

# NUD3160

## Industrial Inductive Load Driver

This MicroIntegration™ 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
- Pb-Free Packages are Available

### 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



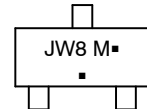
**ON Semiconductor®**

<http://onsemi.com>

### MARKING DIAGRAMS



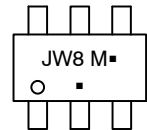
**SOT-23  
CASE 318  
STYLE 21**



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



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

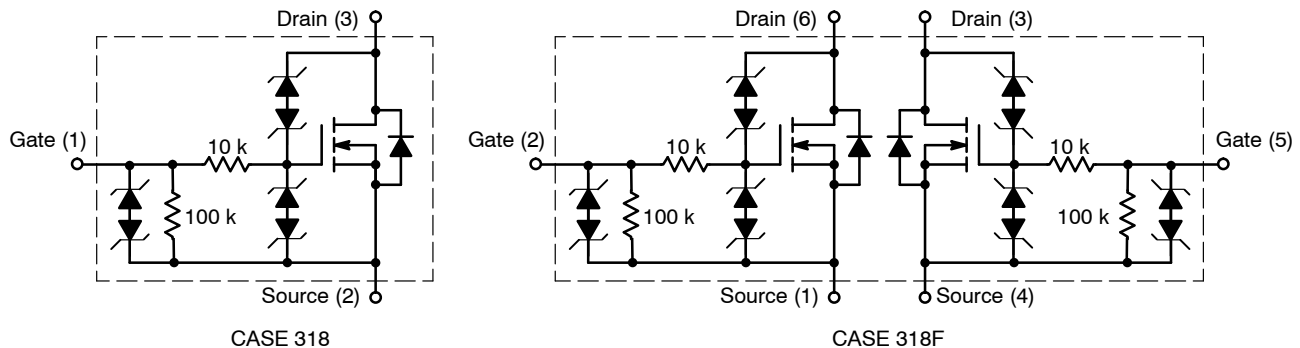


JW8 = Specific Device Code  
M = Date Code  
▪ = Pb-Free Package  
(Note: Microdot may be in either location)

### ORDERING INFORMATION

Device	Package	Shipping†
NUD3160LT1	SOT-23	3000/Tape & Reel
NUD3160LT1G	SOT-23 (Pb-Free)	3000/Tape & Reel
NUD3160DMT1	SC-74	3000/Tape & Reel
NUD3160DMT1G	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**

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## 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 1 and 2) (T <sub>J</sub> Initial = 85°C)	20	W
E <sub>LD1</sub>	Load Dump Pulse, Drain-to-Source (Note 3) 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

## 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 4) Derating above 25°C	SOT-23 225 1.8	mW mW/°C
P <sub>D</sub>	Total Power Dissipation (Note 4) 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-23 556 556 398  SOT-23 395 420 270	°C/W

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.

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## 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

