

# NLAS52231

## Ultra-Low 0.4 $\Omega$ 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  $\Omega$  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

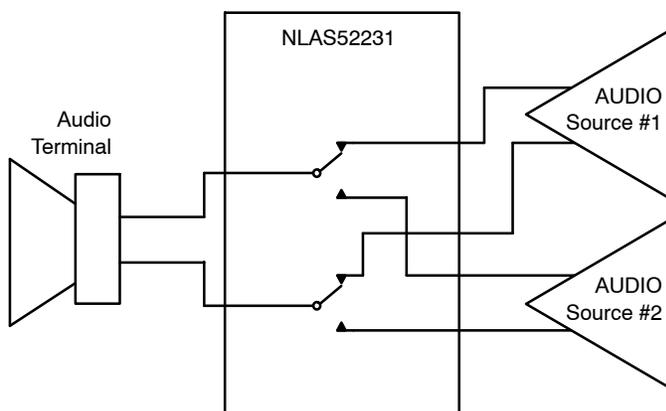


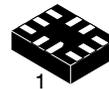
Figure 1. Applications Diagram



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### MARKING DIAGRAM

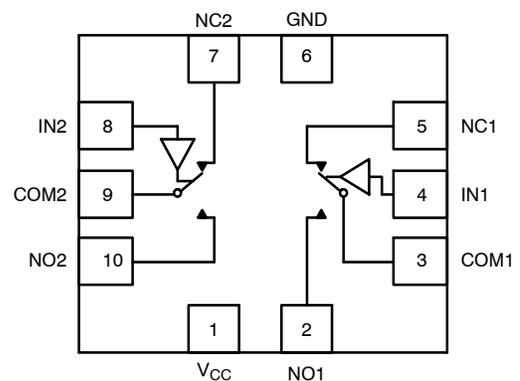


UQFN10  
CASE 488AT



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.

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## 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 <sub>CC</sub>	Positive Supply Voltage

## MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V <sub>CC</sub>	Positive DC Supply Voltage	-0.5 to +5.5	V
V <sub>IS</sub>	Analog Input Voltage (V <sub>NO</sub> , V <sub>NC</sub> , or V <sub>COM</sub> )	-0.5 to V <sub>CC</sub> + 1.6	V
V <sub>IN</sub>	Digital Select Input Voltage	-0.5 to +5.5	V
I <sub>anl1</sub>	Continuous DC Current from COM to NC/NO	±300	mA
I <sub>anl-pk1</sub>	Peak Current from COM to NC/NO, 10 Duty Cycle (Note 1)	±500	mA
I <sub>clmp</sub>	Continuous DC Current into COM/NO/NC with Respect to V <sub>CC</sub> 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 <sub>CC</sub>	DC Supply Voltage	1.65	4.5	V
V <sub>IN</sub>	Digital Select Input Voltage Overshoot Tolerance	GND	4.5	V
V <sub>IS</sub>	Analog Input Voltage (NC, NO, COM)	GND	V <sub>CC</sub> + 1.1	V
T <sub>A</sub>	Operating Temperature Range	-40	+85	°C
t <sub>r</sub> , t <sub>f</sub>	Input Rise or Fall Time, SELECT		20 10	ns/V
			V <sub>CC</sub> = 1.6 V – 2.7 V V <sub>CC</sub> = 3.0 V – 4.5 V	

