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# NLAS9431

## Low Voltage Single Supply Dual DPDT Analog Switch

The NLAS9431 is an advanced dual-independent CMOS double pole-double throw (DPDT) analog switch fabricated with silicon gate CMOS technology. It achieves high speed propagation delays and low ON resistances while maintaining CMOS low power dissipation. This DPDT controls analog and digital voltages that may vary across the full power-supply range (from  $V_{CC}$  to GND).

The device has been designed so the ON resistance ( $R_{ON}$ ) is much lower and more linear over input voltage than  $R_{ON}$  of typical CMOS analog switches.

The channel select input is compatible with standard CMOS outputs.

The channel select input structure provides protection when voltages between 0 V and 5.5 V are applied, regardless of the supply voltage. This input structure helps prevent device destruction caused by supply voltage – input/output voltage mismatch, battery backup, hot insertion, etc.

The NLAS9431 can also be used as a quad 2-to-1 multiplexer-demultiplexer analog switch with two Select pins that each controls two multiplexer-demultiplexers.

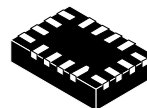
- Direct Battery Connection
- Channel Select Input Over-Voltage Tolerant to 5.5 V
- Fast Switching and Propagation Speeds
- Break-Before-Make Circuitry
- Low Power Dissipation:  $I_{CC} = 2 \mu A$  (Max) at  $T_A = 25^\circ C$
- Diode Protection Provided on Channel Select Input
- Improved Linearity and Lower ON Resistance over Input Voltage
- Latch-up Performance Exceeds 300 mA
- Chip Complexity: 158 FETs
- 16-Lead WQFN Package, 1.8 mm x 2.6 mm
- This is a Pb-Free Device



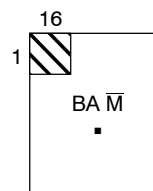
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### MARKING DIAGRAMS



**WQFN16  
CASE 488AP**



|    |                                 |
|----|---------------------------------|
| BA | = Specific Device Code          |
| M  | = Date Code & Assembly Location |
| ■  | = Pb-Free Device                |

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 10 of this data sheet.

FUNCTION TABLE

| Select AB or CD | On Channel |
|-----------------|------------|
| L               | NC to COM  |
| H               | NO to COM  |

