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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 μA (Max) at T_A = 25°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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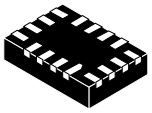
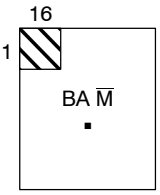
MARKING DIAGRAMS



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

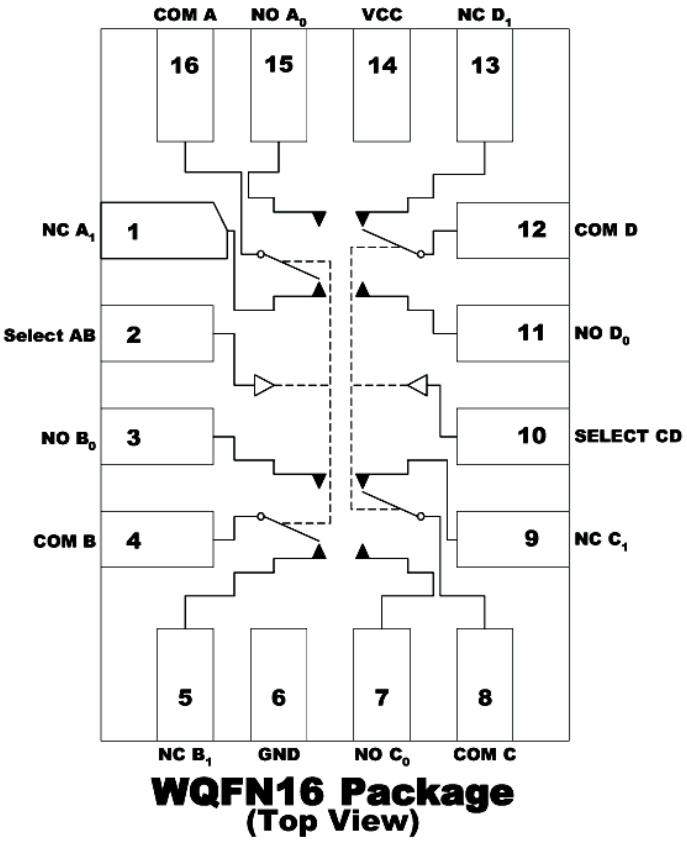


Figure 1. Logic Diagram

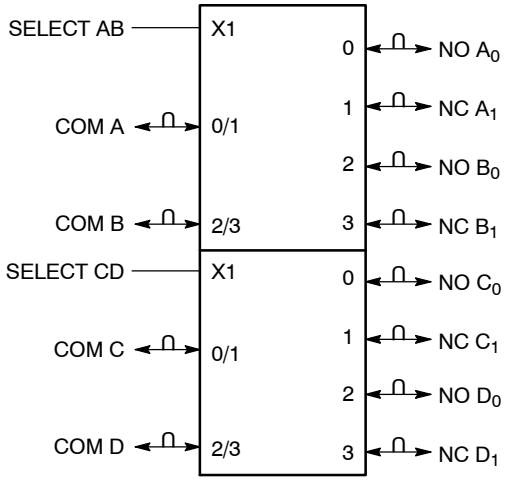


Figure 2. IEC Logic Symbol

MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{CC}	Positive DC Supply Voltage	−0.5 to +7.0	V
V_{IS}	Analog Input Voltage (V_{NO} or V_{COM})	$-0.5 \le V_{IS} \le V_{CC} + 0.5$	
V_{IN}	Digital Select Input Voltage	$-0.5 \le V_I \le +7.0$	V
I_{IK}	DC Current, Into or Out of Any Pin	±50	mA
P_D	Power Dissipation in Still Air	800	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−V0 (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	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_{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 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

