

# NLAS6233

## Audio DPDT Switch with Noise Suppression

### Description

The NLAS6233 is a DPDT switch featuring Popless noise suppression circuitry designed to prevent pass through of undesirable transient signals known as pops. Intended for audio systems within portable applications, it provides protection against audible pops that are generated when switching between two different audio sources, such as an amplifier and a CODEC.

The NLAS6233 incorporates two double throw switches controlled by a single select line which allows the system controller to simultaneously switch between two sets of signal lines. The Popless noise suppression circuitry controls the ON and OFF times that define the time interval when switching between the normally open (NO) and normally closed (NC) terminals. This allows any pops to be dissipated within the system before the switch settles into a closed position.

The NLAS6233 operates off of a single supply voltage,  $V_{CC}$ , and is available in an ultra-thin UQFN10 package.

### Features

- Popless Noise Suppression Circuitry
- OVT up to +4.5 V on Control Pin
- $R_{ON} < 0.5 \Omega$  Across BCC Range, Typical
- THD  $< 0.02 \%$ , Typical
- Off Isolation = -70 dB, Typical
- Crosstalk Attenuation  $< -70$  dB, Typical
- Ultra Small, Thin Package: 1.4 mm x 1.8 mm UQFN10
- This is a Pb-Free Device

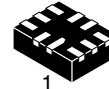
### Typical Applications

- Cell Phones, PDAs, MP3 and Other Portable Media Players



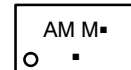
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<http://onsemi.com>



UQFN10  
MU SUFFIX  
CASE 488AT

### MARKING DIAGRAM



AM = Specific Device Code  
M = Date Code  
▪ = Pb-Free Package  
(Note: Microdot may be in either location)

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 8 of this data sheet.

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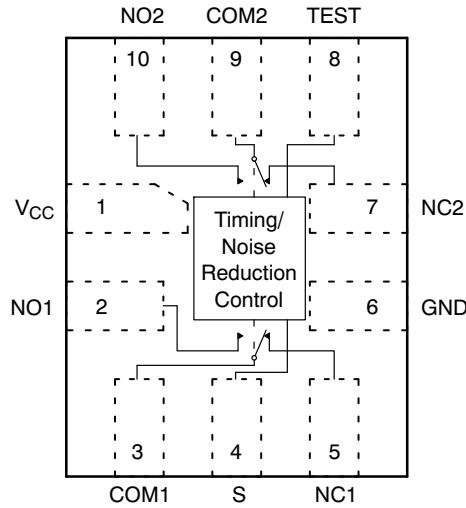


Figure 1. Pin Connections and Logic Diagram (Top View)

NOTE: Pin 8 is for ATE use only, not intended for end customer use.

## PIN ASSIGNMENT

| PIN                | FUNCTION                  |
|--------------------|---------------------------|
| V <sub>CC</sub>    | Supply Voltage            |
| GND                | Ground                    |
| S                  | Control Input Select Line |
| TEST               | ATE Test Pin              |
| NC1, NO1, NC2, NO2 | Independent Channels      |
| COM1, COM2         | Common Channels           |

