# ON Semiconductor

## Is Now

# onsemi™

**To learn more about onsemi™, please visit our website at**
**www.onsemi.com**

# 5 Ω SPDT Switch

# NL5S4257B, NL5S4257C

The NL5S4257B and NL5S4257C are 5 Ω SPDT analog switches with soft−start feature. The devices are designed for a wide operating voltage range.

## Features

- Wide $V_{CC}$ Operating Range: 1.65 V to 5.5 V
- OVT up to +5.5 V for Control pin
- $R_{ON}$: Typically < 5 Ω at $V_{CC}$ = 4.5 V
- Rail−to−Rail Input/Output
- This Device is Pb−Free, Halogen Free/BFR Free and is RoHS Compliant

## Typical Applications

- Cell Phone Speaker/Microphone Switching
- RF PA Routing

**ON Semiconductor®**

**MARKING DIAGRAMS**



SC−88/SC70−6/SOT−363
CASE 419B−02



SC−74
CASE 318F−05
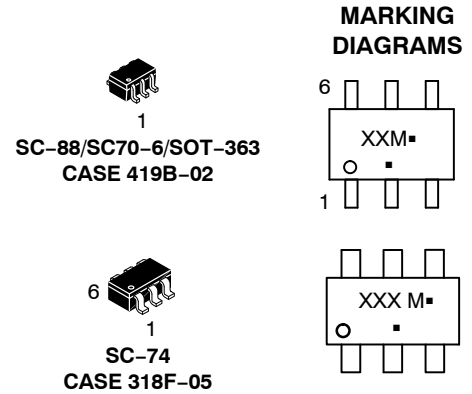
XX = Specific Device Code
M = Date Code*
▪ = Pb−Free Package

(Note: Microdot may be in either location)

*Date Code orientation and/or position may vary depending upon manufacturing location.

WDFN8 2x3, 0.5P
CASE 511EE
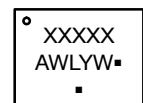


XXXX = Specific Device Code
A = Assembly Location
L = Wafer Lot
Y = Year
W = Work Week
▪ = Pb−Free Package

(Note: Microdot may be in either location)

## ORDERING INFORMATION
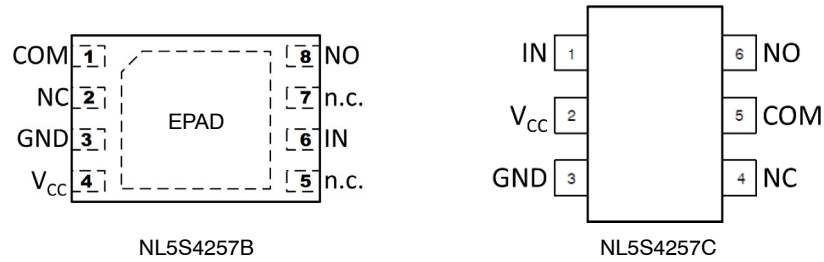
## PIN ASSIGNMENTS



**Figure 1. Pin Assignments (Top View)**
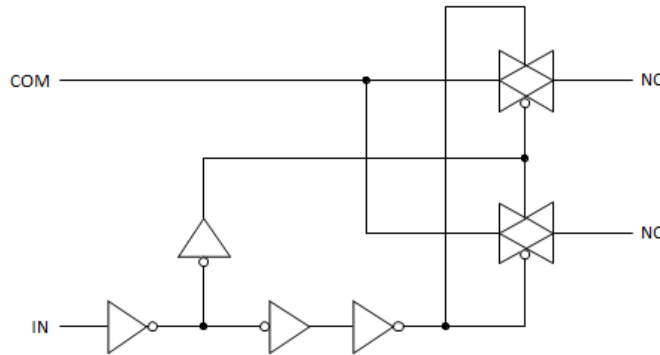


**Figure 2. Analog Symbol**

## PIN DESCRIPTIONS

| NL5S4257B | NL5S4257C | Name | Description |
|---|---|---|---|
| 8 | 6 | NO | Normally−Open Port |
| 4 | 2 | $V_{CC}$ | Supply |
| 2 | 4 | NC | Normally−Closed Port |
| 1 | 5 | COM | Common Port |
| 3, EPAD | 3 | GND | Supply Ground |
| 6 | 1 | IN | Switch Select Input |
| 5, 7 | | n.c. | No Internal Connection |

## FUNCTION TABLE

| IN | Switch |
|---|---|
| L | NC to COM |
| H | NO to COM |

**MAXIMUM RATINGS**

| Symbol | Rating | Value | Unit |
|---|---|---|---|
| $V_{CC}$ | Positive DC Supply Voltage | −0.5 to +6.0 | V |
| $V_{IS}$ | Switch Input / Output Voltage | −0.5 to $V_{CC}$+0.5 | V |
| $V_{IN}$ | Digital Select Input Voltage | −0.5 to +6.0 | V |
| $I_{OK}$ | I/O Port Diode Current | ±50 | mA |
| $I_{IK}$ | Select Input Diode Current | −50 | mA |
| $I_{I/O}$ | Continuous DC Current Through Analog Switch | ±50 | mA |
| $I_{I/O-pk}$ | Peak Current Through Analog Switch, 10% Duty Cycle | ±100 | mA |
| $T_s$ | Storage Temperature | −65 to +150 | °C |
| ESD | Human Body Model (HBM) | 2 | kV |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

