

NLAST9431

Low Voltage Single Supply Dual DPDT Analog Switch

The NLAST9431 is an advanced CMOS dual-independent DPDT (double pole-double throw) 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 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 NLAST9431 can also be used as a quad 2-to-1 multiplexer-demultiplexer analog switch with two Select pins that each controls two multiplexer-demultiplexers.

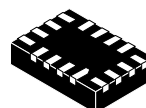
- Select Pins Compatible with TTL Levels
- Channel Select Input Overvoltage Tolerant to 5.5 V
- Fast Switching and Propagation Speeds
- Break-Before-Make Circuitry
- Low Power Dissipation: $I_{CC} = 2 \mu\text{A}$ (Max) at $T_A = 25^\circ\text{C}$
- Diode Protection Provided on Channel Select Input
- Improved Linearity and Lower ON Resistance over Input Voltage
- Latch-up Performance Exceeds 300 mA
- Chip Complexity: 158 FETs
- Pb-Free Packages are Available



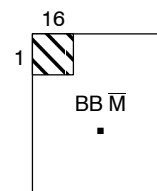
ON Semiconductor®

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MARKING DIAGRAMS



WQFN16
CASE 488AP

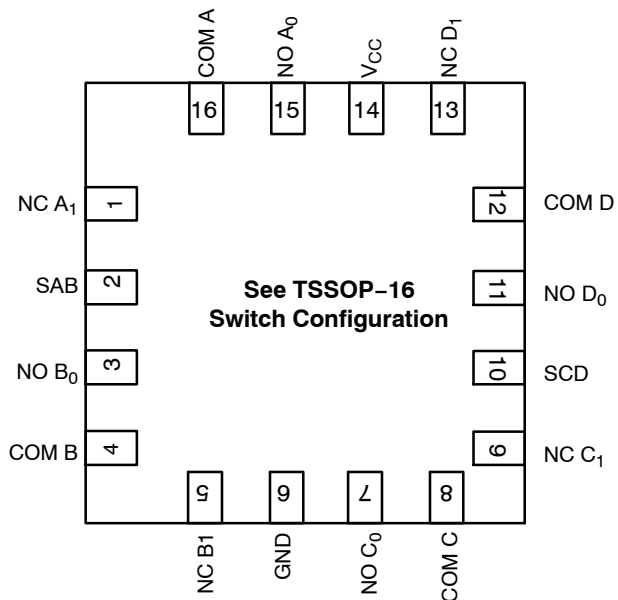


BB = Specific Device Code
M̄ = Date Code & Assembly Location
▪ = Pb-Free Device

ORDERING INFORMATION

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

QFN-16 PACKAGE



FUNCTION TABLE

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

TSSOP-16 PACKAGE

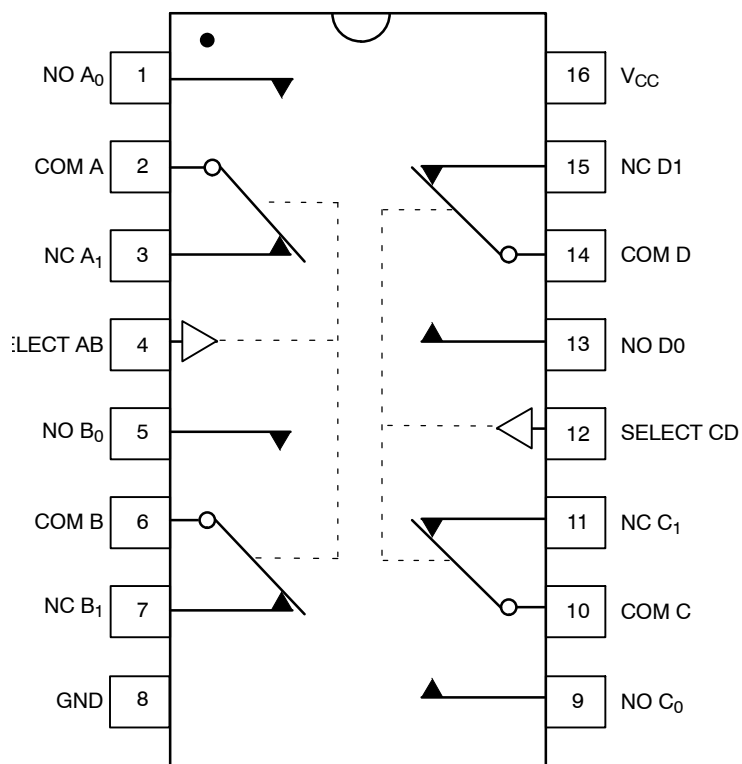


Figure 1. Logic Diagram

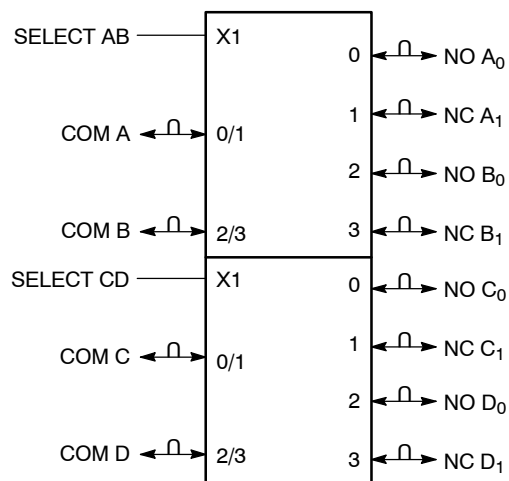


