

# NLAST4501

## Single SPST Analog Switch

The NLAST4501 is an analog switch manufactured in sub-micron silicon-gate CMOS technology. It achieves very low  $R_{ON}$  while maintaining extremely low power dissipation. The device is a bilateral switch suitable for switching either analog or digital signals, which may vary from zero to full supply voltage.

The NLAST4501 is a low voltage, TTL (low threshold) compatible device, pin for pin compatible with the MAX4501.

The Enable pin is compatible with standard TTL level outputs when supply voltage is nominal 5.0 V. It is also over-voltage tolerant, making it a very useful logic level translator.

### Features

- Guaranteed  $R_{ON}$  of  $32\ \Omega$  at 5.5 V
- Low Power Dissipation:  $I_{CC} = 2\ \mu A$
- Low Threshold Enable pin TTL compatible at 5.0 V
- TTL version and pin for pin with NLA4501
- Provides Voltage translation for many different voltage levels  
3.3 to 5.0 V, Enable pin may go as high as +5.5 V  
1.8 to 3.3 V  
1.8 to 2.5 V
- Improved version of MAX4501 (at any voltage between 2 and 5.5 V)
- Chip Complexity: FETs = 11
- Pb-Free Packages are Available

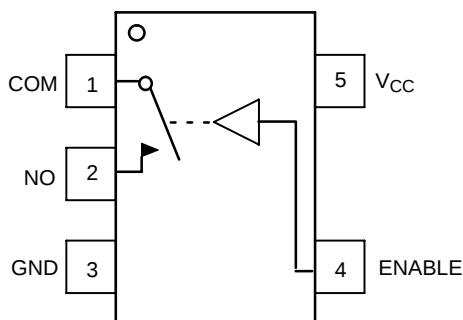


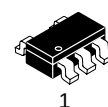
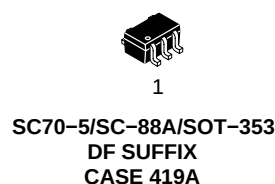
Figure 1. Pinout (Top View)



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### MARKING DIAGRAMS



TSOP-5  
DT SUFFIX  
CASE 483

A3 = Specific Device Code  
M = Date Code\*  
A = Assembly Location  
Y = Year  
W = Work Week  
▪ = Pb-Free Package

(Note: Microdot may be in either location)

\*Date Code orientation and/or position and underbar may vary depending upon manufacturing location.

### PIN ASSIGNMENT

| Pin | Function |
|-----|----------|
| 1   | COM      |
| 2   | NO       |
| 3   | GND      |
| 4   | ENABLE   |
| 5   | $V_{CC}$ |

### FUNCTION TABLE

| On/Off Enable Input | State of Analog Switch |
|---------------------|------------------------|
| L                   | Off                    |
| H                   | On                     |

### ORDERING INFORMATION

See detailed ordering and shipping information on page 8 of this data sheet.

## MAXIMUM RATINGS

| Rating                                          | Symbol                                                                                            | Value                  | Unit |
|-------------------------------------------------|---------------------------------------------------------------------------------------------------|------------------------|------|
| Positive DC Supply Voltage                      | $V_{CC}$                                                                                          | -0.5 to +7.0           | V    |
| Digital Input Voltage (Enable)                  | $V_{IN}$                                                                                          | -0.5 to +7.0           | V    |
| Analog Output Voltage ( $V_{NO}$ or $V_{COM}$ ) | $V_{IS}$                                                                                          | -0.5 to $V_{CC}$ +0.5  | V    |
| DC Current, Into or Out of Any Pin              | $I_{IK}$                                                                                          | $\pm 20$               | mA   |
| Storage Temperature Range                       | $T_{STG}$                                                                                         | -65 to +150            | °C   |
| Lead Temperature, 1 mm from Case for 10 Seconds | $T_L$                                                                                             | 260                    | °C   |
| Junction Temperature under Bias                 | $T_J$                                                                                             | +150                   | °C   |
| Thermal Resistance                              | SC70-5/SC-88A (Note 1)<br>TSOP-5<br>$\theta_{JA}$                                                 | 350<br>230             | °C/W |
| Power Dissipation in Still Air at 85°C          | SC70-5/SC-88A<br>TSOP-5<br>$P_D$                                                                  | 150<br>200             | mW   |
| Moisture Sensitivity                            | MSL                                                                                               | Level 1                |      |
| Flammability Rating                             | Oxygen Index: 30% – 35%<br>$F_R$                                                                  | UL 94 V-0 @ 0.125 in   |      |
| ESD Withstand Voltage                           | Human Body Model (Note 2)<br>Machine Model (Note 3)<br>Charged Device Model (Note 4)<br>$V_{ESD}$ | > 2000<br>> 100<br>N/A | V    |
| Latchup Performance                             | Above $V_{CC}$ and Below GND at 85°C (Note 5)<br>$I_{Latchup}$                                    | $\pm 300$              | mA   |

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. Measured with minimum pad spacing on an FR4 board, using 10 mm-by-1 inch, 2-ounce copper trace with no air flow.
2. Tested to EIA/JESD22-A114-A.
3. Tested to EIA/JESD22-A115-A.
4. Tested to JESD22-C101-A.
5. Tested to EIA/JESD78.

