

# 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

### 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



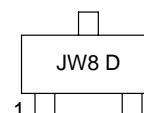
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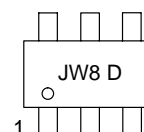
### MARKING DIAGRAMS



**SOT-23**  
**CASE 318**  
**STYLE 21**



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

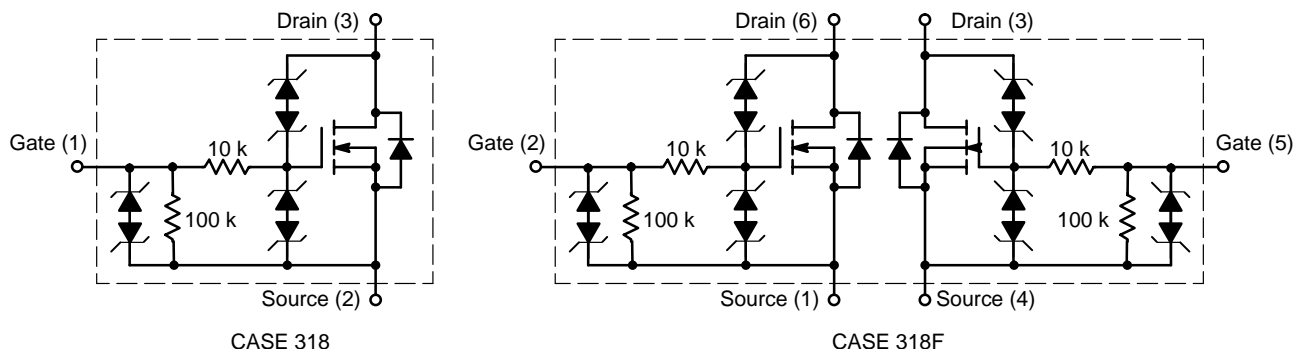


JW8 = Specific Device Code  
D = Date Code

### ORDERING INFORMATION

Device	Package	Shipping†
NUD3160LT1	SOT-23	3000 Tape & Reel
NUD3160DMT1	SC-74	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.



**Figure 1. Internal Circuit Diagrams**

# NUD3160

## 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)	150	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 (Note 4)	SOT-23 556 SC-74 329	°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
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### OFF CHARACTERISTICS

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

### ON CHARACTERISTICS

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

### DYNAMIC CHARACTERISTICS

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

### SWITCHING CHARACTERISTICS

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)	t <sub>PHL</sub> t <sub>PLH</sub>	– –	918 798	– –	ns
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>	– –	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)	t <sub>f</sub> t <sub>r</sub>	– –	2290 618	– –	ns
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>	– –	622 600	– –	ns

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## TYPICAL WAVEFORMS

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

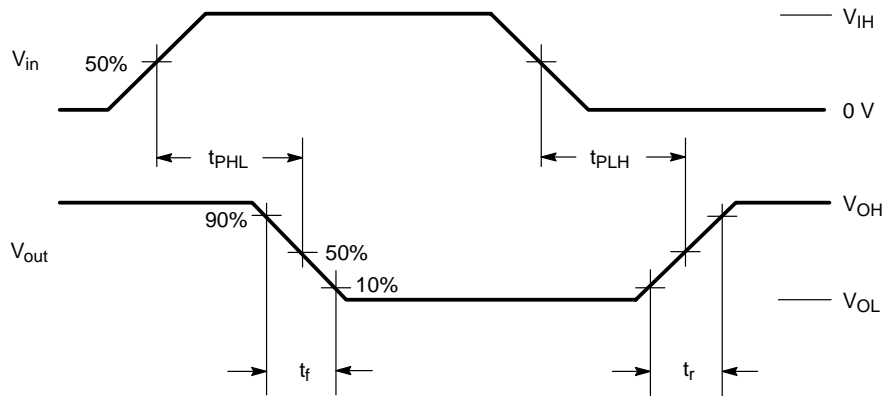


Figure 2. Switching Waveforms

### Load Dump Pulse Not Suppressed:

$V_f = 13.5\text{ V}$  Nominal  $\pm 10\%$   
 $V_S = 60\text{ V}$  Nominal  $\pm 10\%$   
 $T = 300\text{ ms}$  Nominal  $\pm 10\%$   
 $t_r = 1 - 10\text{ ms}$   $\pm 10\%$

