

# 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

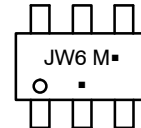
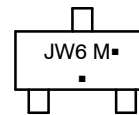


SOT-23  
CASE 318  
STYLE 21



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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### ORDERING INFORMATION

Device	Package	Shipping†
SZNUD3124LT1G	SOT-23 (Pb-Free)	3000 / Tape & Reel
SZNUD3124DMT1G	SC-74 (Pb-Free)	3000 / Tape & Reel

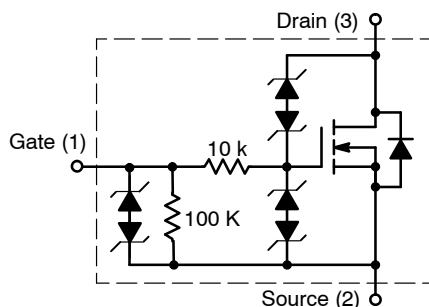
### DISCONTINUED (Note 1)

NUD3124LT1G	SOT-23 (Pb-Free)	3000 / Tape & Reel
NUD3124DMT1G	SC-74 (Pb-Free)	3000 / Tape & Reel

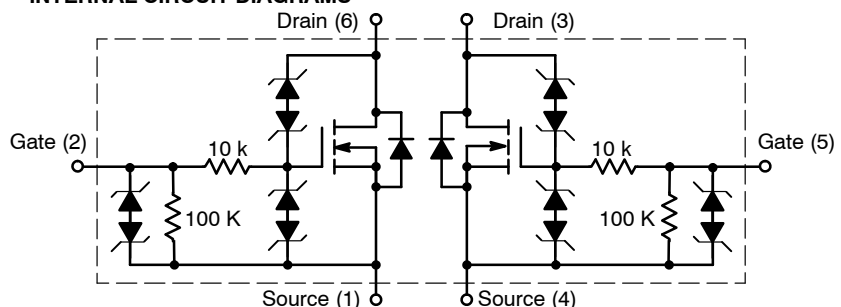
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, [BRD8011/D](#).

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](http://www.onsemi.com).

### INTERNAL CIRCUIT DIAGRAMS



CASE 318



CASE 318F

# NUD3124, SZNUD3124

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

Symbol	Rating	Value	Unit
$V_{\text{DSS}}$	Drain-to-Source Voltage – Continuous ( $T_J = 125^{\circ}\text{C}$ )	28	V
$V_{\text{GSS}}$	Gate-to-Source Voltage – Continuous ( $T_J = 125^{\circ}\text{C}$ )	12	V
$I_{\text{D}}$	Drain Current – Continuous ( $T_J = 125^{\circ}\text{C}$ )	150	mA
$E_{\text{Z}}$	Single Pulse Drain-to-Source Avalanche Energy (For Relay's Coils/Inductive Loads of 80 $\Omega$ or Higher) ( $T_J$ Initial = $85^{\circ}\text{C}$ )	250	mJ
$P_{\text{PK}}$	Peak Power Dissipation, Drain-to-Source (Notes 2 and 3) ( $T_J$ Initial = $85^{\circ}\text{C}$ )	20	W
$E_{\text{LD1}}$	Load Dump Suppressed Pulse, Drain-to-Source (Notes 4 and 5) (Suppressed Waveform: $V_s = 45\text{ V}$ , $R_{\text{SOURCE}} = 0.5\ \Omega$ , $T = 200\text{ ms}$ ) (For Relay's Coils/Inductive Loads of 80 $\Omega$ or Higher) ( $T_J$ Initial = $85^{\circ}\text{C}$ )	80	V
$E_{\text{LD2}}$	Inductive Switching Transient 1, Drain-to-Source (Waveform: $R_{\text{SOURCE}} = 10\ \Omega$ , $T = 2.0\text{ ms}$ ) (For Relay's Coils/Inductive Loads of 80 $\Omega$ or Higher) ( $T_J$ Initial = $85^{\circ}\text{C}$ )	100	V
$E_{\text{LD3}}$	Inductive Switching Transient 2, Drain-to-Source (Waveform: $R_{\text{SOURCE}} = 4.0\ \Omega$ , $T = 50\ \mu\text{s}$ ) (For Relay's Coils/Inductive Loads of 80 $\Omega$ or Higher) ( $T_J$ Initial = $85^{\circ}\text{C}$ )	300	V
Rev-Bat	Reverse Battery, 10 Minutes (Drain-to-Source) (For Relay's Coils/Inductive Loads of 80 $\Omega$ 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.

