# NS3L500

# 3.3V, 8-Channel, 2:1 Gigabit Ethernet LAN Switch with LED Switch

The NS3L500 is a 8−channel 2:1 LAN switch with 3 additional built−in SPDT switches for LED routing. This switch is ideal for Gigabit LAN applications due to its low ON−state resistance and capacitance giving the switch a typical bandwidth of 800 MHz. The switch also has excellent ON−state resistance match, low bit−to−bit skew, and low crosstalk among channels. The switch is bidirectional and offers little or no attenuation of the high−speed signals at the outputs.

This part can be used to replace mechanical relays in low−voltage LAN applications that interface a physical layer over CAT 5 or CAT 6 unshielded twisted pair cable through an isolation transformer. The NS3L500 is available in a 56−pin WQFN package and operates over the extended −40°C to +85°C temperature range.

### Features

- $V_{CC}$ Operating Range: +3.0 V to +3.6 V
- Low ON−State Resistance ($R_{ON}$ = 4 Ω Typical)
- Low ON−State Capacitance ($C_{ON}$ = 7 pF Typical)
- Flat ON−State Resistance ($R_{ON}$(flat) = 0.5 Ω Typical)
- Wide Bandwidth (800 MHz Typical)
- Low Crosstalk ($X_{TALK}$ = −37 dB Typical)
- Near−Zero Propagation Delay: 250 ps
- Low Bit−to−Bit Skew (tsk(o) = 100 ps Max)
- Three SPDT Channels for LED Signal Switching
- Packaging: 56−Pin WQFN
- Pin−to−Pin Compatible with PI3L500−A, TS3L500AE and MAX4927
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

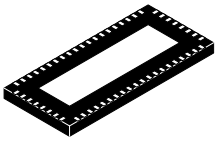
### Typical Applications

- 10/100/1000 Base−T Ethernet Signal Switching
- Notebooks and Docking Stations
- Hub and Router Signal Switching
- Differential (LVDS, LVPECL) Signal Switching

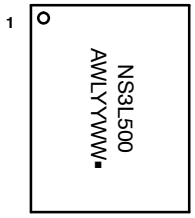
**ON Semiconductor®**

**http://onsemi.com**

**MARKING DIAGRAMS**



**WQFN56**
**MT SUFFIX**
**CASE 510AK**




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

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 9 of this data sheet.