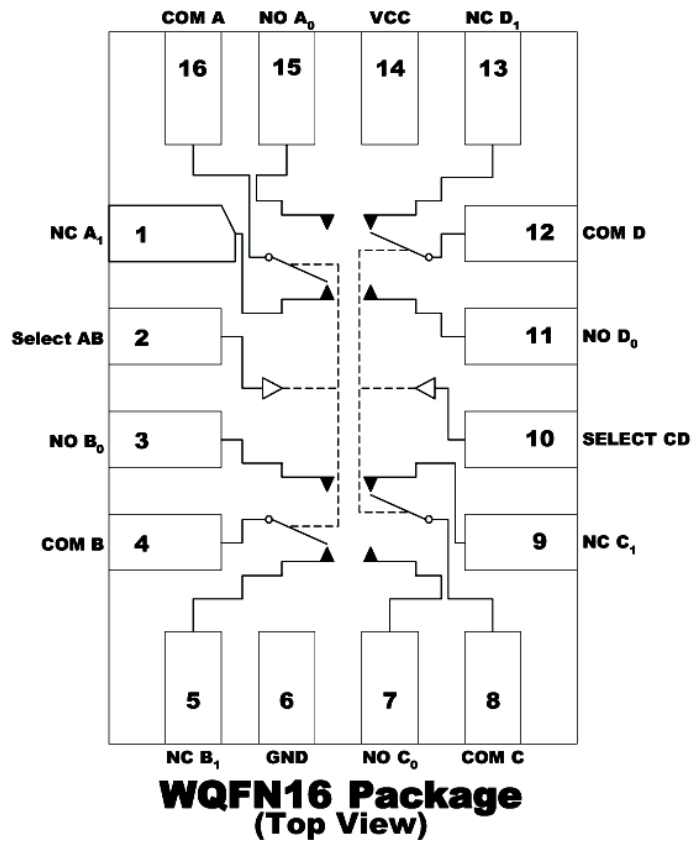


Figure 1. Logic Diagram

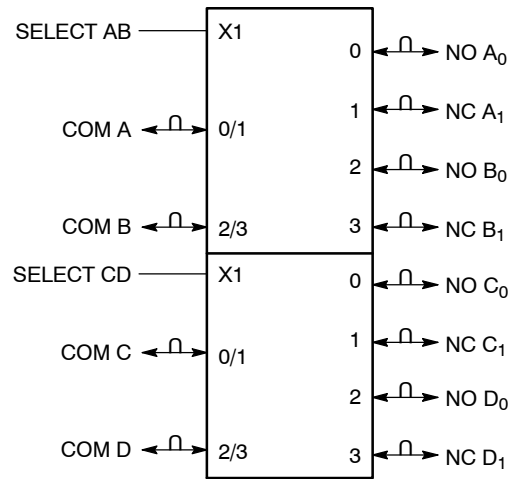


Figure 2. IEC Logic Symbol

## 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> or V <sub>COM</sub> ) | − 0.5 ≤ V <sub>IS</sub> ≤ V <sub>CC</sub> + 0.5       |             |
| V <sub>IN</sub>       | Digital Select Input Voltage                                | − 0.5 ≤ V <sub>I</sub> ≤ +7.0                         | V           |
| I <sub>IK</sub>       | DC Current, Into or Out of Any Pin                          | ± 50                                                  | mA          |
| P <sub>D</sub>        | Power Dissipation in Still Air                              | 800                                                   | mW          |
| T <sub>STG</sub>      | Storage Temperature Range                                   | − 65 to + 150                                         | °C          |
| T <sub>L</sub>        | Lead Temperature, 1 mm from Case for 10 Seconds             | 260                                                   | °C          |
| T <sub>J</sub>        | Junction Temperature Under Bias                             | +150                                                  | °C          |
| MSL                   | Moisture Sensitivity                                        | Level 1                                               |             |
| F <sub>R</sub>        | Flammability Rating                                         | Oxygen Index: 30% – 35%<br>UL 94–V0 (0.125 in)        |             |
| I <sub>Latch-Up</sub> | Latch-Up Performance                                        | Above V <sub>CC</sub> and Below GND at 125°C (Note 1) | ± 300<br>mA |
| θ <sub>JA</sub>       | Thermal Resistance                                          | 80                                                    | °C/W        |

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. Tested to EIA/JESD78.

## RECOMMENDED OPERATING CONDITIONS

| Symbol                          | Parameter                          | Min                                                                | Max             | Unit                   |
|---------------------------------|------------------------------------|--------------------------------------------------------------------|-----------------|------------------------|
| V <sub>CC</sub>                 | DC Supply Voltage                  | 2.0                                                                | 5.5             | V                      |
| V <sub>IN</sub>                 | Digital Select Input Voltage       | GND                                                                | 5.5             | V                      |
| V <sub>IS</sub>                 | Analog Input Voltage (NC, NO, COM) | GND                                                                | V <sub>CC</sub> | V                      |
| T <sub>A</sub>                  | Operating Temperature Range        | − 55                                                               | + 125           | °C                     |
| t <sub>r</sub> , t <sub>f</sub> | Input Rise or Fall Time, SELECT    | V <sub>CC</sub> = 3.3 V ± 0.3 V<br>V <sub>CC</sub> = 5.0 V ± 0.5 V |                 | 0<br>100<br>20<br>ns/V |

## DEVICE JUNCTION TEMPERATURE VERSUS TIME TO 0.1% BOND FAILURES

| Junction Temperature °C | Time, Hours | Time, Years |
|-------------------------|-------------|-------------|
| 80                      | 1,032,200   | 117.8       |
| 90                      | 419,300     | 47.9        |
| 100                     | 178,700     | 20.4        |
| 110                     | 79,600      | 9.4         |
| 120                     | 37,000      | 4.2         |
| 130                     | 17,800      | 2.0         |
| 140                     | 8,900       | 1.0         |

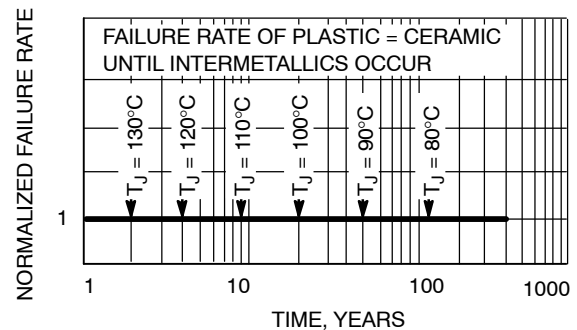


Figure 3. Failure Rate vs. Time Junction Temperature

**DC CHARACTERISTICS – Digital Section** (Voltages Referenced to GND)

| Symbol           | Parameter                                       | Condition                                           | V <sub>CC</sub> | Guaranteed Limit |       |        | Unit |
|------------------|-------------------------------------------------|-----------------------------------------------------|-----------------|------------------|-------|--------|------|
|                  |                                                 |                                                     |                 | –55°C to 25°C    | <85°C | <125°C |      |
| V <sub>IH</sub>  | Minimum High-Level Input Voltage, Select Inputs |                                                     | 2.0             | 1.5              | 1.5   | 1.5    | V    |
|                  |                                                 |                                                     | 2.5             | 1.9              | 1.9   | 1.9    |      |
|                  |                                                 |                                                     | 3.0             | 2.1              | 2.1   | 2.1    |      |
|                  |                                                 |                                                     | 4.5             | 3.15             | 3.15  | 3.15   |      |
|                  |                                                 |                                                     | 5.5             | 3.85             | 3.85  | 3.85   |      |
| V <sub>IL</sub>  | Maximum Low-Level Input Voltage, Select Inputs  |                                                     | 2.0             | 0.5              | 0.5   | 0.5    | V    |
|                  |                                                 |                                                     | 2.5             | 0.6              | 0.6   | 0.6    |      |
|                  |                                                 |                                                     | 3.0             | 0.9              | 0.9   | 0.9    |      |
|                  |                                                 |                                                     | 4.5             | 1.35             | 1.35  | 1.35   |      |
|                  |                                                 |                                                     | 5.5             | 1.65             | 1.65  | 1.65   |      |
| I <sub>IN</sub>  | Maximum Input Leakage Current                   | V <sub>IN</sub> = 5.5 V or GND                      | 5.5             | ±0.2             | ±2.0  | ±2.0   | μA   |
| I <sub>OFF</sub> | Power Off Leakage Current, Select Inputs        | V <sub>IN</sub> = 5.5 V or GND                      | 0               | ±10              | ±10   | ±10    | μA   |
| I <sub>CC</sub>  | Maximum Quiescent Supply Current                | Select and V <sub>IS</sub> = V <sub>CC</sub> or GND | 5.5             | 4.0              | 4.0   | 8.0    | μA   |