## TRUTH TABLE

| S | NC1, NC2 | NO1, NO2 |
|---|----------|----------|
| 0 | ON       | OFF      |
| 1 | OFF      | ON       |

## MAXIMUM RATINGS

| Symbol              | Pins            | Rating  | Value                         | Unit |
|---------------------|-----------------|---|-------------------------------|------|
| V <sub>CC</sub>     | V <sub>CC</sub> | Positive DC Supply Voltage                      | -0.5 to +5.5                  | V    |
| V <sub>IS</sub>     | NOx, NCx, COMx  | Analog Signal Voltage                           | -0.5 to V <sub>CC</sub> + 0.5 | V    |
| V <sub>IN</sub>     | S               | Control Input Voltage                           | -0.5 to +5.5                  | V    |
| I <sub>IS_CON</sub> | NOx, NCx, COMx  | Analog Signal Continuous Current—Closed Switch  | ± 300                         | mA   |
| I <sub>IS_PK</sub>  | NOx, NCx, COMx  | Analog Signal Continuous Current 10% Duty Cycle | ± 500                         | mA   |
| I <sub>IN</sub>     | S               | Control Input Current                           | ± 20                          | mA   |
| T <sub>s</sub>      | T <sub>s</sub>  | 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   | Min | Max             | Unit |
|---------------------------------|-----------------|---|-----|-----------------|------|
| V <sub>CC</sub>                 | V <sub>CC</sub> | Positive DC Supply Voltage                                  | 2.7 | 4.5             | V    |
| V <sub>IS</sub>                 | NOx, NCx, COMx  | Analog Signal Voltage                                       | GND | V <sub>CC</sub> | V    |
| V <sub>IN</sub>                 | S               | Control Input Voltage (OVT Protection)                      | GND | 4.5             | V    |
| T <sub>A</sub>                  |                 | Operating Temperature Range                                 | -40 | +85             | °C   |
| t <sub>r</sub> , t <sub>f</sub> |                 | Input Rise or Fall Time, S V <sub>CC</sub> = 3.0 V to 3.6 V | 0   | 10              | ns/V |

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## DC ELECTRICAL CHARACTERISTICS

### CONTROL INPUT (Typical: T = 25°C, V<sub>CC</sub> = 3.3 V)

| Symbol          | Pins | Parameter                                      | Test Conditions       | V <sub>CC</sub> (V) | -40°C to +85°C |      |            | Unit |
|-----------------|------|--|-----------------------|---------------------|----------------|------|------------|------|
|                 |      |  |                       |                     | Min            | Typ  | Max        |      |
| V <sub>IH</sub> | S    | Minimum High-Level Input Voltage, Select Input |                       | 2.7<br>4.2          | 1.4<br>2.0     | -    | -          | V    |
| V <sub>IL</sub> | S    | Maximum Low-Level Input Voltage, Select Input  |                       | 2.7<br>4.2          | -              | -    | 0.7<br>0.8 | V    |
| I <sub>IN</sub> | S    | Control Input Leakage Current                  | V <sub>IS</sub> = GND | 2.7-4.5             | -              | ±100 | ±1000      | nA   |

### SUPPLY CURRENT AND LEAKAGE (Typical: T = 25°C, V<sub>CC</sub> = 3.3 V, V<sub>IN</sub> = V<sub>CC</sub> or GND)

| Symbol   | Pins            | Parameter                 | Test Conditions   | V <sub>CC</sub> (V) | -40°C to +85°C |      |       | Unit |
|--|-----------------|---------------------------|---|---------------------|----------------|------|-------|------|
|  |                 |                           |   |                     | Min            | Typ  | Max   |      |
| I <sub>CC</sub>                                | V <sub>CC</sub> | Quiescent Supply Current  | V <sub>IS</sub> = V <sub>CC</sub> or GND; I <sub>D</sub> = 0 A        | 2.7 - 4.5           | -              | <100 | 1000  | nA   |
| I <sub>NC(OFF)</sub> ,<br>I <sub>NO(OFF)</sub> | NCx,<br>NOx     | OFF State Leakage Current | V <sub>COM</sub> = 4.5 V<br>V <sub>NO</sub> , V <sub>NC</sub> = 1.0 V | 2.7 - 4.5           | -              | ±10  | ±1000 | nA   |
| I <sub>OFF</sub>                               |                 | Power OFF Leakage Current | V <sub>IS</sub> = GND   | 0                   | -              | ±10  | ±1000 | nA   |

### ON RESISTANCE (Typical: T = 25°C, V<sub>CC</sub> = 3.3 V)

| Symbol            | Pins | Parameter                            | Test Conditions  | V <sub>CC</sub> (V) | -40°C to +85°C |              |              | Unit |
|-------------------|------|--------------------------------------|--|---------------------|----------------|--------------|--------------|------|
|                   |      |                                      |  |                     | Min            | Typ          | Max          |      |
| R <sub>ON</sub>   |      | On-Resistance                        | V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IN</sub> = V <sub>IH</sub><br>V <sub>IS</sub> = 0 to V <sub>CC</sub> ;<br>I <sub>IS</sub> = 100 mA | 2.7<br>4.2          | -              | 0.45<br>0.40 | 0.60<br>0.55 | Ω    |
| R <sub>FLAT</sub> |      | On-Resistance Flatness               | V <sub>IS</sub> = 0 to V <sub>CC</sub> ;<br>I <sub>IS</sub> = 100 mA   | 2.7<br>4.2          | -              | 0.12<br>0.15 | 0.16<br>0.19 | Ω    |
| ΔR <sub>ON</sub>  |      | On-Resistance Match Between Channels | V <sub>IS</sub> = 0 to V <sub>CC</sub> ;<br>I <sub>IS</sub> = 100 mA   | 2.7<br>4.2          | -              | 0.16<br>0.19 | 0.24<br>0.23 | Ω    |