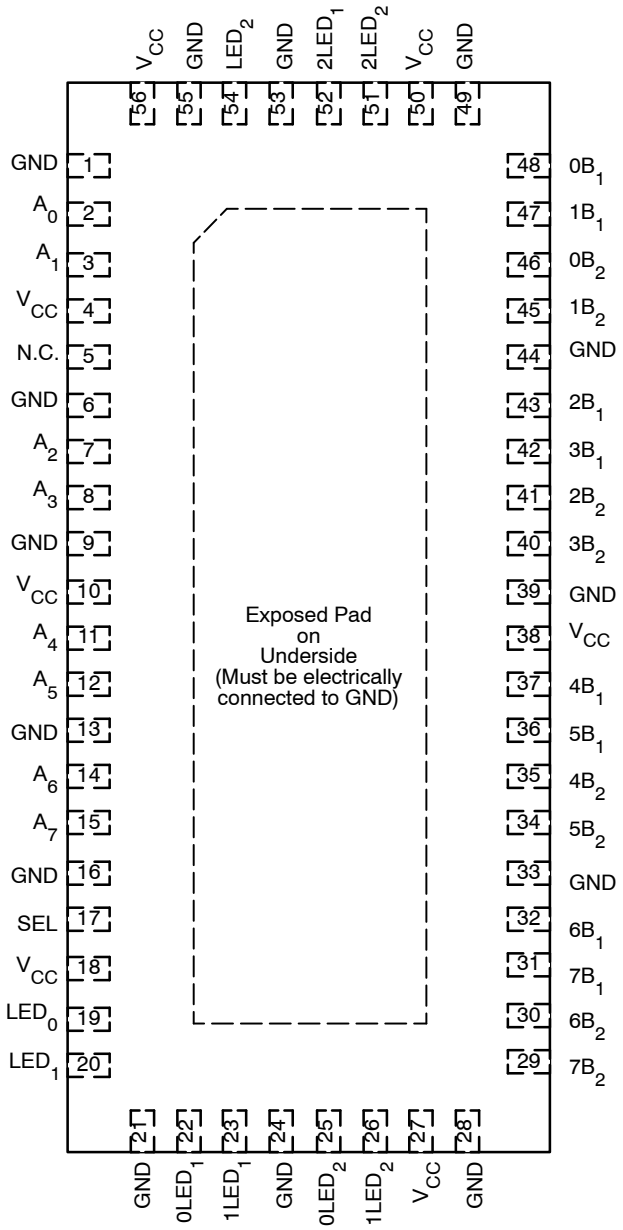



**Figure 1. Pinout**
**(Top View)**

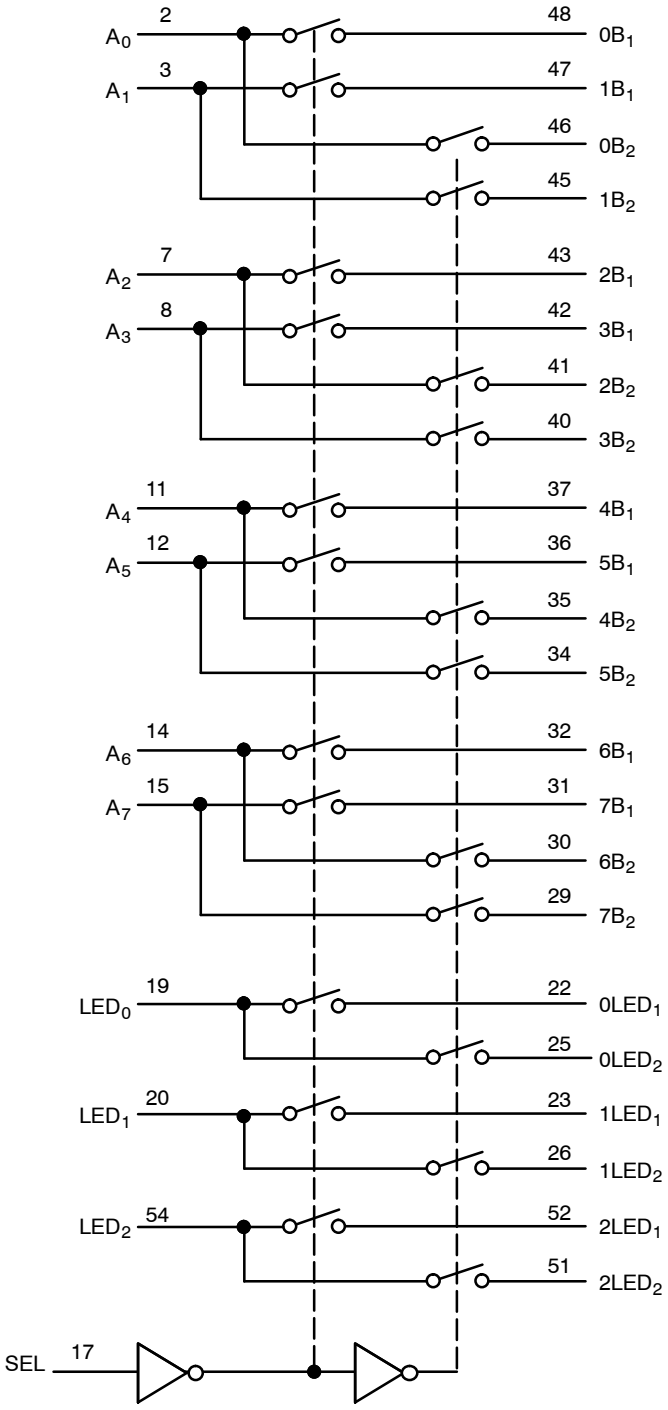



**Figure 2. Block Diagram**

**PIN DESCRIPTION**

| Pin Name | Description |
|---|---|
| $A_x$ | Data I/Os |
| $xB_y$ | Data I/Os |
| SEL | Select Input |
| $LED_x$ | LED I/O Port |
| $xLED_y$ | LED I/O Port |

