# NLAS52231

# Ultra-Low 0.4 Ω Dual SPDT Analog Switch with Overshoot Protection

The NLAS52231 is a dual SPDT analog switch with overshoot protection on the signal lines. It is ideally suited for audio applications that require very low $R_{ON}$ values for maximum signal transfer. The overshoot protection included in the NLAS52231 allows analog signals on the COM, NO or NC lines to swing safely above $V_{CC}$ without incurring significant leakage. This feature provides added protection against undesirable leakage or damage to the device in the event that an incoming audio signal spikes above its nominal level.

The NLAS52231 features a wide $V_{CC}$ operating range, 1.65 V−4.5 V. It is capable of interfacing with control input select line voltages, $V_{IN}$, as low as 1.3 V for a $V_{CC}$ of 3.0 V. The NLAS52231 is offered in a very small 1.4mm x 1.8mm 10−pin UQFN package.

### Features

- Ultra−Low $R_{ON}$: 0.4 Ω at $V_{CC}$ = 4.2 V
- Overshoot Protection: $V_{IS}$ can safely rise up to 1.1 V above $V_{CC}$
- $V_{CC}$ Range: 1.65 V to 4.5 V
- 1.4 x 1.8 x 0.55 mm UQFN10
- These are Pb−Free Devices

### Typical Applications

- Mobile Phones
- Portable Devices

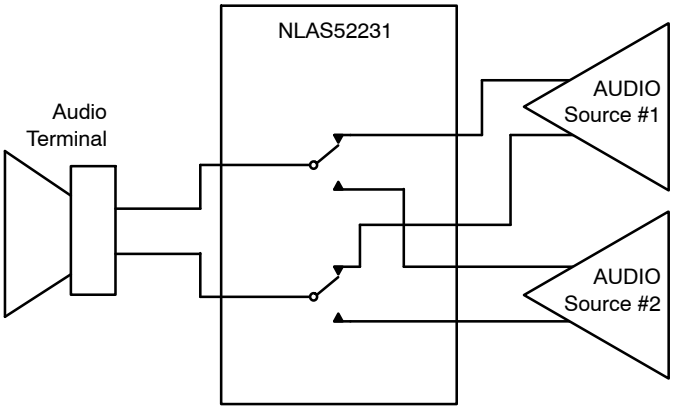
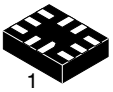



**Figure 1. Applications Diagram**

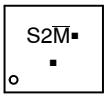
ON Semiconductor®

http://onsemi.com

**MARKING DIAGRAM**

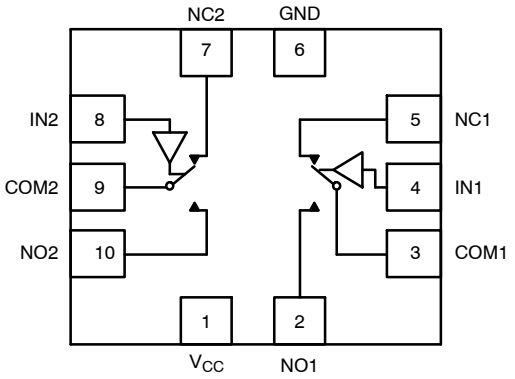



**UQFN10**
**CASE 488AT**




S2 = Specific Device Code
M = Date Code/Assembly Location
▪ = Pb−Free Device

(Note: Microdot may be in either location)




**FUNCTION TABLE**

| IN 1, 2 | NO 1, 2 | NC 1, 2 |
|---|---|---|
| 0 | OFF | ON |
| 1 | ON | OFF |

**ORDERING INFORMATION**

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

## PIN DESCRIPTION

| QFN PIN # | Symbol | Name and Function |
|---|---|---|
| 2, 5, 7, 10 | NC1 to NC2, NO1 to NO2 | Independent Channels |
| 4, 8 | IN1 and IN2 | Controls |
| 3, 9 | COM1 and COM2 | Common Channels |
| 6 | GND | Ground (V) |
| 1 | $V_{CC}$ | Positive Supply Voltage |