## ESD PROTECTION

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

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

Symbol	Parameter	Condition	V <sub>CC</sub>	Guaranteed Limit		Unit
				25°C	-40°C to +85°C	
V <sub>IH</sub>	Minimum High-Level Input Voltage, Select Inputs		3.0	1.3	1.3	V
			4.3	1.6	1.6	
V <sub>IL</sub>	Maximum Low-Level Input Voltage, Select Inputs		3.0	0.5	0.5	V
			4.3	0.6	0.6	
I <sub>IN</sub>	Maximum Input Leakage Current, Select Inputs	V <sub>IN</sub> = 4.5 V or GND	4.3	±0.1	±1.0	µA
I <sub>OFF</sub>	Power Off Leakage Current	V <sub>IN</sub> = 4.5 V or GND	0	±0.5	±2.0	µA
I <sub>CC</sub>	Maximum Quiescent Supply Current (Note 2)	Select and V <sub>IS</sub> = V <sub>CC</sub> 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 <sub>CC</sub>	Guaranteed Maximum Limit				Unit
				25°C		-40°C to +85°C		
				Min	Max	Min	Max	
R <sub>ON</sub> (NC)	NC "ON" Resistance (Note 3)	V <sub>IN</sub> ≤ V <sub>IL</sub> V <sub>IS</sub> = GND to V <sub>CC</sub>  I <sub>IN</sub>   ≤ 100 mA	3.0		0.46		0.56	Ω
			4.3		0.43		0.53	
R <sub>ON</sub> (NO)	NO "ON" Resistance (Note 3)	V <sub>IN</sub> ≥ V <sub>IH</sub> V <sub>IS</sub> = GND to V <sub>CC</sub>  I <sub>IN</sub>   ≤ 100 mA	3.0		0.38		0.48	Ω
			4.3		0.35		0.43	
R <sub>FLAT</sub> (NC)	NC_On-Resistance Flatness (Notes 3, 4)	I <sub>COM</sub> = 100 mA V <sub>IS</sub> = 0 to V <sub>CC</sub>	3.0		0.15		0.17	Ω
			4.3		0.15		0.18	
R <sub>FLAT</sub> (NO)	NO_On-Resistance Flatness (Notes 3, 4)	I <sub>COM</sub> = 100 mA V <sub>IS</sub> = 0 to V <sub>CC</sub>	3.0		0.12		0.14	Ω
			4.3		0.14		0.16	
ΔR <sub>ON</sub>	On-Resistance Match Between Channels (Notes 3 and 5)	V <sub>IS</sub> = 1.5 V; I <sub>COM</sub> = 100 mA V <sub>IS</sub> = 2.2 V; I <sub>COM</sub> = 100 mA	3.0		0.05		0.05	Ω
			4.3		0.05		0.05	
I <sub>NC(OFF)</sub> I <sub>NO(OFF)</sub>	NC or NO Off Leakage Current (Note 3)	V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub> V <sub>NO</sub> or V <sub>NC</sub> = 0.3 V V <sub>COM</sub> = 4.0 V	4.3	-10	10	-100	100	nA
I <sub>COM(ON)</sub>	COM ON Leakage Current (Note 3)	V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub> V <sub>NO</sub> 0.3 V or 4.0 V with V <sub>NC</sub> floating or V <sub>NC</sub> 0.3 V or 4.0 V with V <sub>NO</sub> floating V <sub>COM</sub> = 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. ΔR<sub>ON</sub> = R<sub>ON(MAX)</sub> - R<sub>ON(MIN)</sub> between NC1 and NC2 or between NO1 and NO2.

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## 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	$R_L = 50 \Omega$ , $C_L = 35$ pF (Figures 3 and 4)	2.3 – 4.5	1.5			50		60	ns
$t_{OFF}$	Turn-Off Time	$R_L = 50 \Omega$ , $C_L = 35$ pF (Figures 3 and 4)	2.3 – 4.5	1.5			30		40	ns
$t_{BBM}$	Minimum Break-Before-Make Time	$V_{IS} = 3.0$ $R_L = 50 \Omega$ , $C_L = 35$ 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	
$C_{NO/NC}$	NO, NC Port Capacitance	39	
$C_{COM}$	COM Port Capacitance When Switch is Enabled	85	

\*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, $R_{IS} = 0 \Omega$ , $C_L = 1.0$ nF $Q = C_L \times DV_{OUT}$ (Figure 6)	1.65 – 4.5	53	pC
THD	Total Harmonic Distortion THD + Noise	$F_{IS} = 20$ Hz to 20 kHz, $R_L = R_{gen} = 600 \Omega$ , $C_L = 50$ 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, $R_L = 50 \Omega$ $V_{IN}$ centered between $V_{CC}$ and GND (Figure 5)	1.65 – 4.5	-88	dB

6. Off-Channel Isolation =  $20 \log_{10} (V_{COM}/V_{NO})$ ,  $V_{COM}$  = output,  $V_{NO}$  = input to off switch.

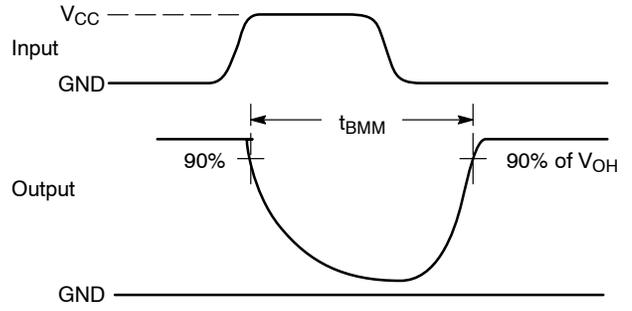
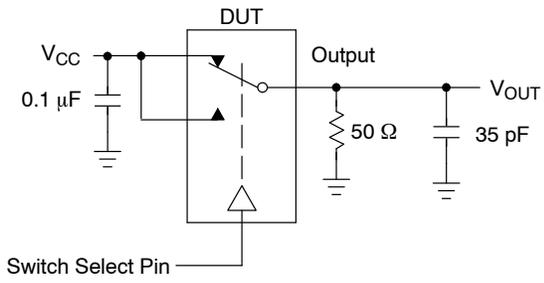