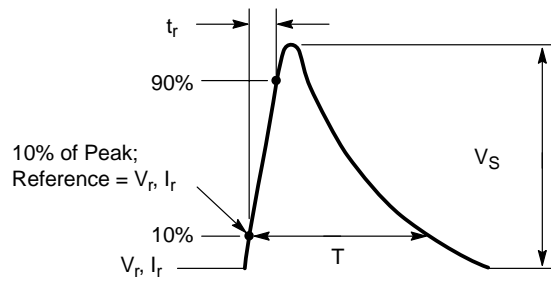


Figure 3. Load Dump Waveform Definition

TYPICAL PERFORMANCE CURVES

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

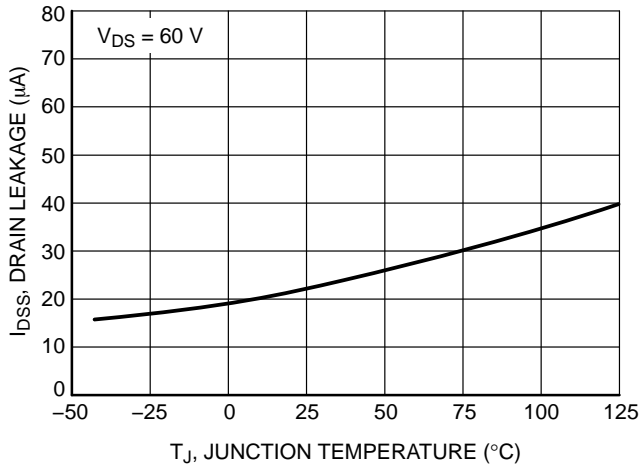


Figure 4. Drain-to-Source Leakage vs. Junction Temperature

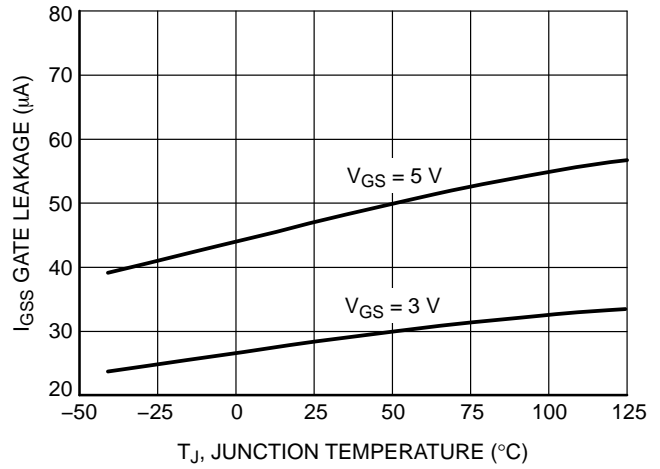


Figure 5. Gate-to-Source Leakage vs. Junction Temperature

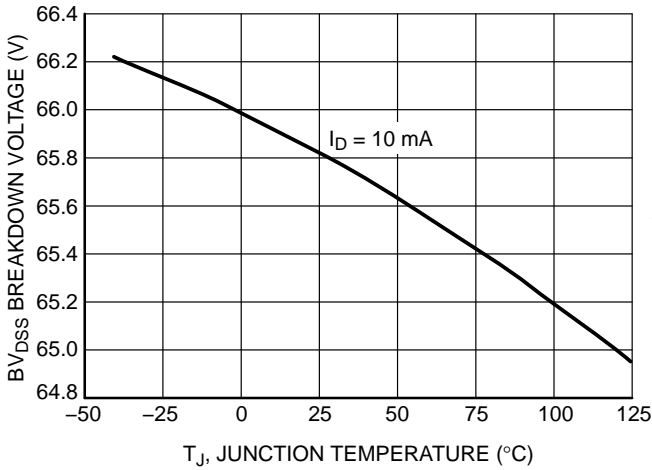


