

# 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 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

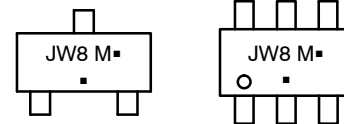


SOT-23  
CASE 318  
STYLE 21



SC-74  
CASE 318F  
STYLE 7

### MARKING DIAGRAMS



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

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

### ORDERING INFORMATION

Device	Package	Shipping <sup>†</sup>
SZNUD3160LT1G	SOT-23 (Pb-Free)	3000 / Tape & Reel
SZNUD3160DMT1G	SC-74 (Pb-Free)	3000 / Tape & Reel

### DISCONTINUED (Note 1)

NU31D60LT1G	SOT-23 (Pb-Free)	3000 / Tape & Reel
NUD3160DMT1G	SC-74 (Pb-Free)	3000 / Tape & Reel

<sup>†</sup>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](#).

1. **DISCONTINUED:** These devices are not recommended for new design. Please contact your **onsemi** representative for information. The most current information on these devices may be available on [www.onsemi.com](#).

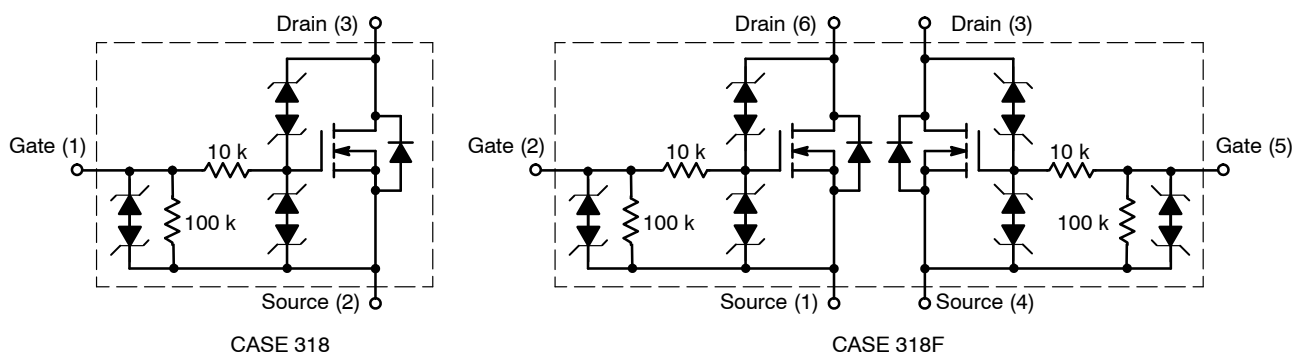


Figure 1. Internal Circuit Diagrams

# NUD3160, SZNUD3160

## MAXIMUM RATINGS (T<sub>J</sub> = 25°C unless otherwise specified)

Symbol	Rating	Value	Unit
V <sub>DSS</sub>	Drain-to-Source Voltage – Continuous (T <sub>J</sub> = 125°C)	60	V
V <sub>GSS</sub>	Gate-to-Source Voltage – Continuous (T <sub>J</sub> = 125°C)	12	V
I <sub>D</sub>	Drain Current – Continuous (T <sub>J</sub> = 125°C) Minimum copper, double sided board, T <sub>A</sub> = 80°C SOT-23 SC74 Single device driven SC74 Both devices driven 1 in <sup>2</sup> copper, double sided board, T <sub>A</sub> = 25°C SOT-23 SC74 Single device driven SC74 Both devices driven	158 157 132 ea  272 263 230 ea	mA
E <sub>Z</sub>	Single Pulse Drain-to-Source Avalanche Energy (For Relay's Coils/Inductive Loads of 80 Ω or Higher) (T <sub>J</sub> Initial = 85°C)	200	mJ
P <sub>PK</sub>	Peak Power Dissipation, Drain-to-Source (Notes 2 and 3) (T <sub>J</sub> Initial = 85°C)	20	W
E <sub>LD1</sub>	Load Dump Pulse, Drain-to-Source (Note 4) R <sub>SOURCE</sub> = 0.5 Ω, T = 300 ms (For Relay's Coils/Inductive Loads of 80 Ω or Higher) (T <sub>J</sub> Initial = 85°C)	60	V
E <sub>LD2</sub>	Inductive Switching Transient 1, Drain-to-Source (Waveform: R <sub>SOURCE</sub> = 10 Ω, T = 2.0 ms) (For Relay's Coils/Inductive Loads of 80 Ω or Higher) (T <sub>J</sub> Initial = 85°C)	100	V
E <sub>LD3</sub>	Inductive Switching Transient 2, Drain-to-Source (Waveform: R <sub>SOURCE</sub> = 4.0 Ω, T = 50 μs) (For Relay's Coils/Inductive Loads of 80 Ω or Higher) (T <sub>J</sub> 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.

