

NCN2612

6-Differential Channel 1:2 Switch for PCIe 2.0 and Display Port 1.1

The NCN2612 is a 6-Channel differential SPDT switch designed to route PCI Express Gen2 and/or DisplayPort 1.1a signals. Due to the ultra-low ON-state capacitance (4.1 pF typ) and resistance (7 Ω typ), these switches have a signal bit rate (BR) of 5 Gbps, ideal for high frequency data signals. This switch pinout is designed to be used in ATX form factor desktop PCs and is available in a space-saving WQFN package. The NCN2612 uses 80% less quiescent power than other comparable PCIe switches.

Features

- V_{DD} Power Supply from 3 V to 3.6 V
- Low Supply Current 250 μ A typ
- 6 Differential Channels 2:1 MUX/DEMUX
- Compatible with Display Port 1.1a & PCIe 2.0
- Data Rate: Supports 5 Gbps
- Low Ron Resistance: 7 Ω typ
- Low Con Capacitance: 4.1 pF
- Space Saving Small WQFN-56 Package
- This is a Pb-Free Device

Typical Applications

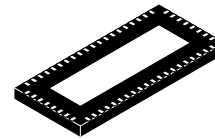
- Notebook Computers
- Desktop Computers
- Server/Storage Networks



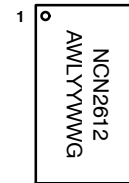
ON Semiconductor®

<http://onsemi.com>

MARKING DIAGRAM



WQFN56
CASE 510AK



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

ORDERING INFORMATION

| Device | Package | Shipping† |
|--------------|---------------------|-----------------------|
| NCN2612MTTWG | WQFN56 (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.

