

Automotive Inductive Load Driver

NUD3124, SZNUD3124

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 Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

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

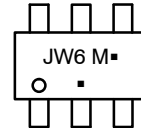
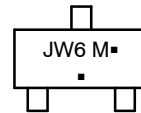


SOT-23
CASE 318
STYLE 21



SC-74
CASE 318F
STYLE 7

MARKING DIAGRAMS



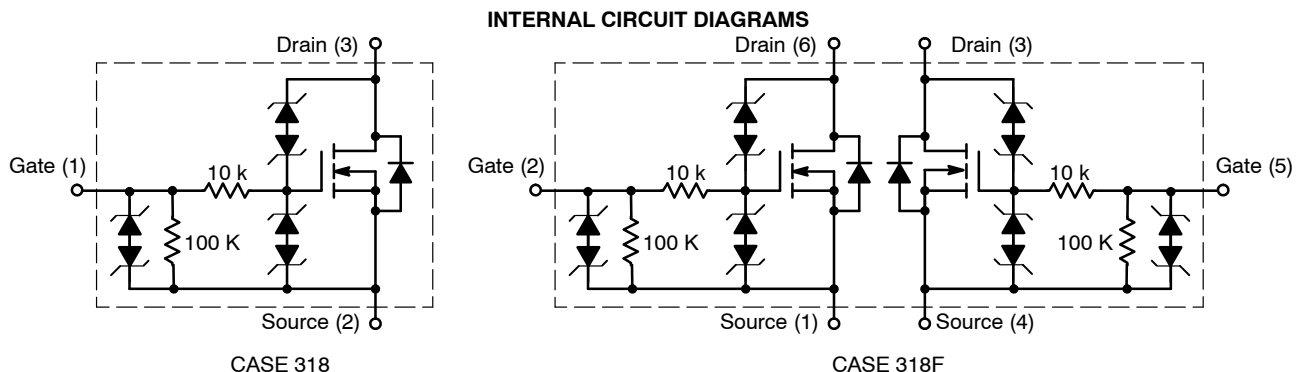
JW6 = Specific Device Code
M = Date Code
▪ = Pb-Free Package
(Note: Microdot may be in either location)

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M = Date Code
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(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 Specifications Brochure, [BRD8011/D](#).



NUD3124, SZNUD3124

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) Derating above 25°C | SOT-23 | 225 | mW |
| | | | 1.8 | mW/°C |
| P _D | Total Power Dissipation (Note 5) Derating above 25°C | SC-74 | 380 | mW |
| | | | 3.0 | mW/°C |
| R _{θJA} | Thermal Resistance Junction-to-Ambient (Note 5) | SOT-23 | 556 | °C/W |
| | | SC-74 | 329 | |

