

NLAS44599

Low Voltage Single Supply Dual DPDT Analog Switch

The NLAS44599 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 NLAS44599 can also be used as a quad 2-to-1 multiplexer-demultiplexer analog switch with two Select pins that each controls two multiplexer-demultiplexers.

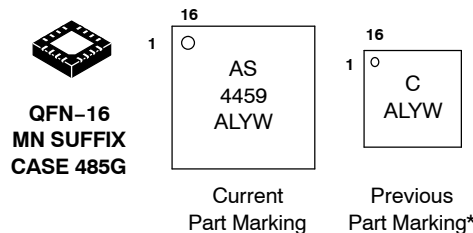
- Channel Select Input Over-Voltage Tolerant to 5.5 V
- Fast Switching and Propagation Speeds
- Break-Before-Make Circuitry
- Low Power Dissipation: $I_{CC} = 2 \mu\text{A}$ (Max) at $T_A = 25^\circ\text{C}$
- Diode Protection Provided on Channel Select Input
- Improved Linearity and Lower ON Resistance over Input Voltage
- Latch-up Performance Exceeds 300 mA
- ESD Performance: Human Body Model; > 2000 V,
Machine Model; > 200 V
- Chip Complexity: 158 FETs
- Pb-Free Packages are Available



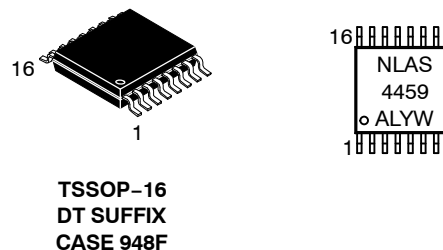
ON Semiconductor®

<http://onsemi.com>

MARKING DIAGRAMS



*Previous releases of this device may be marked as shown in this diagram.