NCN2612

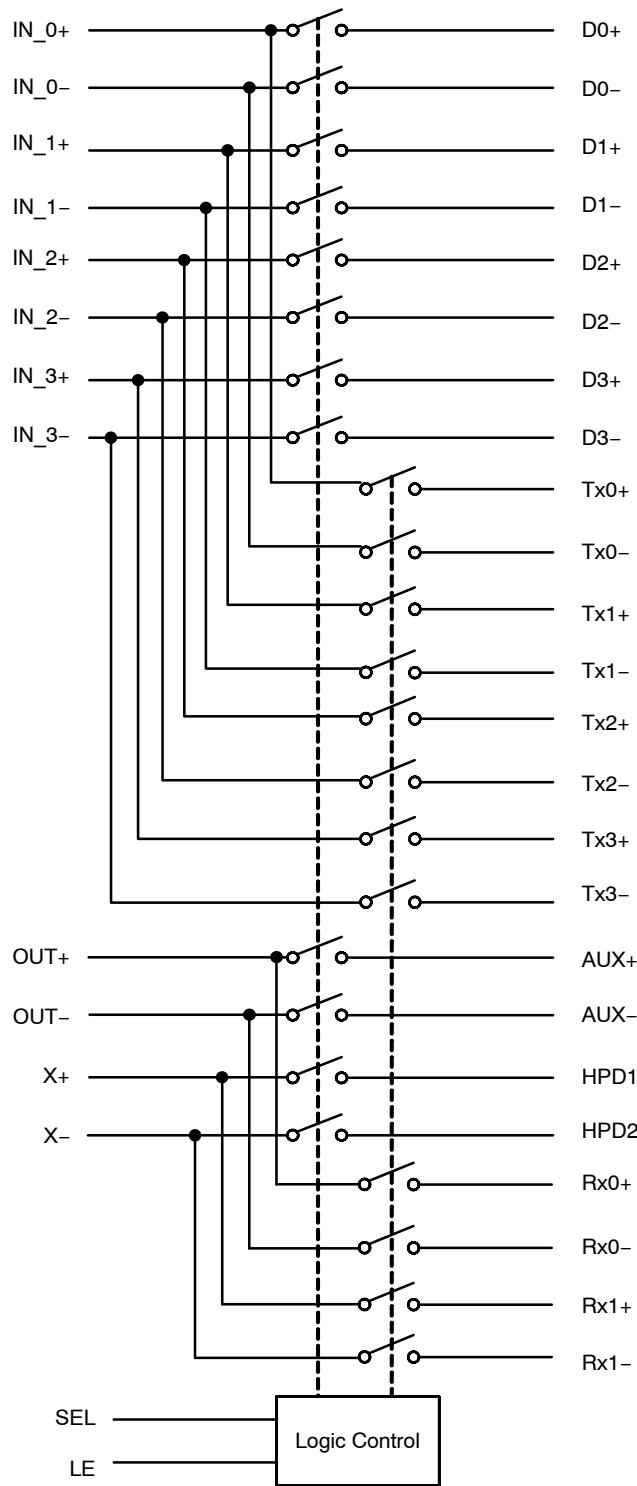


Figure 1. NCN2612 Block Diagram

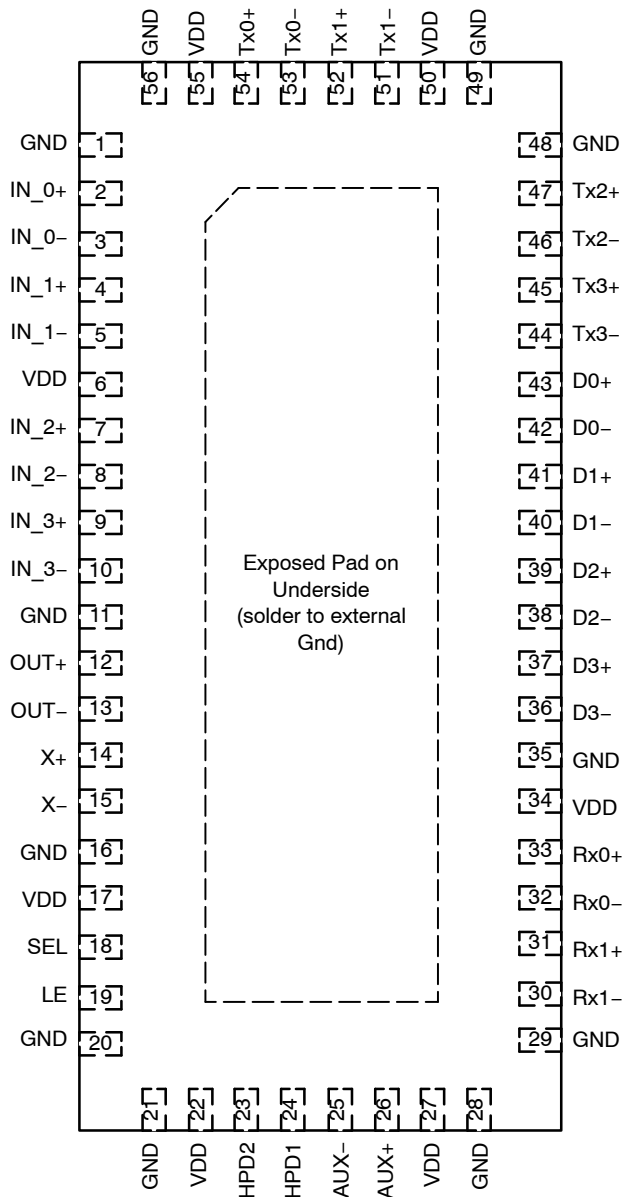
TRUTH TABLE (SEL Control)

| Function | SEL |
|--|-----|
| PCI_Express Gen2 Path is Active (Tx, Rx) | L |
| Digital Video Port is Active (Dx, HPDx, AUX) | H |

TRUTH TABLE (Latch Control)

| LE | Internal Mux Select |
|----|---------------------------|
| 0 | Respond to Changes on SEL |
| 1 | Latched |