## RECOMMENDED OPERATING CONDITIONS

| Parameter                                      | Symbol     | Min                                                                                      | Max            | Unit |
|------------------------------------------------|------------|------------------------------------------------------------------------------------------|----------------|------|
| Positive DC Supply Voltage                     | $V_{CC}$   | 2.0                                                                                      | 5.5            | V    |
| Digital Input Voltage (Enable)                 | $V_{IN}$   | GND                                                                                      | 5.5            | V    |
| Static or Dynamic Voltage Across an Off Switch | $V_{IO}$   | GND                                                                                      | $V_{CC}$       | V    |
| Analog Input Voltage (NO, COM)                 | $V_{IS}$   | GND                                                                                      | $V_{CC}$       | V    |
| Operating Temperature Range, All Package Types | $T_A$      | -55                                                                                      | +125           | °C   |
| Input Rise or Fall Time,<br>(Enable Input)     | $t_r, t_f$ | $V_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}$<br>$V_{CC} = 5.0 \text{ V} \pm 0.5 \text{ V}$ | 0<br>100<br>20 | ns/V |

## DEVICE JUNCTION TEMPERATURE VERSUS TIME TO 0.1% BOND FAILURES

| Junction Temperature °C | Time, Hours | Time, Years |
|-------------------------|-------------|-------------|
| 80                      | 1,032,200   | 117.8       |
| 90                      | 419,300     | 47.9        |
| 100                     | 178,700     | 20.4        |
| 110                     | 79,600      | 9.4         |
| 120                     | 37,000      | 4.2         |
| 130                     | 17,800      | 2.0         |
| 140                     | 8,900       | 1.0         |

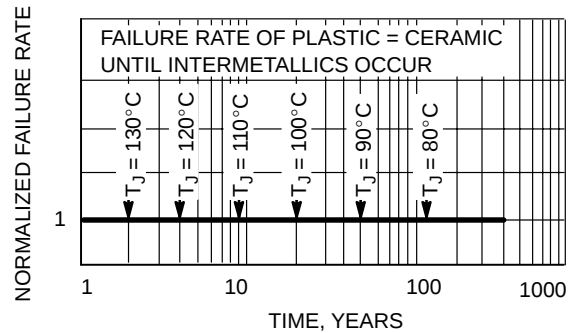


Figure 2. Failure Rate vs. Time Junction Temperature

# NLAST4501

## DC CHARACTERISTICS – Digital Section (Voltages Referenced to GND)

| Parameter                                       | Condition                                           | Symbol          | V <sub>CC</sub> | Guaranteed Max Limit |        |         | Unit |
|-------------------------------------------------|-----------------------------------------------------|-----------------|-----------------|----------------------|--------|---------|------|
|                                                 |                                                     |                 |                 | –55°C to 25°C        | < 85°C | < 125°C |      |
| Minimum High-Level Input Voltage, Enable Inputs |                                                     | V <sub>IH</sub> | 3.0             | 1.4                  | 1.4    | 1.4     | V    |
|                                                 |                                                     |                 | 4.5             | 2.0                  | 2.0    | 2.0     |      |
|                                                 |                                                     |                 | 5.5             | 2.0                  | 2.0    | 2.0     |      |
| Maximum Low-Level Input Voltage, Enable Inputs  |                                                     | V <sub>IL</sub> | 3.0             | 0.53                 | 0.53   | 0.53    | V    |
|                                                 |                                                     |                 | 4.5             | 0.8                  | 0.8    | 0.8     |      |
|                                                 |                                                     |                 | 5.5             | 0.8                  | 0.8    | 0.8     |      |
| Maximum Input Leakage Current, Enable Inputs    | V <sub>IN</sub> = 5.5 V or GND                      | I <sub>IN</sub> | 0 V to 5.5 V    | ±0.1                 | ±1.0   | ±1.0    | µA   |
| Maximum Quiescent Supply Current (per package)  | Enable and V <sub>IS</sub> = V <sub>CC</sub> or GND | I <sub>CC</sub> | 5.5             | 1.0                  | 1.0    | 2.0     | µA   |

## DC ELECTRICAL CHARACTERISTICS – Analog Section

| Parameter                              | Condition                                                                                                                                       | Symbol                | V <sub>CC</sub> | Guaranteed Max Limit |        |         | Unit |
|----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|-----------------|----------------------|--------|---------|------|
|                                        |                                                                                                                                                 |                       |                 | –55°C to 25°C        | < 85°C | < 125°C |      |
| Maximum ON Resistance (Figures 8 – 12) | V <sub>IN</sub> = V <sub>IH</sub><br>V <sub>IS</sub> = V <sub>CC</sub> to GND<br>I <sub>IS</sub> = ≤ 10.0mA                                     | R <sub>ON</sub>       | 3.0             | 45                   | 50     | 55      | Ω    |
|                                        |                                                                                                                                                 |                       | 4.5             | 30                   | 35     | 40      |      |
|                                        |                                                                                                                                                 |                       | 5.5             | 25                   | 30     | 35      |      |
| ON Resistance Flatness                 | V <sub>IN</sub> = V <sub>IH</sub><br>I <sub>IS</sub> = ≤ 10.0 mA<br>V <sub>IS</sub> = 1 V, 2 V, 3.5 V                                           | R <sub>FLAT(ON)</sub> | 4.5             | 4                    | 4      | 5       | Ω    |
| Off Leakage Current, Pin 2 (Figure 3)  | V <sub>IN</sub> = V <sub>IL</sub><br>V <sub>NO</sub> = 1.0 V, V <sub>COM</sub> = 4.5 V or<br>V <sub>COM</sub> = 1.0 V and V <sub>NO</sub> 4.5 V | I <sub>NO(OFF)</sub>  | 5.5             | 1                    | 10     | 100     | nA   |
| Off Leakage Current, Pin 1 (Figure 3)  | V <sub>IN</sub> = V <sub>IL</sub><br>V <sub>NO</sub> = 4.5 V or 1.0 V<br>V <sub>COM</sub> = 1.0 V or 4.5 V                                      | I <sub>COM(OFF)</sub> | 5.5             | 1                    | 10     | 100     | nA   |