**RECOMMENDED OPERATING CONDITIONS**

| Symbol | Parameter | | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{CC}$ | Positive DC Supply Voltage | | 1.65 | 5.5 | V |
| $V_{IS}$ | Switch Input / Output Voltage | | GND | $V_{CC}$ | V |
| $V_{IN}$ | Digital Select Input Voltage | | GND | 5.5 | V |
| $T_A$ | Operating Temperature Range | | −40 | +125 | °C |
| $t_r$, $t_f$ | Input Transition Rise or Fall Time (Select Input IN) | $V_{CC} \leq 3.0$ V | 0 | 20 | ns/V |
| | | $V_{CC} > 3.0$ V | 0 | 10 | |

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

**ELECTRICAL CHARACTERISTICS**

| Symbol | Parameter | Condition | $V_{CC}$ (V) | Guaranteed Limit | | | | | | | Unit |
|--------|-----------|-----------|--------------|------|-----|-----|-----|-----|-----|-----|------|
| | | | | 25°C | | | −40°C to 85°C | | −40°C to 125°C | | |
| | | | | Min | Typ | Max | Min | Max | Min | Max | |
| $V_{IH}$ | Input High Voltage | | 2.7 | 1.1 | | | 1.1 | | 1.1 | | V |
| | | | 5.0 | 1.42 | | | 1.42 | | 1.42 | | |
| $V_{IL}$ | Input Low Voltage | | 2.7 | | | 0.4 | | 0.4 | | 0.4 | V |
| | | | 5.0 | | | 0.7 | | 0.7 | | 0.7 | |
| $I_{IN}$ | Input Leakage Current | $V_{IN}$ = 0 V to 5.5 V | 1.65 – 5.5 | | | ±0.1 | | ±1 | | ±1 | μA |
| $I_{OFF}$ | Input Leakage Current | $V_{IN}$ = 0 to 5.5 V | 0 | | | 0.05 | | 1 | | 1 | μA |
| $I_{S(ON)}$ | ON–State Switch Leakage Current | $V_{IS}$ = GND to $V_{CC}$, $V_{OS}$ = Open | 5.5 | | | ±4.0 | | ±40 | | ±200 | nA |
| $I_{S(OFF)}$ | OFF–State Switch Leakage Current | $V_{IS}$ = $V_{CC}$ and $V_{OS}$ = GND, or $_{IS}$ = GND and $V_{OS}$ = $V_{CC}$ | 5.5 | | | ±4.0 | | ±20 | | ±200 | nA |
| $I_{CC}$ | Quiescent Supply Current | $V_{IN}$ = $V_{CC}$ or GND, $I_{OS}$ = 0 mA | 5.5 | | | 0.5 | | 5 | | 5 | μA |

## ANALOG SWITCH CHARACTERISTICS

| Symbol | Parameter | Condition | $V_{CC}$ (V) | Guaranteed Limit | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 25°C | | | −40°C to 125°C | | |
| | | | | Min | Typ | Max | Min | Max | |
| $R_{ON}$ (Note 1) | Switch ON Resistance | $V_{IS}$ = 0 to $V_{CC}$, $I_O$ = 15 mA | 2.7 | | 8.0 | 15.0 | | 16.0 | $\Omega$ |
| | | | 4.5 | | 5.0 | 6.0 | | 7.5 | |
| $\Delta R_{ON}$ (Notes 1, 2, 3) | ON Resistance Match Between Channels | $V_{IS}$ = 1.5 V, $I_A$ = 15 mA | 2.7 | | 0.1 | 0.5 | | 0.5 | $\Omega$ |
| | | $V_{IS}$ = 2.5 V, $I_A$ = 15 mA | 4.5 | | 0.08 | 0.5 | | 0.5 | |
| $R_{FLAT}$ (Notes 1, 2, 4) | ON Resistance Flatness | $V_{IS}$ = 0 to $V_{CC}$, $I_O$ = 15 mA | 2.7 | | 3.7 | | | | $\Omega$ |
| | | | 4.5 | | 1.2 | | | | |
| Q (Note 5) | Charge Injection | $C_L$ = 1 nF, $V_{GEN}$ = 0 V, $R_{GEN}$ = 0 $\Omega$ | 2.7 | | 26 | | | | pC |
| | | | 4.5 | | 48 | | | | |
| $V_{ISO}$ (Note 6) | Off−Isolation | $R_L$ = 50 $\Omega$, f = 1 MHz | 2.7 − 5.5 | | −65 | | | | dB |
| $V_{CT}$ | Crosstalk | $R_L$ = 50 $\Omega$, f = 1 MHz | 2.7 − 5.5 | | −70 | | | | dB |
| BW | −3 dB Bandwidth | $R_L$ = 50 $\Omega$ | 2.7 − 5.5 | | 130 | | | | MHz |
| THD (Note 5) | Total Harmonic Distortion | $R_L$ = 600 $\Omega$, $V_{IS}$ = 0.5 $V_{P-P}$, f = 20 Hz to 20 kHz | 2.7 − 5.5 | | 0.019 | | | | % |
| $C_I$ | Select Input Capacitance | f = 1 MHz | 0 | | 4.5 | | | | pF |
| $C_{OFF}$ | NC/NO Port Off Capacitance | f = 1 MHz | 4.5 | | 14 | | | | pF |
| $C_{ON}$ | COM Port ON Capacitance | f = 1 MHz | 4.5 | | 35 | | | | pF |