## MAXIMUM RATINGS

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{CC}$ | Positive DC Supply Voltage | −0.5 to +5.5 | V |
| $V_{IS}$ | Analog Input Voltage ($V_{NO}$, $V_{NC}$, or $V_{COM}$) | −0.5 to $V_{CC}$ + 1.6 | V |
| $V_{IN}$ | Digital Select Input Voltage | −0.5 to +5.5 | V |
| $I_{anl1}$ | Continuous DC Current from COM to NC/NO | ±300 | mA |
| $I_{anl-pk1}$ | Peak Current from COM to NC/NO, 10 Duty Cycle (Note 1) | ±500 | mA |
| $I_{clmp}$ | Continuous DC Current into COM/NO/NC with Respect to $V_{CC}$ or GND | ±100 | 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. Defined as 10% ON, 90% OFF Duty Cycle.

## RECOMMENDED OPERATING CONDITIONS

| Symbol | Parameter | | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{CC}$ | DC Supply Voltage | | 1.65 | 4.5 | V |
| $V_{IN}$ | Digital Select Input Voltage Overshoot Tolerance | | GND | 4.5 | V |
| $V_{IS}$ | Analog Input Voltage (NC, NO, COM) | | GND | $V_{CC}$ + 1.1 | V |
| $T_A$ | Operating Temperature Range | | −40 | +85 | °C |
| $t_r$, $t_f$ | Input Rise or Fall Time, SELECT | $V_{CC}$ = 1.6 V – 2.7 V<br>$V_{CC}$ = 3.0 V – 4.5 V | | 20<br>10 | ns/V |

## ESD PROTECTION

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| ESD | Human Body Model (HBM) | 3.0 | kV |
| ESD | Machine Model (MM) | 100 | V |

**NLAS52231 DC CHARACTERISTICS – DIGITAL SECTION** (Voltages Referenced to GND)

| Symbol | Parameter | Condition | $V_{CC}$ | Guaranteed Limit | | Unit |
|---|---|---|---|---|---|---|
| | | | | 25°C | –40°C to +85°C | |
| $V_{IH}$ | Minimum High–Level Input Voltage, Select Inputs | | 3.0<br>4.3 | 1.3<br>1.6 | 1.3<br>1.6 | V |
| $V_{IL}$ | Maximum Low–Level Input Voltage, Select Inputs | | 3.0<br>4.3 | 0.5<br>0.6 | 0.5<br>0.6 | V |
| $I_{IN}$ | Maximum Input Leakage Current, Select Inputs | $V_{IN}$ = 4.5 V or GND | 4.3 | ±0.1 | ±1.0 | μA |
| $I_{OFF}$ | Power Off Leakage Current | $V_{IN}$ = 4.5 V or GND | 0 | ±0.5 | ±2.0 | μA |
| $I_{CC}$ | Maximum Quiescent Supply Current (Note 2) | Select and $V_{IS}$ = $V_{CC}$ or GND | 1.65 to 4.5 | ±1.0 | ±2.0 | μA |

