

# NLAS5223, NLAS5223L

## Ultra-Low 0.5 $\Omega$ Dual SPDT Analog Switch

The NLAS5223 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 0.5  $\Omega$ , at  $V_{CC} = 3.0 \pm 0.3$  V.

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

### Features

- Ultra-Low  $R_{ON}$ , < 0.5  $\Omega$  at  $V_{CC} = 3.0 \pm 0.3$  V
- NLAS5223 Interfaces with 2.8 V Chipset
- NLAS5223L Interfaces with 1.8 V Chipset
- Single Supply Operation from 1.65–3.6 V
- Smallest 1.4 x 1.8 x 0.75 mm Thin QFN Package
- 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  
± 300 mA Through Each Switch
- Large Current Clamping Diodes at Analog Inputs  
± 300 mA Continuous Current Capability
- ESD Human Body Model > 2000 V
- These are Pb-Free Devices

### Applications

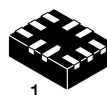
- Cell Phone Audio Block
- Speaker and Earphone Switching
- Ring-Tone Chip / Amplifier Switching
- Modems



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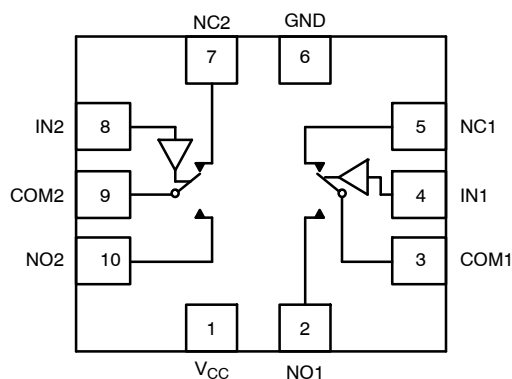
### MARKING DIAGRAM



WQFN-10  
CASE 488AQ



XX = Specific Device Code  
AU = NLAS5223  
AV = NLAS5223L  
M = Date Code  
▪ = 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 10 of this data sheet.

# NLAS5223, NLAS5223L

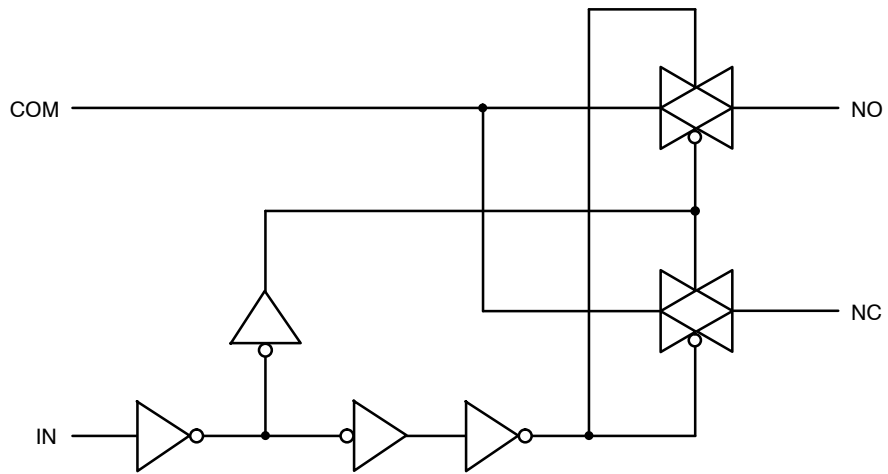


Figure 1. Logic Equivalent Circuit

## 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

# NLAS5223, NLAS5223L

## MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
$V_{CC}$	Positive DC Supply Voltage	-0.5 to +4.6	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	$-0.5 \leq V_{IN} \leq +4.6$	V
$I_{anI1}$	Continuous DC Current from COM to NC/NO	$\pm 300$	mA
$I_{anI-pk1}$	Peak Current from COM to NC/NO, 10 Duty Cycle (Note 1)	$\pm 500$	mA
$I_{clmp}$	Continuous DC Current into COM/NO/NC with Respect to $V_{CC}$ or GND	$\pm 100$	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	3.6	V
$V_{IN}$	Digital Select Input Voltage (OVT) Overvoltage Tolerance	GND	3.6	V
$V_{IS}$	Analog Input Voltage (NC, NO, COM)	GND	$V_{CC}$	V
$T_A$	Operating Temperature Range	-40	+85	°C
$t_r, t_f$	Input Rise or Fall Time, SELECT		20 10	ns/V
			$V_{CC} = 1.6\text{ V} - 2.7\text{ V}$ $V_{CC} = 3.0\text{ V} - 3.6\text{ V}$	

