# NUD3124, SZNUD3124

# Automotive Inductive Load Driver

This micro−integrated part provides a single component solution to switch inductive loads such as relays, solenoids, and small DC motors without the need of a free−wheeling diode. It accepts logic level inputs, thus allowing it to be driven by a large variety of devices including logic gates, inverters, and microcontrollers.

### Features

- Provides Robust Interface between D.C. Relay Coils and Sensitive Logic
- Capable of Driving Relay Coils Rated up to 150 mA at 12 Volts
- Replaces 3 or 4 Discrete Components for Lower Cost
- Internal Zener Eliminates Need for Free−Wheeling Diode
- Meets Load Dump and other Automotive Specs
- SZ Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q101 Qualified and PPAP Capable
- These are Pb−Free Devices

### Typical Applications

- Automotive and Industrial Environment
- Drives Window, Latch, Door, and Antenna Relays

### Benefits

- Reduced PCB Space
- Standardized Driver for Wide Range of Relays
- Simplifies Circuit Design and PCB Layout
- Compliance with Automotive Specifications

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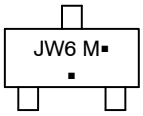
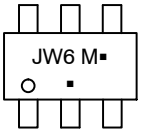
### MARKING DIAGRAMS


**SOT−23**
**CASE 318**
**STYLE 21**




JW6 = Specific Device Code
M = Date Code
▪ = Pb−Free Package
(Note: Microdot may be in either location)


**SC−74**
**CASE 318F**
**STYLE 7**



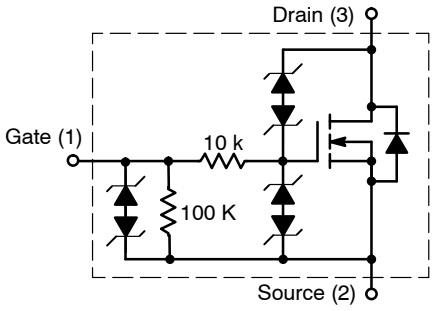

JW6 = Specific Device Code
M = Date Code
▪ = Pb−Free Package
(Note: Microdot may be in either location)

### ORDERING INFORMATION

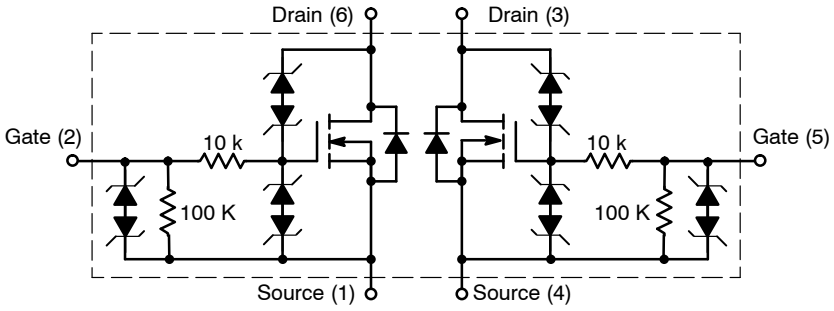
| Device | Package | Shipping† |
|---|---|---|
| NUD3124LT1G | SOT−23 (Pb−Free) | 3000 / Tape & Reel |
| SZNUD3124LT1G | SOT−23 (Pb−Free) | 3000 / Tape & Reel |
| NUD3124DMT1G | SC−74 (Pb−Free) | 3000 / Tape & Reel |
| SZNUD3124DMT1G | SC−74 (Pb−Free) | 3000 / Tape & Reel |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

### INTERNAL CIRCUIT DIAGRAMS




CASE 318




CASE 318F

**MAXIMUM RATINGS** ($T_J$ = 25°C unless otherwise specified)

| Symbol | Rating | Value | Unit |
|---|---|---|---|
| $V_{DSS}$ | Drain−to−Source Voltage − Continuous ($T_J$ = 125°C) | 28 | V |
| $V_{GSS}$ | Gate−to−Source Voltage − Continuous ($T_J$ = 125°C) | 12 | V |
| $I_D$ | Drain Current − Continuous ($T_J$ = 125°C) | 150 | mA |
| $E_Z$ | Single Pulse Drain−to−Source Avalanche Energy (For Relay's Coils/Inductive Loads of 80 Ω or Higher) ($T_J$ Initial = 85°C) | 250 | mJ |
| $P_{PK}$ | Peak Power Dissipation, Drain−to−Source (Notes 1 and 2) ($T_J$ Initial = 85°C) | 20 | W |
| $E_{LD1}$ | Load Dump Suppressed Pulse, Drain−to−Source (Notes 3 and 4) (Suppressed Waveform: $V_s$ = 45 V, $R_{SOURCE}$ = 0.5 Ω, T = 200 ms) (For Relay's Coils/Inductive Loads of 80 Ω or Higher) ($T_J$ Initial = 85°C) | 80 | V |
| $E_{LD2}$ | Inductive Switching Transient 1, Drain−to−Source (Waveform: $R_{SOURCE}$ = 10 Ω, T = 2.0 ms) (For Relay's Coils/Inductive Loads of 80 Ω or Higher) ($T_J$ Initial = 85°C) | 100 | V |
| $E_{LD3}$ | Inductive Switching Transient 2, Drain−to−Source (Waveform: $R_{SOURCE}$ = 4.0 Ω, T = 50 μs) (For Relay's Coils/Inductive Loads of 80 Ω or Higher) ($T_J$ Initial = 85°C) | 300 | V |
| Rev−Bat | Reverse Battery, 10 Minutes (Drain−to−Source) (For Relay's Coils/Inductive Loads of 80 Ω or more) | −14 | V |
| Dual−Volt | Dual Voltage Jump Start, 10 Minutes (Drain−to−Source) | 28 | V |
| ESD | Human Body Model (HBM) According to EIA/JESD22/A114 Specification | 2,000 | V |

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.