## THERMAL CHARACTERISTICS

Symbol	Rating	Value	Unit	
T <sub>A</sub>	Operating Ambient Temperature	-40 to 125	°C	
T <sub>J</sub>	Maximum Junction Temperature	150	°C	
T <sub>STG</sub>	Storage Temperature Range	-65 to 150	°C	
P <sub>D</sub>	Total Power Dissipation (Note 5) Derating above 25°C	SOT-23 225 1.8	mW mW/°C	
P <sub>D</sub>	Total Power Dissipation (Note 5) Derating above 25°C	SC-74 380 3.0	mW mW/°C	
R <sub>θJA</sub>	Thermal Resistance, Junction-to-Ambient Minimum Copper  300 mm <sup>2</sup> Copper	SOT-23 SC-74 One Device Powered SC-74 Both Devices Equally Powered  SOT-23 SC-74 One Device Powered SC-74 Both Devices Equally Powered	556 556 398  395 420 270	°C/W

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

# NUD3160, SZNUD3160

## ELECTRICAL CHARACTERISTICS (T<sub>J</sub> = 25°C unless otherwise specified)

Characteristic	Symbol	Min	Typ	Max	Unit
<b>OFF CHARACTERISTICS</b>					
Drain to Source Sustaining Voltage (I <sub>D</sub> = 10 mA)	V <sub>BRDSS</sub>	61	66	70	V
Drain to Source Leakage Current (V <sub>DS</sub> = 12 V, V <sub>GS</sub> = 0 V) (V <sub>DS</sub> = 12 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 125°C) (V <sub>DS</sub> = 60 V, V <sub>GS</sub> = 0 V) (V <sub>DS</sub> = 60 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 125°C)	I <sub>DSS</sub>	–	–	0.5 1.0 50 80	μA
Gate Body Leakage Current (V <sub>GS</sub> = 3.0 V, V <sub>DS</sub> = 0 V) (V <sub>GS</sub> = 3.0 V, V <sub>DS</sub> = 0 V, T <sub>J</sub> = 125°C) (V <sub>GS</sub> = 5.0 V, V <sub>DS</sub> = 0 V) (V <sub>GS</sub> = 5.0 V, V <sub>DS</sub> = 0 V, T <sub>J</sub> = 125°C)	I <sub>GSS</sub>	–	–	60 80 90 110	μA
<b>ON CHARACTERISTICS</b>					
Gate Threshold Voltage (V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 1.0 mA) (V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 1.0 mA, T <sub>J</sub> = 125°C)	V <sub>GS(th)</sub>	1.3 1.3	1.8 –	2.0 2.0	V
Drain to Source On-Resistance (I <sub>D</sub> = 150 mA, V <sub>GS</sub> = 3.0 V) (I <sub>D</sub> = 150 mA, V <sub>GS</sub> = 3.0 V, T <sub>J</sub> = 125°C) (I <sub>D</sub> = 150 mA, V <sub>GS</sub> = 5.0 V) (I <sub>D</sub> = 150 mA, V <sub>GS</sub> = 5.0 V, T <sub>J</sub> = 125°C)	R <sub>DS(on)</sub>	–	–	2.4 3.7 1.8 2.9	Ω
Output Continuous Current (V <sub>DS</sub> = 0.3 V, V <sub>GS</sub> = 5.0 V) (V <sub>DS</sub> = 0.3 V, V <sub>GS</sub> = 5.0 V, T <sub>J</sub> = 125°C)	I <sub>DS(on)</sub>	150 100	200 –	– –	mA
Forward Transconductance (V <sub>DS</sub> = 12 V, I <sub>D</sub> = 150 mA)	g <sub>FS</sub>	–	400	–	mmho
<b>DYNAMIC CHARACTERISTICS</b>					
Input Capacitance (V <sub>DS</sub> = 12 V, V <sub>GS</sub> = 0 V, f = 10 kHz)	C <sub>iss</sub>	–	30	–	pf
Output Capacitance (V <sub>DS</sub> = 12 V, V <sub>GS</sub> = 0 V, f = 10 kHz)	C <sub>oss</sub>	–	14	–	pf
Transfer Capacitance (V <sub>DS</sub> = 12 V, V <sub>GS</sub> = 0 V, f = 10 kHz)	C <sub>rss</sub>	–	6.0	–	pf
<b>SWITCHING CHARACTERISTICS</b>					
Propagation Delay Times: High to Low Propagation Delay; Figure 2, (V <sub>DS</sub> = 12 V, V <sub>GS</sub> = 3.0 V) Low to High Propagation Delay; Figure 2, (V <sub>DS</sub> = 12 V, V <sub>GS</sub> = 3.0 V)  High to Low Propagation Delay; Figure 2, (V <sub>DS</sub> = 12 V, V <sub>GS</sub> = 5.0 V) Low to High Propagation Delay; Figure 2, (V <sub>DS</sub> = 12 V, V <sub>GS</sub> = 5.0 V)	t <sub>PHL</sub> t <sub>PLH</sub>  t <sub>PHL</sub> t <sub>PLH</sub>	– –  – –	918 798  331 1160	– –  – –	ns
Transition Times: Fall Time; Figure 2, (V <sub>DS</sub> = 12 V, V <sub>GS</sub> = 3.0 V) Rise Time; Figure 2, (V <sub>DS</sub> = 12 V, V <sub>GS</sub> = 3.0 V)  Fall Time; Figure 2, (V <sub>DS</sub> = 12 V, V <sub>GS</sub> = 5.0 V) Rise Time; Figure 2, (V <sub>DS</sub> = 12 V, V <sub>GS</sub> = 5.0 V)	t <sub>f</sub> t <sub>r</sub>  t <sub>f</sub> t <sub>r</sub>	– –  – –	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)