NCN2612



**Figure 2. Pinout
(Top View)**

NCN2612

PIN FUNCTION AND DESCRIPTION

| Pin | Name | Description |
|---|------------|---|
| 6, 17, 22, 27, 34, 50, 55 | VDD | DC Supply, 3.3 V \pm 10% |
| 1, 11, 16, 20, 21, 28, 29, 35, 48, 49, 56 | GND | Power Ground. |
| Exposed Pad | - | The exposed pad on the backside of package is internally connected to Gnd. Externally the exposed pad should also be user-connected to GND. |
| 2 | IN_0+ | Differential input from GMCH PCIE outputs. IN_0+ makes a differential pair with IN_0-. |
| 3 | IN_0- | Differential input from GMCH PCIE outputs. IN_0- makes a differential pair with IN_0+. |
| 4 | IN_1+ | Differential input from GMCH PCIE outputs. IN_1+ makes a differential pair with IN_1-. |
| 5 | IN_1- | Differential input from GMCH PCIE outputs. IN_1- makes a differential pair with IN_1+. |
| 7 | IN_2+ | Differential input from GMCH PCIE outputs. IN_2+ makes a differential pair with IN_2-. |
| 8 | IN_2- | Differential input from GMCH PCIE outputs. IN_2- makes a differential pair with IN_2+. |
| 9 | IN_3+ | Differential input from GMCH PCIE outputs. IN_3+ makes a differential pair with IN_3-. |
| 10 | IN_3- | Differential input from GMCH PCIE outputs. IN_3- makes a differential pair with IN_3+. |
| 12 | OUT+ | Pass-through output from AUX+ input when SEL = 1. Pass-through output from Rx0+ input when SEL = 0. |
| 13 | OUT- | Pass-through output from AUX- input when SEL = 1. Pass-through output from Rx0- input when SEL = 0. |
| 14 | X+ | X+ is an analog pass-through output corresponding to Rx1+. |
| 15 | X- | X- is an analog pass-through output corresponding to the Rx1- input. The path from Rx1- to X- must be matched with the path from Rx1+ to X+. X+ and X- form a differential pair when the pass-through mux mode is selected. |
| 18 | SEL | SEL controls the mux through a flow-through latch. SEL = 0 for PCIE Mode; SEL = 1 for DP Mode |
| 19 | LE | The latch gate is controlled by LE. |
| 43, 42 | D0+, D0- | Analog pass-through output#1 corresponding to IN_0+ and IN_0-, when SEL = 1. |
| 41, 40 | D1+, D1- | Analog pass-through output#1 corresponding to IN_1+ and IN_1-, when SEL = 1. |
| 39, 38 | D2+, D2- | Analog pass-through output#1 corresponding to IN_2+ and IN_2-, when SEL = 1. |
| 37, 36 | D3+, D3- | Analog pass-through output#1 corresponding to IN_3+ and IN_3-, when SEL = 1. |
| 54, 53 | Tx0+, Tx0- | Analog pass-through output#2 corresponding to IN_0+ and IN_0- when SEL = 0. |
| 52, 51 | Tx1+, Tx1- | Analog pass-through output#2 corresponding to IN_1+ and IN_1- when SEL = 0. |
| 47, 46 | Tx2+, Tx2- | Analog pass-through output#2 corresponding to IN_2+ and IN_2- when SEL = 0. |
| 45, 44 | Tx3+, Tx3- | Analog pass-through output#2 corresponding to IN_3+ and IN_3- when SEL = 0. |
| 26 | AUX+ | Differential input from HDMI/DP connector. AUX+ makes a differential pair with AUX-. AUX+ is passed through to the OUT+ pin when SEL = 1. |
| 25 | AUX- | Differential input from HDMI/DP connector. AUX- makes a differential pair with AUX+. AUX- is passed through to the OUT- pin when SEL = 1. |
| 24 | HPD1 | Positive low frequency HPD input handshake protocol signal. |
| 23 | HPD2 | Negative low frequency HPD input handshake protocol signal (normally not connected). |
| 33 | Rx0+ | Differential input from PCIE connector or device. Rx0+ makes a differential pair with Rx0-. Rx0+ is passed through to the OUT+ pin when SEL = 0. |
| 32 | Rx0- | Differential input from PCIE connector or device. Rx0- makes a differential pair with Rx0+. Rx0- is passed through to the OUT- pin when SEL = 0. |
| 31 | Rx1+ | Differential input from PCIE connector or device. Rx1+ makes a differential pair with Rx1-. Rx1+ is passed through to the X+ pin when SEL = 0. |
| 30 | Rx1- | Differential input from PCIE connector or device. Rx1- makes a differential pair with Rx1+. Rx1- is passed through to the X- pin on the path that matches the Rx1+ to X+ pin. |