Figure 2. IEC Logic Symbol

NLAST9431

MAXIMUM RATINGS

| Symbol | Parameter | Value | Unit | |
|-----------------------|---|---|---------------------|------|
| V _{CC} | Positive DC Supply Voltage | -0.5 to +7.0 | V | |
| V _{IS} | Analog Input Voltage (V _{NO} or V _{COM}) | -0.5 ≤ V _{IS} ≤ V _{CC} + 0.5 | V | |
| V _{IN} | Digital Select Input Voltage | -0.5 ≤ V _I ≤ +7.0 | V | |
| I _{IK} | DC Current, Into or Out of Any Pin | ±50 | mA | |
| P _D | Power Dissipation in Still Air | QFN-16 TSSOP-16 | 800 450 | mW |
| T _{STG} | Storage Temperature Range | -65 to +150 | °C | |
| T _L | Lead Temperature, 1 mm from Case for 10 Seconds | 260 | °C | |
| T _J | Junction Temperature Under Bias | +150 | °C | |
| MSL | Moisture Sensitivity | Level 1 | | |
| F _R | Flammability Rating | Oxygen Index: 30% – 35% | UL-94-VO (0.125 in) | |
| I _{LATCH-UP} | Latch-Up Performance | Above V _{CC} and Below GND at 125°C (Note 1) | ±300 | mA |
| θ _{JA} | Thermal Resistance | QFN-16 TSSOP-16 | 80 164 | °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 _{CC} | DC Supply Voltage | 2.0 | 5.5 | V |
| V _{IN} | Digital Select Input Voltage | GND | 5.5 | V |
| V _{IS} | Analog Input Voltage (NC, NO, COM) | GND | V _{CC} | V |
| T _A | Operating Temperature Range | -55 | +125 | °C |
| t _r , t _f | Input Rise or Fall Time, SELECT | V _{CC} = 3.3 V ± 0.3 V V _{CC} = 5.0 V ± 0.5 V | 0 100 20 | 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 |

