

# NLAS9099

## Product Preview

### Dual DPDT Ultra-Low $R_{ON}$ Switch

The NLAS9099 is a dual independent ultra-low  $R_{ON}$  DPDT analog switch. This device is designed for low operating voltage, high current switching of speaker output for cell phone applications. It can switch a balanced stereo output. The NLAS9099 can handle a balanced microphone/speaker/ring-tone generator in a monophone mode. The device contains a break-before-make feature.

#### Features

- Suitable for Dual SIM Cards
- Single Supply Operation  
1.65 to 4.5 V  $V_{CC}$   
Function Directly from LiON Battery
- Maximum Breakdown Voltage: 5.5 V
- Tiny 3 x 3 mm QFN Pb-Free Package  
Meet JEDEC MO-220 Specifications
- Low Static Power
- This is a Pb-Free Device\*

#### Typical Applications

- Cell Phone Speaker/Microphone Switching
- Ringtone-Chip/Amplifier Switching
- Four Unbalanced (Single-Ended) Switches
- Stereo Balanced (Push-Pull) Switching

#### Important Information

- ESD Protection:  
HBM (Human Body Model) > 8000 V  
MM (Machine Model) > 400 V
- Continuous Current Rating Through each Switch  $\pm 300$  mA
- Conforms to: JEDEC MO-220, Issue H, Variation VEED-6
- Pin for Pin Compatible with STG3699

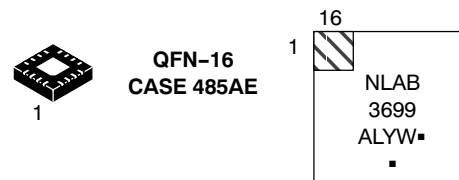
For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.



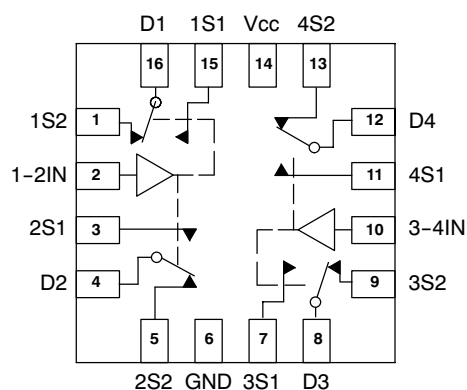
ON Semiconductor®

<http://onsemi.com>

#### MARKING DIAGRAMS



A = Assembly Location  
L = Wafer Lot  
Y = Year  
W = Work Week  
▪ = Pb-Free Package  
(Note: Microdot may be in either location)



#### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 9 of this data sheet.

# NLAS9099

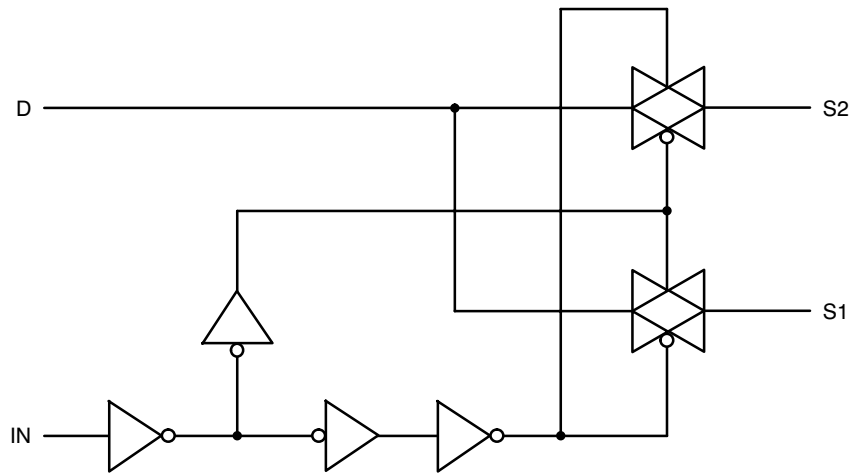


Figure 1. Input Equivalent Circuit

## PIN DESCRIPTION

QFN PIN #	Symbol	Name and Function
1, 3, 5, 7, 9, 11, 13, 15	1S1 to 4S1, 1S2 to 4S2	Independent Channels
2, 10	1-2IN, 3-4IN	Controls
4, 8, 12, 16	D1 to D4	Common Channels
6	GND	Ground (V)
14	V <sub>CC</sub>	Positive Supply Voltage

## TRUTH TABLE

IN	S1	S2
H	ON	OFF(*)
L	OFF(*)	ON

High impedance.