## AC ELECTRICAL CHARACTERISTICS (Input t<sub>r</sub> = t<sub>f</sub> = 3.0 ns)

| Parameter                               | Test Conditions                                                          | Symbol                             | V <sub>CC</sub><br>(V) | Guaranteed Max Limit |      |     |        |     |     |         |     |     | Unit |
|-----------------------------------------|--------------------------------------------------------------------------|------------------------------------|------------------------|----------------------|------|-----|--------|-----|-----|---------|-----|-----|------|
|                                         |                                                                          |                                    |                        | – 55°C to 25°C       |      |     | < 85°C |     |     | < 125°C |     |     |      |
|                                         |                                                                          |                                    |                        | Min                  | Typ  | Max | Min    | Typ | Max | Min     | Typ | Max |      |
| Turn-On Time                            | R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF<br>(Figures 4, 5, and 13) | t <sub>ON</sub>                    | 2.0                    |                      | 7.0  | 14  |        |     | 16  |         |     | 16  | ns   |
|                                         |                                                                          |                                    | 3.0                    |                      | 5.0  | 10  |        |     | 12  |         |     | 12  |      |
|                                         |                                                                          |                                    | 4.5                    |                      | 4.5  | 9   |        |     | 11  |         |     | 11  |      |
|                                         |                                                                          |                                    | 5.5                    |                      | 4.5  | 9   |        |     | 11  |         |     | 11  |      |
| Turn-Off Time                           | R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF<br>(Figures 4, 5, and 13) | t <sub>OFF</sub>                   | 2.0                    |                      | 11.0 | 22  |        |     | 24  |         |     | 24  | ns   |
|                                         |                                                                          |                                    | 3.0                    |                      | 7.0  | 14  |        |     | 16  |         |     | 16  |      |
|                                         |                                                                          |                                    | 4.5                    |                      | 5.0  | 10  |        |     | 12  |         |     | 12  |      |
|                                         |                                                                          |                                    | 5.5                    |                      | 5.0  | 10  |        |     | 12  |         |     | 12  |      |
| Typical @ 25, V <sub>CC</sub> = 5.0 V   |                                                                          |                                    |                        |                      |      |     |        |     |     |         |     |     |      |
| Maximum Input Capacitance, Select Input |                                                                          | C <sub>IN</sub>                    | 8                      |                      |      |     |        |     |     |         |     | pF  |      |
| Analog I/O (switch off)                 |                                                                          | C <sub>NO</sub> or C <sub>NC</sub> | 10                     |                      |      |     |        |     |     |         |     |     |      |
| Common I/O (switch off)                 |                                                                          | C <sub>COM(OFF)</sub>              | 10                     |                      |      |     |        |     |     |         |     |     |      |
| Feedthrough (switch on)                 |                                                                          | C <sub>COM(ON)</sub>               | 20                     |                      |      |     |        |     |     |         |     |     |      |

# NLAST4501

## ADDITIONAL APPLICATION CHARACTERISTICS (Voltages Referenced to GND Unless Noted)

| Parameter                                                       | Condition                                                                                                                                                                                                                       | Symbol           | V <sub>CC</sub><br>V | Limit<br>25°C     | Unit |
|-----------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|----------------------|-------------------|------|
| Maximum On-Channel -3dB Bandwidth or Minimum Frequency Response | V <sub>IS</sub> = 0 dBm<br>V <sub>IS</sub> centered between V <sub>CC</sub> and GND<br>(Figures 6 and 14)                                                                                                                       | BW               | 3.0<br>4.5<br>5.5    | 190<br>200<br>220 | MHz  |
| Maximum Feedthrough On Loss                                     | V <sub>IS</sub> = 0 dBm @ 10 kHz<br>V <sub>IS</sub> centered between V <sub>CC</sub> and GND<br>(Figure 6)                                                                                                                      | V <sub>ONL</sub> | 3.0<br>4.5<br>5.5    | -2<br>-2<br>-2    | dB   |
| Off-Channel Isolation                                           | f = 100 kHz; V <sub>IS</sub> = 1 V RMS<br>V <sub>IS</sub> centered between V <sub>CC</sub> and GND<br>(Figures 6 and 15)                                                                                                        | V <sub>ISO</sub> | 3.0<br>4.5<br>5.5    | -93               | dB   |
| Charge Injection<br>Enable Input to Common I/O                  | V <sub>IS</sub> = V <sub>CC</sub> to GND, F <sub>IS</sub> = 20 kHz<br>t <sub>r</sub> = t <sub>f</sub> = 3 ns<br>R <sub>IS</sub> = 0 Ω, C <sub>L</sub> = 1000 pF<br>Q = C <sub>L</sub> * ΔV <sub>OUT</sub><br>(Figures 7 and 16) | Q                | 3.0<br>5.5           | 1.5<br>3.0        | pC   |
| Total Harmonic Distortion<br>THD + Noise                        | F <sub>IS</sub> = 20 Hz to 1 MHz, R <sub>L</sub> = R <sub>gen</sub> = 600 Ω, C <sub>L</sub> = 50 pF<br>V <sub>IS</sub> = 3.0 V <sub>PP</sub> sine wave<br>V <sub>IS</sub> = 5.0 V <sub>PP</sub> sine wave<br>(Figure 17)        | THD              | 3.3<br>5.5           | 0.3<br>0.15       | %    |

