Ultra-Low 0.4 Ω Dual SPDT Analog Switch with Overshoot

The NLAS52231 is a dual SPDT analog switch with overshoot capability on the signal lines. It is ideally suited for audio applications that require very low R_{ON} values for maximum signal transfer. The overshoot feature 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 Capability: 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

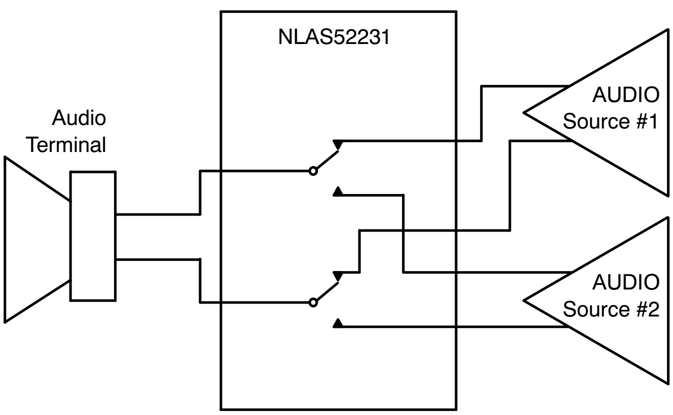
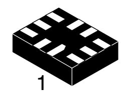


Figure 1. Applications Diagram

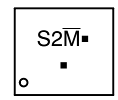
ON Semiconductor®

http://onsemi.com

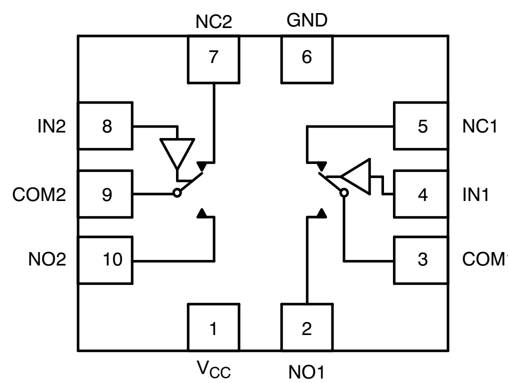
MARKING DIAGRAM



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})	$-0.5 \leq V_{IS} \leq V_{CC} + 0.5$	V
V_{IN}	Digital Select Input Voltage	$-0.5 \leq V_{IN} \leq +5.5$	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 V_{CC} = 3.0 V − 4.5 V		20 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 4.3	1.3 1.6	1.3 1.6	V
V_{IL}	Maximum Low−Level Input Voltage, Select Inputs		3.0 4.3	0.5 0.6	0.5 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)	$V_{IN} \leq V_{IL}$ V_{IS} = GND to V_{CC} $I_{IN}I \leq$ 100 mA	3.0 4.3		0.46 0.43		0.56 0.53	Ω
R_{ON} (NO)	NO "ON" Resistance (Note 3)	$V_{IN} \geq V_{IH}$ V_{IS} = GND to V_{CC} $I_{IN}I \leq$ 100 mA	3.0 4.3		0.38 0.35		0.48 0.43	Ω
R_{FLAT} (NC)	NC_On−Resistance Flatness (Notes 3, 4)	I_{COM} = 100 mA V_{IS} = 0 to V_{CC}	3.0 4.3		0.15 0.15		0.17 0.18	Ω
R_{FLAT} (NO)	NO_On−Resistance Flatness (Notes 3, 4)	I_{COM} = 100 mA V_{IS} = 0 to V_{CC}	3.0 4.3		0.12 0.14		0.14 0.16	Ω
ΔR_{ON}	On−Resistance Match Between Channels (Notes 3 and 5)	V_{IS} = 1.5 V; I_{COM} = 100 mA V_{IS} = 2.2 V; I_{COM} = 100 mA	3.0 4.3		0.05 0.05		0.05 0.05	Ω
$I_{NC(OFF)}$ $I_{NO(OFF)}$	NC or NO Off Leakage Current (Note 3)	V_{IN} = V_{IL} or V_{IH} V_{NO} or V_{NC} = 0.3 V 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} V_{NO} 0.3 V or 4.0 V with V_{NC} floating or V_{NC} 0.3 V or 4.0 V with V_{NO} floating 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 25°C Min	25°C Typ*	25°C Max	−40°C to +85°C Min	−40°C to +85°C Max	Unit
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	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 Typical	Unit
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 = 20log10 (V_{COM}/V_{NO}), V_{COM} = output, V_{NO} = input to off switch.

