



5.0Gbps PCI Express Passive Switches

MAX4888A/MAX4889A

General Description

The MAX4888A/MAX4889A high-speed passive switches route PCI Express® (PCIe) data between two possible destinations. The MAX4888A is a quad single-pole/double-throw (4 x SPDT) switch ideally suited for switching two half lanes of PCIe data between two destinations. The MAX4889A is an octal single-pole/double-throw (8 x SPDT) switch ideal for switching four half lanes of PCIe data between four destinations. The MAX4888A/MAX4889A feature a single digital control input (SEL) to switch signal paths.

The MAX4888A/MAX4889A are fully specified to operate from a single 3.0V to 3.6V power supply and also operate down to +1.65V. The MAX4888A is available in a 3.5mm x 5.5mm, 28-pin TQFN package. The MAX4889A is available in a 3.5mm x 9.0mm, 42-pin TQFN package. Both devices operate over the -40°C to +85°C temperature range.

Applications

- Desktop Computers
- Servers/Storage Area Networks
- Laptops

PCI Express is a registered trademark of PCI-Sig Corp.

Features

- ◆ Single 1.65V to 3.6V Power-Supply Voltage
- ◆ Low Same-Pair Skew of 7ps
- ◆ Low 120µA (Max) Quiescent Current
- ◆ Supports PCIe Gen I and Gen II Data Rates
- ◆ Flow-Through Pin Configuration for Ease of Layout
- ◆ Industry-Compatible Pinout
- ◆ Lead-Free Packaging

Ordering Information/Selector Guide

PART	PIN-PACKAGE	CONFIGURATION	PKG CODE
MAX4888AETI+	28 TQFN-EP*	Two Half Lanes	T283555-1
MAX4889AETO+	42 TQFN-EP*	Four Half Lanes	T423590M-1

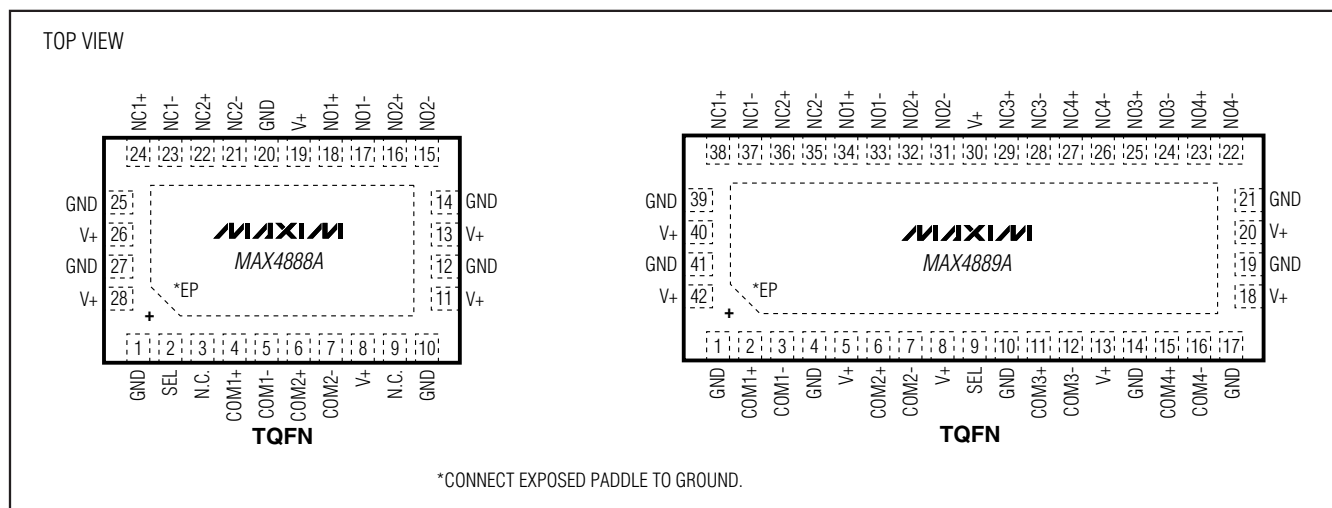
Note: All devices are specified over the -40°C to +85°C operating temperature range.

+ Denotes lead-free package.

*EP = Exposed paddle.

Typical Application Circuit appears at end of data sheet.

Pin Configurations



For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

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ABSOLUTE MAXIMUM RATINGS

(All voltages referenced to GND, unless otherwise noted.)

V+	.....-0.3V to +4V
SEL, COM__, NO__, NC__ (Note 1)	.....-0.3V to (V+ + 0.3V)
I COM__ - NO__ I, I COM__ - NC__ I (Note 1)	.....0 to 2V
Continuous Current (COM__ to NO__/NC__)	.....±70mA
Peak Current (COM__ to NO__/NC__)	
(pulsed at 1ms, 10% duty cycle)	.....±70mA
Continuous Current (SEL)	.....±30mA
Peak Current (SEL)	
(pulsed at 1ms, 10% duty cycle)	.....±150mA

Continuous Power Dissipation (T_A = +70°C)

28-Pin TQFN (derate 20.8mW/°C above +70°C)	.....1666.7mW
42-Pin TQFN (derate 35.7mW/°C above +70°C)	.....2857.1mW
Operating Temperature Range	.....-40°C to +85°C
Storage Temperature Range	.....-65°C to +150°C
Lead Temperature (soldering, 10s)	.....+300°C
Junction Temperature	.....+150°C

Note 1: Signals on SEL, NO__, NC__ or COM__ exceeding V+ or GND are clamped by internal diodes. Limit forward-diode current to maximum current rating.

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 in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(V+ = 3.0V to 3.6V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at V+ = 3.3V, T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
ANALOG SWITCH						
Analog-Signal Range	V _{COM_} , V _{NO_} , V _{NC_}		-0.1		(V+ - 1.2)	V
Voltage Between COM and NO/NC	I V _{COM_} - V _{NO_} I, I V _{COM_} - V _{NC_} I		0		1.8	V
On-Resistance	R _{ON}	V+ = 3.0V, I _{COM_} = 15mA, V _{NO_} or V _{NC_} = 0V, 1.8V		7		Ω
On-Resistance Match Between Pairs of Same Channel	ΔR _{ON}	V+ = 3.0V, I _{COM_} = 15mA, V _{NO_} or V _{NC_} = 0V (Notes 3, 4)		0.1	1	Ω
On-Resistance Match Between Channels	ΔR _{ON}	V+ = 3.0V, I _{COM_} = 15mA, V _{NO_} or V _{NC_} = 0V (Notes 3, 4)		0.6	2	Ω
On-Resistance Flatness	R _{FLAT(ON)}	V+ = 3.0V, I _{COM_} = 15mA V _{NO_} or V _{NC_} = 0V, 1.8V (Notes 4, 5)		0.06	2	Ω
NO_ or NC_ Off-Leakage Current	I _{NO_(OFF)} I _{NC_(OFF)}	V+ = 3.6V, V _{COM_} = 0V, 1.8V, V _{NO_} or V _{NC_} = 1.8V, 0V	-1		+1	μA
COM_ On-Leakage Current	I _{COM_(ON)}	V+ = 3.6V, V _{COM_} = 0V, 1.8V, V _{NO_} or V _{NC_} = V _{COM_} or unconnected	-1		+1	μA