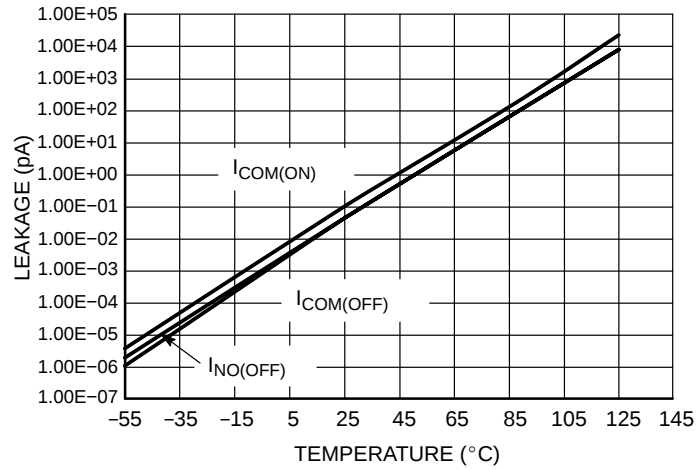


Figure 3. Switch Leakage vs. Temperature

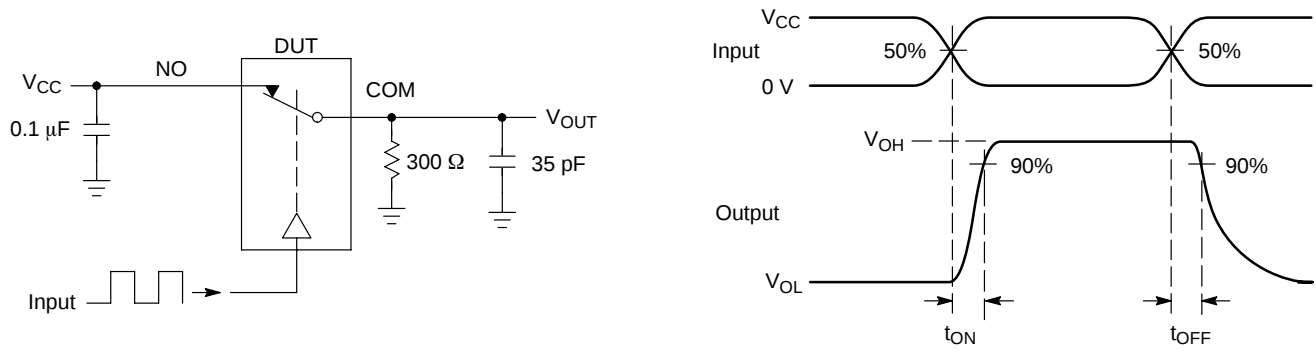


Figure 4.  $t_{ON}/t_{OFF}$

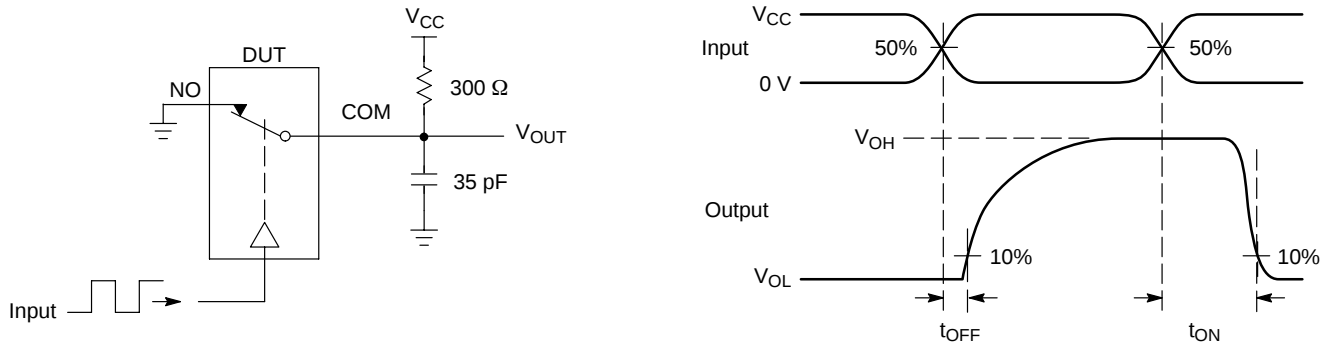
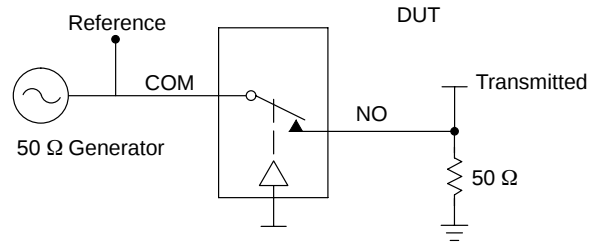