MAXIMUM RATINGS

| Parameter | Symbol | Rating | Unit |
|---|-----------------|-----------------------------------|------|
| Power Supply Voltages | V_{DD} | $-0.5 \leq V_{DD} \leq 5.3$ | V |
| Input/Output Voltage Range of the Switch | V_I & V_O | $-0.7 \leq V_I \leq V_{DD} + 0.3$ | V |
| Selection Pin Voltages | V_{SEL} | $-0.5 \leq V_I \leq V_{DD} + 0.3$ | V |
| Continuous Current Through One Switch Channel | I_{IO} | ± 120 | mA |
| Maximum Junction Temperature (Note 1) | T_J | 125 | °C |
| Operating Ambient Temperature | T_A | -40 to +85 | °C |
| Storage Temperature Range | T_{stg} | -65 to +150 | °C |
| Thermal Resistance, Junction-to-Air (Note 2) | $R_{\theta JA}$ | 37 | °C/W |

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. This parameter is based on EIA/JEDEC 51-7 with a 4-layer PCB, 80mm x 80mm, two 1oz Cu material internal planes and top planes of 2oz Cu material.

MAXIMUM POWER DISSIPATION

The maximum power that can be safely dissipated is limited by the associated rise in junction temperature.

For the plastic packages, the maximum safe junction temperature is 125°C. If the maximum is exceeded

momentarily, proper circuit operation will be restored as soon as the die temperature is reduced. Leaving the device in the “overheated” condition for an extended period can result in device burnout. To ensure proper operation, it is important to observe the de-rating curves.

NCN2612

ELECTRICAL CHARACTERISTICS ($V_{DD} = +3.3V \pm 10\%$, $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$, unless otherwise noted. All Typical values are at $V_{DD} = +3.3V$, $T_A = +25^\circ\text{C}$, unless otherwise noted)

| Symbol | Characteristics | Conditions | Min | Typ | Max | Unit |
|--------|-----------------|------------|-----|-----|-----|------|
|--------|-----------------|------------|-----|-----|-----|------|

POWER SUPPLY

| | | | | | | |
|-----------------|----------------------|---|-----|-----|-----|----|
| V _{DD} | Supply Voltage Range | | 3.0 | 3.3 | 3.6 | V |
| I _{DD} | Power Supply Current | V _{DD} = 3.6 V, V _{IN} = GND or V _{DD} | | 250 | 500 | μA |

DATA SWITCH PERFORMANCE (for both PCIe and Display Port applications, unless otherwise noted)