Figure 2.  $t_{BMM}$  (Time Break-Before-Make)

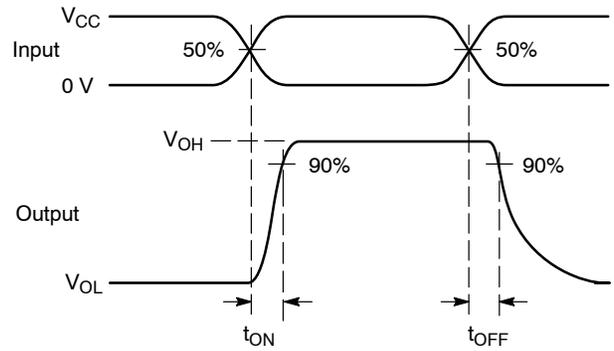
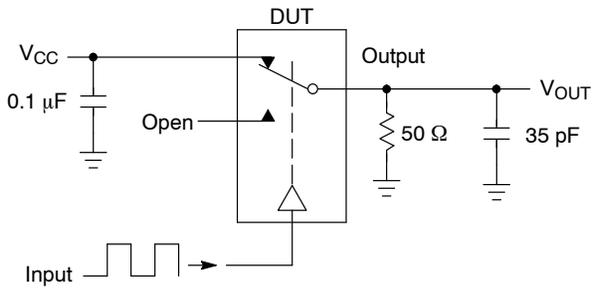


Figure 3.  $t_{ON}/t_{OFF}$

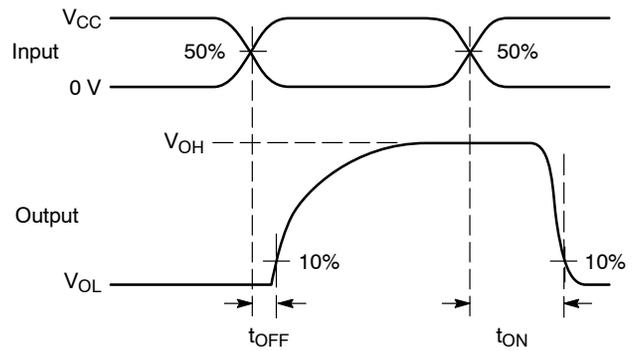
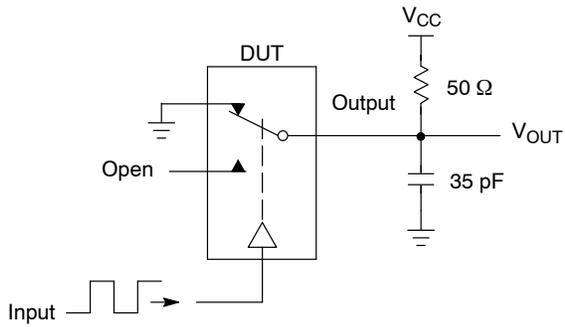
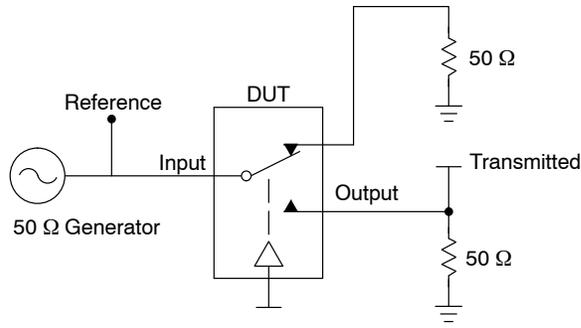


Figure 4.  $t_{ON}/t_{OFF}$



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.