2. Guaranteed by design. Resistance measurements do not include test circuit or package resistance.

**NLAS52231 DC ELECTRICAL CHARACTERISTICS – ANALOG SECTION**

| Symbol | Parameter | Condition | $V_{CC}$ | Guaranteed Maximum Limit | | | | Unit |
|---|---|---|---|---|---|---|---|---|
| | | | | 25°C | | –40°C to +85°C | | |
| | | | | Min | Max | Min | Max | |
| $R_{ON}$ (NC) | NC “ON” Resistance (Note 3) | $V_{IN} \leq V_{IL}$<br>$V_{IS}$ = GND to $V_{CC}$<br>$I_{IN}I \leq$ 100 mA | 3.0<br>4.3 | | 0.46<br>0.43 | | 0.56<br>0.53 | Ω |
| $R_{ON}$ (NO) | NO “ON” Resistance (Note 3) | $V_{IN} \geq V_{IH}$<br>$V_{IS}$ = GND to $V_{CC}$<br>$I_{IN}I \leq$ 100 mA | 3.0<br>4.3 | | 0.38<br>0.35 | | 0.48<br>0.43 | Ω |
| $R_{FLAT}$ (NC) | NC_On–Resistance Flatness (Notes 3, 4) | $I_{COM}$ = 100 mA<br>$V_{IS}$ = 0 to $V_{CC}$ | 3.0<br>4.3 | | 0.15<br>0.15 | | 0.17<br>0.18 | Ω |
| $R_{FLAT}$ (NO) | NO_On–Resistance Flatness (Notes 3, 4) | $I_{COM}$ = 100 mA<br>$V_{IS}$ = 0 to $V_{CC}$ | 3.0<br>4.3 | | 0.12<br>0.14 | | 0.14<br>0.16 | Ω |
| $\Delta R_{ON}$ | On–Resistance Match Between Channels (Notes 3 and 5) | $V_{IS}$ = 1.5 V;<br>$I_{COM}$ = 100 mA<br>$V_{IS}$ = 2.2 V;<br>$I_{COM}$ = 100 mA | 3.0<br>4.3 | | 0.05<br>0.05 | | 0.05<br>0.05 | Ω |
| $I_{NC(OFF)}$<br>$I_{NO(OFF)}$ | NC or NO Off Leakage Current (Note 3) | $V_{IN}$ = $V_{IL}$ or $V_{IH}$<br>$V_{NO}$ or $V_{NC}$ = 0.3 V<br>$V_{COM}$ = 4.0 V | 4.3 | –10 | 10 | –100 | 100 | nA |
| $I_{COM(ON)}$ | COM ON Leakage Current (Note 3) | $V_{IN}$ = $V_{IL}$ or $V_{IH}$<br>$V_{NO}$ 0.3 V or 4.0 V with $V_{NC}$ floating or<br>$V_{NC}$ 0.3 V or 4.0 V with $V_{NO}$ floating<br>$V_{COM}$ = 0.3 V or 4.0 V | 4.3 | –10 | 10 | –100 | 100 | nA |

3. Guaranteed by design. Resistance measurements do not include test circuit or package resistance.
4. Flatness is defined as the difference between the maximum and minimum value of On–resistance as measured over the specified analog signal ranges.
5. $\Delta R_{ON}$ = $R_{ON(MAX)}$ – $R_{ON(MIN)}$ between NC1 and NC2 or between NO1 and NO2.

**AC ELECTRICAL CHARACTERISTICS** (Input $t_r = t_f = 3.0$ ns)

| Symbol | Parameter | Test Conditions | $V_{CC}$ (V) | $V_{IS}$ (V) | Guaranteed Maximum Limit | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 25°C | | | −40°C to +85°C | | |
| | | | | | Min | Typ* | Max | Min | Max | |
| $t_{ON}$ | Turn−On Time | $R_L$ = 50 Ω, $C_L$ = 35 pF (Figures 3 and 4) | 2.3 – 4.5 | 1.5 | | | 50 | | 60 | ns |
| $t_{OFF}$ | Turn−Off Time | $R_L$ = 50 Ω, $C_L$ = 35 pF (Figures 3 and 4) | 2.3 – 4.5 | 1.5 | | | 30 | | 40 | ns |
| $t_{BBM}$ | Minimum Break−Before−Make Time | $V_{IS}$ = 3.0 $R_L$ = 50 Ω, $C_L$ = 35 pF (Figure 2) | 3.0 | 1.5 | 2 | 15 | | | | ns |

| | | Typical @ 25, $V_{CC}$ = 3.6 V | |
|---|---|---|---|
| $C_{IN}$ | Control Pin Input Capacitance | 3.5 | pF |
| $C_{NO/NC}$ | NO, NC Port Capacitance | 39 | pF |
| $C_{COM}$ | COM Port Capacitance When Switch is Enabled | 85 | pF |

*Typical Characteristics are at 25°C.