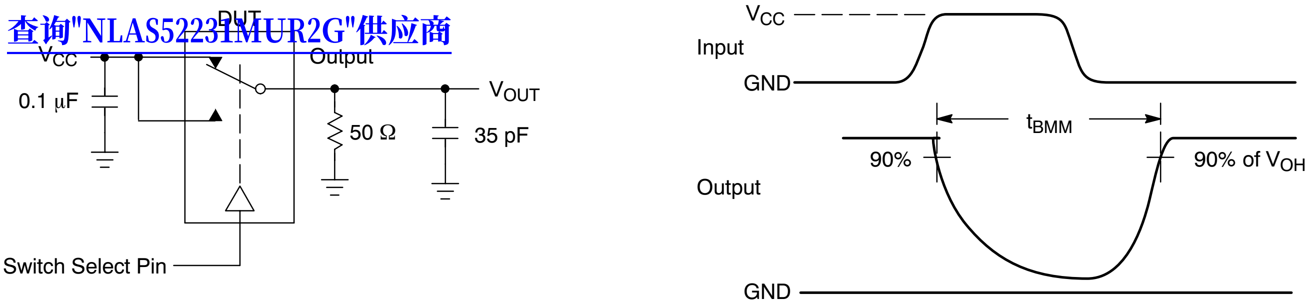


Figure 2. t_{BBM} (Time Break−Before−Make)

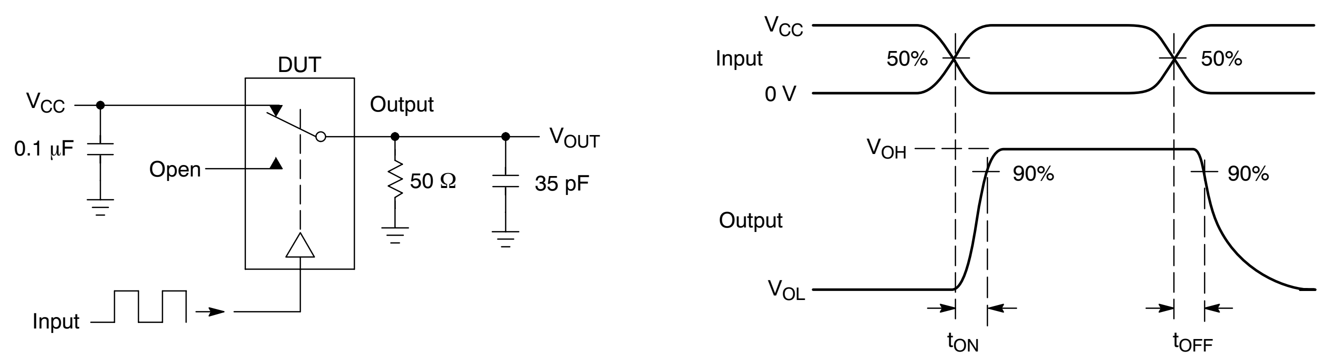


Figure 3. t_{ON}/t_{OFF}

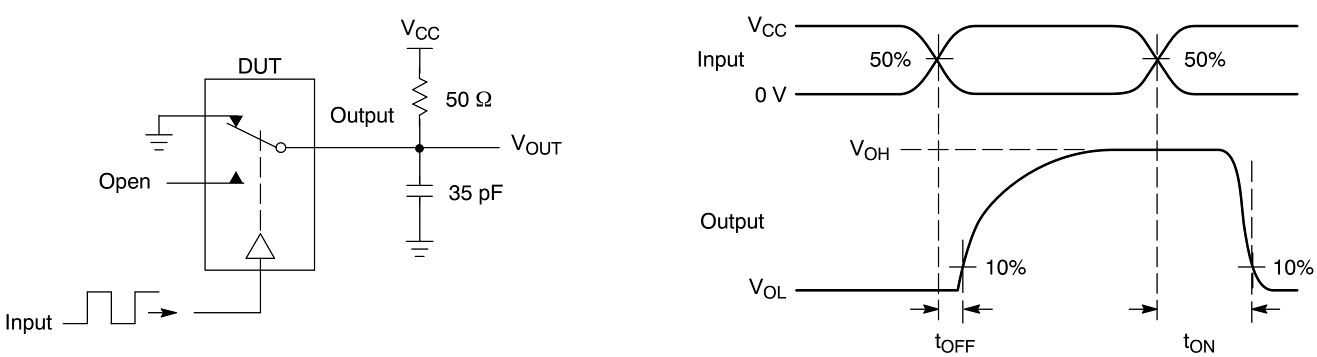
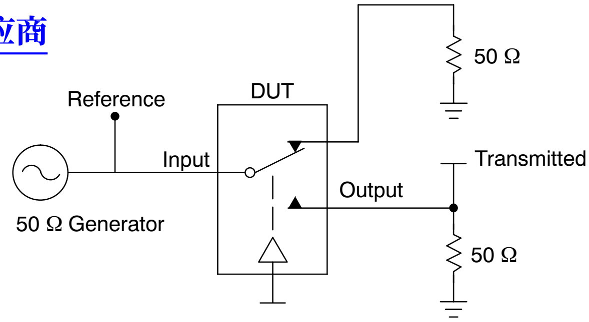