- Nonrepetitive current square pulse 1.0 ms duration.
- For different square pulse durations, see Figure 2.
- Nonrepetitive load dump suppressed pulse per Figure 3.
- For relay's coils/inductive loads higher than 80  $\Omega$ , see Figure 4.

## **THERMAL CHARACTERISTICS**

Symbol	Rating	Value	Unit
$T_A$	Operating Ambient Temperature	-40 to 125	$^{\circ}\text{C}$
$T_J$	Maximum Junction Temperature	150	$^{\circ}\text{C}$
$T_{\text{STG}}$	Storage Temperature Range	-65 to 150	$^{\circ}\text{C}$
$P_{\text{D}}$	Total Power Dissipation (Note 6) Derating above $25^{\circ}\text{C}$	SOT-23 225	mW
		1.8	mW/ $^{\circ}\text{C}$
$P_{\text{D}}$	Total Power Dissipation (Note 6) Derating above $25^{\circ}\text{C}$	SC-74 380	mW
		3.0	mW/ $^{\circ}\text{C}$
$R_{\theta\text{JA}}$	Thermal Resistance Junction-to-Ambient (Note 6)	SOT-23 556	$^{\circ}\text{C}/\text{W}$
		SC-74 329	

- Mounted onto minimum pad board.

# NUD3124, SZNUD3124

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

Characteristic	Symbol	Min	Typ	Max	Unit
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### **OFF CHARACTERISTICS**

Drain to Source Sustaining Voltage ( $I_D = 10\text{ mA}$ )	$V_{\text{BRDSS}}$	28	34	38	V
Drain to Source Leakage Current ( $V_{\text{DS}} = 12\text{ V}$ , $V_{\text{GS}} = 0\text{ V}$ ) ( $V_{\text{DS}} = 12\text{ V}$ , $V_{\text{GS}} = 0\text{ V}$ , $T_J = 125^\circ\text{C}$ ) ( $V_{\text{DS}} = 28\text{ V}$ , $V_{\text{GS}} = 0\text{ V}$ ) ( $V_{\text{DS}} = 28\text{ V}$ , $V_{\text{GS}} = 0\text{ V}$ , $T_J = 125^\circ\text{C}$ )	$I_{\text{DSS}}$	– – – –	– – – –	0.5 1.0 50 80	$\mu\text{A}$
Gate Body Leakage Current ( $V_{\text{GS}} = 3.0\text{ V}$ , $V_{\text{DS}} = 0\text{ V}$ ) ( $V_{\text{GS}} = 3.0\text{ V}$ , $V_{\text{DS}} = 0\text{ V}$ , $T_J = 125^\circ\text{C}$ ) ( $V_{\text{GS}} = 5.0\text{ V}$ , $V_{\text{DS}} = 0\text{ V}$ ) ( $V_{\text{GS}} = 5.0\text{ V}$ , $V_{\text{DS}} = 0\text{ V}$ , $T_J = 125^\circ\text{C}$ )	$I_{\text{GSS}}$	– – – –	– – – –	60 80 90 110	$\mu\text{A}$