1. Measured by the voltage drop between NC/NO and COM pins at the indicated current through the switch. On Resistance is determined by the lower of the voltages on the two (NO, NC, COM).
2. Parameter is characterized but not tested in production.
3. $\Delta R_{ON}$ = $R_{ON}$ max − $R_{ON}$ min measured at identical $V_{CC}$, temperature and voltage levels.
4. Flatness is defined as the difference between the maximum and minimum value of On Resistance over the specified range of conditions.
5. Guaranteed by Design.
6. $V_{ISO}$ = 20 log10 [$V_{COM}/V_{NO,NC}$].

## SWITCHING CHARACTERISTICS

| Symbol | Parameter | Condition | V$_{CC}$ (V) | Guaranteed Limit | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 25°C | | | −40°C to 125°C | | |
| | | | | Min | Typ | Max | Min | Max | |
| t$_{PD}$ (Note 7) | Propagation Delay | V$_{IN}$ = V$_{IH}$ or V$_{IL}$ | 2.7 | | | 1.0 | | 1.0 | ns |
| | | | 4.5 | | | 0.5 | | 0.5 | |
| t$_{ON}$ | Turn−on Time, (COM to NO or NC) | R$_L$ = 50 Ω, C$_L$ = 100 pF | | | | | | | ns |
| | | V$_{IS}$ = 1.5 V | 2.7 | | | 300 | | 300 | |
| | | V$_{IS}$ = 3.0 V | 4.5 | | | 300 | | 300 | |
| | | R$_L$ = 50 Ω, C$_L$ = 100 pF | | | | | | | |
| | | V$_{IS}$ = 1.5 V | 3.3 | | | 300 | | 300 | |
| t$_{OFF}$ | Turn−off Time, (COM to NO or NC) | R$_L$ = 50 Ω, C$_L$ = 100 pF | | | | | | | ns |
| | | V$_{IS}$ = 1.5 V | 2.7 | | | 300 | | 300 | |
| | | V$_{IS}$ = 3.0 V | 4.5 | | | 300 | | 300 | |
| | | R$_L$ = 50 Ω, C$_L$ = 100 pF | | | | | | | |
| | | V$_{IS}$ = 1.5 V | 3.3 | | | 300 | | 300 | |
| t$_{BBM}$ (Note 5) | Break Before Make Time | R$_L$ = 50 Ω, C$_L$ = 100 pF | 2.7 | 15 | | | 15 | | ns |
| | | | 4.5 | 10 | | | 10 | | |

7. This parameter is guaranteed by design but not tested. The bus switch contributes no propagation delay other than the RC delay of the On Resistance of the switch and the 50 pF load capacitance, when driven by an ideal voltage source (zero output impedance).

## ORDERING INFORMATION

| Device | Package | Marking | Pin 1 Orientation (See below) | Shipping† |
|---|---|---|---|---|
| NL5S4257BMT1TAG (Contact ON Semiconductor) | WDFN8 2x3, 0.5P | AA | Q1 | 3000 / Tape & Reel |
| NL5S4257CDFT2G | SC−88/SC70−6/SOT−363 | AV | Q4 | 3000 / Tape & Reel |
| NL5S4257CDBVT1G (Contact ON Semiconductor) | SC−74 | TBD | Q4 | 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.
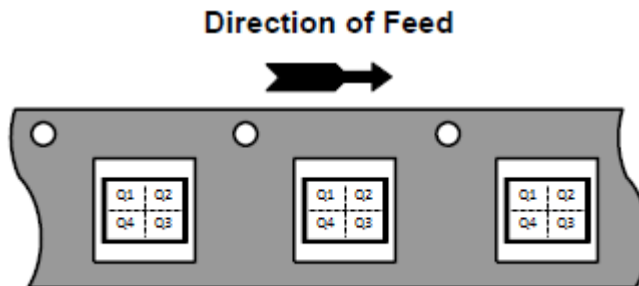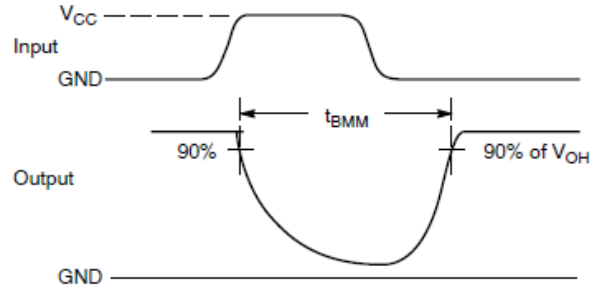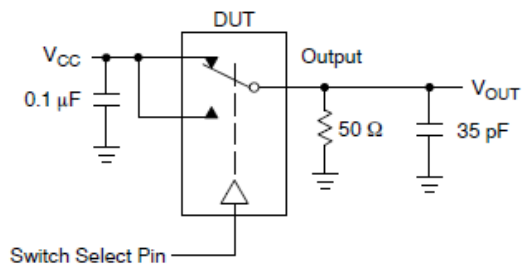
**Pin 1 Orientation in Tape and Reel**