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## TYPICAL WAVEFORMS

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

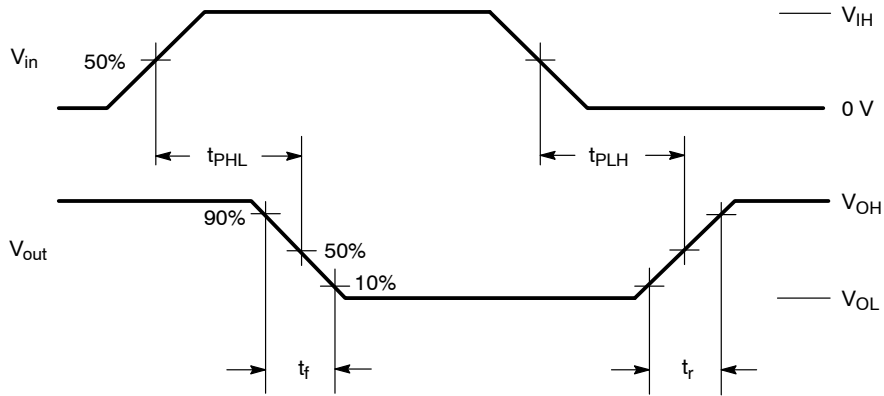


Figure 2. Switching Waveforms

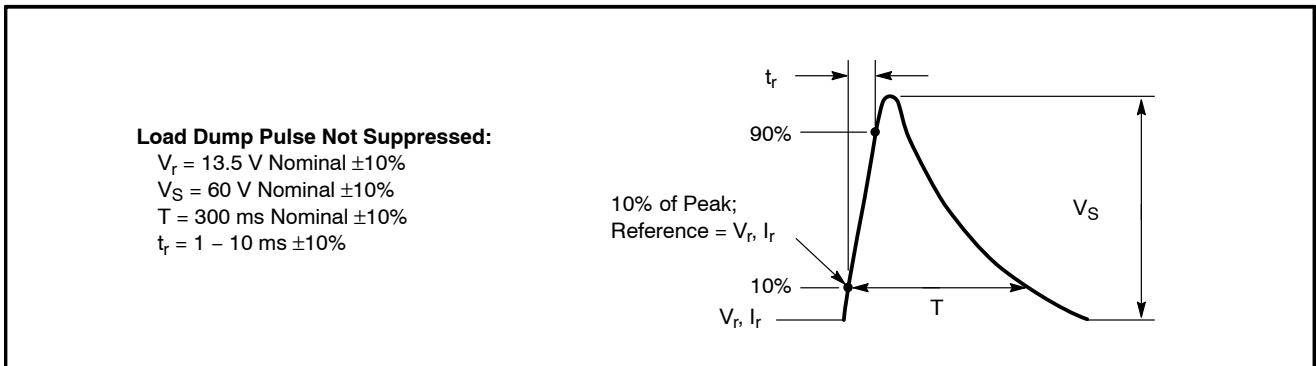


Figure 3. Load Dump Waveform Definition

TYPICAL PERFORMANCE CURVES

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

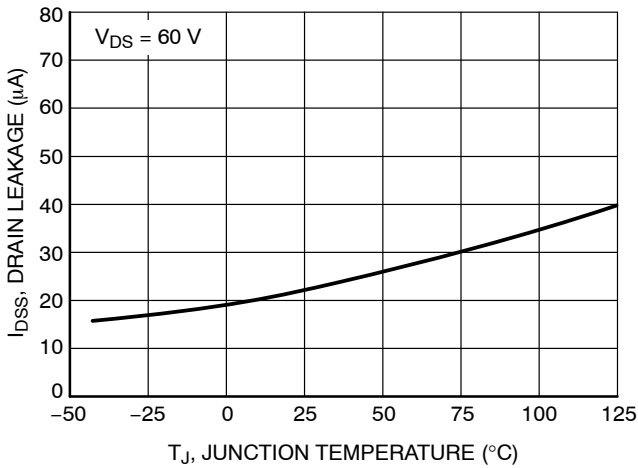