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

| Symbol | Parameter | Condition | $V_{CC}$ (V) | 25°C | Unit |
|---|---|---|---|---|---|
| | | | | Typical | |
| BW | Maximum On−Channel −3 dB Bandwidth or Minimum Frequency Response | $V_{IN}$ centered between $V_{CC}$ and GND (Figure 5) | 1.65 – 4.5 | 36 | MHz |
| $V_{ONL}$ | Maximum Feed−through On Loss | $V_{IN}$ = 0 dBm @ 100 kHz to 50 MHz $V_{IN}$ centered between $V_{CC}$ and GND (Figure 5) | 1.65 – 4.5 | −0.06 | dB |
| $V_{ISO}$ | Off−Channel Isolation | f = 100 kHz; $V_{IS}$ = 1 V RMS; $C_L$ = 5.0 pF $V_{IN}$ centered between $V_{CC}$ and GND (Figure 5) | 1.65 – 4.5 | −62 | dB |
| Q | Charge Injection Select Input to Common I/O | $V_{IN}$ = $V_{CC\ to}$ GND, $R_{IS}$ = 0 Ω, $C_L$ = 1.0 nF Q = $C_L$ x $DV_{OUT}$ (Figure 6) | 1.65 – 4.5 | 53 | pC |
| THD | Total Harmonic Distortion THD + Noise | $F_{IS}$ = 20 Hz to 20 kHz, $R_L$ = $R_{gen}$ = 600 Ω, $C_L$ = 50 pF $V_{IS}$ = 2.0 V RMS | 3.0 | 0.03 | % |
| VCT | Channel−to−Channel Crosstalk | f = 100 kHz; $V_{IS}$ = 1.0 V RMS, $C_L$ = 5.0 pF, $R_L$ = 50 Ω $V_{IN}$ centered between $V_{CC}$ and GND (Figure 5) | 1.65 – 4.5 | −88 | dB |