# NLAS5223, NLAS5223L

## NLAS5223 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	1.4	1.4	V
			3.6	1.7	1.7	
V <sub>IL</sub>	Maximum Low-Level Input Voltage, Select Inputs		3.0	0.7	0.7	V
			3.6	0.8	0.8	
I <sub>IN</sub>	Maximum Input Leakage Current, Select Inputs	V <sub>IN</sub> = 3.6 V or GND	3.6	±0.1	±1.0	µA
I <sub>OFF</sub>	Power Off Leakage Current	V <sub>IN</sub> = 3.6 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 3.6	±1.0	±2.0	µA

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

## NLAS5223 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		0.3		0.4	Ω
			3.6		0.3		0.4	
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		0.15		0.15	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> = 1.8 V; I <sub>COM</sub> = 100 mA	3.0		0.05		0.05	Ω
			3.6		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> = 3.3 V	3.6	-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 3.3 V with V <sub>NC</sub> floating or V <sub>NC</sub> 0.3 V or 3.3 V with V <sub>NO</sub> floating V <sub>COM</sub> = 0.3 V or 3.3 V	3.6	-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.

# NLAS5223, NLAS5223L

## NLAS5223L 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	1.1	1.1	V
			3.6	1.3	1.3	
V <sub>IL</sub>	Maximum Low-Level Input Voltage, Select Inputs		3.0	0.5	0.5	V
			3.6	0.5	0.5	
I <sub>IN</sub>	Maximum Input Leakage Current, Select Inputs	V <sub>IN</sub> = 3.6 V or GND	3.6	±0.1	±1.0	μA
I <sub>OFF</sub>	Power Off Leakage Current	V <sub>IN</sub> = 3.6 V or GND	0	±0.5	±2.0	μA
I <sub>CC</sub>	Maximum Quiescent Supply Current (Note 6)	Select and V <sub>IS</sub> = V <sub>CC</sub> or GND	1.65 to 3.6	±1.0	±2.0	μA

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

## NLAS5223L 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		0.3		0.4	Ω
			3.6		0.3		0.4	
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		0.15		0.15	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> = 1.8 V; I <sub>COM</sub> = 100 mA	3.0		0.05		0.05	Ω
			3.6		0.05		0.05	
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> = 3.3 V	3.6	-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 3.3 V with V <sub>NC</sub> floating or V <sub>NC</sub> 0.3 V or 3.3 V with V <sub>NO</sub> floating V <sub>COM</sub> = 0.3 V or 3.3 V	3.6	-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.

# NLAS5223, NLAS5223L

## 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 – 3.6	1.5			50		60	ns
$t_{OFF}$	Turn-Off Time	$R_L = 50 \Omega$ , $C_L = 35$ pF (Figures 3 and 4)	2.3 – 3.6	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	75	
$C_{COM}$	COM Port Capacitance When Switch is Enabled	240	

\*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 – 3.6	17	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 – 3.6	-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 – 3.6	-65	dB
Q	Charge Injection Select Input to Common I/O	$V_{IN} = V_{CC}$ to GND, $R_{IS} = 0$ W, $C_L = 1.0$ nF $Q = C_L \times DV_{OUT}$ (Figure 6)	1.65 – 3.6	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	0.12	%
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 – 3.6	-70	dB

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

# NLAS5223, NLAS5223L

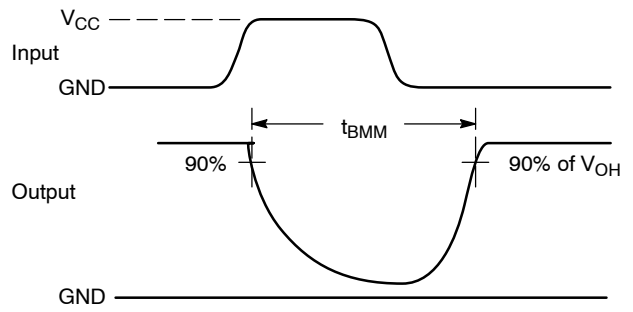
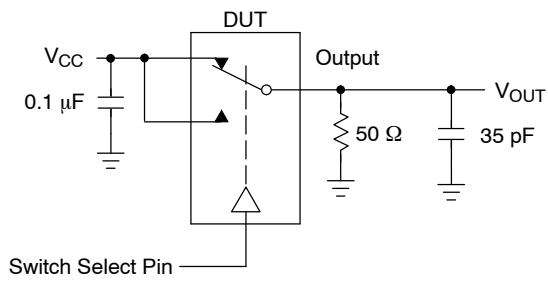