**Figure 3.**

**Test Setups**



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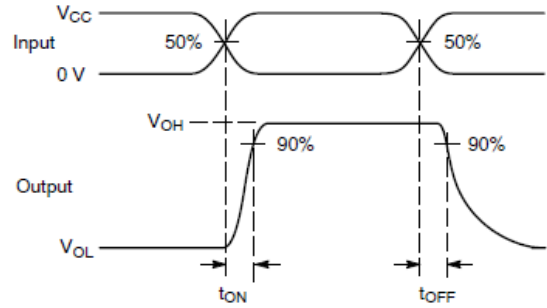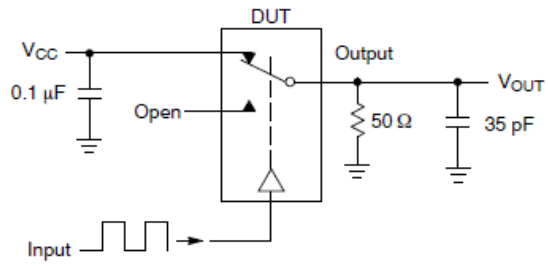


**Figure 5. $t_{ON}/t_{OFF}$**



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

Off–Isolation

Crosstalk
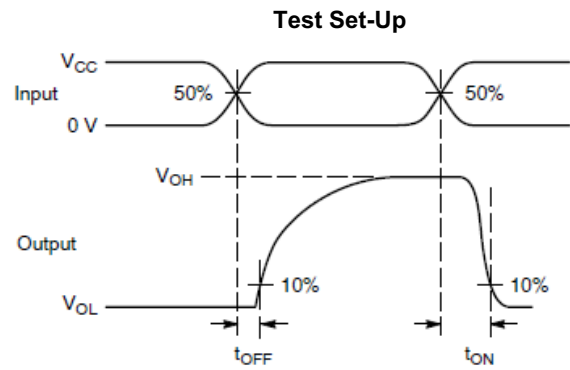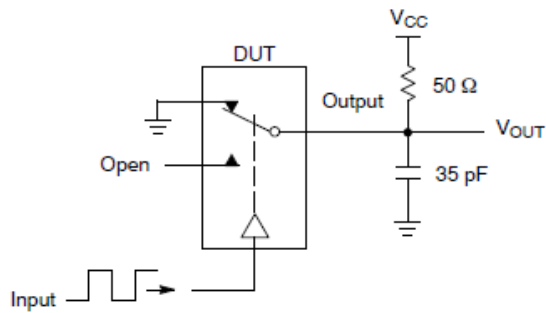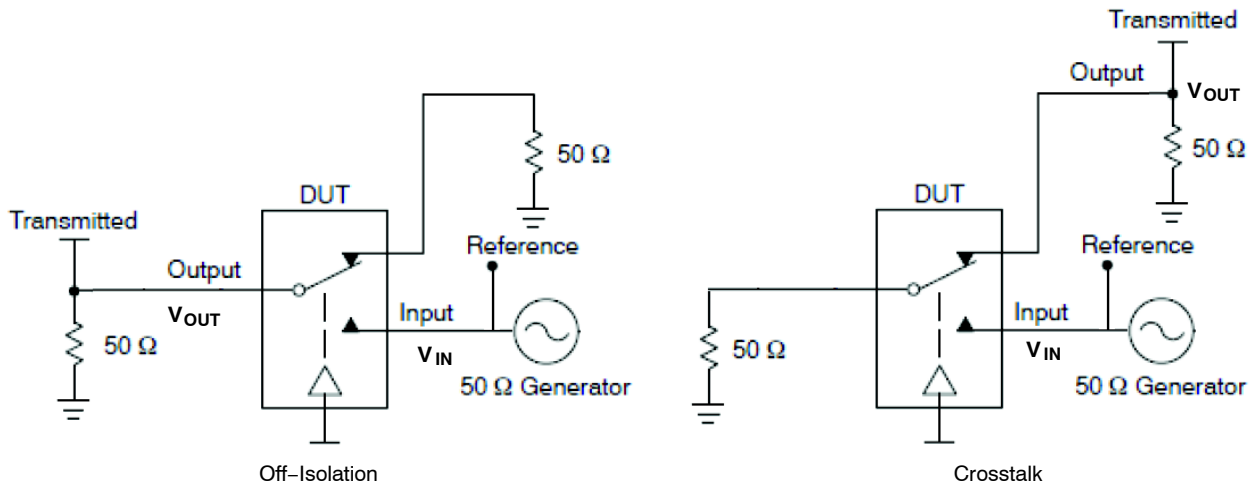
Channel switch control/s test socket is normalized. Off isolation is measured across an off channel. Crosstalk is measured from an off channel to an on channel. On loss is the bandwidth of an On switch. $V_{ISO}$, $V_{CT}$, Bandwidth and $V_{ONL}$ are independent of the input signal direction.