5. Mounted onto minimum pad board.

NUD3124, SZNUD3124

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 (V _{DS} = 12 V, V _{GS} = 0 V) (V _{DS} = 12 V, V _{GS} = 0 V, T _J = 125°C) (V _{DS} = 28 V, V _{GS} = 0 V) (V _{DS} = 28 V, V _{GS} = 0 V, T _J = 125°C) | I _{DSS} | – | – | 0.5 1.0 50 80 | μA |
| Gate Body Leakage Current (V _{GS} = 3.0 V, V _{DS} = 0 V) (V _{GS} = 3.0 V, V _{DS} = 0 V, T _J = 125°C) (V _{GS} = 5.0 V, V _{DS} = 0 V) (V _{GS} = 5.0 V, V _{DS} = 0 V, T _J = 125°C) | I _{GSS} | – | – | 60 80 90 110 | μA |
| ON CHARACTERISTICS | | | | | |
| Gate Threshold Voltage (V _{GS} = V _{DS} , I _D = 1.0 mA) (V _{GS} = V _{DS} , I _D = 1.0 mA, T _J = 125°C) | V _{GS(th)} | 1.3 1.3 | 1.8 – | 2.0 2.0 | V |
| Drain to Source On-Resistance (I _D = 150 mA, V _{GS} = 3.0 V) (I _D = 150 mA, V _{GS} = 3.0 V, T _J = 125°C) (I _D = 150 mA, V _{GS} = 5.0 V) (I _D = 150 mA, V _{GS} = 5.0 V, T _J = 125°C) | R _{DS(on)} | – | – | 1.4 1.7 0.8 1.1 | Ω |
| Output Continuous Current (V _{DS} = 0.25 V, V _{GS} = 3.0 V) (V _{DS} = 0.25 V, V _{GS} = 3.0 V, T _J = 125°C) | I _{DS(on)} | 150 140 | 200 – | – – | mA |
| 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) | C _{iss} | – | 32 | – | pf |
| Output Capacitance (V _{DS} = 12 V, V _{GS} = 0 V, f = 10 kHz) | C _{oss} | – | 21 | – | pf |
| Transfer Capacitance (V _{DS} = 12 V, V _{GS} = 0 V, f = 10 kHz) | C _{rss} | – | 8.0 | – | pf |
| SWITCHING CHARACTERISTICS | | | | | |
| Propagation Delay Times: High to Low Propagation Delay; Figure 1, (V _{DS} = 12 V, V _{GS} = 3.0 V) Low to High Propagation Delay; Figure 1, (V _{DS} = 12 V, V _{GS} = 3.0 V) High to Low Propagation Delay; Figure 1, (V _{DS} = 12 V, V _{GS} = 5.0 V) Low to High Propagation Delay; Figure 1, (V _{DS} = 12 V, V _{GS} = 5.0 V) | t _{PHL} t _{PLH} t _{PHL} t _{PLH} | – – – – | 890 912 324 1280 | – – – – | ns |
| Transition Times: Fall Time; Figure 1, (V _{DS} = 12 V, V _{GS} = 3.0 V) Rise Time; Figure 1, (V _{DS} = 12 V, V _{GS} = 3.0 V) Fall Time; Figure 1, (V _{DS} = 12 V, V _{GS} = 5.0 V) Rise Time; Figure 1, (V _{DS} = 12 V, V _{GS} = 5.0 V) | t _f t _r t _f t _r | – – – – | 2086 708 556 725 | – – – – | ns |

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.

NUD3124, SZNUD3124

TYPICAL PERFORMANCE CURVES

($T_J = 25^\circ\text{C}$ unless otherwise noted)

