

# NCN2411

## 4-Channel Differential 1:2 Mux/Demux Switch for PCI Express Gen2

The NCN2411 is a 4-Channel differential SPDT switch designed to route PCI Express Gen2 signals. When used in a PCI Express application, the switch can handle up to two PCIe lanes. Due to the ultra-low ON-state capacitance (2 pF typ) and resistance (7.5  $\Omega$  typ), this switch is ideal for switching high frequency signals up to a signal bit rate (BR) of 5 Gbps. This switch pinout is designed to be used in BTX form factor desktop PCs and is available in a space-saving 3.5x9x0.75 mm WQFN42 package.

### Features

- $V_{DD}$  Power Supply from 1.5 V to 2.0 V
- 4 Differential Channels 2:1 MUX/DEMUX
- Compatible with PCIe 2.0
- Data Rate: Supports 5 Gbps
- Low Crosstalk: -30 dB @ 3 GHz
- Low Bit-to-Bit Skew: 5 ps
- Low  $R_{ON}$  Resistance: 13  $\Omega$  max
- Low  $C_{ON}$  Capacitance: 2 pF
- Low Supply Current: 200  $\mu$ A
- Insertion Loss: -2 dB @ 3 GHz
- Space Saving, Small WQFN-42 Package
- This is a Pb-Free Device

### Typical Applications

- Notebook Computer
- Desktop computer
- Server/Storage Area Network

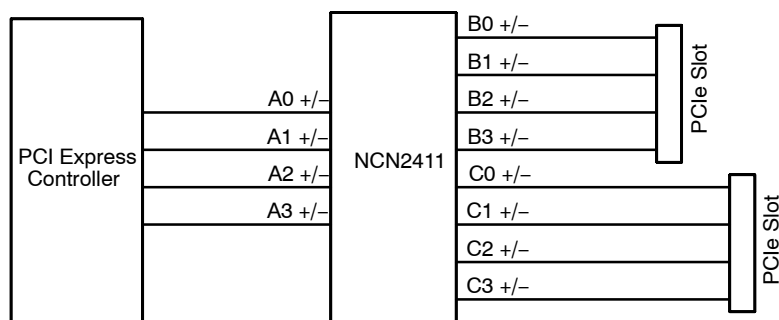


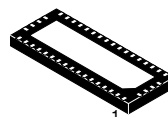
Figure 1. Application Schematic



ON Semiconductor®

<http://onsemi.com>

### MARKING DIAGRAM



WQFN42  
CASE 510AP

NCN2411  
AWLYYWWG

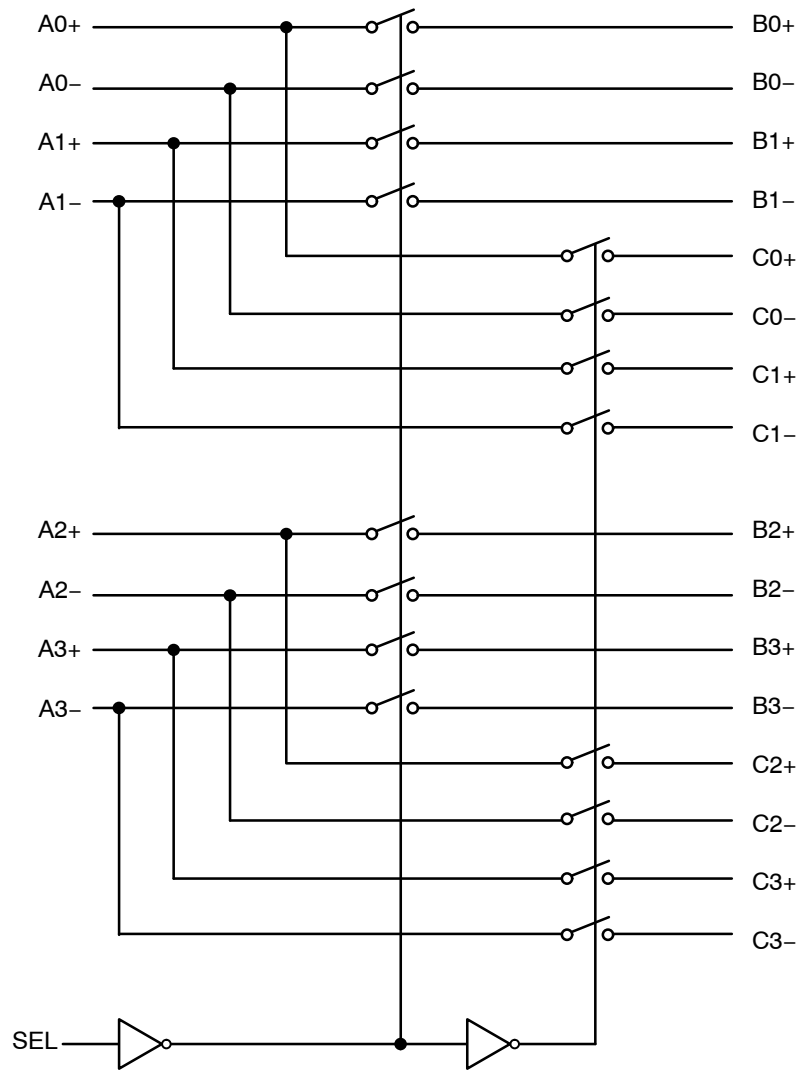
A = Assembly Location  
WL = Wafer Lot  
YY = Year  
WW = Work Week  
G = Pb-Free Package