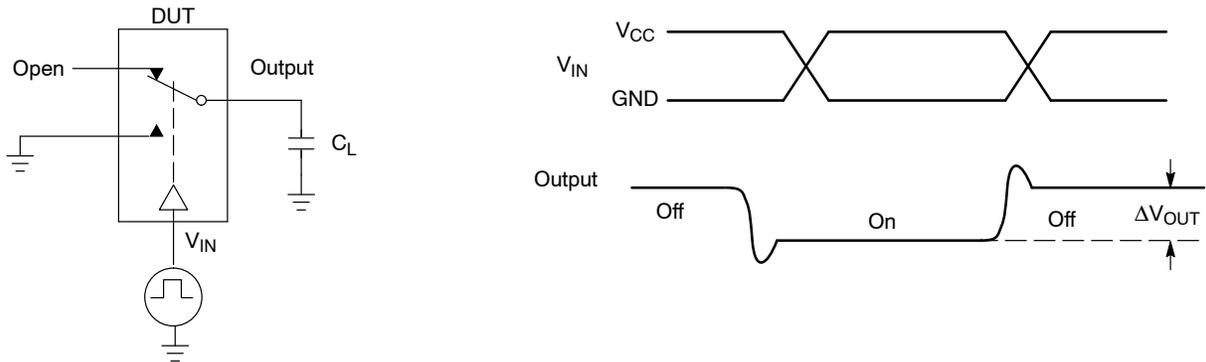
$$V_{ISO} = \text{Off Channel Isolation} = 20 \text{ Log} \left( \frac{V_{OUT}}{V_{IN}} \right) \text{ for } V_{IN} \text{ at } 100 \text{ kHz}$$