**TRUTH TABLE**

| SEL | Function |
|---|---|
| L | $A_x$ to $xB_1$: $LED_x$ to $xLED_1$ |
| H | $A_x$ to $xB_2$: $LED_x$ to $xLED_2$ |

## MAXIMUM RATINGS

| Symbol | Pins | Parameter | Value | Unit |
|---|---|---|---|---|
| $V_{CC}$ | $V_{CC}$ | Positive DC Supply Voltage | −0.5 to +5.5 | V |
| $V_{IN}$ | SEL | Control Input Voltage | −0.5 to +5.5 | V |
| $V_{I/O}$ | $A_X$, $xB_Y$, $LED_X$, $xLED_Y$ | Switch I/O Voltage Range | −0.5 to $V_{CC}$ +0.5 | V |
| $I_{CC}$ | $V_{CC}$ | DC Output Current | ±120 | mA |
| $I_{IK}$ | SEL | Control Input Clamp Current | −50 | mA |
| $I_{I/O}$ | $A_X$, $xB_Y$, $LED_X$, $xLED_Y$ | ON−State Switch Current | ±120 | mA |
| $R_{\theta JA}$ | | Thermal Resistance, Junction−to−Air | 125 | °C/W |
| $T_S$ | | Storage Temperature | −65 to +150 | °C |

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.

## RECOMMENDED OPERATING CONDITIONS

| Symbol | Pins | Parameter | Value | Unit |
|---|---|---|---|---|
| $V_{CC}$ | $V_{CC}$ | Positive DC Supply Voltage | +3.0 to +3.6 | V |
| $V_{IN}$ | SEL | Control Input Voltage | 0 to +5.5 | V |
| $V_{I/O}$ | $A_X$, $xB_Y$, $LED_X$, $xLED_Y$ | Switch I/O Voltage Range | 0 to $V_{CC}$ | V |
| $T_A$ | | Operating Temperature | −40 to +85 | °C |

Minimum and maximum values are guaranteed through test or design across the Recommended Operating Conditions, where applicable. Typical values are listed for guidance only and are based on the particular conditions listed for section, where applicable. These conditions are valid for all values found in the characteristics tables unless otherwise specified in the test conditions.