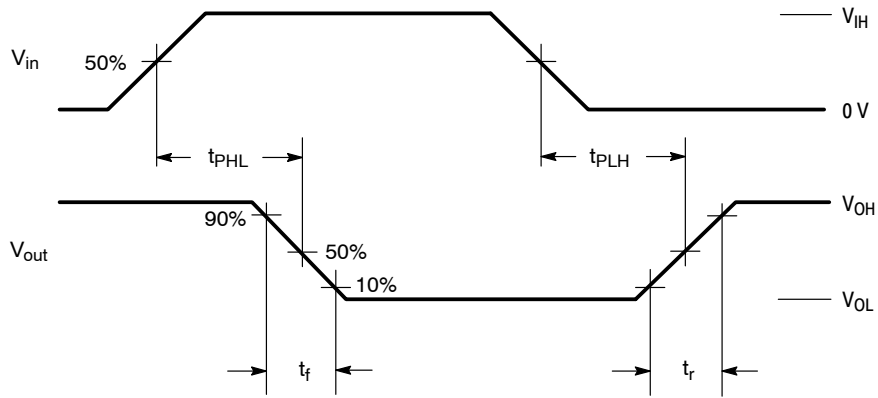


Figure 1. Switching Waveforms

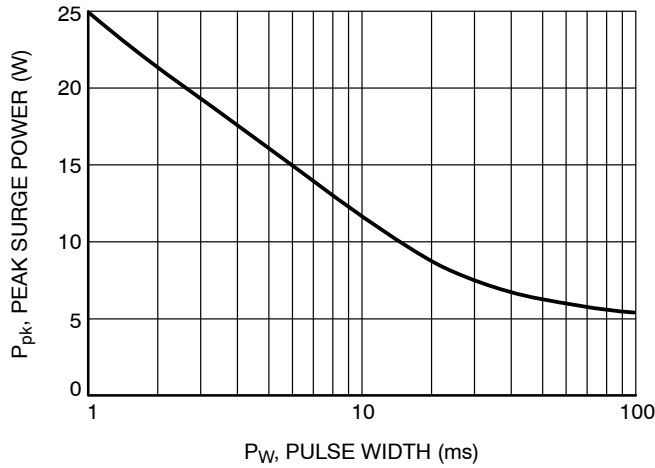


Figure 2. Maximum Non-repetitive Surge Power versus Pulse Width

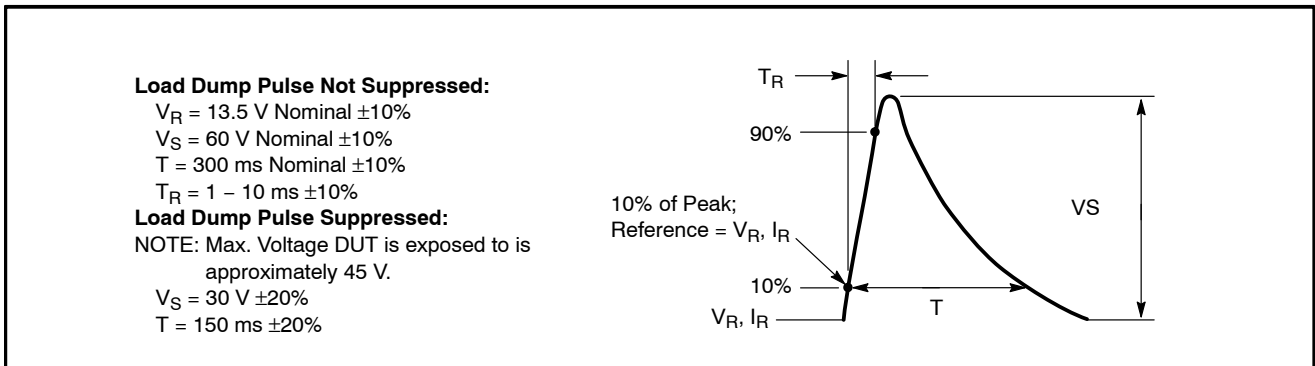


Figure 3. Load Dump Waveform Definition

NUD3124, SZNUD3124

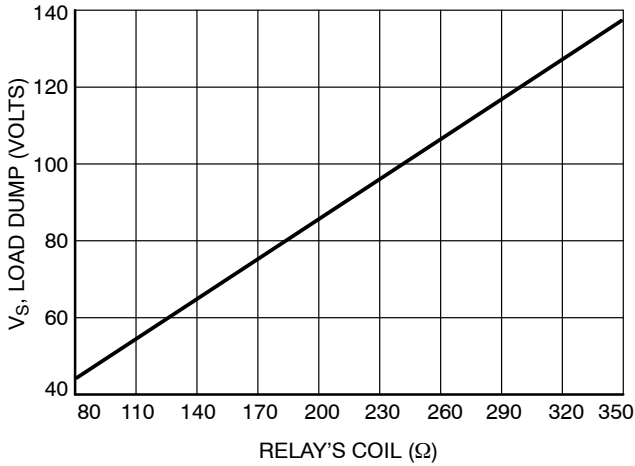


Figure 4. Load Dump Capability versus Relay's Coil dc Resistance