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

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



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

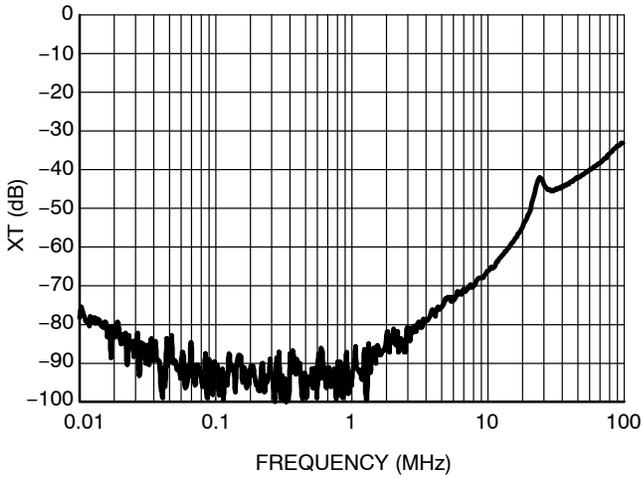


Figure 7. Cross Talk vs. Frequency  
@  $V_{CC} = 4.3\text{ V}$

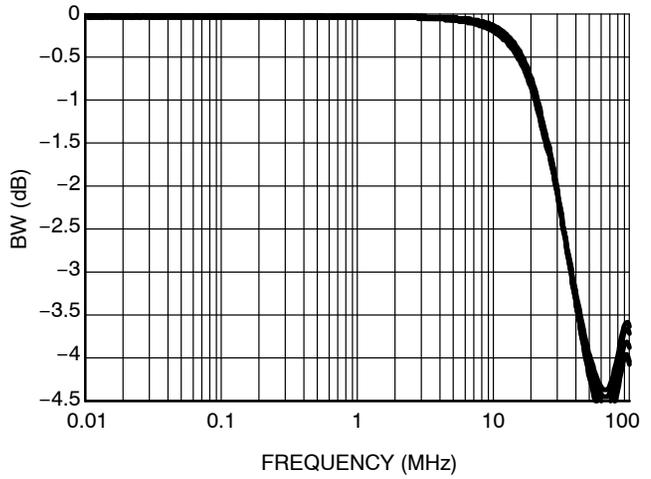


Figure 8. Bandwidth vs. Frequency

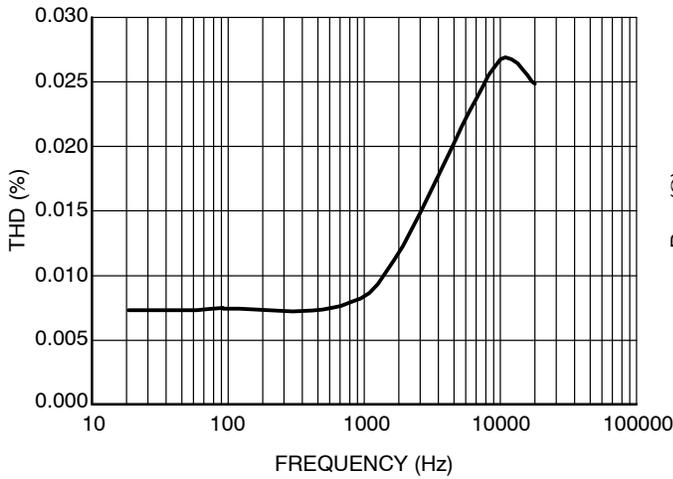


Figure 9. Total Harmonic Distortion

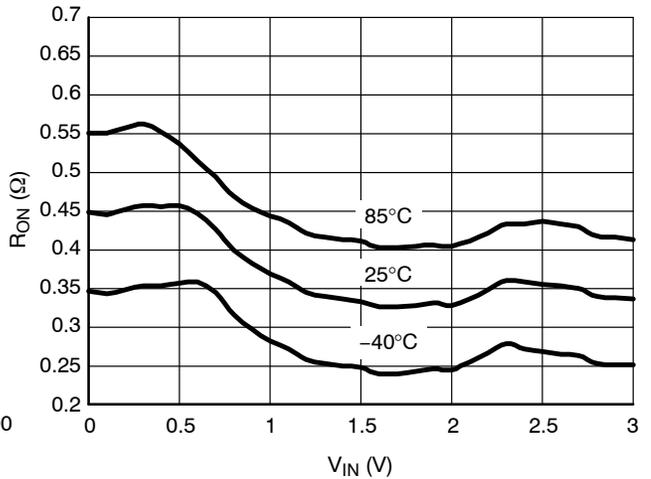


Figure 10. On-Resistance vs. Input Voltage  
@  $V_{CC} = 3.0\text{ V}$

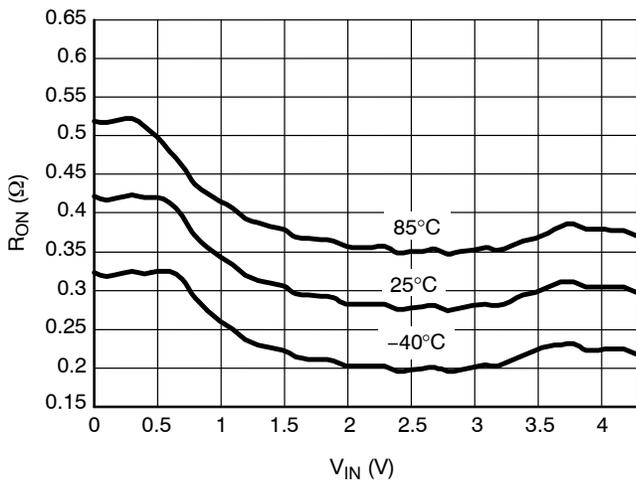


Figure 11. On-Resistance vs. Input Voltage  
@  $V_{CC} = 4.3\text{ V}$

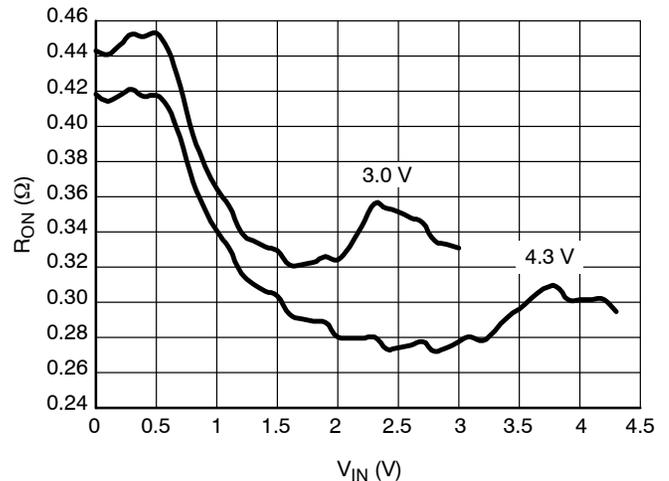


Figure 12. On-Resistance vs. Input Voltage

# NLAS52231

## 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.

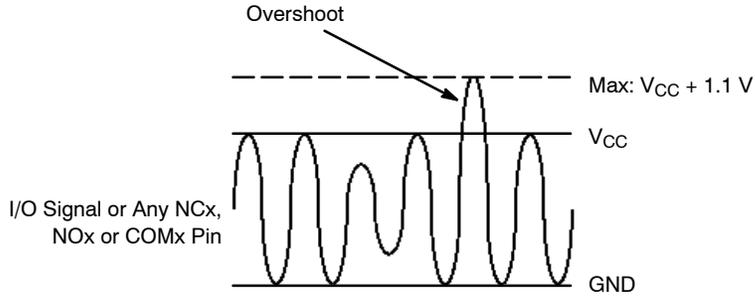


Figure 13.

### ORDERING INFORMATION

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

<sup>†</sup>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.