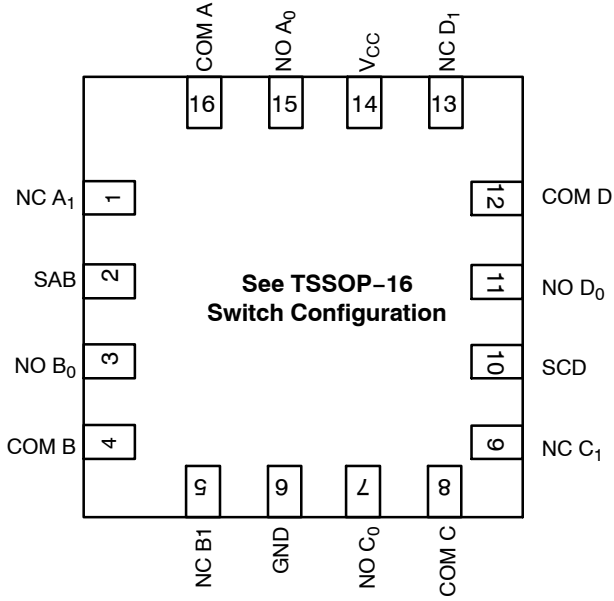


A = Assembly Location
L = Wafer Lot
Y = Year
W = Work Week

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

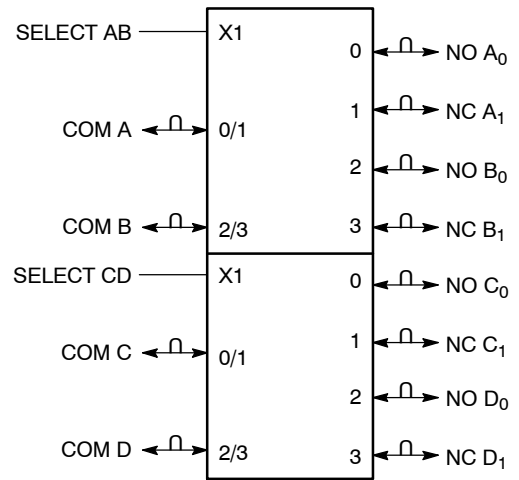
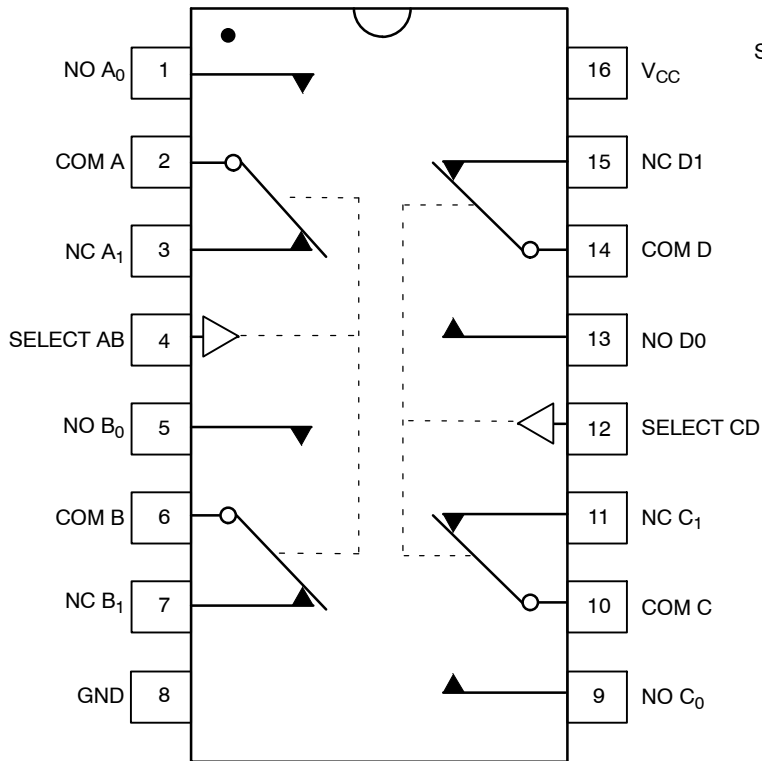


Figure 2. IEC Logic Symbol

Figure 1. Logic Diagram

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 _{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-V0 (0.125 in) | |
| V _{ESD} | ESD Withstand Voltage | Human Body Model (Note 1) Machine Model (Note 2) Charged Device Model (Note 3) | 2000 200 1000 | V |
| I _{Latch-Up} | Latch-Up Performance | Above V _{CC} and Below GND at 125°C (Note 4) | ±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/JESD22-A114-A.
2. Tested to EIA/JESD22-A115-A.
3. Tested to JESD22-C101-A.
4. 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 |

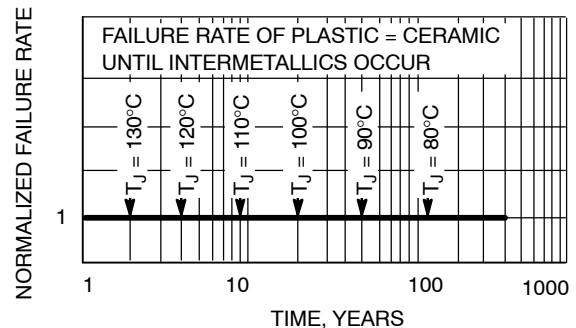


Figure 3. Failure Rate vs. Time Junction Temperature

NLAS44599

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 | 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 _{IL} | 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 _{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 |

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 | | |

| Symbol | Parameter | Typical @ 25, V _{CC} = 5.0 V | | | Unit |
|------------------------------------|---|---------------------------------------|-----|-----|------|
| | | Min | Typ | 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 | | |

*Typical Characteristics are at 25°C.

ADDITIONAL APPLICATION CHARACTERISTICS (Voltages Referenced to GND Unless Noted)

| Symbol | Parameter | Condition | V _{CC} V | Typical | Unit |
|------------------|---|---|----------------------|---------|------|
| | | | | 25°C | |
| BW | Maximum On-Channel -3dB 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 | |