6. Off−Channel Isolation = 20log10 ($V_{COM}/V_{NO}$), $V_{COM}$ = output, $V_{NO}$ = input to off switch.

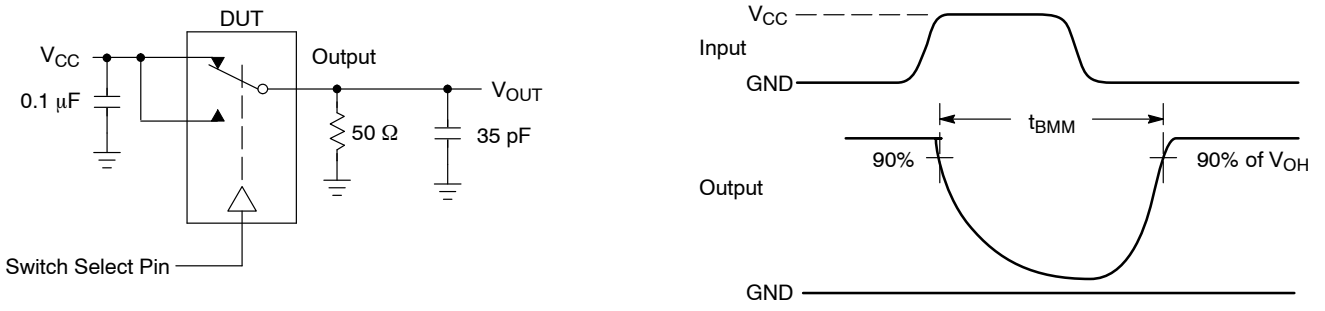



**Figure 2. $t_{BBM}$ (Time Break−Before−Make)**

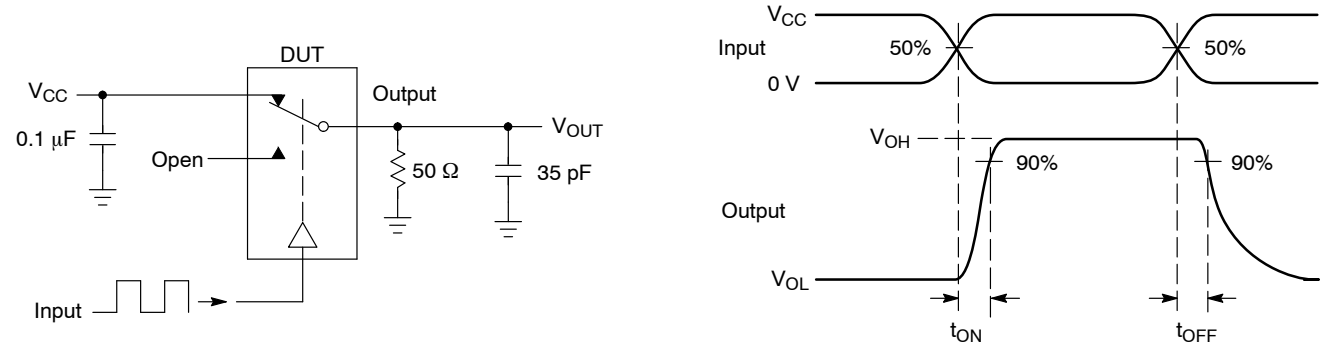



**Figure 3. $t_{ON}/t_{OFF}$**

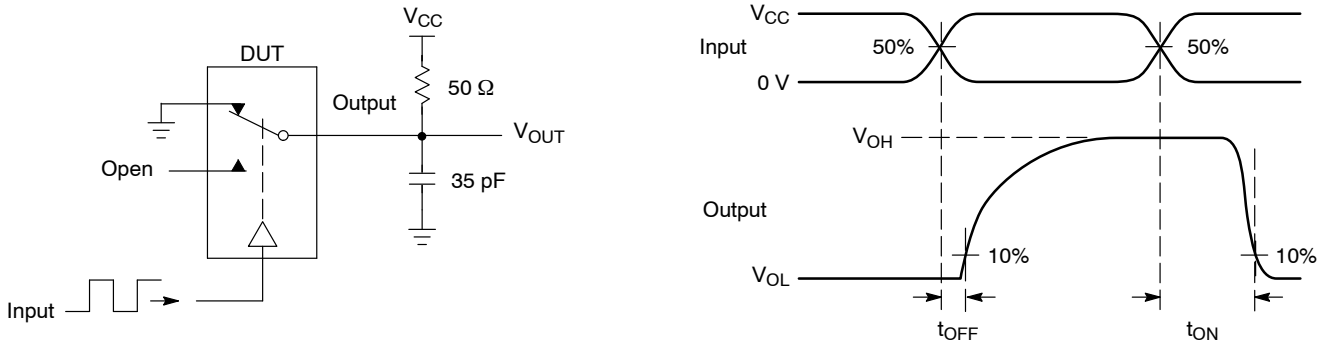
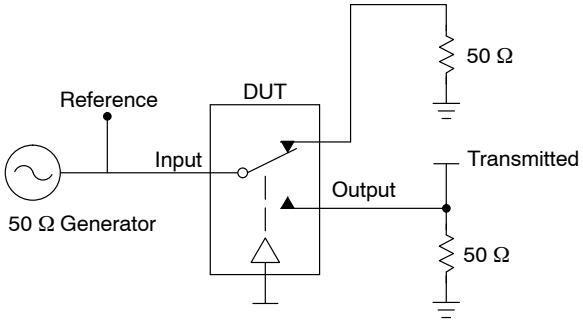



**Figure 4. $t_{ON}/t_{OFF}$**




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.

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

$V_{ONL}$ = On Channel Loss = 20 Log$\left(\frac{V_{OUT}}{V_{IN}}\right)$ for $V_{IN}$ at 100 kHz to 50 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 5. Off Channel Isolation/On Channel Loss (BW)/Crosstalk (On Channel to Off Channel)/$V_{ONL}$**