**DC ELECTRICAL CHARACTERISTICS – Analog Section**

| Symbol                                       | Parameter                                 | Condition                                                                                                                                                                                                                    | V <sub>CC</sub> | Guaranteed Limit |       |        | Unit |
|----------------------------------------------|-------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|------------------|-------|--------|------|
|                                              |                                           |                                                                                                                                                                                                                              |                 | –55°C to 25°C    | <85°C | <125°C |      |
| R <sub>ON</sub>                              | Maximum “ON” Resistance (Figures 17 – 23) | V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br>V <sub>IS</sub> = GND to V <sub>CC</sub><br> I <sub>IN</sub>   ≤ 10.0 mA                                                                                             | 2.5             | 85               | 95    | 105    | Ω    |
|                                              |                                           |                                                                                                                                                                                                                              | 3.0             | 45               | 50    | 55     |      |
|                                              |                                           |                                                                                                                                                                                                                              | 4.5             | 30               | 35    | 40     |      |
|                                              |                                           |                                                                                                                                                                                                                              | 5.5             | 25               | 30    | 35     |      |
| R <sub>FLAT (ON)</sub>                       | ON Resistance Flatness (Figures 17 – 23)  | V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br> I <sub>IN</sub>   ≤ 10.0 mA<br>V <sub>IS</sub> = 1 V, 2 V, 3.5 V                                                                                                    | 4.5             | 4                | 4     | 5      | Ω    |
| I <sub>NC(OFF)</sub><br>I <sub>NO(OFF)</sub> | NO or NC Off Leakage Current (Figure 9)   | V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br>V <sub>NO</sub> or V <sub>NC</sub> = 1.0 V <sub>COM</sub> 4.5 V                                                                                                      | 5.5             | 1                | 10    | 100    | nA   |
| I <sub>COM(ON)</sub>                         | COM ON Leakage Current (Figure 9)         | V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub><br>V <sub>NO</sub> 1.0 V or 4.5 V with V <sub>NC</sub> floating or<br>V <sub>NO</sub> 1.0 V or 4.5 V with V <sub>NO</sub> floating<br>V <sub>COM</sub> = 1.0 V or 4.5 V | 5.5             | 1                | 10    | 100    | nA   |

**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 |
|------------------|--------------------------------------|---------------------------------------------------------------------|------------------------|------------------------|--------------------------|------|-----|--------|-----|---------|-----|------|
|                  |                                      |                                                                     |                        |                        | – 55°C to 25°C           |      |     | < 85°C |     | < 125°C |     |      |
|                  |                                      |                                                                     |                        |                        | Min                      | Typ* | Max | Min    | Max | Min     | Max |      |
| t <sub>ON</sub>  | Turn-On Time<br>(Figures 12 and 13)  | R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF<br>(Figures 5 and 6) | 2.5                    | 2.0                    | 5                        | 23   | 35  | 5      | 38  | 5       | 41  | ns   |
|                  |                                      |                                                                     | 3.0                    | 2.0                    | 5                        | 16   | 24  | 5      | 27  | 5       | 30  |      |
|                  |                                      |                                                                     | 4.5                    | 3.0                    | 2                        | 11   | 16  | 2      | 19  | 2       | 22  |      |
|                  |                                      |                                                                     | 5.5                    | 3.0                    | 2                        | 9    | 14  | 2      | 17  | 2       | 20  |      |
| t <sub>OFF</sub> | Turn-Off Time<br>(Figures 12 and 13) | R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF<br>(Figures 5 and 6) | 2.5                    | 2.0                    | 1                        | 7    | 12  | 1      | 15  | 1       | 18  | ns   |
|                  |                                      |                                                                     | 3.0                    | 2.0                    | 1                        | 5    | 10  | 1      | 13  | 1       | 16  |      |
|                  |                                      |                                                                     | 4.5                    | 3.0                    | 1                        | 4    | 6   | 1      | 9   | 1       | 12  |      |
|                  |                                      |                                                                     | 5.5                    | 3.0                    | 1                        | 3    | 5   | 1      | 8   | 1       | 11  |      |
| t <sub>BBM</sub> | Minimum Break-Before-Make<br>Time    | R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF<br>(Figure 4)        | 2.5                    | 2.0                    | 1                        | 12   |     | 1      |     | 1       |     | ns   |
|                  |                                      |                                                                     | 3.0                    | 2.0                    | 1                        | 11   |     | 1      |     | 1       |     |      |
|                  |                                      |                                                                     | 4.5                    | 3.0                    | 1                        | 6    |     | 1      |     | 1       |     |      |
|                  |                                      |                                                                     | 5.5                    | 3.0                    | 1                        | 5    |     | 1      |     | 1       |     |      |

|                                    |                                         | Typical @ 25, V <sub>CC</sub> = 5.0 V | pF |
|------------------------------------|-----------------------------------------|---------------------------------------|----|
| C <sub>IN</sub>                    | Maximum Input Capacitance, Select Input | 8                                     |    |
| C <sub>NO</sub> or C <sub>NC</sub> | Analog I/O (switch off)                 | 10                                    |    |
| C <sub>COM</sub>                   | Common I/O (switch off)                 | 10                                    |    |
| C <sub>(ON)</sub>                  | Feedthrough (switch on)                 | 20                                    |    |

\*Typical Characteristics are at 25°C.