### ORDERING INFORMATION

| Device       | Package          | Shipping†          |
|--------------|------------------|--------------------|
| NCN2411MTTWG | WQFN42 (Pb-Free) | 2000 / Tape & Reel |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

# NCN2411

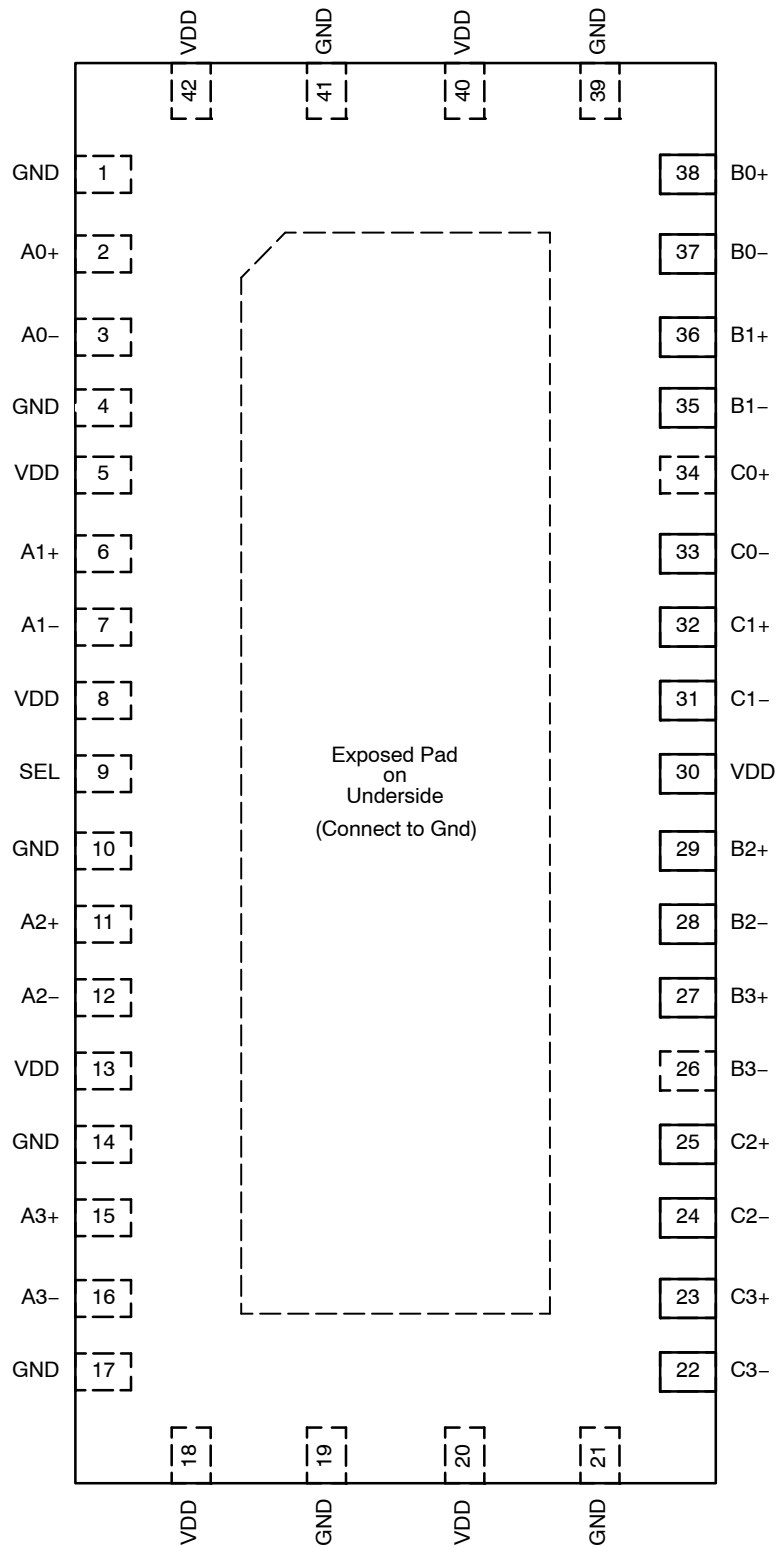


**Figure 2. NCN2411 Functional Block Diagram  
(Top View)**

## TRUTH TABLE

| Function       | SEL |
|----------------|-----|
| $A_N$ to $B_N$ | L   |
| $A_N$ to $C_N$ | H   |