### **ON CHARACTERISTICS**

Gate Threshold Voltage ( $V_{\text{GS}} = V_{\text{DS}}$ , $I_D = 1.0\text{ mA}$ ) ( $V_{\text{GS}} = V_{\text{DS}}$ , $I_D = 1.0\text{ mA}$ , $T_J = 125^\circ\text{C}$ )	$V_{\text{GS(th)}}$	1.3 1.3	1.8 –	2.0 2.0	V
Drain to Source On-Resistance ( $I_D = 150\text{ mA}$ , $V_{\text{GS}} = 3.0\text{ V}$ ) ( $I_D = 150\text{ mA}$ , $V_{\text{GS}} = 3.0\text{ V}$ , $T_J = 125^\circ\text{C}$ ) ( $I_D = 150\text{ mA}$ , $V_{\text{GS}} = 5.0\text{ V}$ ) ( $I_D = 150\text{ mA}$ , $V_{\text{GS}} = 5.0\text{ V}$ , $T_J = 125^\circ\text{C}$ )	$R_{\text{DS(on)}}$	– – – –	– – – –	1.4 1.7 0.8 1.1	$\Omega$
Output Continuous Current ( $V_{\text{DS}} = 0.25\text{ V}$ , $V_{\text{GS}} = 3.0\text{ V}$ ) ( $V_{\text{DS}} = 0.25\text{ V}$ , $V_{\text{GS}} = 3.0\text{ V}$ , $T_J = 125^\circ\text{C}$ )	$I_{\text{DS(on)}}$	150 140	200 –	– –	mA
Forward Transconductance ( $V_{\text{DS}} = 12\text{ V}$ , $I_D = 150\text{ mA}$ )	$g_{\text{FS}}$	–	500	–	mmho

### **DYNAMIC CHARACTERISTICS**

Input Capacitance ( $V_{\text{DS}} = 12\text{ V}$ , $V_{\text{GS}} = 0\text{ V}$ , $f = 10\text{ kHz}$ )	$C_{\text{iss}}$	–	32	–	pf
Output Capacitance ( $V_{\text{DS}} = 12\text{ V}$ , $V_{\text{GS}} = 0\text{ V}$ , $f = 10\text{ kHz}$ )	$C_{\text{oss}}$	–	21	–	pf
Transfer Capacitance ( $V_{\text{DS}} = 12\text{ V}$ , $V_{\text{GS}} = 0\text{ V}$ , $f = 10\text{ kHz}$ )	$C_{\text{rss}}$	–	8.0	–	pf

### **SWITCHING CHARACTERISTICS**

Propagation Delay Times: High to Low Propagation Delay; Figure 1, ( $V_{\text{DS}} = 12\text{ V}$ , $V_{\text{GS}} = 3.0\text{ V}$ ) Low to High Propagation Delay; Figure 1, ( $V_{\text{DS}} = 12\text{ V}$ , $V_{\text{GS}} = 3.0\text{ V}$ )	$t_{\text{PHL}}$ $t_{\text{PLH}}$	– –	890 912	– –	ns
High to Low Propagation Delay; Figure 1, ( $V_{\text{DS}} = 12\text{ V}$ , $V_{\text{GS}} = 5.0\text{ V}$ ) Low to High Propagation Delay; Figure 1, ( $V_{\text{DS}} = 12\text{ V}$ , $V_{\text{GS}} = 5.0\text{ V}$ )	$t_{\text{PHL}}$ $t_{\text{PLH}}$	– –	324 1280	– –	ns
Transition Times: Fall Time; Figure 1, ( $V_{\text{DS}} = 12\text{ V}$ , $V_{\text{GS}} = 3.0\text{ V}$ ) Rise Time; Figure 1, ( $V_{\text{DS}} = 12\text{ V}$ , $V_{\text{GS}} = 3.0\text{ V}$ )	$t_f$ $t_r$	– –	2086 708	– –	ns
Fall Time; Figure 1, ( $V_{\text{DS}} = 12\text{ V}$ , $V_{\text{GS}} = 5.0\text{ V}$ ) Rise Time; Figure 1, ( $V_{\text{DS}} = 12\text{ V}$ , $V_{\text{GS}} = 5.0\text{ V}$ )	$t_f$ $t_r$	– –	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)

