

# NLAS5223C, NLAS5223CL

## Ultra-Low 0.35 $\Omega$ Dual SPDT Analog Switch

The NLAS5223C is an advanced CMOS analog switch fabricated in Sub-micron silicon gate CMOS technology. The device is a dual Independent Single Pole Double Throw (SPDT) switch featuring Ultra-Low  $R_{ON}$  of 0.35  $\Omega$ , at  $V_{CC} = 4.3$  V.

The part also features guaranteed Break Before Make (BBM) switching, assuring the switches never short the driver.

### Features

- Ultra-Low  $R_{ON}$ , 0.35  $\Omega$  (typ) at  $V_{CC} = 4.3$  V
- NLAS5223C Interfaces with 2.8 V Chipset
- NLAS5223CL Interfaces with 1.8 V Chipset
- Single Supply Operation from 1.65–4.5 V
- Full 0– $V_{CC}$  Signal Handling Capability
- High Off-Channel Isolation
- Low Standby Current, < 50 nA
- Low Distortion
- $R_{ON}$  Flatness of 0.15  $\Omega$
- High Continuous Current Capability
  - ♦  $\pm 320$  mA Through Each Switch
- Large Current Clamping Diodes at Analog Inputs
  - ♦  $\pm 100$  mA Continuous Current Capability
- Package:
  - ♦ 1.4 x 1.8 x 0.55 mm UQFN10 Pb-Free
- These are Pb-Free Devices

### Applications

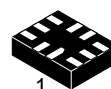
- Cell Phone Audio Block
- Speaker and Earphone Switching
- Ring-Tone Chip/Amplifier Switching
- Modems



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### MARKING DIAGRAM

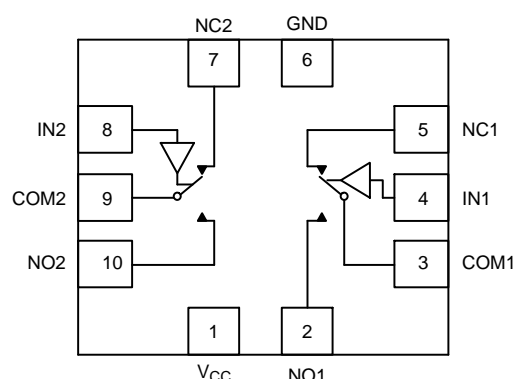


**UQFN10  
CASE 488AT**



XX = 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, marking and shipping information in the package dimensions section on page 9 of this data sheet.