1. Nonrepetitive current square pulse 1.0 ms duration.
2. For different square pulse durations, see Figure 2.
3. Nonrepetitive load dump suppressed pulse per Figure 3.
4. For relay's coils/inductive loads higher than 80 Ω, see Figure 4.

## THERMAL CHARACTERISTICS

| Symbol | Rating | | Value | Unit |
|---|---|---|---|---|
| $T_A$ | Operating Ambient Temperature | | −40 to 125 | °C |
| $T_J$ | Maximum Junction Temperature | | 150 | °C |
| $T_{STG}$ | Storage Temperature Range | | −65 to 150 | °C |
| $P_D$ | Total Power Dissipation (Note 5)<br>Derating above 25°C | SOT−23 | 225<br>1.8 | mW<br>mW/°C |
| $P_D$ | Total Power Dissipation (Note 5)<br>Derating above 25°C | SC−74 | 380<br>3.0 | mW<br>mW/°C |
| $R_{\theta JA}$ | Thermal Resistance Junction−to−Ambient (Note 5) | SOT−23<br>SC−74 | 556<br>329 | °C/W |

5. Mounted onto minimum pad board.

**ELECTRICAL CHARACTERISTICS** ($T_J$ = 25°C unless otherwise specified)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| Drain to Source Sustaining Voltage ($I_D$ = 10 mA) | $V_{BRDSS}$ | 28 | 34 | 38 | V |
| Drain to Source Leakage Current | $I_{DSS}$ | | | | μA |
| ($V_{DS}$ = 12 V, $V_{GS}$ = 0 V) | | – | – | 0.5 | |
| ($V_{DS}$ = 12 V, $V_{GS}$ = 0 V, $T_J$ = 125°C) | | – | – | 1.0 | |
| ($V_{DS}$ = 28 V, $V_{GS}$ = 0 V) | | – | – | 50 | |
| ($V_{DS}$ = 28 V, $V_{GS}$ = 0 V, $T_J$ = 125°C) | | – | – | 80 | |
| Gate Body Leakage Current | $I_{GSS}$ | | | | μA |
| ($V_{GS}$ = 3.0 V, $V_{DS}$ = 0 V) | | – | – | 60 | |
| ($V_{GS}$ = 3.0 V, $V_{DS}$ = 0 V, $T_J$ = 125°C) | | – | – | 80 | |
| ($V_{GS}$ = 5.0 V, $V_{DS}$ = 0 V) | | – | – | 90 | |
| ($V_{GS}$ = 5.0 V, $V_{DS}$ = 0 V, $T_J$ = 125°C) | | – | – | 110 | |
| **ON CHARACTERISTICS** | | | | | |
| Gate Threshold Voltage | $V_{GS(th)}$ | | | | V |
| ($V_{GS}$ = $V_{DS}$, $I_D$ = 1.0 mA) | | 1.3 | 1.8 | 2.0 | |
| ($V_{GS}$ = $V_{DS}$, $I_D$ = 1.0 mA, $T_J$ = 125°C) | | 1.3 | – | 2.0 | |
| Drain to Source On−Resistance | $R_{DS(on)}$ | | | | Ω |
| ($I_D$ = 150 mA, $V_{GS}$ = 3.0 V) | | – | – | 1.4 | |
| ($I_D$ = 150 mA, $V_{GS}$ = 3.0 V, $T_J$ = 125°C) | | – | – | 1.7 | |
| ($I_D$ = 150 mA, $V_{GS}$ = 5.0 V) | | – | – | 0.8 | |
| ($I_D$ = 150 mA, $V_{GS}$ = 5.0 V, $T_J$ = 125°C) | | – | – | 1.1 | |
| Output Continuous Current | $I_{DS(on)}$ | | | | mA |
| ($V_{DS}$ = 0.25 V, $V_{GS}$ = 3.0 V) | | 150 | 200 | – | |
| ($V_{DS}$ = 0.25 V, $V_{GS}$ = 3.0 V, $T_J$ = 125°C) | | 140 | – | – | |
| Forward Transconductance ($V_{DS}$ = 12 V, $I_D$ = 150 mA) | $g_{FS}$ | – | 500 | – | mmho |
| **DYNAMIC CHARACTERISTICS** | | | | | |
| Input Capacitance ($V_{DS}$ = 12 V, $V_{GS}$ = 0 V, f = 10 kHz) | Ciss | – | 32 | – | pf |
| Output Capacitance ($V_{DS}$ = 12 V, $V_{GS}$ = 0 V, f = 10 kHz) | Coss | – | 21 | – | pf |
| Transfer Capacitance ($V_{DS}$ = 12 V, $V_{GS}$ = 0 V, f = 10 kHz) | Crss | – | 8.0 | – | pf |
| **SWITCHING CHARACTERISTICS** | | | | | |
| Propagation Delay Times: | | | | | ns |
| High to Low Propagation Delay; Figure 1, ($V_{DS}$ = 12 V, $V_{GS}$ = 3.0 V) | $t_{PHL}$ | – | 890 | – | |
| Low to High Propagation Delay; Figure 1, ($V_{DS}$ = 12 V, $V_{GS}$ = 3.0 V) | $t_{PLH}$ | – | 912 | – | |
| High to Low Propagation Delay; Figure 1, ($V_{DS}$ = 12 V, $V_{GS}$ = 5.0 V) | $t_{PHL}$ | – | 324 | – | |
| Low to High Propagation Delay; Figure 1, ($V_{DS}$ = 12 V, $V_{GS}$ = 5.0 V) | $t_{PLH}$ | – | 1280 | – | |
| Transition Times: | | | | | ns |
| Fall Time; Figure 1, ($V_{DS}$ = 12 V, $V_{GS}$ = 3.0 V) | $t_f$ | – | 2086 | – | |
| Rise Time; Figure 1, ($V_{DS}$ = 12 V, $V_{GS}$ = 3.0 V) | $t_r$ | – | 708 | – | |
| Fall Time; Figure 1, ($V_{DS}$ = 12 V, $V_{GS}$ = 5.0 V) | $t_f$ | – | 556 | – | |
| Rise Time; Figure 1, ($V_{DS}$ = 12 V, $V_{GS}$ = 5.0 V) | $t_r$ | – | 725 | – | |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