**ADDITIONAL APPLICATION CHARACTERISTICS** (Voltages Referenced to GND Unless Noted)

| Symbol           | Parameter                                                                         | Condition                                                                                                                                                                                                               | V <sub>CC</sub><br>V | Typical | Unit |
|------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|---------|------|
|                  |                                                                                   |                                                                                                                                                                                                                         |                      | 25°C    |      |
| BW               | Maximum On-Channel –3dB<br>Bandwidth or Minimum Frequency<br>Response (Figure 11) | V <sub>IS</sub> = 0 dBm<br>V <sub>IS</sub> centered between V <sub>CC</sub> and GND<br>(Figure 7)                                                                                                                       | 3.0                  | 145     | MHz  |
|                  |                                                                                   |                                                                                                                                                                                                                         | 4.5                  | 170     |      |
|                  |                                                                                   |                                                                                                                                                                                                                         | 5.5                  | 175     |      |
| V <sub>ONL</sub> | Maximum Feedthrough On Loss                                                       | V <sub>IS</sub> = 0 dBm @ 100 kHz to 50 MHz<br>V <sub>IS</sub> centered between V <sub>CC</sub> and GND<br>(Figure 7)                                                                                                   | 3.0                  | –3      | dB   |
|                  |                                                                                   |                                                                                                                                                                                                                         | 4.5                  | –3      |      |
|                  |                                                                                   |                                                                                                                                                                                                                         | 5.5                  | –3      |      |
| V <sub>ISO</sub> | Off-Channel Isolation (Figure 10)                                                 | f = 100 kHz; V <sub>IS</sub> = 1 V RMS<br>V <sub>IS</sub> centered between V <sub>CC</sub> and GND<br>(Figure 7)                                                                                                        | 3.0                  | –93     | dB   |
|                  |                                                                                   |                                                                                                                                                                                                                         | 4.5                  | –93     |      |
|                  |                                                                                   |                                                                                                                                                                                                                         | 5.5                  | –93     |      |
| Q                | Charge Injection Select Input to<br>Common I/O (Figure 15)                        | V <sub>IS</sub> = V <sub>CC</sub> to GND, F <sub>IN</sub> = 20 kHz<br>t <sub>r</sub> = t <sub>f</sub> = 3 ns<br>R <sub>IS</sub> = 0 Ω, C <sub>L</sub> = 1000 pF<br>Q = C <sub>L</sub> * ΔV <sub>OUT</sub><br>(Figure 8) | 3.0                  | 1.5     | pC   |
|                  |                                                                                   |                                                                                                                                                                                                                         | 5.5                  | 3.0     |      |
| THD              | Total Harmonic Distortion THD +<br>Noise (Figure 14)                              | F <sub>IN</sub> = 20 Hz to 100 kHz, R <sub>L</sub> = R <sub>gen</sub> = 600 Ω, C <sub>L</sub> = 50 pF<br>V <sub>IS</sub> = 5.0 V <sub>PP</sub> sine wave                                                                | 5.5                  | 0.1     | %    |
| VCT              | Channel-to-Channel Crosstalk                                                      | f = 100 kHz; V <sub>IS</sub> = 1 V RMS<br>V <sub>IS</sub> centered between V <sub>CC</sub> and GND<br>(Figure 7)                                                                                                        | 5.5                  | –90     | dB   |
|                  |                                                                                   |                                                                                                                                                                                                                         | 3.0                  | –90     |      |

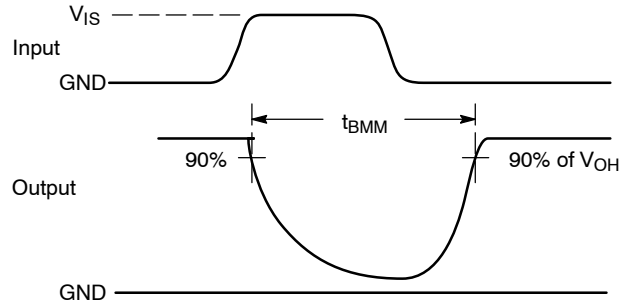
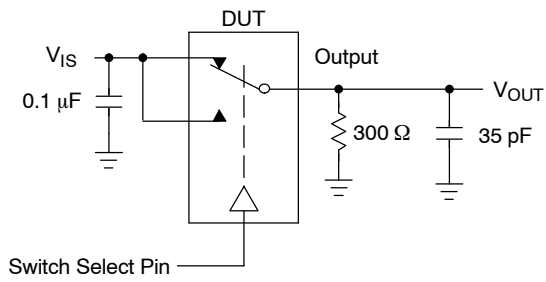


Figure 4.  $t_{BMM}$  (Time Break-Before-Make)

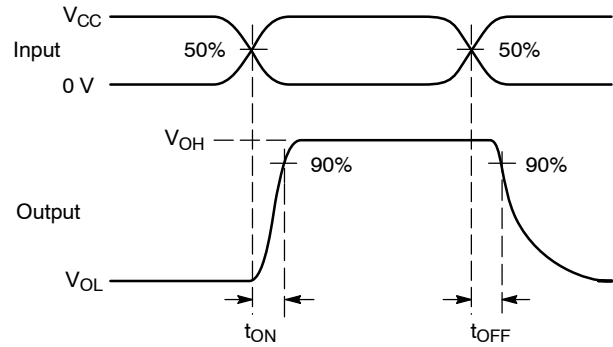
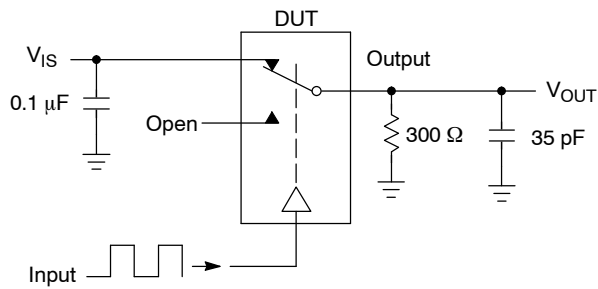