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## AC ELECTRICAL CHARACTERISTICS

**TIMING/FREQUENCY** (Typical: T = 25°C, V<sub>CC</sub> = 3.3 V, R<sub>L</sub> = 50 Ω, C<sub>L</sub> = 35 pF, f = 1 MHz)

| Symbol           | Pins | Parameter                                  | Test Conditions                                      | V <sub>CC</sub> (V) | -40°C to +85°C |     |     | Unit |
|------------------|------|--|--|---------------------|----------------|-----|-----|------|
|                  |      |  |  |                     | Min            | Typ | Max |      |
| t <sub>ON</sub>  | -    | Turn-ON Time (Figures 2, 3, 12)            |  | 2.7-4.5             |                | 17  |     | ns   |
| t <sub>OFF</sub> | -    | Turn-OFF Time (Figures 2, 3, 13)           |  | 2.7-4.5             |                | 9.0 |     | ns   |
| t <sub>BBM</sub> | -    | Minimum Break Before Make Time (Figure 14) | V <sub>IS</sub> = 3.0, typ @ V <sub>CC</sub> = 3.6 V | 3.4-4.2             |                | 175 |     | ms   |
| BW               | -    | -3 dB Bandwidth                            | V <sub>IS</sub> = 0 dB                               | 2.7-4.5             |                | 36  |     | MHz  |

**ISOLATION** (Typical: T = 25°C, V<sub>CC</sub> = 3.3 V, R<sub>L</sub> = 50 Ω, C<sub>L</sub> = 5 pF)

| Symbol           | Pins           | Parameter                 | Test Conditions   | V <sub>CC</sub> (V) | -40°C to +85°C |      |     | Unit |
|------------------|----------------|---------------------------|---|---------------------|----------------|------|-----|------|
|                  |                |                           |   |                     | Min            | Typ  | Max |      |
| O <sub>IRR</sub> | NOx            | OFF-Isolation             | V <sub>IS</sub> = 1.0 V <sub>RMS</sub> ,<br>f = 100 kHz             | 2.7-4.5             |                | -70  |     | dB   |
| XTALK            | COM 1 to COM 2 | Crosstalk                 | V <sub>IS</sub> = 1.0 V <sub>RMS</sub> ,<br>f = 100 kHz             | 2.7-4.5             |                | -98  |     | dB   |
| THD              | -              | Total Harmonic Distortion | R <sub>L</sub> = 600 Ω,<br>V <sub>COMn</sub> = 2.0 V <sub>p-p</sub> | 3.0                 |                | 0.02 |     | %    |

**CAPACITANCE** (Typical: T = 25°C, V<sub>CC</sub> = 3.3 V, R<sub>L</sub> = 50 Ω, C<sub>L</sub> = 5 pF, f = 1 MHz)

| Symbol           | Pins        | Parameter                | Test Conditions                  | V <sub>CC</sub> (V) | -40°C to +85°C |     |     | Unit |
|------------------|-------------|--------------------------|----------------------------------|---------------------|----------------|-----|-----|------|
|                  |             |                          |                                  |                     | Min            | Typ | Max |      |
| C <sub>IN</sub>  | S           | Select Input Capacitance |                                  | 0                   |                | 2.5 |     | pF   |
| C <sub>OFF</sub> | NOx         | OFF-Capacitance          | V <sub>IS</sub> = 3.3 V, S = 0 V | 2.7-4.5             |                | 45  |     | pF   |
| C <sub>ON</sub>  | COMx to NCx | ON-Capacitance           | S = 0 V                          | 2.7-4.5             |                | 110 |     | pF   |