$V_{ISO}$ or $V_{CT}$ = Off Channel Isolation or crosstalk = 20 Log for $V_{OUT}$ / $V_{IN}$

$V_{ONL}$ = On Channel Loss = 20 Log for $V_{OUT}$ / $V_{IN}$ at 100 kHz to 50 MHz

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

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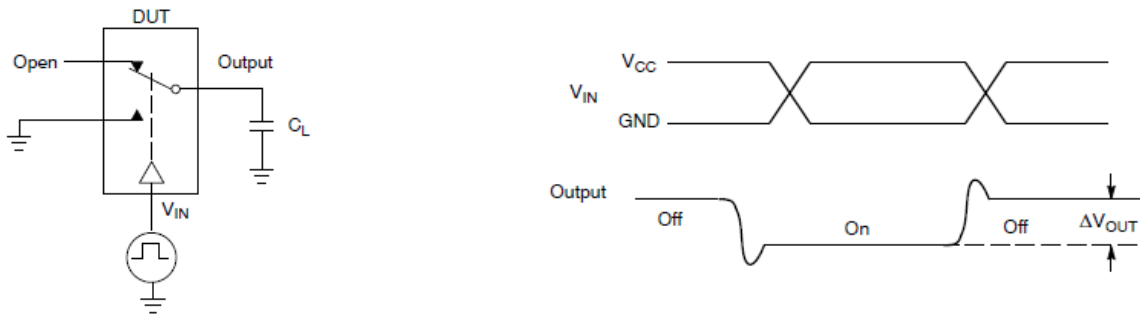


**Figure 8. Charge Injection: (Q)**

## TYPICAL CHARACTERISTICS
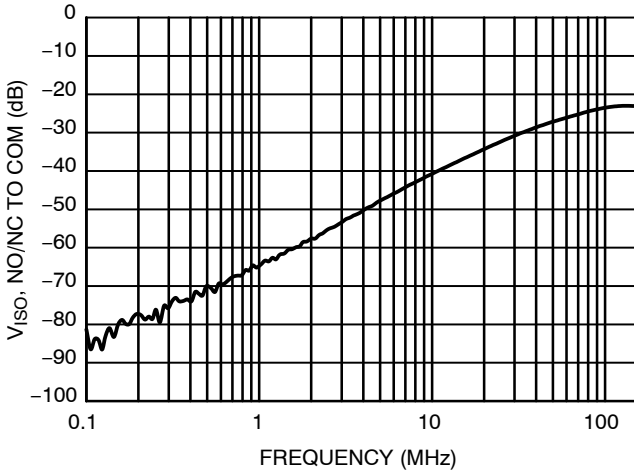
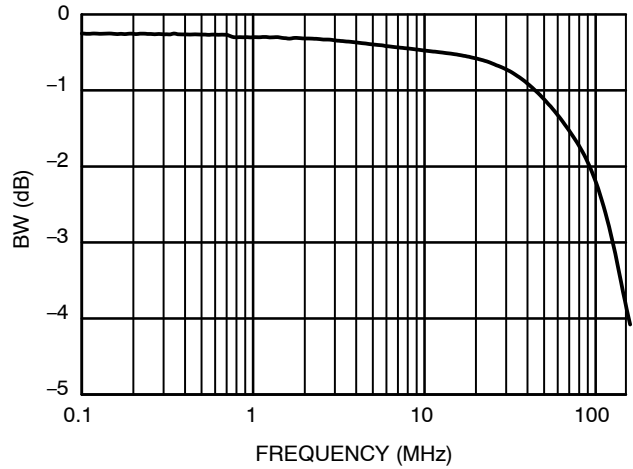**Figure 9. V$_{ISO}$ vs. Frequency**
**@ V$_{CC}$ = 4.5 V**