## TYPICAL PERFORMANCE CURVES

($T_J$ = 25°C unless otherwise noted)

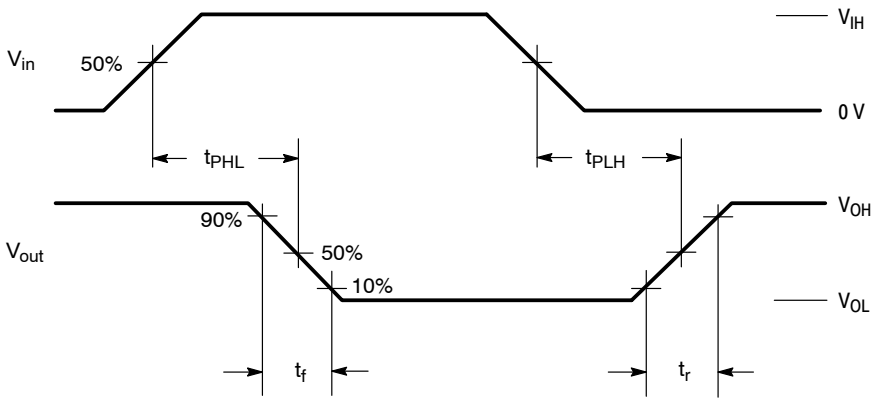



**Figure 1. Switching Waveforms**

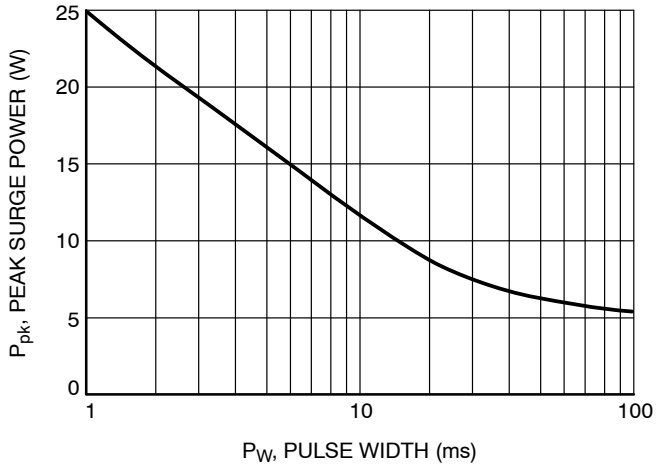



**Figure 2. Maximum Non−repetitive Surge Power versus Pulse Width**

**Load Dump Pulse Not Suppressed:**
$V_R$ = 13.5 V Nominal ±10%
$V_S$ = 60 V Nominal ±10%
T = 300 ms Nominal ±10%
$T_R$ = 1 − 10 ms ±10%
**Load Dump Pulse Suppressed:**
NOTE: Max. Voltage DUT is exposed to is approximately 45 V.
$V_S$ = 30 V ±20%
T = 150 ms ±20%

