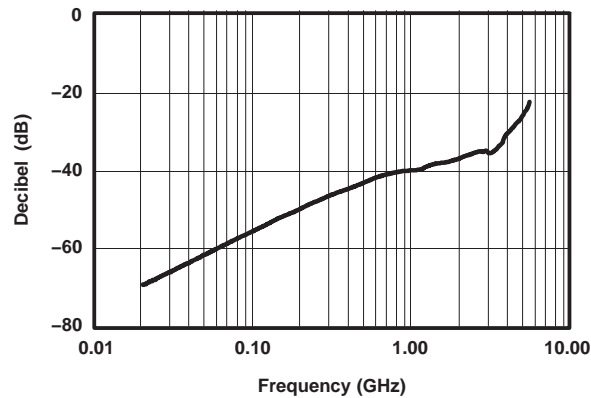
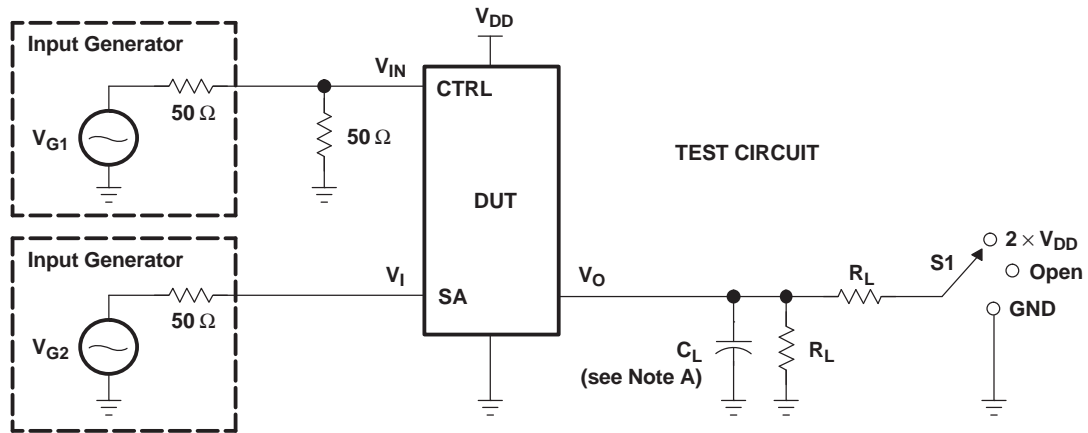
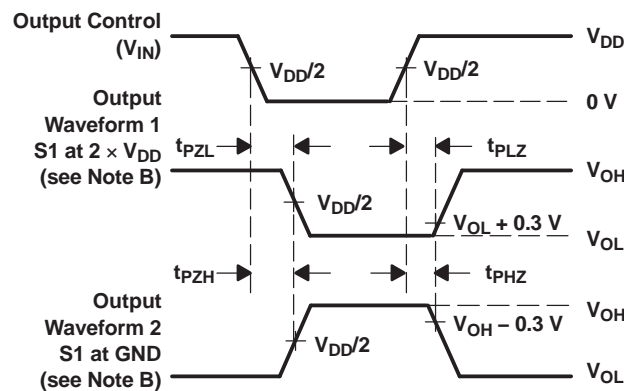


Figure 5. Differential Crosstalk vs Frequency

PARAMETER MEASUREMENT INFORMATION
(Enable and Disable Times)



TEST	V _{CC}	S1	R _L	V _I	C _L	V _Δ
t _{PLZ} /t _{PZL}	1.8 V ± 0.1 V	2 × V _{DD}	100 Ω	GND	No Load	0.3 V
t _{PHZ} /t _{PZH}	1.8 V ± 0.1 V	GND	100 Ω	V _{DD}	No Load	0.3 V

