

# 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

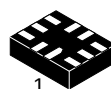
- Cell Phone Audio Block
- Speaker and Earphone Switching
- Ring-Tone Chip/Amplifier Switching
- Modems



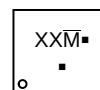
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### MARKING DIAGRAM

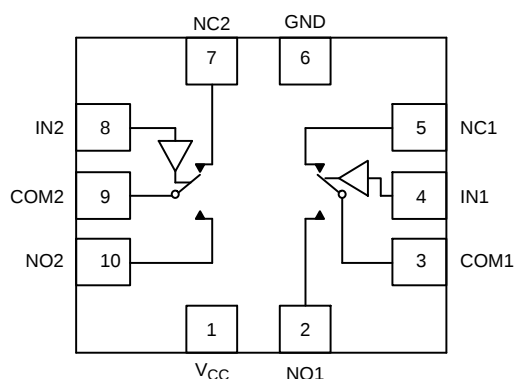


**UQFN10  
CASE 488AT**



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.

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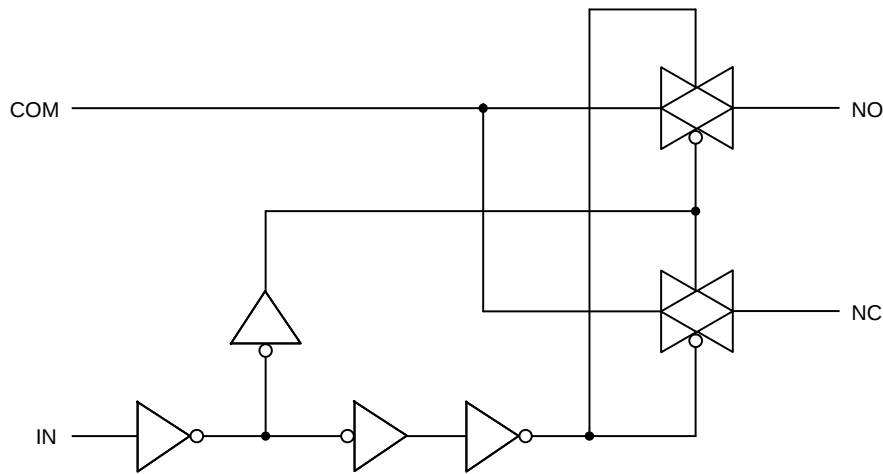


Figure 1. Logic Equivalent Circuit

## 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<br>V <sub>CC</sub> = 1.6 V – 2.7 V<br>V <sub>CC</sub> = 3.0 V – 4.5 V |      | 20<br>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<br>4.3      | 1.4<br>2.0       | 1.4<br>2.0     | V    |
| V <sub>IL</sub>  | Maximum Low-Level Input Voltage, Select Inputs  |                                                     | 3.0<br>4.3      | 0.7<br>0.8       | 0.7<br>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<br>(Note 3)                         | V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IN</sub> = V <sub>IH</sub><br>V <sub>IS</sub> = GND to V <sub>CC</sub><br>I <sub>COM</sub> = 100 mA                                                                                    | 3.0<br>4.3      |                          | 0.4<br>0.35  |                | 0.5<br>0.4   | Ω    |
| R <sub>FLAT</sub>                            | NC/NO On-Resistance Flatness<br>(Notes 3 and 4)         | I <sub>COM</sub> = 100 mA<br>V <sub>IS</sub> = 0 to V <sub>CC</sub>                                                                                                                                                                | 3.0<br>4.3      |                          | 0.16<br>0.11 |                | 0.20<br>0.14 | Ω    |
| ΔR <sub>ON</sub>                             | On-Resistance Match Between Channels<br>(Notes 3 and 5) | V <sub>IS</sub> = 1.5 V;<br>I <sub>COM</sub> = 100 mA<br>V <sub>IS</sub> = 2.2 V;<br>I <sub>COM</sub> = 100 mA                                                                                                                     | 3.0<br>4.3      |                          | 0.05<br>0.05 |                | 0.05<br>0.05 | Ω    |
| I <sub>NC(OFF)</sub><br>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><br>V <sub>NO</sub> or V <sub>NC</sub> = 0.3 V<br>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<br>(Note 3)                      | V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br>V <sub>NO</sub> 0.3 V or 4.0 V with<br>V <sub>NC</sub> floating or<br>V <sub>NC</sub> 0.3 V or 4.0 V with<br>V <sub>NO</sub> floating<br>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.