Figure 6. Breakdown Voltage vs. Junction Temperature

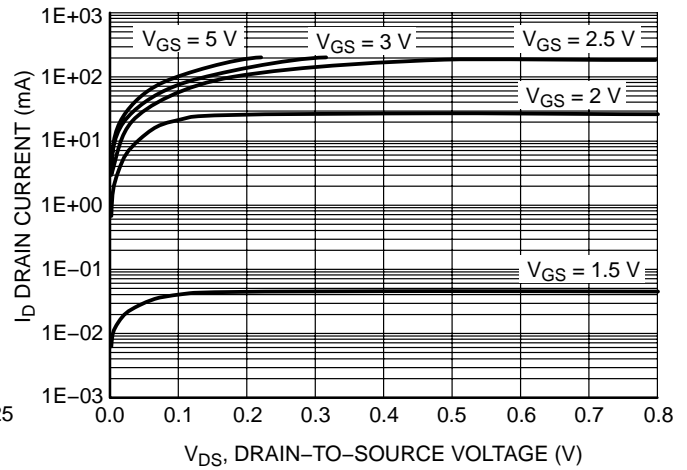


Figure 7. Output Characteristics

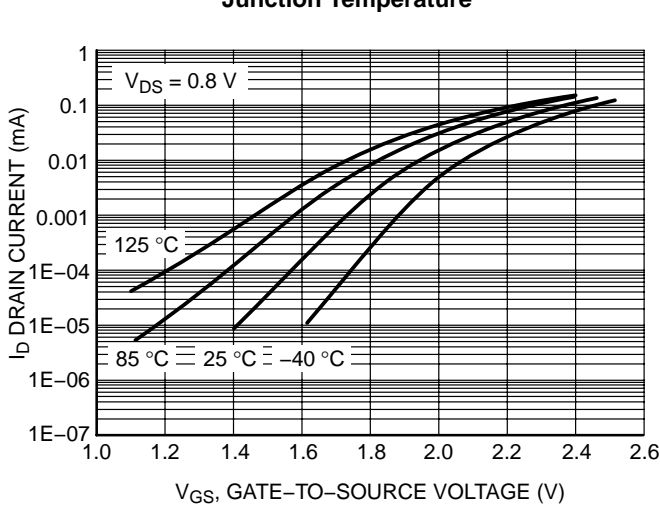


Figure 8. Transfer Function

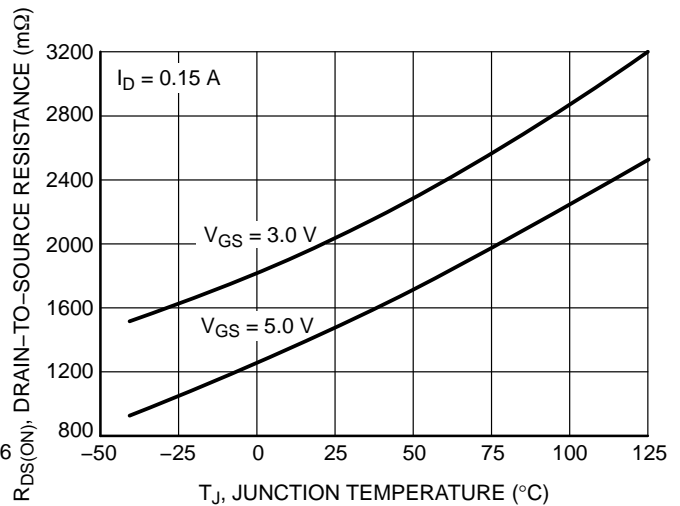
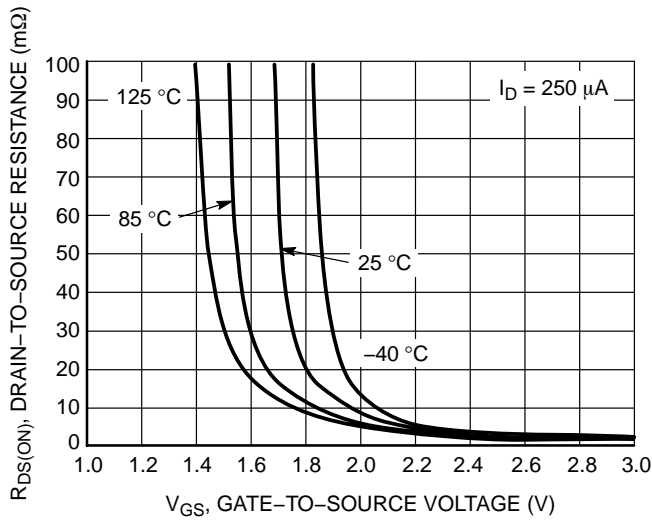


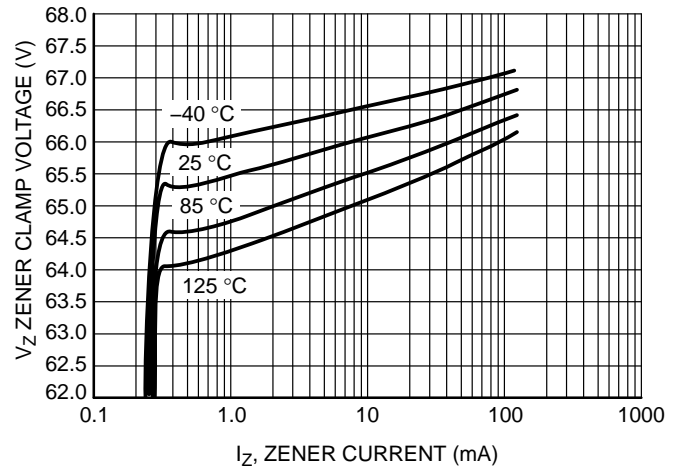
Figure 9. On Resistance Variation vs. Junction Temperature

