

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

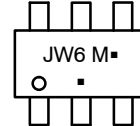
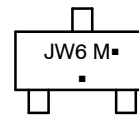


SOT-23
CASE 318
STYLE 21



SC-74
CASE 318F
STYLE 7

MARKING DIAGRAMS



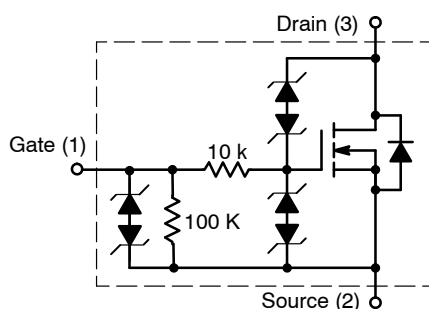
JW6 = Specific Device Code
M = Date Code
▪ = Pb-Free Package
(Note: Microdot may be in either location)

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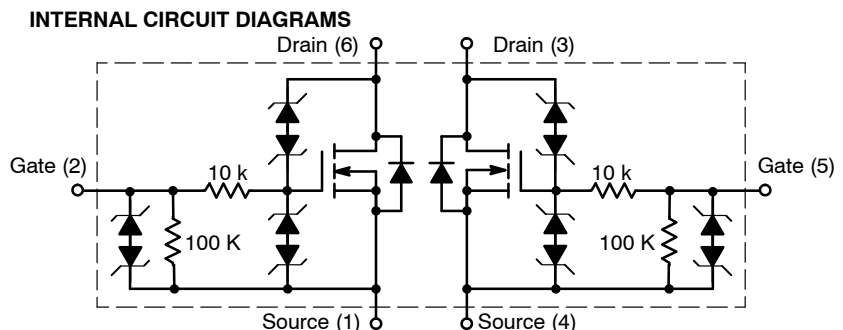
ORDERING INFORMATION

Device	Package	Shipping†
NUD3124LT1G	SOT-23 (Pb-Free)	3000 / Tape & Reel
SZNUD3124LT1G	SOT-23 (Pb-Free)	3000 / Tape & Reel
NUD3124DMT1G	SC-74 (Pb-Free)	3000 / Tape & Reel
SZNUD3124DMT1G	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](#).



CASE 318



CASE 318F

NUD3124, SZNUD3124

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

Symbol	Rating	Value	Unit
V_{DSS}	Drain-to-Source Voltage – Continuous ($T_J = 125^{\circ}\text{C}$)	28	V
V_{GSS}	Gate-to-Source Voltage – Continuous ($T_J = 125^{\circ}\text{C}$)	12	V
I_{D}	Drain Current – Continuous ($T_J = 125^{\circ}\text{C}$)	150	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)	250	mJ
P_{PK}	Peak Power Dissipation, Drain-to-Source (Notes 1 and 2) (T_J Initial = 85°C)	20	W
E_{LD1}	Load Dump Suppressed Pulse, Drain-to-Source (Notes 3 and 4) (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 Ω or Higher) (T_J Initial = 85°C)	80	V
E_{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 Ω or Higher) (T_J Initial = 85°C)	100	V
E_{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 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	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.

1. Nonrepetitive current square pulse 1.0 ms duration.
2. For different square pulse durations, see Figure 2.
3. Nonrepetitive load dump suppressed pulse per Figure 3.
4. For relay's coils/inductive loads higher than 80 Ω , 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_{STG}	Storage Temperature Range	-65 to 150	$^{\circ}\text{C}$
P_{D}	Total Power Dissipation (Note 5) Derating above 25°C	SOT-23 225	mW
		1.8	mW/ $^{\circ}\text{C}$
P_{D}	Total Power Dissipation (Note 5) Derating above 25°C	SC-74 380	mW
		3.0	mW/ $^{\circ}\text{C}$
$R_{\theta\text{JA}}$	Thermal Resistance Junction-to-Ambient (Note 5)	SOT-23 556	$^{\circ}\text{C/W}$
		SC-74 329	

5. 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_{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_{DSS}	– – – –	– – – –	0.5 1.0 50 80	μA
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_{GSS}	– – – –	– – – –	60 80 90 110	μA

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	Ω
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_{FS}	–	500	–	mmho