Figure 5.  $t_{ON}/t_{OFF}$

## NLAST4501



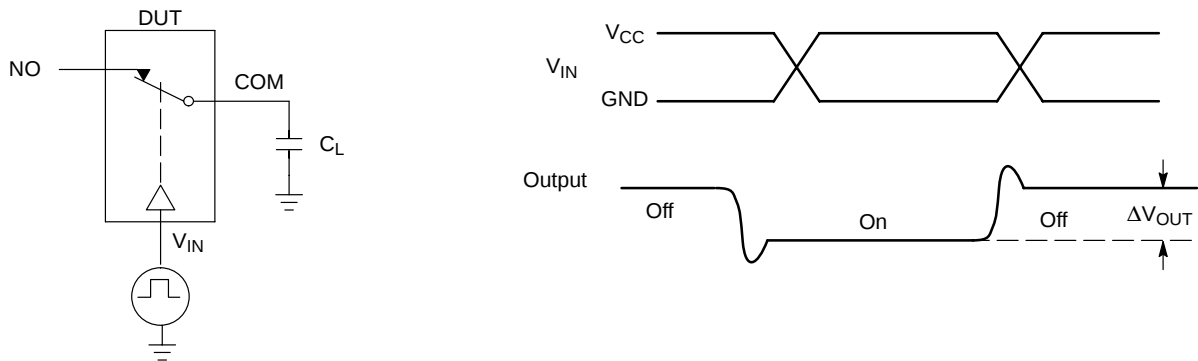
Channel switch control/s test socket is normalized. Off isolation is measured across an off channel. On loss is the bandwidth of an On switch.  $V_{ISO}$ , Bandwidth and  $V_{ONL}$  are independent of the input signal direction.

$$V_{ISO} = \text{Off Channel Isolation} = 20 \text{ Log} \left( \frac{V_{OUT}}{V_{IN}} \right) \text{ for } V_{IN} \text{ at } 100 \text{ kHz}$$

$$V_{ONL} = \text{On Channel Loss} = 20 \text{ Log} \left( \frac{V_{OUT}}{V_{IN}} \right) \text{ for } V_{IN} \text{ at } 100 \text{ kHz to } 50 \text{ MHz}$$

Bandwidth (BW) = the frequency 3 dB below  $V_{ONL}$

**Figure 6. Off Channel Isolation/On Channel Loss (BW)/Crosstalk  
(On Channel to Off Channel)/ $V_{ONL}$**



**Figure 7. Charge Injection: (Q)**

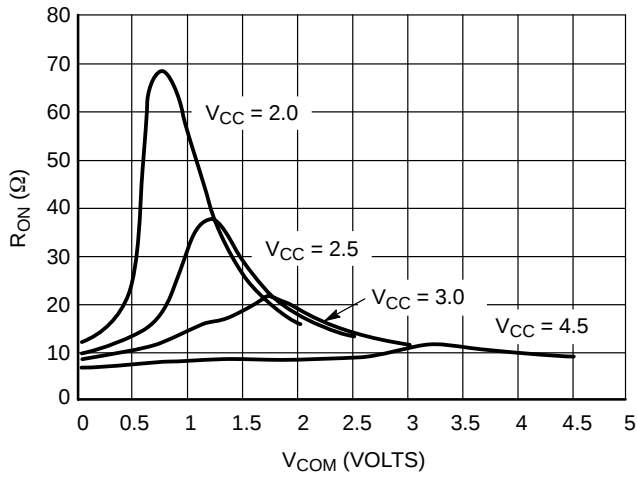


Figure 8.  $R_{ON}$  vs.  $V_{COM}$  and  $V_{CC}$  (@25°C)