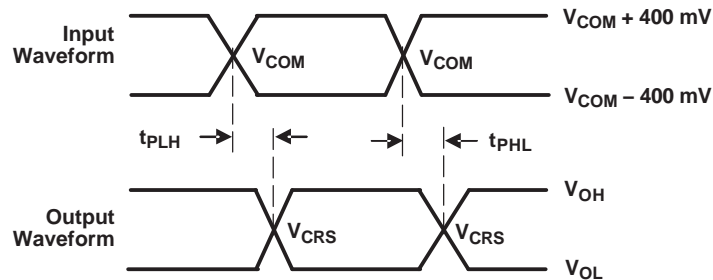
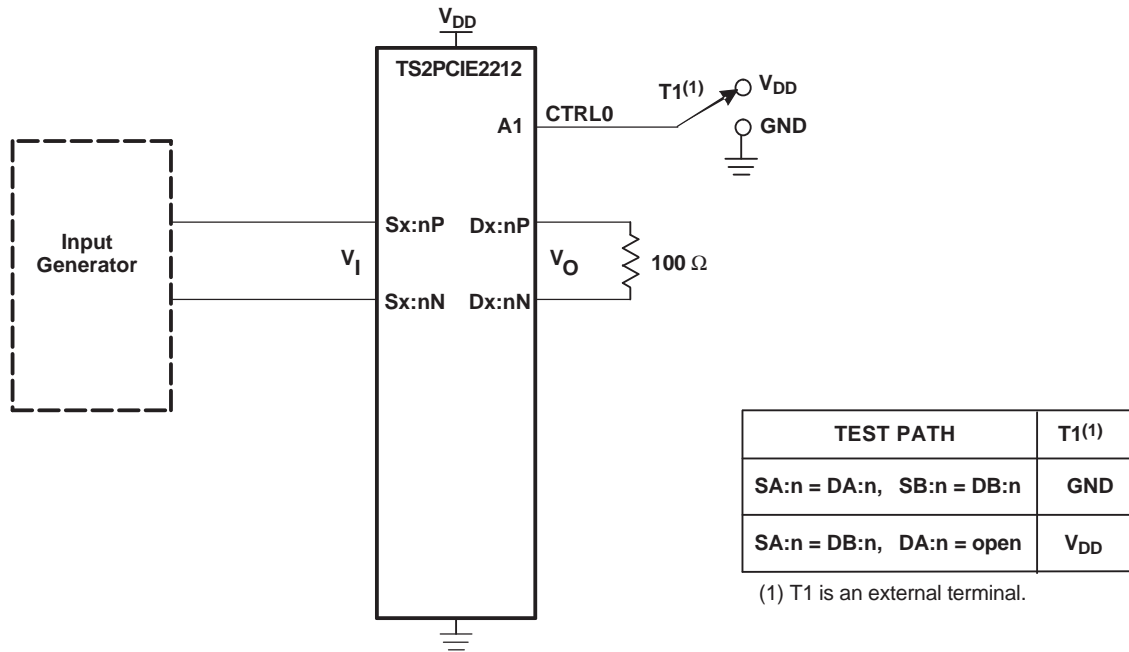


VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

- 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 Ω, t_r ≤ 2.5 ns, t_f ≤ 2.5 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}.