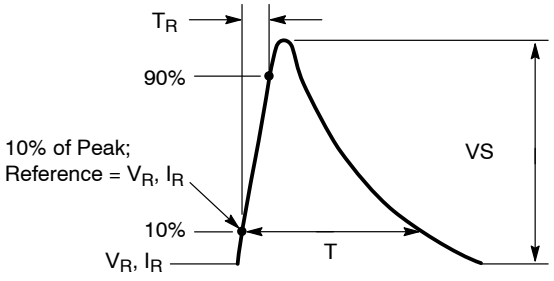



**Figure 3. Load Dump Waveform Definition**

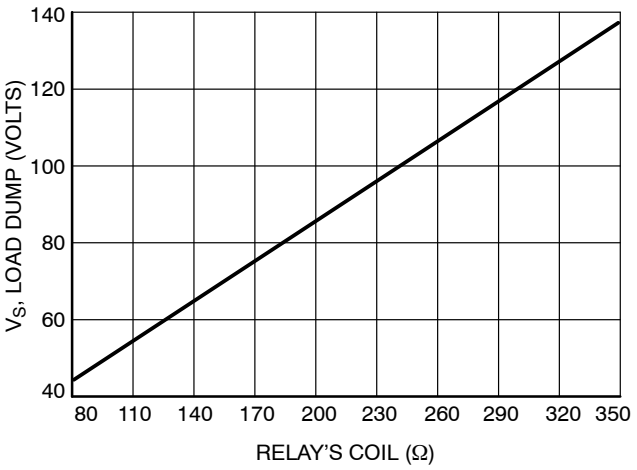



**Figure 4. Load Dump Capability versus Relay's Coil dc Resistance**

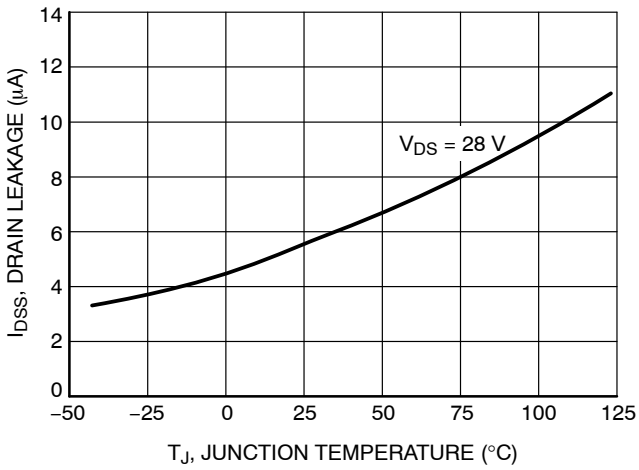



**Figure 5. Drain−to−Source Leakage versus Junction Temperature**

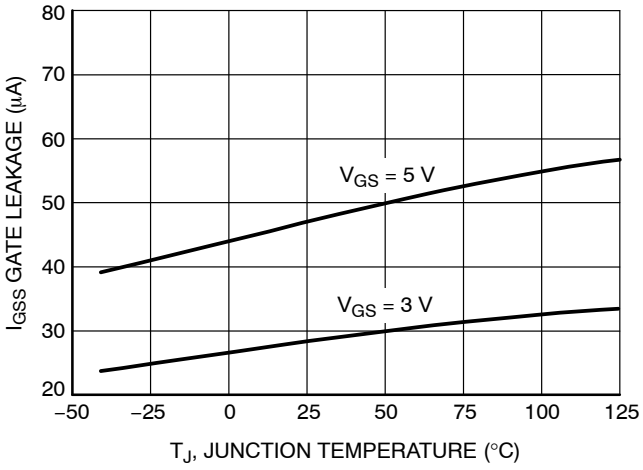



**Figure 6. Gate−to−Source Leakage versus Junction Temperature**

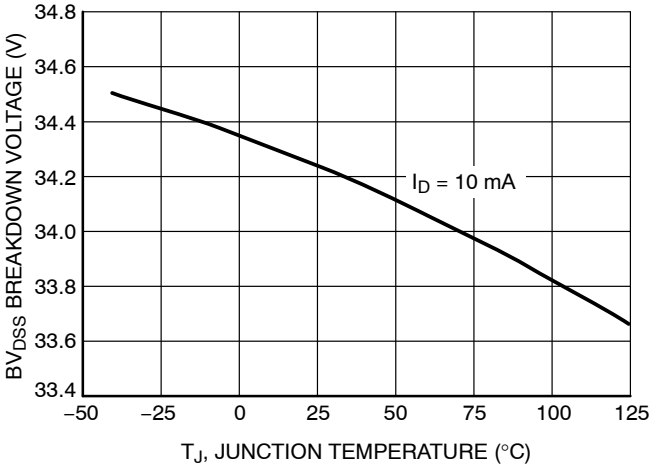



**Figure 7. Breakdown Voltage versus Junction Temperature**

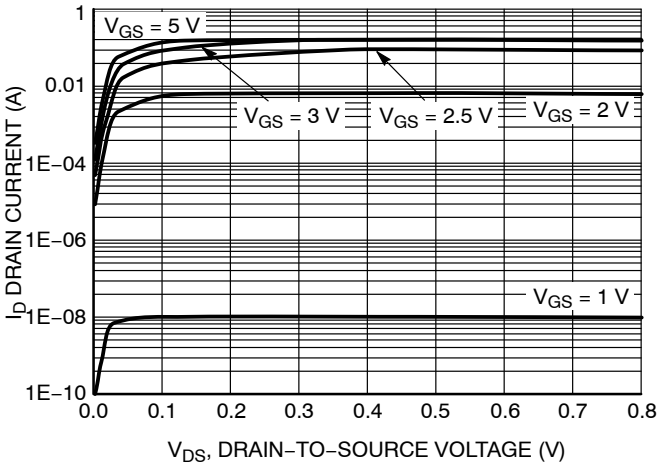



**Figure 8. Output Characteristics**

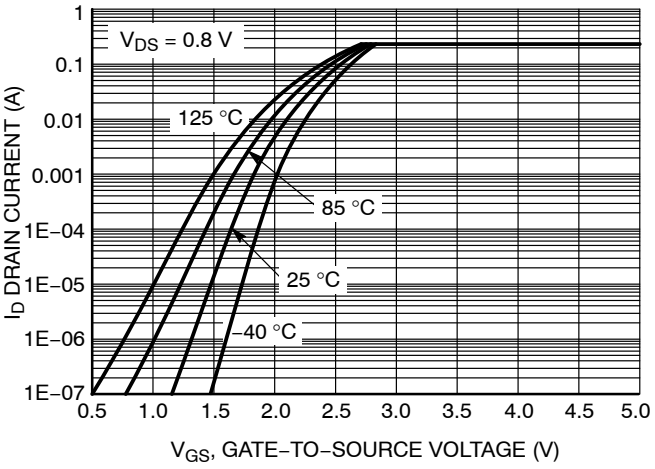



**Figure 9. Transfer Function**

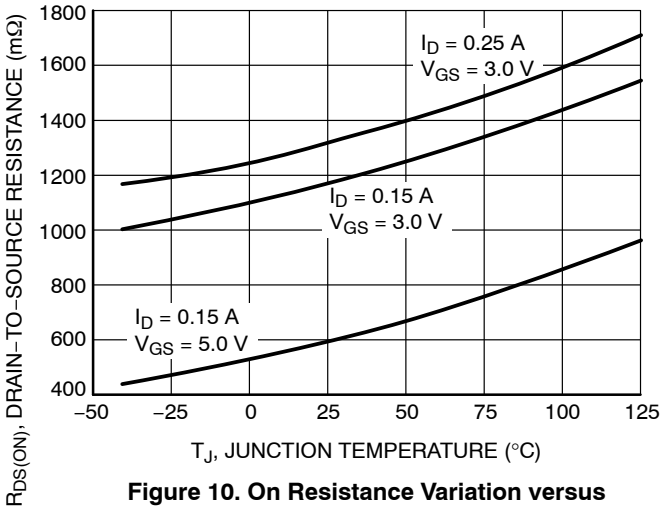



**Figure 10. On Resistance Variation versus Junction Temperature**

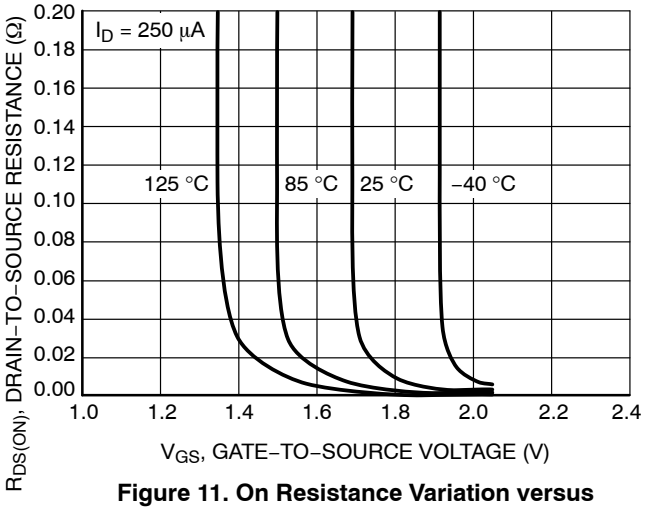



**Figure 11. On Resistance Variation versus Gate−to−Source Voltage**

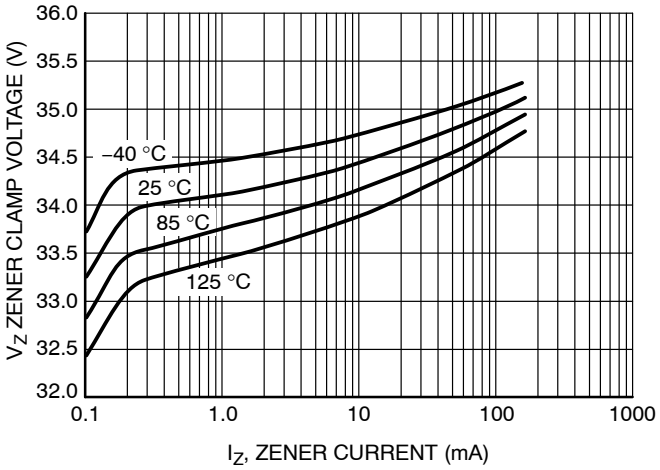