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MAX4888A/MAX4889A

ELECTRICAL CHARACTERISTICS (continued)

(V+ = 3.0V to 3.6V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at V+ = 3.3V, T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
DYNAMIC							
Turn-On Time	t _{ON}	V _{NO_} or V _{NC_} = 1.0V, R _L = 50Ω, Figure 1			90	250	ns
Turn-Off Time	t _{OFF}	V _{NO_} or V _{NC_} = 1.0V, R _L = 50Ω, Figure 1			10	50	ns
Propagation Delay	t _{PD}	R _S = R _L = 50Ω, unbalanced, Figure 2			50		ps
Output Skew Between Pairs	t _{SK1}	R _S = R _L = 50Ω, unbalanced; skew between any two pairs, Figure 2			50		ps
Output Skew Between Same Pair	t _{SK2}	R _S = R _L = 50Ω, unbalanced; skew between two lines on same pair, Figure 2			10		ps
On-Loss	G _{LOS}	R _S = R _L = 50Ω, unbalanced, Figure 3	1MHz < f < 100MHz		-0.5		dB
			500MHz < f < 1.25GHz		-1.4		
Crosstalk	V _{CT1}	Crosstalk between any two pairs, R _S = R _L = 50Ω, unbalanced, Figure 3	f = 50MHz		-53		dB
			f = 1.25GHz		-32		
Signaling Data Rate	BR	R _S = R _L = 50Ω			5.0		Gbps
Off-Isolation	V _{ISO}	Signal = 0dBm, R _S = R _L = 50Ω, Figure 3	f = 10MHz		-56		dB
			f = 1.25GHz		-26		
NO_/NC_ Off-Capacitance	C _{NO_/NC_(OFF)}	Figure 4			1		pF
COM_ On-Capacitance	C _{COM_(ON)}	Figure 4			2		pF
LOGIC INPUT							
Input-Logic Low	V _{IL}					0.5	V
Input-Logic High	V _{IH}			1.4			V
Input-Logic Hysteresis	V _{HYST}				100		mV
Input Leakage Current	I _{IN}	V _{SEL} = 0V or V+		-1		+1	μA
POWER SUPPLY							
Power-Supply Range	V+			1.65		3.60	V
V+ Supply Current	I+	V _{SEL} = 0V or V+	MAX4888A			60	μA
			MAX4889A			120	

Note 2: All units are 100% production tested at T_A = +85°C. Limits over the operating temperature range are guaranteed by design and characterization and are not production tested.

Note 3: ΔRON = RON (MAX) - RON (MIN).

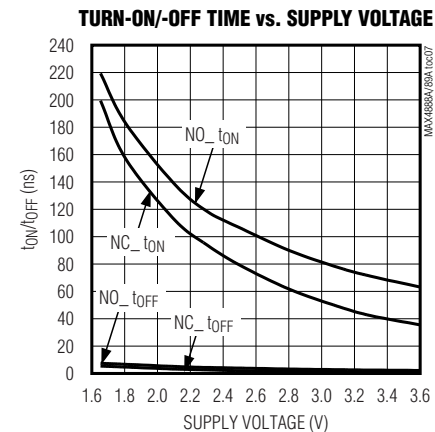
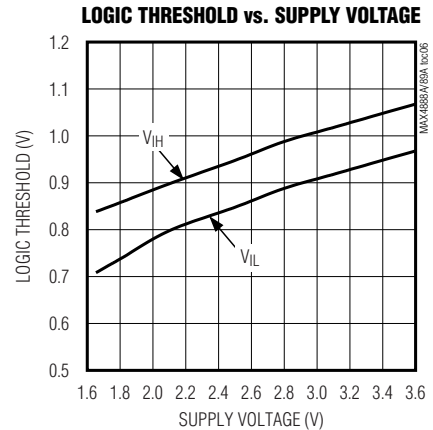
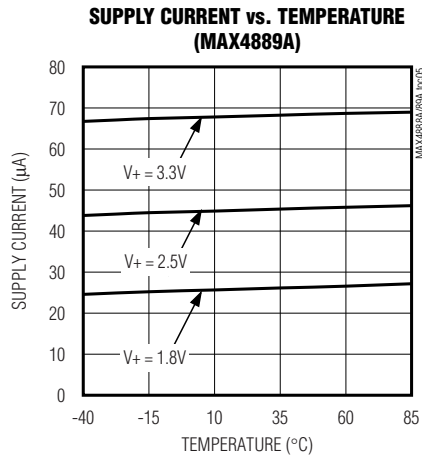
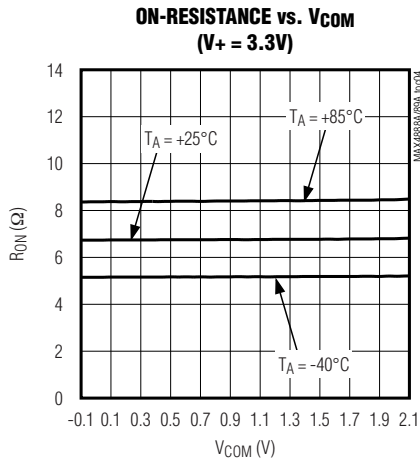
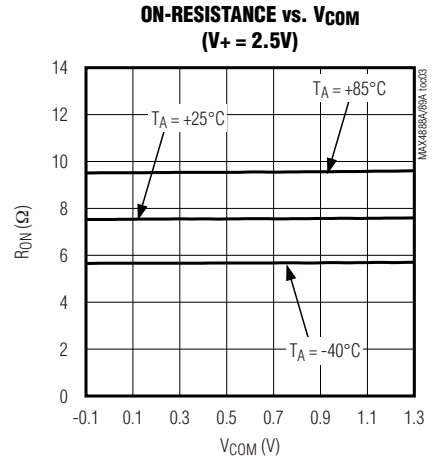
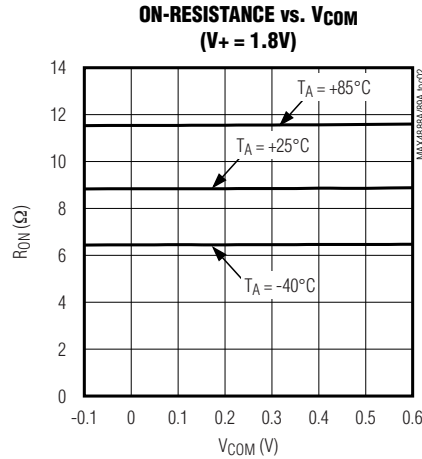
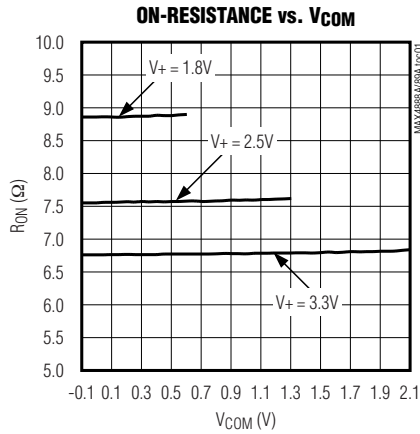
Note 4: Guaranteed by design. Not production tested.