DYNAMIC CHARACTERISTICS

Input Capacitance ($V_{\text{DS}} = 12\text{ V}$, $V_{\text{GS}} = 0\text{ V}$, $f = 10\text{ kHz}$)	C_{iss}	–	32	–	pf
Output Capacitance ($V_{\text{DS}} = 12\text{ V}$, $V_{\text{GS}} = 0\text{ V}$, $f = 10\text{ kHz}$)	C_{oss}	–	21	–	pf
Transfer Capacitance ($V_{\text{DS}} = 12\text{ V}$, $V_{\text{GS}} = 0\text{ V}$, $f = 10\text{ kHz}$)	C_{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, ($V_{\text{DS}} = 12\text{ V}$, $V_{\text{GS}} = 3.0\text{ V}$) 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_{PHL} t_{PLH} t_{PHL} t_{PLH}	– – – –	890 912 324 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, ($V_{\text{DS}} = 12\text{ V}$, $V_{\text{GS}} = 3.0\text{ V}$) 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 t_f t_r	– – – –	2086 708 556 725	– – – –	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)

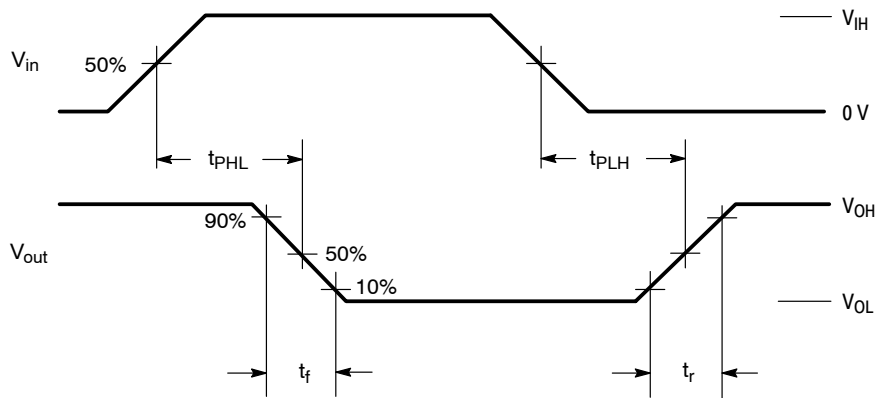


Figure 1. Switching Waveforms

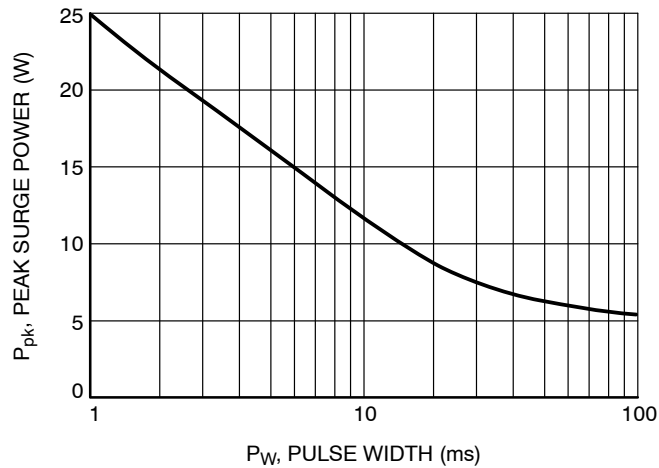


Figure 2. Maximum Non-repetitive Surge Power versus Pulse Width

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.