# TYPICAL PERFORMANCE CURVES

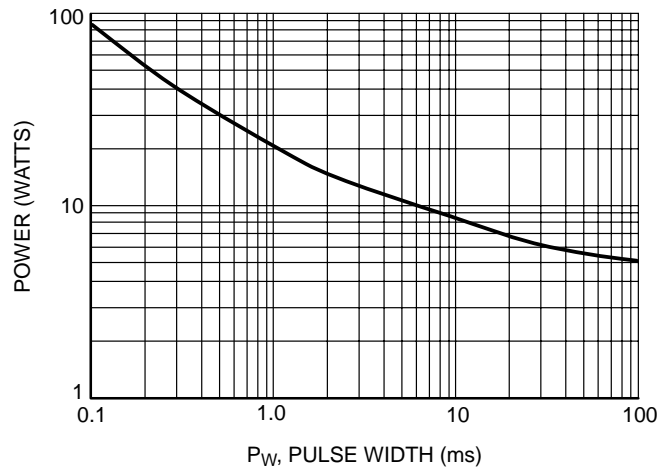
( $T_J = 25^\circ\text{C}$  unless otherwise specified)



**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**

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## APPLICATIONS INFORMATION

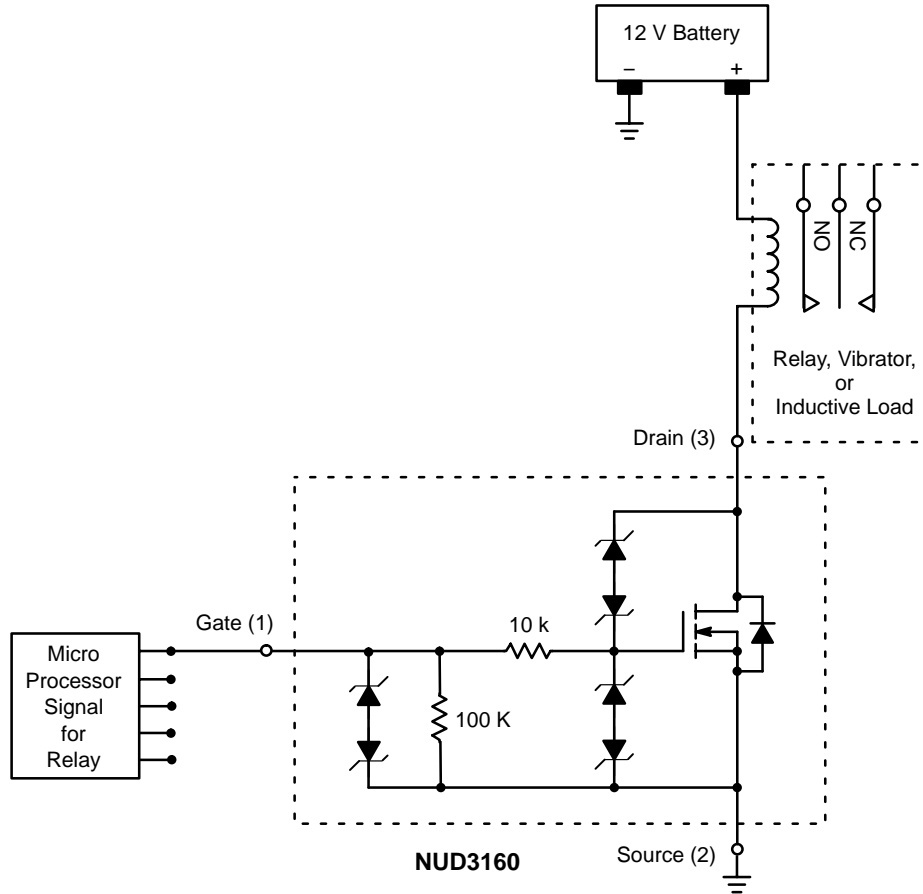
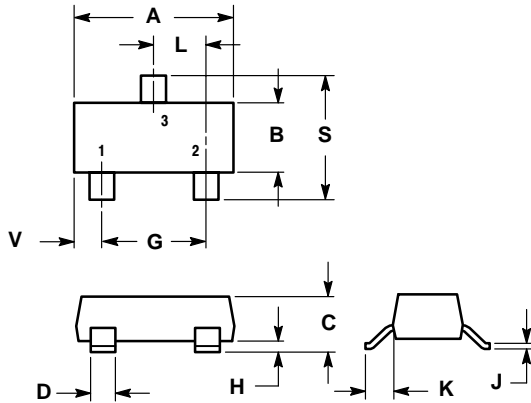