Note 5: Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal range.

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Typical Operating Characteristics

($T_A = +25^\circ\text{C}$, unless otherwise noted.)

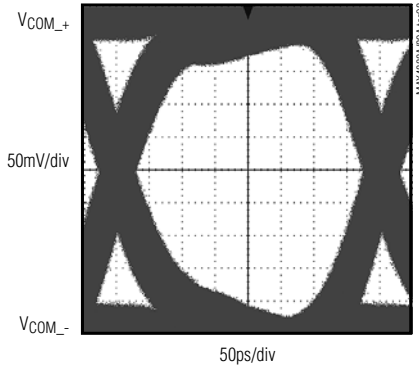


5.0Gbps PCI Express Passive Switches

Typical Operating Characteristics (continued)

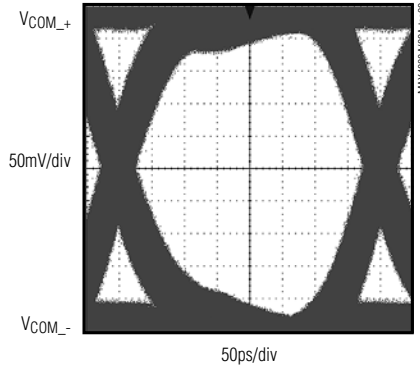
($T_A = +25^\circ\text{C}$, unless otherwise noted.)

EYE DIAGRAM
**($V_+ = 1.8\text{V}$, $f = 1.25\text{GHz}$,
600mV_{p-p} PRBS SIGNAL, $R_S = R_L = 50\Omega$)†**



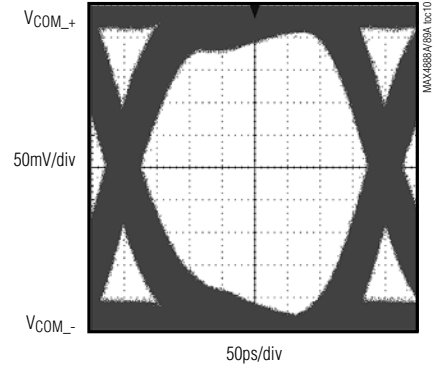
*PRBS = PSEUDORANDOM BIT SEQUENCE
 † = GEN 1, 2.5Gbps; U1 = 400ps

EYE DIAGRAM
**($V_+ = 2.5\text{V}$, $f = 1.25\text{GHz}$,
600mV_{p-p} PRBS SIGNAL, $R_S = R_L = 50\Omega$)†**



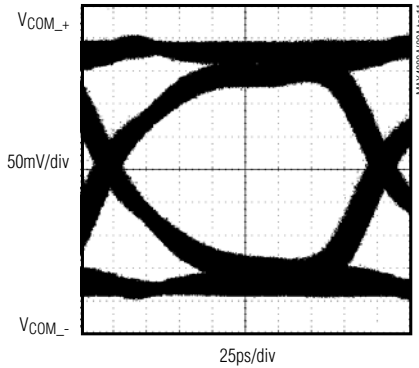
*PRBS = PSEUDORANDOM BIT SEQUENCE
 † = GEN 1, 2.5Gbps; U1 = 400ps

EYE DIAGRAM
**($V_+ = 3.3\text{V}$, $f = 1.25\text{GHz}$,
600mV_{p-p} PRBS SIGNAL, $R_S = R_L = 50\Omega$)†**



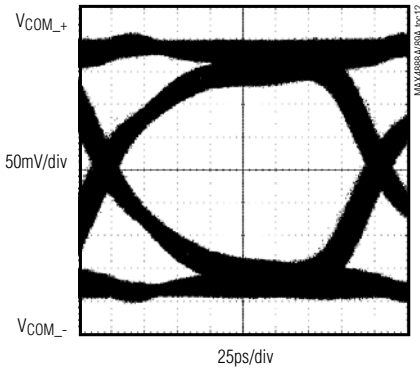
*PRBS = PSEUDORANDOM BIT SEQUENCE
 † = GEN 1, 2.5Gbps; U1 = 400ps

EYE DIAGRAM
**($V_+ = 1.8\text{V}$, $f = 2.5\text{GHz}$,
600mV_{p-p} PRBS SIGNAL, $R_S = R_L = 50\Omega$)††**



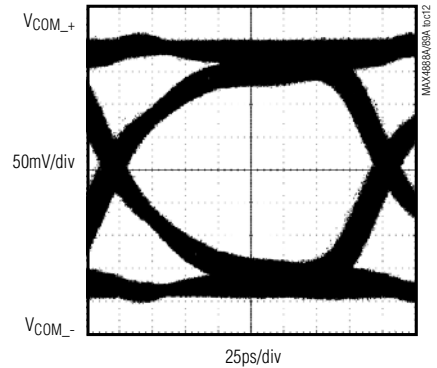
*PRBS = PSEUDORANDOM BIT SEQUENCE
 †† = GEN 11, 5.0Gbps; U1 = 200ps

EYE DIAGRAM
**($V_+ = 2.5\text{V}$, $f = 2.5\text{GHz}$,
600mV_{p-p} PRBS SIGNAL, $R_S = R_L = 50\Omega$)††**



*PRBS = PSEUDORANDOM BIT SEQUENCE
 †† = GEN 11, 5.0Gbps; U1 = 200ps

EYE DIAGRAM
**($V_+ = 3.3\text{V}$, $f = 2.5\text{GHz}$,
600mV_{p-p} PRBS SIGNAL, $R_S = R_L = 50\Omega$)††**