| | | | | | | |
|-----------------------|---|---|------|-----|-----------------|----|
| V _{IN} | Data Input/Output Voltage Range | | -0.1 | | V _{DD} | V |
| R _{ON} | On Resistance (Tx, Rx) | V _{DD} = 3 V, 0 V ≤ V _{IN} ≤ V _{DD} , I _{IN} = 40 mA | | 7 | 13 | Ω |
| R _{ON} | On Resistance (Dx,HP-Dx,AUX) | V _{DD} = 3 V, 0 V ≤ V _{IN} ≤ V _{DD} , I _{IN} = 40 mA | | 7.5 | 13 | Ω |
| R _{ON(Flat)} | On Resistance Flatness | V _{DD} = 3 V, 0 V ≤ V _{IN} ≤ V _{DD} , I _{IN} = 40 mA | | 0.1 | 1.24 | Ω |
| ΔR _{ON} | On Resistance Matching (Tx, Rx) | V _{DD} = 3 V, V _{IN} = 0 V, I _{IN} = 40 mA | | | 0.35 | Ω |
| ΔR _{ON} | On Resistance Matching (Dx,HPDx,AUX) | V _{DD} = 3 V, V _{IN} = 0 V, I _{IN} = 40 mA | | | 0.35 | Ω |
| C _{ON} | On Capacitance | f = 1 MHz, Switch On, Open Output | | 4.1 | | pF |
| C _{OFF} | Off Capacitance | f = 1 MHz, Switch Off | | 2.6 | | pF |
| I _{ON} | On Leakage Current (I _N / X _{OUT}) | V _{DD} = +3.6 V, V _{IN} = V _X = V _{OUT} = 0 V, +1.2 V; V _D or V _{TX} or V _{HPD} or V _{RX} or V _{AUX} = unconnected | -1 | | +1 | μA |
| I _{OFF} | Off Leakage Current (I _D / TX _{HPD} / RX _{AUX}) | V _{DD} = +3.6 V, V _{IN} = V _X = V _{OUT} = 0 V, +1.2 V; V _D or V _{TX} or V _{HPD} / AUX or V _{RX} = 1.2 V, 0 V | -1 | | +1 | μA |

CONTROL LOGIC CHARACTERISTICS (SEL and LE pins)

| | | | | | | |
|-----------------|--------------------|--|----|---|-----------------|----|
| V _{IL} | Off voltage input | | 0 | | 0.8 | V |
| V _{IH} | High voltage input | | 2 | | V _{DD} | V |
| I _{IN} | Off voltage input | V _{IN} = 0 V or V _{DD} | -1 | | +1 | μA |
| C _{IN} | High voltage input | f = 1 MHz | | 1 | | pF |

DYNAMIC CHARACTERISTICS

| | | | | | | |
|-------------------|-----------------------------|--|--|-----|--|------|
| BR | Signal Data Rate | R _S = R _L = 100 Ω differential | | 5 | | Gbps |
| I _{LOSS} | Differential Insertion Loss | R _S = R _L = 50 Ω, F = 2.7 GHz | | -4 | | dB |
| | | R _S = R _L = 50 Ω, F = 5 GHz | | -7 | | |
| | | R _S = R _L = 50 Ω, F = 7.5 GHz | | -13 | | |
| V _{ISO} | Differential Off Isolation | R _S = R _L = 50 Ω, F = 100 MHz | | -41 | | dB |
| | | R _S = R _L = 50 Ω, F = 1.35 GHz | | -19 | | |
| | | R _S = R _L = 50 Ω, F = 3 GHz | | -16 | | |
| X _{talk} | Differential Crosstalk | R _S = R _L = 50 Ω, F = 2.5 GHz | | -27 | | dB |
| | | R _S = R _L = 50 Ω, F = 5 GHz | | -20 | | |
| | | R _S = R _L = 50 Ω, F = 7.5 GHz | | -10 | | |

NCN2612

SWITCHING CHARACTERISTICS ($V_{DD} = +3.3\text{ V}$, $T_A = 25^\circ\text{C}$, unless otherwise specified)