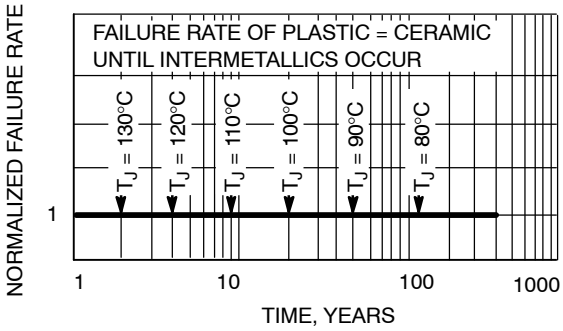


Figure 3. Failure Rate vs. Time Junction Temperature

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		2.0 2.5 3.0 4.5 5.5	1.5 1.9 2.1 3.15 3.85	1.5 1.9 2.1 3.15 3.85	1.5 1.9 2.1 3.15 3.85	V
V_{IL}	Maximum Low–Level Input Voltage, Select Inputs		2.0 2.5 3.0 4.5 5.5	0.5 0.6 0.9 1.35 1.65	0.5 0.6 0.9 1.35 1.65	0.5 0.6 0.9 1.35 1.65	V
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} $I_{IN}I \leq$ 10.0 mA	2.5 3.0 4.5 5.5	85 45 30 25	95 50 35 30	105 55 40 35	Ω
$R_{FLAT\ (ON)}$	ON Resistance Flatness (Figures 17 – 23)	V_{IN} = V_{IL} or V_{IH} $I_{IN}I \leq$ 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

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	R_L = 300 Ω, C_L = 35 pF (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_{CC} = 5.0 V	pF
C_{IN}	Maximum Input Capacitance, Select Input	8	
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	

*Typical Characteristics are at 25°C.

ADDITIONAL APPLICATION CHARACTERISTICS (Voltages Referenced to GND Unless Noted)

Symbol	Parameter	Condition	V_{CC} V	Typical 25°C	Unit
BW	Maximum On−Channel −3dB Bandwidth or Minimum Frequency Response (Figure 11)	V_{IS} = 0 dBm V_{IS} centered between V_{CC} and GND (Figure 7)	3.0 4.5 5.5	145 170 175	MHz
V_{ONL}	Maximum Feedthrough On Loss	V_{IS} = 0 dBm @ 100 kHz to 50 MHz V_{IS} centered between V_{CC} and GND (Figure 7)	3.0 4.5 5.5	−3 −3 −3	dB
V_{ISO}	Off−Channel Isolation (Figure 10)	f = 100 kHz; V_{IS} = 1 V RMS V_{IS} centered between V_{CC} and GND (Figure 7)	3.0 4.5 5.5	−93 −93 −93	dB
Q	Charge Injection Select Input to Common I/O (Figure 15)	V_{IS} = V_{CC} to GND, F_{IN} = 20 kHz $t_r = t_f$ = 3 ns R_{IS} = 0 Ω, C_L = 1000 pF $Q = C_L * \Delta V_{OUT}$ (Figure 8)	 3.0 5.5 	 1.5 3.0 	pC
THD	Total Harmonic Distortion THD + Noise (Figure 14)	F_{IN} = 20 Hz to 100 kHz, R_L = Rgen = 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_{IS} centered between V_{CC} and GND (Figure 7)	 5.5 3.0	 −90 −90	dB

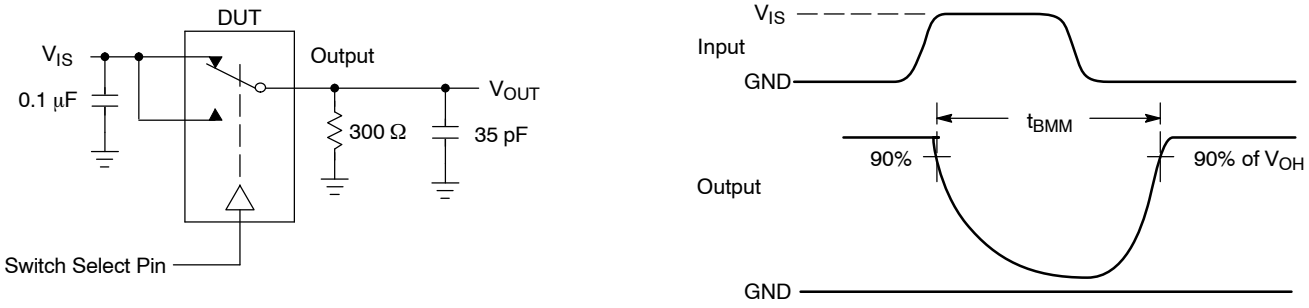


Figure 4. t_{BBM} (Time Break−Before−Make)

