

Industrial Inductive Load Driver

NUD3160, SZNUD3160

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 V, 24 V or 48 V
- 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



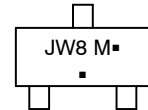
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MARKING DIAGRAMS



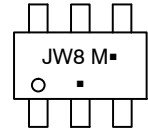
**SOT-23
CASE 318
STYLE 21**



JW8 = Specific Device Code
M = Date Code
▪ = Pb-Free Package
(Note: Microdot may be in either location)



**SC-74
CASE 318F
STYLE 7**



JW8 = Specific Device Code
M = Date Code
▪ = Pb-Free Package
(Note: Microdot may be in either location)

ORDERING INFORMATION

| Device | Package | Shipping† |
|----------------|------------------|--------------------|
| NUD3160LT1G | SOT-23 (Pb-Free) | 3000 / Tape & Reel |
| SZNUD3160LT1G | SOT-23 (Pb-Free) | 3000 / Tape & Reel |
| NUD3160DMT1G | SC-74 (Pb-Free) | 3000 / Tape & Reel |
| SZNUD3160DMT1G | 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.

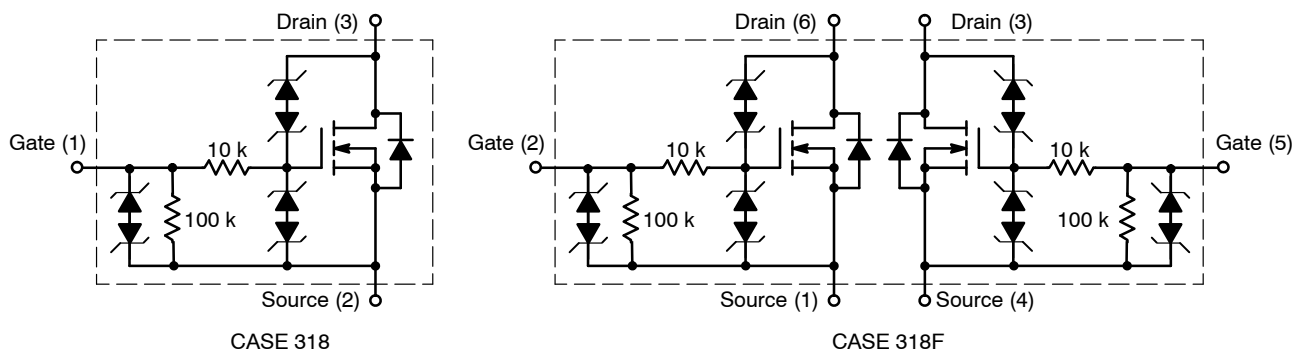


Figure 1. Internal Circuit Diagrams

NUD3160, SZNUD3160

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

| Symbol | Rating | Value | Unit |
|------------------|---|--|------|
| V _{DSS} | Drain-to-Source Voltage – Continuous (T _J = 125°C) | 60 | V |
| V _{GSS} | Gate-to-Source Voltage – Continuous (T _J = 125°C) | 12 | V |
| I _D | Drain Current – Continuous (T _J = 125°C) Minimum copper, double sided board, T _A = 80°C SOT-23 SC74 Single device driven SC74 Both devices driven 1 in ² copper, double sided board, T _A = 25°C SOT-23 SC74 Single device driven SC74 Both devices driven | 158 157 132 ea 272 263 230 ea | 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) | 200 | mJ |
| P _{PK} | Peak Power Dissipation, Drain-to-Source (Notes 1 and 2) (T _J Initial = 85°C) | 20 | W |
| E _{LD1} | Load Dump Pulse, Drain-to-Source (Note 3) R _{SOURCE} = 0.5 Ω, T = 300 ms (For Relay's Coils/Inductive Loads of 80 Ω or Higher) (T _J Initial = 85°C) | 60 | 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 | 2000 | 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.