Figure 4. Drain-to-Source Leakage vs. Junction Temperature

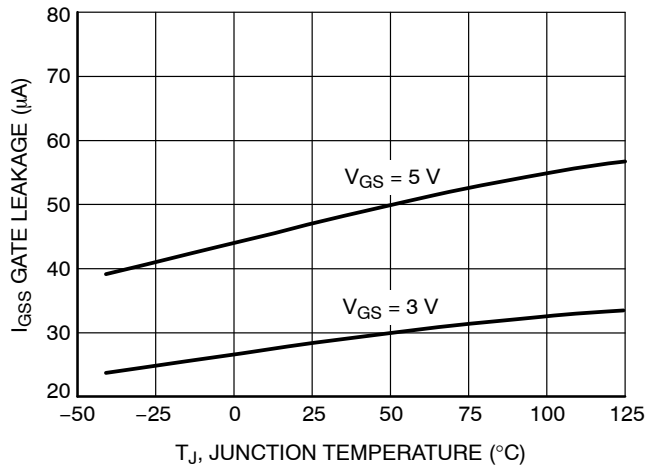


Figure 5. Gate-to-Source Leakage vs. Junction Temperature

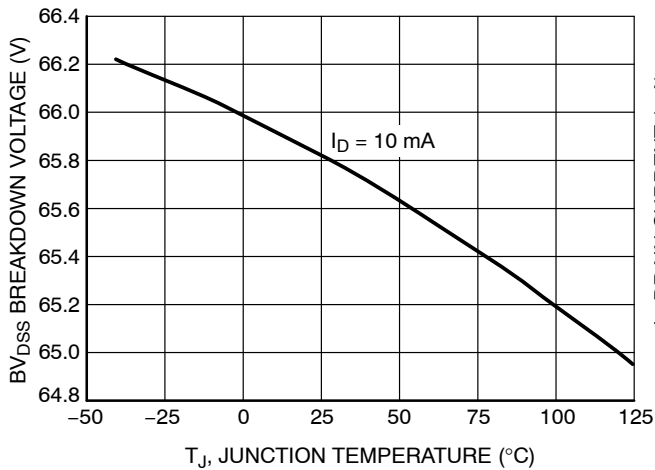


Figure 6. Breakdown Voltage vs. Junction Temperature

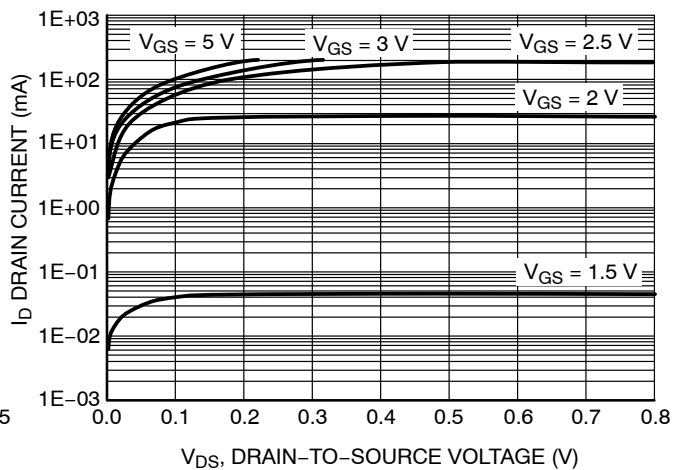


Figure 7. Output Characteristics

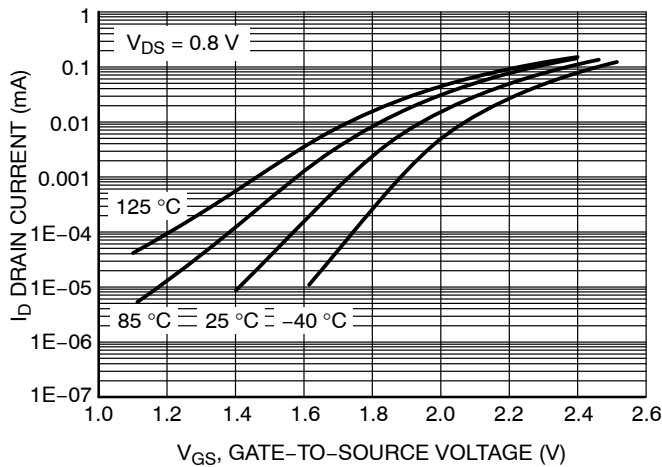