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

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

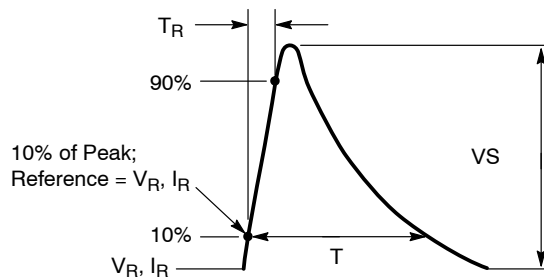


Figure 3. Load Dump Waveform Definition

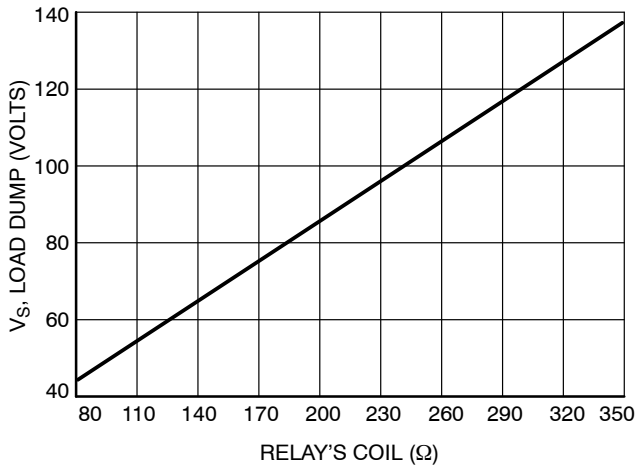


Figure 4. Load Dump Capability versus Relay's Coil dc Resistance