# NLAS5223C, NLAS5223CL

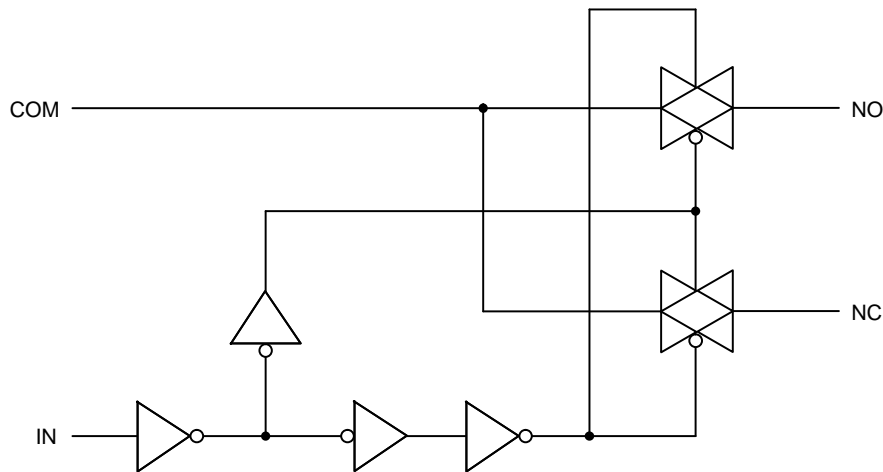


Figure 1. Logic Equivalent Circuit

## 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 +7.0	V
V <sub>IS</sub>	Analog Input Voltage (V <sub>NO</sub> , V <sub>NC</sub> , or V <sub>COM</sub> )	-0.5 ≤ V <sub>IS</sub> ≤ V <sub>CC</sub> + 0.5	V
V <sub>IN</sub>	Digital Select Input Voltage	-0.5 ≤ V <sub>IN</sub> ≤ +5.5	V
I <sub>anl1</sub>	Continuous DC Current from COM to NC/NO	±320	mA
I <sub>anl-pk1</sub>	Peak Current from COM to NC/NO, 10% Duty Cycle, 100 ms = t <sub>ON</sub> (Note 1)	±600	mA
I <sub>anl-pk2</sub>	Instantaneous Peak Current from COM to NC/NO, 10% Duty Cycle, t <sub>ON</sub> < 1 μs	±850	mA
I <sub>clmp</sub>	Continuous DC Current into COM/NO/NC with Respect to V <sub>CC</sub> or GND	±100	mA
ESD	ESD Withstand Voltage Human Body Model (HBM)	>3000	V

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

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 (OVT) Overvoltage Tolerance	GND	4.5	V
V <sub>IS</sub>	Analog Input Voltage (NC, NO, COM)	GND	V <sub>CC</sub>	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 V <sub>CC</sub> = 1.6 V – 2.7 V V <sub>CC</sub> = 3.0 V – 4.5 V		20 10	ns/V

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

# NLAS5223C, NLAS5223CL

## NLAS5223C 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 4.3	1.4 2.0	1.4 2.0	V
V <sub>IL</sub>	Maximum Low–Level Input Voltage, Select Inputs		3.0 4.3	0.7 0.8	0.7 0.8	V
I <sub>IN</sub>	Maximum Input Leakage Current, Select Inputs	V <sub>IN</sub> = V <sub>CC</sub> or GND	4.3	±0.1	±1.0	μA
I <sub>OFF</sub>	Power Off Leakage Current	V <sub>IN</sub> = V <sub>CC</sub> 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.

## NLAS5223C 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/NO On–Resistance (Note 3)	V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IN</sub> = V <sub>IH</sub> V <sub>IS</sub> = GND to V <sub>CC</sub> I <sub>COM</sub> = 100 mA	3.0 4.3		0.4 0.35		0.5 0.4	Ω
R <sub>FLAT</sub>	NC/NO On–Resistance Flatness (Notes 3 and 4)	I <sub>COM</sub> = 100 mA V <sub>IS</sub> = 0 to V <sub>CC</sub>	3.0 4.3		0.16 0.11		0.20 0.14	Ω
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 4.3		0.05 0.05		0.05 0.05	Ω
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	–5.0	5.0	–50	50	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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## NLAS5223CL 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 4.3	1.3 1.6	1.3 1.6	V
V <sub>IL</sub>	Maximum Low–Level Input Voltage, Select Inputs		3.0 4.3	0.5 0.6	0.5 0.6	V
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	Select and V <sub>IS</sub> = V <sub>CC</sub> or GND	1.65 to 4.5	±1.0	±2.0	μA
I <sub>CCV</sub>	Maximum Quiescent Supply Current, Low Voltage Driving (Note 6)	V <sub>IS</sub> = V <sub>CC</sub> or GND V <sub>IN</sub> = 1.65 V	4.3	±145	±150	μA
		V <sub>IS</sub> = V <sub>CC</sub> or GND V <sub>IN</sub> = 1.80 V		±125	±130	
		V <sub>IS</sub> = V <sub>CC</sub> or GND V <sub>IN</sub> = 2.60 V		±50	±55	

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

## NLAS5223CL 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/NO On–Resistance (Note 7)	V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IN</sub> = V <sub>IH</sub> V <sub>IS</sub> = GND to V <sub>CC</sub> I <sub>COM</sub> = 100 mA	3.0 4.3		0.4 0.35		0.5 0.4	Ω
R <sub>FLAT</sub>	NC/NO On–Resistance Flatness (Notes 7 and 8)	I <sub>COM</sub> = 100 mA V <sub>IS</sub> = 0 to V <sub>CC</sub>	3.0 4.3		0.16 0.11		0.20 0.14	Ω
ΔR <sub>ON</sub>	On–Resistance Match Between Channels (Notes 7 and 9)	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 4.3		0.05 0.05		0.05 0.05	Ω
I <sub>NC(OFF)</sub> I <sub>NO(OFF)</sub>	NC or NO Off Leakage Current (Note 7)	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 7)	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

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

8. Flatness is defined as the difference between the maximum and minimum value of On–resistance as measured over the specified analog signal ranges.