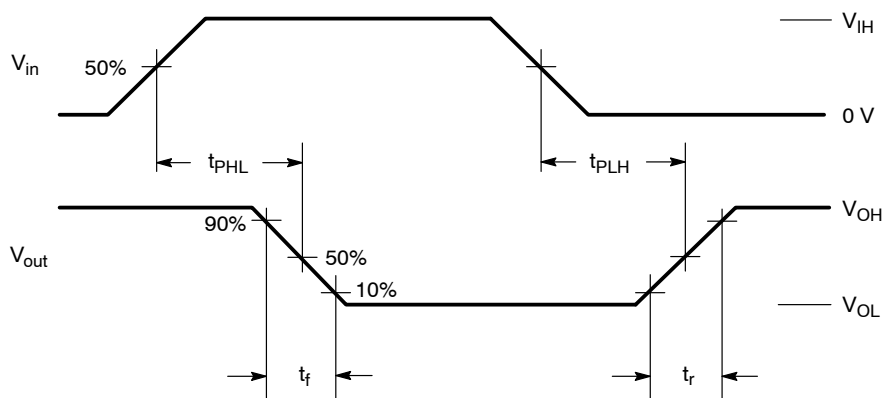


Figure 2. Switching Waveforms

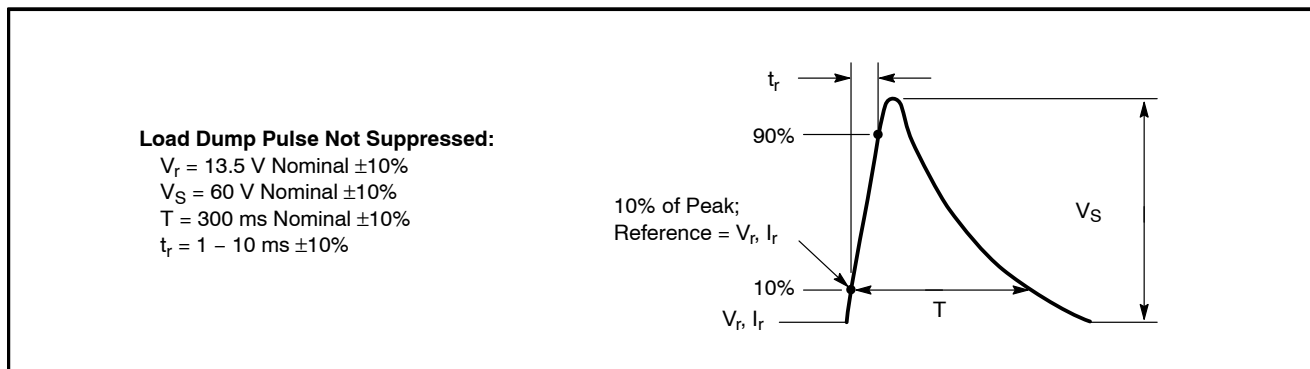
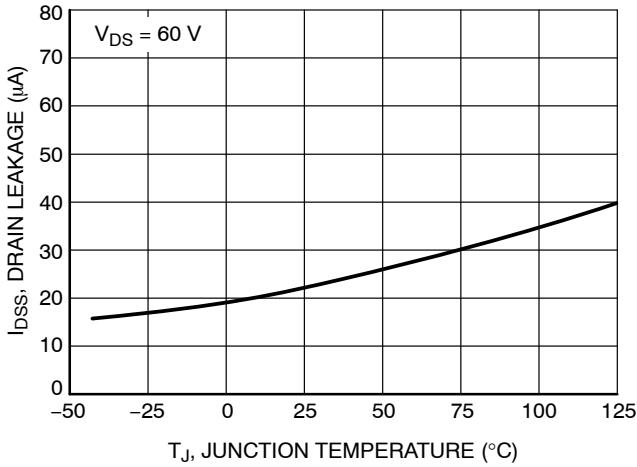


Figure 3. Load Dump Waveform Definition

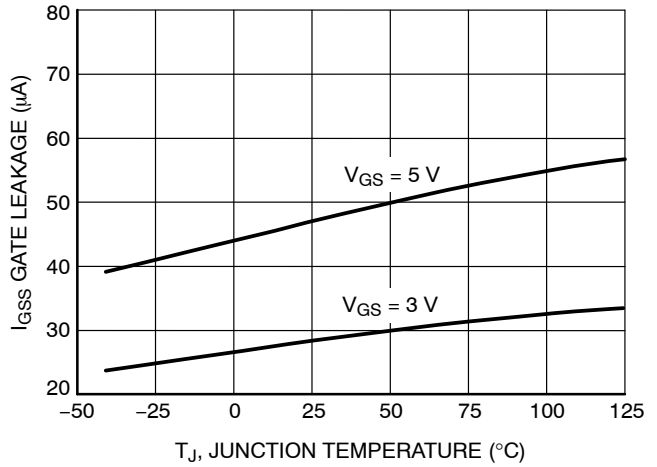