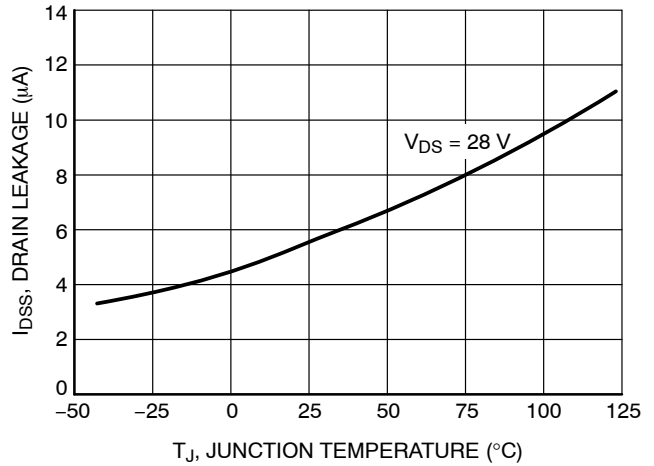


Figure 5. Drain-to-Source Leakage versus Junction Temperature

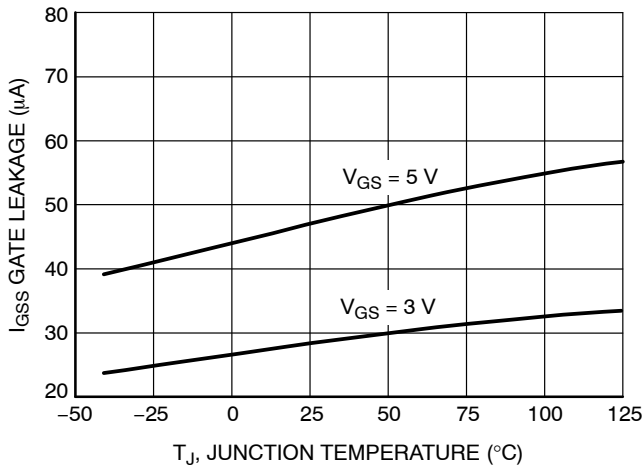


Figure 6. Gate-to-Source Leakage versus Junction Temperature

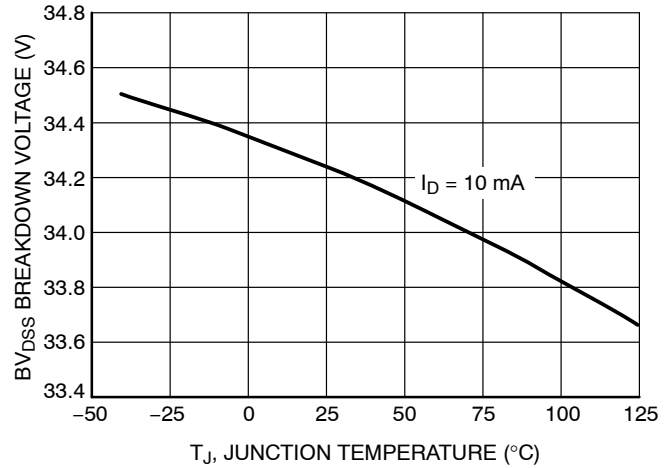


Figure 7. Breakdown Voltage versus Junction Temperature

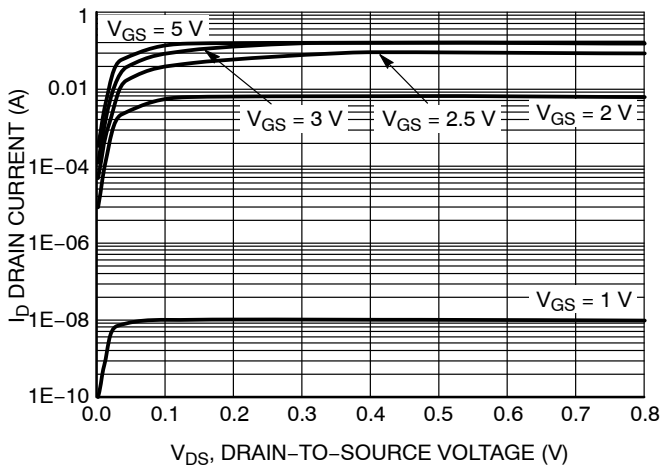


Figure 8. Output Characteristics

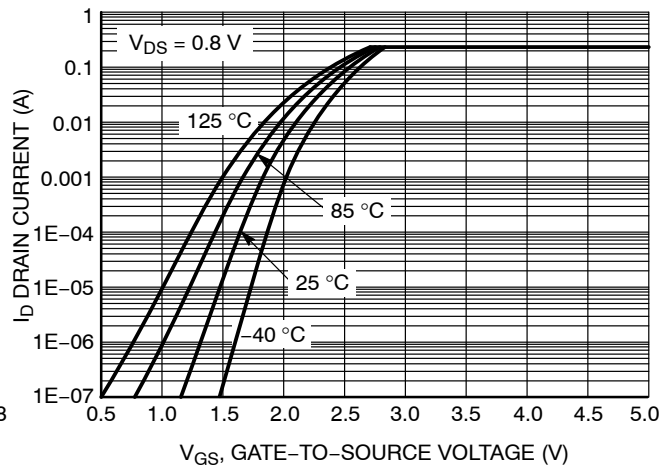