Figure 5.  $t_{ON}/t_{OFF}$

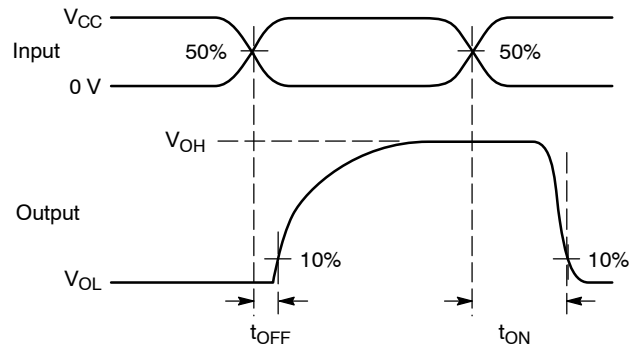
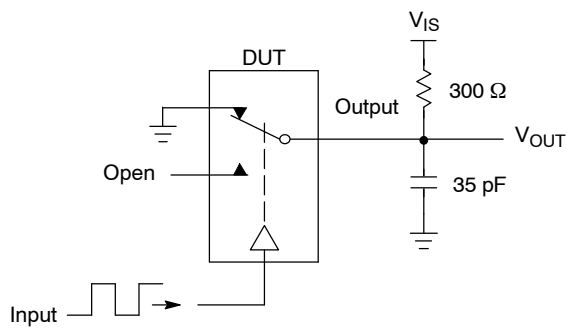
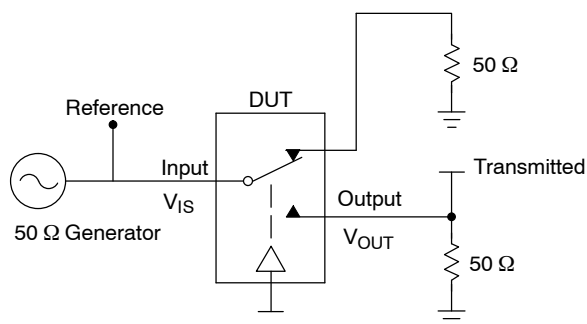


Figure 6.  $t_{ON}/t_{OFF}$



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.

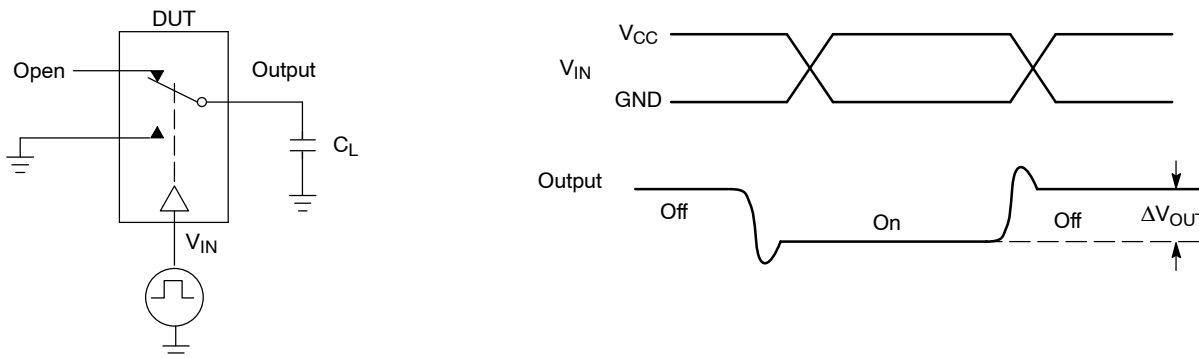
$$V_{ISO} = \text{Off Channel Isolation} = 20 \log \left( \frac{V_{OUT}}{V_{IS}} \right) \text{ for } V_{IN} \text{ at } 100 \text{ kHz}$$

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

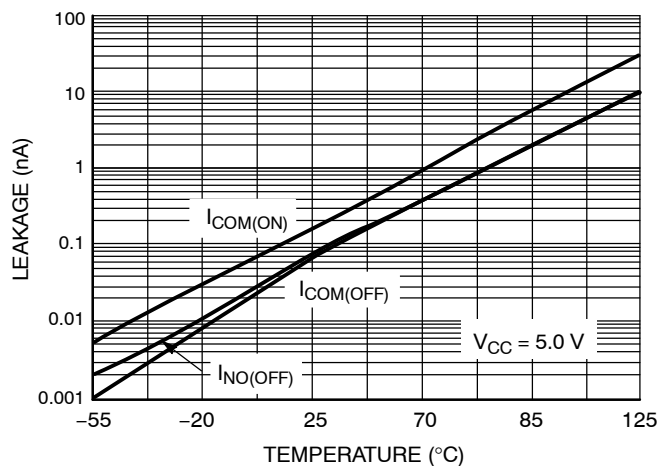
Bandwidth (BW) = the frequency 3 dB below  $V_{ONL}$

$V_{CT}$  = Use  $V_{ISO}$  setup and test to all other switch analog input/outputs terminated with 50 Ω