# NLAS5223C, NLAS5223CL

## 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<br>4.3      | 1.3<br>1.6       | 1.3<br>1.6     | V    |
| V <sub>IL</sub>  | Maximum Low-Level Input Voltage, Select Inputs                 |                                                                      | 3.0<br>4.3      | 0.5<br>0.6       | 0.5<br>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<br>V <sub>IN</sub> = 1.65 V | 4.3             | ±145             | ±150           | µA   |
|                  |                                                                | V <sub>IS</sub> = V <sub>CC</sub> or GND<br>V <sub>IN</sub> = 1.80 V |                 | ±125             | ±130           |      |
|                  |                                                                | V <sub>IS</sub> = V <sub>CC</sub> or GND<br>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<br>(Note 7)                         | V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IN</sub> = V <sub>IH</sub><br>V <sub>IS</sub> = GND to V <sub>CC</sub><br>I <sub>COM</sub> = 100 mA                                                                                    | 3.0<br>4.3      |                          | 0.4<br>0.35  |                | 0.5<br>0.4   | Ω    |
| R <sub>FLAT</sub>                            | NC/NO On-Resistance Flatness<br>(Notes 7 and 8)         | I <sub>COM</sub> = 100 mA<br>V <sub>IS</sub> = 0 to V <sub>CC</sub>                                                                                                                                                                | 3.0<br>4.3      |                          | 0.16<br>0.11 |                | 0.20<br>0.14 | Ω    |
| ΔR <sub>ON</sub>                             | On-Resistance Match Between Channels<br>(Notes 7 and 9) | V <sub>IS</sub> = 1.5 V;<br>I <sub>COM</sub> = 100 mA<br>V <sub>IS</sub> = 2.2 V;<br>I <sub>COM</sub> = 100 mA                                                                                                                     | 3.0<br>4.3      |                          | 0.05<br>0.05 |                | 0.05<br>0.05 | Ω    |
| I <sub>NC(OFF)</sub><br>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><br>V <sub>NO</sub> or V <sub>NC</sub> = 0.3 V<br>V <sub>COM</sub> = 4.0 V                                                                                                     | 4.3             | –10                      | 10           | –100           | 100          | nA   |
| I <sub>COM(ON)</sub>                         | COM ON Leakage Current<br>(Note 7)                      | V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br>V <sub>NO</sub> 0.3 V or 4.0 V with<br>V <sub>NC</sub> floating or<br>V <sub>NC</sub> 0.3 V or 4.0 V with<br>V <sub>NO</sub> floating<br>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><br>(V) | V <sub>IS</sub><br>(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<br>(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<br>(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<br>R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 35 pF<br>(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                                                                                                                       | $V_{CC}$<br>(V) | 25°C    | Unit |
|-----------|------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|-----------------|---------|------|
|           |                                                                  |                                                                                                                                 |                 | Typical |      |
| BW        | Maximum On-Channel -3 dB Bandwidth or Minimum Frequency Response | $V_{IN}$ centered between $V_{CC}$ and GND<br>(Figure 5)                                                                        | 1.65 – 4.5      | 24      | MHz  |
| $V_{ONL}$ | Maximum Feed-through On Loss                                     | $V_{IN} = 0$ dBm @ 100 kHz to 50 MHz<br>$V_{IN}$ 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<br>$V_{IN}$ 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<br>$Q = C_L \times DV_{OUT}$ (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<br>$V_{IS} = 2.0$ 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, $R_L = 50 \Omega$<br>$V_{IN}$ 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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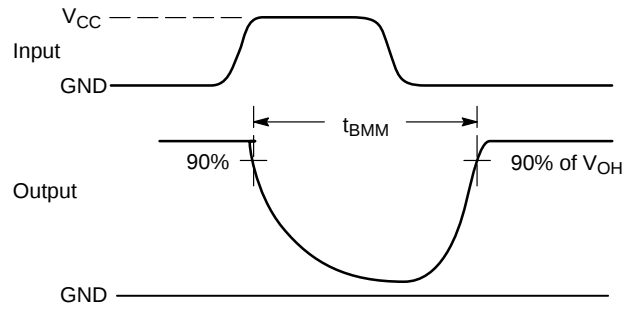
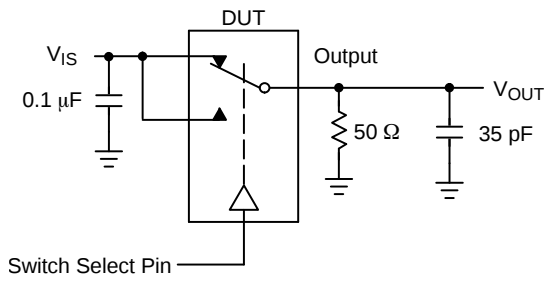