Figure 6. Test Circuit and Voltage Waveforms

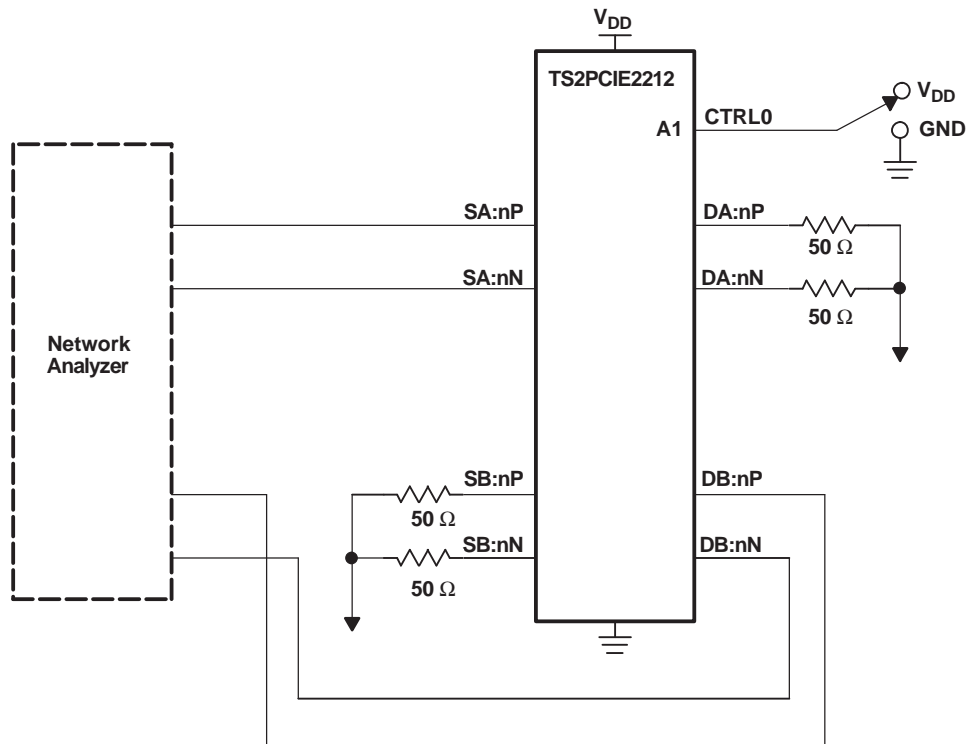
PARAMETER MEASUREMENT INFORMATION



$V_{COM} = 1.5\text{ V}$
 V_{CRS} is the cross point of the differential signal.
 $t_{sk} = |t_{PLHn} - t_{PHLn}|$

Figure 7. Test Circuit for Propagation Delay and Intra-Pair Skew

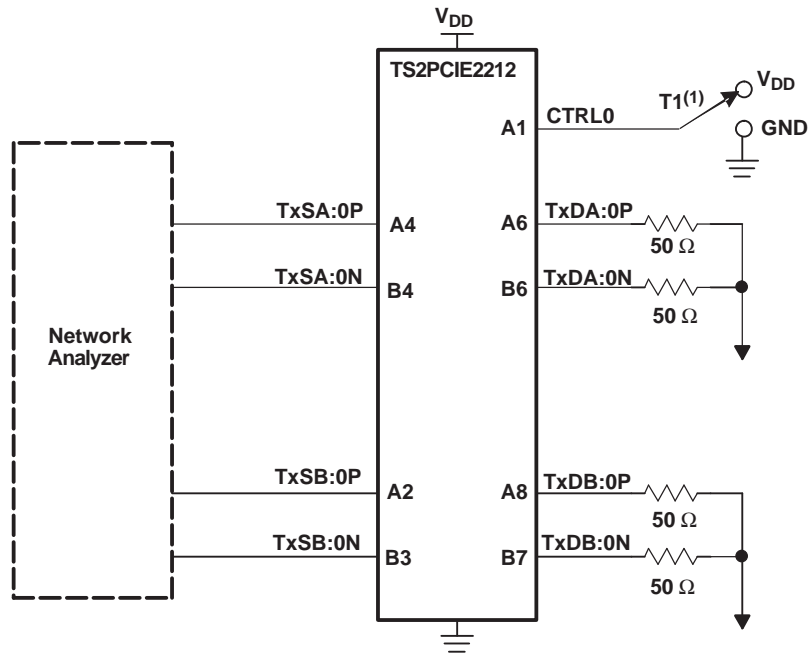
PARAMETER MEASUREMENT INFORMATION (continued)



TEST	VNA MEASUREMENT
Differential insertion loss	S_{21}
Differential return loss	S_{11}
Common-mode insertion loss	S_{21}

Figure 8. Differential Insertion Loss, Differential Return Loss, and Common-Mode Insertion Loss Test Circuit

PARAMETER MEASUREMENT INFORMATION (continued)



TEST	T1 ⁽¹⁾
Differential crosstalk	GND
Differential OFF isolation	V _{DD}

(1) T1 is an external terminal.

Figure 9. Differential Crosstalk and OFF Isolation Test Circuit

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
TS2PCIE2212ZAHR	ACTIVE	NFBGA	ZAH	48	3000	Pb-Free (RoHS)	SNAGCU	Level-3-260C-168 HR
TS2PCIE2212ZAHRG1	ACTIVE	NFBGA	ZAH	48	3000	Green (RoHS & no Sb/Br)	SNAGCU	Level-3-260C-168 HR

⁽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)