# NLAS9099

## MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
$V_{CC}$	Positive DC Supply Voltage	- 0.5 to +5.5	V
$V_{IS}$	Analog Input Voltage ( $V_{NO}$ , $V_{NC}$ , or $V_{COM}$ )	$-0.5 \leq V_{IS} \leq V_{CC}$	V
$V_{IN}$	Digital Select Input Voltage	$-0.5 \leq V_I \leq +5.5$	V
$I_{ani1}$	Continuous DC Current from COM to NC/NO	$\pm 300$	mA
$I_{ani-pk 1}$	Peak Current from COM to NC/NO, 10 duty cycle (Note NO TAG)	$\pm 500$	mA
$I_{clmp}$	Continuous DC Current into COM/NO/NC with respect to $V_{CC}$ or GND	$\pm 100$	mA
$t_r, t_f$	Input Rise or Fall Time, SELECT	$V_{CC} = 1.6\text{ V} - 2.7\text{ V}$ $V_{CC} = 3.0\text{ V} - 4.5\text{ V}$	0      20 0      10 ns/V

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.

Defined as 10% ON, 90% off duty cycle.

## RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min	Max	Unit
$V_{CC}$	DC Supply Voltage	1.65	4.5	V
$V_{IN}$	Digital Select Input Voltage	GND	$V_{CC}$	V
$V_{IS}$	Analog Input Voltage (NC, NO, COM)	GND	$V_{CC}$	V
$T_A$	Operating Temperature Range	-40	+85	°C
$t_r, t_f$	Input Rise or Fall Time, SELECT	$V_{CC} = 1.6\text{ V} - 2.7\text{ V}$ $V_{CC} = 3.0\text{ V} - 4.5\text{ V}$	0      20 0      10 ns/V	

# NLAS9099

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

Symbol	Parameter	Condition	V <sub>CC</sub>	Guaranteed Limit		Unit
				-40°C to 25°C	<85°C	
V <sub>IH</sub>	Minimum High-Level Input Voltage, Select Inputs		1.8	1.2	1.2	V
			2.5	1.7	1.7	
			3.6	2.2	2.2	
			4.3	2.6	2.6	
V <sub>IL</sub>	Maximum Low-Level Input Voltage, Select Inputs		1.8	0.4	0.4	V
			2.5	0.5	0.5	
			3.6	0.7	0.7	
			4.3	0.9	0.9	
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 NO TAG)	Select and V <sub>IS</sub> = V <sub>CC</sub> or GND	1.65 to 4.5	±1.0	±2.0	μA