Figure 8. Transfer Function

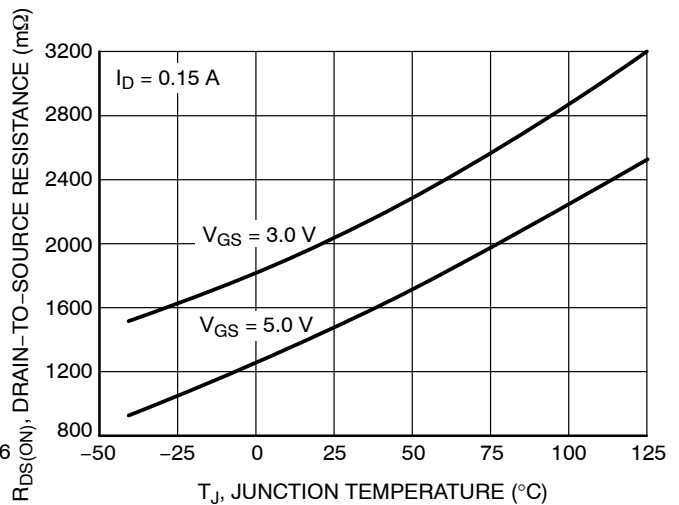
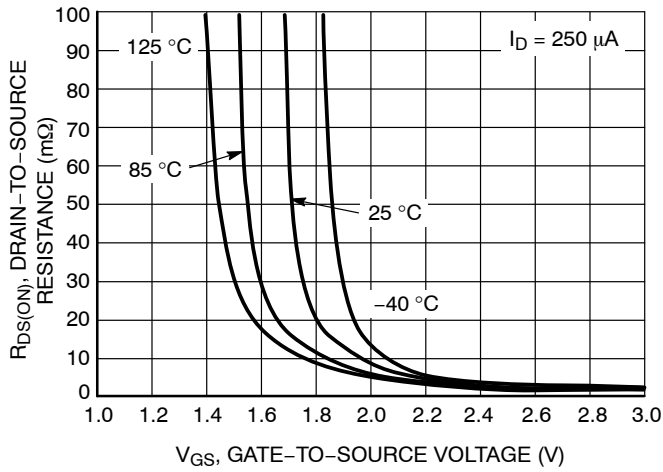


Figure 9. On Resistance Variation vs. Junction Temperature

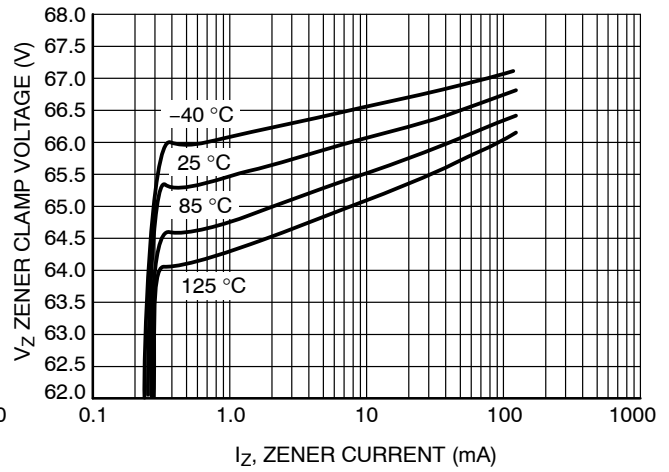
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## TYPICAL PERFORMANCE CURVES

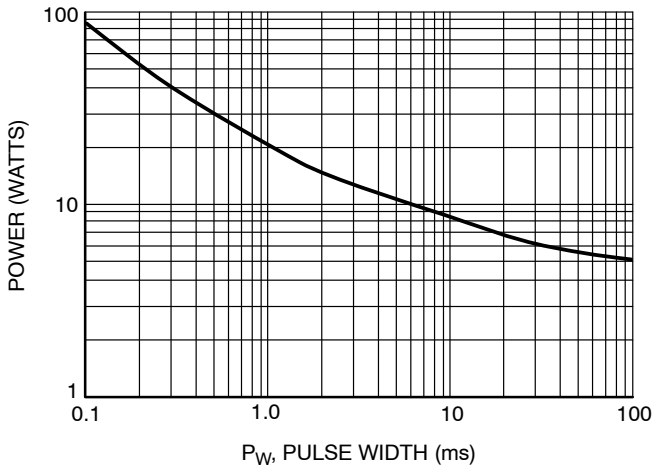
( $T_J = 25^\circ\text{C}$  unless otherwise specified)