9. 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 <sub>CC</sub> (V)	V <sub>IS</sub> (V)	Guaranteed Maximum Limit					Unit
					25°C			−40°C to +85°C		
					Min	Typ*	Max	Min	Max	
t <sub>ON</sub>	Turn-On Time	R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 35 pF (Figures 3 and 4)	2.3 – 4.5	1.5			50		60	ns
t <sub>OFF</sub>	Turn-Off Time	R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 35 pF (Figures 3 and 4)	2.3 – 4.5	1.5			30		40	ns
t <sub>BBM</sub>	Minimum Break-Before-Make Time	V <sub>IS</sub> = 3.0 R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 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		60	pF
$C_{COM}$	COM Port Capacitance When Switch is Enabled		200	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	24	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	-68	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	38	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	0.08	%
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	-70	dB

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

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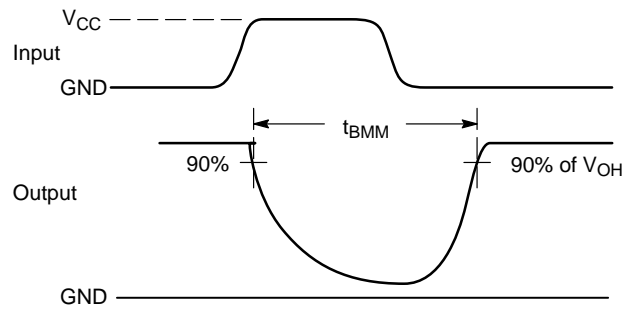
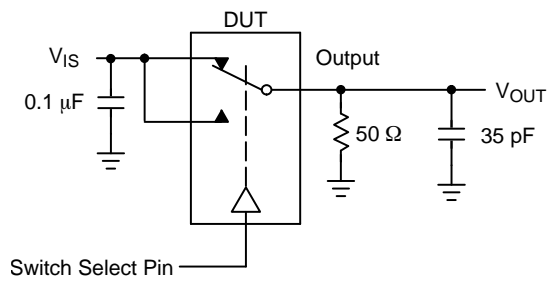


Figure 2.  $t_{BMM}$  (Time Break-Before-Make)

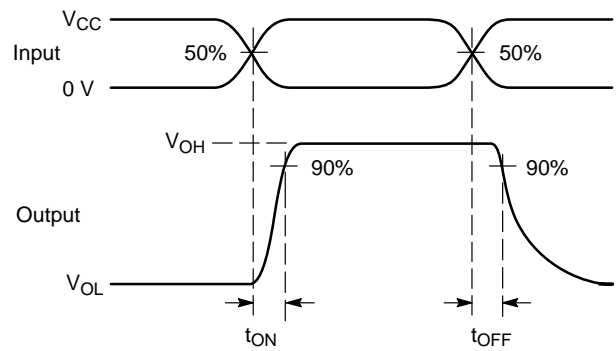
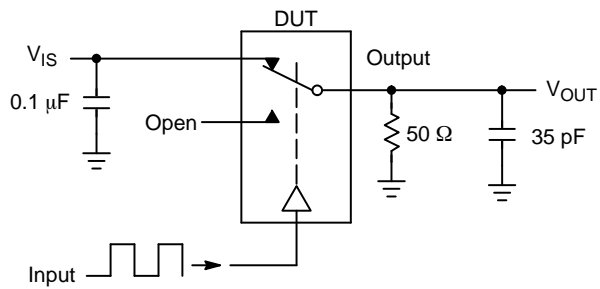