## DC ELECTRICAL CHARACTERISTICS – Analog Section

Symbol	Parameter	Condition	V <sub>CC</sub>	Guaranteed Maximum Limit				Unit
				-40°C to 25°C		<85°C		
				Min	Max	Min	Max	
R <sub>ON</sub>	NC/NO On-Resistance (Note NO TAG)	V <sub>IN</sub> ≤ V <sub>IL</sub> or V <sub>IN</sub> ≥ V <sub>IH</sub> V <sub>IS</sub> = GND to V <sub>CC</sub>  I <sub>IN</sub>   ≤ 100 mA	2.5		0.65		0.75	Ω
			3.0		0.6		0.75	
			4.3		0.55		0.70	
R <sub>FLAT</sub>	NC/NO On-Resistance Flatness (Notes NO TAG, NO TAG)	I <sub>COM</sub> = 100 mA V <sub>IS</sub> = 0 to V <sub>CC</sub>	2.5		0.15		0.15	Ω
			3.0		0.15		0.15	
			4.3		0.15		0.15	
ΔR <sub>ON</sub>	On-Resistance Match Between Channels (Notes NO TAG and NO TAG)	V <sub>IS</sub> = 1.3 V; I <sub>COM</sub> = 100 mA V <sub>IS</sub> = 1.5 V; I <sub>COM</sub> = 100 mA V <sub>IS</sub> = 2.2 V; I <sub>COM</sub> = 100 mA	2.5		0.06		0.06	Ω
			3.0		0.05		0.05	
			4.3		0.05		0.05	
I <sub>NC(OFF)</sub> I <sub>NO(OFF)</sub>	NC or NO Off Leakage Current (Note NO TAG)	V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub> V <sub>NO</sub> or V <sub>NC</sub> = 0.3 V V <sub>COM</sub> = 4.0 V	4.3	-10	10	-100	100	nA
I <sub>COM(ON)</sub>	COM ON Leakage Current (Note NO TAG)	V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub> V <sub>NO</sub> 0.3 V or 4.0 V with V <sub>NC</sub> floating or V <sub>NC</sub> 0.3 V or 4.0 V with V <sub>NO</sub> floating V <sub>COM</sub> = 0.3 V or 4.0 V	4.3	-10	10	-100	100	nA

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

ΔR<sub>ON</sub> = R<sub>ON(MAX)</sub> - R<sub>ON(MIN)</sub> between nS1 or nS2.

Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal ranges.

# NLAS9099

## 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
					-40°C to 25°C			< 85°C		
					Min	Typ*	Max	Min	Max	
$t_{ON}$	Turn-On Time	$R_L = 50 \Omega$ , $C_L = 35$ pF (Figures 3 and 4)	2.3 - 4.5	1.5			50		60	ns
$t_{OFF}$	Turn-Off Time	$R_L = 50 \Omega$ , $C_L = 35$ pF (Figures 3 and 4)	2.3 - 4.5	1.5			30		40	ns
$t_{BBM}$	Minimum Break-Before-Make Time	$V_{IS} = 3.0$ $R_L = 50 \Omega$ , $C_L = 35$ pF (Figure 2)	3.0	1.5	2	15				ns

		Typical @ 25, $V_{CC} = 4.5$ V		
$C_{IN}$	Control Pin Input Capacitance	7.0		pF
$C_{SN}$	SN Port Capacitance	72		pF
$C_D$	D Port Capacitance When Switch is Enabled	230		pF

Typical Characteristics  
are at 25°C.

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

Symbol	Parameter	Condition	$V_{CC}$ (V)	25°C	Unit
				Typical	
BW	Maximum On-Channel -3dB Bandwidth or Minimum Frequency Response (Figure 12)	$V_{IN}$ centered between $V_{CC}$ and GND (Figure 5)	1.65 - 4.5	20	MHz
$V_{ONL}$	Maximum Feed-through On Loss	$V_{IN} = 0$ dBm @ 100 kHz to 50 MHz $V_{IN}$ centered between $V_{CC}$ and GND (Figure 5)	1.65 - 4.5	-0.06	dB
$V_{ISO}$	Off-Channel Isolation (Figure 13)	$f = 100$ kHz; $V_{IS} = 1$ V RMS; $C_L = 5$ pF $V_{IN}$ centered between $V_{CC}$ and GND (Figure 5)	1.65 - 4.5	-62	dB
Q	Charge Injection Select Input to Common I/O (Figure 8)	$V_{IN} = V_{CC}$ to GND, $R_{IS} = 0 \Omega$ , $C_L = 1$ nF $Q = C_L \times \Delta V_{OUT}$ (Figure 6)	1.65 - 4.5	50	pC
THD	Total Harmonic Distortion THD + Noise (Figure 7)	$F_{IS} = 20$ Hz to 20 kHz, $R_L = R_{gen} = 600 \Omega$ , $C_L = 50$ pF $V_{IS} = 2$ V <sub>PP</sub>	4.5	0.01	%
VCT	Channel-to-Channel Crosstalk	$f = 100$ kHz; $V_{IS} = 1$ V RMS, $C_L = 5$ pF, $R_L = 50 \Omega$ $V_{IN}$ centered between $V_{CC}$ and GND (Figure 5)	1.65 - 4.5	-62	dB