Figure 4. t_{ON}/t_{OFF}



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

V_{ONL} = On Channel Loss = $20 \text{ Log}\left(\frac{V_{OUT}}{V_{IN}}\right)$ 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}

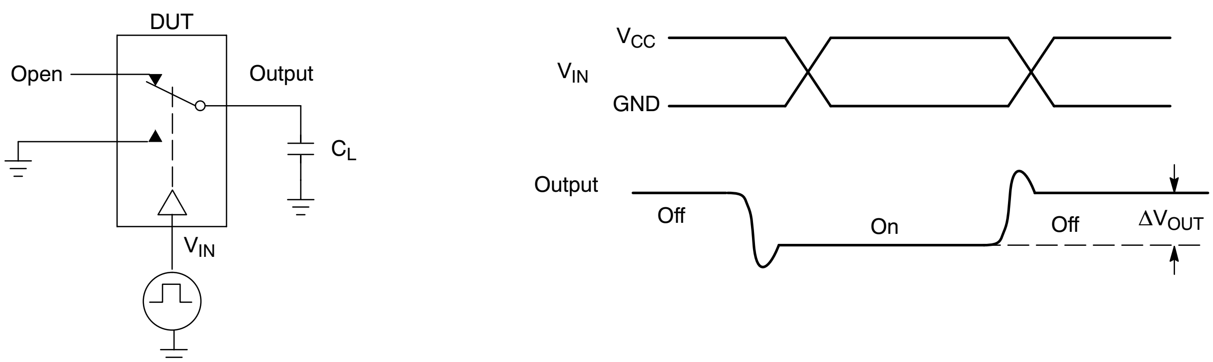


Figure 6. Charge Injection: (Q)