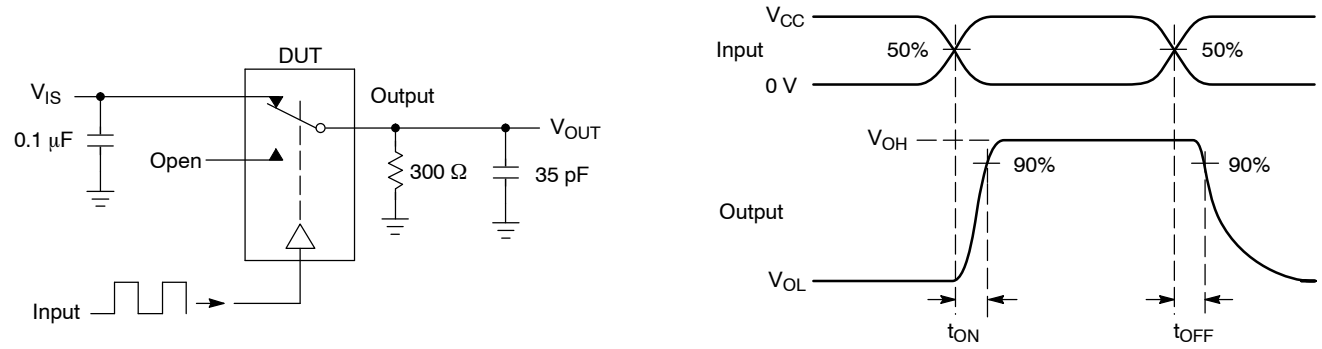


Figure 5. t_{ON}/t_{OFF}

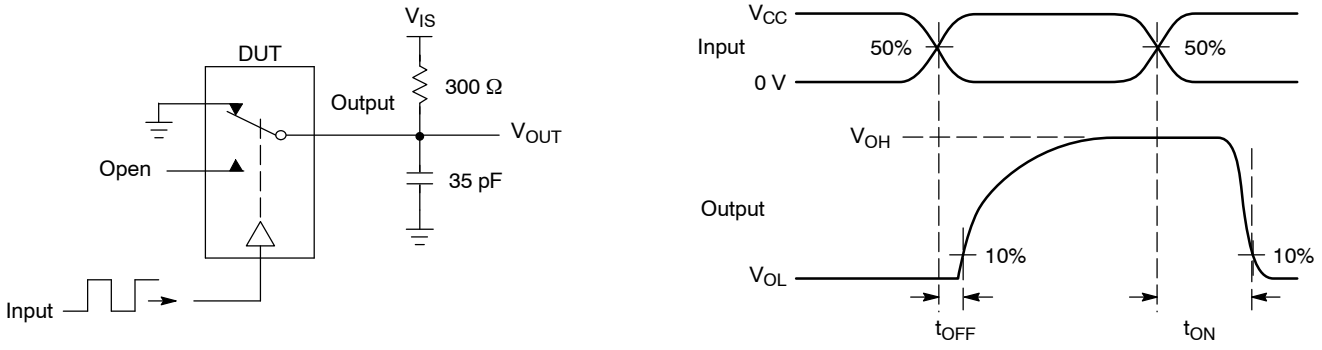
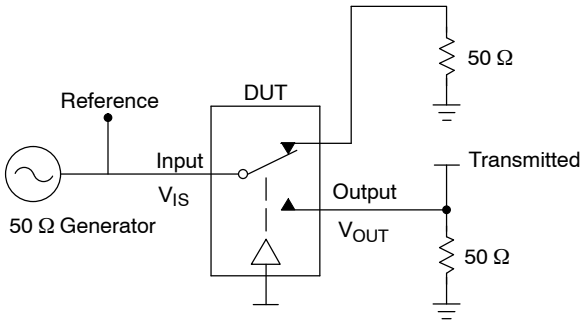