*PRBS = PSEUDORANDOM BIT SEQUENCE
 †† = GEN 11, 5.0Gbps; U1 = 200ps

MAX4888A/MAX4889A

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Pin Description

PIN		NAME	FUNCTION
MAX4888A	MAX4889A		
1, 10, 12, 14, 20, 25, 27	1, 4, 10, 14, 17, 19, 21, 39, 41	GND	Ground
2	9	SEL	Digital Control Input
3, 9	—	N.C.	No Connection. Not internally connected.
4	2	COM1+	Analog Switch 1. Common Positive Terminal.
5	3	COM1-	Analog Switch 1. Common Negative Terminal.
6	6	COM2+	Analog Switch 2. Common Positive Terminal.
7	7	COM2-	Analog Switch 2. Common Negative Terminal.
8, 11, 13, 19, 26, 28	5, 8, 13, 18, 20, 30, 40, 42	V+	Positive-Supply Voltage Input. Connect V+ to a 1.65V to 3.6V supply voltage. Bypass V+ to GND with a 0.1 μ F capacitor placed as close to the device as possible (See the <i>Board Layout</i> section).
15	31	NO2-	Analog Switch 2. Normally Open Negative Terminal.
16	32	NO2+	Analog Switch 2. Normally Open Positive Terminal.
17	33	NO1-	Analog Switch 1. Normally Open Negative Terminal.
18	34	NO1+	Analog Switch 1. Normally Open Positive Terminal.
21	35	NC2-	Analog Switch 2. Normally Closed Negative Terminal.
22	36	NC2+	Analog Switch 2. Normally Closed Positive Terminal.
23	37	NC1-	Analog Switch 1. Normally Closed Negative Terminal.
24	38	NC1+	Analog Switch 1. Normally Closed Positive Terminal.
—	11	COM3+	Analog Switch 3. Common Positive Terminal.
—	12	COM3-	Analog Switch 3. Common Negative Terminal.
—	15	COM4+	Analog Switch 4. Common Positive Terminal.
—	16	COM4-	Analog Switch 4. Common Negative Terminal.
—	22	NO4-	Analog Switch 4. Normally Open Negative Terminal.
—	23	NO4+	Analog Switch 4. Normally Open Positive Terminal.
—	24	NO3-	Analog Switch 3. Normally Open Negative Terminal.
—	25	NO3+	Analog Switch 3. Normally Open Positive Terminal.
—	26	NC4-	Analog Switch 4. Normally Closed Negative Terminal.
—	27	NC4+	Analog Switch 4. Normally Closed Positive Terminal.
—	28	NC3-	Analog Switch 3. Normally Closed Negative Terminal.
—	29	NC3+	Analog Switch 3. Normally Closed Positive Terminal.
EP	EP	EP	Exposed Paddle. Connect EP to GND.

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Test Circuits/Timing Diagrams

MAX4888A/MAX4889A

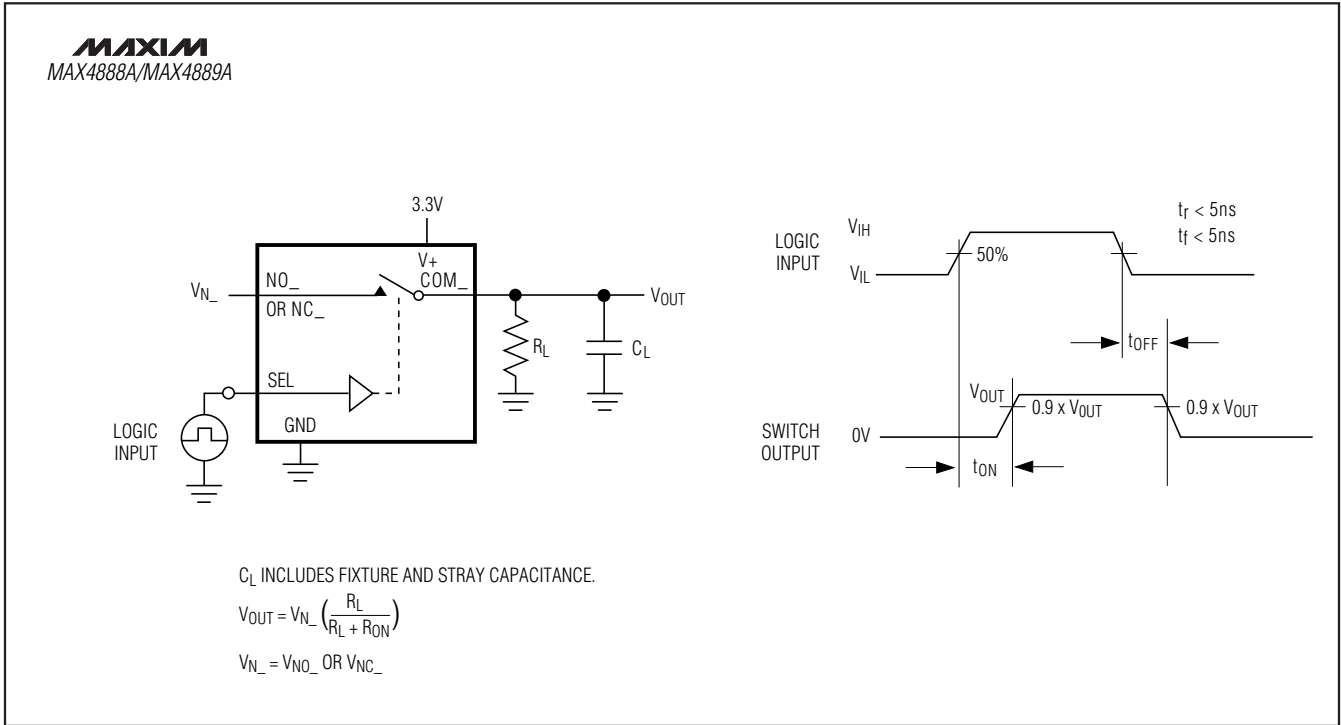


Figure 1. Switching Time

5.0Gbps PCI Express Passive Switches

Test Circuits/Timing Diagrams (continued)