NUD3160, SZNUD3160

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 4) Derating above 25°C | SOT-23 | 225 | mW |
| | | | 1.8 | mW/°C |
| P_D | Total Power Dissipation (Note 4) Derating above 25°C | SC-74 | 380 | mW |
| | | | 3.0 | mW/°C |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient Minimum Copper | SOT-23 | 556 | °C/W |
| | | SC-74 One Device Powered | 556 | |
| | | SC-74 Both Devices Equally Powered | 398 | |
| | 300 mm ² Copper | SOT-23 | 395 | |
| | | SC-74 One Device Powered | 420 | |
| | | SC-74 Both Devices Equally Powered | 270 | |

1. Nonrepetitive current square pulse 1.0 ms duration.
2. For different square pulse durations, see Figure 12.
3. Nonrepetitive load dump pulse per Figure 3.
4. Mounted onto minimum pad board.

NUD3160, SZNUD3160

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} | 61 | 66 | 70 | 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} = 60 V, V _{GS} = 0 V) (V _{DS} = 60 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)} | – | – | 2.4 3.7 1.8 2.9 | Ω |
| Output Continuous Current (V _{DS} = 0.3 V, V _{GS} = 5.0 V) (V _{DS} = 0.3 V, V _{GS} = 5.0 V, T _J = 125°C) | I _{DS(on)} | 150 100 | 200 – | – – | mA |
| Forward Transconductance (V _{DS} = 12 V, I _D = 150 mA) | g _{FS} | – | 400 | – | mmho |
| DYNAMIC CHARACTERISTICS | | | | | |
| Input Capacitance (V _{DS} = 12 V, V _{GS} = 0 V, f = 10 kHz) | C _{iss} | – | 30 | – | pf |
| Output Capacitance (V _{DS} = 12 V, V _{GS} = 0 V, f = 10 kHz) | C _{oss} | – | 14 | – | pf |
| Transfer Capacitance (V _{DS} = 12 V, V _{GS} = 0 V, f = 10 kHz) | C _{rss} | – | 6.0 | – | pf |
| SWITCHING CHARACTERISTICS | | | | | |
| Propagation Delay Times: High to Low Propagation Delay; Figure 2, (V _{DS} = 12 V, V _{GS} = 3.0 V) Low to High Propagation Delay; Figure 2, (V _{DS} = 12 V, V _{GS} = 3.0 V) High to Low Propagation Delay; Figure 2, (V _{DS} = 12 V, V _{GS} = 5.0 V) Low to High Propagation Delay; Figure 2, (V _{DS} = 12 V, V _{GS} = 5.0 V) | t _{PHL} t _{PLH} t _{PHL} t _{PLH} | – – – – | 918 798 331 1160 | – – – – | ns |
| Transition Times: Fall Time; Figure 2, (V _{DS} = 12 V, V _{GS} = 3.0 V) Rise Time; Figure 2, (V _{DS} = 12 V, V _{GS} = 3.0 V) Fall Time; Figure 2, (V _{DS} = 12 V, V _{GS} = 5.0 V) Rise Time; Figure 2, (V _{DS} = 12 V, V _{GS} = 5.0 V) | t _f t _r t _f t _r | – – – – | 2290 618 622 600 | – – – – | 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.