Figure 2.  $t_{BMM}$  (Time Break-Before-Make)

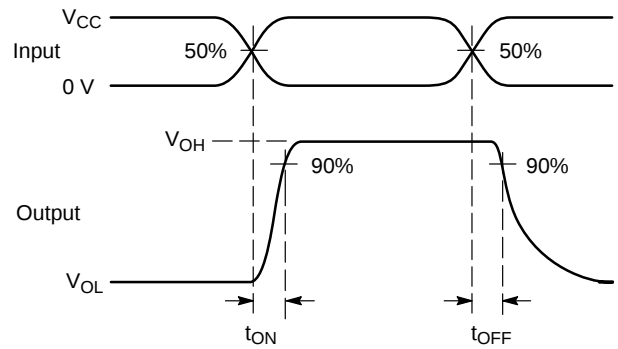
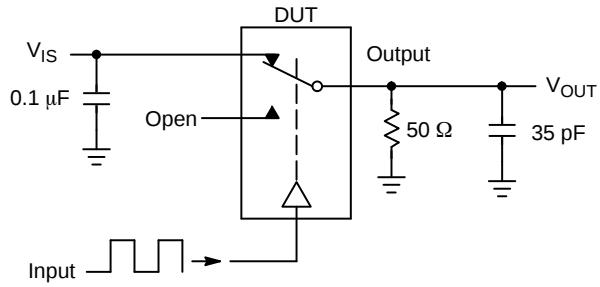


Figure 3.  $t_{ON}/t_{OFF}$

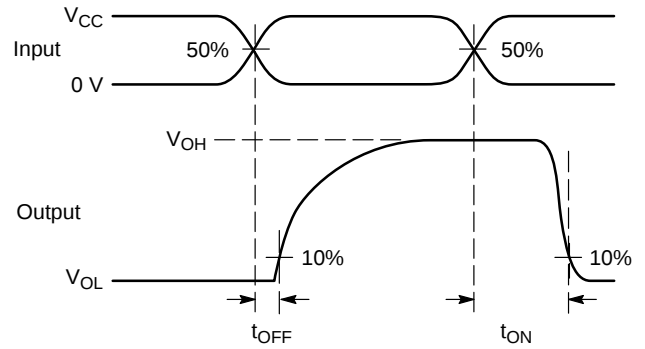
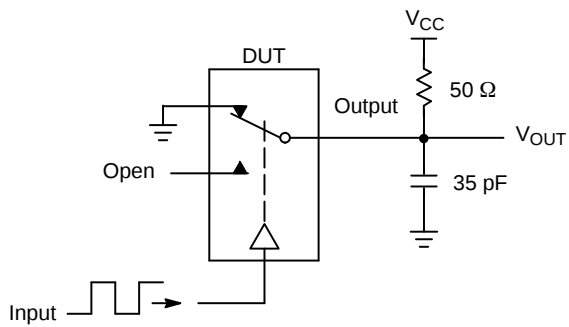
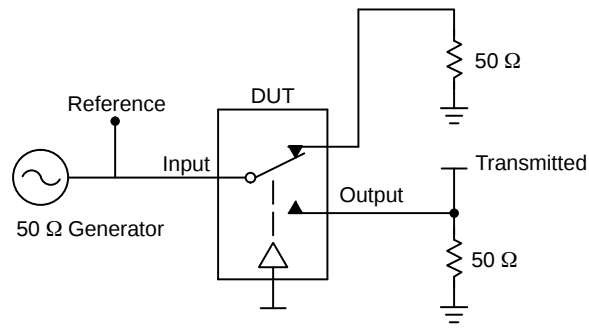


Figure 4.  $t_{ON}/t_{OFF}$

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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.