**Figure 12. Zener Clamp Voltage versus Zener Current**

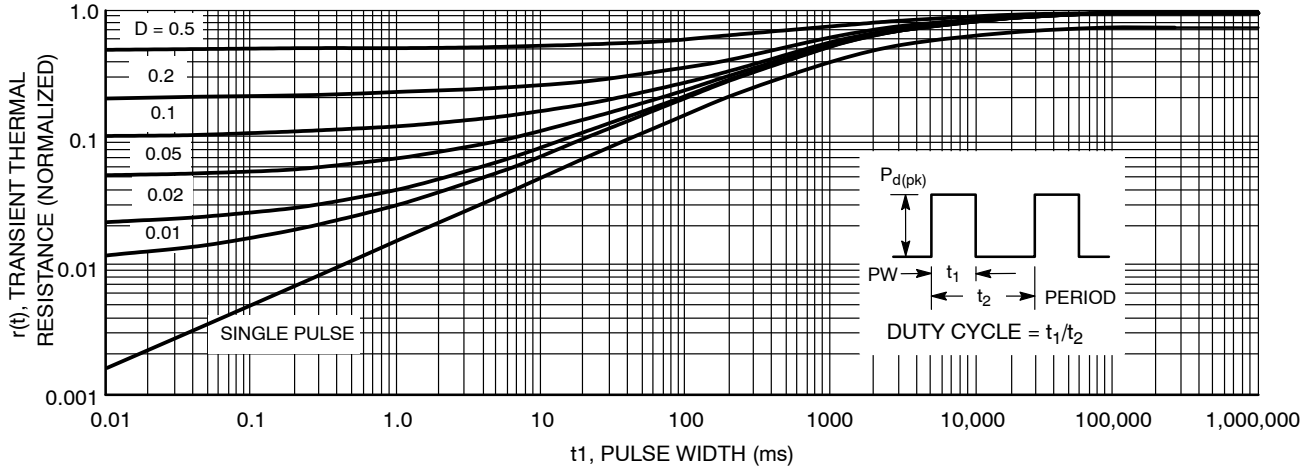



**Figure 13. Transient Thermal Response for NUD3124LT1G**

## APPLICATIONS INFORMATION

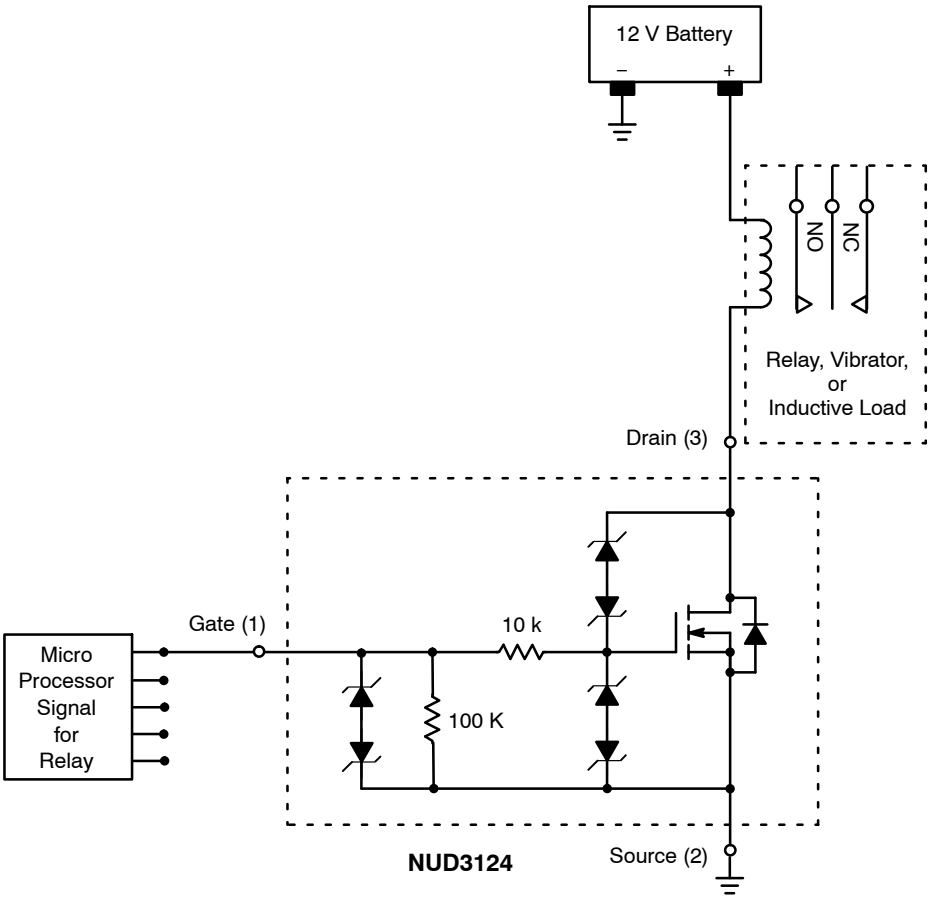



**Figure 14. Applications Diagram**

# MECHANICAL CASE OUTLINE
## PACKAGE DIMENSIONS

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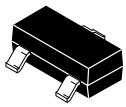
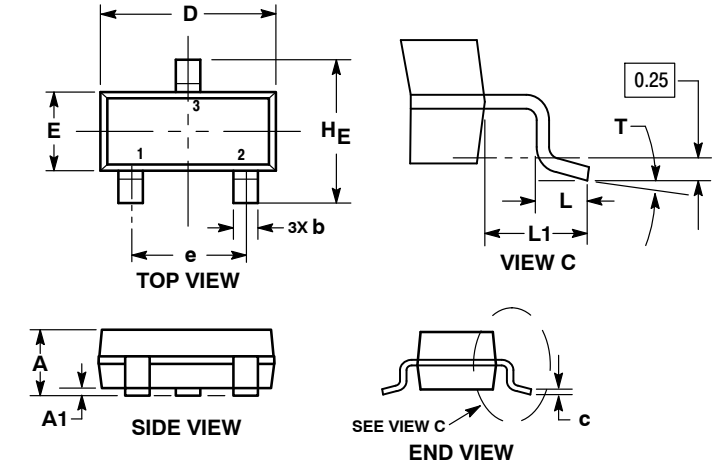


**SOT−23 (TO−236)**
CASE 318−08
ISSUE AS

DATE 30 JAN 2018

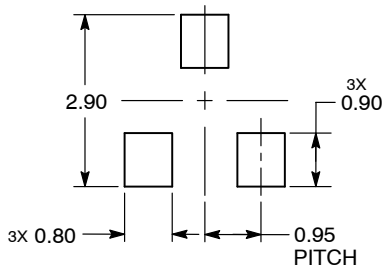
SCALE 4:1




NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF THE BASE MATERIAL.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

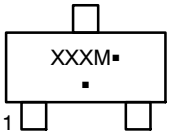
| | MILLIMETERS | | | INCHES | | |
|---|---|---|---|---|---|---|
| DIM | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 0.89 | 1.00 | 1.11 | 0.035 | 0.039 | 0.044 |
| A1 | 0.01 | 0.06 | 0.10 | 0.000 | 0.002 | 0.004 |