NUD3160, SZNUD3160

TYPICAL WAVEFORMS

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

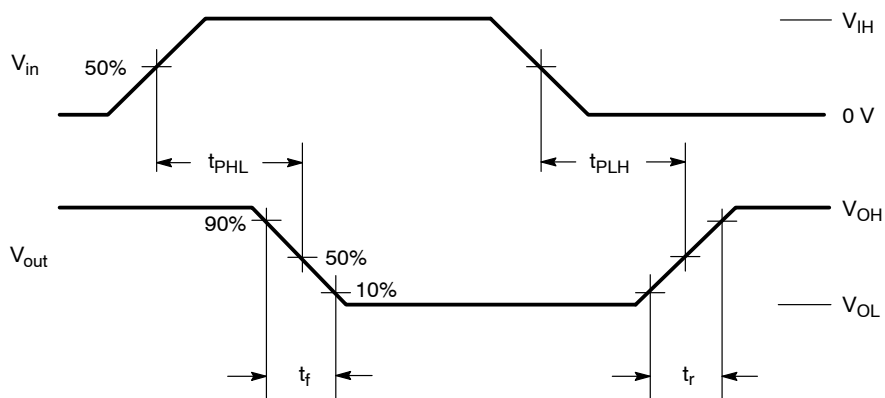


Figure 2. Switching Waveforms

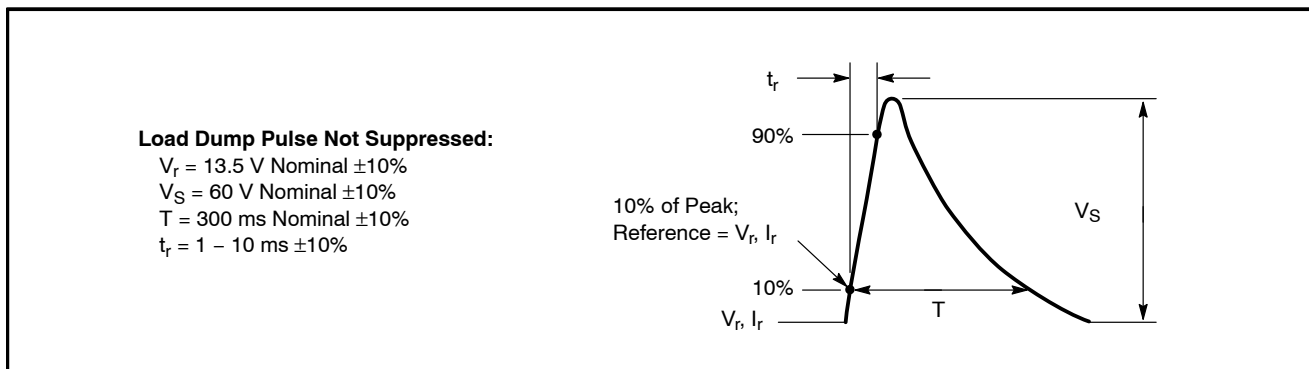


Figure 3. Load Dump Waveform Definition

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TYPICAL PERFORMANCE CURVES

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

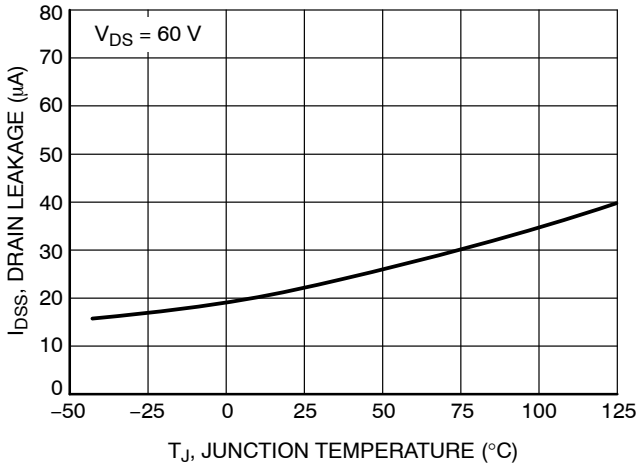


Figure 4. Drain-to-Source Leakage vs. Junction Temperature

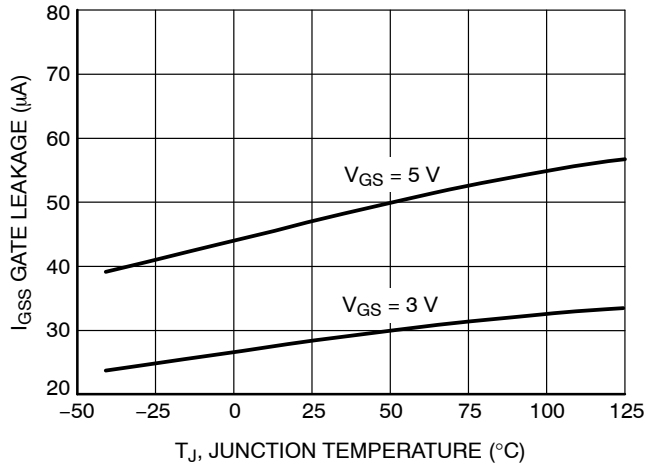


Figure 5. Gate-to-Source Leakage vs. Junction Temperature

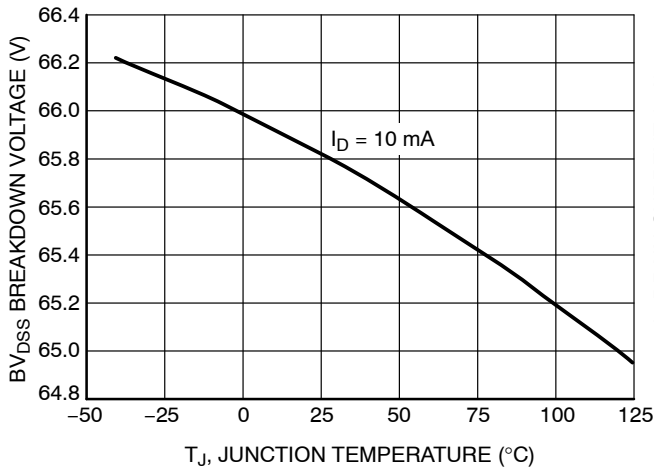