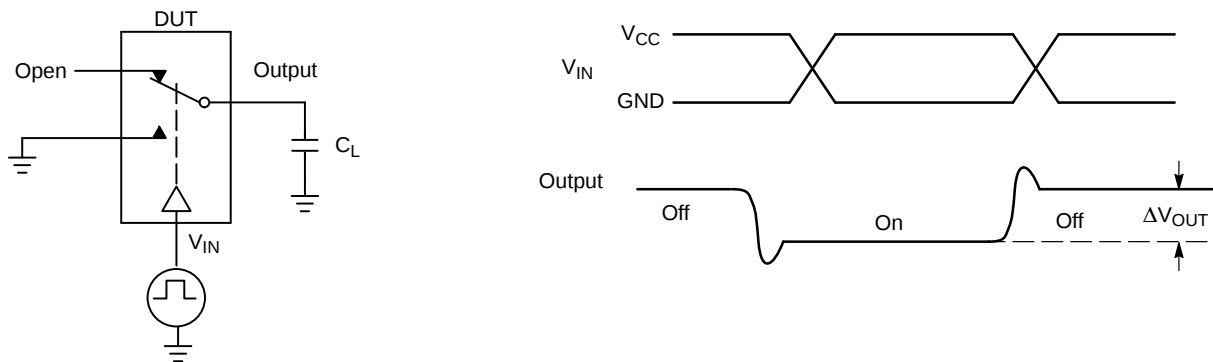
$$V_{ISO} = \text{Off Channel Isolation} = 20 \log \left( \frac{V_{OUT}}{V_{IN}} \right) \text{ for } V_{IN} \text{ at } 100 \text{ kHz}$$

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

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)**

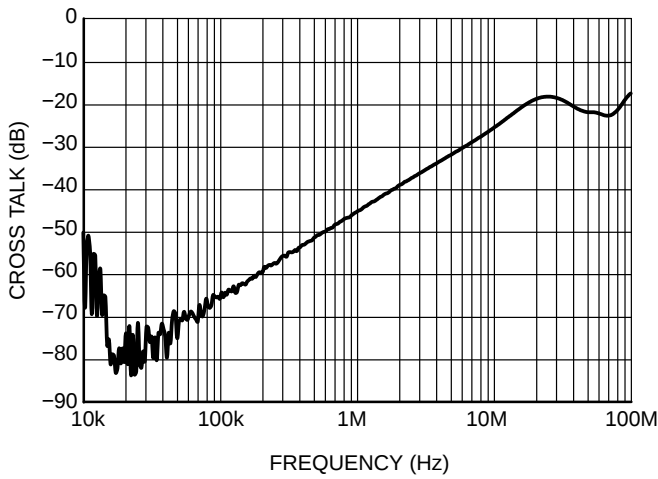


Figure 7. Cross Talk vs. Frequency  
( $V_{CC} = 3.0 \text{ V}$ )

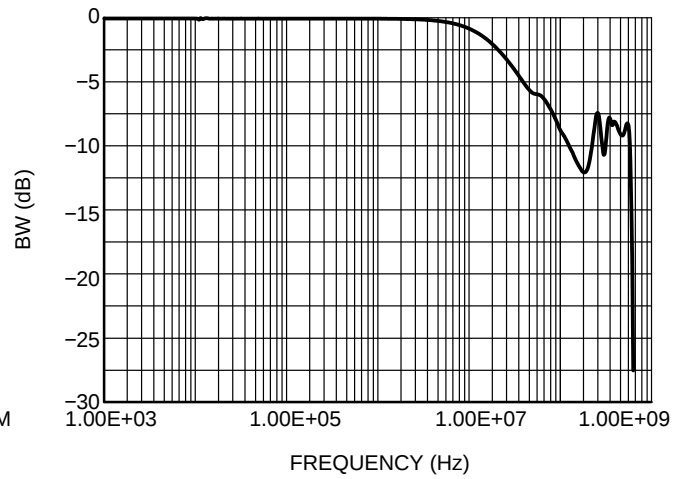


Figure 8. Bandwidth  
( $V_{CC} = 3.0 \text{ V}$ )

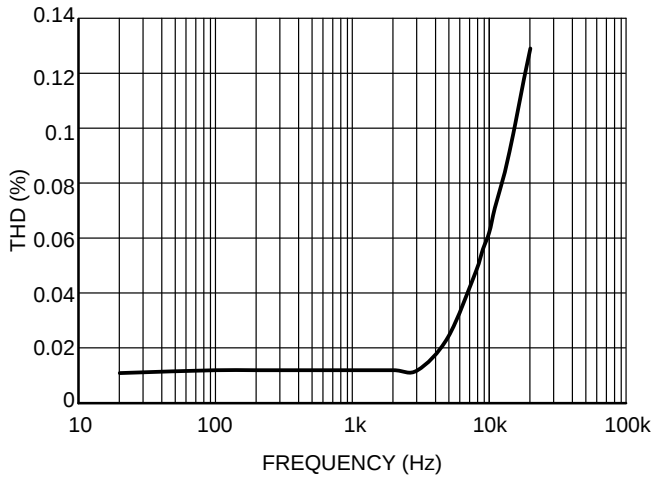


Figure 9. Total Harmonic Distortion  
( $V_{CC} = 3.0 \text{ V}$ )