Figure 9. Transfer Function

NUD3124, SZNUD3124

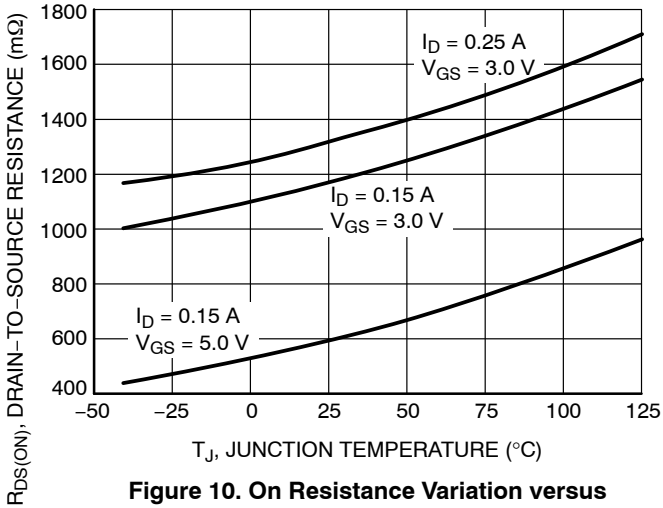


Figure 10. On Resistance Variation versus Junction Temperature

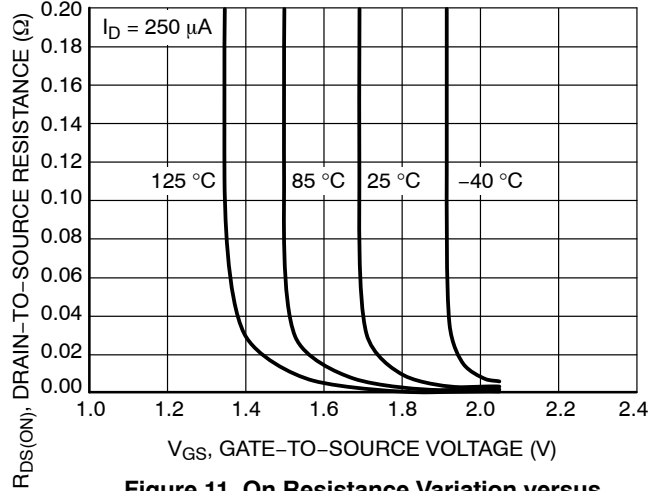


Figure 11. On Resistance Variation versus Gate-to-Source Voltage

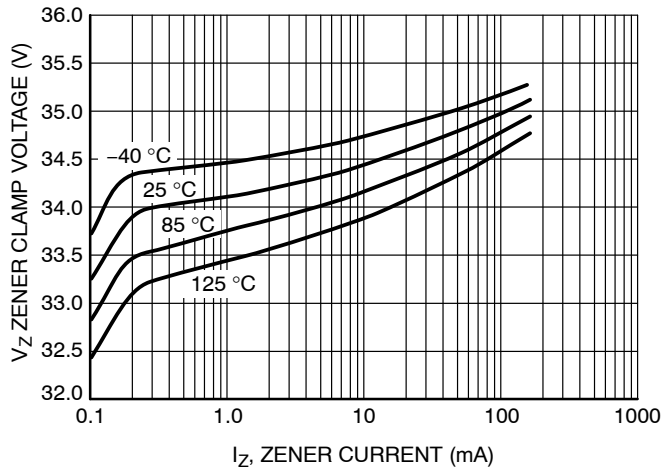


Figure 12. Zener Clamp Voltage versus Zener Current

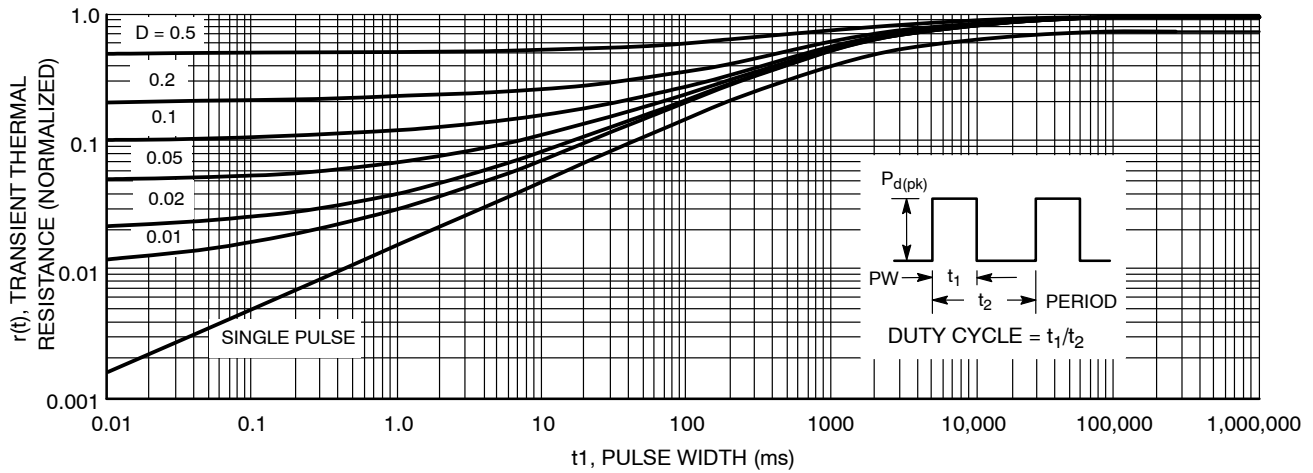