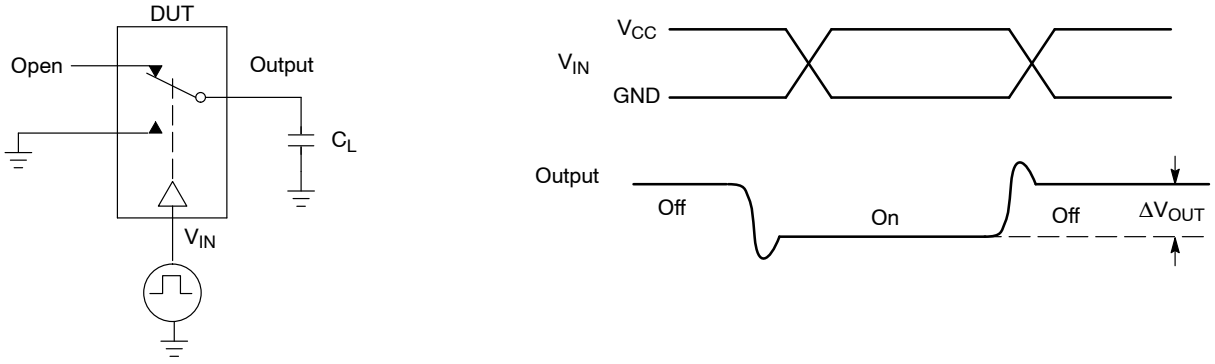



**Figure 6. Charge Injection: (Q)**

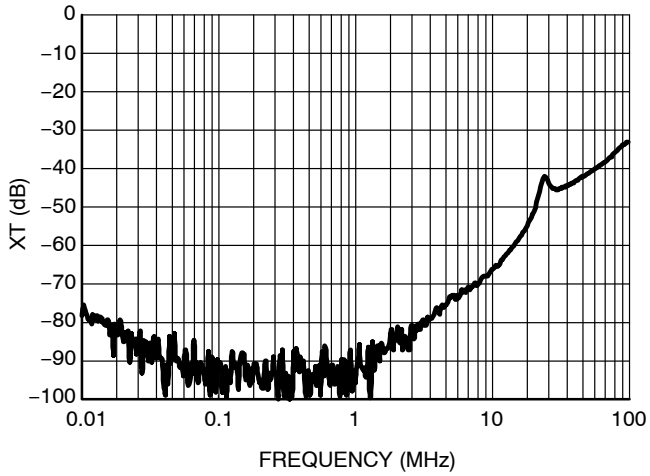



**Figure 7. Cross Talk vs. Frequency @ $V_{CC}$ = 4.3 V**

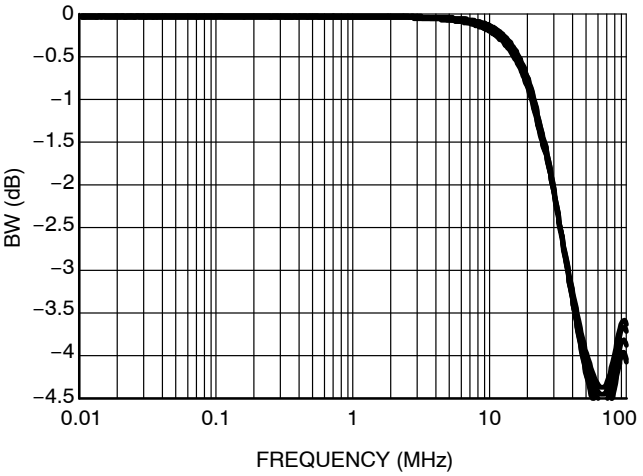



**Figure 8. Bandwidth vs. Frequency**

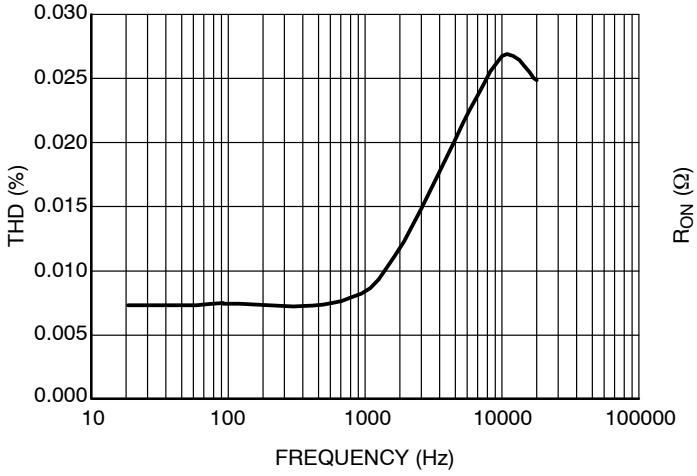



**Figure 9. Total Harmonic Distortion**

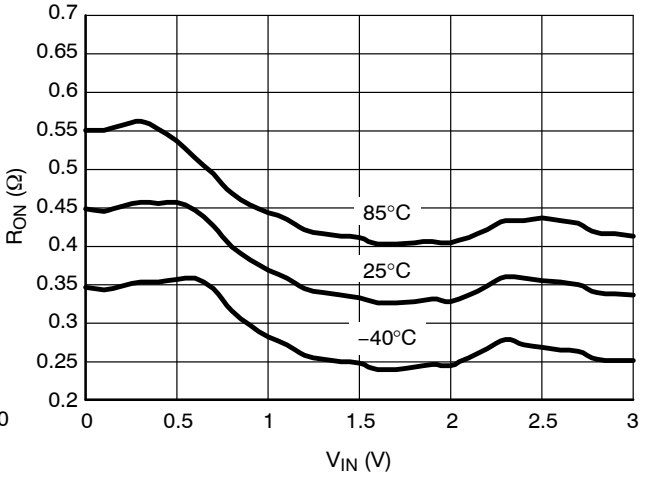



**Figure 10. On−Resistance vs. Input Voltage @ $V_{CC}$ = 3.0 V**

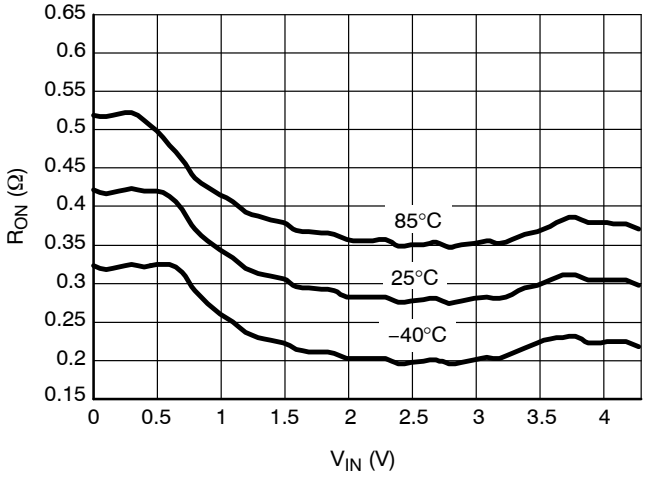



**Figure 11. On−Resistance vs. Input Voltage @ $V_{CC}$ = 4.3 V**

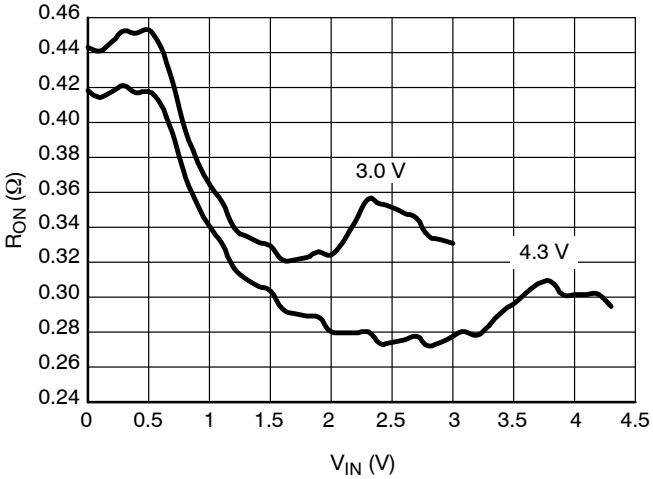



**Figure 12. On−Resistance vs. Input Voltage**

## DETAILED DESCRIPTION

### Overshoot Protection

The NLAS52231 features overshoot protection on the signal lines. This allows input signals to exceed the $V_{CC}$ voltage of the switch up to 1.1 V. This is useful in applications where the input signal has a wide dynamic range and may at times exceed the typical signal swing. It is also helpful in designs that pair a moderate signal swing range with a fairly low operating voltage. Up to 1.1 V above $V_{CC}$, the NLAS52231 switch will pass signals without distortion and maintain all specified performance characteristics.