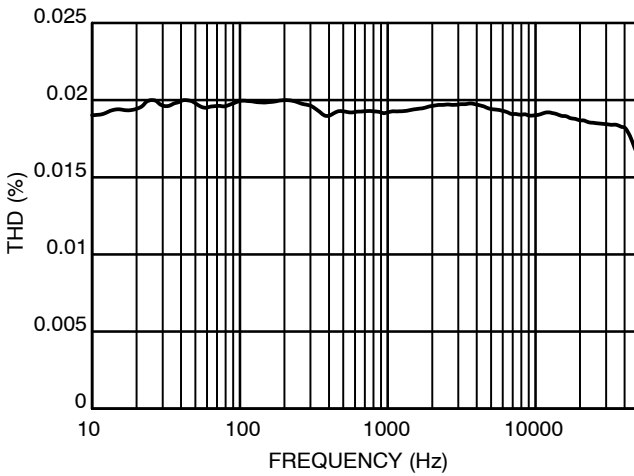**Figure 10. Bandwidth vs. Frequency**

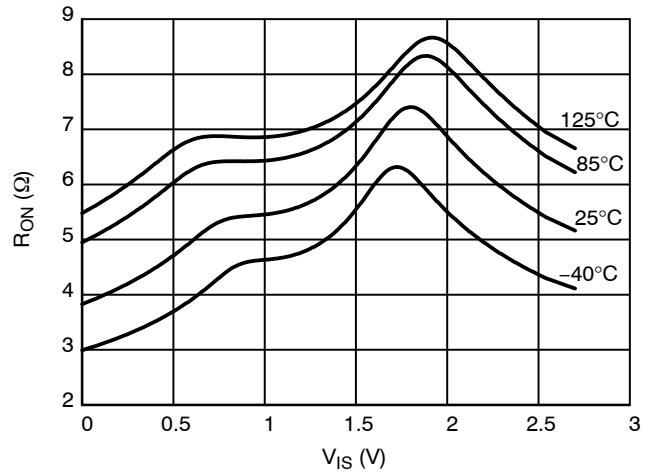**Figure 11. Total Harmonic Distortion**

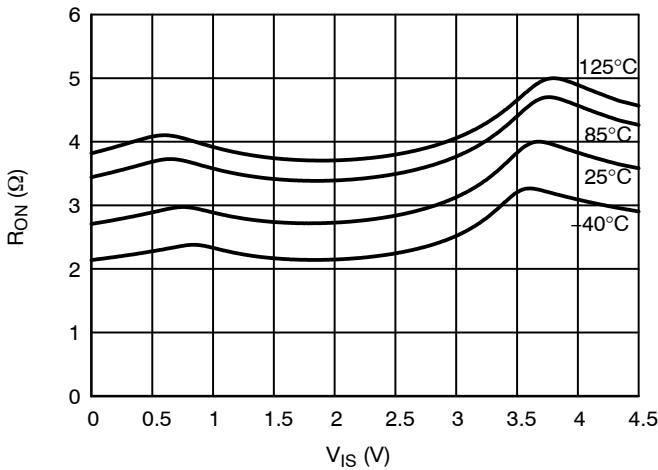**Figure 12. ON Resistance vs. Switch Voltage**
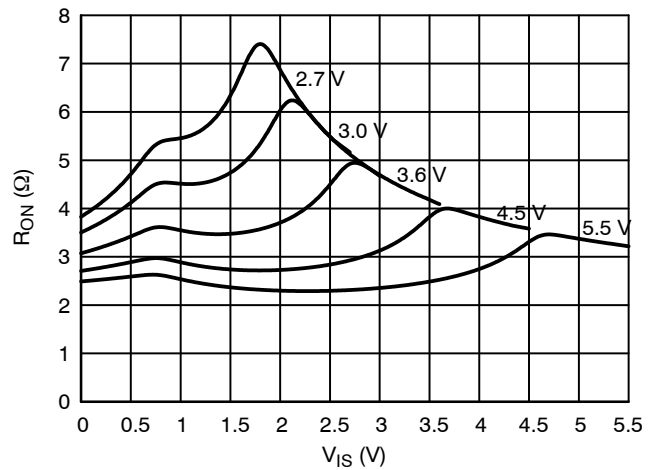**@ V$_{CC}$ = 2.7 V**

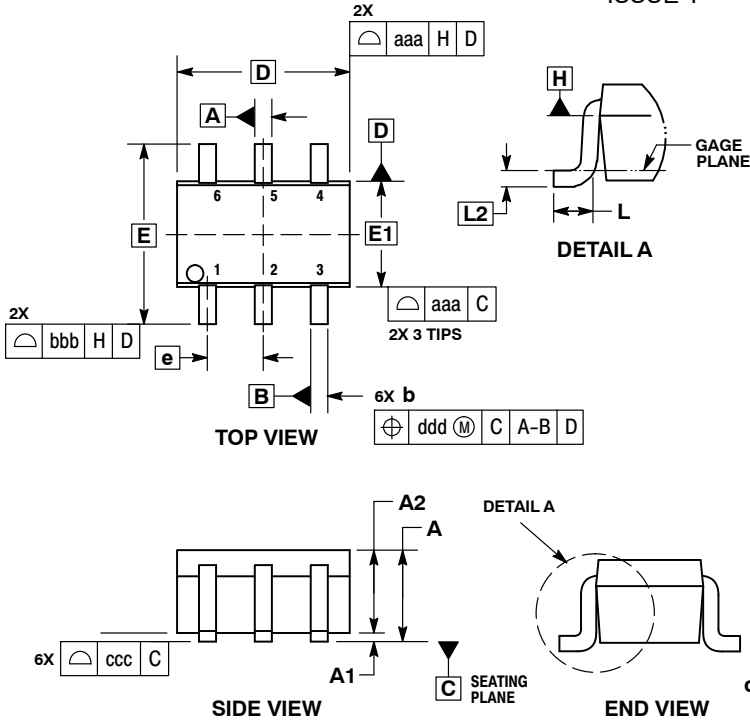**Figure 13. ON Resistance vs. Switch Voltage**
**@ V$_{CC}$ = 4.5 V**