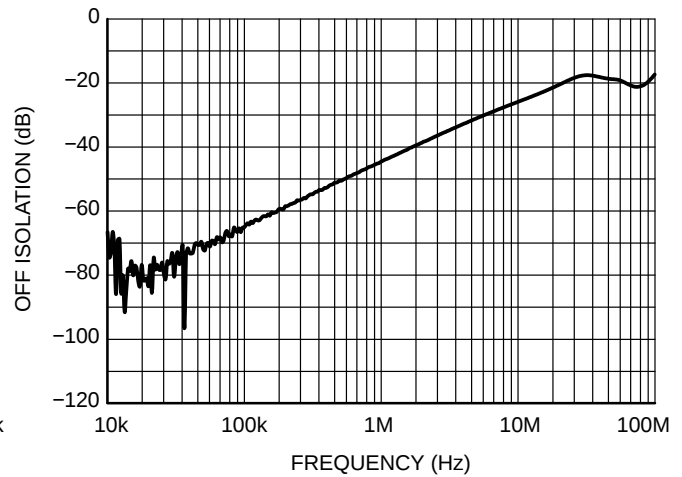


Figure 10. Off Isolation  
( $V_{CC} = 3.0 \text{ V}$ )

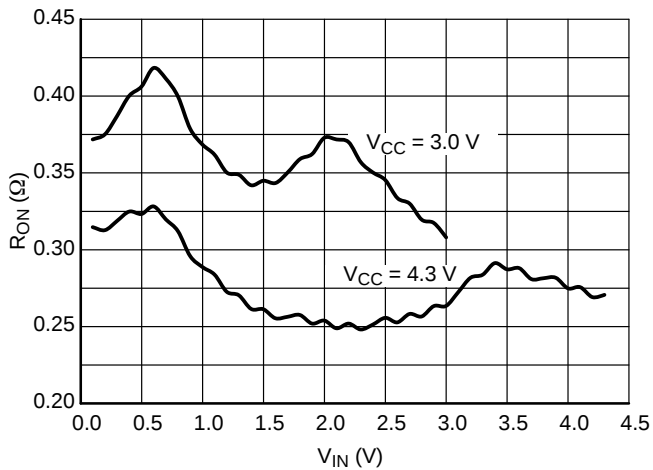


Figure 11. On-Resistance vs. Input Voltage  
@  $25^\circ\text{C}$  and  $V_{CC} = 3.0 \text{ V}$  and  $4.3 \text{ V}$

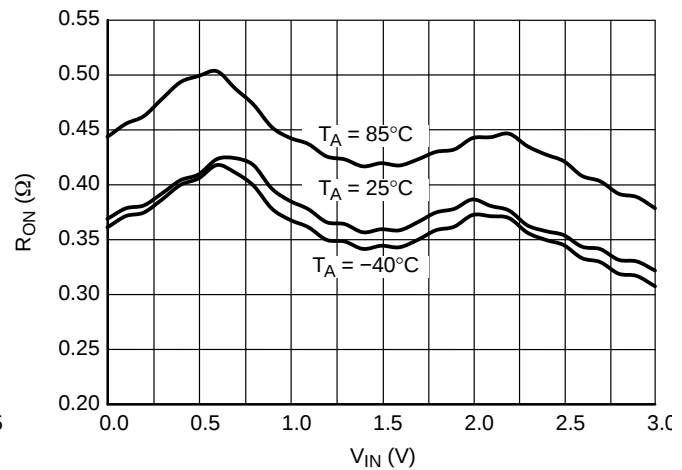
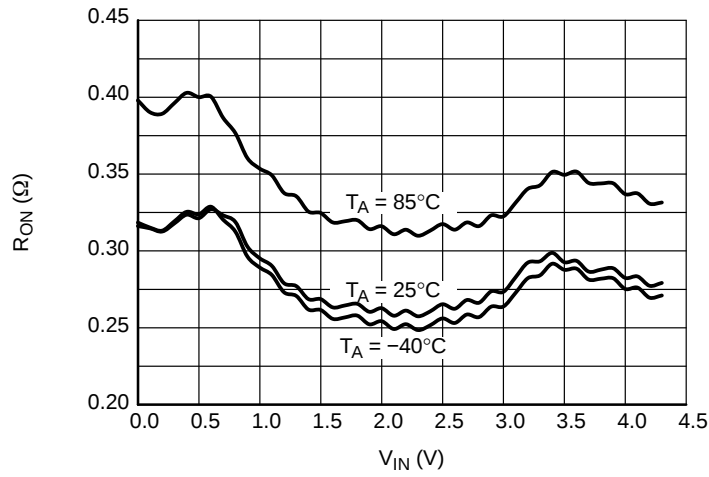