Figure 13. Transient Thermal Response for NUD3124LT1G

NUD3124, SZNUD3124

APPLICATIONS INFORMATION

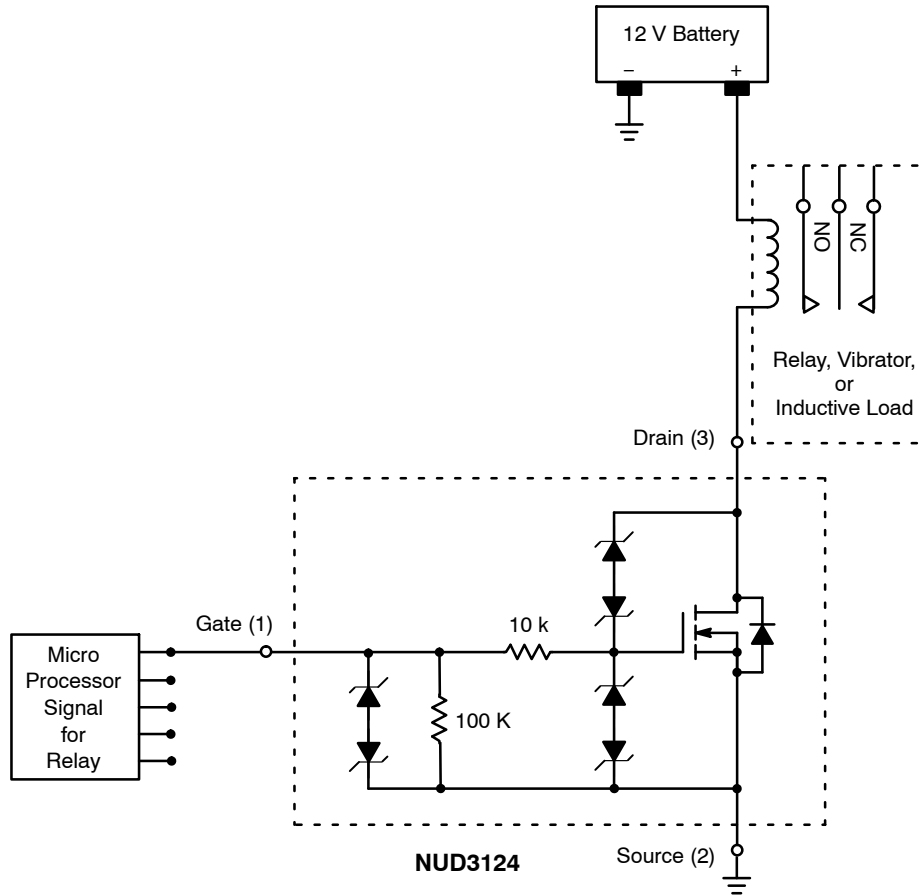
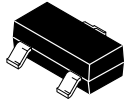


Figure 14. Applications Diagram

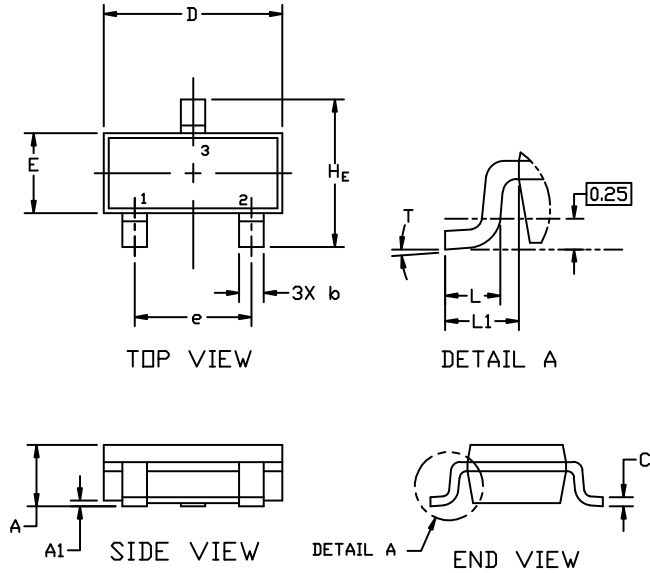
MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



SOT-23 (TO-236)
CASE 318
ISSUE AT

DATE 01 MAR 2023

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.