**DC ELECTRICAL CHARACTERISTICS** (Typical: T = 25°C, $V_{CC}$ = 3.3 V)

| Symbol | Pins | Parameters | Conditions | −40°C to +85°C | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min | Typ | Max | |
| **1000 BASE−T ETHERNET SWITCHING** | | | | | | | |
| $V_{IH}$ | SEL | Control Input HIGH Voltage | | 2 | | 5.5 | V |
| $V_{IL}$ | SEL | Control Input LOW Voltage | | −0.5 | | 0.8 | V |
| $V_{IK}$ | SEL | Clamp Diode Voltage | $V_{CC}$ = Max, $I_{IN}$ = −18 mA | | −0.7 | −1.2 | V |
| $I_{IH}$ | SEL | Input HIGH Current | $V_{CC}$ = Max, $V_{IN}$ = $V_{CC}$ | −1 | | +1 | μA |
| $I_{IL}$ | SEL | Input LOW Current | $V_{CC}$ = Max, $V_{IN}$ = GND | −1 | | +1 | μA |
| $I_{OFF}$ | SEL | Off−Leakage Current | $V_{CC}$ = 0 V, $V_{IN}$ = 0 V to 3.6 V | | | ±1.5 | μA |
| $I_{CC}$ | $V_{CC}$ | Quiescent Supply Current | $V_{CC}$ = 3.6 V,, $V_{IN}$ = $V_{CC}$ or GND, $I_O$ = 0 mA | | 250 | 600 | μA |
| $I_{LA(OFF)}$ | $A_X$, $xB_Y$ | Off−Leakage Current | $V_{CC}$ = 3.6 V, $VA_X$ = 0.3 V, 3.3 V; $VxB_1$ or $VxB_2$ = 3.3 V, 0.3 V | −1 | | +1 | μA |
| $I_{LA\_(ON)}$ | $A_X$, $xB_Y$ | On−Leakage Current | $V_{CC}$ = 3.6 V, $VA_X$ = 0.3 V, 3.3 V; $VxB_1$ or $VxB_2$ = 0.3 V, 3.3 V, or floating | −1 | | +1 | μA |
| $R_{ON}$ | $A_X$, $xB_Y$ | On−Resistance | $V_{CC}$ = 3 V, 1.5 V ≤ $V_{IN}$ ≤ $V_{CC}$, $I_O$ = −40 mA | | 4 | 7 | Ω |
| $R_{ON(FLAT)}$ | $A_X$, $xB_Y$ | On−Resistance Flatness | $V_{CC}$ = 3 V, $V_{IN}$ = 1.5 V and $V_{CC}$, $I_O$ = −40 mA | | 0.5 | | Ω |
| $\Delta R_{ON}$ | $A_X$, $xB_Y$ | On−Resistance Match Between Switch Pairs | $V_{CC}$ = 3 V, 1.5 V ≤ $V_{IN}$ ≤ $V_{CC}$, $I_O$ = −40 mA | | 0.4 | 1 | Ω |
| **10/100 BASE−T ETHERNET SWITCHING** | | | | | | | |
| $V_{IH}$ | SEL | Control Input HIGH Voltage | | 2 | | 5.5 | V |
| $V_{IL}$ | SEL | Control Input LOW Voltage | | −0.5 | | 0.8 | V |
| $V_{IK}$ | SEL | Clamp Diode Voltage | $V_{CC}$ = Max, $I_{IN}$ = −18 mA | | −0.7 | −1.2 | V |
| $I_{IH}$ | SEL | Input HIGH Current | $V_{CC}$ = Max, $V_{IN}$ = $V_{CC}$ | −1 | | +1 | μA |
| $I_{IL}$ | SEL | Input LOW Current | $V_{CC}$ = Max, $V_{IN}$ = GND | −1 | | +1 | μA |
| $I_{OFF}$ | SEL | Off−Leakage Current | $V_{CC}$ = 0 V, $V_{IN}$ = 0 V to 3.6 V | | | ±1.5 | μA |
| $I_{CC}$ | $V_{CC}$ | Quiescent Supply Current | $V_{CC}$ = 3.6 V, $V_{IN}$ = $V_{CC}$ or GND $I_O$ = 0 mA | | 250 | 600 | μA |
| $I_{LA(OFF)}$ | $A_X$, $xB_Y$ | Off−Leakage Current | $V_{CC}$ = 3.6 V, $VA_X$ = 0.3 V, 3.3 V; $VxB_1$ or $VxB_2$ = 3.3 V, 0.3 V | −1 | | +1 | μA |
| $I_{LA\_(ON)}$ | $A_X$, $xB_Y$ | On−Leakage Current | $V_{CC}$ = 3.6 V, $VA_X$ = 0.3 V, 3.3 V; $VxB_1$ or $VxB_2$ = 0.3 V, 3.3 V, or floating | −1 | | +1 | μA |
| $R_{ON}$ | $A_X$, $xB_Y$ | On−Resistance | $V_{CC}$ = 3 V, 1.25 V ≤ $V_{IN}$ ≤ $V_{CC}$, $I_O$ = −10 mA to −30 mA | | 4 | 6 | Ω |
| $R_{ON(FLAT)}$ | $A_X$, $xB_Y$ | On−Resistance Flatness | $V_{CC}$ = 3 V, $V_{IN}$ = 1.25 V and $V_{CC}$, $I_O$ = −10 mA to −30 mA | | 0.5 | | Ω |
| $\Delta R_{ON}$ | $A_X$, $xB_Y$ | On−Resistance Match Between Switch Pairs | $V_{CC}$ = 3 V, 1.25 V ≤ $V_{IN}$ ≤ $V_{CC}$, $I_O$ = −10 mA to −30 mA | | 0.4 | 1 | Ω |