Figure 3.  $t_{ON}/t_{OFF}$

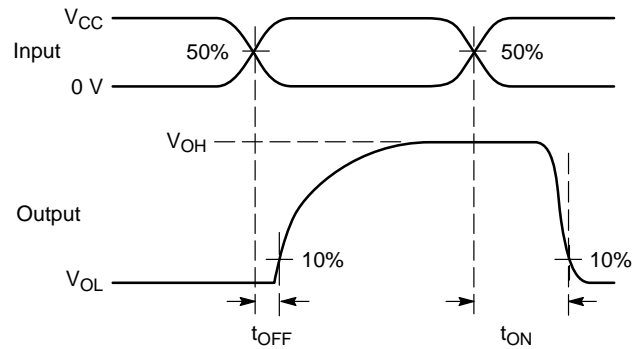
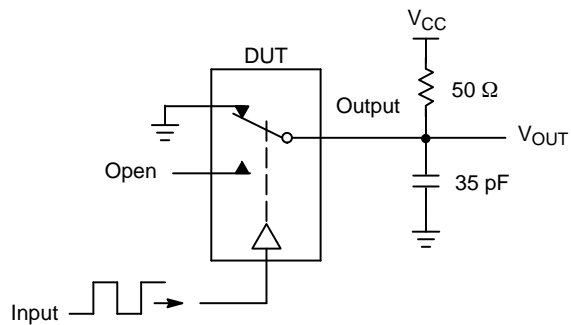
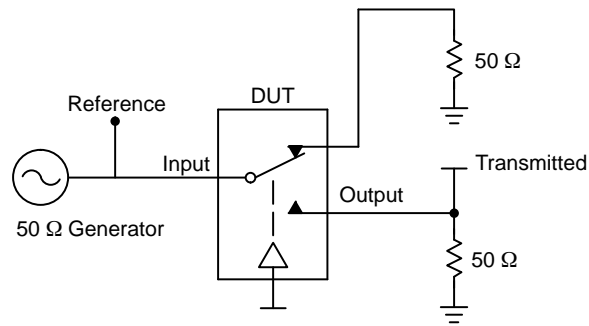


Figure 4.  $t_{ON}/t_{OFF}$

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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.

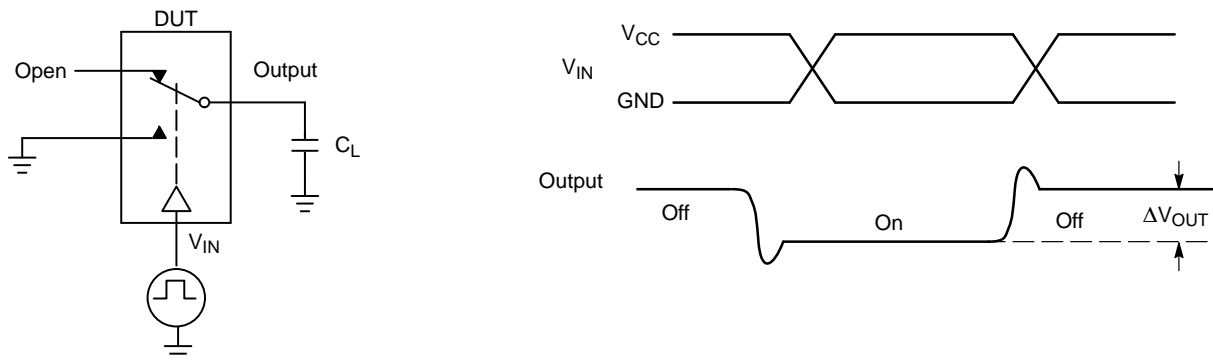
$$V_{ISO} = \text{Off Channel Isolation} = 20 \text{ Log} \left( \frac{V_{OUT}}{V_{IN}} \right) \text{ for } V_{IN} \text{ at } 100 \text{ kHz}$$