# NUD3160, SZNUD3160

## TYPICAL PERFORMANCE CURVES

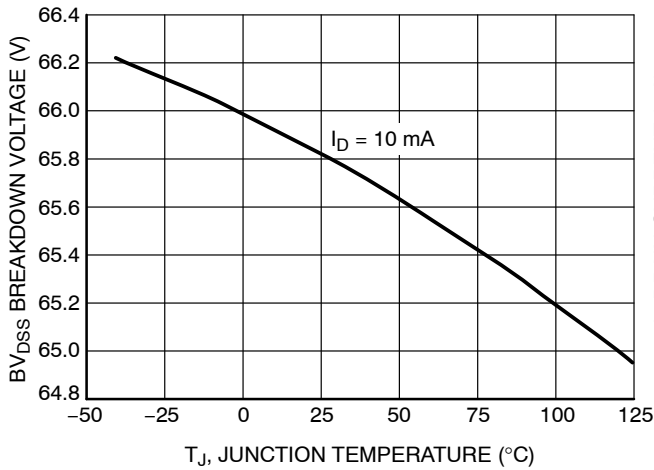
( $T_J = 25^\circ\text{C}$  unless otherwise specified)



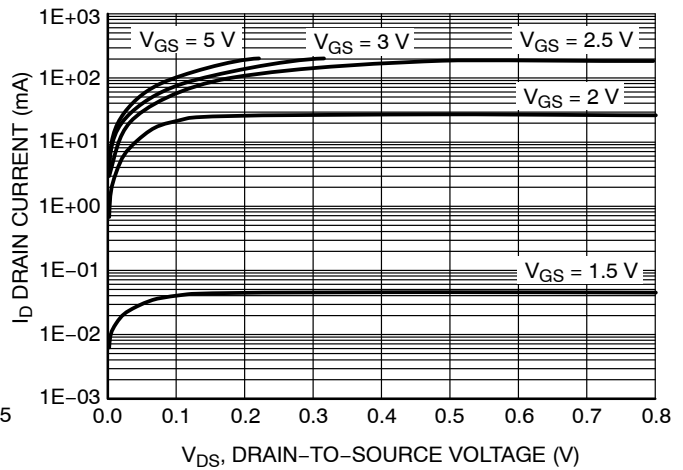
**Figure 4. Drain-to-Source Leakage vs. Junction Temperature**