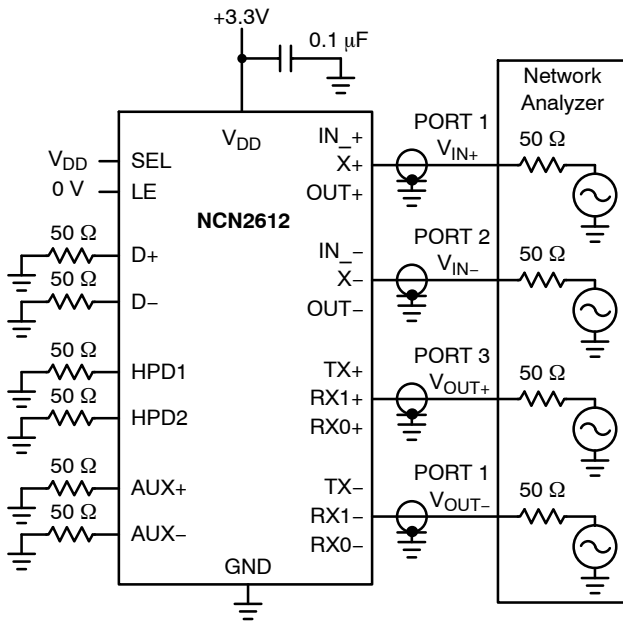
| Symbol | Characteristics | Conditions | Min | Typ | Max | Unit |
|-----------|--|---|-----|-----|-----|------|
| T_{SK1} | Bit-to-bit skew within same differential channel | $R_S = 50\ \Omega$, $R_L = 200\ \Omega$, $C_L = 4\ \text{pF}$ | | 7 | | ps |
| T_{SK2} | Channel-to-channel skew | $R_S = 50\ \Omega$, $R_L = 200\ \Omega$, $C_L = 4\ \text{pF}$ | | 55 | | ps |

SELECTION PINS SWITCHING CHARACTERISTICS ($V_{DD} = +3.3\text{ V}$, $T_A = 25^\circ\text{C}$, unless otherwise specified)

| Symbol | Characteristics | Conditions | Min | Typ | Max | Unit |
|--------------------|-----------------------------|--|-----|-----|-----|------|
| $T_{SELO\text{N}}$ | SEL to Switch turn ON time | V_{DX_A} or $V_{DX_B} = +1.0\text{ V}$, $R_L = 50\ \Omega$, V_{HPD_X} or $V_{AUX_X} = +1.0\text{ V}$, $R_L = 50\ \Omega$, $LE = V_{DD}$, $C_L = 100\ \text{pF}$ | | 8 | 20 | ns |
| $T_{SELO\text{F}}$ | SEL to Switch turn OFF time | V_{DX_A} or $V_{DX_B} = +1.0\text{ V}$, $R_L = 50\ \Omega$, V_{HPD_X} or $V_{AUX_X} = +1.0\text{ V}$, $R_L = 50\ \Omega$, $LE = V_{DD}$, $C_L = 100\ \text{pF}$ | | 5 | 10 | ns |
| $T_{SE\text{T}}$ | LE setup time SEL to LE | V_{DX_A} or $V_{DX_B} = +1.0\text{ V}$, $R_L = 50\ \Omega$, V_{HPD_X} or $V_{AUX_X} = +1.0\text{ V}$, $R_L = 50\ \Omega$, $LE = V_{DD}$, $C_L = 100\ \text{pF}$ | | 1 | | ns |
| $T_{SE\text{H}}$ | LE hold time LE to SEL | V_{DX_A} or $V_{DX_B} = +1.0\text{ V}$, $R_L = 50\ \Omega$, V_{HPD_X} or $V_{AUX_X} = +1.0\text{ V}$, $R_L = 50\ \Omega$, $LE = V_{DD}$, $C_L = 100\ \text{pF}$ | | 1 | | ns |