**DC ELECTRICAL CHARACTERISTICS** (Typical: T = 25°C, $V_{CC}$ = 3.3 V)

| Symbol | Pins | Parameters | Conditions | −40°C to +85°C | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min | Typ | Max | |
| **LED SWITCHING** | | | | | | | |
| $R_{ON}$ | $LED_X$, $xLED_Y$ | On−Resistance | $V_{CC}$ = 3 V, 1.25 V ≤ $V_{IN}$ ≤ $V_{CC}$, $I_O$ = −40 mA | | 15 | 25 | Ω |
| $R_{ON(FLAT)}$ | $LED_X$, $xLED_Y$ | On−Resistance Flatness | $V_{CC}$ = 3 V, $V_{IN}$ = 1.25 V and $V_{CC}$, $I_O$ = −40 mA | | 8 | | Ω |
| $\Delta R_{ON}$ | $LED_X$, $xLED_Y$ | On−Resistance Match Between Switch Pairs | $V_{CC}$ = 3 V, 1.25 V ≤ $V_{IN}$ ≤ $V_{CC}$, $I_O$ = −40 mA | | 1 | 2 | Ω |

**AC ELECTRICAL CHARACTERISTICS** (Typicals: T = 25°C, $V_{CC}$ = 3.3 V)*

| Symbol | Pins | Parameters | Conditions | −40°C to +85°C | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min | Typ | Max | |
| **SWITCHING CHARACTERISTICS** | | | | | | | |
| $t_{PLH}$, $t_{PHL}$ | $A_x$, $xB_y$ | Propagation Delay | $V_{CC}$ = 3.0 V to 3.6 V (Figure 3) | | 0.25 | | ns |
| $t_{ON}$ | SEL, $xLED_y$ | Line Enable Time − SEL to $xLED_Y$ | Output: Closed to Open $V_{CC}$ = 3.0 V to 3.6 V (Figure 4) | 0.5 | | 15 | ns |
| | SEL, $xB_y$ | Lines Enable Time − SEL to $xB_y$ | | 0.5 | | 3 | μs |
| $t_{OFF}$ | SEL, $xLED_y$ | Line Enable Time − SEL to $xLED_Y$ | Output: Open to Closed $V_{CC}$ = 3.0 V to 3.6 V (Figure 4) | 0.5 | | 9 | ns |
| | SEL, $xB_y$ | Lines Enable Time − SEL to $xB_y$ | | 0.5 | | 35 | ns |
| $t_{SK(O)}$ | $A_x$, $xB_y$ | Output Skew between center port to any other port | $V_{CC}$ = 3.0 V to 3.6 V (Calculated, Figure 3) | | 50 | 100 | ps |
| $t_{SK(P)}$ | $A_x$, $xB_y$ | Skew between opposite transition of the same output ($t_{PHL} - t_{PLH}$) | $V_{CC}$ = 3.0 V to 3.6 V (Calculated, Figure 3) | | 50 | 100 | ps |
| **DYNAMIC ELECTRICAL CHARACTERISTICS** | | | | | | | |
| BW | $xB_y$, $xLED_y$ | −3 dB Bandwidth | $R_L$ = 100 Ω (Figure 5) | | 800 | | MHz |
| $O_{IRR}$ | $A_X$, $LED_X$ | Off − Isolation | $R_L$ = 100 Ω, f = 250 MHz (Figure 6) | | −37 | | dB |
| $X_{TALK}$ | $A_X$ to $xB_Y$ $A_{(X+2)}$ to $(X+2)B_Y$ | Crosstalk | $R_L$ = 100 Ω, f = 250 MHz (Figure 7) | | −37 | | dB |
| **CAPACITANCE** | | | | | | | |
| $C_{IN}$ | SEL | Control Pin Input Capacitance | $V_{IN}$ = 0 V, f = 1 MHz | | 2 | 3 | pF |
| $C_{ON}$ | $A_X$, $xB_y$ | ON Capacitance | $V_{IN}$ = 0 V, f = 1 MHz, Outputs Open, Switch ON | | 7 | 10 | pF |
| $C_{OFF}$ | xBy | B Port Switch Capacitance | $V_{IN}$ = 0 V, f = 1 MHz, Outputs Open, Switch OFF | | 5 | 6 | pF |

*Guaranteed by design and/or characterization.