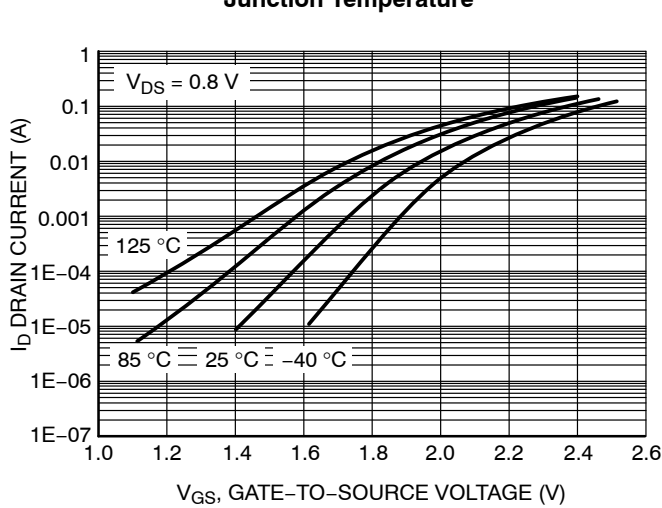
**Figure 5. Gate-to-Source Leakage vs. Junction Temperature**



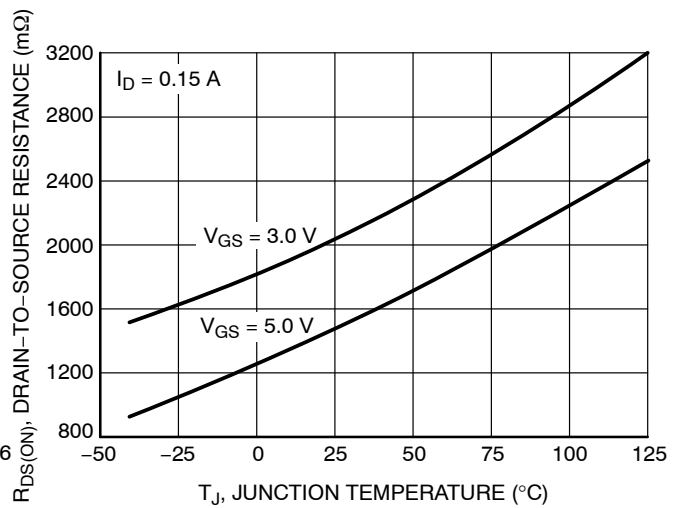
**Figure 6. Breakdown Voltage vs. Junction Temperature**