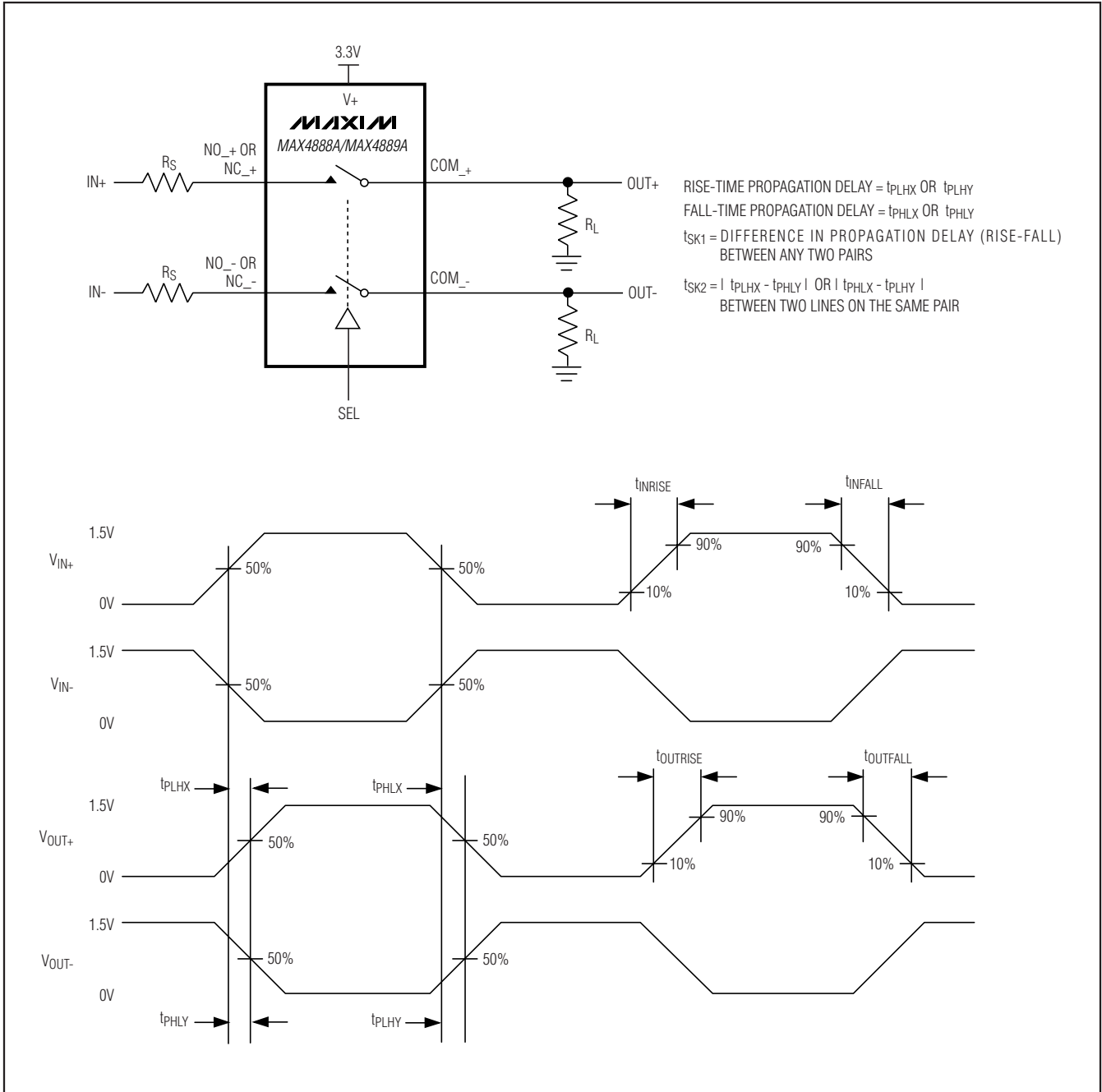


Figure 2. Propagation Delay and Output Skew

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MAX4888A/MAX4889A

Test Circuits/Timing Diagrams (continued)

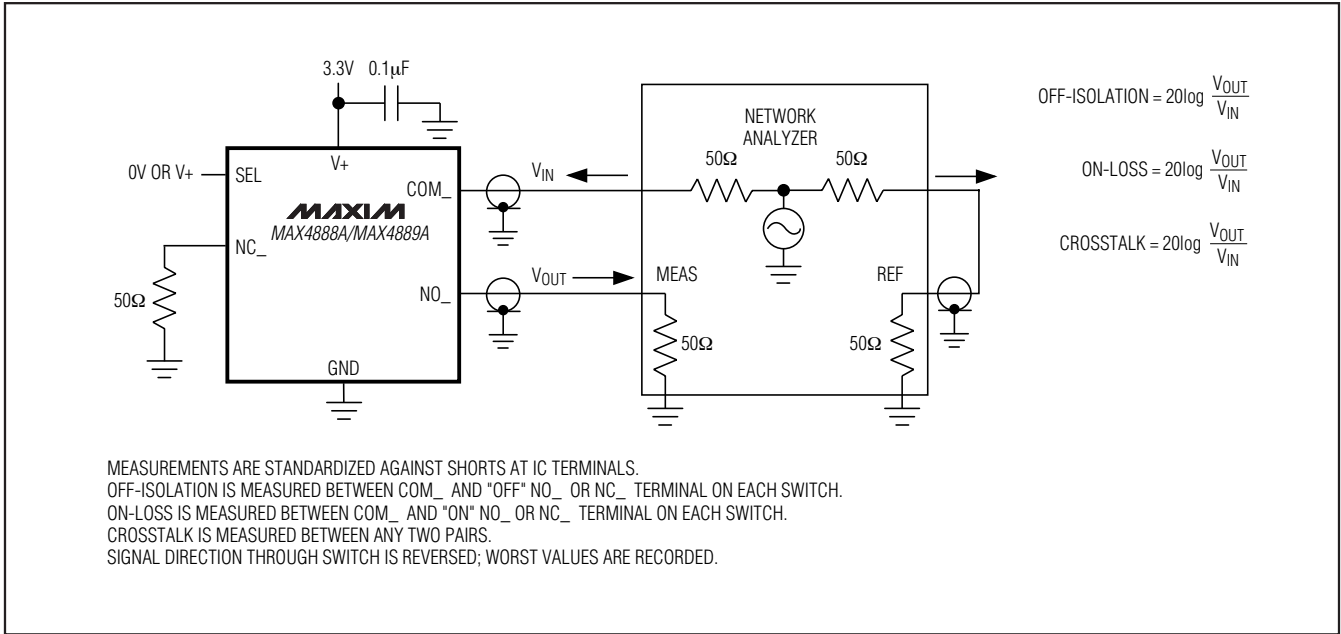


Figure 3. On-Loss, Off-Isolation, and Crosstalk

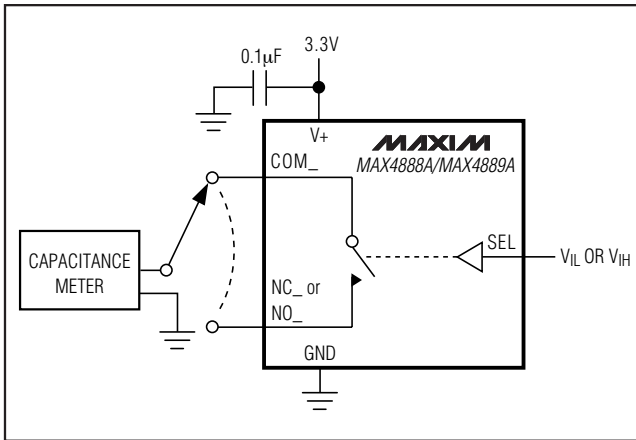


Figure 4. Channel Off-/On-Capacitance

Detailed Description

The MAX4888A/MAX4889A high-speed passive switches route PCIe data between two possible destinations. The MAX4888A/MAX4889A are ideal for routing PCIe signals to change the system configuration. For example, in a graphics application, the MAX4888A/MAX4889A create

two sets of eight lanes from a single 16-lane bus. The MAX4888A/MAX4889A feature a single digital control input (SEL) to switch signal paths.