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

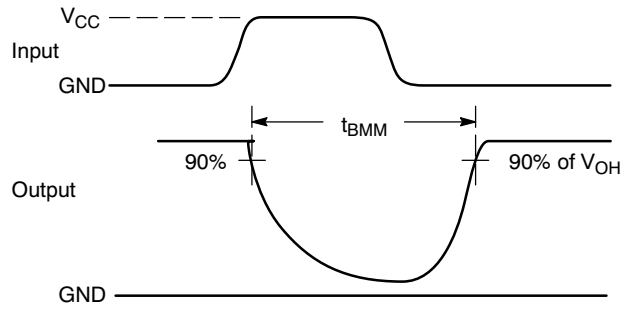
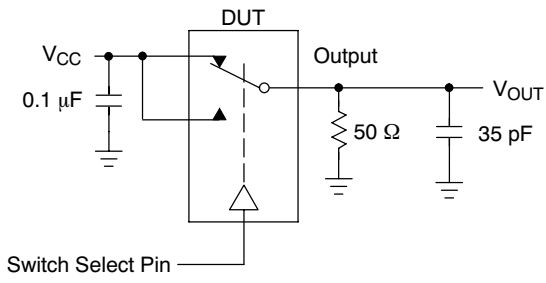


Figure 2.  $t_{BMM}$  (Time Break-Before-Make)

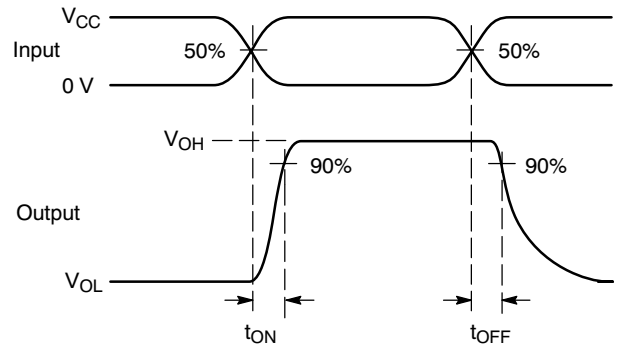
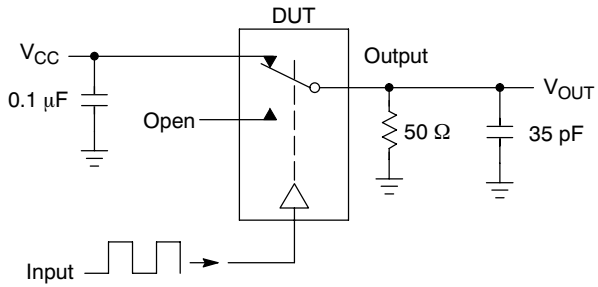