**Figure 14. ON Resistance vs. Switch Voltage**

# NL5S4257B, NL5S4257C
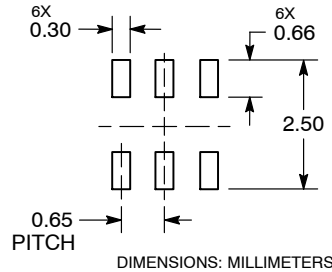
## PACKAGE DIMENSIONS

**SC−88/SC70−6/SOT−363**
CASE 419B−02
ISSUE Y

NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSIONS D AND E1 DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS. MOLD FLASH, PROTRU-SIONS, OR GATE BURRS SHALL NOT EXCEED 0.20 PER END.
4. DIMENSIONS D AND E1 AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY AND DATUM H.
5. DATUMS A AND B ARE DETERMINED AT DATUM H.
6. DIMENSIONS b AND c APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN 0.08 AND 0.15 FROM THE TIP.
7. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 TOTAL IN EXCESS OF DIMENSION b AT MAXIMUM MATERIAL CONDI-TION. THE DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OF THE FOOT.

| DIM | MILLIMETERS | | | INCHES | | |
|-----|-----|-----|-----|-----|-----|-----|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | --- | --- | 1.10 | --- | --- | 0.043 |
| A1 | 0.00 | --- | 0.10 | 0.000 | --- | 0.004 |
| A2 | 0.70 | 0.90 | 1.00 | 0.027 | 0.035 | 0.039 |
| b | 0.15 | 0.20 | 0.25 | 0.006 | 0.008 | 0.010 |
| C | 0.08 | 0.15 | 0.22 | 0.003 | 0.006 | 0.009 |
| D | 1.80 | 2.00 | 2.20 | 0.070 | 0.078 | 0.086 |
| E | 2.00 | 2.10 | 2.20 | 0.078 | 0.082 | 0.086 |
| E1 | 1.15 | 1.25 | 1.35 | 0.045 | 0.049 | 0.053 |
| e | 0.65 BSC | | | 0.026 BSC | | |
| L | 0.26 | 0.36 | 0.46 | 0.010 | 0.014 | 0.018 |
| L2 | 0.15 BSC | | | 0.006 BSC | | |
| aaa | 0.15 | | | 0.006 | | |
| bbb | 0.30 | | | 0.012 | | |
| ccc | 0.10 | | | 0.004 | | |
| ddd | 0.10 | | | 0.004 | | |