**Figure 7. Output Characteristics**



**Figure 8. Transfer Function**

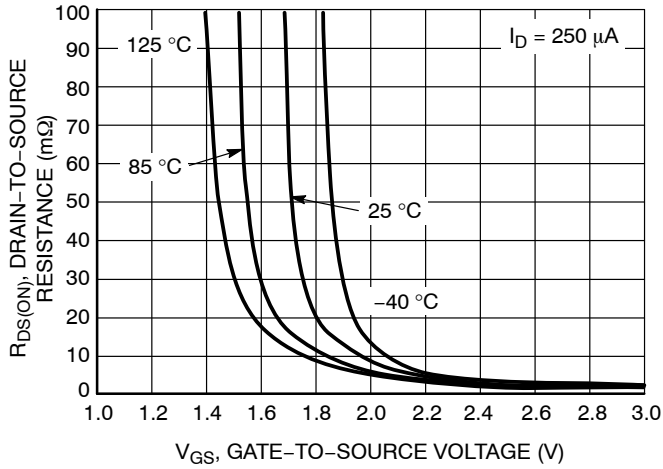


**Figure 9. On Resistance Variation vs. Junction Temperature**

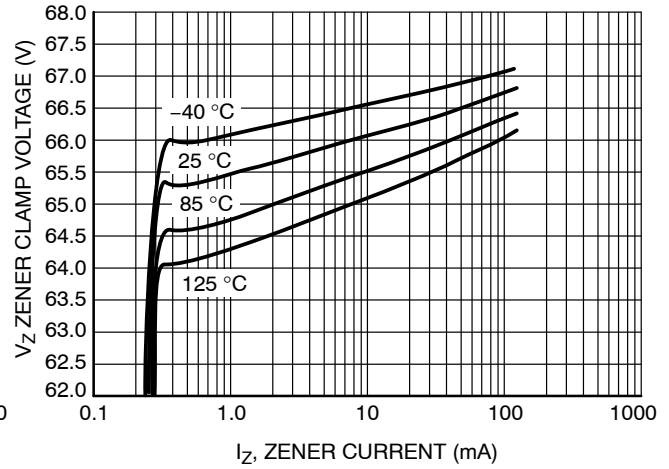
# NUD3160, SZNUD3160

## TYPICAL PERFORMANCE CURVES

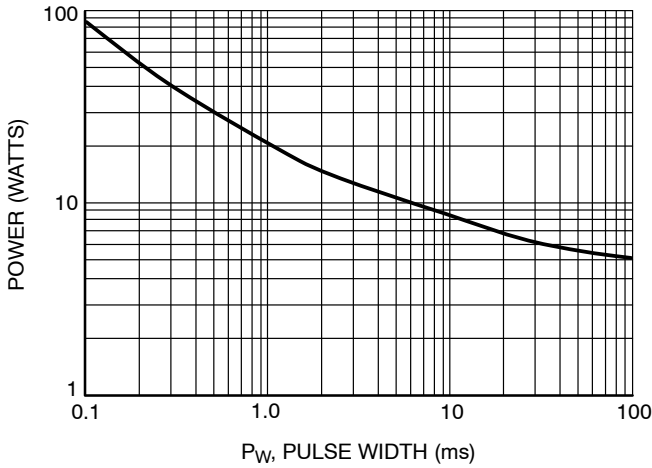
( $T_J = 25^\circ\text{C}$  unless otherwise specified)



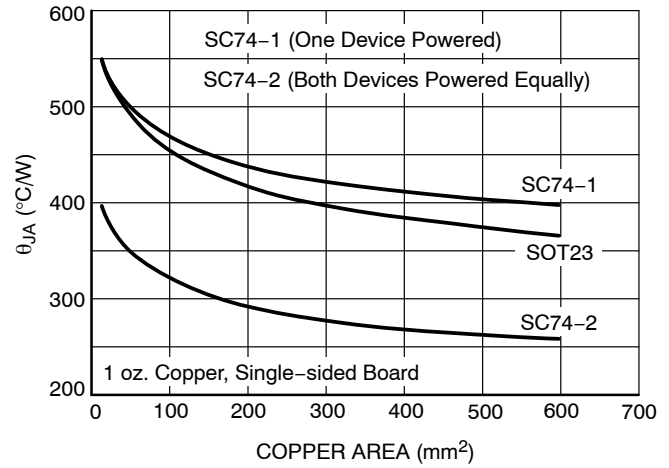
**Figure 10. On Resistance Variation vs. Gate-to-Source Voltage**