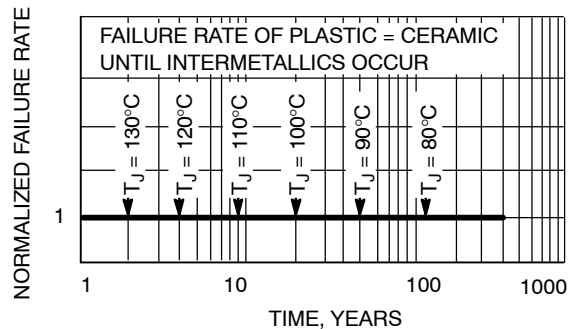


Figure 3. Failure Rate vs. Time Junction Temperature

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DC CHARACTERISTICS – Digital Section (Voltages Referenced to GND)

| Symbol | Parameter | Condition | V _{CC} | Guaranteed Limit | | | Unit |
|------------------|---|---|-----------------|------------------|--------|---------|------|
| | | | | –55°C to 25°C | < 85°C | < 125°C | |
| V _{IH} | Minimum High-Level Input Voltage, Select Inputs | | 3.0 | 1.4 | 1.4 | 1.4 | V |
| | | | 4.5 | 2.0 | 2.0 | 2.0 | |
| | | | 5.5 | 2.0 | 2.0 | 2.0 | |
| V _{IL} | Maximum Low-Level Input Voltage, Select Inputs | | 3.0 | 0.5 | 0.5 | 0.5 | V |
| | | | 4.5 | 0.8 | 0.8 | 0.8 | |
| | | | 5.5 | 0.8 | 0.8 | 0.8 | |
| I _{IN} | Maximum Input Leakage Current | V _{IN} = 5.5 V or GND | 5.5 | ± 0.2 | ± 2.0 | ± 2.0 | μA |
| I _{OFF} | Power Off Leakage Current, Select Inputs | V _{IN} = 5.5 V or GND | 0 | ± 10 | ± 10 | ± 10 | μA |
| I _{CC} | Maximum Quiescent Supply Current | Select and V _{IS} = V _{CC} or GND | 5.5 | 4.0 | 4.0 | 8.0 | μA |

DC ELECTRICAL CHARACTERISTICS – Analog Section

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

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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 | |
|------------------|--------------------------------------|--|------------------------|------------------------|--------------------------|------|-----|--------|-----|---------|------|-----|
| | | | | | -55°C to 25°C | | | < 85°C | | < 125°C | | |
| | | | | | Min | Typ* | Max | Min | Max | Min | | Max |
| t _{ON} | Turn-On Time (Figures 12 and 13) | R _L = 300 Ω, C _L = 35 pF (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 _{OFF} | Turn-Off Time (Figures 12 and 13) | R _L = 300 Ω, C _L = 35 pF (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 _{BBM} | Minimum Break-Before-Make Time | V _{IS} = 3.0 V (Figure 4) R _L = 300 Ω, C _L = 35 pF | 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 Characteristics are at 25°C.

| Symbol | Parameter | Typical @ 25, V _{CC} = 5.0 V | | Unit |
|------------------------------------|---|---------------------------------------|-----|------|
| | | Min | Max | |
| C _{IN} | Maximum Input Capacitance, Select Input | | 8 | pF |
| C _{NO} or C _{NC} | Analog I/O (Switch Off) | | 10 | |
| C _{COM} | Common I/O (Switch Off) | | 10 | |
| C _(ON) | Feedthrough (Switch On) | | 20 | |

ADDITIONAL APPLICATION CHARACTERISTICS (Voltages Referenced to GND Unless Noted)

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

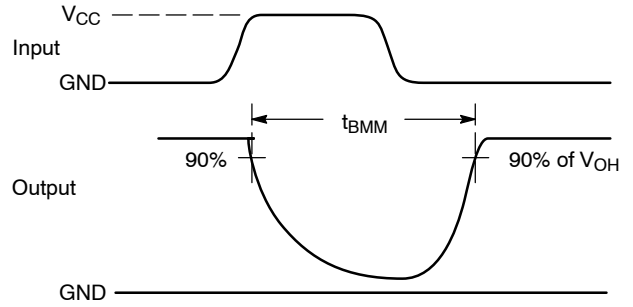
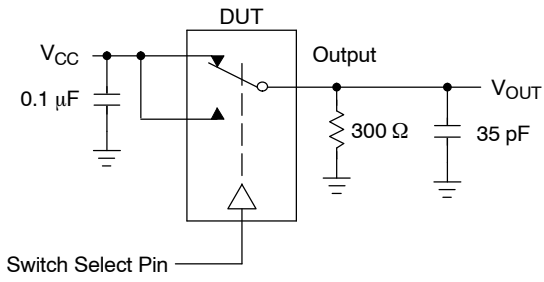