**TOP VIEW**

**DETAIL A**

**SIDE VIEW**

**END VIEW**

GAGE PLANE

SEATING PLANE

## RECOMMENDED SOLDERING FOOTPRINT*

6X 0.30

6X 0.66

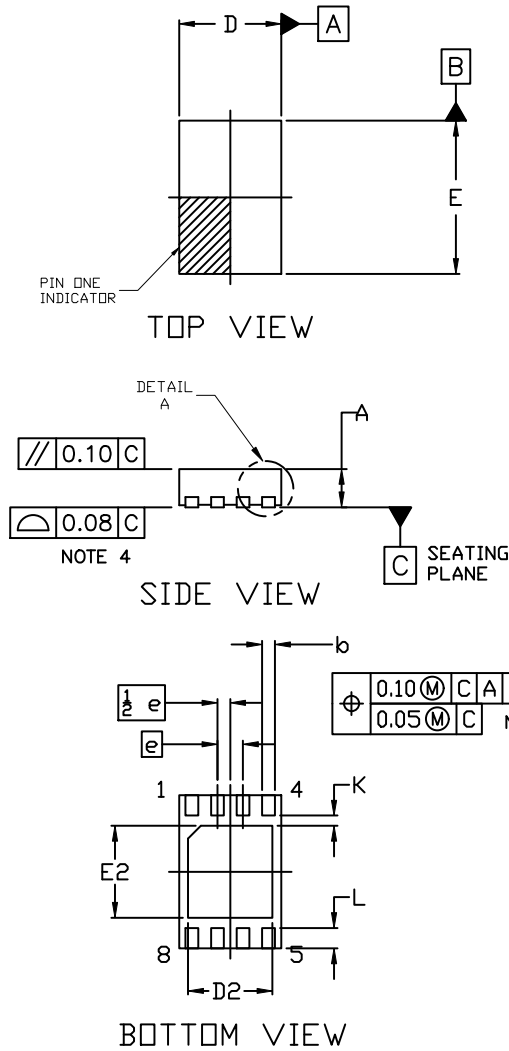2.50

0.65 PITCH

DIMENSIONS: MILLIMETERS

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

# NL5S4257B, NL5S4257C
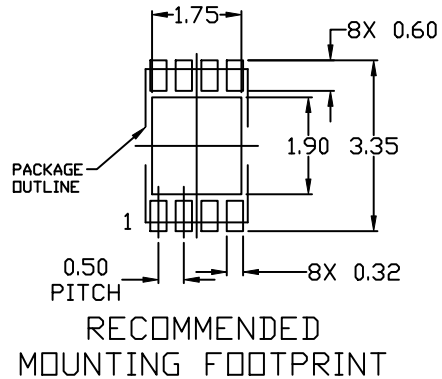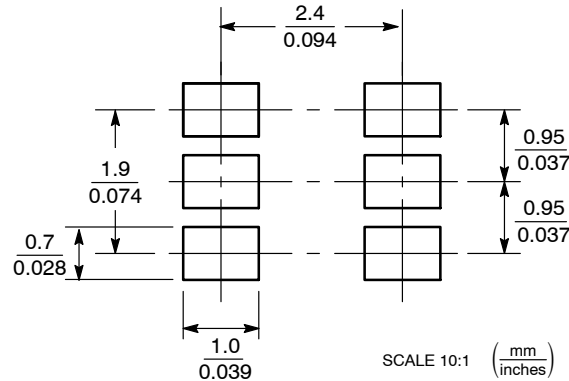
## PACKAGE DIMENSIONS

**WDFN8 2x3, 0.5P**
CASE 511EE
ISSUE O

NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.

2. CONTROLLING DIMENSION: MILLIMETERS

3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.25MM FROM THE TERMINAL TIP.

4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

5. POSITIONAL TOLERANCE APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

| DIM | MILLIMETERS | | |
|-----|------|------|------|
| | MIN | NOM | MAX |
| A | 0.70 | 0.75 | 0.80 |
| A1 | 0.00 | --- | 0.05 |
| A3 | 0.20 REF | | |
| b | 0.20 | 0.25 | 0.30 |
| D | 1.90 | 2.00 | 2.10 |
| D2 | 1.55 | 1.65 | 1.75 |
| E | 2.90 | 3.00 | 3.10 |
| E2 | 1.70 | 1.80 | 1.90 |
| e | 0.50 BSC | | |
| K | 0.20 REF | | |
| L | 0.30 | 0.40 | 0.50 |

TOP VIEW

PIN ONE INDICATOR

DETAIL A

SIDE VIEW

NOTE 4

SEATING PLANE

BOTTOM VIEW

NOTE 5

RECOMMENDED MOUNTING FOOTPRINT

PACKAGE OUTLINE

0.50 PITCH

8X 0.60

1.75

1.90  3.35

8X 0.32

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

## PACKAGE DIMENSIONS

**SC−74**
CASE 318F−05
ISSUE N
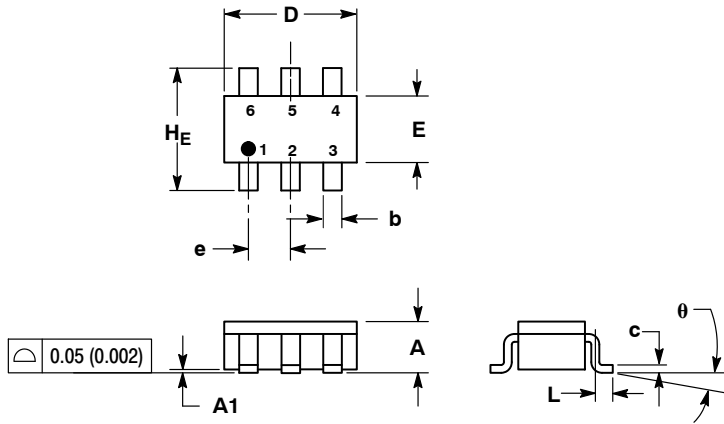


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. 318F−01, −02, −03, −04 OBSOLETE. NEW STANDARD 318F−05.

| DIM | MILLIMETERS | | | INCHES | | |
|---|---|---|---|---|---|---|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 0.90 | 1.00 | 1.10 | 0.035 | 0.039 | 0.043 |
| A1 | 0.01 | 0.06 | 0.10 | 0.001 | 0.002 | 0.004 |
| b | 0.25 | 0.37 | 0.50 | 0.010 | 0.015 | 0.020 |
| c | 0.10 | 0.18 | 0.26 | 0.004 | 0.007 | 0.010 |
| D | 2.90 | 3.00 | 3.10 | 0.114 | 0.118 | 0.122 |
| E | 1.30 | 1.50 | 1.70 | 0.051 | 0.059 | 0.067 |
| e | 0.85 | 0.95 | 1.05 | 0.034 | 0.037 | 0.041 |
| L | 0.20 | 0.40 | 0.60 | 0.008 | 0.016 | 0.024 |
| $H_E$ | 2.50 | 2.75 | 3.00 | 0.099 | 0.108 | 0.118 |
| θ | 0° | – | 10° | 0° | – | 10° |

## SOLDERING FOOTPRINT*



SCALE 10:1 $\left(\dfrac{mm}{inches}\right)$

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