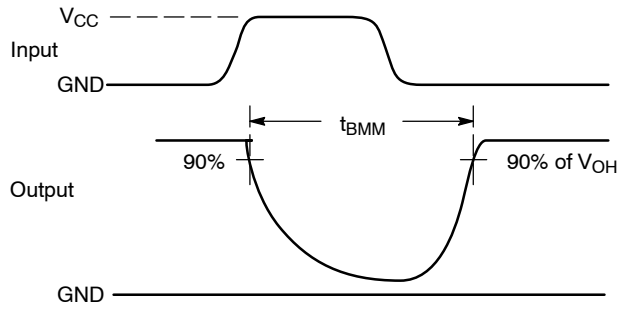
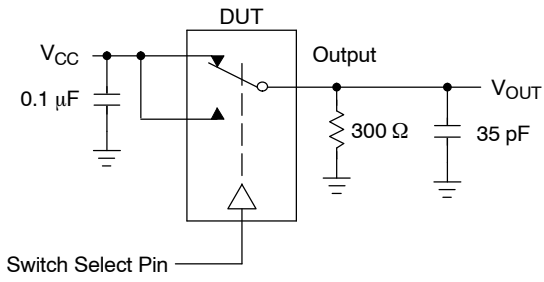


Figure 4. t_{BMM} (Time Break-Before-Make)

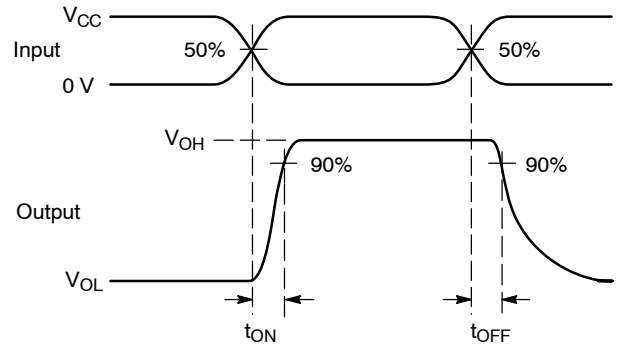
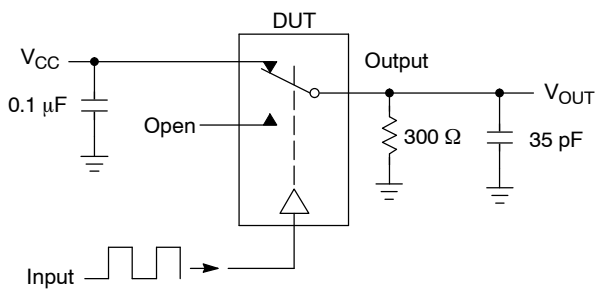


Figure 5. t_{ON}/t_{OFF}

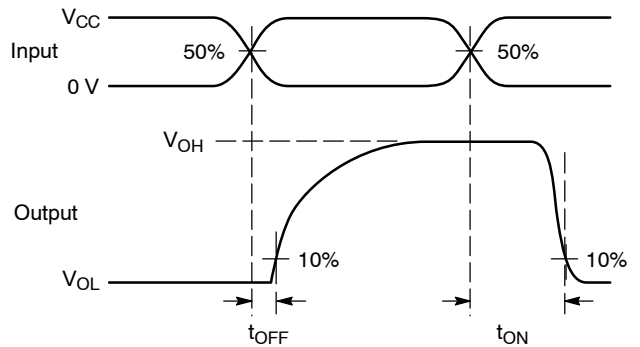
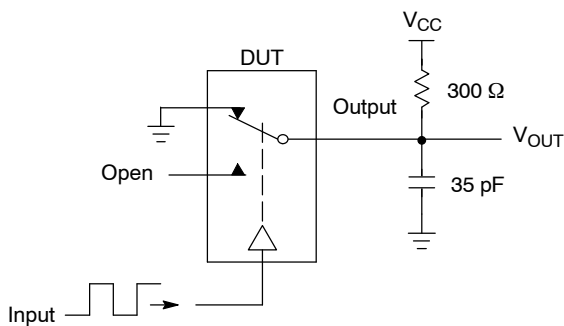
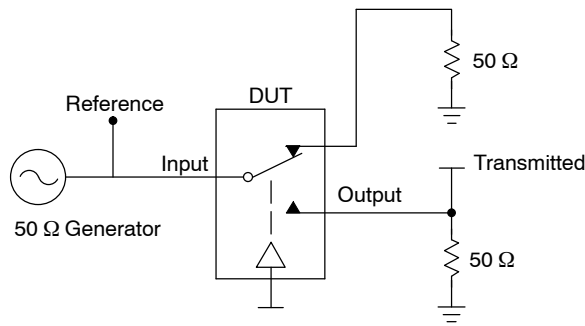