**Figure 7. Off Channel Isolation/On Channel Loss (BW)/Crosstalk (On Channel to Off Channel)/ $V_{ONL}$**



**Figure 8. Charge Injection: (Q)**



**Figure 9. Switch Leakage vs. Temperature**

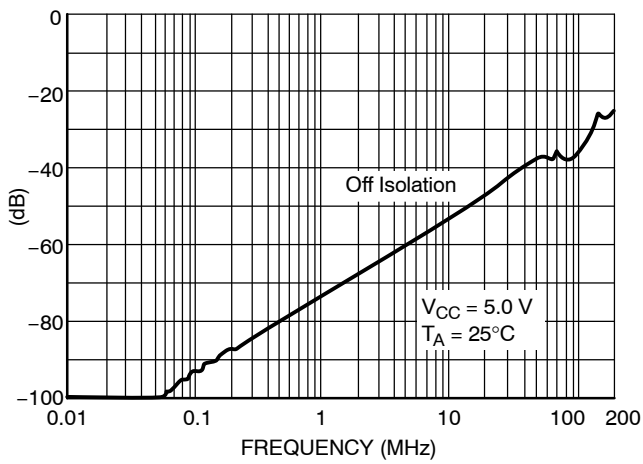


Figure 10. Off-Channel Isolation

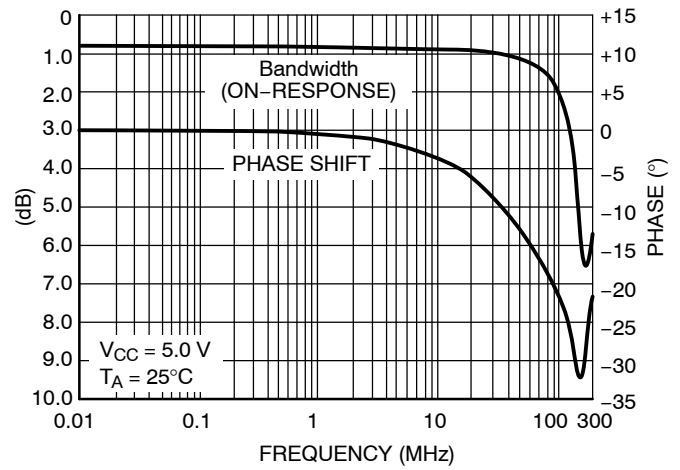


Figure 11. Typical Bandwidth and Phase Shift

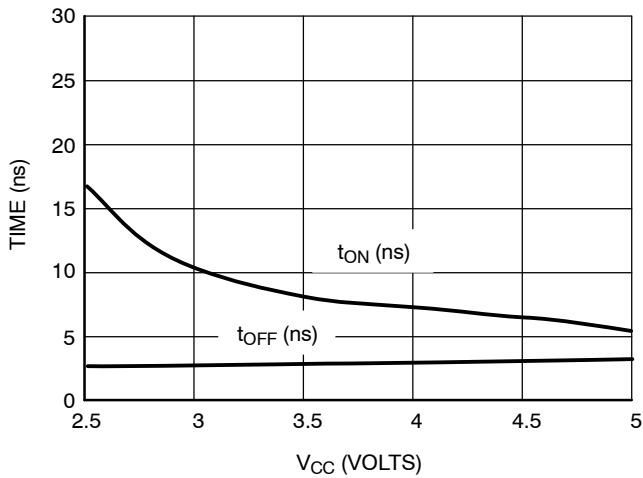


Figure 12.  $t_{ON}$  and  $t_{OFF}$  vs.  $V_{CC}$  at  $25^\circ\text{C}$

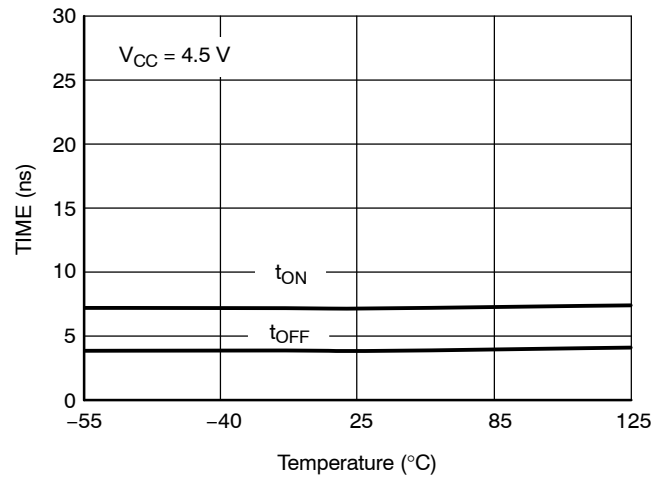


Figure 13.  $t_{ON}$  and  $t_{OFF}$  vs. Temp

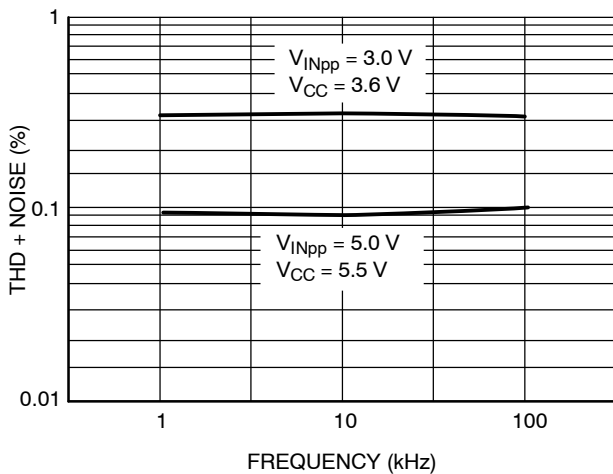


Figure 14. Total Harmonic Distortion Plus Noise vs. Frequency

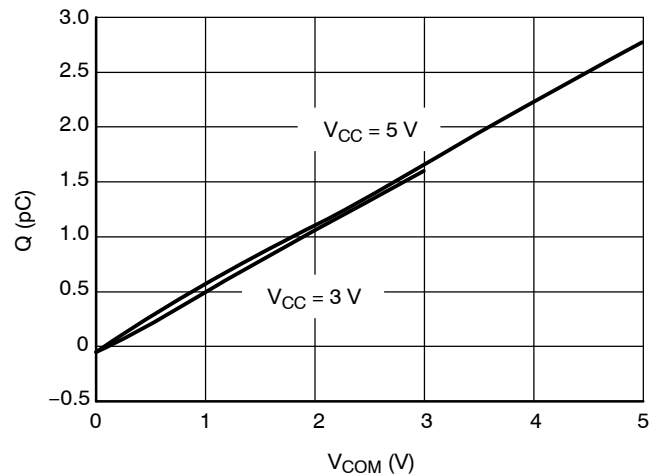


Figure 15. Charge Injection vs. COM Voltage