| b | 0.37 | 0.44 | 0.50 | 0.015 | 0.017 | 0.020 |
| c | 0.08 | 0.14 | 0.20 | 0.003 | 0.006 | 0.008 |
| D | 2.80 | 2.90 | 3.04 | 0.110 | 0.114 | 0.120 |
| E | 1.20 | 1.30 | 1.40 | 0.047 | 0.051 | 0.055 |
| e | 1.78 | 1.90 | 2.04 | 0.070 | 0.075 | 0.080 |
| L | 0.30 | 0.43 | 0.55 | 0.012 | 0.017 | 0.022 |
| L1 | 0.35 | 0.54 | 0.69 | 0.014 | 0.021 | 0.027 |
| $H_E$ | 2.10 | 2.40 | 2.64 | 0.083 | 0.094 | 0.104 |
| T | 0° | −−− | 10° | 0° | −−− | 10° |

### RECOMMENDED SOLDERING FOOTPRINT




DIMENSIONS: MILLIMETERS

### GENERIC MARKING DIAGRAM*




XXX = Specific Device Code
M = Date Code
▪ = 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.

STYLE 1 THRU 5:
CANCELLED

STYLE 6:
PIN 1. BASE
2. EMITTER
3. COLLECTOR

STYLE 7:
PIN 1. EMITTER
2. BASE
3. COLLECTOR

STYLE 8:
PIN 1. ANODE
2. NO CONNECTION
3. CATHODE

STYLE 9:
PIN 1. ANODE
2. ANODE
3. CATHODE

STYLE 10:
PIN 1. DRAIN
2. SOURCE
3. GATE

STYLE 11:
PIN 1. ANODE
2. CATHODE
3. CATHODE−ANODE