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

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)**

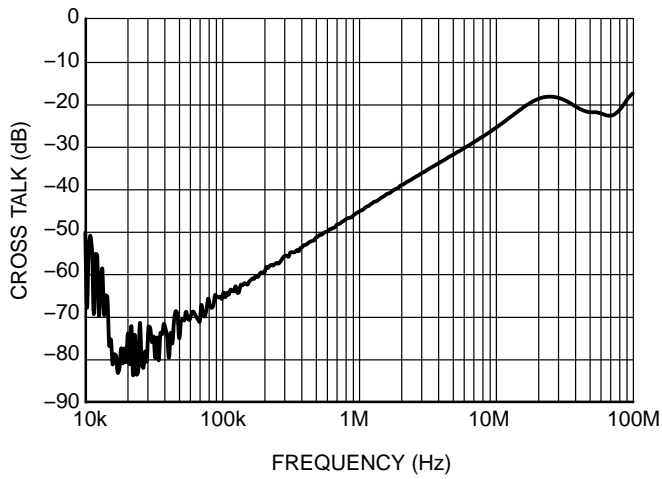


Figure 7. Cross Talk vs. Frequency  
( $V_{CC} = 3.0 \text{ V}$ )

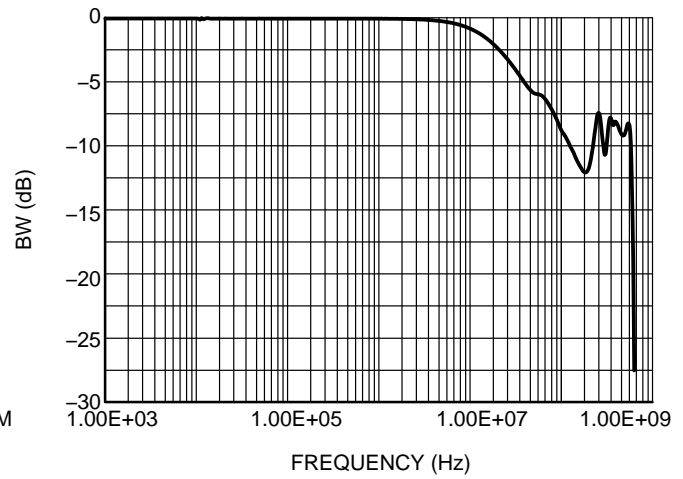


Figure 8. Bandwidth  
( $V_{CC} = 3.0 \text{ V}$ )

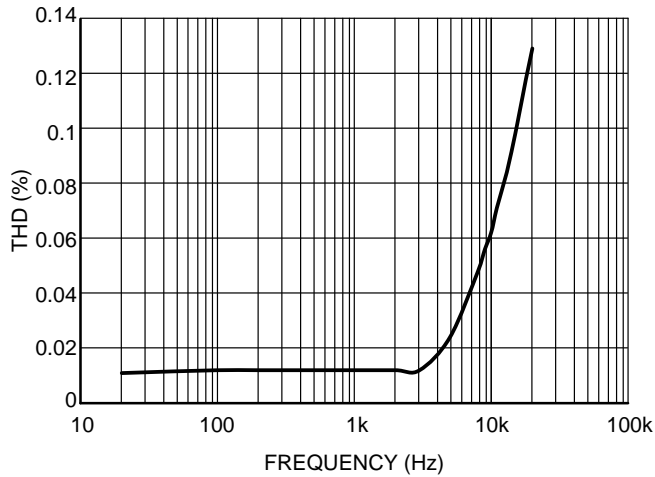


Figure 9. Total Harmonic Distortion  
( $V_{CC} = 3.0 \text{ V}$ )