Figure 6. t_{ON}/t_{OFF}



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

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

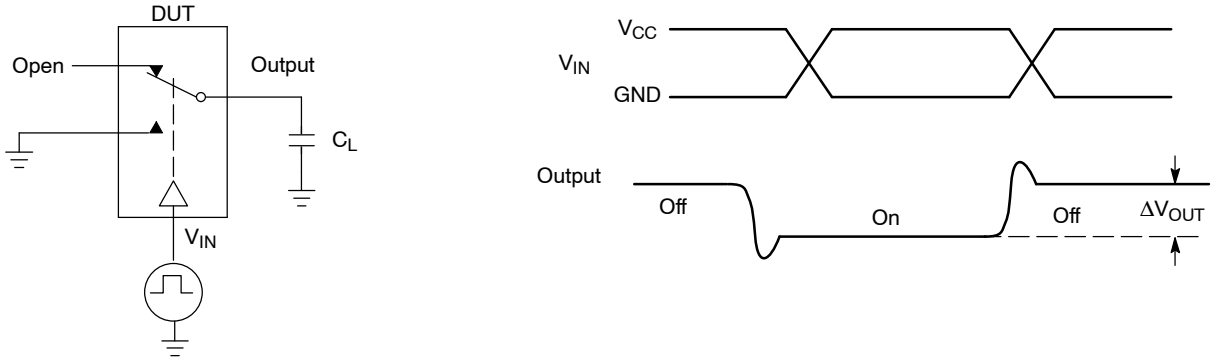


Figure 8. Charge Injection: (Q)