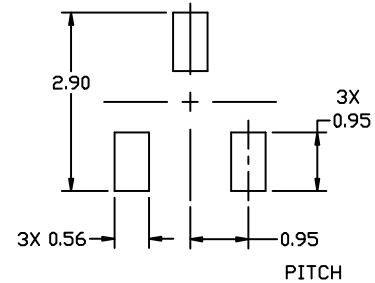
| DIM | MILLIMETERS | | | INCHES | | |
|----------------|-------------|------|------|--------|-------|-------|
| | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. |
| A | 0.89 | 1.00 | 1.11 | 0.035 | 0.039 | 0.044 |
| A1 | 0.01 | 0.06 | 0.10 | 0.000 | 0.002 | 0.004 |
| b | 0.37 | 0.44 | 0.50 | 0.015 | 0.017 | 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° |

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. Some products may not follow the Generic Marking.



RECOMMENDED MOUNTING 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.

STYLES ON PAGE 2

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MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS



SOT-23 (TO-236)
CASE 318
ISSUE AT

DATE 01 MAR 2023

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

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MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



SCALE 2:1

SC-74
CASE 318F
ISSUE P

DATE 07 OCT 2021

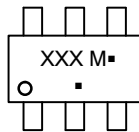


NOTES:

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2. CONTROLLING DIMENSION: INCHES
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF THE BASE MATERIAL.

| 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 |
| HE | 2.50 | 2.75 | 3.00 | 0.099 | 0.108 | 0.118 |
| L | 0.20 | 0.40 | 0.60 | 0.008 | 0.016 | 0.024 |
| M | 0* | --- | 10* | 0* | --- | 10* |

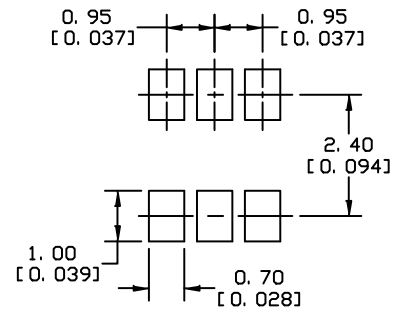
GENERIC MARKING DIAGRAM*



- 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. Some products may not follow the Generic Marking.



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

SOLDERING FOOTPRINT

- | | | | | | |
|--|---|--|---|--|--|
| <p>STYLE 1: PIN 1. CATHODE 2. ANODE 3. CATHODE 4. CATHODE 5. ANODE 6. CATHODE</p> | <p>STYLE 2: PIN 1. NO CONNECTION 2. COLLECTOR 3. EMITTER 4. NO CONNECTION 5. COLLECTOR 6. BASE</p> | <p>STYLE 3: PIN 1. EMITTER 1 2. BASE 1 3. COLLECTOR 2 4. EMITTER 2 5. BASE 2 6. COLLECTOR 1</p> | <p>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</p> | <p>STYLE 5: PIN 1. CHANNEL 1 2. ANODE 3. CHANNEL 2 4. CHANNEL 3 5. CATHODE 6. CHANNEL 4</p> | <p>STYLE 6: PIN 1. CATHODE 2. ANODE 3. CATHODE 4. CATHODE 5. CATHODE 6. CATHODE</p> |
| <p>STYLE 7: PIN 1. SOURCE 1 2. GATE 1 3. DRAIN 2 4. SOURCE 2 5. GATE 2 6. DRAIN 1</p> | <p>STYLE 8: PIN 1. EMITTER 1 2. BASE 2 3. COLLECTOR 2 4. EMITTER 2 5. BASE 1 6. COLLECTOR 1</p> | <p>STYLE 9: PIN 1. EMITTER 2 2. BASE 2 3. COLLECTOR 1 4. EMITTER 1 5. BASE 1 6. COLLECTOR 2</p> | <p>STYLE 10: PIN 1. ANODE/CATHODE 2. BASE 3. EMITTER 4. COLLECTOR 5. ANODE 6. CATHODE</p> | <p>STYLE 11: PIN 1. EMITTER 2. BASE 3. ANODE/CATHODE 4. ANODE 5. CATHODE 6. COLLECTOR</p> | |

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