Figure 6. Breakdown Voltage vs. Junction Temperature

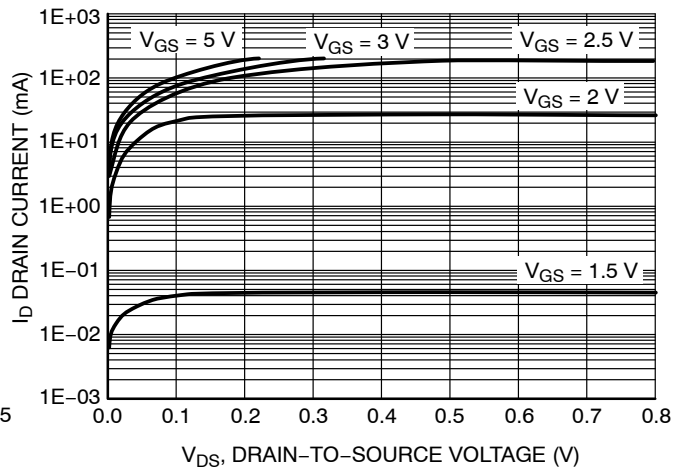


Figure 7. Output Characteristics

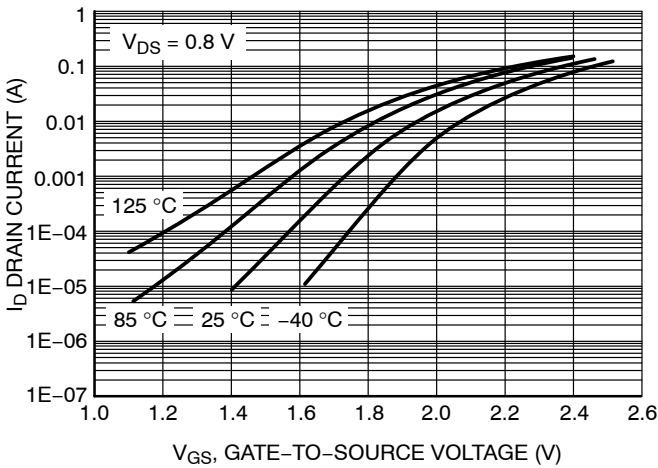


Figure 8. Transfer Function

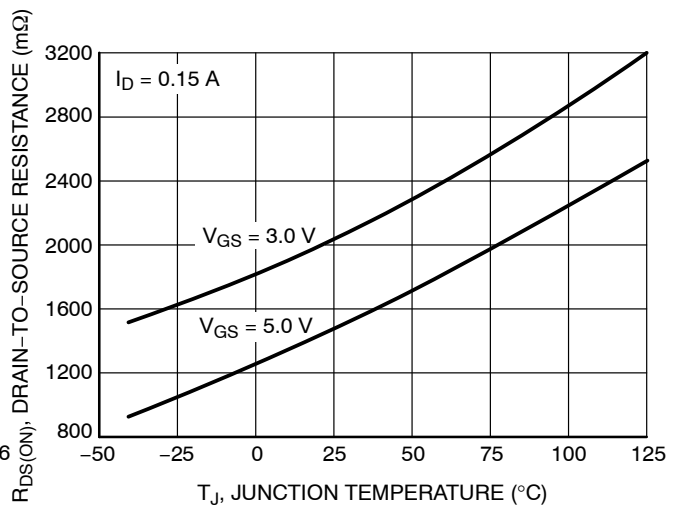


Figure 9. On Resistance Variation vs. Junction Temperature

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TYPICAL PERFORMANCE CURVES

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

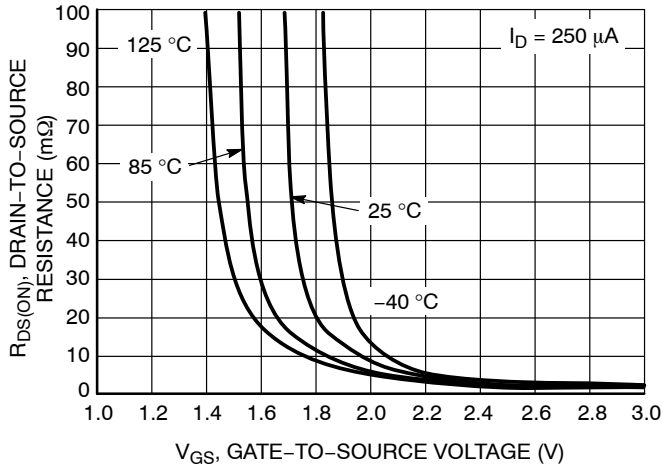


Figure 10. On Resistance Variation vs. Gate-to-Source Voltage

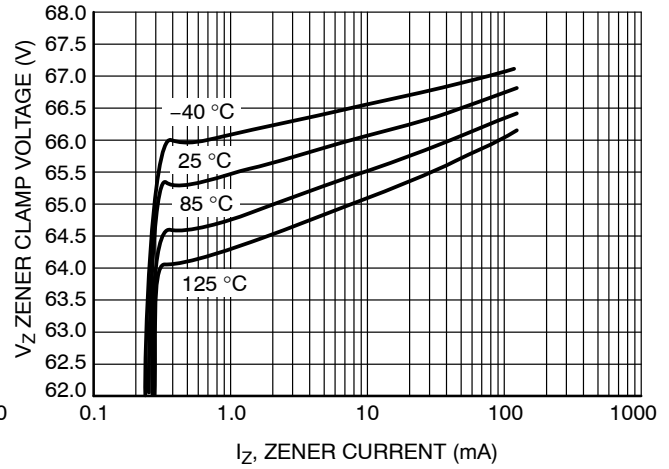


Figure 11. Zener Clamp Voltage vs. Zener Current

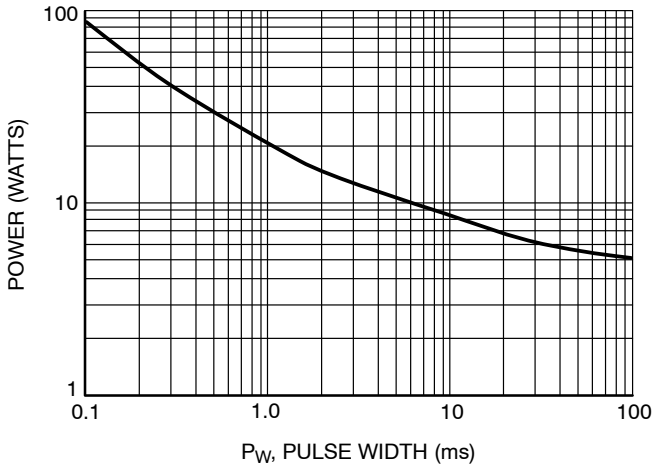