**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**

# NUD3160, SZNUD3160

## APPLICATIONS INFORMATION

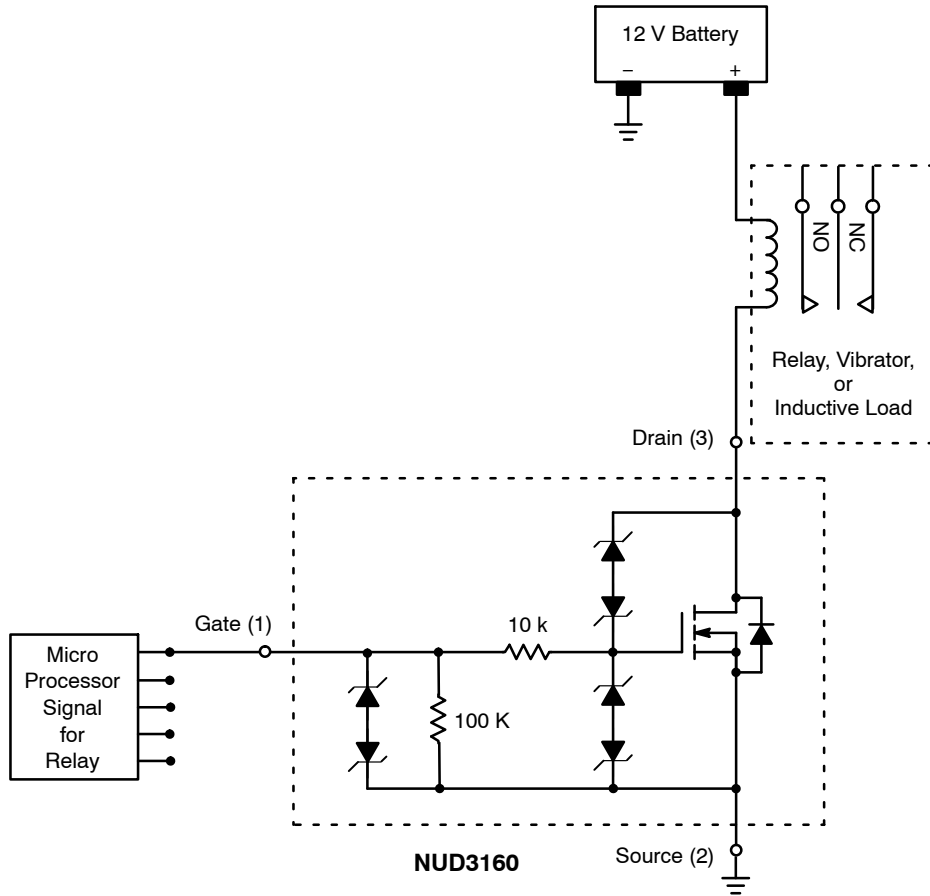
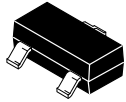


Figure 14. Applications Diagram

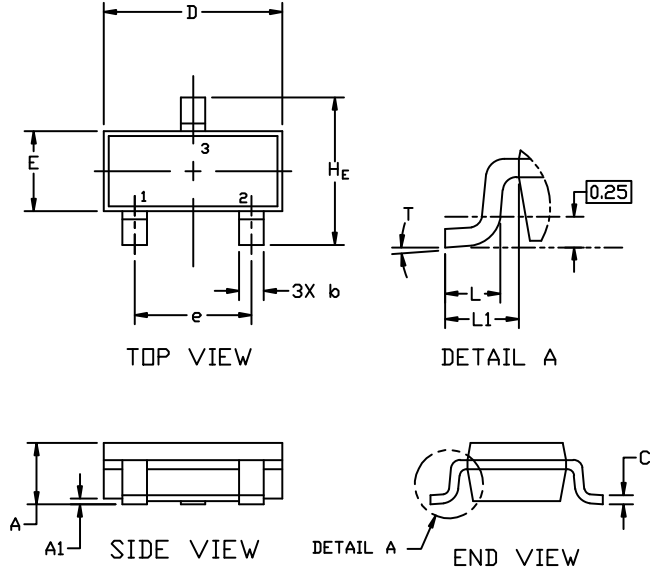
# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



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

DATE 01 MAR 2023

SCALE 4:1

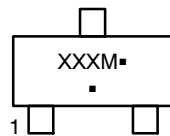


**NOTES:**

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.

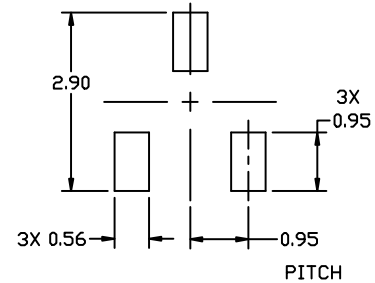
DIM	MILLIMETERS			INCHES		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.89	1.00	1.11	0.035	0.039	0.044
A1	0.01	0.06	0.10	0.000	0.002	0.004
b	0.37	0.44	0.50	0.015	0.017	0.020
c	0.08	0.14	0.20	0.003	0.006	0.008
D	2.80	2.90	3.04	0.110	0.114	0.120
E	1.20	1.30	1.40	0.047	0.051	0.055
e	1.78	1.90	2.04	0.070	0.075	0.080
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 <sub>E</sub>	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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<b>DESCRIPTION:</b>	<b>SOT-23 (TO-236)</b>	<b>PAGE 1 OF 2</b>