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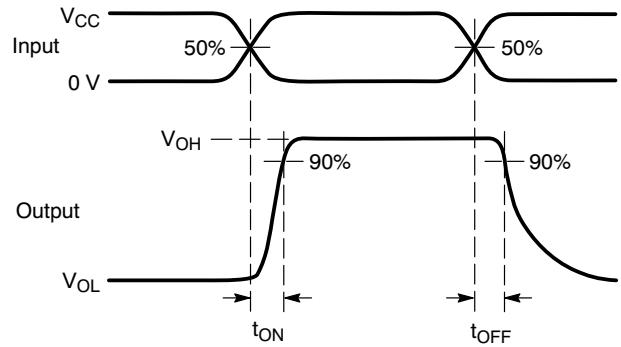
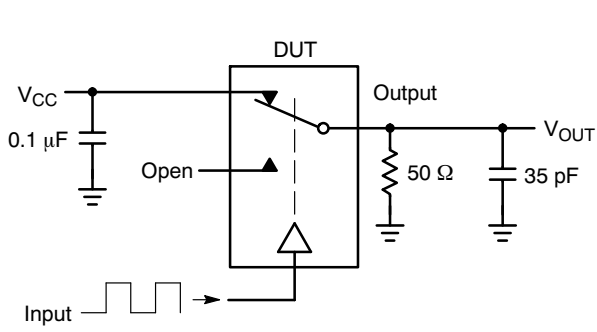


Figure 2.  $t_{ON} / t_{OFF}$   $V_{is} = V_{CC}$

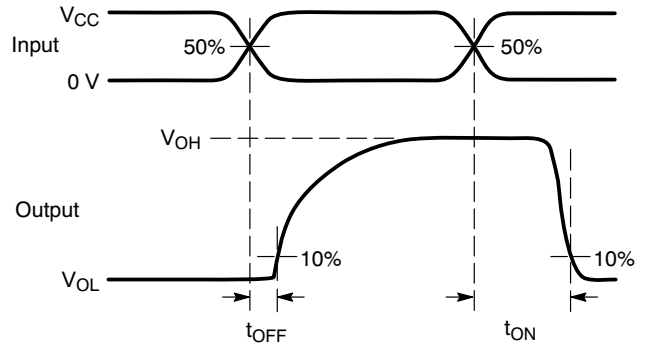
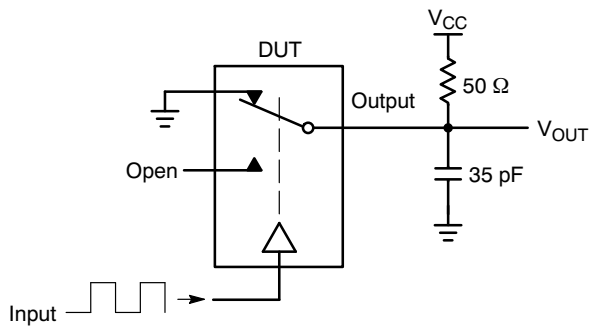
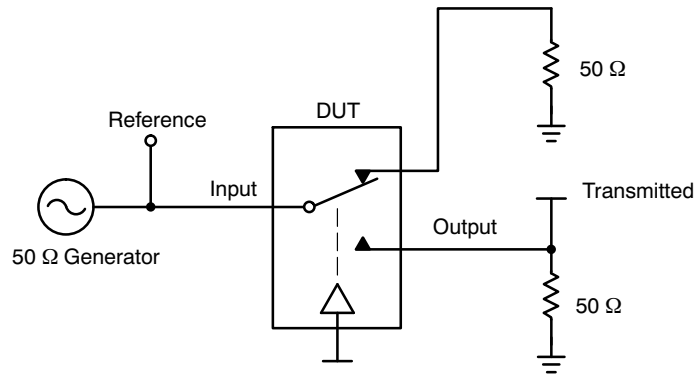


Figure 3.  $t_{ON} / t_{OFF}$   $V_{is} = GND$



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  $V_{ONL}$

$V_{CT}$  = Use  $V_{ISO}$  setup and test to all other switch analog input/outputs terminated with 50 Ω

Figure 4. Off-Channel Isolation/On Channel Loss (BW)/Crosstalk (On Channel to Off Channel)/ $V_{ONL}$