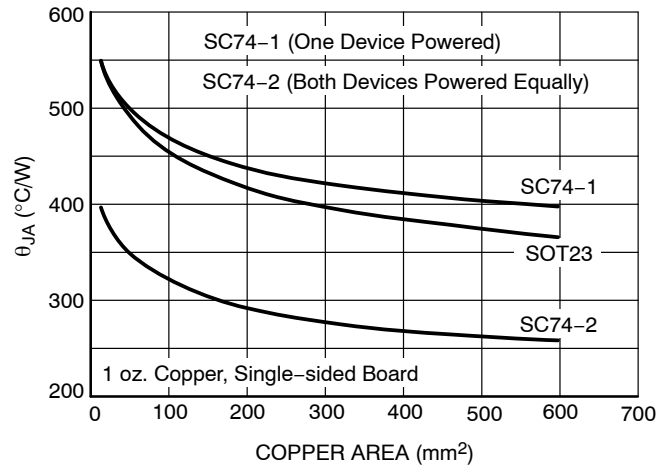
**Figure 10. On Resistance Variation vs. Gate-to-Source Voltage**



**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

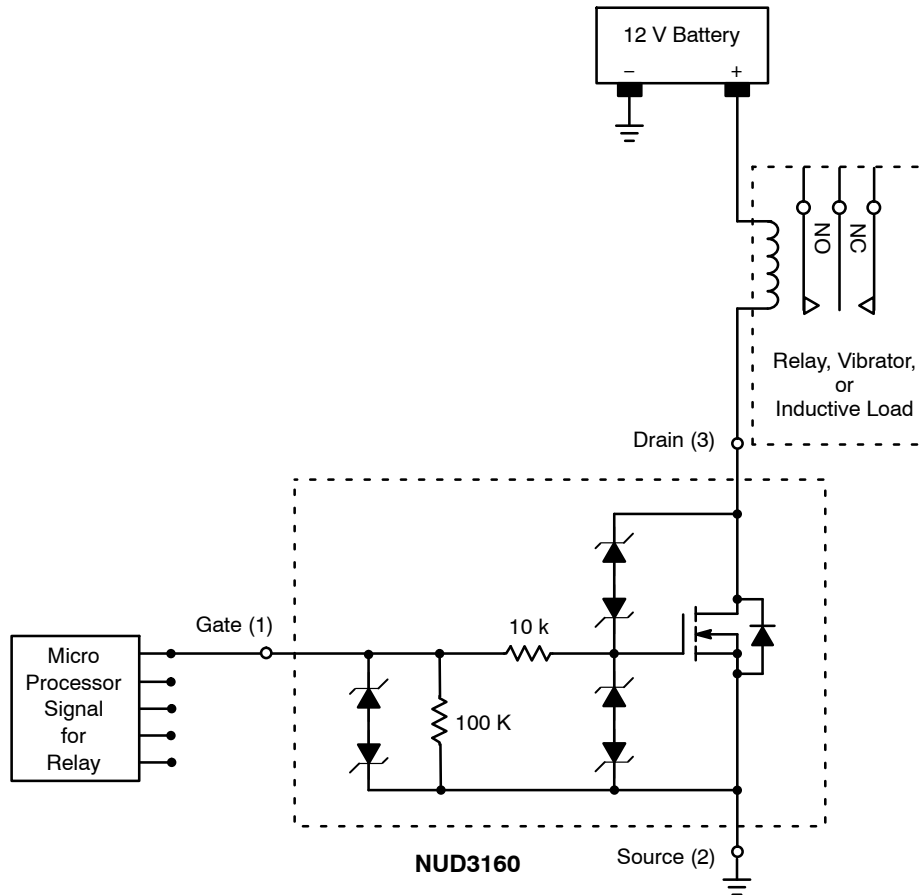
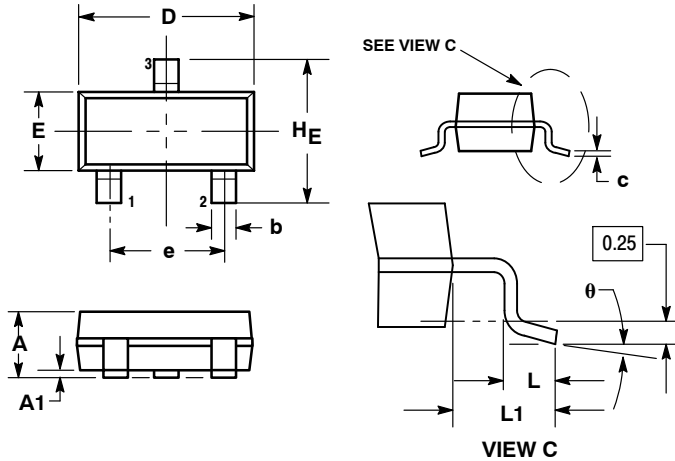