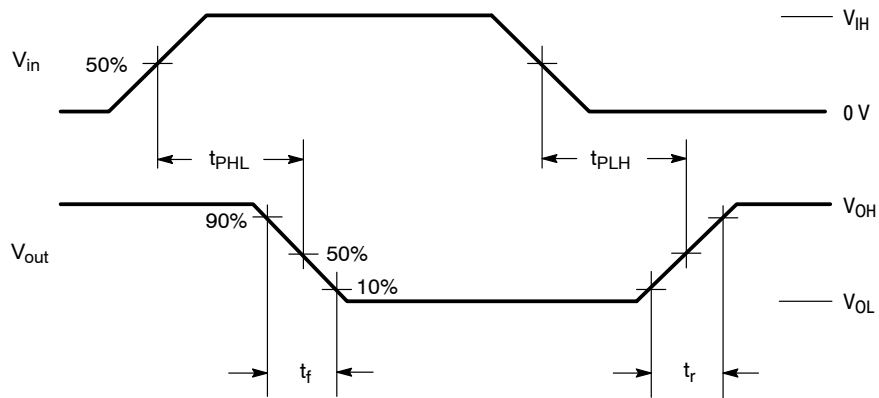


Figure 1. Switching Waveforms

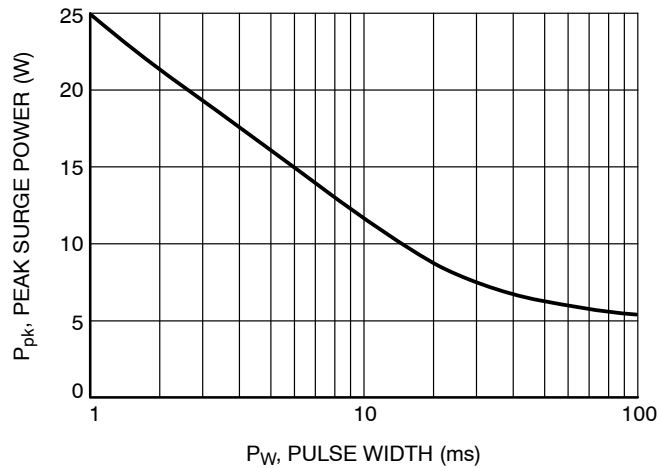


Figure 2. Maximum Non-repetitive Surge Power versus Pulse Width

### Load Dump Pulse Not Suppressed:

$V_R = 13.5\text{ V}$  Nominal  $\pm 10\%$

$V_S = 60\text{ V}$  Nominal  $\pm 10\%$

$T = 300\text{ ms}$  Nominal  $\pm 10\%$

$T_R = 1 - 10\text{ ms}$   $\pm 10\%$

### Load Dump Pulse Suppressed:

NOTE: Max. Voltage DUT is exposed to is approximately 45 V.

$V_S = 30\text{ V}$   $\pm 20\%$

$T = 150\text{ ms}$   $\pm 20\%$

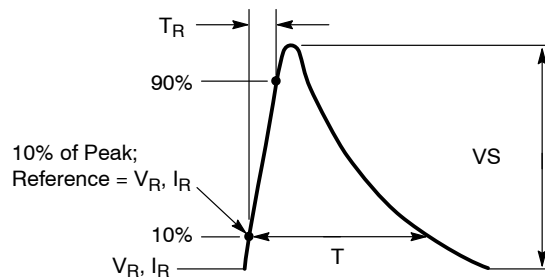
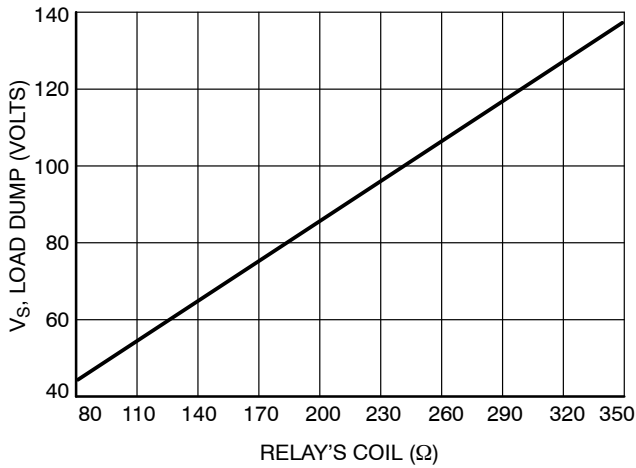
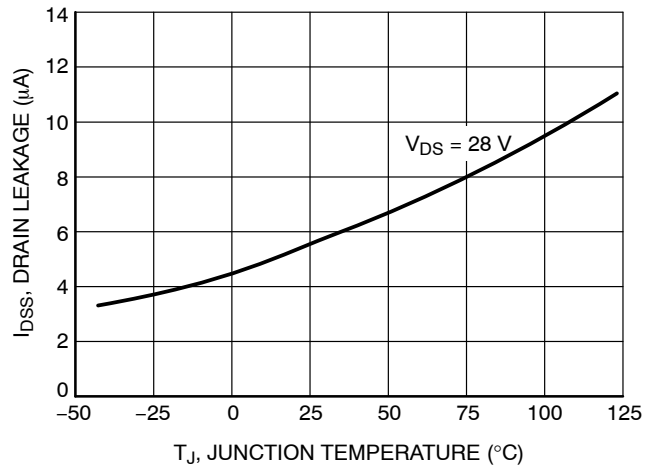