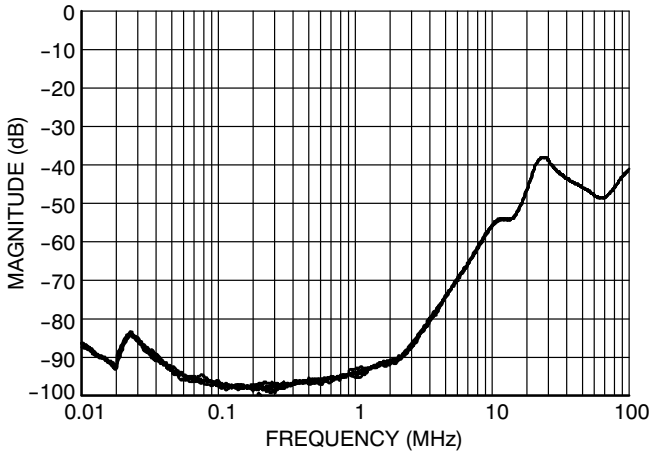


Figure 5. Crosstalk vs. Frequency @ 25°C

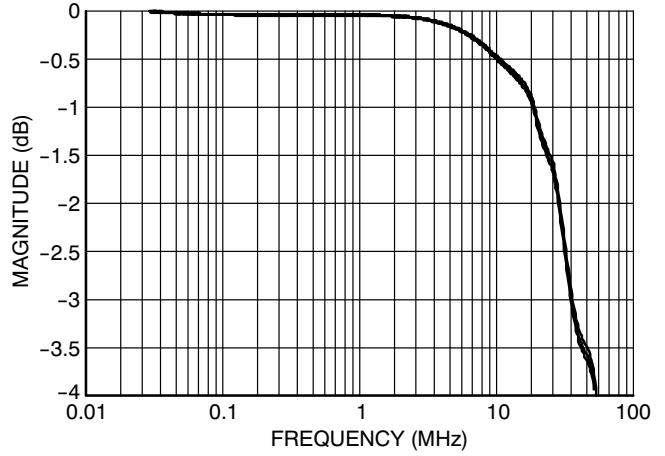


Figure 6. Bandwidth vs. Frequency @  $V_{CC} = 3\text{ V}$

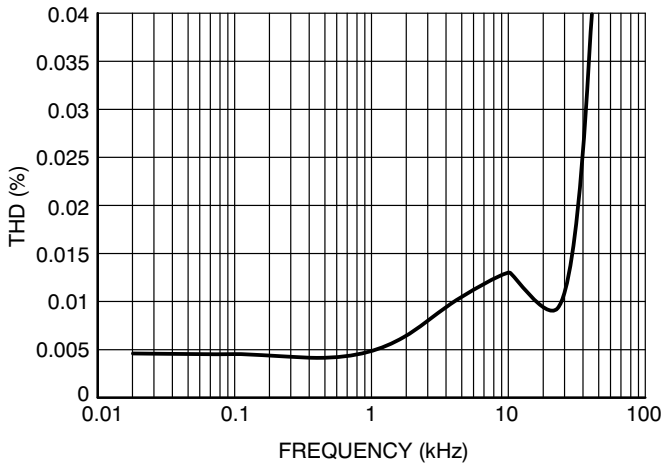


Figure 7. Total Harmonic Distortion @  $V_{CC} = 3\text{ V}$

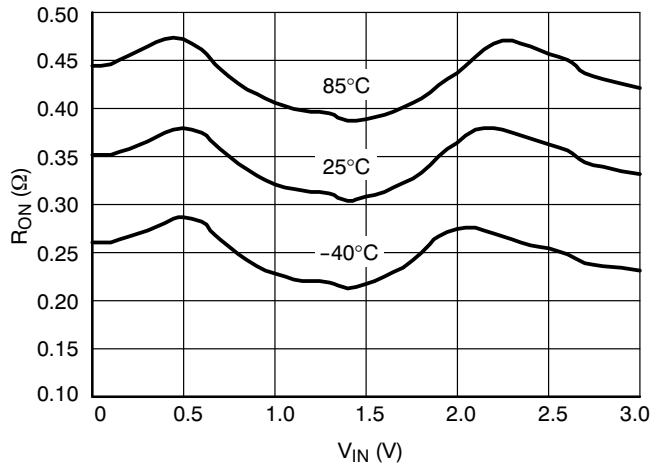


Figure 8. On-Resistance vs. Input Voltage @  $V_{CC} = 3.0\text{ V}$

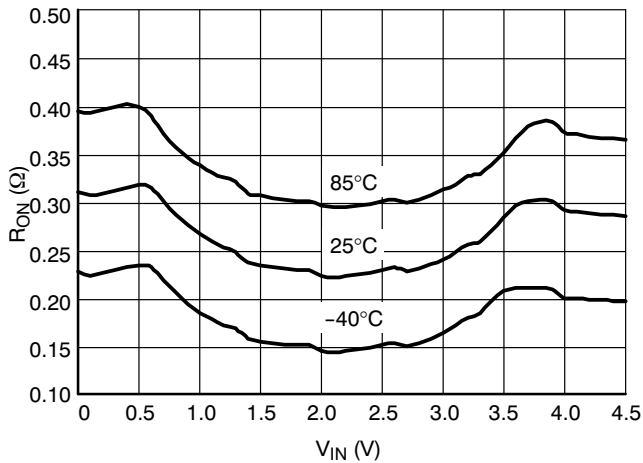


Figure 9. On-Resistance vs. Input Voltage @  $V_{CC} = 4.3\text{ V}$

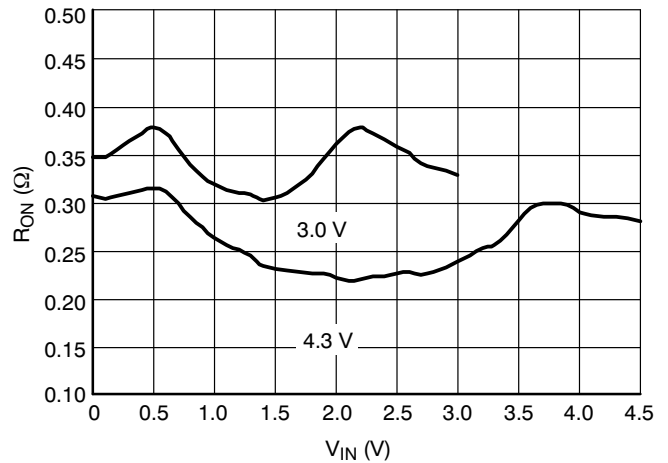


Figure 10. On-Resistance vs. Input Voltage @ 25°C

# NLAS6233

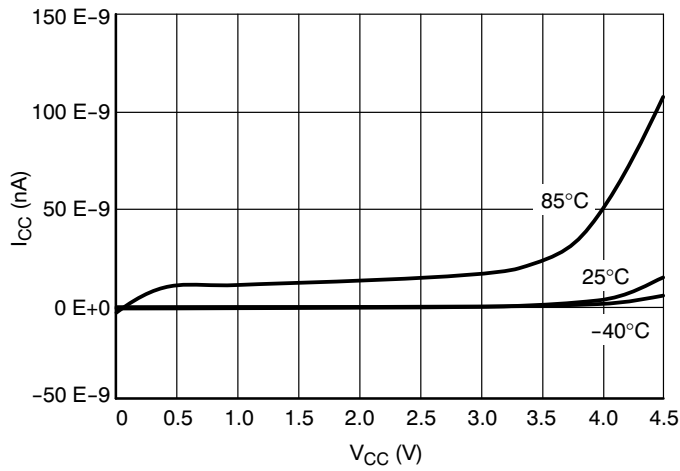


Figure 11.  $I_{CC}$  vs  $V_{CC}$

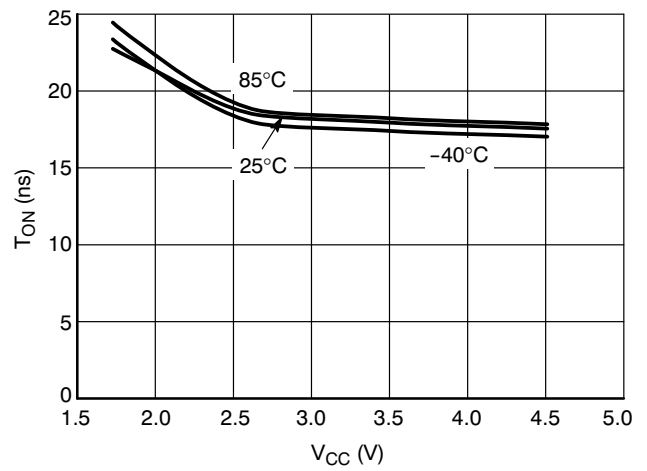


Figure 12.  $t_{ON}$  vs  $V_{CC}$