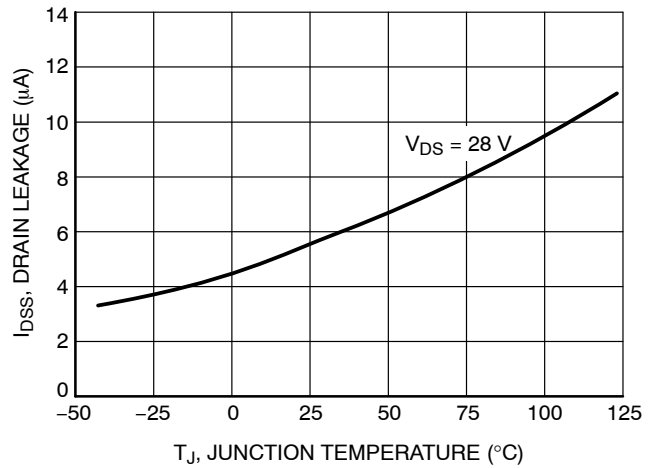


Figure 5. Drain-to-Source Leakage versus Junction Temperature

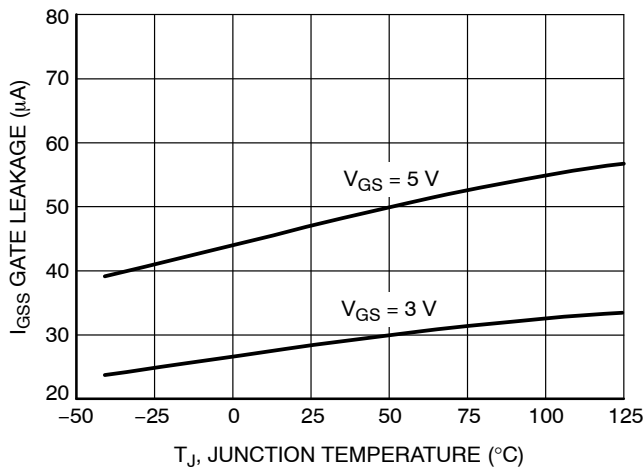


Figure 6. Gate-to-Source Leakage versus Junction Temperature

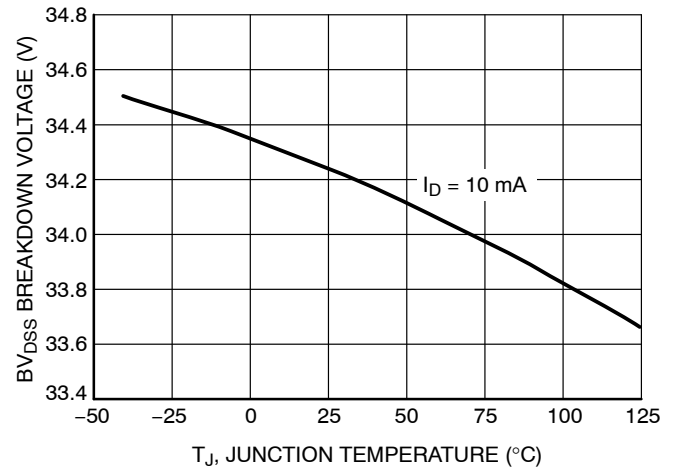


Figure 7. Breakdown Voltage versus Junction Temperature