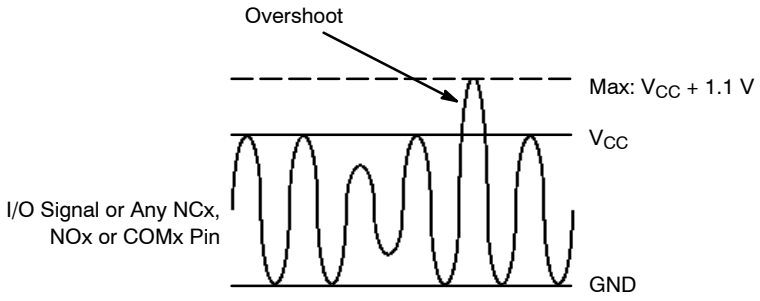



**Figure 13.**

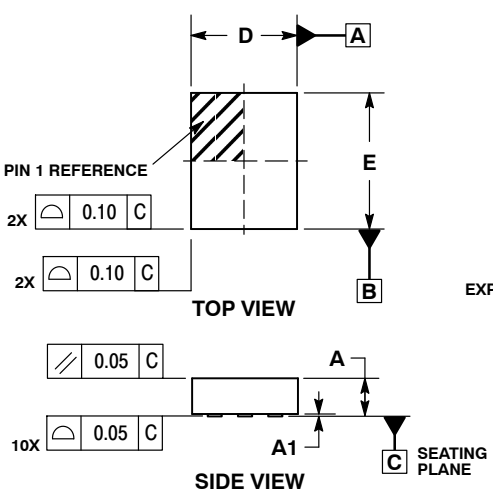
### ORDERING INFORMATION

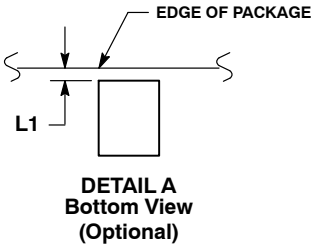
| Device | Package | Shipping† |
|---|---|---|
| NLAS52231MUR2G | UQFN10<br>(Pb−Free) | 3000 / Tape & Reel |

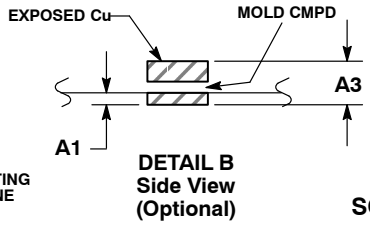
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

## PACKAGE DIMENSIONS

**UQFN10 1.4x1.8, 0.4P**
CASE 488AT−01
ISSUE A

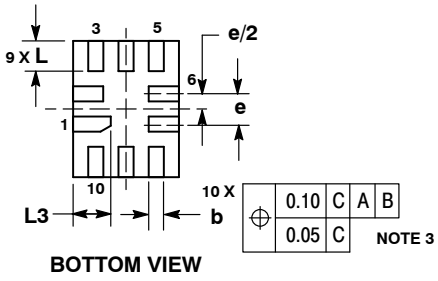


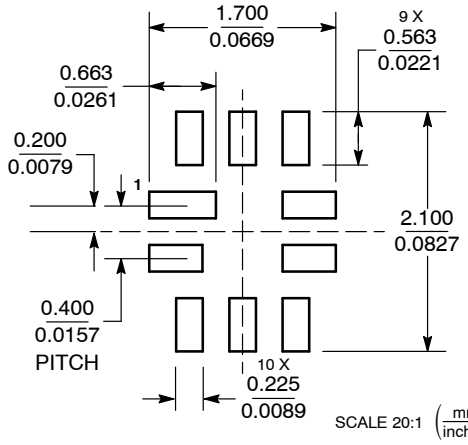




NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.25 AND 0.30 MM FROM TERMINAL.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

| | 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 |




### 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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