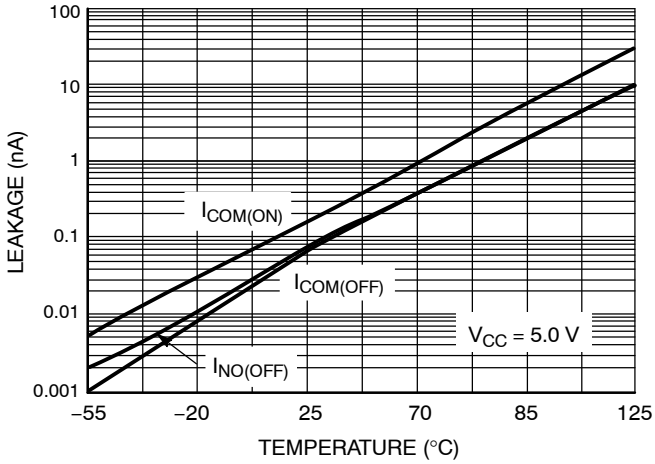


Figure 9. Switch Leakage vs. Temperature

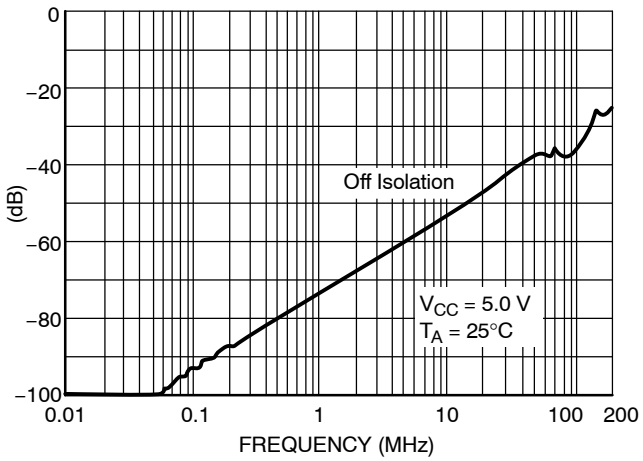


Figure 10. Off−Channel Isolation

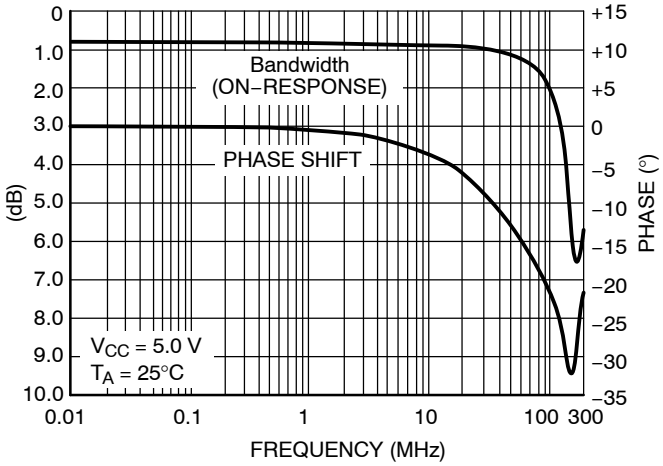


Figure 11. Typical Bandwidth and Phase Shift

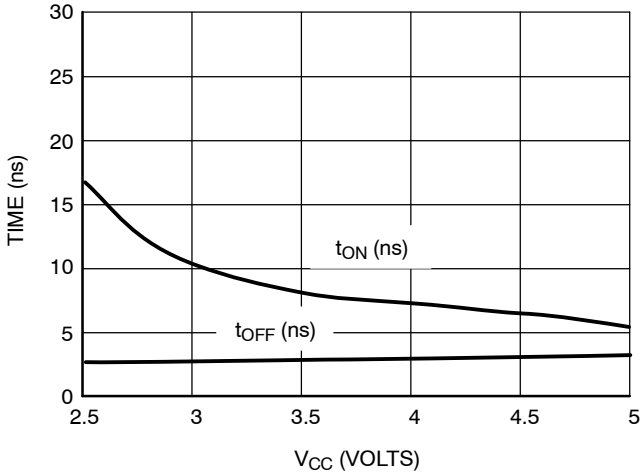


Figure 12. t_{ON} and t_{OFF} vs. V_{CC} at 25°C

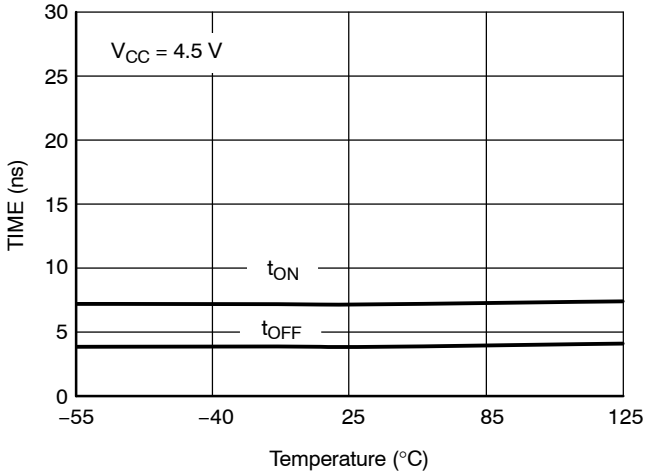


Figure 13. t_{ON} and t_{OFF} vs. Temp

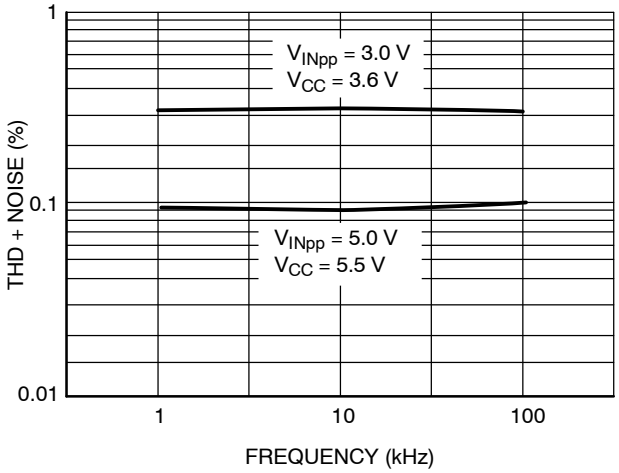


Figure 14. Total Harmonic Distortion Plus Noise vs. Frequency

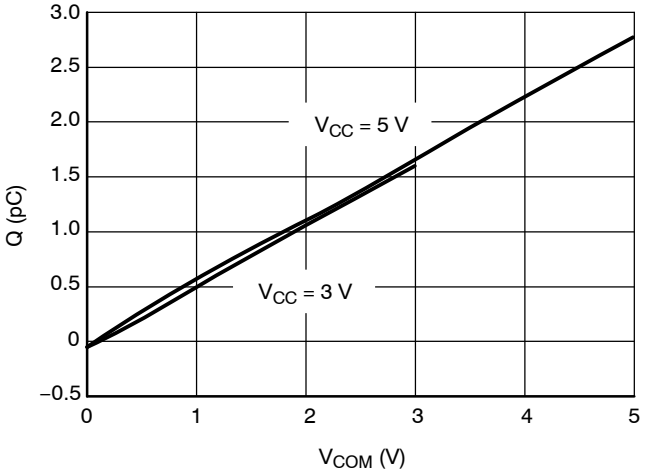


Figure 15. Charge Injection vs. COM Voltage