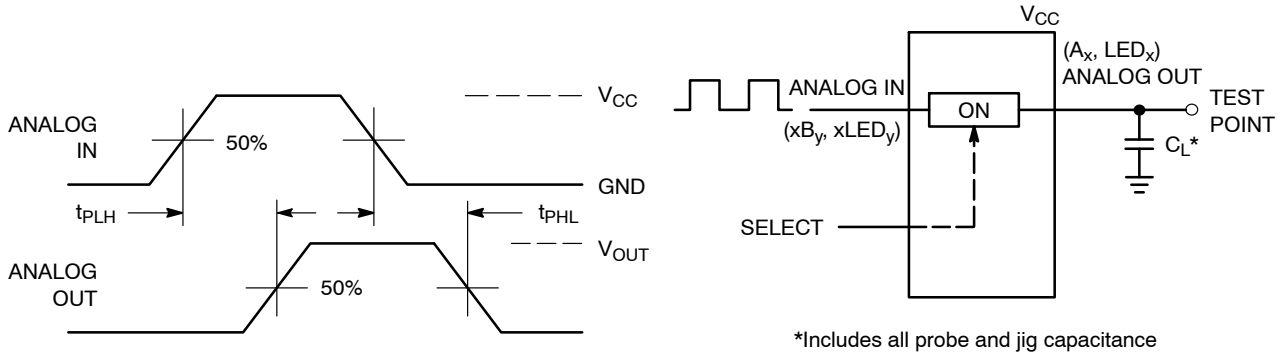



**Figure 3. Propagation Delay**

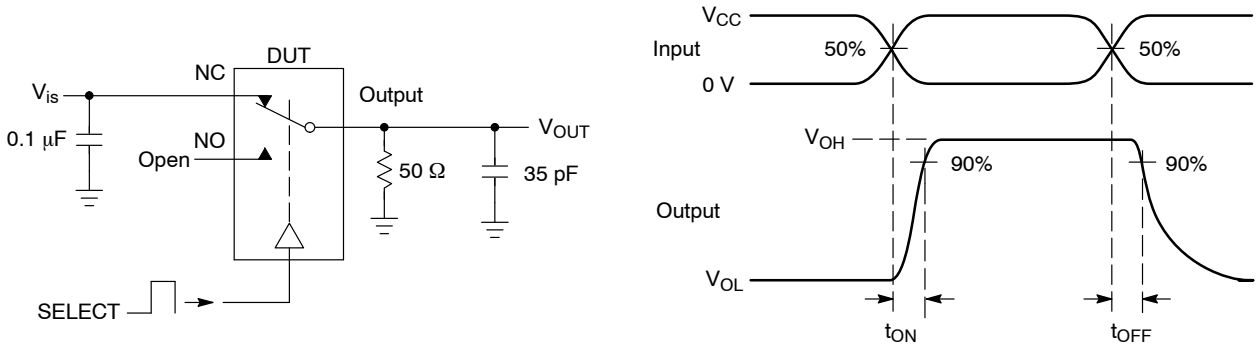



**Figure 4. $t_{ON}/t_{OFF}$**

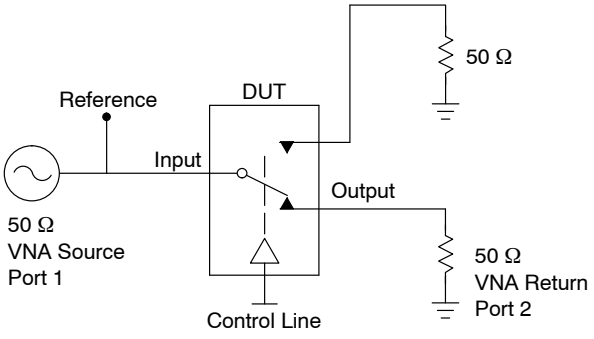



**Figure 5. Bandwidth**

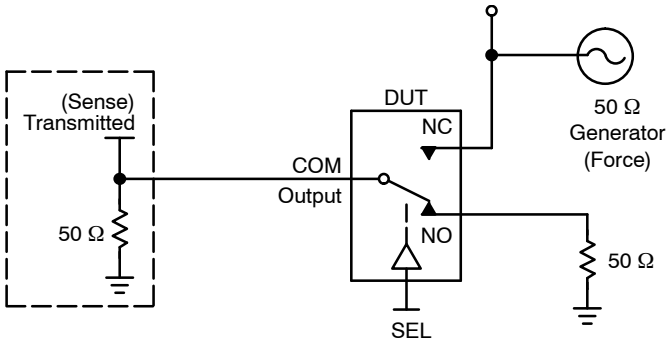
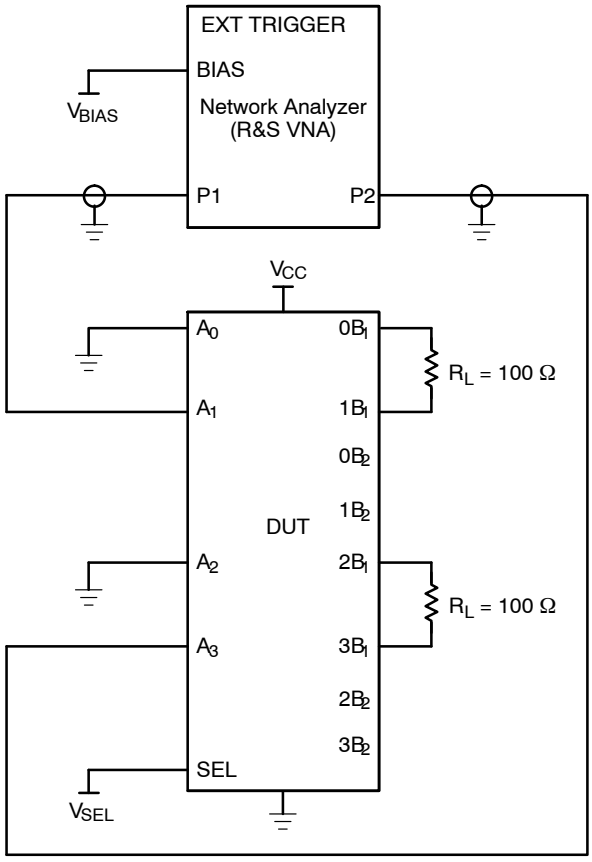



**Figure 6. Off−Isolation**




1. $C_L$ includes probe and jig capacitance.
2. A 50 Ω termination resistor is needed to match the loading of the network analyzer.

**Figure 7. Test Circuit for Crosstalk ($X_{TALK}$)**

Crosstalk is measured at the output of the nonadjacent ON channel. For example, when $V_{SEL}$ = 0 and $A_0$ is the input, the output is measured at $1B_1$. All unused analog input (A) ports are connected to GND, and output (B) ports are connected to GND through 50 Ω pulldown resistors.

## APPLICATION INFORMATION

### Logic Inputs

The logic control inputs can be driven up to +3.6 V regardless of the supply voltage. For example, given a +3.3 V supply, the output enables or select pins may be driven low to 0 V and high to 3.6 V> Driving IN Rail−to−Rail® minimizes power consumption.

### Power−Supply Sequencing

Proper power−supply sequencing is advised for all CMOS devices. It is recommended to always apply $V_{CC}$ before applying signals to the input/output or control pins.

### ORDERING INFORMATION

| Device | Package | Shipping† |
|---|---|---|
| NS3L500MTTWG | WQFN56<br>(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.

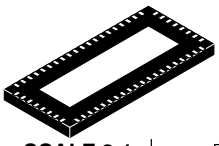
Rail−to−Rail is a registered trademark of Nippon Motorola, Ltd.