# NCN2411



**Figure 3. Pin Description  
(Top View)**

## PIN FUNCTION AND DESCRIPTION

| Pin                                    | Pin Name | Description                                                                                                                         |
|----------------------------------------|----------|-------------------------------------------------------------------------------------------------------------------------------------|
| 2, 3                                   | A0+, A0– | Signal I/O, Channel 0, Port A                                                                                                       |
| 6, 7                                   | A1+, A1– | Signal I/O, Channel 1, Port A                                                                                                       |
| 11, 12                                 | A2+, A2– | Signal I/O, Channel 2, Port A                                                                                                       |
| 15, 16                                 | A3+, A3– | Signal I/O, Channel 3, Port A                                                                                                       |
| 38, 37                                 | B0+, B0– | Signal I/O, Channel 0, Port B                                                                                                       |
| 36, 35                                 | B1+, B1– | Signal I/O, Channel 1, Port B                                                                                                       |
| 29, 28                                 | B2+, B2– | Signal I/O, Channel 2, Port B                                                                                                       |
| 27, 26                                 | B3+, B3– | Signal I/O, Channel 3, Port B                                                                                                       |
| 34, 33                                 | C0+, C0– | Signal I/O, Channel 0, Port C                                                                                                       |
| 32, 31                                 | C1+, C1– | Signal I/O, Channel 1, Port C                                                                                                       |
| 25, 24                                 | C2+, C2– | Signal I/O, Channel 2, Port C                                                                                                       |
| 23, 22                                 | C3+, C3– | Signal I/O, Channel 3, Port C                                                                                                       |
| 9                                      | SEL      | Operational Mode Select (When SEL = 0: A → B, When SEL = 1: A → C) Do not float this pin.                                           |
| 5, 8, 13, 18,<br>20, 30, 40, 42        | VDD      | DC Supply: 1.5 V to 2.0 V                                                                                                           |
| 1, 4, 10, 14,<br>17, 19, 21,<br>39, 41 | GND      | Power Ground                                                                                                                        |
| Exposed Pad                            | –        | The exposed pad on the backside of package is internally connected to GND. Externally the pad should also be user-connected to GND. |

## MAXIMUM RATINGS

| Parameter                                                          | Symbol          | Rating           | Units    |
|--------------------------------------------------------------------|-----------------|------------------|----------|
| Power Supply Voltage                                               | $V_{DD}$        | –0.5 to 2.5      | $V_{DC}$ |
| Input/Output Voltage Range of the Switch ( $A_N$ , $B_N$ , $C_N$ ) | $V_{IS}$        | –0.5 to $V_{DD}$ | $V_{DC}$ |
| Selection Pin Voltages                                             | $V_{SEL}$       | –0.5 to $V_{DD}$ | $V_{DC}$ |
| Continuous Current Through One Switch                              | $I_{CC}$        | ±120             | mA       |
| Maximum Junction Temperature (Note 1)                              | $T_J$           | 150              | °C       |
| Operating Ambient Temperature                                      | $T_A$           | –40 to +85       | °C       |
| Storage Temperature Range                                          | $T_{stg}$       | –65 to +150      | °C       |
| Thermal Resistance, Junction-to-Air                                | $R_{\theta JA}$ | 75               | °C/W     |
| Latch-up Current (Note 2)                                          | $I_{LU}$        | ±100             | mA       |
| Human Body Model (HBM) ESD Rating (Note 3)                         | ESD HBM         | 7000             | V        |
| Machine Model (MM) ESD Rating (Note 3)                             | ESD MM          | 400              | V        |
| Moisture Sensitivity (Note 4)                                      | MSL             | Level 1          | –        |

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. Power dissipation must be considered to ensure maximum junction temperature ( $T_J$ ) is not exceeded.
2. Latch up Current Maximum Rating: ±100 mA per JEDEC standard: JESD78.
3. This device series contains ESD protection and passes the following tests:  
Human Body Model (HBM) ±7.0 kV per JEDEC standard: JESD22-A114 for all pins.  
Machine Model (MM) ±400 V per JEDEC standard: JESD22-A115 for all pins.
4. Moisture Sensitivity Level (MSL): 1 per IPC/JEDEC standard: J-STD-020A.

# NCN2411

## DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE ( $T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ , $V_{DD} = 1.5\text{ V}$ to $2.0\text{ V}$ , $\text{GND} = 0\text{V}$ )

| Symbol | Pins | Parameters | Conditions (Note 5) | Min. | Typ<br>(Note 6) | Max. | Units |
|--------|------|------------|---------------------|------|-----------------|------|-------|
|--------|------|------------|---------------------|------|-----------------|------|-------|

### POWER SUPPLY

|          |                      |                          |                                                            |     |     |     |               |
|----------|----------------------|--------------------------|------------------------------------------------------------|-----|-----|-----|---------------|
| $V_{DD}$ | $V_{DD}, \text{GND}$ | Supply Voltage Range     | With respect to GND                                        | 1.5 | 1.8 | 2.0 | V             |
| $I_{DD}$ | $V_{DD}, \text{GND}$ | Quiescent Supply Current | $V_{DD} = 2\text{ V}$ , $V_{SEL} = \text{GND}$ or $V_{DD}$ |     | 200 | 300 | $\mu\text{A}$ |