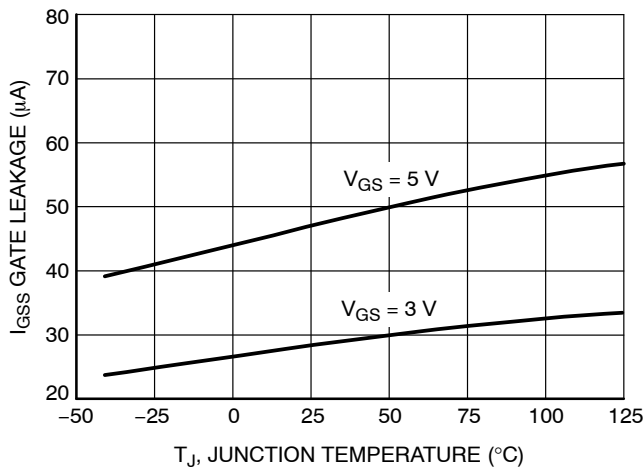
Figure 3. Load Dump Waveform Definition



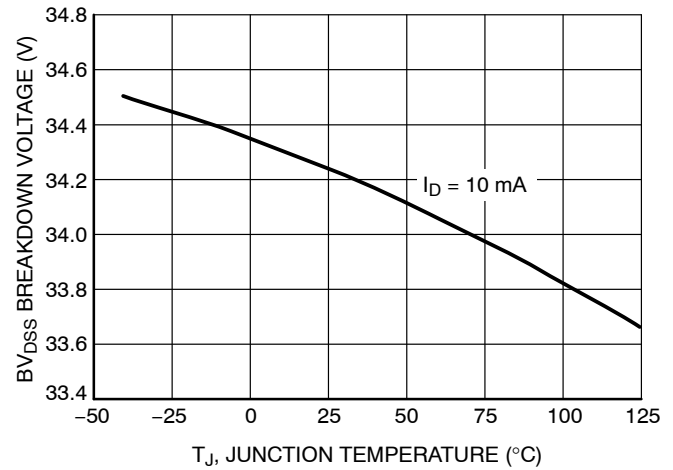
**Figure 4. Load Dump Capability versus Relay's Coil dc Resistance**



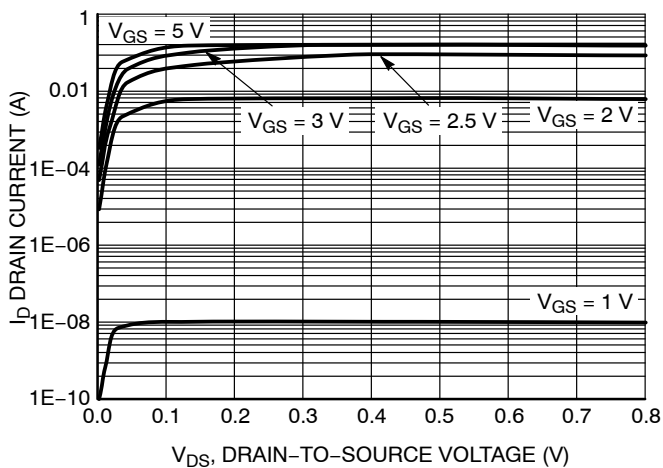
**Figure 5. Drain-to-Source Leakage versus Junction Temperature**