Figure 12. Maximum Non-repetitive Surge Power vs. Pulse Width

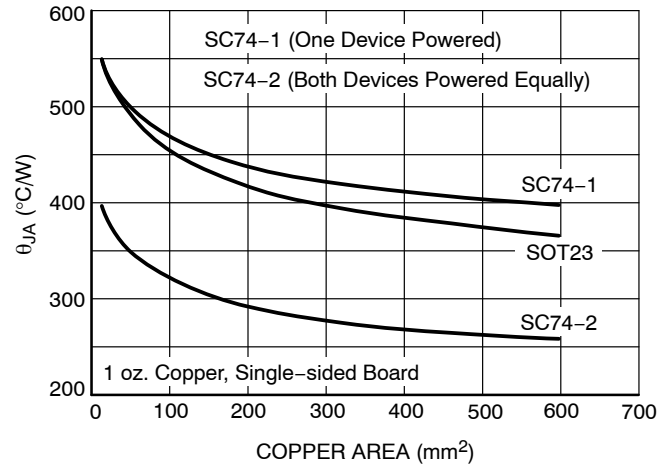


Figure 13. Thermal Performance vs. Board Copper Area

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APPLICATIONS INFORMATION

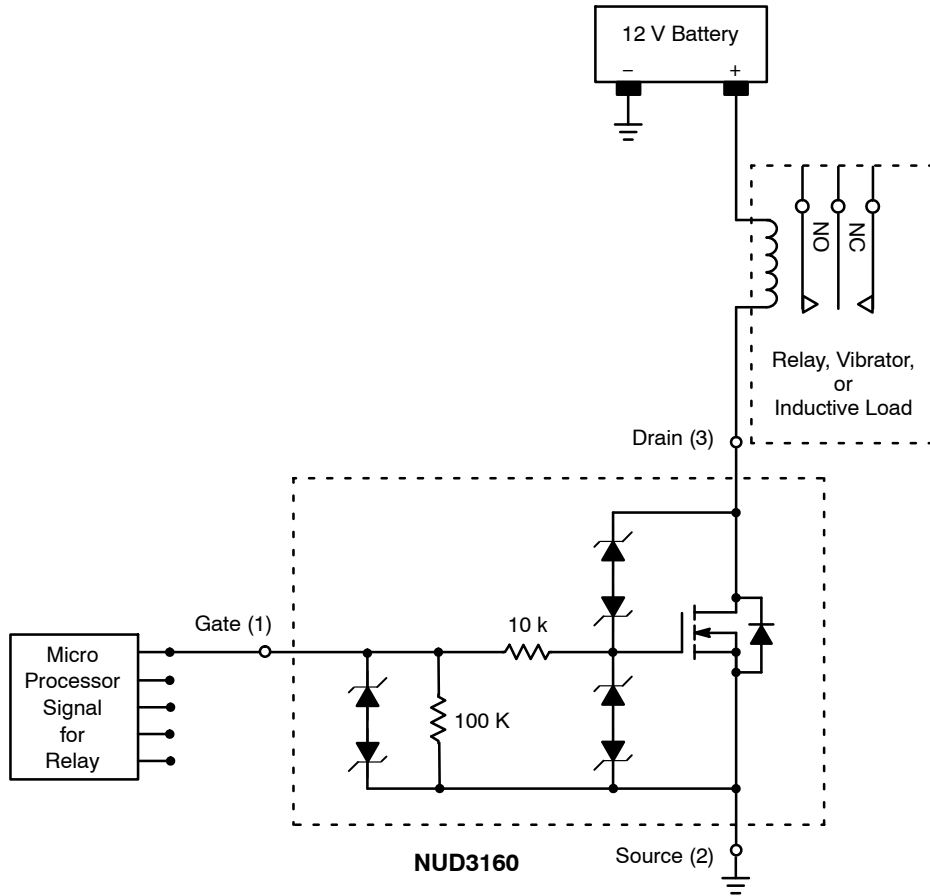


Figure 14. Applications Diagram

MECHANICAL CASE OUTLINE

PACKAGE DIMENSIONS

ON Semiconductor®



SOT-23 (TO-236) CASE 318-08 ISSUE AS

DATE 30 JAN 2018

SCALE 4:1

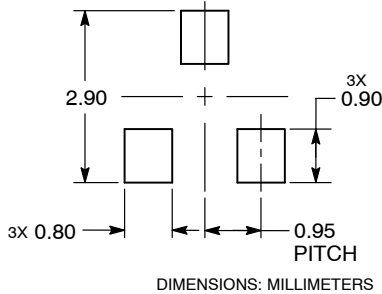


NOTES:

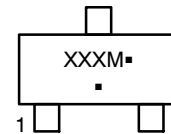
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF THE BASE MATERIAL.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