Figure 4. t_{BMM} (Time Break-Before-Make)

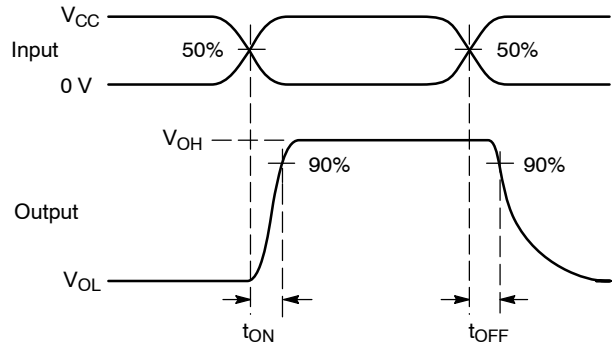
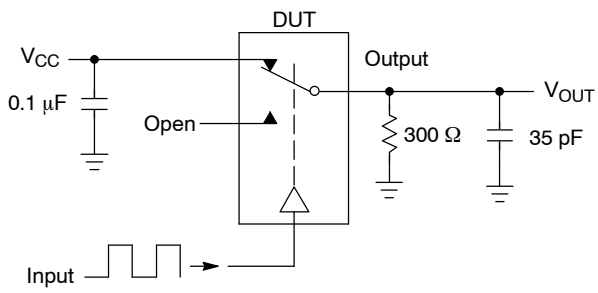


Figure 5. t_{ON}/t_{OFF}

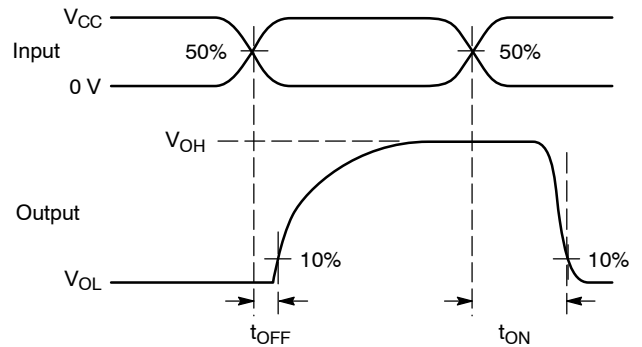
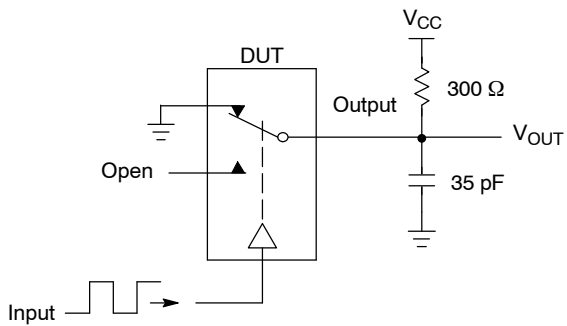
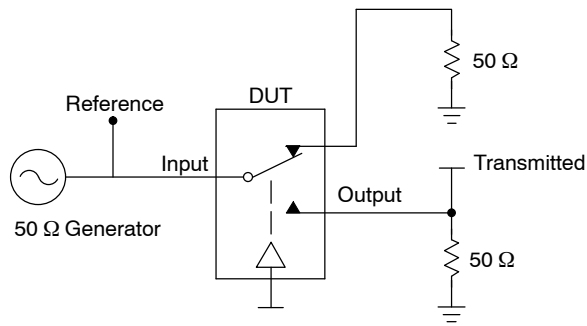


Figure 6. t_{ON}/t_{OFF}

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



Figure 8. Charge Injection: (Q)