Figure 6. t_{ON}/t_{OFF}



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)

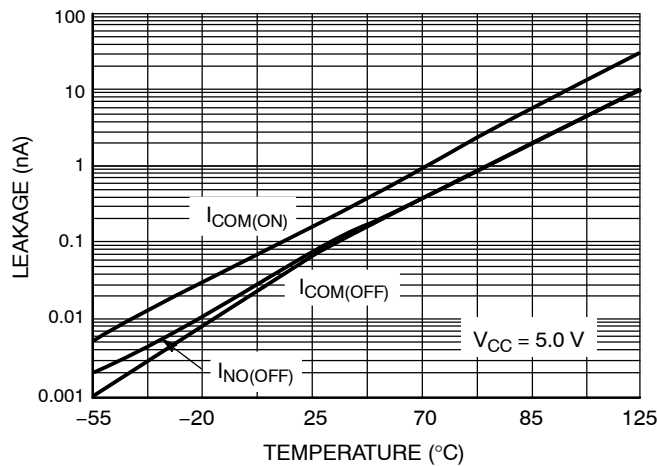


Figure 9. Switch Leakage vs. Temperature

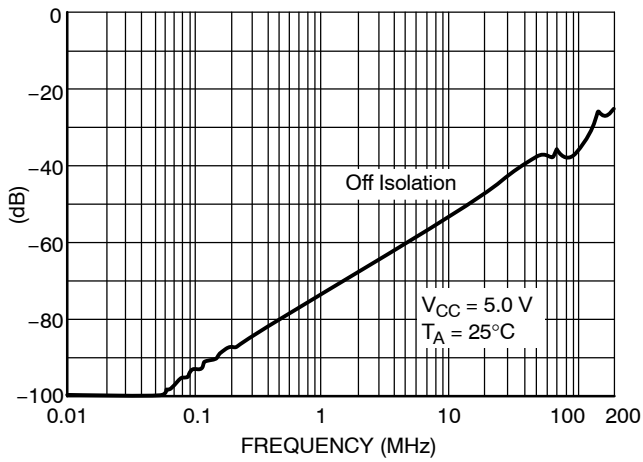


Figure 10. Off-Channel Isolation

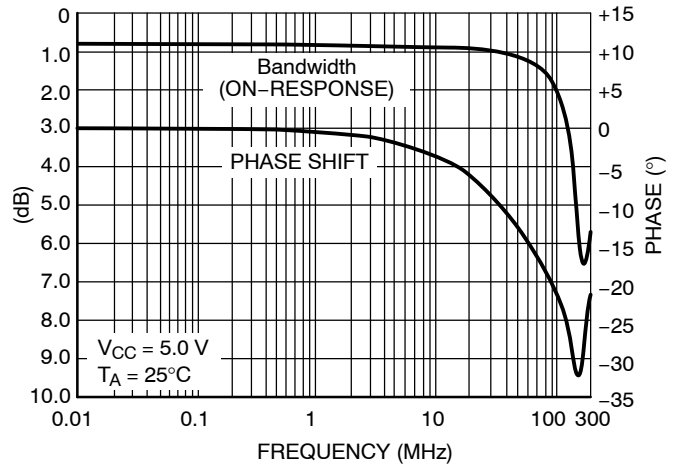


Figure 11. Typical Bandwidth and Phase Shift



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

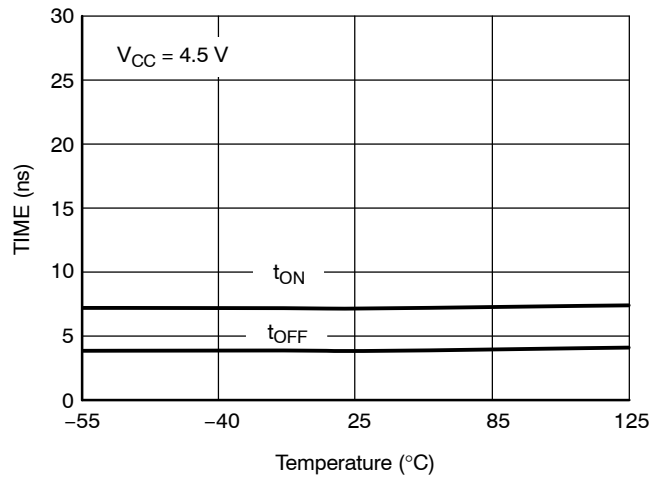


Figure 13. t_{ON} and t_{OFF} vs. Temp



Figure 14. Total Harmonic Distortion Plus Noise vs. Frequency



Figure 15. Charge Injection vs. COM Voltage



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

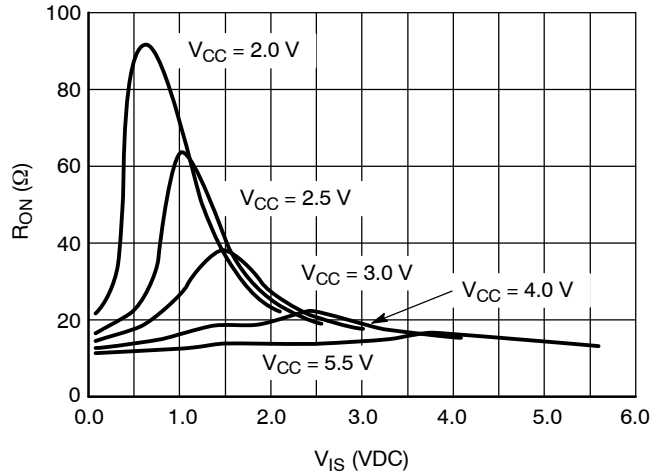