STYLE 12:
PIN 1. CATHODE
2. CATHODE
3. ANODE

STYLE 13:
PIN 1. SOURCE
2. DRAIN
3. GATE

STYLE 14:
PIN 1. CATHODE
2. GATE
3. ANODE

STYLE 15:
PIN 1. GATE
2. CATHODE
3. ANODE

STYLE 16:
PIN 1. ANODE
2. CATHODE
3. CATHODE

STYLE 17:
PIN 1. NO CONNECTION
2. ANODE
3. CATHODE

STYLE 18:
PIN 1. NO CONNECTION
2. CATHODE
3. ANODE

STYLE 19:
PIN 1. CATHODE
2. ANODE
3. CATHODE−ANODE

STYLE 20:
PIN 1. CATHODE
2. ANODE
3. GATE

STYLE 21:
PIN 1. GATE
2. SOURCE
3. DRAIN

STYLE 22:
PIN 1. RETURN
2. OUTPUT
3. INPUT

STYLE 23:
PIN 1. ANODE
2. ANODE
3. CATHODE

STYLE 24:
PIN 1. GATE
2. DRAIN
3. SOURCE

STYLE 25:
PIN 1. ANODE
2. CATHODE
3. GATE

STYLE 26:
PIN 1. CATHODE
2. ANODE
3. NO CONNECTION

STYLE 27:
PIN 1. CATHODE
2. CATHODE
3. CATHODE

STYLE 28:
PIN 1. ANODE
2. ANODE
3. ANODE

| DOCUMENT NUMBER: | 98ASB42226B | Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped “CONTROLLED COPY” in red. |
|---|---|---|
| DESCRIPTION: | SOT−23 (TO−236) | PAGE 1 OF 1 |