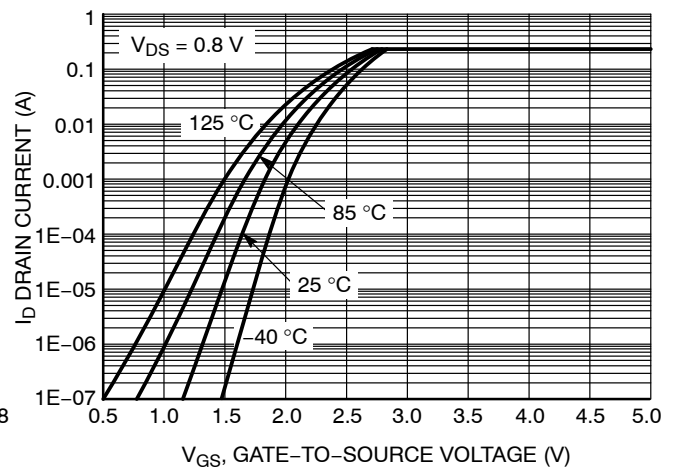
**Figure 6. Gate-to-Source Leakage versus Junction Temperature**



**Figure 7. Breakdown Voltage versus Junction Temperature**

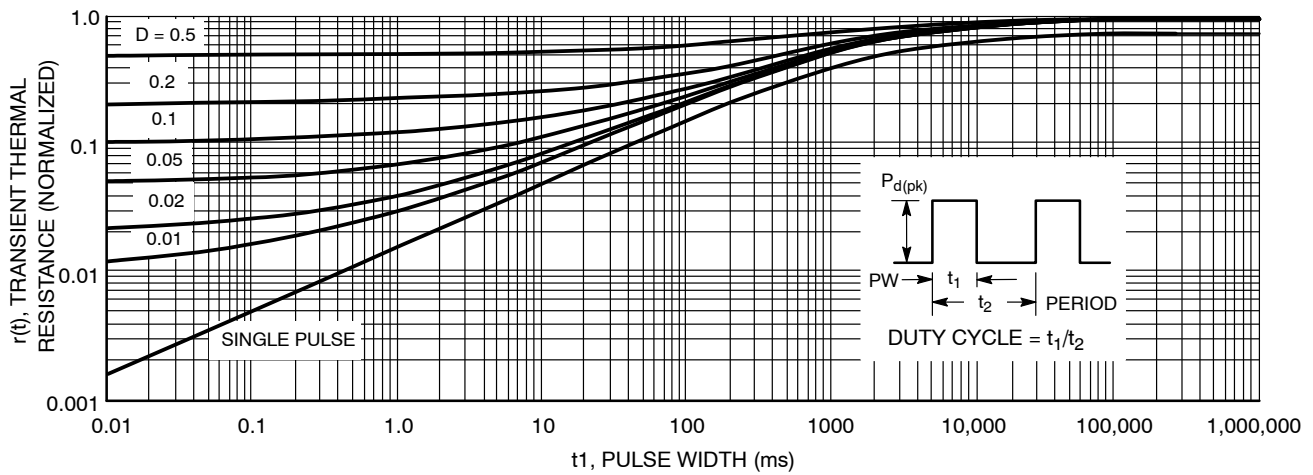
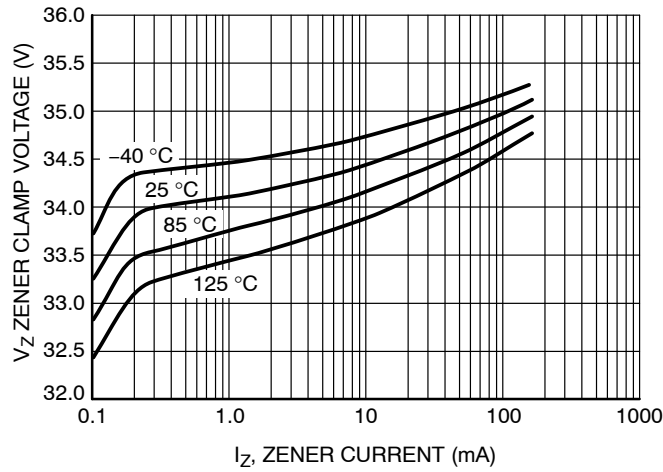
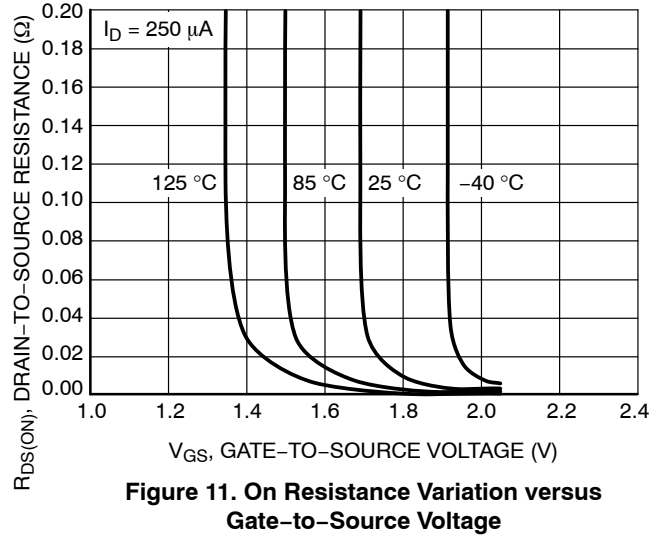
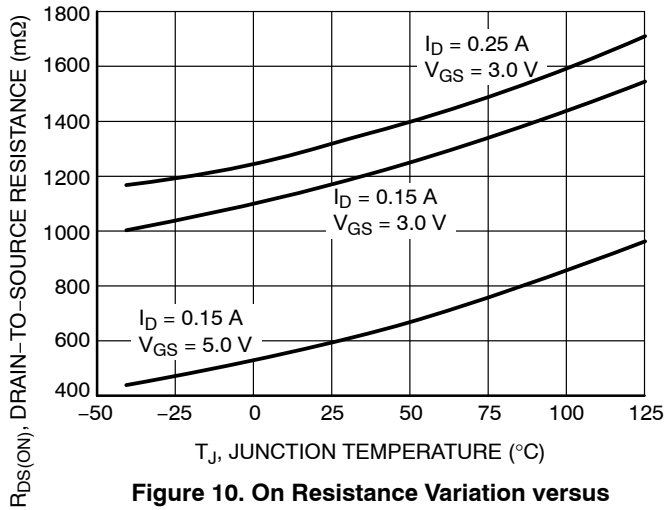