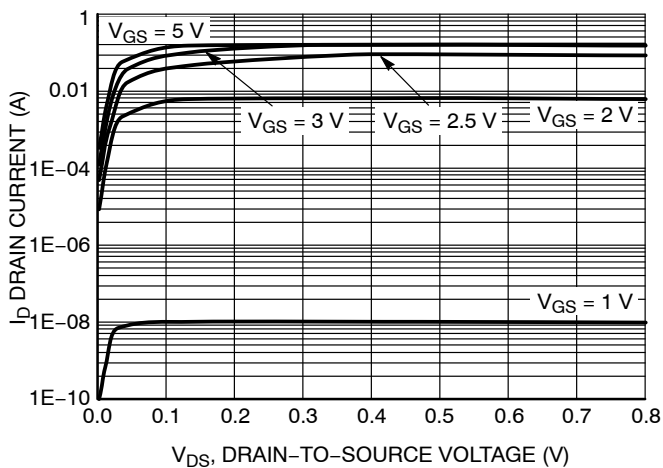


Figure 8. Output Characteristics

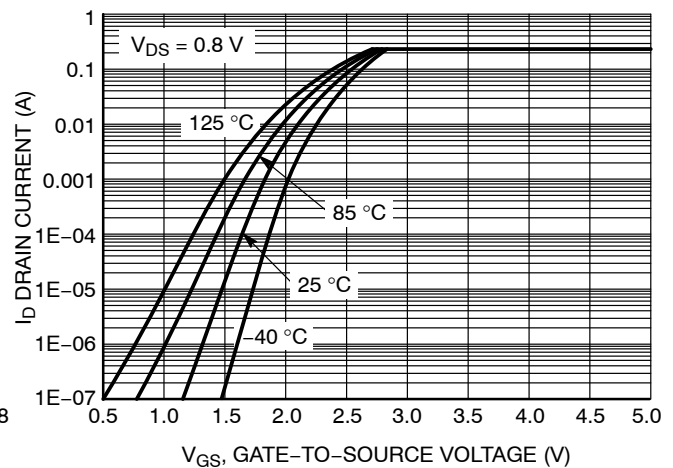
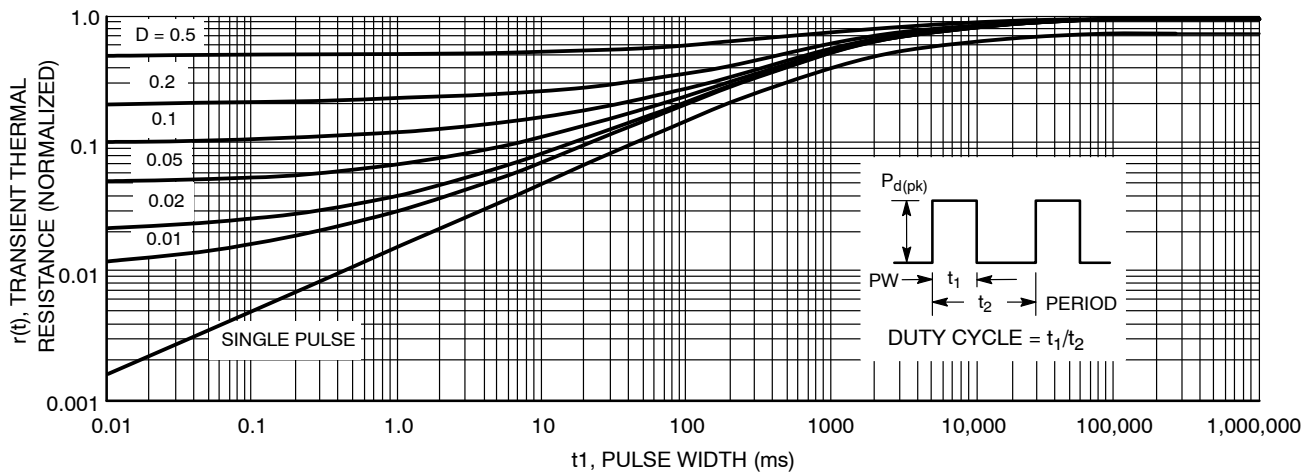
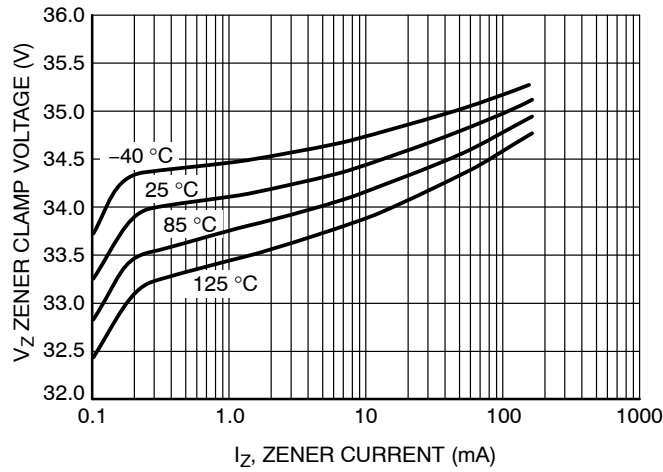
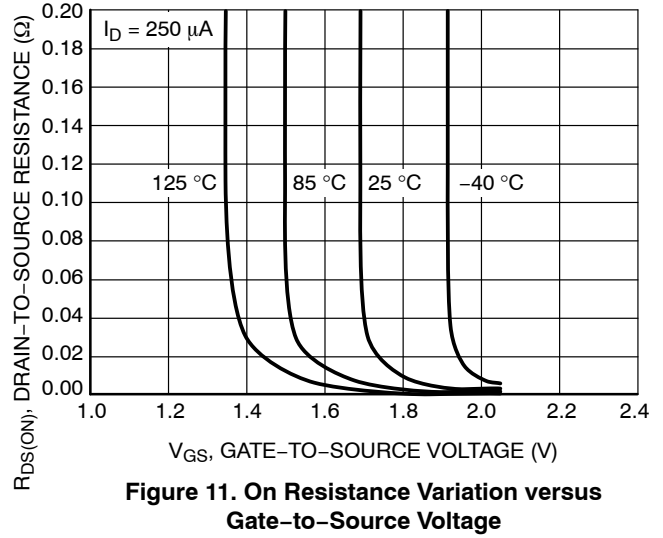
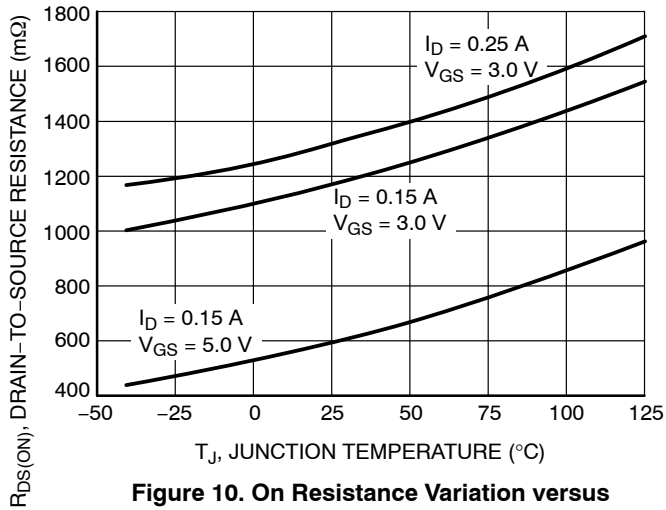