Figure 12. On-Resistance vs. Input Voltage  
@  $V_{CC} = 3.0 \text{ V}$ ,  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$

## NLAS5223C, NLAS5223CL

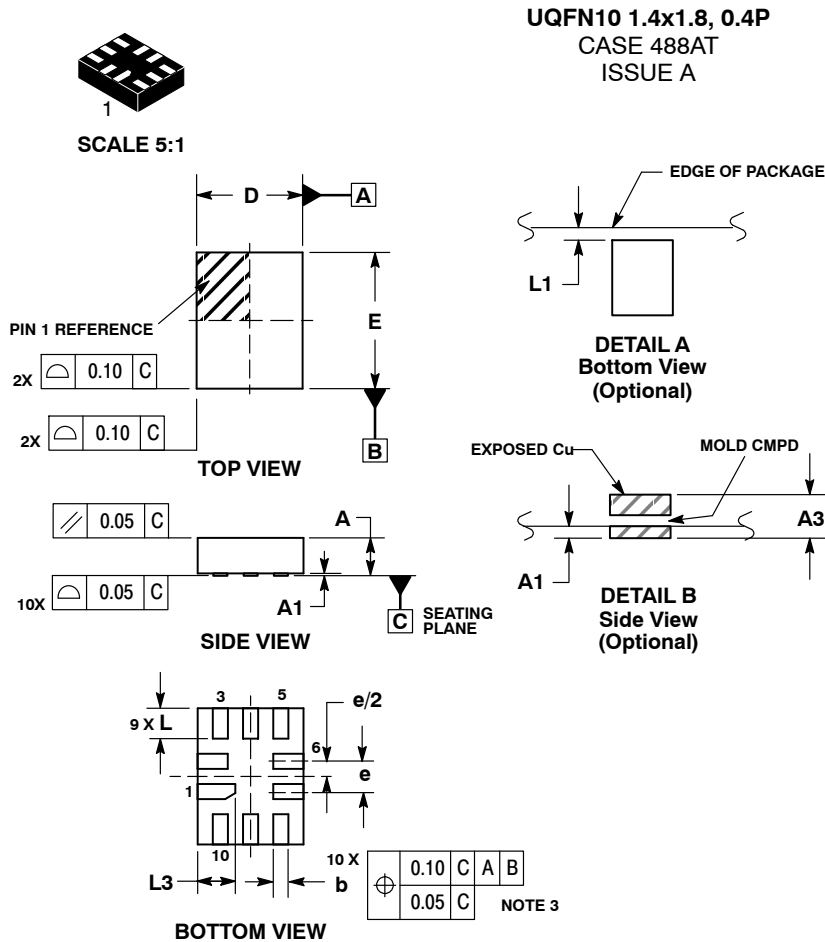


**Figure 13. On-Resistance vs. Input Voltage**  
@  $V_{CC} = 3.0\text{ V}$ ,  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$

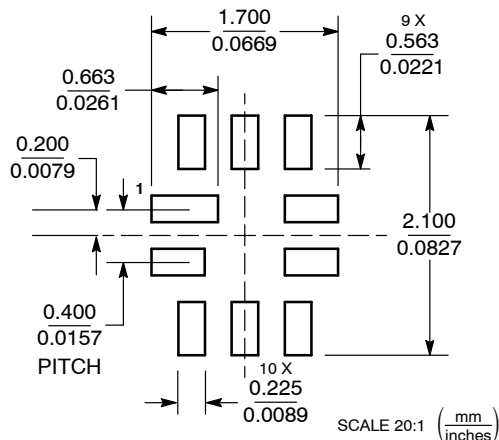
### ORDERING INFORMATION

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



### MOUNTING FOOTPRINT



|                         |                                     |                                                                                                                                                                                  |
|-------------------------|-------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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| <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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