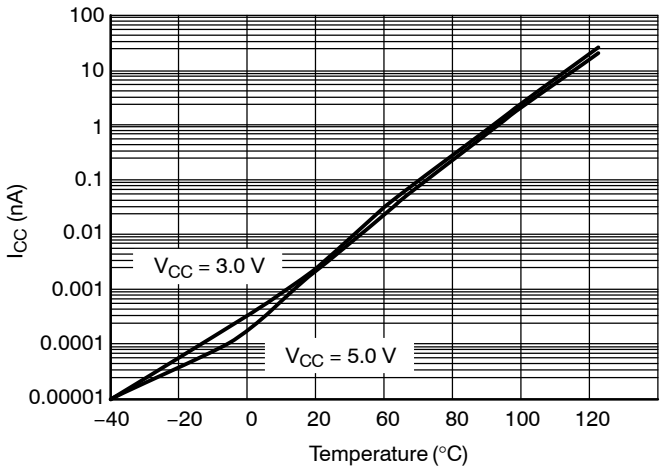


Figure 16. I_{CC} vs. Temp, V_{CC} = 3 V & 5 V

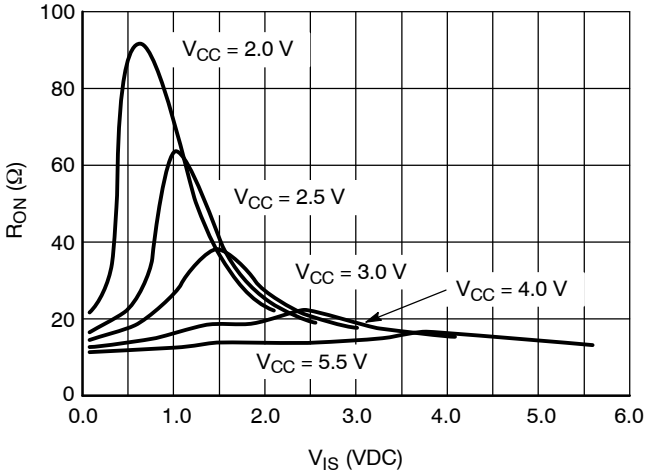


Figure 17. R_{ON} vs. V_{CC}, Temp = 25°C

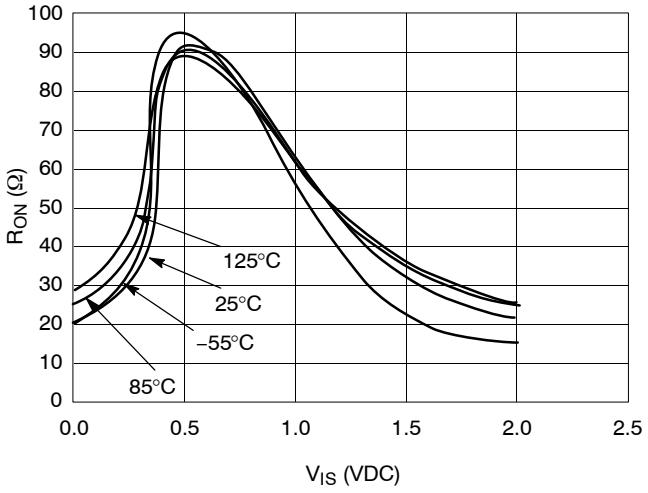


Figure 18. R_{ON} vs Temp, V_{CC} = 2.0 V

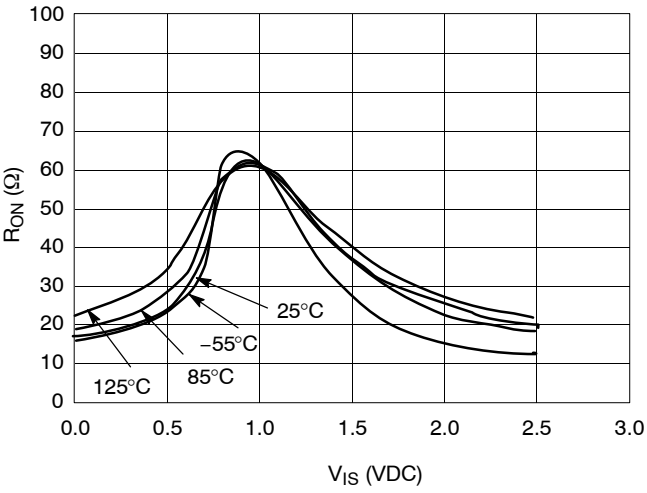


Figure 19. R_{ON} vs. Temp, V_{CC} = 2.5 V

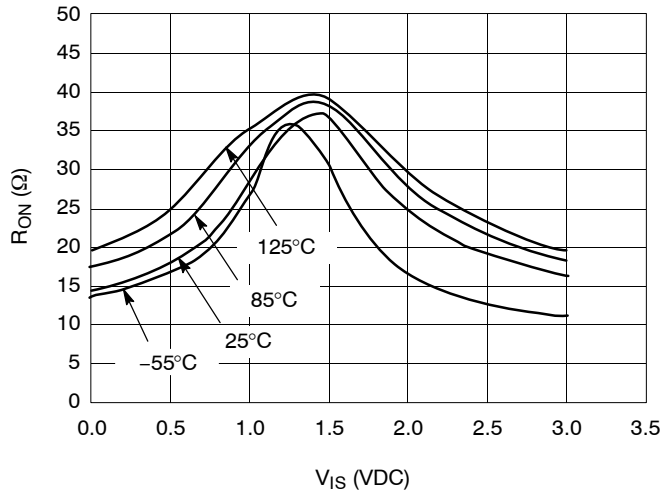


Figure 20. R_{ON} vs. Temp, V_{CC} = 3.0 V

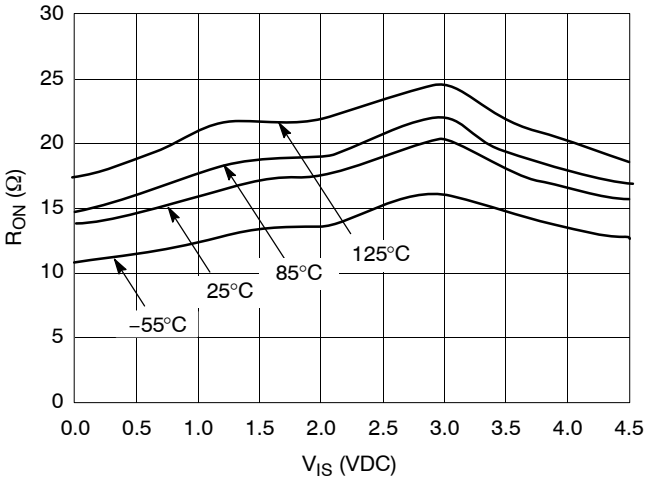


Figure 21. R_{ON} vs. Temp, V_{CC} = 4.5 V

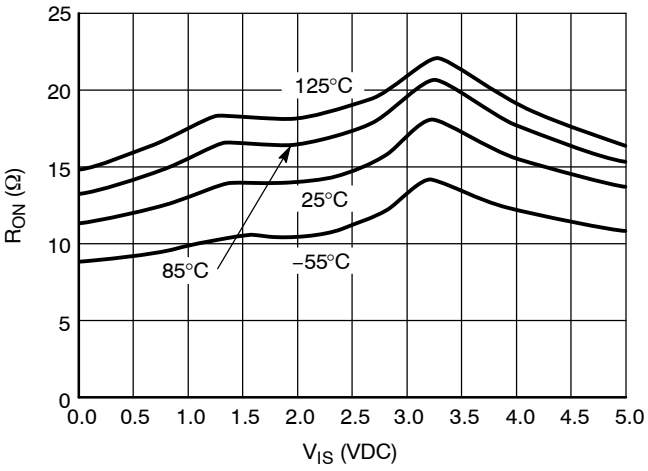