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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:<br>CANCELLED                            | STYLE 6:<br>PIN 1. BASE<br>2. EMITTER<br>3. COLLECTOR | STYLE 7:<br>PIN 1. EMITTER<br>2. BASE<br>3. COLLECTOR       | STYLE 8:<br>PIN 1. ANODE<br>2. NO CONNECTION<br>3. CATHODE  |   |   |
| STYLE 9:<br>PIN 1. ANODE<br>2. ANODE<br>3. CATHODE      | STYLE 10:<br>PIN 1. DRAIN<br>2. SOURCE<br>3. GATE     | STYLE 11:<br>PIN 1. ANODE<br>2. CATHODE<br>3. CATHODE-ANODE | STYLE 12:<br>PIN 1. CATHODE<br>2. CATHODE<br>3. ANODE       | STYLE 13:<br>PIN 1. SOURCE<br>2. DRAIN<br>3. GATE           | STYLE 14:<br>PIN 1. CATHODE<br>2. GATE<br>3. ANODE          |
| STYLE 15:<br>PIN 1. GATE<br>2. CATHODE<br>3. ANODE      | STYLE 16:<br>PIN 1. ANODE<br>2. CATHODE<br>3. CATHODE | STYLE 17:<br>PIN 1. NO CONNECTION<br>2. ANODE<br>3. CATHODE | STYLE 18:<br>PIN 1. NO CONNECTION<br>2. CATHODE<br>3. ANODE | STYLE 19:<br>PIN 1. CATHODE<br>2. ANODE<br>3. CATHODE-ANODE | STYLE 20:<br>PIN 1. CATHODE<br>2. ANODE<br>3. GATE          |
| STYLE 21:<br>PIN 1. GATE<br>2. SOURCE<br>3. DRAIN       | STYLE 22:<br>PIN 1. RETURN<br>2. OUTPUT<br>3. INPUT   | STYLE 23:<br>PIN 1. ANODE<br>2. ANODE<br>3. CATHODE         | STYLE 24:<br>PIN 1. GATE<br>2. DRAIN<br>3. SOURCE           | STYLE 25:<br>PIN 1. ANODE<br>2. CATHODE<br>3. GATE          | STYLE 26:<br>PIN 1. CATHODE<br>2. ANODE<br>3. NO CONNECTION |
| STYLE 27:<br>PIN 1. CATHODE<br>2. CATHODE<br>3. CATHODE | STYLE 28:<br>PIN 1. ANODE<br>2. ANODE<br>3. ANODE     |   |   |   |   |

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<b>DESCRIPTION:</b>	<b>SOT-23 (TO-236)</b>	<b>PAGE 2 OF 2</b>

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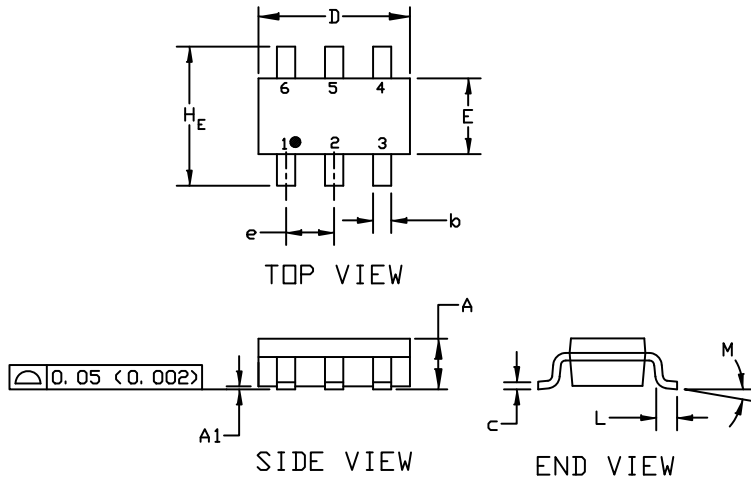
# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



SCALE 2:1

SC-74  
CASE 318F  
ISSUE P

DATE 07 OCT 2021

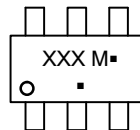


NOTES:

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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
H <sub>E</sub>	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*

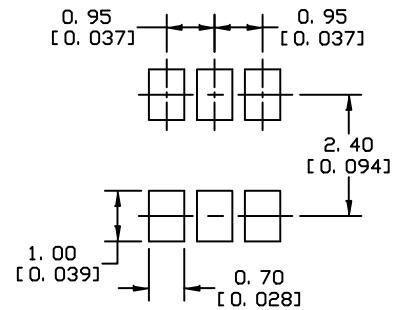
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\* For additional information on our Pb-Free strategy and soldering details, please download the DN Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERM/D.

SOLDERING FOOTPRINT

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

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