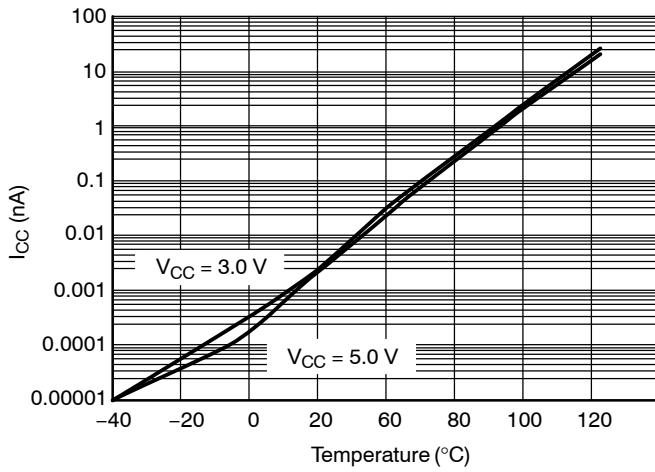


Figure 16.  $I_{CC}$  vs. Temp,  $V_{CC} = 3\text{ V}$  &  $5\text{ V}$

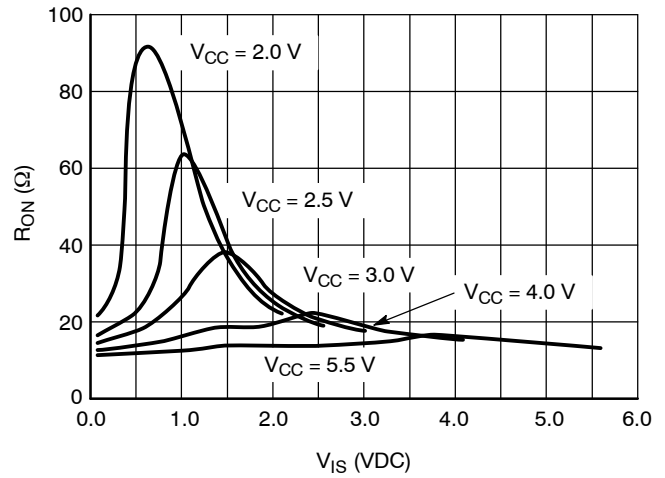


Figure 17.  $R_{ON}$  vs.  $V_{CC}$ , Temp =  $25^{\circ}\text{C}$

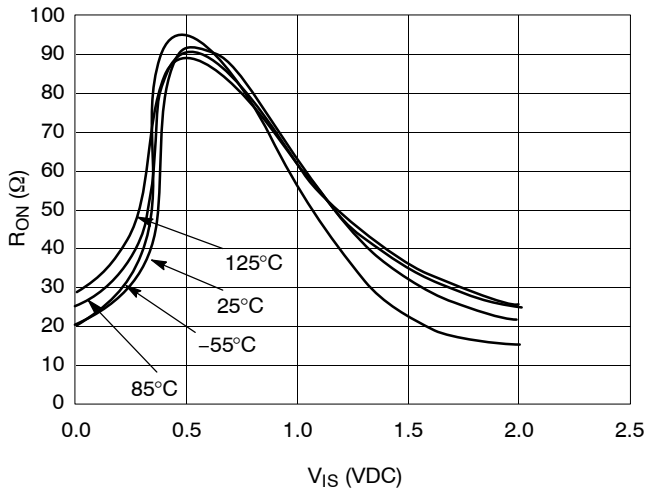


Figure 18.  $R_{ON}$  vs. Temp,  $V_{CC} = 2.0\text{ V}$

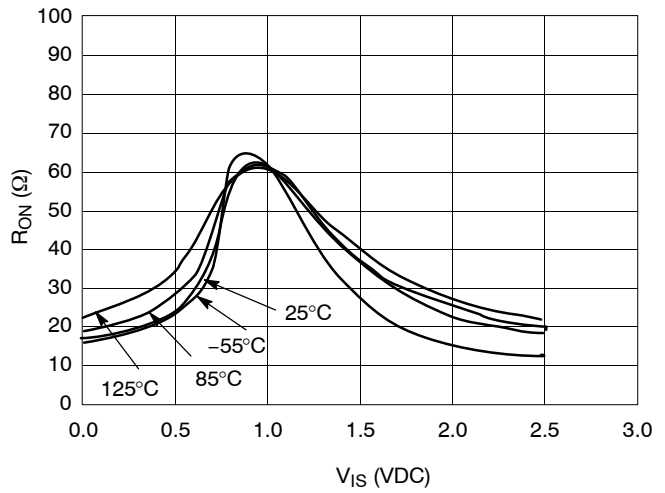


Figure 19.  $R_{ON}$  vs. Temp,  $V_{CC} = 2.5\text{ V}$

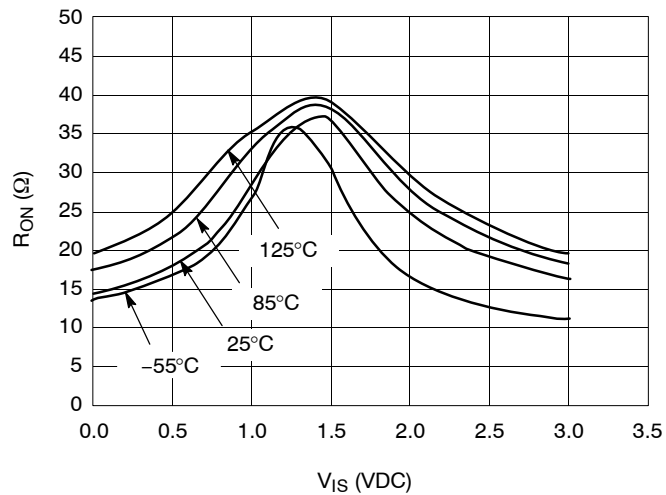


Figure 20.  $R_{ON}$  vs. Temp,  $V_{CC} = 3.0\text{ V}$

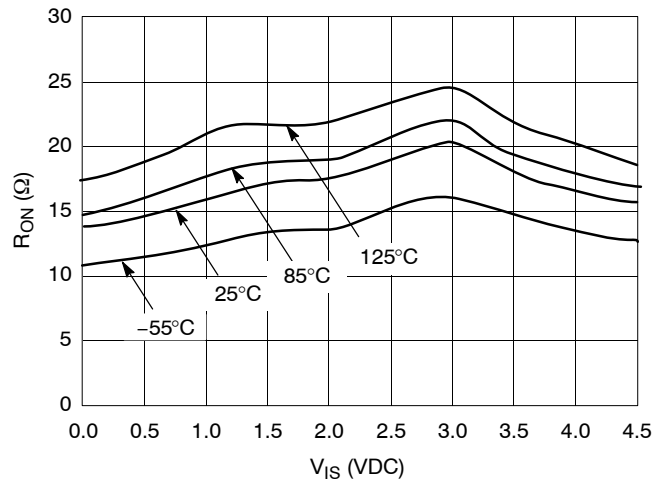


Figure 21.  $R_{ON}$  vs. Temp,  $V_{CC} = 4.5\text{ V}$

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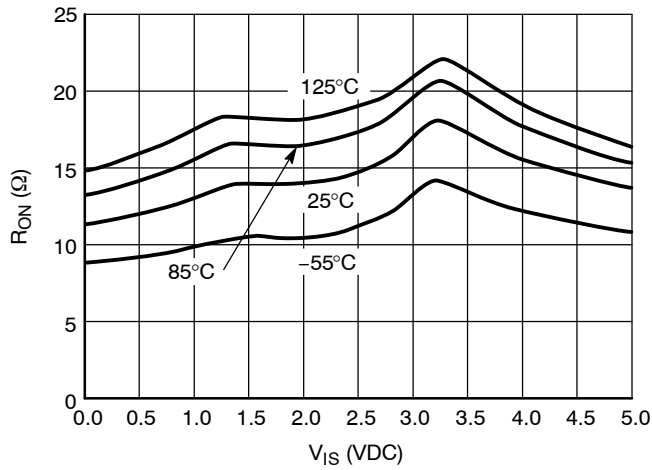


Figure 22.  $R_{ON}$  vs. Temp,  $V_{CC} = 5.0$  V