### DATA SWITCH PERFORMANCE

|                       |                                    |                                 |                                                                                                                                          |    |     |      |               |
|-----------------------|------------------------------------|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|----|-----|------|---------------|
| $V_{IS}$              | $A_N, B_N, C_N$                    | Data Input/Output Voltage Range |                                                                                                                                          | 0  |     | 1.2  | V             |
| $R_{ON}$              | $B_N$                              | On Resistance ( $B_N$ )         | $V_{DD} = 1.5\text{ V}$ , $V_{IS} = 0\text{ V}$ to $1.2\text{ V}$ ,<br>$I_{IS} = 15\text{ mA}$                                           |    | 7.5 | 13   | $\Omega$      |
| $R_{ON}$              | $C_N$                              | On Resistance ( $C_N$ )         | $V_{DD} = 1.5\text{ V}$ , $V_{IS} = 0\text{ V}$ to $1.2\text{ V}$ ,<br>$I_{IS} = 15\text{ mA}$                                           |    | 8.0 | 13   | $\Omega$      |
| $R_{ON(\text{flat})}$ | $B_N$                              | On Resistance Flatness          | $V_{DD} = 1.5\text{ V}$ , $V_{IS} = 0\text{ V}$ to $1.2\text{ V}$ ,<br>$I_{IS} = 15\text{ mA}$ (Note 7)                                  |    | 0.1 | 1.24 | $\Omega$      |
| $R_{ON(\text{flat})}$ | $C_N$                              | On Resistance Flatness          | $V_{DD} = 1.5\text{ V}$ , $V_{IS} = 0\text{ V}$ to $1.2\text{ V}$ ,<br>$I_{IS} = 15\text{ mA}$ (Note 7)                                  |    | 0.1 | 1.24 | $\Omega$      |
| $\Delta R_{ON}$       | $B_N$                              | On Resistance Matching( $B_N$ ) | $V_{DD} = 1.5\text{ V}$ , $V_{IS} = 0\text{ V}$ ,<br>$I_{IS} = 15\text{ mA}$ (Note 7)                                                    |    |     | 0.35 | $\Omega$      |
| $\Delta R_{ON}$       | $C_N$                              | On Resistance Matching( $C_N$ ) | $V_{DD} = 1.5\text{ V}$ , $V_{IS} = 0\text{ V}$ ,<br>$I_{IS} = 15\text{ mA}$ (Note 7)                                                    |    |     | 0.35 | $\Omega$      |
| $C_{ON}$              | $A_N$ to $B_N$ ,<br>$A_N$ to $C_N$ | On Capacitance                  | $f = 1\text{ MHz}$ , Switch On, Open Output                                                                                              |    | 2.0 |      | pF            |
| $C_{OFF}$             | $A_N$ to $B_N$ ,<br>$A_N$ to $C_N$ | Off Capacitance                 | $f = 1\text{ MHz}$ , Switch Off                                                                                                          |    | 1.5 |      | pF            |
| $I_{ON}$              | $A_N$ to $B_N$ ,<br>$A_N$ to $C_N$ | On Leakage Current              | $V_{DD} = 2\text{ V}$ , $V_{AN} = 0\text{ V}$ , $1.2\text{ V}$ , Switch On to $B_N/C_N$ , $B_N/C_N$ pins are unconnected                 | -1 |     | +1   | $\mu\text{A}$ |
| $I_{OFF}$             | $A_N$ to $B_N$ ,<br>$A_N$ to $C_N$ | Off Leakage Current             | $V_{DD} = 2\text{ V}$ , $V_{AN} = 0\text{ V}$ , $1.2\text{ V}$ , Switch Off to $B_N/C_N$ , $V_{BN}/V_{CN} = 1.2\text{ V}$ , $0\text{ V}$ | -1 |     | +1   | $\mu\text{A}$ |

### LOGIC INPUT CHARACTERISTICS (SEL Pin)

|          |     |                     |                                                   |                      |      |                      |               |
|----------|-----|---------------------|---------------------------------------------------|----------------------|------|----------------------|---------------|
| $V_{IH}$ | SEL | Input HIGH Voltage  | (Note 7)                                          | $0.65 \times V_{DD}$ |      | $V_{DD}$             | V             |
| $V_{IL}$ | SEL | Input LOW Voltage   | (Note 7)                                          | 0                    |      | $0.35 \times V_{DD}$ | V             |
| $V_{IK}$ | SEL | Clamp Diode Voltage | $V_{DD} = \text{Max}$ , $I_{SEL} = -18\text{ mA}$ |                      | -0.7 | -1.2                 | V             |
| $I_{IH}$ | SEL | Input HIGH Current  | $V_{DD} = \text{Max}$ , $V_{SEL} = V_{DD}$        |                      |      | $\pm 5$              | $\mu\text{A}$ |
| $I_{IL}$ | SEL | Input LOW Current   | $V_{DD} = \text{Max}$ , $V_{SEL} = \text{GND}$    |                      |      | $\pm 5$              | $\mu\text{A}$ |