Figure 3.  $t_{ON}/t_{OFF}$

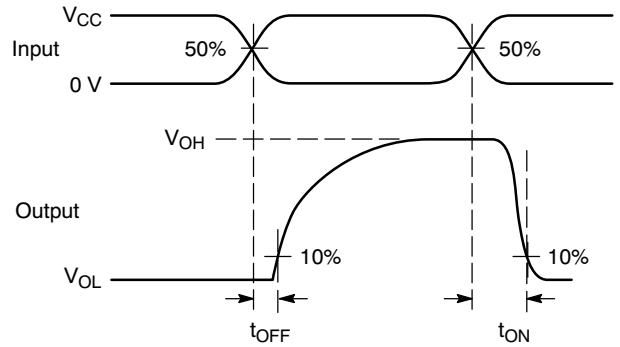
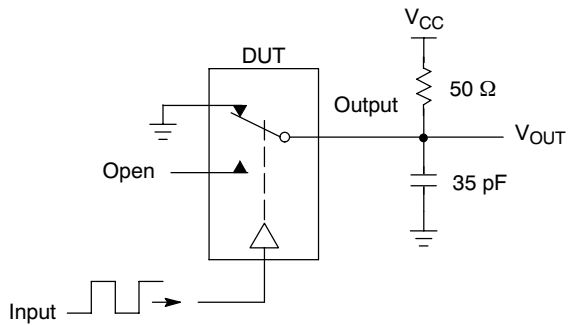
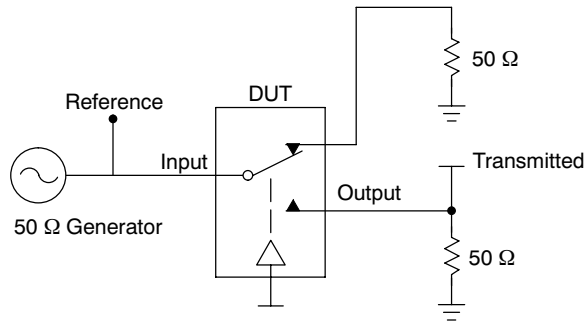


Figure 4.  $t_{ON}/t_{OFF}$



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.

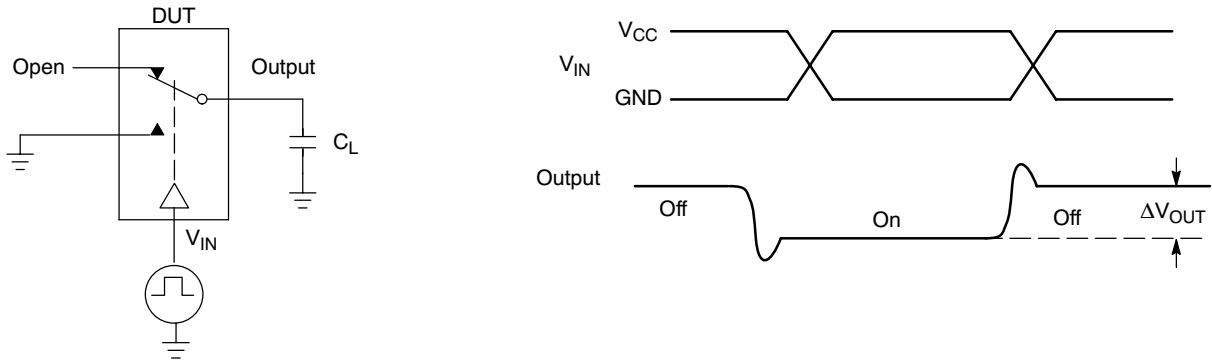
$$V_{ISO} = \text{Off Channel Isolation} = 20 \text{ Log} \left( \frac{V_{OUT}}{V_{IN}} \right) \text{ for } V_{IN} \text{ at } 100 \text{ kHz}$$

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

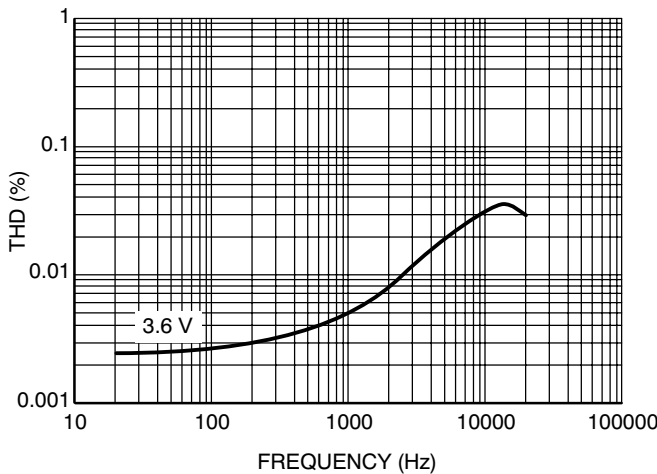
Bandwidth (BW) = the frequency 3 dB below  $V_{ONL}$