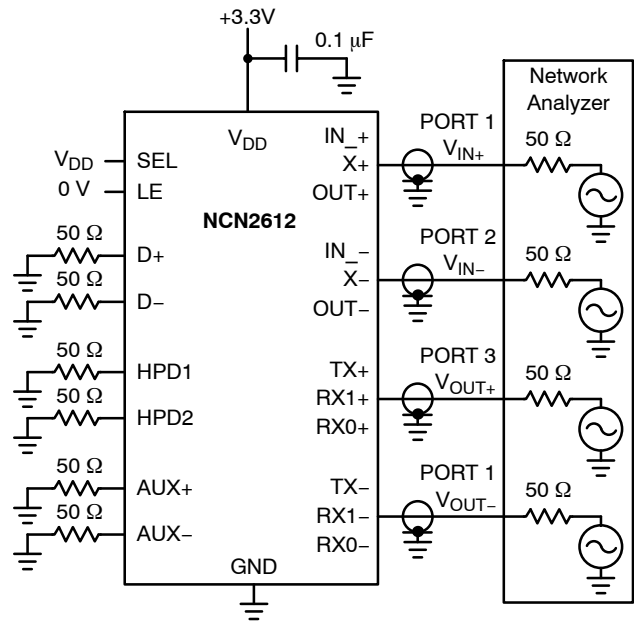
NOTE: Device will meet the specifications after thermal equilibrium has been established when mounted in a test socket or printed circuit board with maintained transverse airflow greater than 500 lpm. Electrical parameters are guaranteed only over the declared operating temperature range. Functional operation of the device exceeding these conditions is not implied. Device specification limit values are applied individually under normal operating conditions and not valid simultaneously.

NCN2612



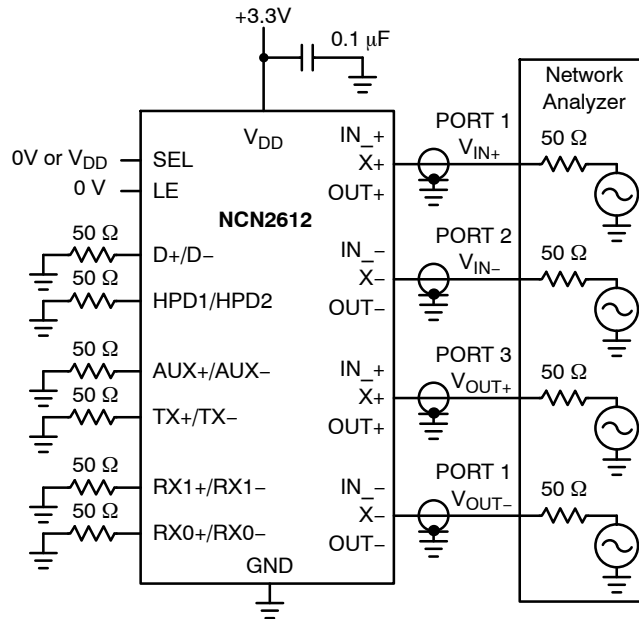
$$\text{Differential Insertion Loss} = 20\log\left(\frac{V_{\text{OUT}+} - V_{\text{OUT}-}}{V_{\text{IN}+} - V_{\text{IN}-}}\right)$$

Figure 3. Differential Insertion Loss/Differential Return Loss



$$\text{Differential Off Isolation} = 20\log\left(\frac{V_{\text{OUT}+} - V_{\text{OUT}-}}{V_{\text{IN}+} - V_{\text{IN}-}}\right)$$

Figure 4. Differential Off-Isolation



$$\text{Differential Crosstalk} = 20\log\left(\frac{V_{\text{OUT}+} - V_{\text{OUT}-}}{V_{\text{IN}+} - V_{\text{IN}-}}\right)$$

Figure 5. Differential Crosstalk

Measurements are standardized against shorts at IC terminals.

Differential OFF-Isolation is measured between IN₋ and "OFF" D or TX, X and "OFF" HPD or RX1, OUT and "OFF" AUX or RX0 terminal on each switch under Figure 3.