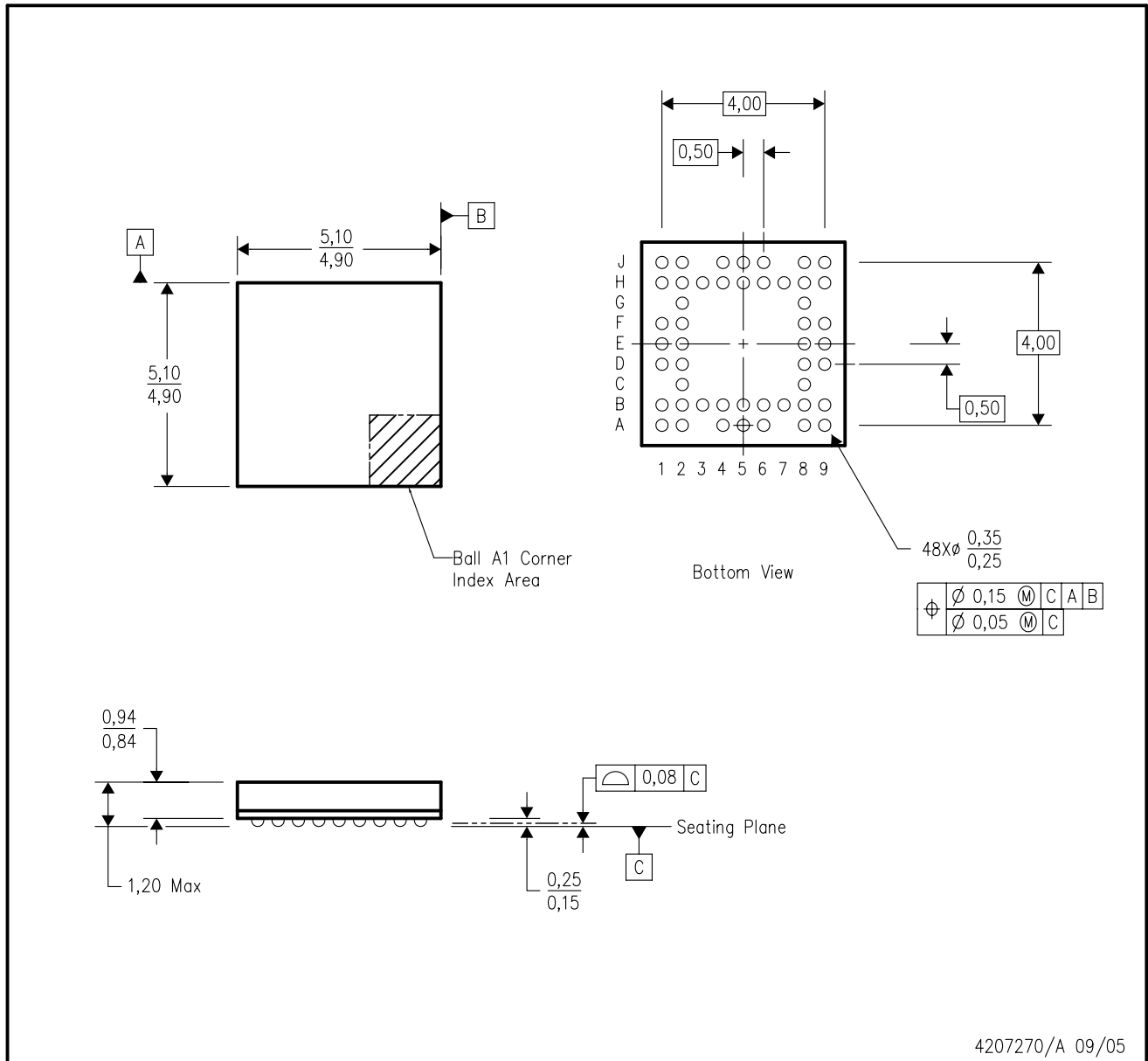
⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

Important Information and Disclaimer:The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

ZAH (S-PBGA-N48)

PLASTIC BALL GRID ARRAY



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. JEDEC MO-225 registration is pending.
 - D. This is a lead-free solder ball design.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products

Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
RF/IF and ZigBee® Solutions	www.ti.com/lprf

Applications

Audio	www.ti.com/audio
Automotive	www.ti.com/automotive
Broadband	www.ti.com/broadband
Digital Control	www.ti.com/digitalcontrol
Medical	www.ti.com/medical
Military	www.ti.com/military
Optical Networking	www.ti.com/opticalnetwork
Security	www.ti.com/security
Telephony	www.ti.com/telephony
Video & Imaging	www.ti.com/video
Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2008, Texas Instruments Incorporated