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

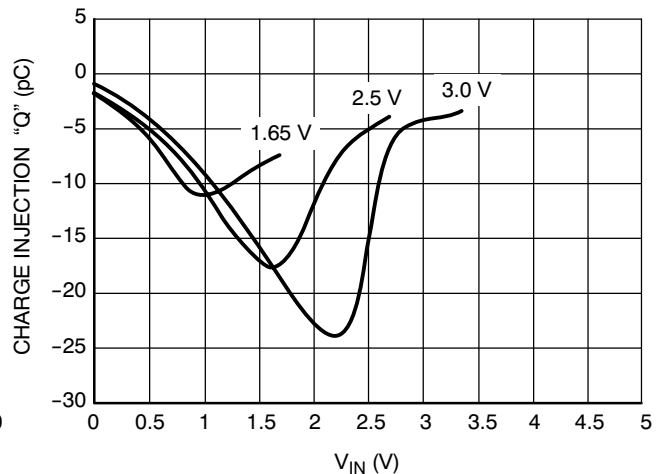
**Figure 5. Off Channel Isolation/On Channel Loss (BW)/Crosstalk (On Channel to Off Channel)/ $V_{ONL}$**



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



**Figure 7. Total Harmonic Distortion Plus Noise Versus Frequency**



**Figure 8. Charge Injection versus  $V_{is}$**

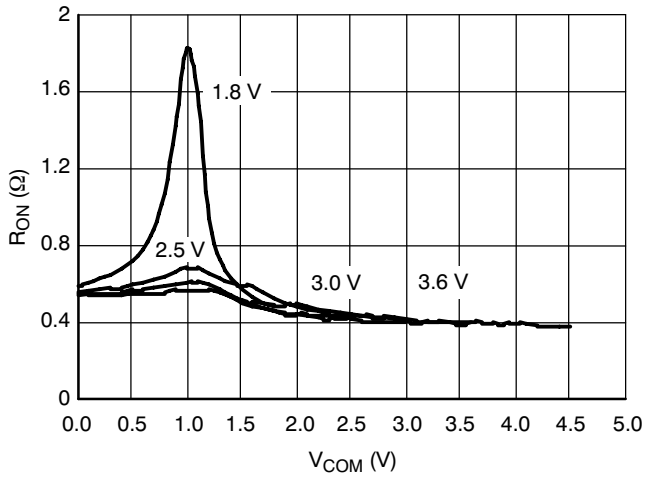


Figure 9. On-Resistance vs. COM Voltage