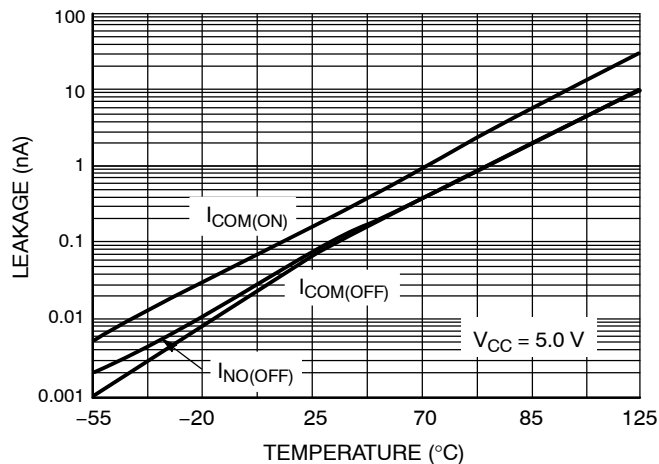


Figure 9. Switch Leakage vs. Temperature

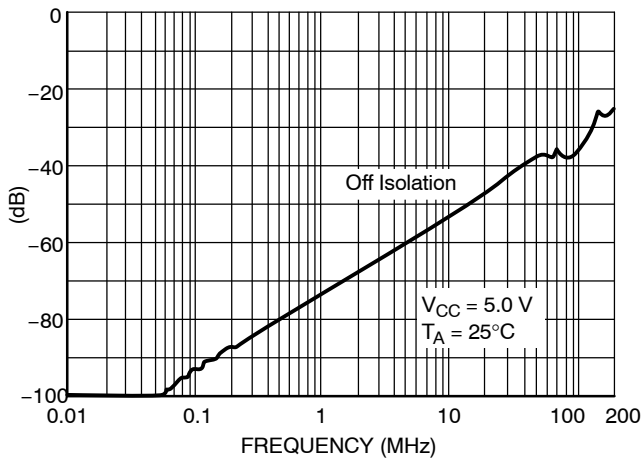


Figure 10. Off-Channel Isolation

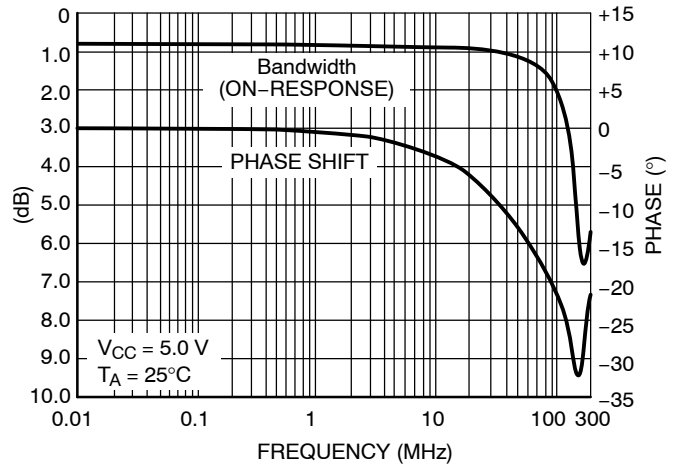


Figure 11. Typical Bandwidth and Phase Shift



Figure 12. t_{ON} and t_{OFF} vs. V_{CC} at 25°C

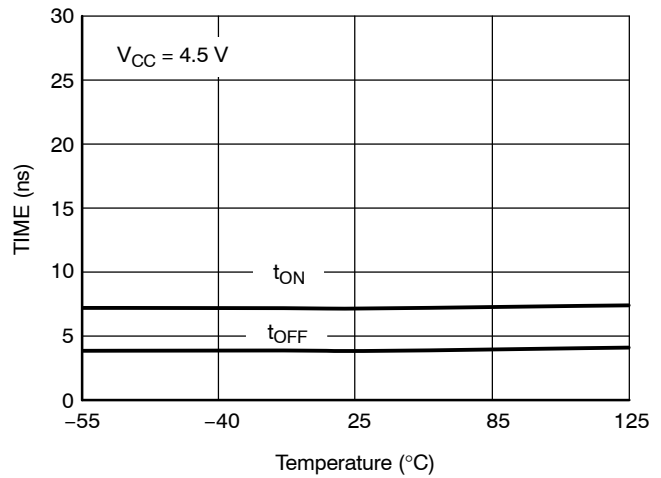


Figure 13. t_{ON} and t_{OFF} vs. Temp



Figure 14. Total Harmonic Distortion Plus Noise vs. Frequency



Figure 15. Charge Injection vs. COM Voltage



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