### SWITCHING CHARACTERISTICS

|              |                           |                         |                                                                           |  |     |  |    |
|--------------|---------------------------|-------------------------|---------------------------------------------------------------------------|--|-----|--|----|
| $t_{SELON}$  | SEL, $A_N$ ,<br>$B_N/C_N$ | Line Enable Time        | SEL to $A_N$ , $B_N$ , $C_N$<br>$R_L = 50\ \Omega$ , $C_L = 20\text{ pF}$ |  | 8.0 |  | ns |
| $t_{SELOFF}$ | SEL, $A_N$ ,<br>$B_N/C_N$ | Line Disable Time       | SEL to $A_N$ , $B_N$ , $C_N$<br>$R_L = 50\ \Omega$ , $C_L = 20\text{ pF}$ |  | 5.0 |  | ns |
| $t_{b-b}$    | $A_N$ , $B_N/C_N$         | Bit-to-bit skew         | Within the same differential pair                                         |  | 9.0 |  | ps |
| $t_{ch-ch}$  | $A_N$ , $B_N$             | Channel-to channel skew | Maximum skew between all channels                                         |  | 50  |  | ps |

5. For Max. or Min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device type.

6. Typical values are at  $V_{DD} = 1.8\text{ V}$ ,  $T_A = 25^{\circ}\text{C}$  ambient and maximum loading.

7. Guaranteed by design and/or characterization.

# NCN2411

## DC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE ( $T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ , $V_{DD} = 1.5\text{ V}$ to $2.0\text{ V}$ , $\text{GND} = 0\text{V}$ )

| Symbol | Pins | Parameters | Conditions (Note 5) | Min. | Typ<br>(Note 6) | Max. | Units |
|--------|------|------------|---------------------|------|-----------------|------|-------|
|--------|------|------------|---------------------|------|-----------------|------|-------|

## DYNAMIC ELECTRICAL CHARACTERISTICS OVER OPERATING RANGE

|                  |                                    |                             |                      |  |      |  |      |
|------------------|------------------------------------|-----------------------------|----------------------|--|------|--|------|
| BR               | $A_N$ to $B_N$ ,<br>$A_N$ to $C_N$ | Signal Bit Rate             |                      |  | 5.0  |  | Gbps |
| D <sub>IL</sub>  | $A_N$ to $B_N$ ,<br>$A_N$ to $C_N$ | Differential Insertion Loss | $f = 3\text{ GHz}$   |  | -2.0 |  | dB   |
|                  |                                    |                             | $f = 100\text{ MHz}$ |  | -0.7 |  | dB   |
| D <sub>CTK</sub> | $A_N$ , $B_N$ , $C_N$              | Differential Crosstalk      | $f = 3\text{ GHz}$   |  | -30  |  | dB   |
|                  |                                    |                             | $f = 100\text{ MHz}$ |  | -58  |  | dB   |
| D <sub>ISO</sub> | $A_N$ to $B_N$ ,<br>$A_N$ to $C_N$ | Differential Off Isolation  | $f = 3\text{ GHz}$   |  | -23  |  | dB   |
|                  |                                    |                             | $f = 100\text{ MHz}$ |  | -58  |  | dB   |
| D <sub>RL</sub>  | $A_N$ to $B_N$ ,<br>$A_N$ to $C_N$ | Differential Return Loss    | $f = 3\text{ GHz}$   |  | -6.0 |  | dB   |
|                  |                                    |                             | $f = 100\text{ MHz}$ |  | -22  |  | dB   |

5. For Max. or Min. conditions, use appropriate value specified under Electrical Characteristics for the applicable device type.

6. Typical values are at  $V_{DD} = 1.8\text{ V}$ ,  $T_A = 25^{\circ}\text{C}$  ambient and maximum loading.

7. Guaranteed by design and/or characterization.

# TYPICAL OPERATING CHARACTERISTICS

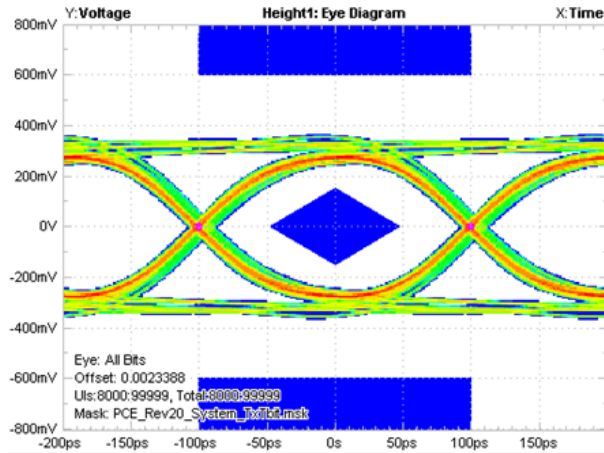


Figure 4. PCI Express Eye Diagram at 5 Gbps, 800 mVpp Differential Swing (Minimum Case)