**Figure 8. Output Characteristics**



**Figure 9. Transfer Function**

# NUD3124, SZNUD3124



# NUD3124, SZNUD3124

## APPLICATIONS INFORMATION

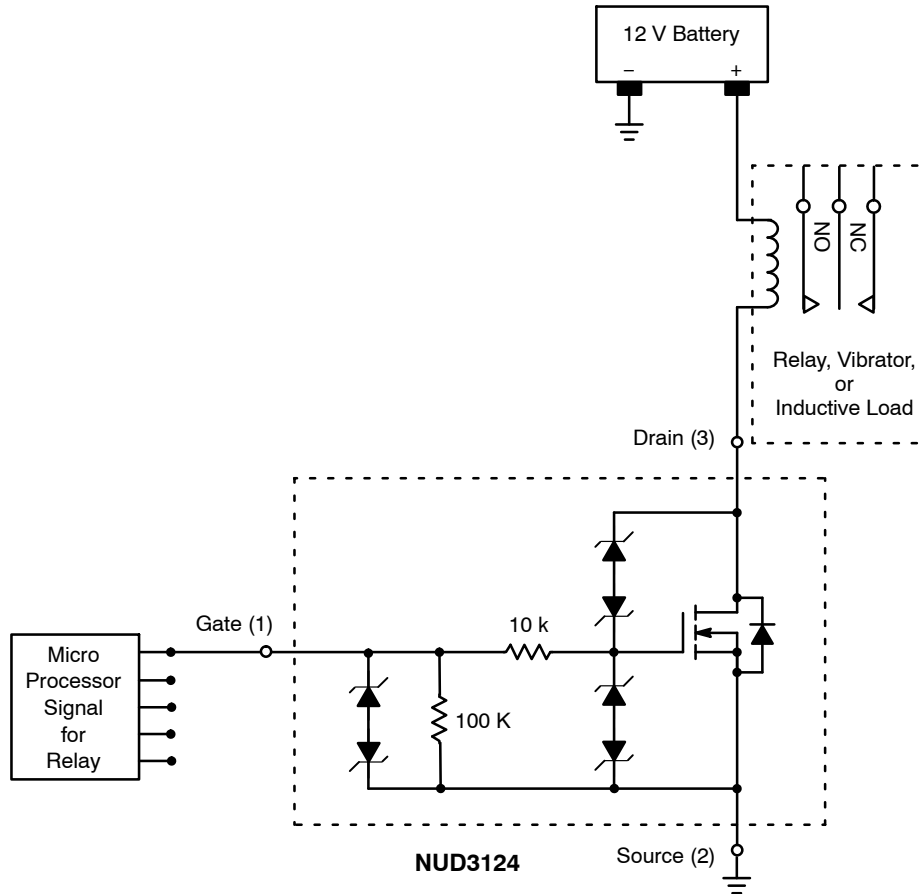


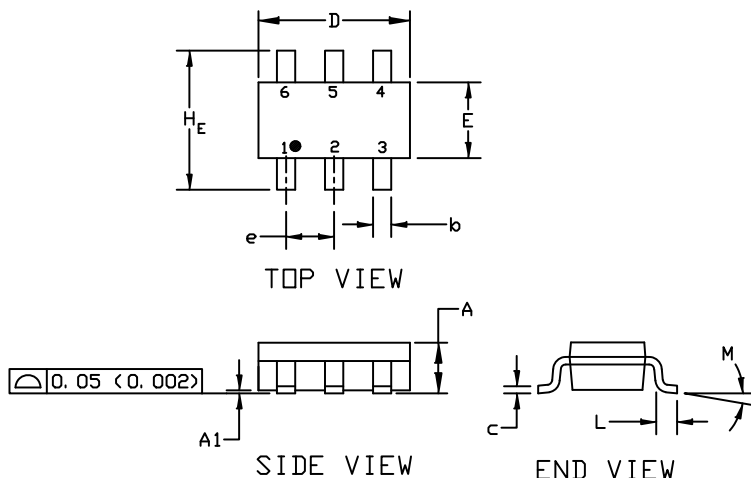
Figure 14. Applications Diagram



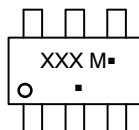
SCALE 2:1

SC-74  
CASE 318F  
ISSUE P

DATE 07 OCT 2021



GENERIC  
MARKING DIAGRAM\*



XXX = Specific Device Code  
M = Date Code  
▪ = Pb-Free Package

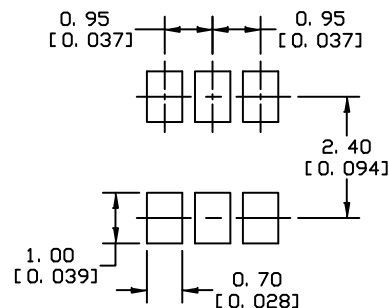
(Note: Microdot may be in either location)

\*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.

NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994
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
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°



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

SOLDERING FOOTPRINT

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

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