Figure 17. R_{ON} vs. V_{CC} , Temp = 25°C

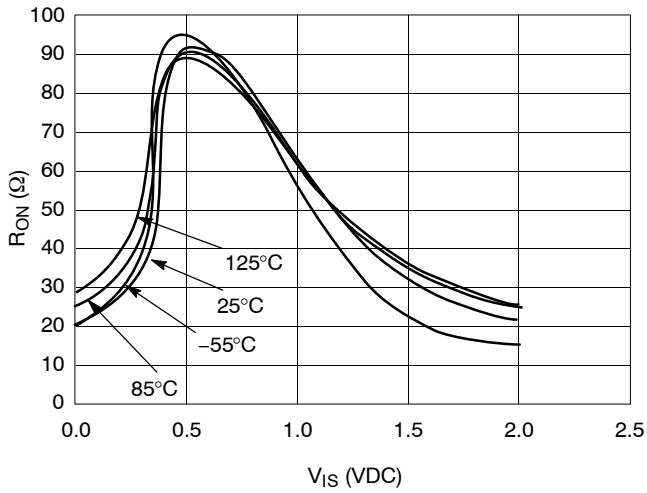


Figure 18. R_{ON} vs Temp, $V_{CC} = 2.0\text{ V}$

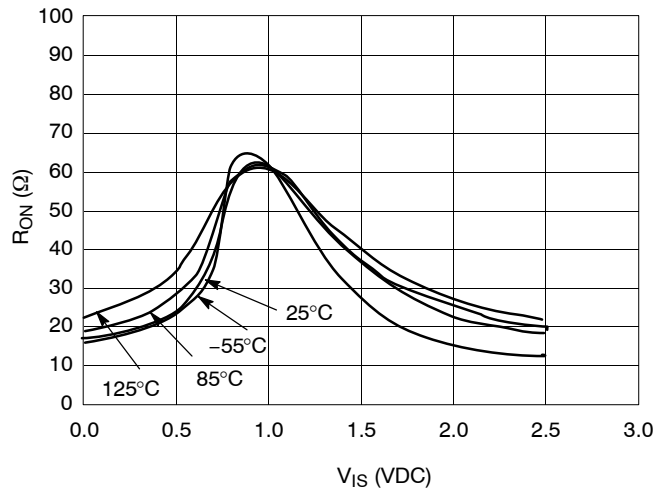


Figure 19. R_{ON} vs. Temp, $V_{CC} = 2.5\text{ V}$

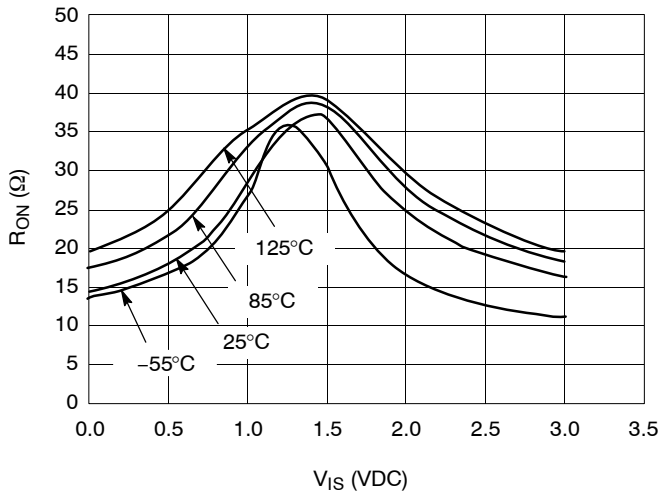


Figure 20. R_{ON} vs. Temp, $V_{CC} = 3.0\text{ V}$

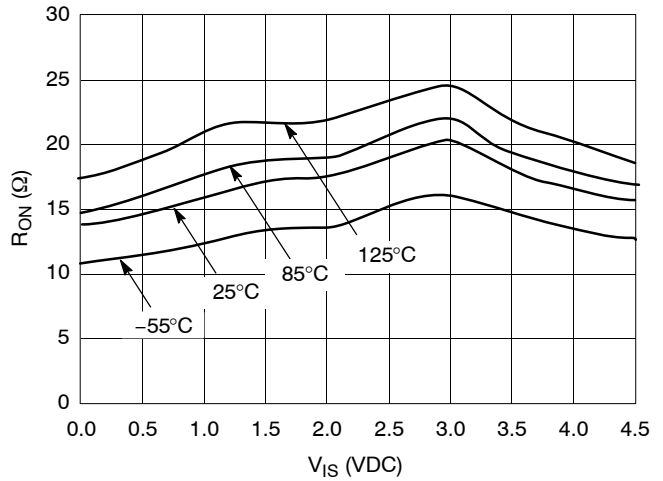


Figure 21. R_{ON} vs. Temp, $V_{CC} = 4.5\text{ V}$

NLAS44599



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

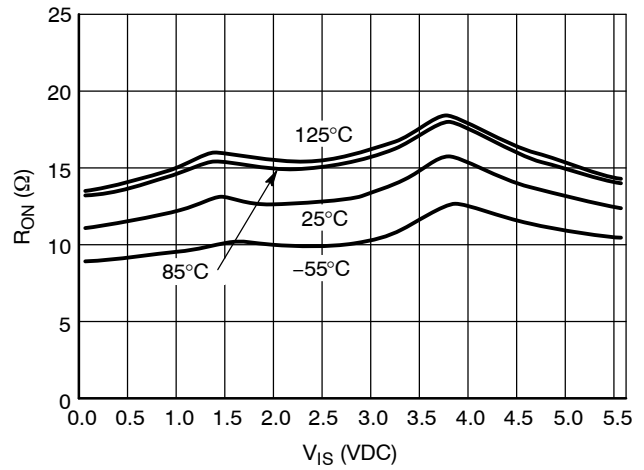


Figure 23. R_{ON} vs. Temp, $V_{CC} = 5.5$ V

DEVICE ORDERING INFORMATION

| Device | Device Nomenclature | | | | | Package Type | Shipping [†] |
|----------------|---------------------|------------|-----------------|----------------|--------------------|------------------|-----------------------|
| | Circuit Indicator | Technology | Device Function | Package Suffix | Tape & Reel Suffix | | |
| NLAS44599DT | NL | AS | 44599 | DT | | TSSOP-16* | 96 / Unit Rail |
| NLAS44599DTR2 | NL | AS | 44599 | DT | R2 | TSSOP-16* | 2500 / Tape & Reel |
| NLAS44599MN | NL | AS | 44599 | MN | | QFN-16 | 124 Unit / Rail |
| NLAS44599MNG | NL | AS | 44599 | MN | | QFN-16 (Pb-Free) | 124 Unit / Rail |
| NLAS44599MNR2 | NL | AS | 44599 | MN | R2 | QFN-16 | 2500 / Tape & Reel |
| NLAS44599MNR2G | NL | AS | 44599 | MN | R2 | QFN-16 (Pb-Free) | 2500 / 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.

MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



SCALE 2:1

QFN16 3x3, 0.5P
CASE 485G
ISSUE G

DATE 08 OCT 2021



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 0.15 AND 0.30 MM FROM THE TERMINAL TIP.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.



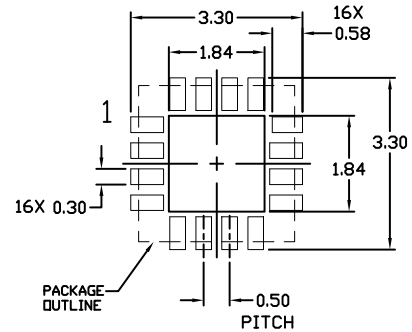
DETAIL B
ALTERNATE
CONSTRUCTIONS



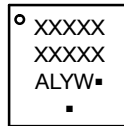
DETAIL A
ALTERNATE TERMINAL
CONSTRUCTIONS

| DIM | MILLIMETERS | | |
|----------|-------------|------|------|
| | MIN. | NDM. | MAX. |
| A | 0.80 | 0.90 | 1.00 |
| A1 | 0.00 | 0.03 | 0.05 |
| A3 | 0.20 REF | | |
| <i>b</i> | 0.18 | 0.24 | 0.30 |
| D | 3.00 BSC | | |
| D2 | 1.65 | 1.75 | 1.85 |
| E | 3.00 BSC | | |
| E2 | 1.65 | 1.75 | 1.85 |
| <i>e</i> | 0.50 BSC | | |
| <i>k</i> | 0.18 TYP | | |
| L | 0.30 | 0.40 | 0.50 |
| L1 | 0.00 | 0.08 | 0.15 |

MOUNTING FOOTPRINT



GENERIC MARKING DIAGRAM*



- XXXXX = Specific Device Code
- A = Assembly Location
- L = Wafer Lot
- Y = Year
- W = Work Week
- = Pb-Free Package

(Note: Microdot may be in either location)

*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

| | | |
|-------------------------|------------------------|--|
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| DESCRIPTION: | QFN16 3X3, 0.5P | PAGE 1 OF 1 |

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MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



TSSOP-16 WB
CASE 948F
ISSUE B

DATE 19 OCT 2006



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
5. DIMENSION K DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE K DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
7. DIMENSION A AND B ARE TO BE DETERMINED AT DATUM PLANE -W-.

| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|------|-----------|-------|
| | MIN | MAX | MIN | MAX |
| A | 4.90 | 5.10 | 0.193 | 0.200 |
| B | 4.30 | 4.50 | 0.169 | 0.177 |
| C | --- | 1.20 | --- | 0.047 |
| D | 0.05 | 0.15 | 0.002 | 0.006 |
| F | 0.50 | 0.75 | 0.020 | 0.030 |
| G | 0.65 BSC | | 0.026 BSC | |
| H | 0.18 | 0.28 | 0.007 | 0.011 |
| J | 0.09 | 0.20 | 0.004 | 0.008 |
| J1 | 0.09 | 0.16 | 0.004 | 0.006 |
| K | 0.19 | 0.30 | 0.007 | 0.012 |
| K1 | 0.19 | 0.25 | 0.007 | 0.010 |
| L | 6.40 BSC | | 0.252 BSC | |
| M | 0° | 8° | 0° | 8° |

**RECOMMENDED
SOLDERING FOOTPRINT***



**GENERIC
MARKING DIAGRAM***



- XXXX = Specific Device Code
- A = Assembly Location
- L = Wafer Lot
- Y = Year
- W = Work Week
- G or ■ = Pb-Free Package

*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "■", may or may not be present. Some products may not follow the Generic Marking.

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

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|-------------------------|--------------------|--|
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