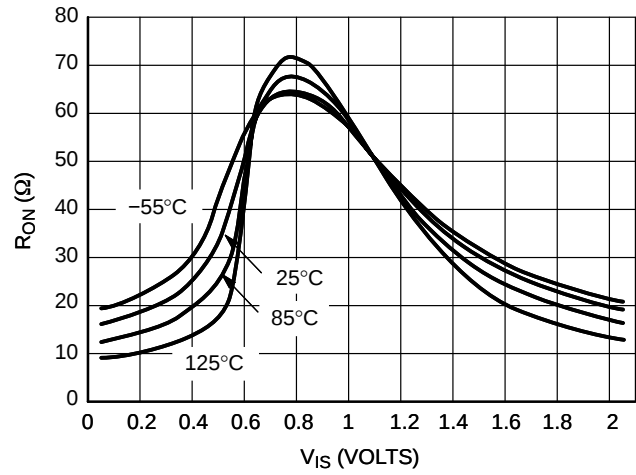


Figure 9.  $R_{ON}$  vs.  $V_{COM}$  and Temperature,  $V_{CC} = 2.0$  V

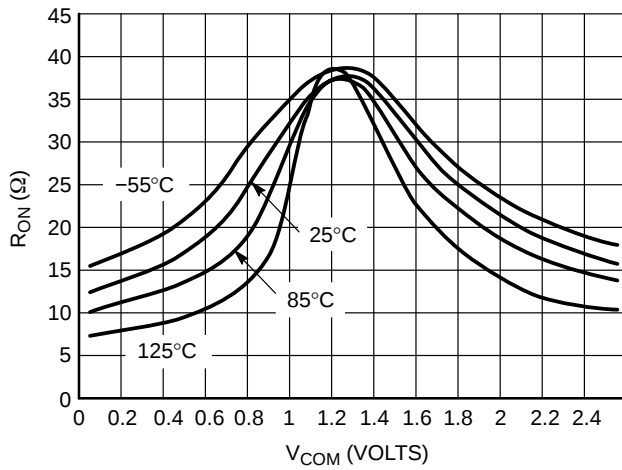


Figure 10.  $R_{ON}$  vs.  $V_{COM}$  and Temperature,  $V_{CC} = 2.5$  V

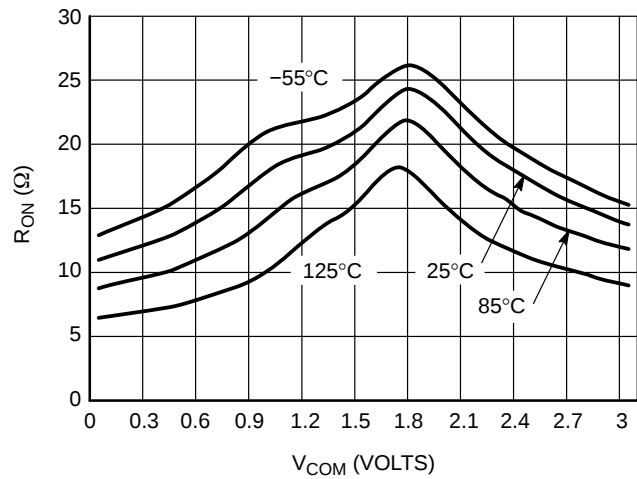


Figure 11.  $R_{ON}$  vs.  $V_{COM}$  and Temperature,  $V_{CC} = 3.0$  V

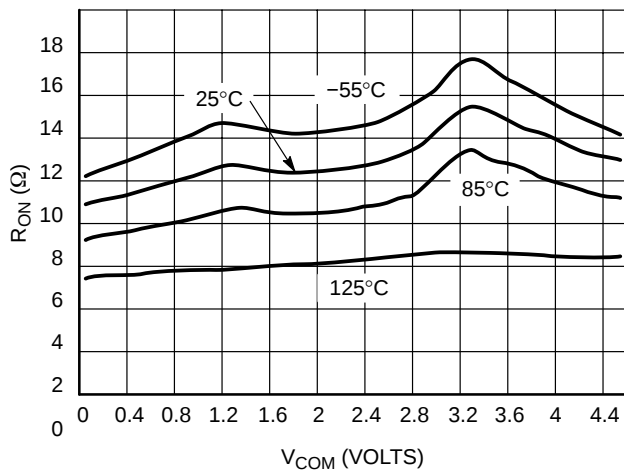


Figure 12.  $R_{ON}$  vs.  $V_{COM}$  and Temperature,  $V_{CC} = 4.5$  V

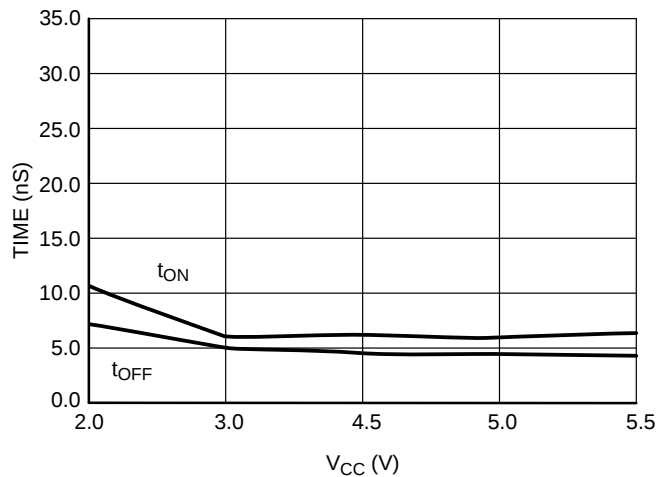


Figure 13. Switching Time vs. Supply Voltage,  $T = 25^\circ\text{C}$

# NLAST4501

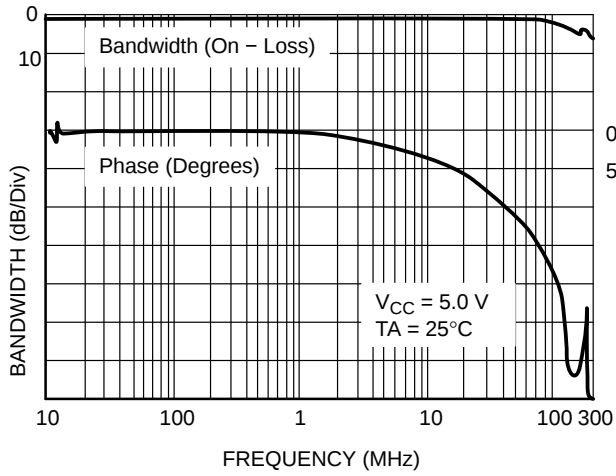


Figure 14. ON Channel Bandwidth and Phase Shift Over Frequency

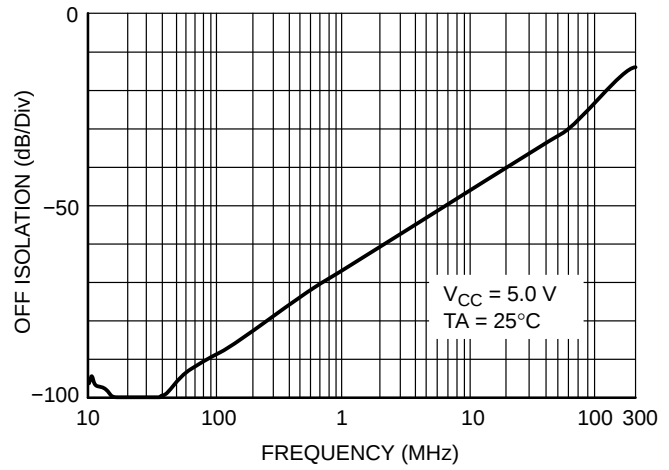


Figure 15. Off Channel Isolation

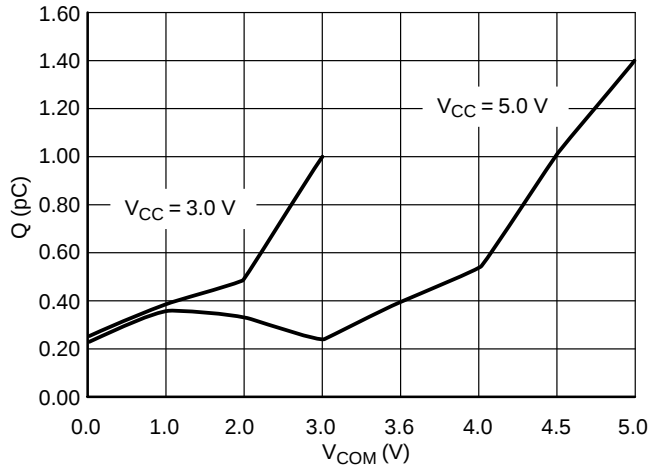


Figure 16. Charge Injection vs.  $V_{COM}$

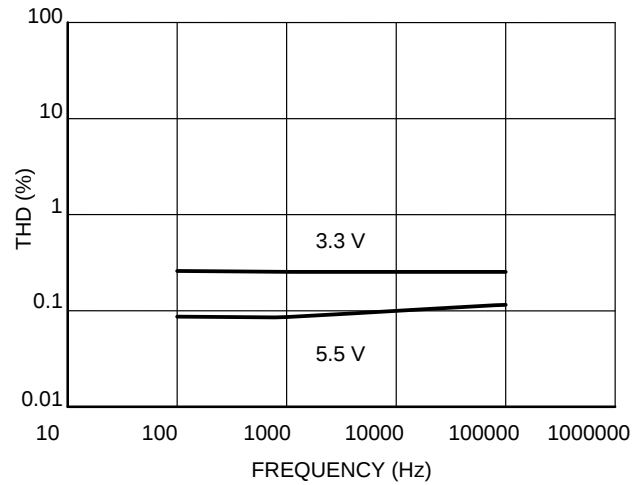


Figure 17. THD vs. Frequency

## ORDERING INFORMATION

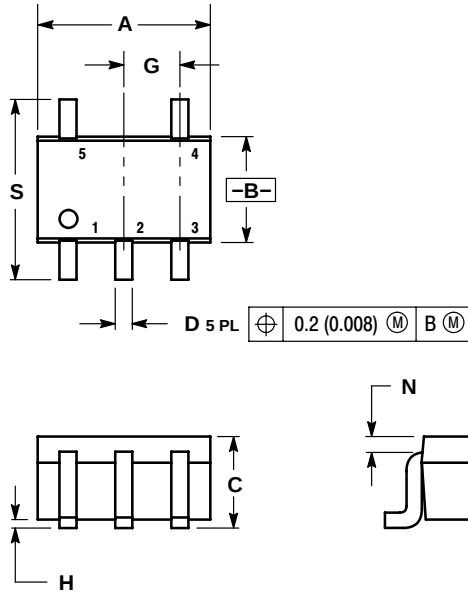
| Device         | Device Nomenclature |            |                 |                |                    | Package                       | Shipping <sup>†</sup> |
|----------------|---------------------|------------|-----------------|----------------|--------------------|-------------------------------|-----------------------|
|                | Circuit Indicator   | Technology | Device Function | Package Suffix | Tape & Reel Suffix |                               |                       |
| NLAST4501DFT2  | NL                  | AST        | 4501            | DF             | T2                 | SC-88A/SOT-353/SC70           | 3000/Tape & Reel      |
| NLAST4501DFT2G |                     |            |                 |                |                    | SC-88A/SOT-353/SC70 (Pb-Free) |                       |
| NLAST4501DTT1  |                     |            |                 | DT             | T1                 | TSOP-5                        |                       |
| NLAST4501DTT1G |                     |            |                 |                |                    | TSOP-5 (Pb-Free)              |                       |