Figure 2.  $t_{BMM}$  (Time Break-Before-Make)

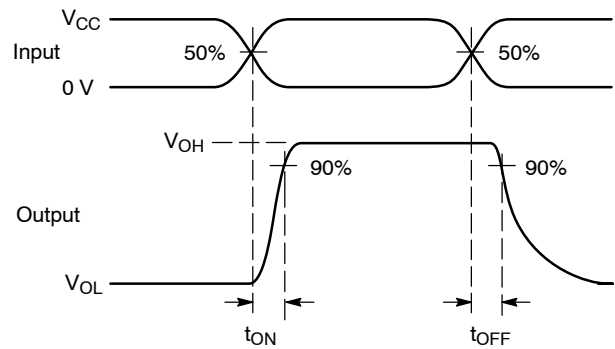
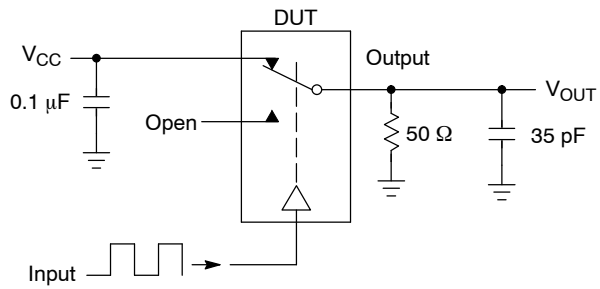


Figure 3.  $t_{ON}/t_{OFF}$

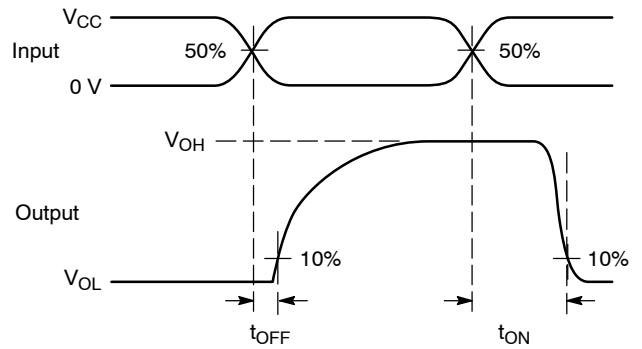
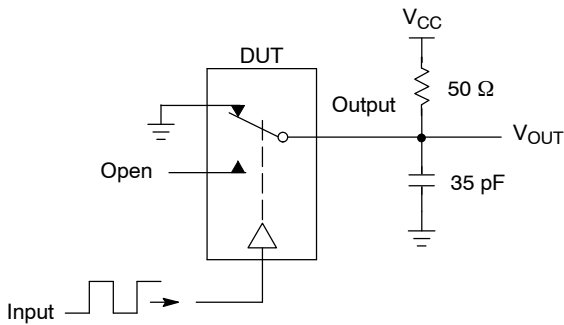
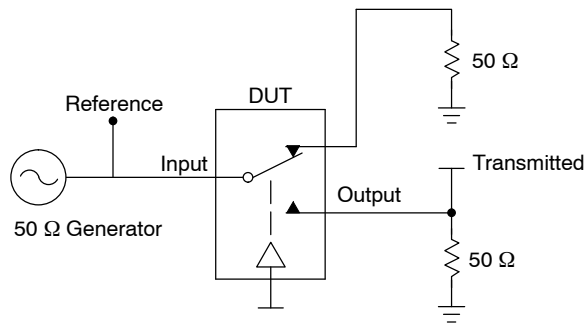


Figure 4.  $t_{ON}/t_{OFF}$

## NLAS5223, NLAS5223L



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.