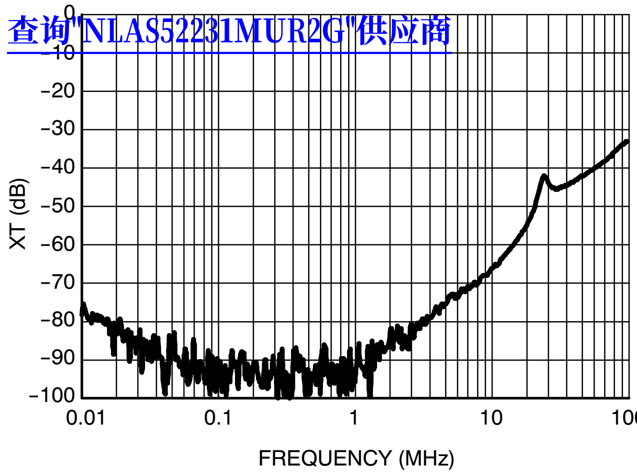


Figure 7. Cross Talk vs. Frequency @ V_{CC} = 4.3 V

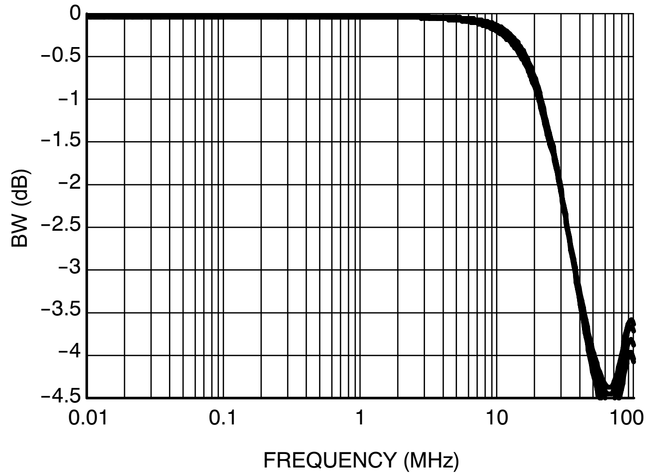


Figure 8. Bandwidth vs. Frequency

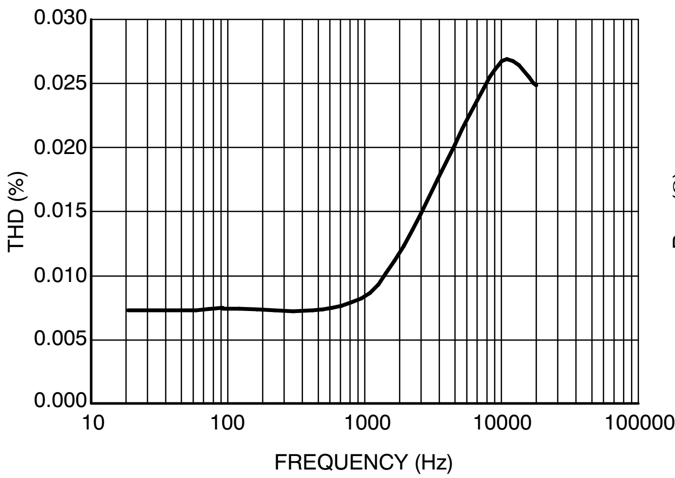


Figure 9. Total Harmonic Distortion

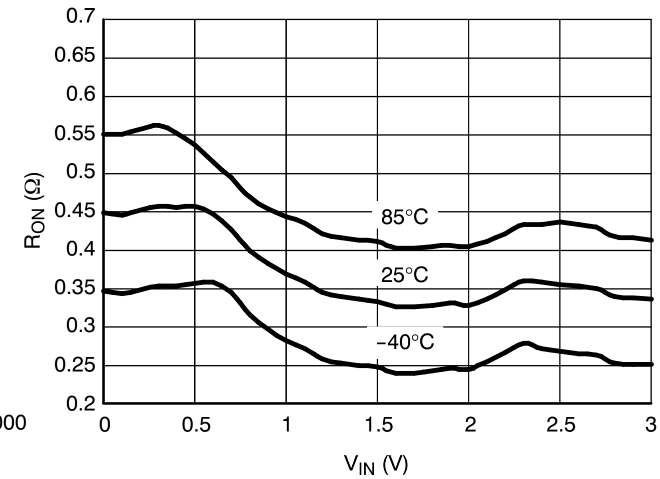


Figure 10. On−Resistance vs. Input Voltage @ V_{CC} = 3.0 V

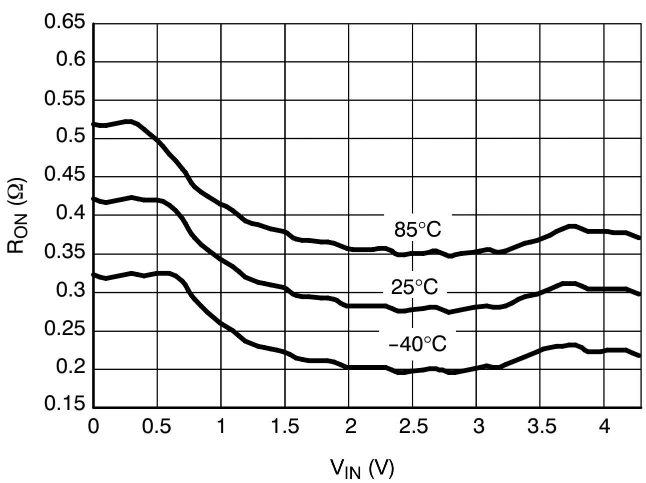


Figure 11. On−Resistance vs. Input Voltage @ V_{CC} = 4.3 V

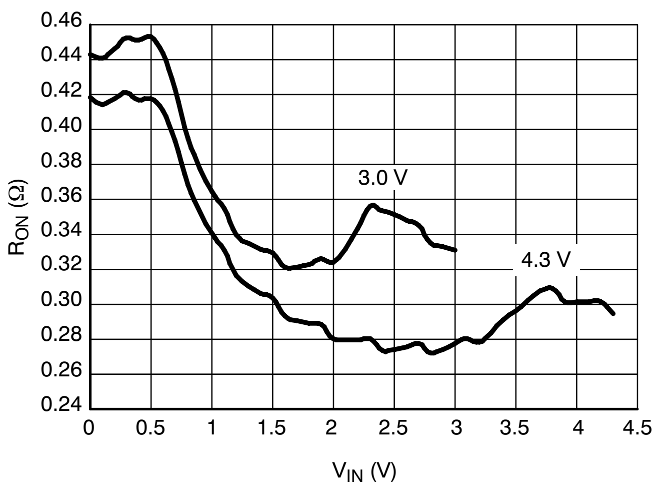


Figure 12. On−Resistance vs. Input Voltage

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.