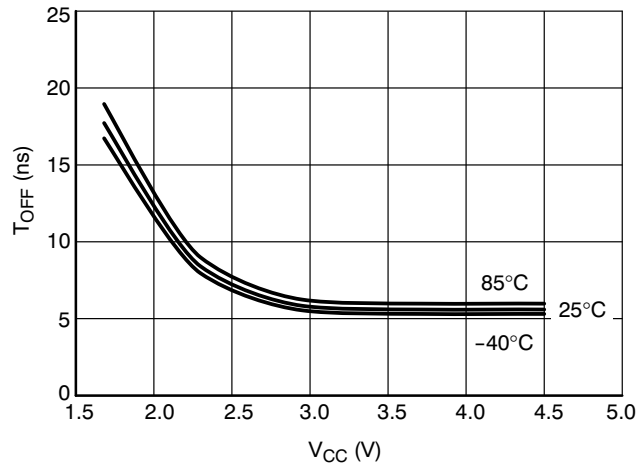


Figure 13.  $t_{OFF}$  vs  $V_{CC}$

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## Popless Implementation on the NLAS6233

Audio sources such as amplifiers or CODECs can generate undesirable, transient voltage spikes when powering up and down. Those voltage spikes can be translated into current surges and ultimately lead to audible pop noises in the speaker if not diverted or suppressed. The NLAS6233 includes popless noise suppression circuitry designed to prevent such undesirable pops from propagating through to the speaker. This feature is realized through a deliberate increase in the Break-Before-Make time,  $t_{BBM}$ , and is useful in applications

where a switch is used to alternate between two different audio sources.