The MAX4888A/MAX4889A are fully specified to operate from a single 3.0V to 3.6V power supply and also operate down to 1.65V.

Digital Control Input (SEL)

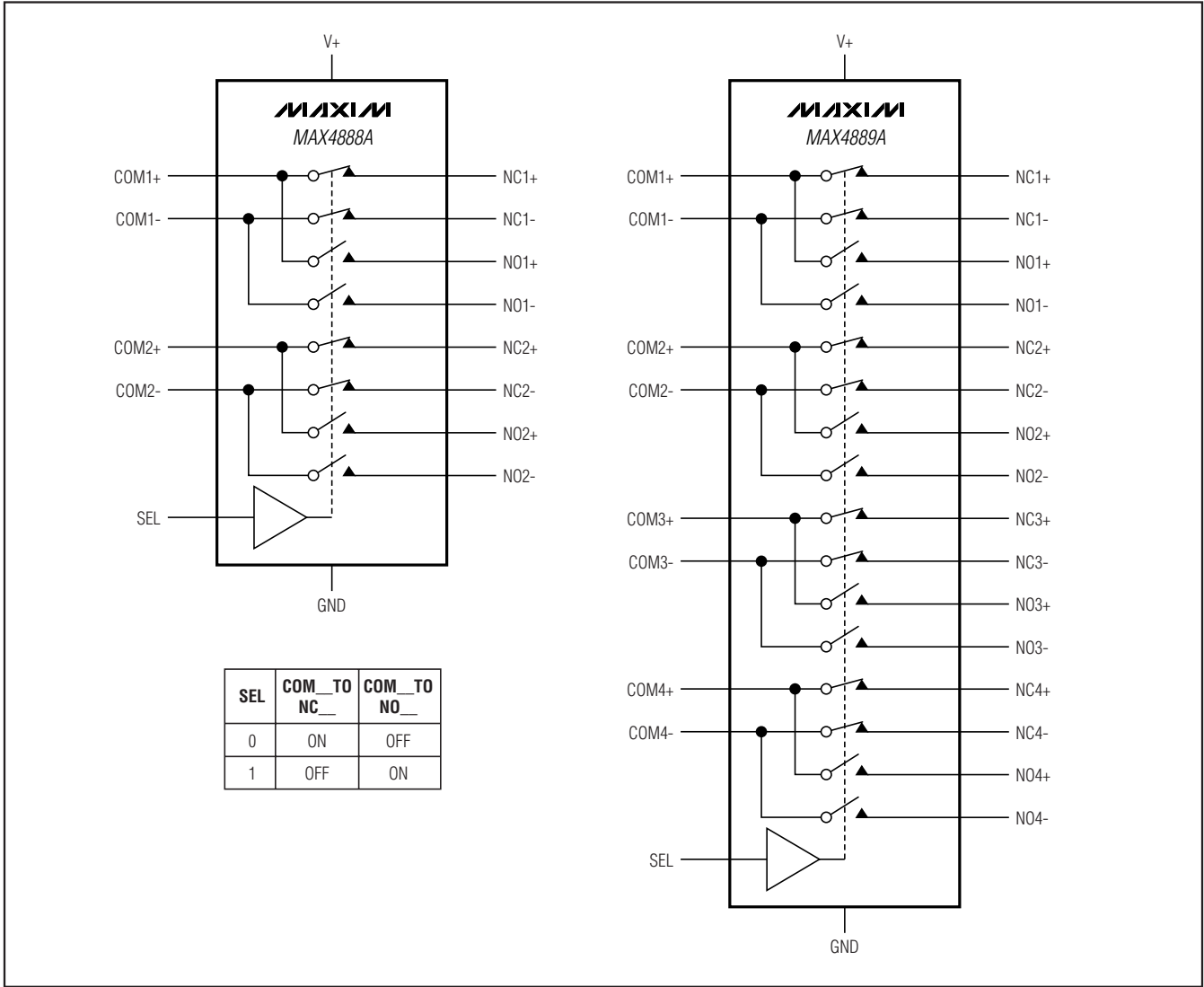
The MAX4888A/MAX4889A provide a single digital control input (SEL) to select the signal path between the COM_ and NO_/NC_ channels. The truth tables for the MAX4888A/MAX4889A are depicted in the *Functional Diagrams/Truth Table* section. Drive SEL rail-to-rail to minimize power consumption.

Analog Signal Levels

The MAX4888A/MAX4889A accept standard PCIe signals to a maximum of $V_+ - 1.2V$. Signals on the COM_+ channels are routed to either the NO_+ or NC_+ channels, and signals on the COM_- channels are routed to either the NO_- or NC_- channels. The MAX4888A/MAX4889A are bidirectional switches, allowing COM_, NO_, and NC_ to be used as either inputs or outputs.

5.0Gbps PCI Express Passive Switches

Functional Diagrams/Truth Table



5.0Gbps PCI Express Passive Switches

Applications Information

PCIe Switching

The MAX4888A/MAX4889A primary applications are aimed at reallocating PCIe lanes (see Figure 5). For example, in graphics applications, several manufacturers have found that it is possible to improve performance by a factor of nearly two by splitting a single 16-lane PCIe bus into two 8-lane buses. Two of the more prominent examples are SLI™ (Scaled Link Interface) and CrossFire™. The MAX4889A permits a computer motherboard to operate properly with a single 16-lane graphics card, and can later be updated to dual cards. The same motherboard can be used with dual cards where the user sets a jumper or a bit through software to switch between single- or dual-card operation. Common mode below 1V operation requirement.

Board Layout

High-speed switches require proper layout and design procedures for optimum performance. Keep design-controlled impedance PCB traces as short as possible or follow impedance layouts per the PCIe specification. Ensure that power-supply bypass capacitors are placed as close to the device as possible. Multiple bypass capacitors are recommended. Connect all grounds and the exposed pad to large ground planes. Common mode below 1V operation requirement.