| 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 |
| HE | 2.10 | 2.40 | 2.64 | 0.083 | 0.094 | 0.104 |
| T | 0° | --- | 10° | 0° | --- | 10° |

RECOMMENDED SOLDERING FOOTPRINT



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

| | | |
|-------------------------|------------------------|--|
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| DESCRIPTION: | SOT-23 (TO-236) | PAGE 1 OF 1 |

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MECHANICAL CASE OUTLINE

PACKAGE DIMENSIONS

ON Semiconductor®



SC-74

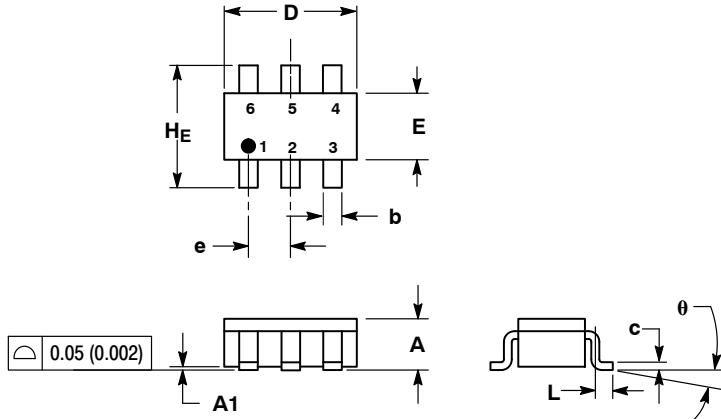
CASE 318F-05

ISSUE N

DATE 08 JUN 2012



SCALE 2:1

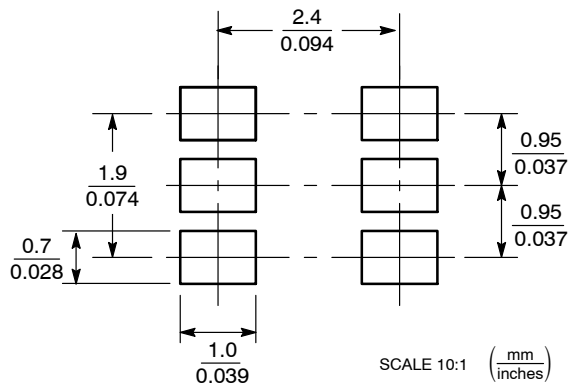


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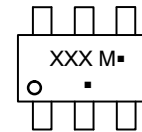
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. 318F-01, -02, -03, -04 OBSOLETE. NEW STANDARD 318F-05.

| 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 |
| HE | 2.50 | 2.75 | 3.00 | 0.099 | 0.108 | 0.118 |
| θ | 0° | - | 10° | 0° | - | 10° |

SOLDERING FOOTPRINT*



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.

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

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

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