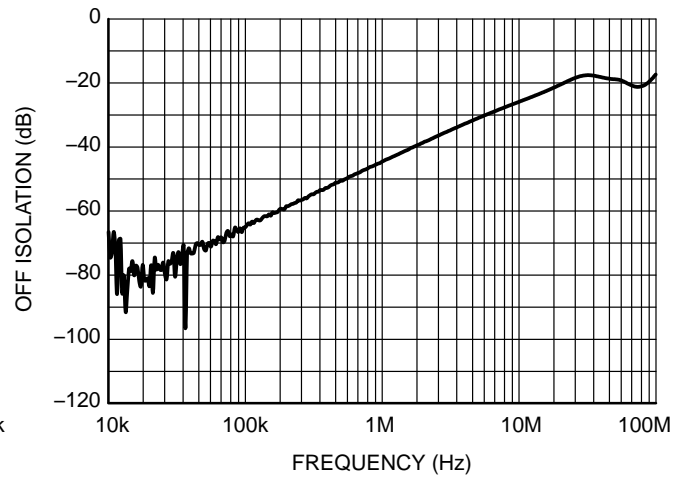


Figure 10. Off Isolation  
( $V_{CC} = 3.0 \text{ V}$ )

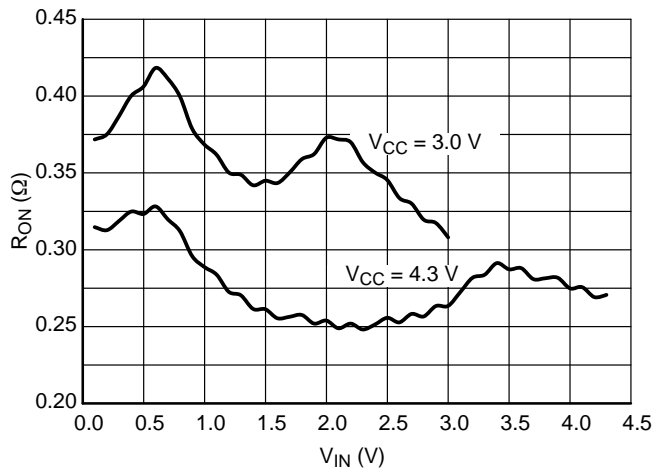


Figure 11. On-Resistance vs. Input Voltage  
@  $25^\circ\text{C}$  and  $V_{CC} = 3.0 \text{ V}$  and  $4.3 \text{ V}$

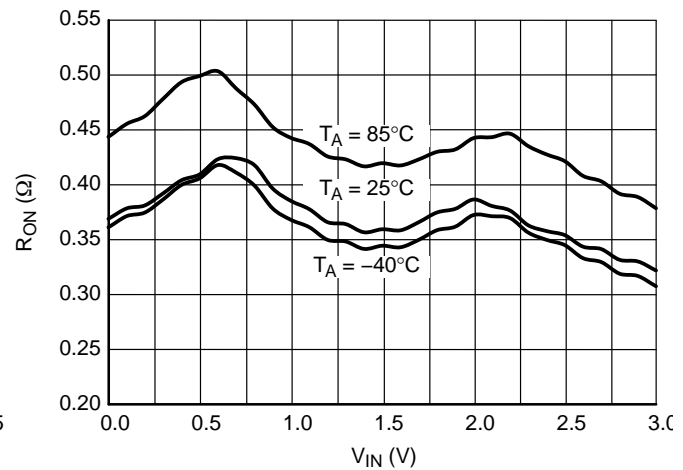
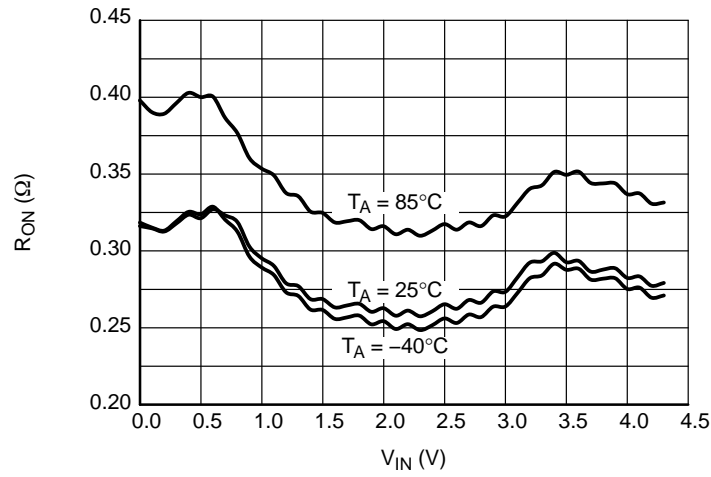