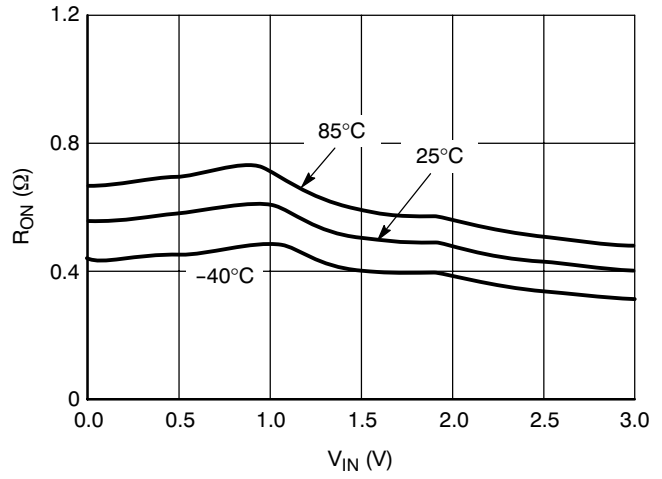


Figure 10.  $R_{ON}$  vs.  $V_{IN}$  vs. Temperature @  $V_{CC} = 3.0\text{ V}$

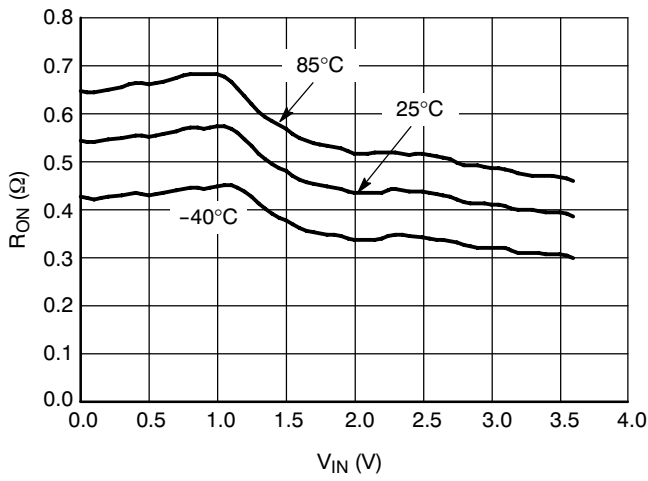


Figure 11.  $R_{ON}$  vs.  $V_{IN}$  vs. Temperature @  $V_{CC} = 3.6\text{ V}$

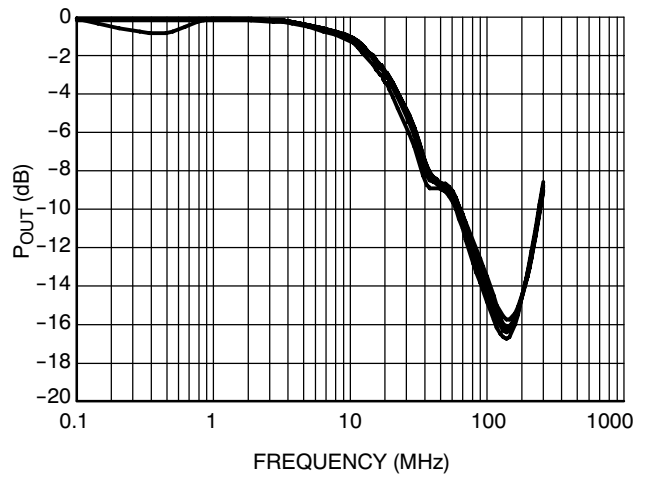


Figure 12. Bandwidth vs. Frequency @  $V_{CC} = 1.65\text{ V to }3.6\text{ V}$

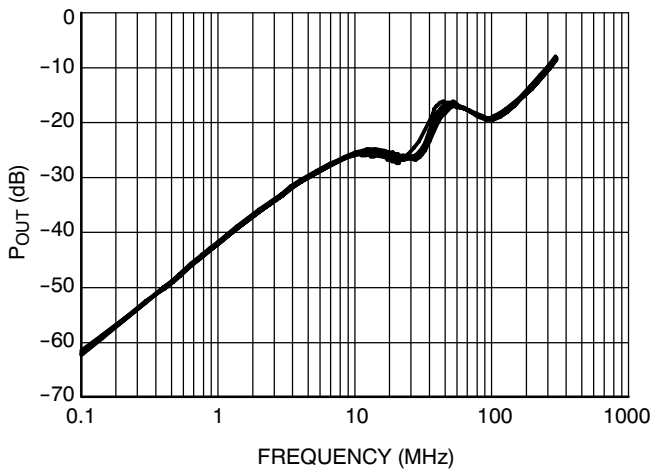


Figure 13. Off-Isolation vs. Frequency @  $V_{CC} = 1.65\text{ V to }3.6\text{ V}$