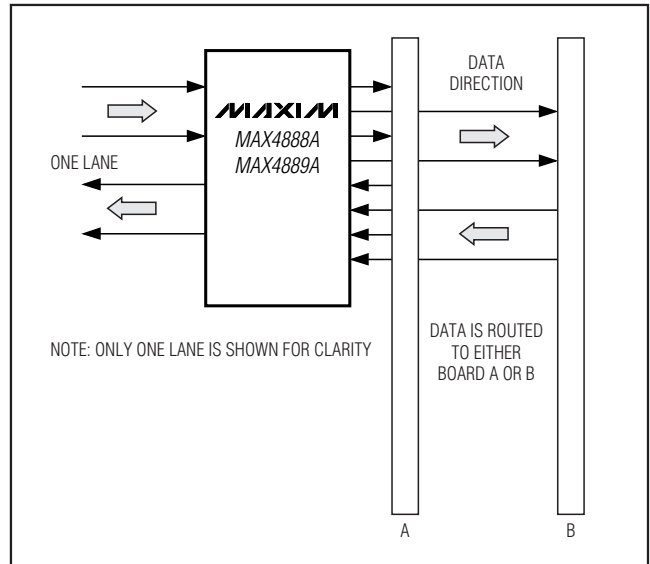


Figure 5. The MAX4888A/MAX4889A Used as a Single-Lane Switch

MAX4888A/MAX4889A

Chip Information

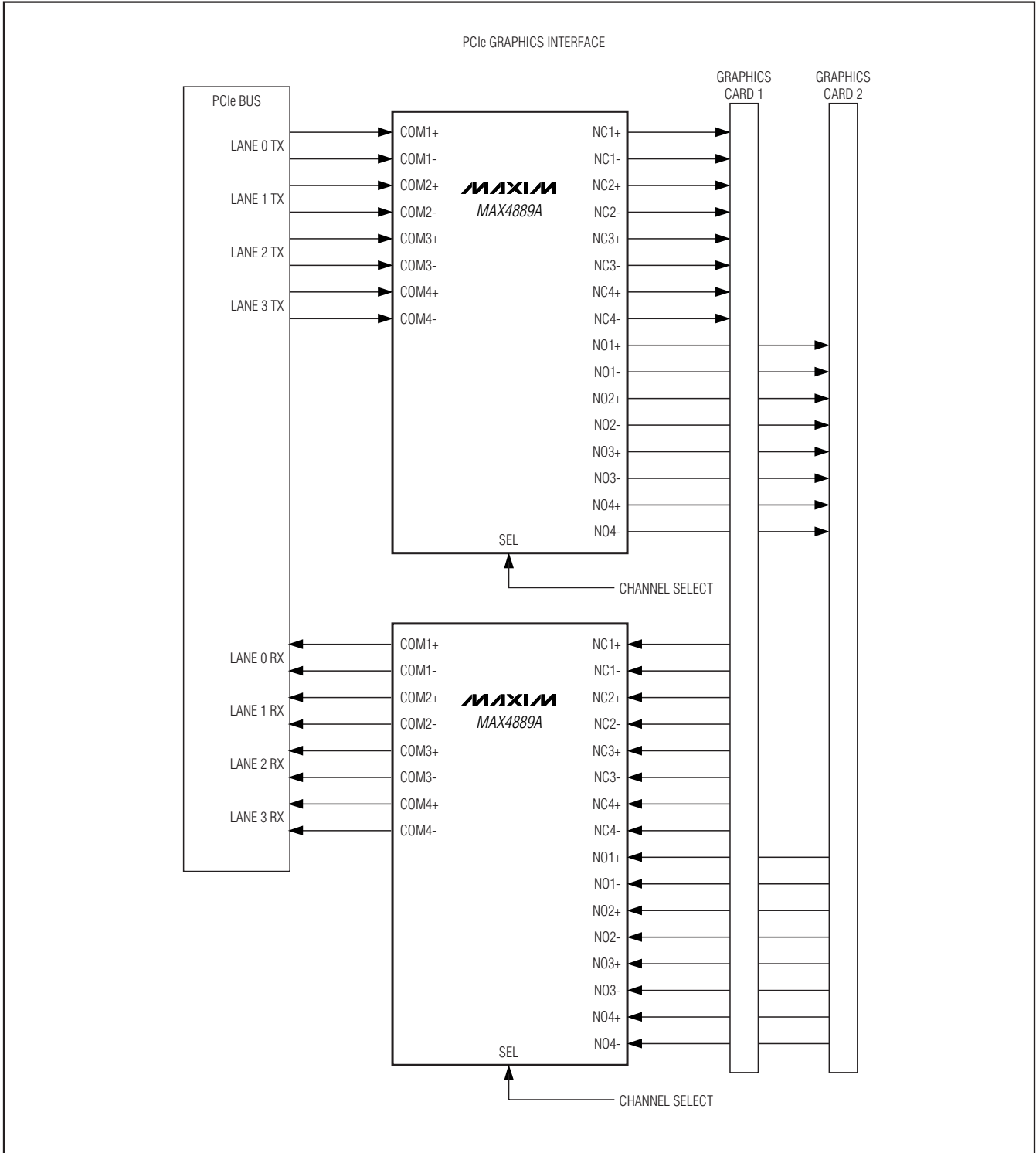
PROCESS: CMOS

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SLI is a trademark of NVIDIA Corporation.