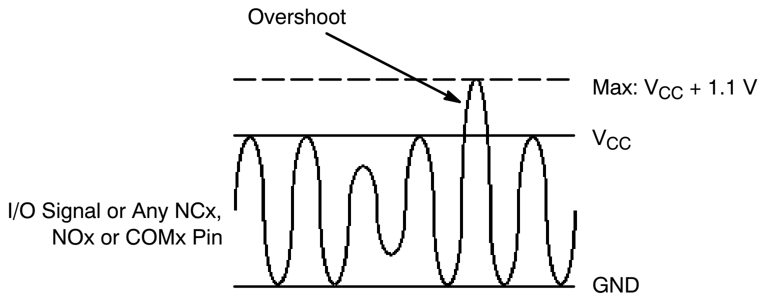


Figure 13.

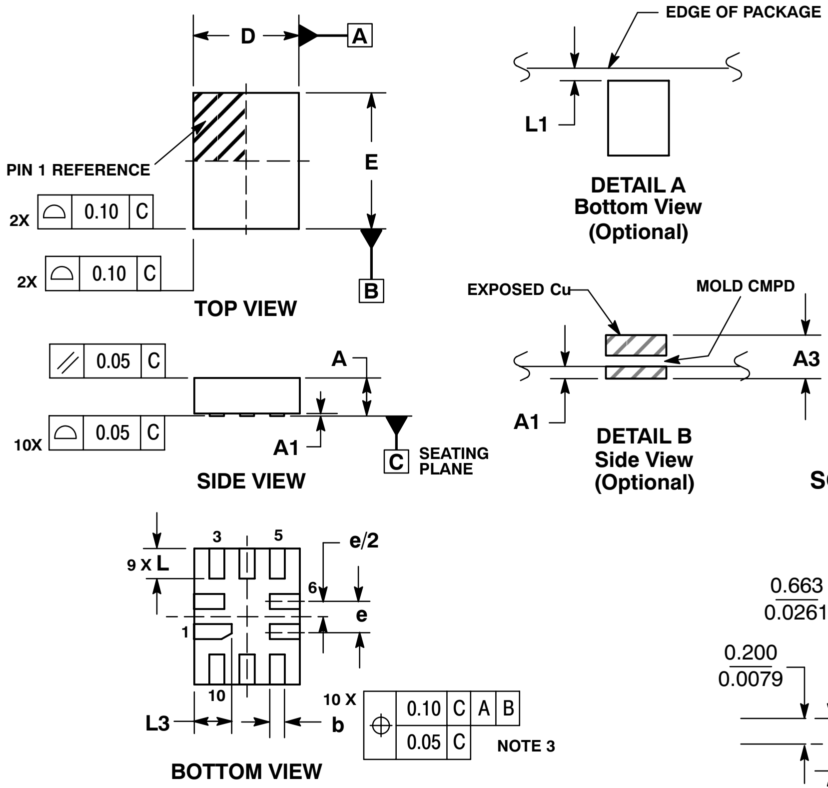
ORDERING INFORMATION

Device	Package	Shipping†
NLAS52231MUR2G	UQFN10 (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

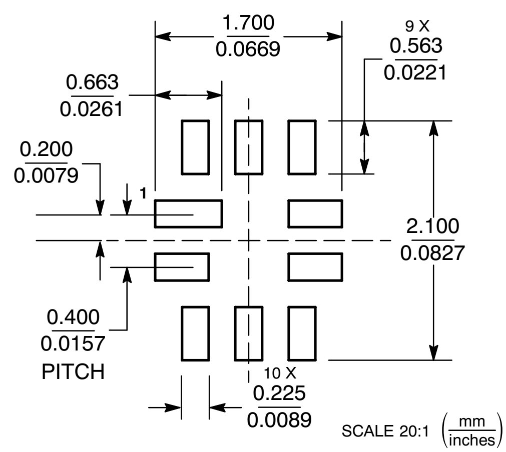
UQFN10 1.4x1.8, 0.4P
CASE 488AT−01
ISSUE A



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.

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Literature Distribution Center for ON Semiconductor
P.O. Box 5163, Denver, Colorado 80217 USA
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