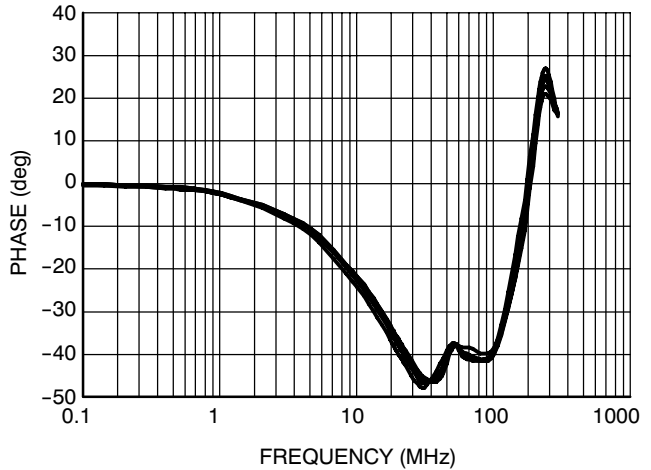


Figure 14. Phase Angle vs. Frequency @  $V_{CC} = 1.65\text{ V to }3.6\text{ V}$



# NLAS9099

## DEVICE ORDERING INFORMATION

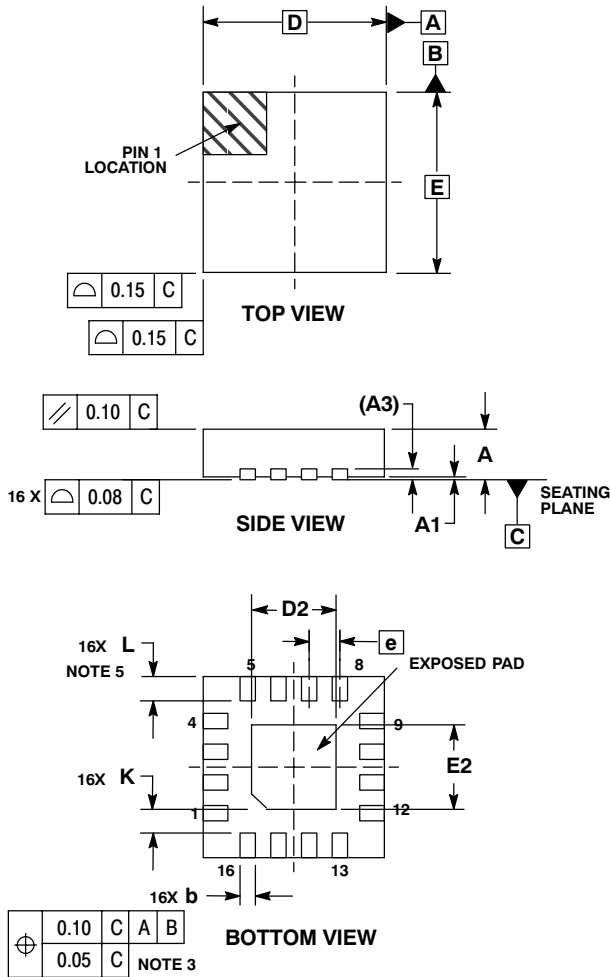
Device Order Number	Device Nomenclature					Package Type	Tape & Reel Size <sup>†</sup>
	Circuit Indicator	Technology	Device Function	Package Suffix	Tape & Reel Suffix		
NLAS9099MN1R2G	NL	AS	9099	MN1	R2G	QFN (Pb-Free)	3000 Unit / Reel

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.

# NLAS9099

## PACKAGE DIMENSIONS

QFN-16 (3 x 3 x 0.85 mm)  
CASE 485AE-01  
ISSUE O



### 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. OUTLINE MEETS JEDEC DIMENSIONS PER MO-220, VARIATION VEED-6.

DIM	MILLIMETERS		
	MIN	NOM	MAX
A	0.800	0.900	1.000
A1	0.000	0.025	0.050
A3	0.200 REF		
b	0.180	0.250	0.300
D	3.00 BSC		
D2	1.250	1.40	1.550
E	3.00 BSC		
E2	1.250	1.40	1.550
e	0.500 BSC		
K	0.200	---	---
L	0.300	0.400	0.500

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