Figure 22. R_{ON} vs. Temp, V_{CC} = 5.0 V

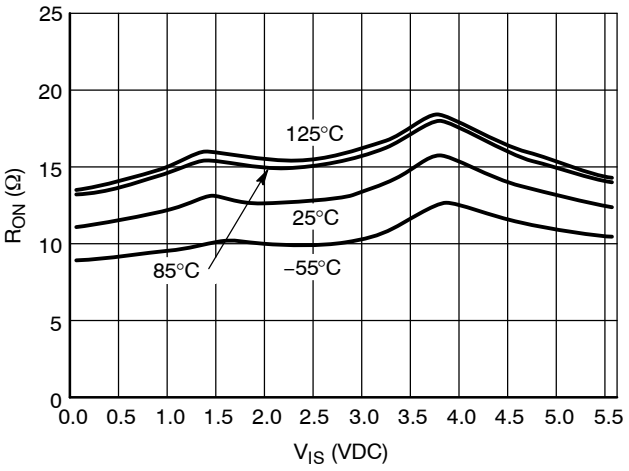


Figure 23. R_{ON} vs. Temp, V_{CC} = 5.5 V

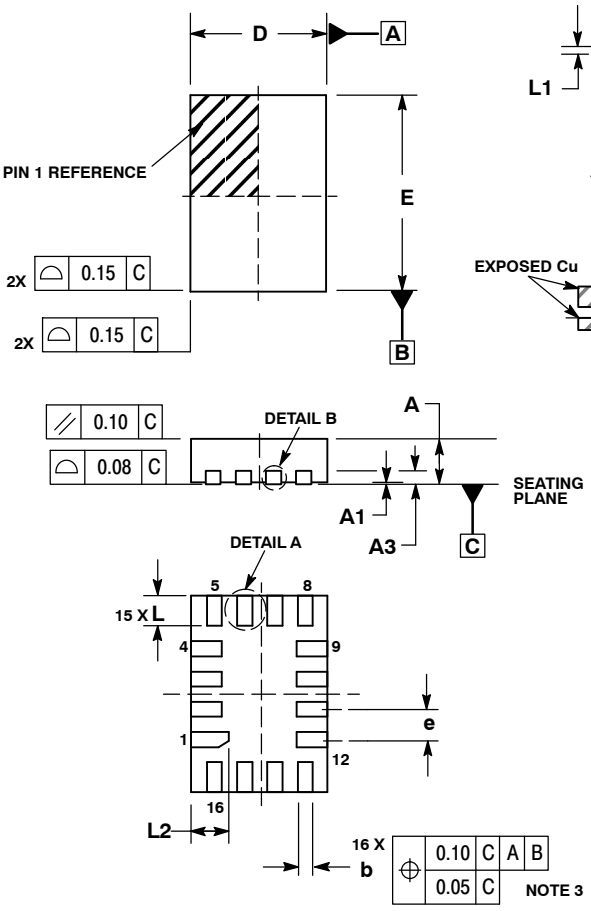
DEVICE ORDERING INFORMATION

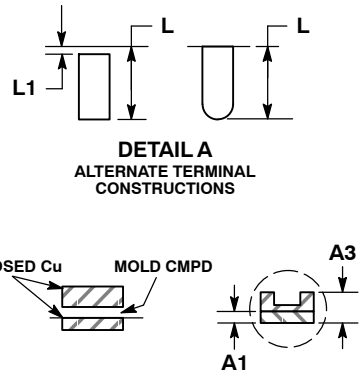
Device	Device Nomenclature					Package Type	Shipping†
	Circuit Indicator	Technology	Device Function	Package Suffix	Tape & Reel Suffix		
NLAS9431MTR2G	NL	AS	9431	MT	R2	WQFN16 (Pb−Free)	3000 / Tape & Reel

†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.

PACKAGE DIMENSIONS

WQFN16, 1.8x2.6, 0.4P
CASE 488AP−01
ISSUE B

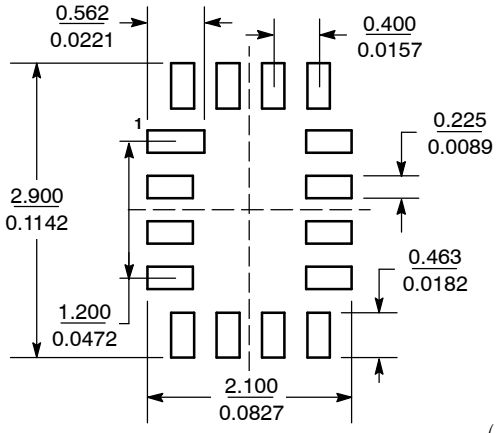




NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.25 AND 0.30 MM FROM TERMINAL.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.
5. EXPOSED PADS CONNECTED TO DIE FLAG. USED AS TEST CONTACTS.

	MILLIMETERS	
DIM	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*



SCALE 20:1 (mm / inches)

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Literature Distribution Center for ON Semiconductor
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Fax: 303−675−2176 or 800−344−3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

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