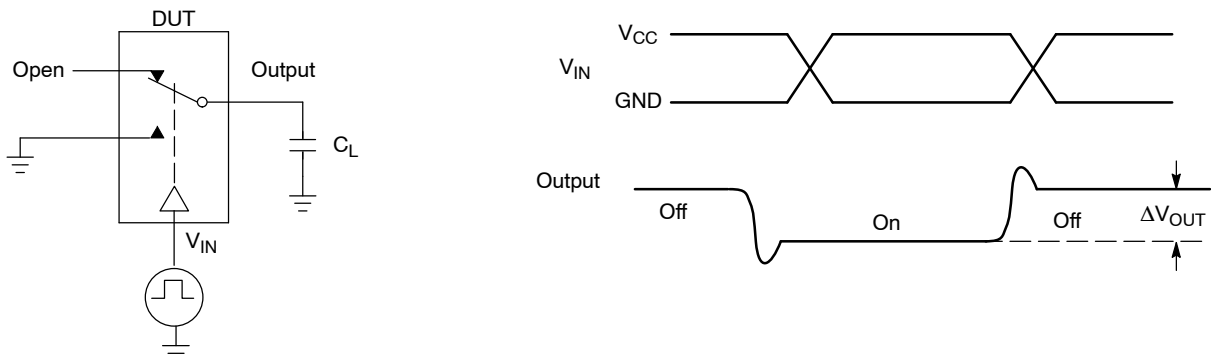
$$V_{ISO} = \text{Off Channel Isolation} = 20 \text{ Log} \left( \frac{V_{OUT}}{V_{IN}} \right) \text{ for } V_{IN} \text{ at } 100 \text{ kHz}$$