5.0Gbps PCI Express Passive Switches

Typical Application Circuit

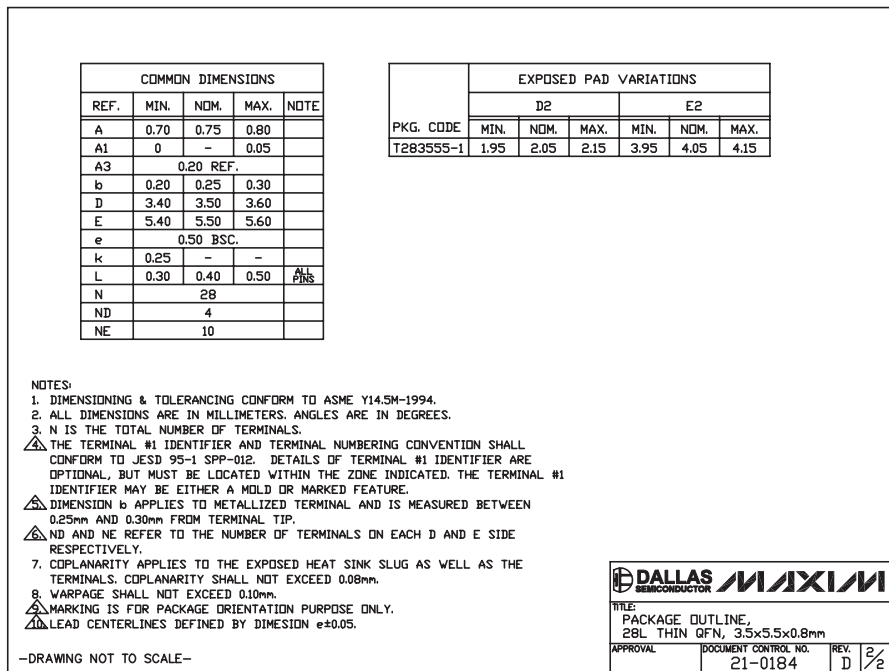
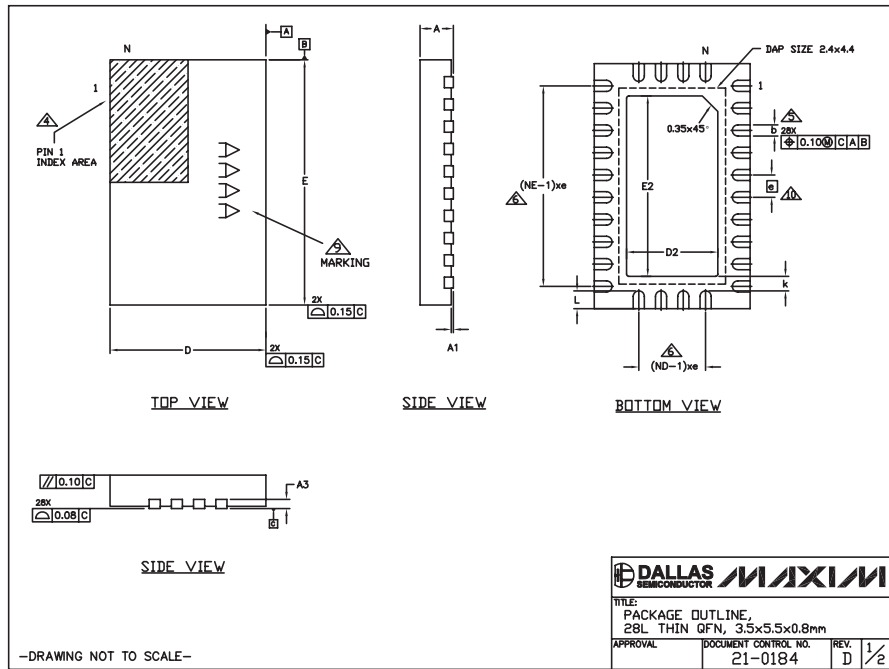


5.0Gbps PCI Express Passive Switches

Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to www.maxim-ic.com/packages.)

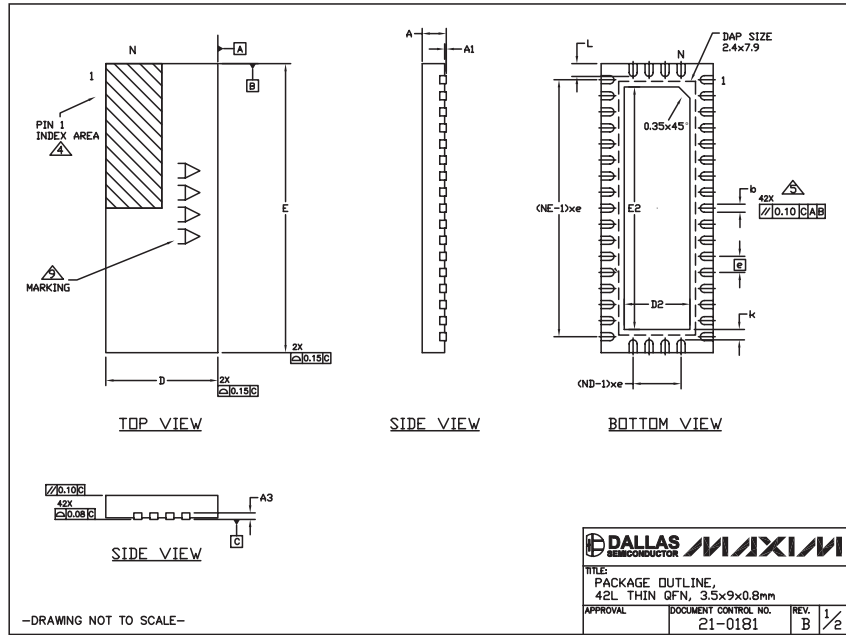
MAX4888A/MAX4889A



5.0Gbps PCI Express Passive Switches

Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to www.maxim-ic.com/packages.)



COMMON DIMENSIONS					EXPOSED PAD VARIATIONS						
REF.	MIN.	NOM.	MAX.	NOTE	PKG. CODE	D2			E2		
						MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.70	0.75	0.80		T423590-1	1.95	2.05	2.15	7.45	7.55	7.65
A1	0	-	0.05		T423590M-1	1.95	2.05	2.15	7.45	7.55	7.65
A3	0.20 REF.										
b	0.20	0.25	0.30								
D	3.40	3.50	3.60								
E	8.90	9.00	9.10								
e	0.50 BSC.										
k	0.25	-	-								
L	0.35	0.40	0.45	ALL PINS							
N	42										
ND	4										
NE	17										

NOTES:
 1. DIMENSIONING & TOLERANCING CONFORM TO ASME Y14.5M-1994.
 2. ALL DIMENSIONS ARE IN MILLIMETERS. ANGLES ARE IN DEGREES.
 3. N IS THE TOTAL NUMBER OF TERMINALS.
 4. THE TERMINAL #1 IDENTIFIER AND TERMINAL NUMBERING CONVENTION SHALL CONFORM TO JEDEC 95-1 SPP-012. DETAILS OF TERMINAL #1 IDENTIFIER ARE OPTIONAL, BUT MUST BE LOCATED WITHIN THE ZONE INDICATED. THE TERMINAL #1 IDENTIFIER MAY BE EITHER A MOLD OR MARKED FEATURE.
 5. DIMENSION b APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.25mm AND 0.30mm FROM TERMINAL TIP.
 6. ND AND NE REFER TO THE NUMBER OF TERMINALS ON EACH D AND E SIDE RESPECTIVELY.
 7. COPLANARITY APPLIES TO THE EXPOSED HEAT SINK SLUG AS WELL AS THE TERMINALS. COPLANARITY SHALL NOT EXCEED 0.08mm.
 8. WARPAGE SHALL NOT EXCEED 0.10mm.
 9. MARKING IS FOR PACKAGE ORIENTATION PURPOSE ONLY.
 10. LEAD CENTERLINES TO BE AS DEFINED BY DIMENSION e ±0.05.

-DRAWING NOT TO SCALE-

Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.

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