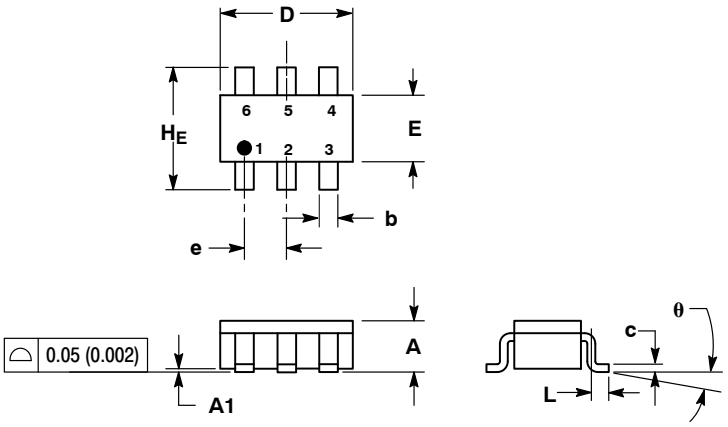
# MECHANICAL CASE OUTLINE
## PACKAGE DIMENSIONS

ON Semiconductor®


**SC−74**
CASE 318F−05
ISSUE N

DATE 08 JUN 2012

**SCALE 2:1**




NOTES:
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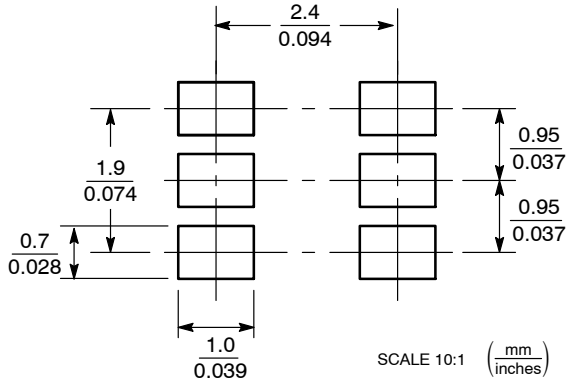
2. CONTROLLING DIMENSION: INCH.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. 318F−01, −02, −03, −04 OBSOLETE. NEW STANDARD 318F−05.

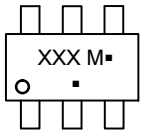
| | MILLIMETERS | | | INCHES | | |
|---|---|---|---|---|---|---|
| DIM | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 0.90 | 1.00 | 1.10 | 0.035 | 0.039 | 0.043 |
| A1 | 0.01 | 0.06 | 0.10 | 0.001 | 0.002 | 0.004 |
| b | 0.25 | 0.37 | 0.50 | 0.010 | 0.015 | 0.020 |
| c | 0.10 | 0.18 | 0.26 | 0.004 | 0.007 | 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*




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

### GENERIC MARKING DIAGRAM*




XXX = Specific Device Code
M = Date Code
▪ = 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.

STYLE 1:
PIN 1. CATHODE
2. ANODE
3. CATHODE
4. CATHODE
5. ANODE
6. CATHODE

STYLE 2:
PIN 1. NO CONNECTION
2. COLLECTOR
3. EMITTER
4. NO CONNECTION
5. COLLECTOR
6. BASE

STYLE 3:
PIN 1. EMITTER 1
2. BASE 1
3. COLLECTOR 2
4. EMITTER 2
5. BASE 2
6. COLLECTOR 1

STYLE 4:
PIN 1. COLLECTOR 2
2. EMITTER 1/EMITTER 2
3. COLLECTOR 1
4. EMITTER 3
5. BASE 1/BASE 2/COLLECTOR 3
6. BASE 3

STYLE 5:
PIN 1. CHANNEL 1
2. ANODE
3. CHANNEL 2
4. CHANNEL 3
5. CATHODE
6. CHANNEL 4

STYLE 6:
PIN 1. CATHODE
2. ANODE
3. CATHODE
4. CATHODE
5. CATHODE
6. CATHODE

STYLE 7:
PIN 1. SOURCE 1
2. GATE 1
3. DRAIN 2
4. SOURCE 2
5. GATE 2
6. DRAIN 1

STYLE 8:
PIN 1. EMITTER 1
2. BASE 2
3. COLLECTOR 2
4. EMITTER 2
5. BASE 1
6. COLLECTOR 1

STYLE 9:
PIN 1. EMITTER 2
2. BASE 2
3. COLLECTOR 1
4. EMITTER 1
5. BASE 1
6. COLLECTOR 2

STYLE 10:
PIN 1. ANODE/CATHODE
2. BASE
3. EMITTER
4. COLLECTOR
5. ANODE
6. CATHODE

STYLE 11:
PIN 1. EMITTER
2. BASE
3. ANODE/CATHODE
4. ANODE
5. CATHODE
6. COLLECTOR

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