When the signal from the common pin is removed from one terminal, the switch waits an extended amount of time before connecting to the opposite terminal. The time interval for  $t_{BBM}$  is a function of the supply voltage of the switch,  $V_{CC}$ . Figure 14 shows the relationship of  $t_{BBM}$  for each  $V_{CC}$  value within the recommended operating voltage range.

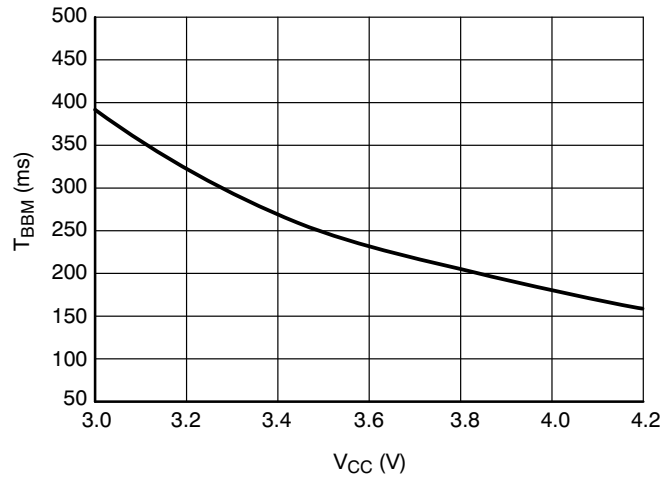


Figure 14. NLAS6233  $t_{BBM}$  vs.  $V_{CC}$

## DEVICE ORDERING INFORMATION

| Device        | Package             | Shipping†        |
|---------------|---------------------|------------------|
| NLAS6233MUTBG | UQFN10<br>(Pb-Free) | 3000/Tape & Reel |

†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.



# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

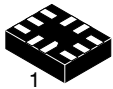
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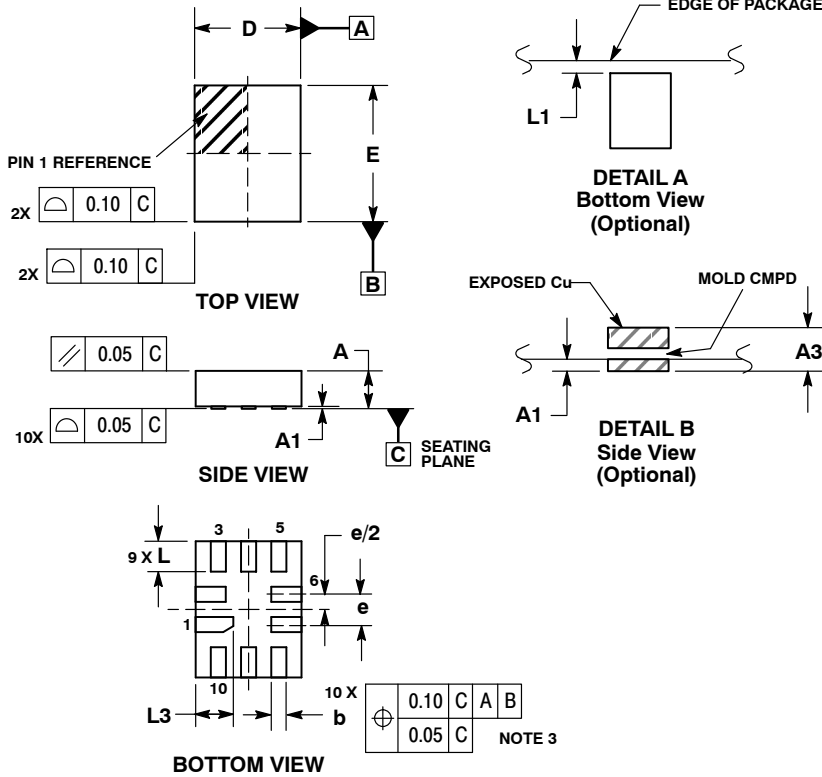
### UQFN10 1.4x1.8, 0.4P

CASE 488AT-01  
ISSUE A

DATE 01 AUG 2007



SCALE 5:1

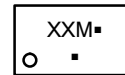


NOTES:

- DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
- CONTROLLING DIMENSION: MILLIMETERS
- DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.25 AND 0.30 MM FROM TERMINAL.
- COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

| MILLIMETERS |           |      |
|-------------|-----------|------|
| DIM         | MIN       | MAX  |
| A           | 0.45      | 0.60 |
| A1          | 0.00      | 0.05 |
| A3          | 0.127 REF |      |
| b           | 0.15      | 0.25 |
| D           | 1.40      | BSC  |
| E           | 1.80      | BSC  |
| e           | 0.40      | BSC  |
| L           | 0.30      | 0.50 |
| L1          | 0.00      | 0.15 |
| L3          | 0.40      | 0.60 |

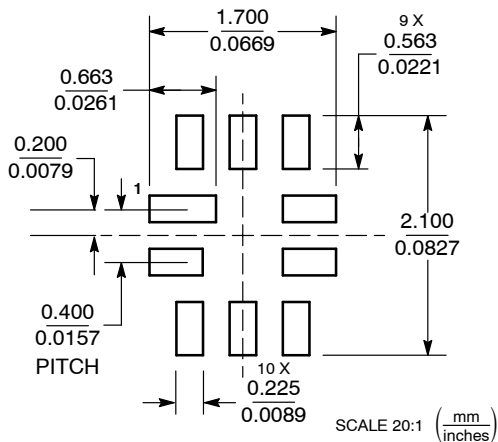
### GENERIC MARKING DIAGRAM\*



- XX = Specific Device Code
  - M = Date Code
  - = Pb-Free Package
- (Note: Microdot may be in either location)

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

### MOUNTING FOOTPRINT



|                         |                                     |  |
|-------------------------|-------------------------------------|--|
| <b>DOCUMENT NUMBER:</b> | <b>98AON22493D</b>                  | Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red. |
| <b>DESCRIPTION:</b>     | <b>10 PIN UQFN, 1.4 X 1.8, 0.4P</b> | <b>PAGE 1 OF 1</b>   |

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