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

# NLAST4501

## PACKAGE DIMENSIONS

SC-88A / SOT-353 / SC-70  
CASE 419A-02  
ISSUE J

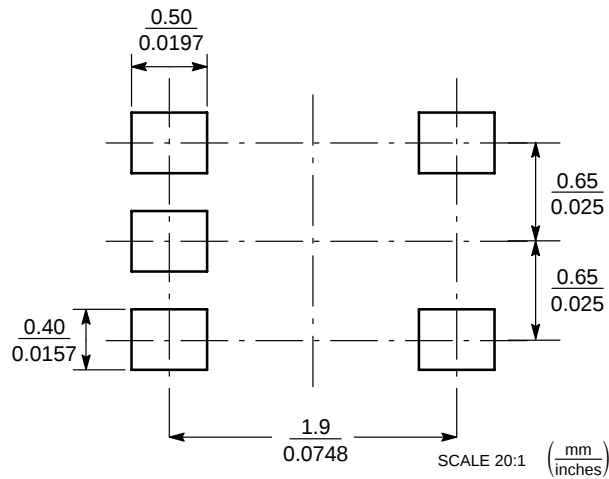


### NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. 419A-01 OBSOLETE. NEW STANDARD 419A-02.
4. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

| DIM | INCHES    |       | MILLIMETERS |      |
|-----|-----------|-------|-------------|------|
|     | MIN       | MAX   | MIN         | MAX  |
| A   | 0.071     | 0.087 | 1.80        | 2.20 |
| B   | 0.045     | 0.053 | 1.15        | 1.35 |
| C   | 0.031     | 0.043 | 0.80        | 1.10 |
| D   | 0.004     | 0.012 | 0.10        | 0.30 |
| G   | 0.026 BSC |       | 0.65 BSC    |      |
| H   | ---       | 0.004 | ---         | 0.10 |
| J   | 0.004     | 0.010 | 0.10        | 0.25 |
| K   | 0.004     | 0.012 | 0.10        | 0.30 |
| N   | 0.008 REF |       | 0.20 REF    |      |
| S   | 0.079     | 0.087 | 2.00        | 2.20 |

## SOLDERING FOOTPRINT\*

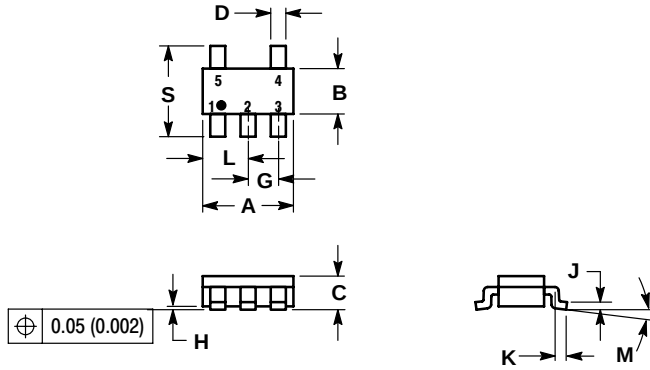


\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

# NLAST4501

## PACKAGE DIMENSIONS

### TSOP-5 CASE 483-02 ISSUE E

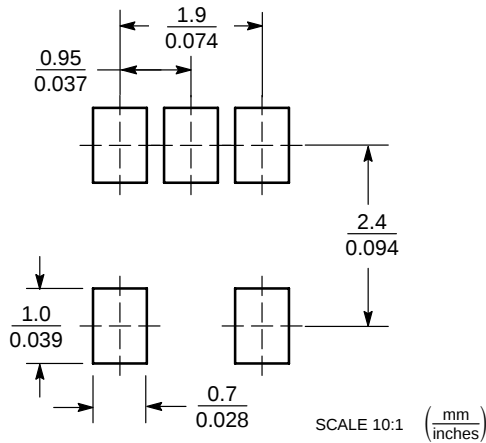


#### NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. A AND B DIMENSIONS DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

| DIM | MILLIMETERS |       | INCHES |        |
|-----|-------------|-------|--------|--------|
|     | MIN         | MAX   | MIN    | MAX    |
| A   | 2.90        | 3.10  | 0.1142 | 0.1220 |
| B   | 1.30        | 1.70  | 0.0512 | 0.0669 |
| C   | 0.90        | 1.10  | 0.0354 | 0.0433 |
| D   | 0.25        | 0.50  | 0.0098 | 0.0197 |
| G   | 0.85        | 1.05  | 0.0335 | 0.0413 |
| H   | 0.013       | 0.100 | 0.0005 | 0.0040 |
| J   | 0.10        | 0.26  | 0.0040 | 0.0102 |
| K   | 0.20        | 0.60  | 0.0079 | 0.0236 |
| L   | 1.25        | 1.55  | 0.0493 | 0.0610 |
| M   | 0°          | 10°   | 0°     | 10°    |
| S   | 2.50        | 3.00  | 0.0985 | 0.1181 |

### 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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Телефон: 8 (812) 309-75-97 (многоканальный)

Факс: 8 (812) 320-03-32

Электронная почта: [ocean@oceanchips.ru](mailto:ocean@oceanchips.ru)

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Адрес: 198099, г. Санкт-Петербург, ул. Калинина, д. 2, корп. 4, лит. А