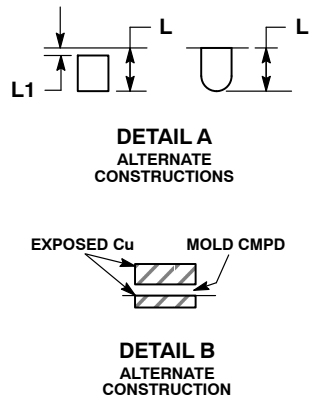
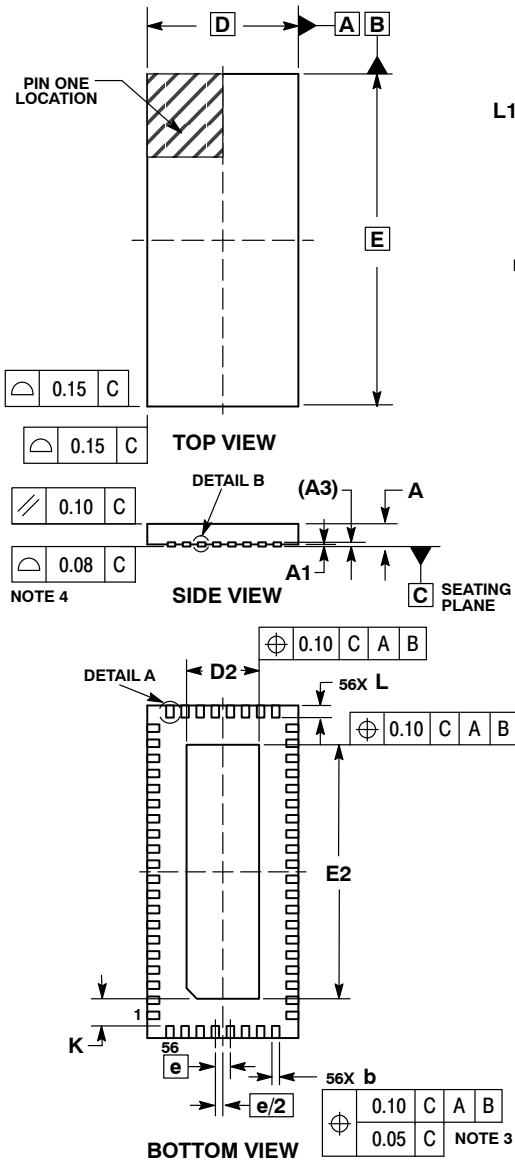
Differential ON-Isolation is measured between IN₋ and "ON" D or TX, X and "ON" HPD or RX1, OUT and "ON" AUX or RX0 terminal on each switch under Figure 4.

Differential Crosstalk is measured between any two pairs.

NCN2612

PACKAGE DIMENSIONS

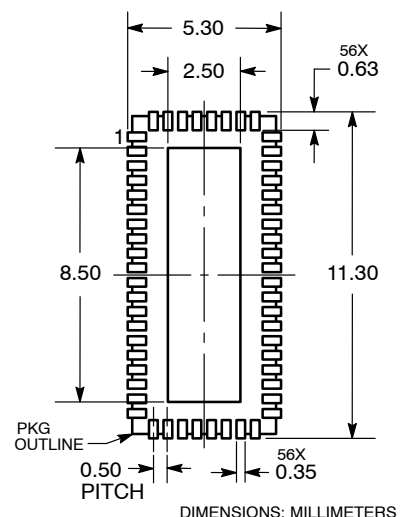
WQFN56 5x11, 0.5P
CASE 510AK-01
ISSUE A



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

| MILLIMETERS | | |
|-------------|-------|------|
| DIM | MIN | MAX |
| A | 0.70 | 0.80 |
| A1 | --- | 0.05 |
| A3 | 0.20 | REF |
| b | 0.20 | 0.30 |
| D | 5.00 | BSC |
| D2 | 2.30 | 2.50 |
| E | 11.00 | BSC |
| E2 | 8.30 | 8.50 |
| e | 0.50 | BSC |
| K | 0.20 | MIN |
| L | 0.30 | 0.50 |
| L1 | --- | 0.15 |

RECOMMENDED SOLDERING FOOTPRINT*



*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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