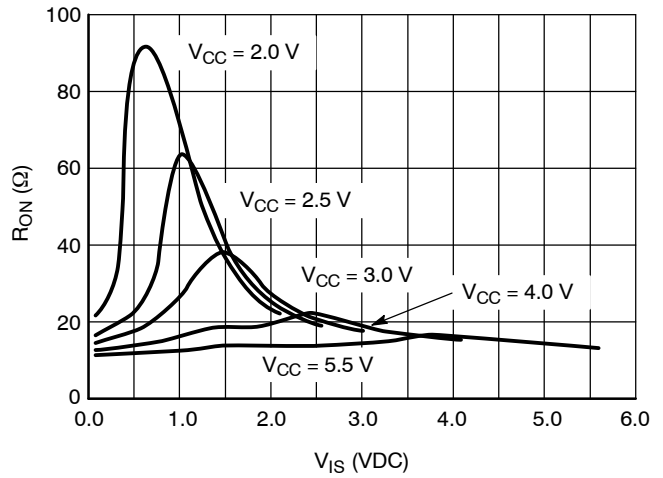


Figure 17. R_{ON} vs. V_{CC} , Temp = 25°C

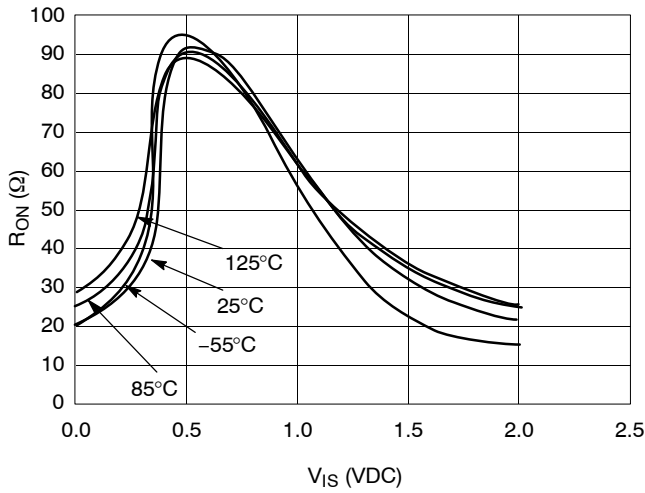


Figure 18. R_{ON} vs Temp, $V_{CC} = 2.0\text{ V}$

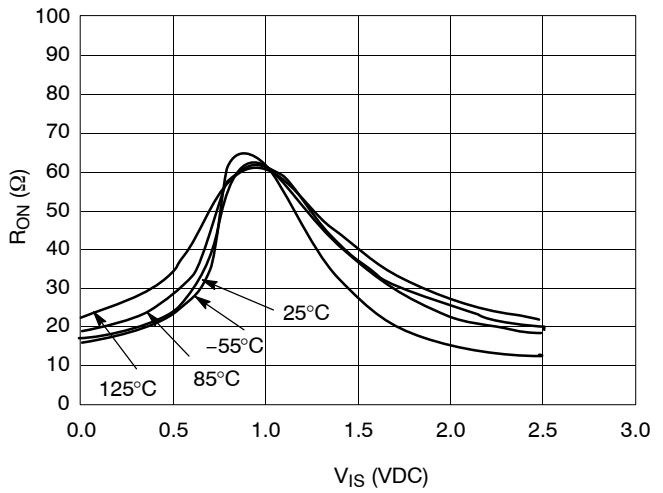


Figure 19. R_{ON} vs. Temp, $V_{CC} = 2.5\text{ V}$

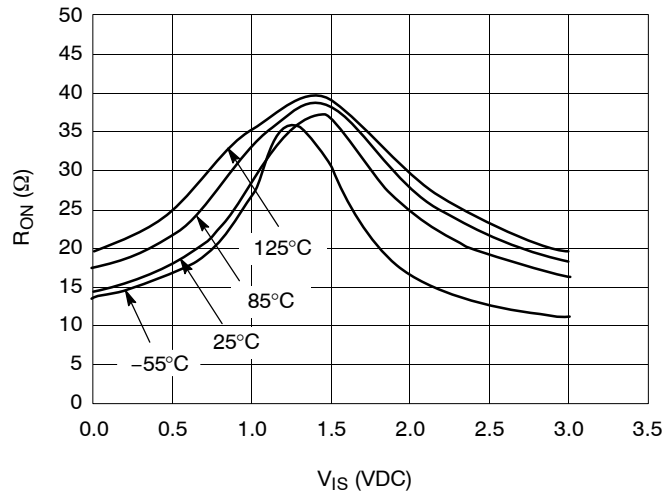


Figure 20. R_{ON} vs. Temp, $V_{CC} = 3.0\text{ V}$

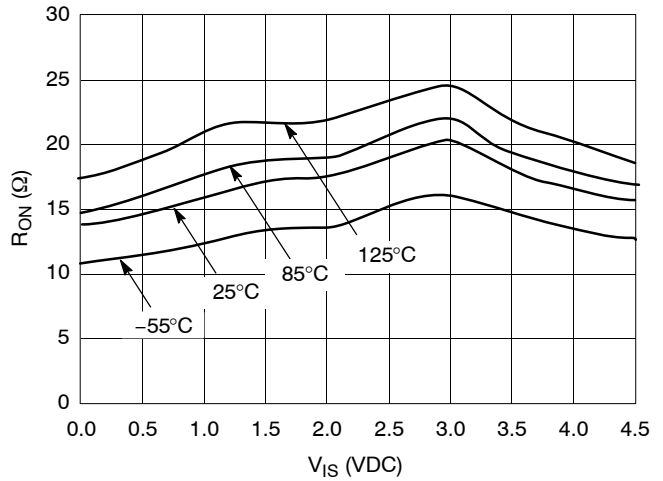


Figure 21. R_{ON} vs. Temp, $V_{CC} = 4.5\text{ V}$

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

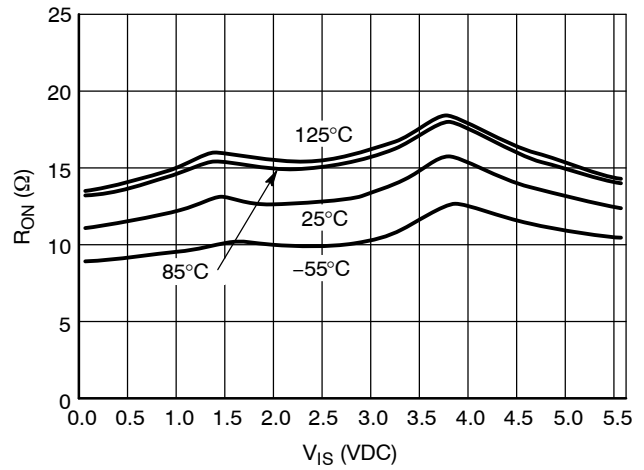


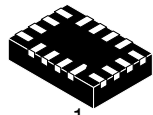
Figure 23. R_{ON} vs. Temp, $V_{CC} = 5.5$ V

DEVICE ORDERING INFORMATION

| Device Order Number | Device Nomenclature | | | | | Package Type | Shipping [†] |
|---------------------|---------------------|------------|-----------------|----------------|----------------------|----------------------|-----------------------|
| | Circuit Indicator | Technology | Device Function | Package Suffix | Tape and Reel Suffix | | |
| NLAST9431MTR2G | NL | AST | 9431 | MT | R2G | WQFN-16 (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.