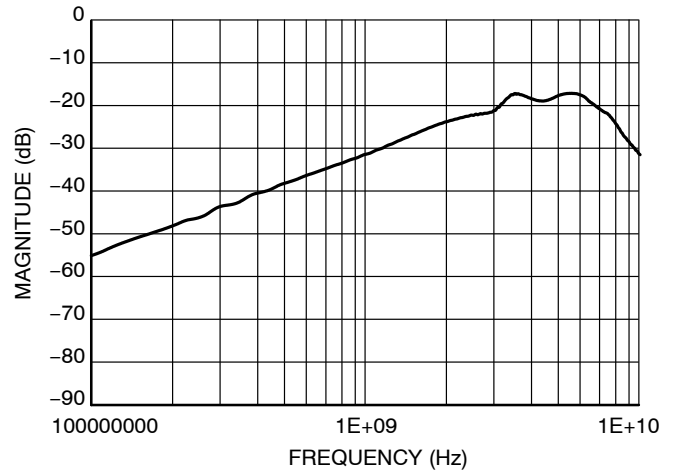


Figure 5. Differential Off Isolation

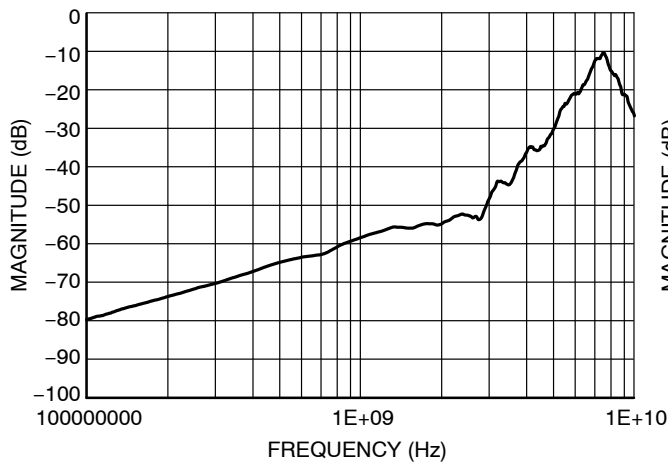


Figure 6. Differential Crosstalk

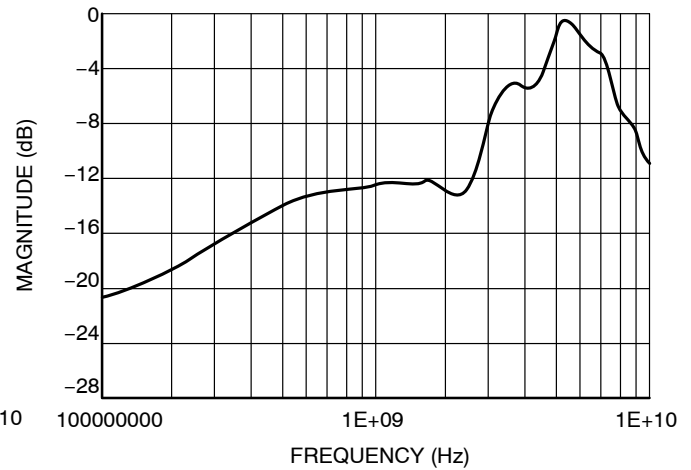


Figure 7. Differential Return Loss

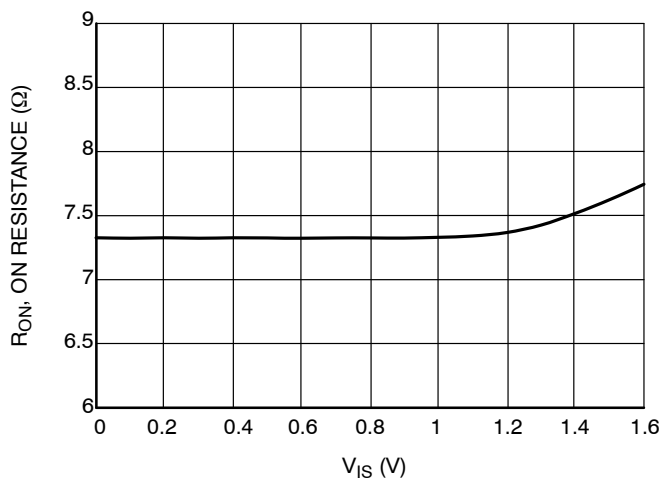
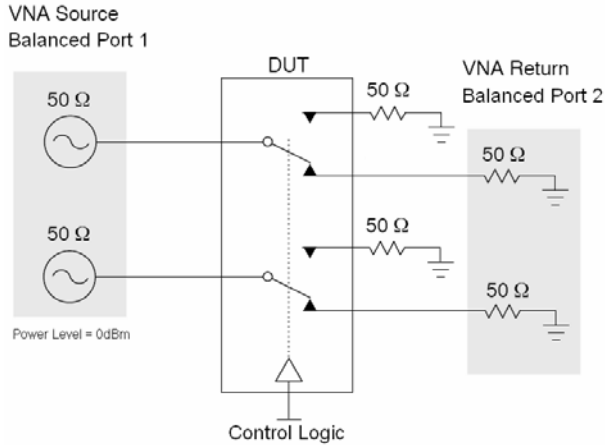
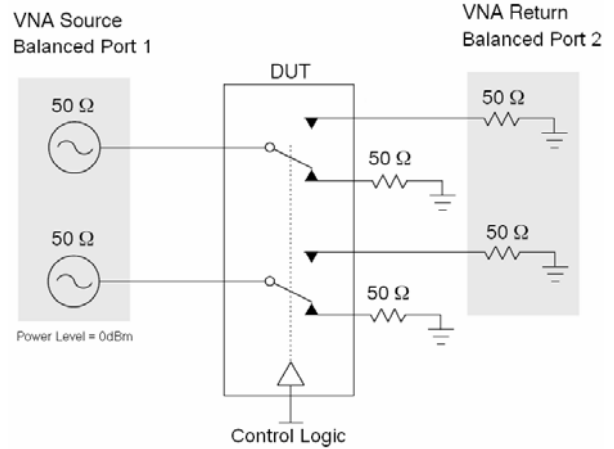