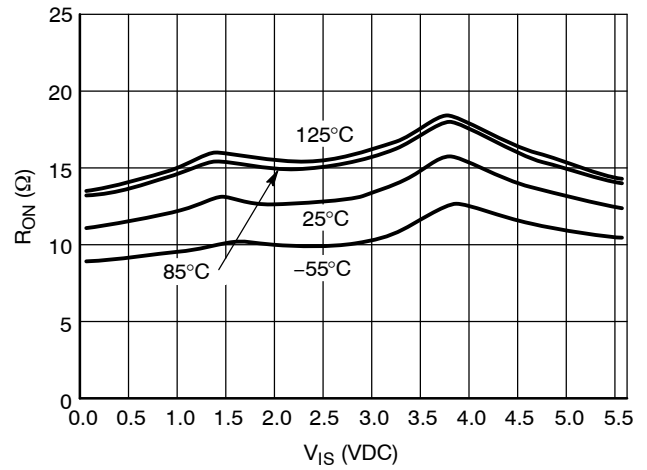


Figure 23.  $R_{ON}$  vs. Temp,  $V_{CC} = 5.5$  V

## DEVICE ORDERING INFORMATION

| Device        | Device Nomenclature |            |                 |                |                    | Package Type     | Shipping <sup>†</sup> |
|---------------|---------------------|------------|-----------------|----------------|--------------------|------------------|-----------------------|
|               | Circuit Indicator   | Technology | Device Function | Package Suffix | Tape & Reel Suffix |                  |                       |
| NLAS9431MTR2G | NL                  | AS         | 9431            | MT             | R2                 | WQFN16 (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.

\*This package is inherently Pb-Free.