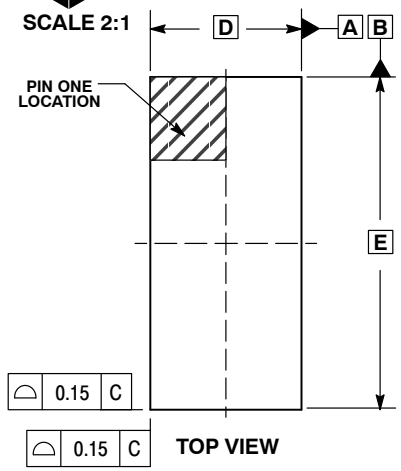
# MECHANICAL CASE OUTLINE
## PACKAGE DIMENSIONS

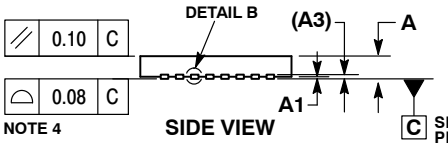
ON Semiconductor®

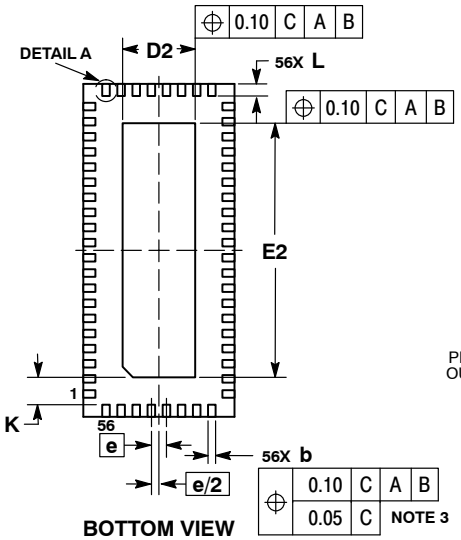
**WQFN56 5x11, 0.5P**
CASE 510AK−01
ISSUE A

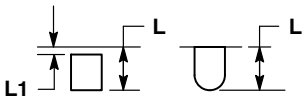
DATE 02 MAR 2010



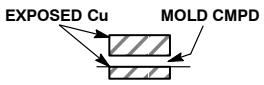



**DETAIL A**
**ALTERNATE CONSTRUCTIONS**

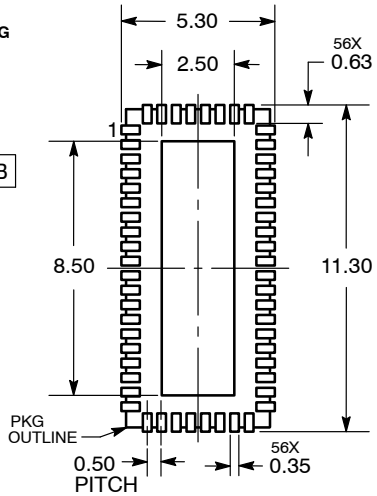



**DETAIL B**
**ALTERNATE CONSTRUCTION**

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.

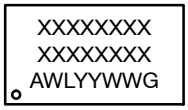
| | MILLIMETERS | |
|---|---|---|
| DIM | MIN | MAX |
| A | 0.70 | 0.80 |
| A1 | −−− | 0.05 |
| A3 | 0.20 REF | |
| b | 0.20 | 0.30 |
| D | 5.00 BSC | |
| D2 | 2.30 | 2.50 |
| E | 11.00 BSC | |
| E2 | 8.30 | 8.50 |
| e | 0.50 BSC | |
| K | 0.20 MIN | |
| L | 0.30 | 0.50 |
| L1 | −−− | 0.15 |

### RECOMMENDED SOLDERING FOOTPRINT




DIMENSIONS: MILLIMETERS

### GENERIC MARKING DIAGRAM*




XXXXX = 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.

| | | |
|---|---|---|
| **DOCUMENT NUMBER:** | **98AON45390E** | Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped “CONTROLLED COPY” in red. |
| **DESCRIPTION:** | **WQFN56 5x11, 0.5P** | **PAGE 1 OF 1** |

## PUBLICATION ORDERING INFORMATION

**LITERATURE FULFILLMENT**:
**Email Requests to:** orderlit@onsemi.com

**onsemi Website:** www.onsemi.com

**TECHNICAL SUPPORT**
**North American Technical Support:**
Voice Mail: 1 800−282−9855 Toll Free USA/Canada
Phone: 011 421 33 790 2910

**Europe, Middle East and Africa Technical Support:**
Phone: 00421 33 790 2910
For additional information, please contact your local Sales Representative

◊