Figure 8.  $R_{ON}$  vs.  $V_{IS}$

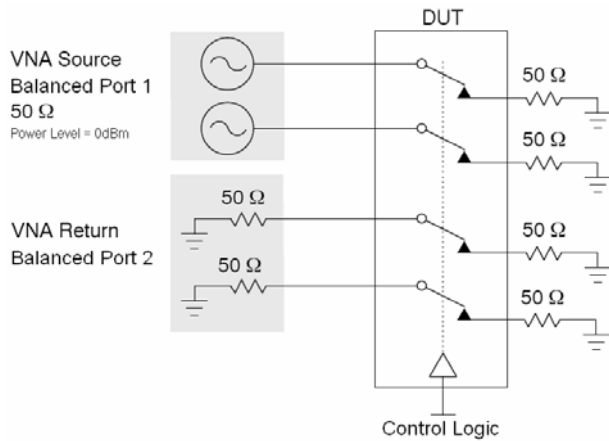
# PARAMETER MEASUREMENT INFORMATION



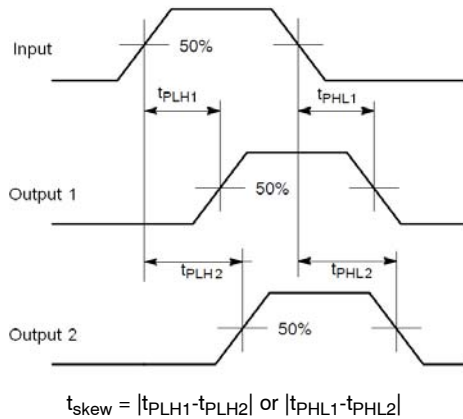
**Figure 9. Differential Insertion Loss ( $S_{DD21}$ ) and Differential Return Loss ( $S_{DD11}$ )**



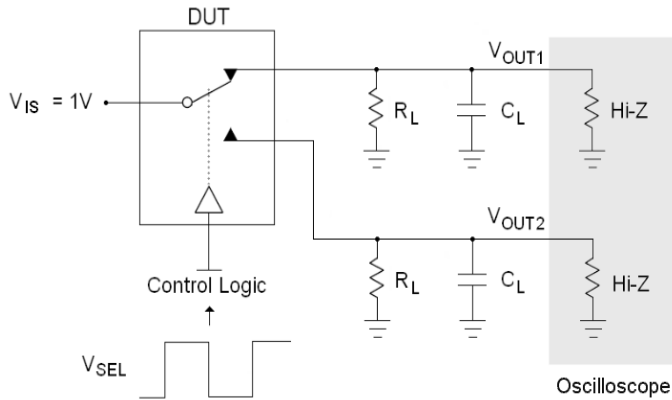
**Figure 10. Differential Off Isolation ( $S_{DD21}$ )**



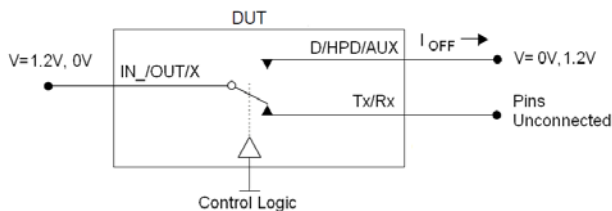
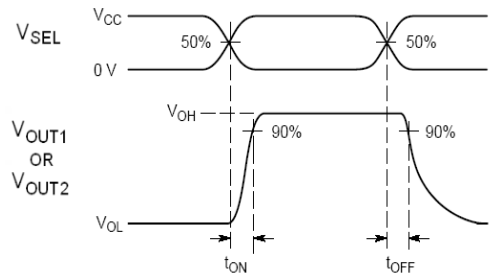
**Figure 11. Differential Crosstalk ( $S_{DD21}$ )**