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

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  $\Omega$

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



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



NLAS5223, NLAS5223L

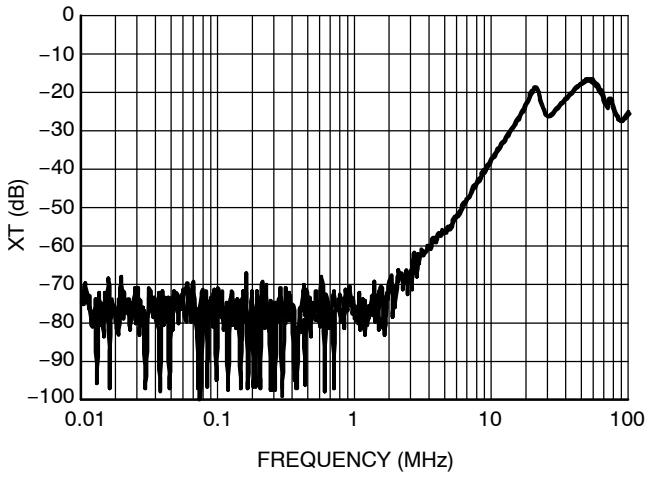


Figure 7. Cross Talk vs. Frequency  
@  $V_{CC} = 3.6\text{ V}$

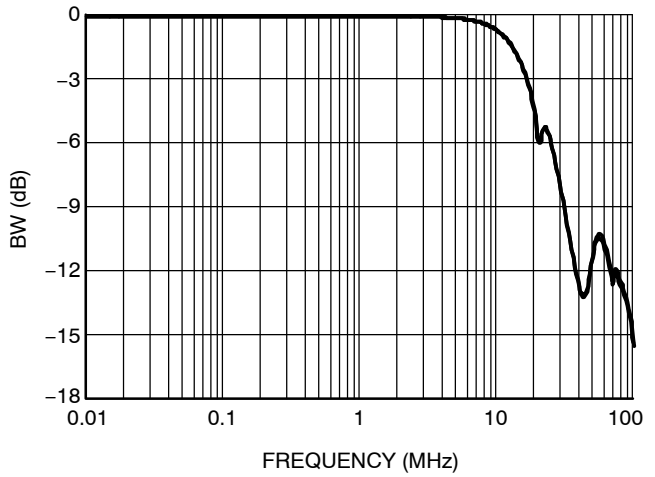


Figure 8. Bandwidth vs. Frequency

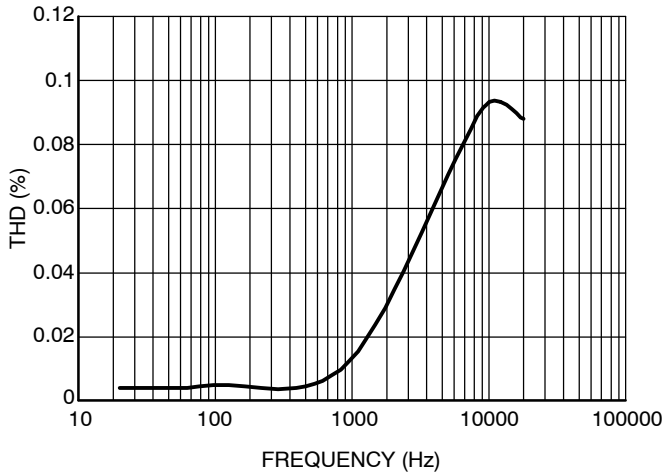


Figure 9. Total Harmonic Distortion

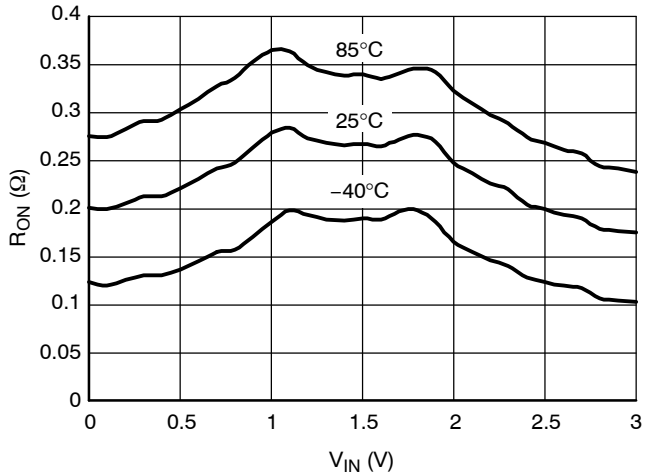


Figure 10. On-Resistance vs. Input Voltage  
@  $V_{CC} = 3.0\text{ V}$

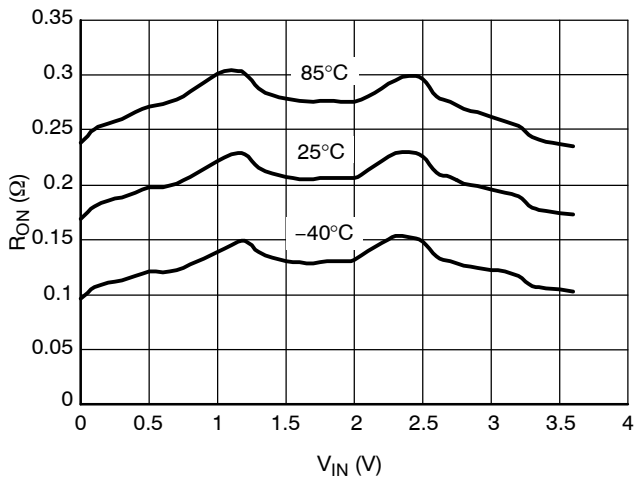


Figure 11. On-Resistance vs. Input Voltage  
@  $V_{CC} = 3.6\text{ V}$

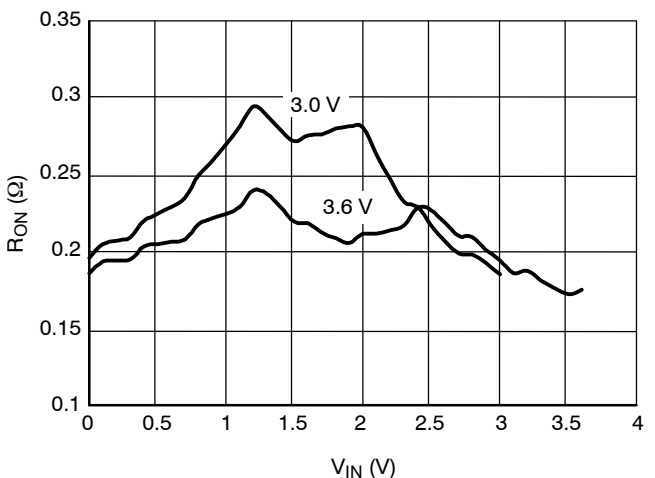


Figure 12. On-Resistance vs. Input Voltage

## NLAS5223, NLAS5223L

### ORDERING INFORMATION

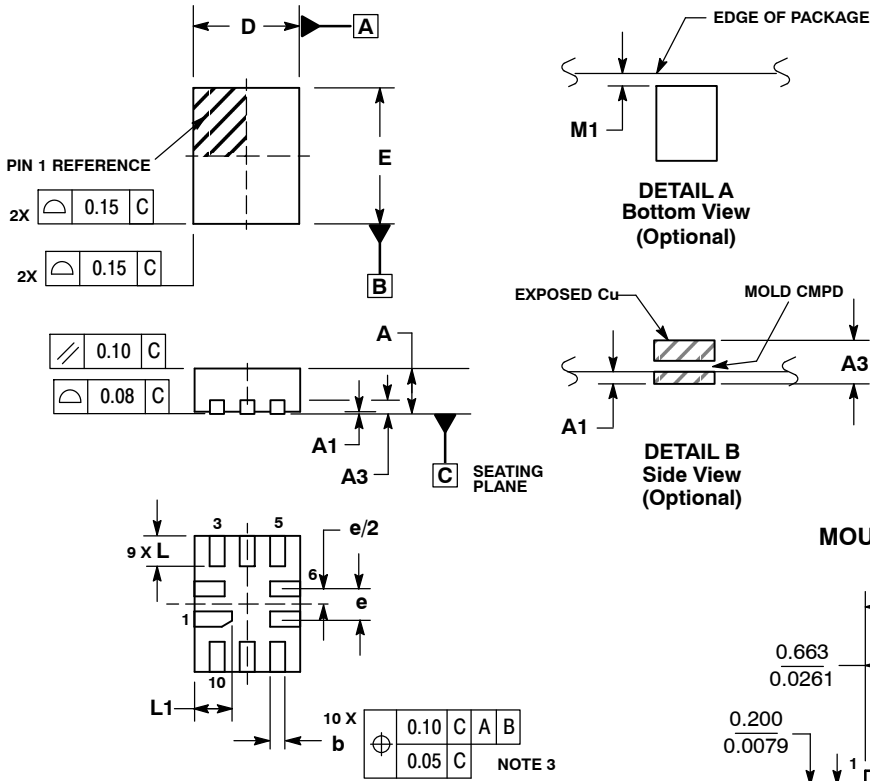
Device	Package	Shipping†
NLAS5223MNR2G	WQFN-10 (Pb-Free)	3000 / Tape & Reel
NLAS5223LMNR2G	WQFN-10 (Pb-Free)	3000 / Tape & Reel