Figure 13. Applications Diagram

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## PACKAGE DIMENSIONS

SOT-23 (TO-236)  
CASE 318-09  
ISSUE AH



### NOTES:

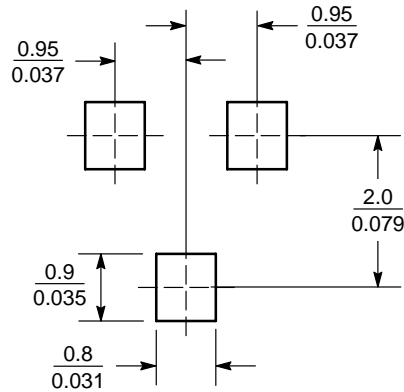
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. 318-01, -02, AND -06 OBSOLETE, NEW STANDARD 318-09.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.1102	0.1197	2.80	3.04
B	0.0472	0.0551	1.20	1.40
C	0.0385	0.0498	0.99	1.26
D	0.0140	0.0200	0.36	0.50
G	0.0670	0.0826	1.70	2.10
H	0.0040	0.0098	0.10	0.25
J	0.0034	0.0070	0.085	0.177
K	0.0180	0.0236	0.45	0.60
L	0.0350	0.0401	0.89	1.02
S	0.0830	0.0984	2.10	2.50
V	0.0177	0.0236	0.45	0.60

### STYLE 21:

- PIN 1. GATE
- SOURCE
- DRAIN

## SOLDERING FOOTPRINT

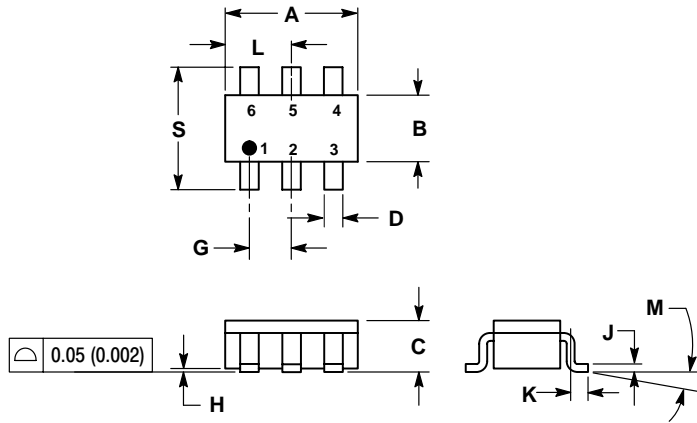




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## PACKAGE DIMENSIONS

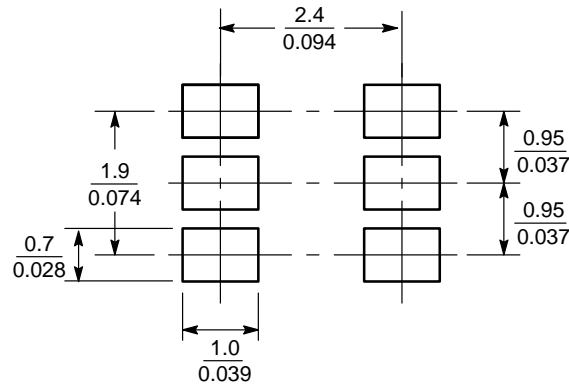
SC-74  
CASE 318F-05  
ISSUE K




- 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 OBSOLETE. NEW STANDARD 318F-04.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.1142	0.1220	2.90	3.10
B	0.0512	0.0669	1.30	1.70
C	0.0354	0.0433	0.90	1.10
D	0.0098	0.0197	0.25	0.50
G	0.0335	0.0413	0.85	1.05
H	0.0005	0.0040	0.013	0.100
J	0.0040	0.0102	0.10	0.26
K	0.0079	0.0236	0.20	0.60
L	0.0493	0.0649	1.25	1.65
M	0°	10°	0°	10°
S	0.0985	0.1181	2.50	3.00

## SOLDERING FOOTPRINT



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