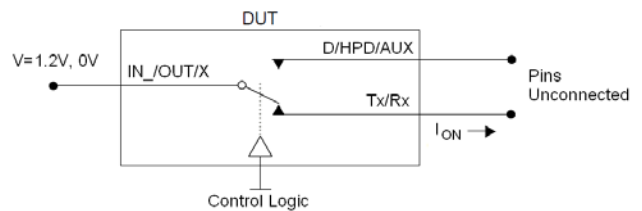
**Figure 12. Bit-to-Bit and Channel-to-Channel Skew**



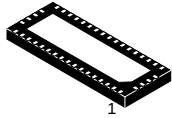
**Figure 13.  $t_{ON}$  and  $t_{OFF}$**



**Figure 14. Off State Leakage**



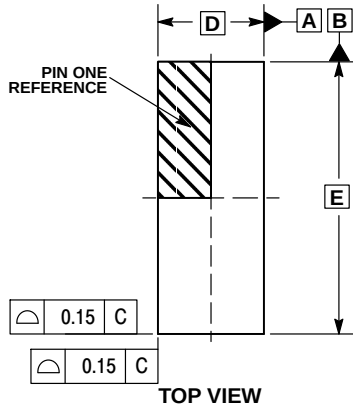
**Figure 15. On State Leakage**



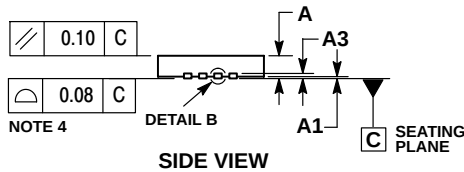
SCALE 2:1

**WQFN42 3.5x9, 0.5P**  
CASE 510AP  
ISSUE O

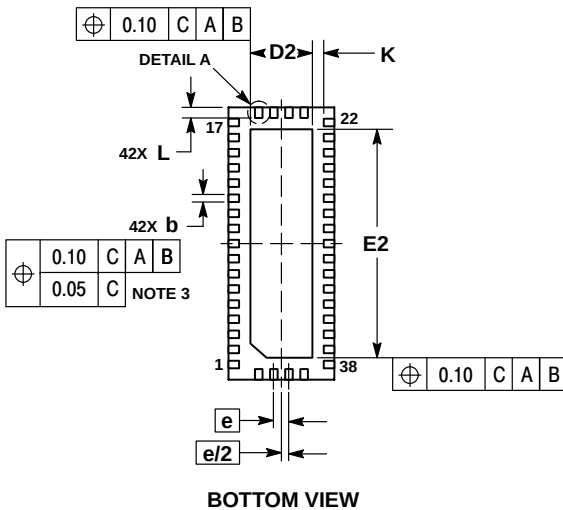
DATE 15 FEB 2010



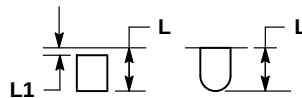
TOP VIEW



SIDE VIEW



BOTTOM VIEW


**DETAIL A**  
ALTERNATE TERMINAL  
CONSTRUCTIONS

**DETAIL B**  
ALTERNATE  
CONSTRUCTION

## NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30 MM FROM TERMINAL TIP.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

| DIM | MILLIMETERS |      |
|-----|-------------|------|
|     | MIN         | MAX  |
| A   | 0.70        | 0.80 |
| A1  | 0.00        | 0.05 |
| A3  | 0.20        | REF  |
| b   | 0.20        | 0.30 |
| D   | 3.50        | BSC  |
| D2  | 1.95        | 2.15 |
| E   | 9.00        | BSC  |
| E2  | 7.45        | 7.65 |
| e   | 0.50        | BSC  |
| K   | 0.20        | ---  |
| L   | 0.30        | 0.50 |
| L1  | 0.00        | 0.15 |

**GENERIC**  
**MARKING DIAGRAM\***

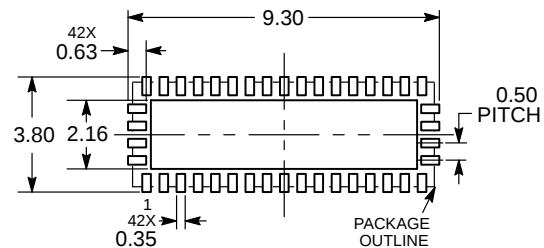
```

XXXXXXXX
XXXXXXXX
o AWLYYWWG

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XXXXXX = Specific Device Code  
A = Assembly Location  
WL = Wafer Lot  
YY = Year  
WW = Work Week  
G = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G", may or not be present.

**RECOMMENDED**  
**MOUNTING FOOTPRINT**


DIMENSIONS: MILLIMETERS

|                         |                           |                                                                                                                                                                                     |
|-------------------------|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>DOCUMENT NUMBER:</b> | <b>98AON48316E</b>        | Electronic versions are uncontrolled except when accessed directly from the Document Repository.<br>Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red. |
| <b>DESCRIPTION:</b>     | <b>WQFN42 3.5X9, 0.5P</b> | <b>PAGE 1 OF 1</b>                                                                                                                                                                  |

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