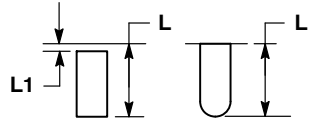
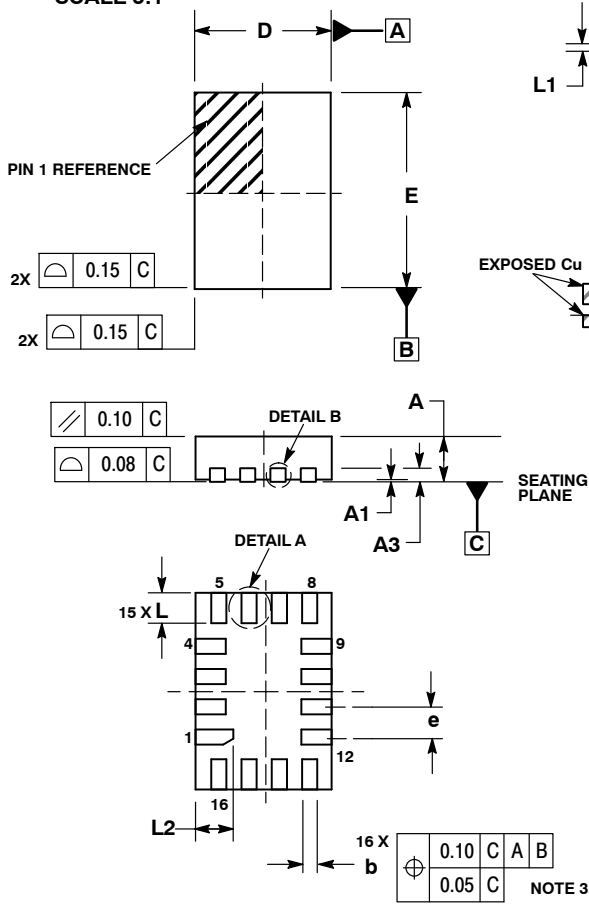
*This package is inherently Pb-Free.



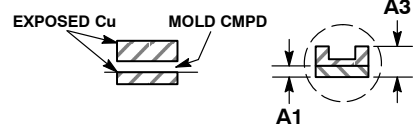
SCALE 5:1

WQFN16, 1.8x2.6, 0.4P
CASE 488AP
ISSUE B

DATE 25 JUN 2008



DETAIL A
ALTERNATE TERMINAL
CONSTRUCTIONS



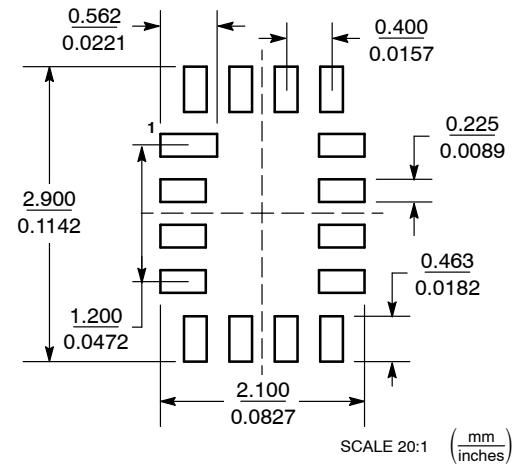
DETAIL B
ALTERNATE
CONSTRUCTIONS

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 | 1.80 BSC | |
| E | 2.60 BSC | |
| e | 0.40 BSC | |
| L | 0.30 | 0.50 |
| L1 | 0.00 | 0.15 |
| L2 | 0.40 | 0.60 |

MOUNTING FOOTPRINT



| | | |
|------------------|-------------------------|--|
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| DESCRIPTION: | WQFN16, 1.8 X 2.6, 0.4P | PAGE 1 OF 1 |

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