Figure 12. On-Resistance vs. Input Voltage  
@  $V_{CC} = 3.0 \text{ V}$ ,  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$



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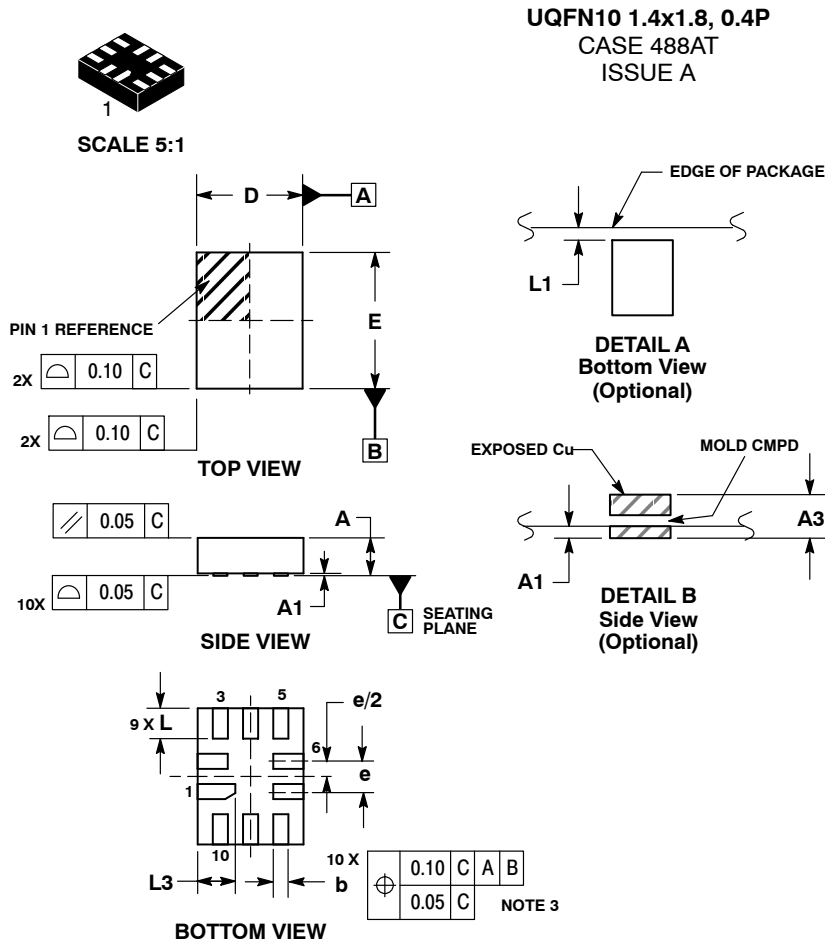


**Figure 13. On-Resistance vs. Input Voltage**  
@  $V_{CC} = 3.0\text{ V}$ ,  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$

### ORDERING INFORMATION

Device	Marking	Package	Shipping <sup>†</sup>
NLAS5223CMUTAG	AK	UQFN10 (Pb-Free)	3000 / Tape & Reel
NLAS5223CLMUTAG	AU	UQFN10 (Pb-Free)	3000 / Tape & Reel

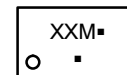
<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.



- 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

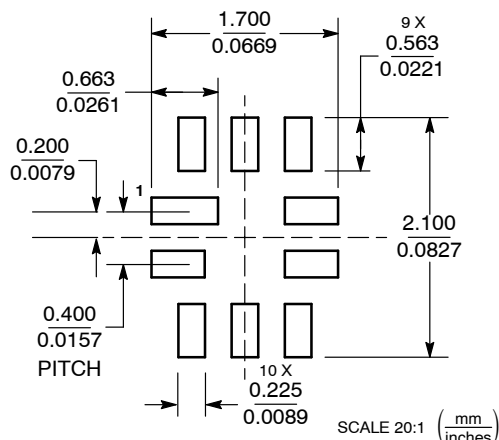
### GENERIC MARKING DIAGRAM\*



- 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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