Figure 14. Applications Diagram

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## PACKAGE DIMENSIONS

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



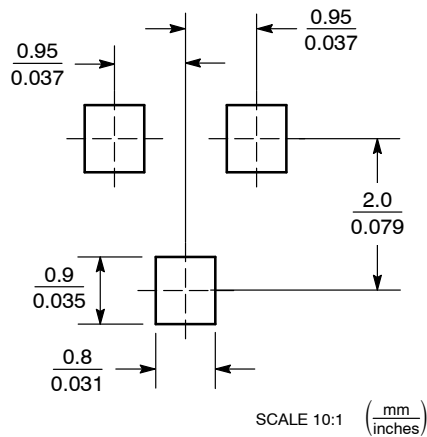
NOTES:

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. 318-01 THRU -07 AND -09 OBSOLETE, NEW STANDARD 318-08.

DIM	MILLIMETERS			INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.89	1.00	1.11	0.035	0.040	0.044
A1	0.01	0.06	0.10	0.001	0.002	0.004
b	0.37	0.44	0.50	0.015	0.018	0.020
c	0.09	0.13	0.18	0.003	0.005	0.007
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	0.081
L	0.10	0.20	0.30	0.004	0.008	0.012
L1	0.35	0.54	0.69	0.014	0.021	0.029
HE	2.10	2.40	2.64	0.083	0.094	0.104

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

### SOLDERING FOOTPRINT\*



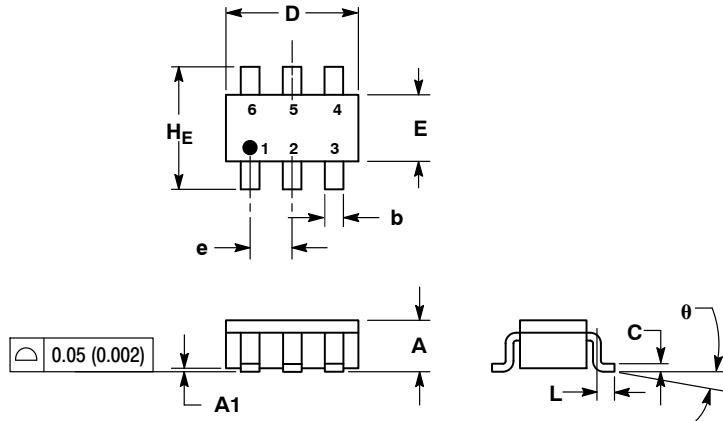
\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.



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## PACKAGE DIMENSIONS

SC-74  
CASE 318F-05  
ISSUE L



NOTES:

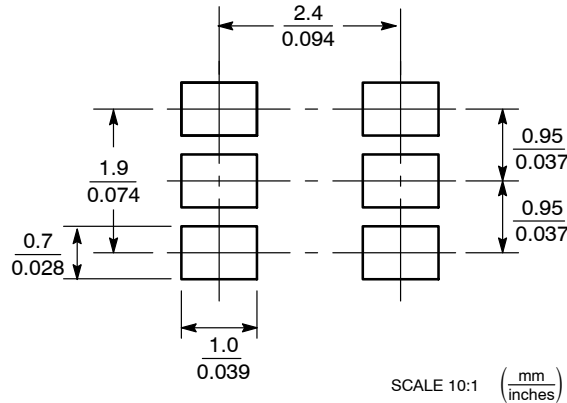
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. 318F-01, -02, -03 OBSOLETE. NEW STANDARD 318F-04.

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°

STYLE 7:

- PIN 1. SOURCE 1
- 2. GATE 1
- 3. DRAIN 2
- 4. SOURCE 2
- 5. GATE 2
- 6. DRAIN 1

### 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.

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