†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.

# NLAS5223, NLAS5223L

## PACKAGE DIMENSIONS

### WQFN10, 1.4x1.8, 0.4P CASE 488AQ-01 ISSUE C

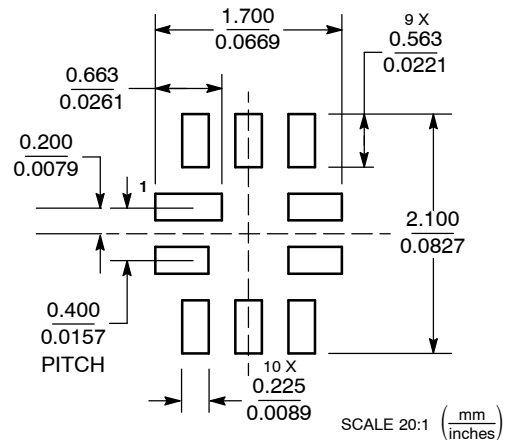


#### NOTES:

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.
5. EXPOSED PADS CONNECTED TO DIE FLAG. USED AS TEST CONTACTS.

DIM	MILLIMETERS	
	MIN	MAX
A	0.70	0.80
A1	0.00	0.050
A3	0.20 REF	
b	0.15	0.25
D	1.40 BSC	
E	1.80 BSC	
e	0.40 BSC	
L	0.30	0.50
L1	0.40	0.60
M1	0.00	0.05

#### MOUNTING 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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- Поставка специализированных компонентов (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Aeroflex, Peregrine, Syfer, Eurofarad, Texas Instrument, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

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- Подбор оптимального решения, техническое обоснование при выборе компонента;
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



#### Как с нами связаться

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