Figure 9. Transfer Function

NUD3124, SZNUD3124



NUD3124, SZNUD3124

APPLICATIONS INFORMATION

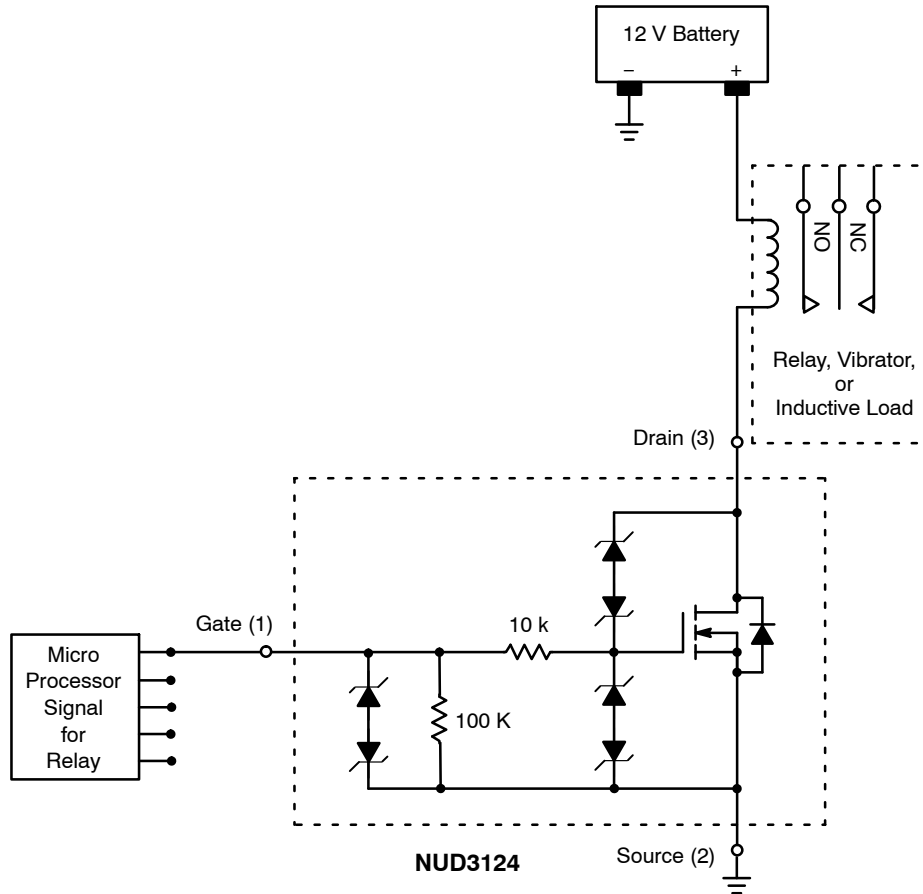
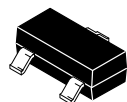


Figure 14. Applications Diagram

MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



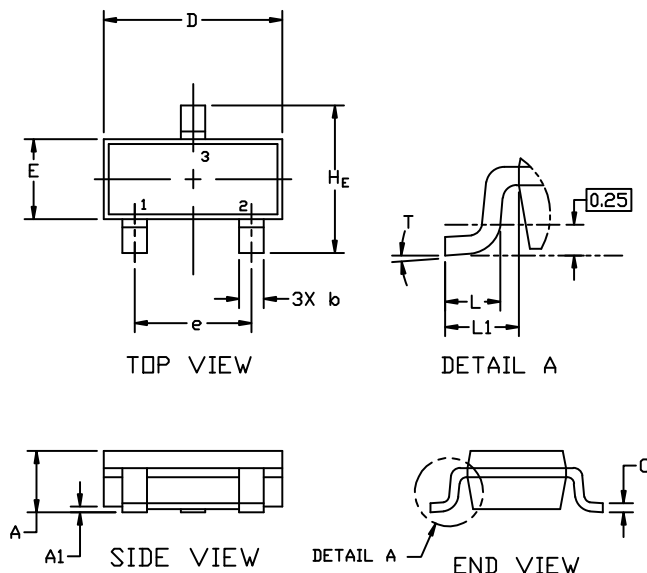
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SOT-23 (TO-236)

CASE 318

ISSUE AT

DATE 01 MAR 2023

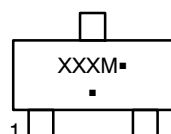


NOTES:

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.

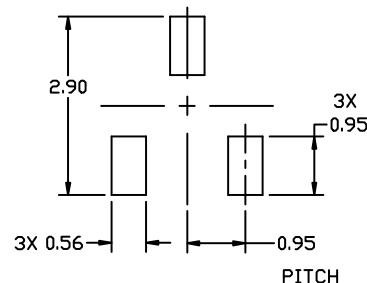
DIM	MILLIMETERS			INCHES		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.89	1.00	1.11	0.035	0.039	0.044
A1	0.01	0.06	0.10	0.000	0.002	0.004
b	0.37	0.44	0.50	0.015	0.017	0.020
c	0.08	0.14	0.20	0.003	0.006	0.008
D	2.80	2.90	3.04	0.110	0.114	0.120
E	1.20	1.30	1.40	0.047	0.051	0.055
e	1.78	1.90	2.04	0.070	0.075	0.080
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 _E	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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MECHANICAL CASE OUTLINE

PACKAGE DIMENSIONS



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

DATE 01 MAR 2023

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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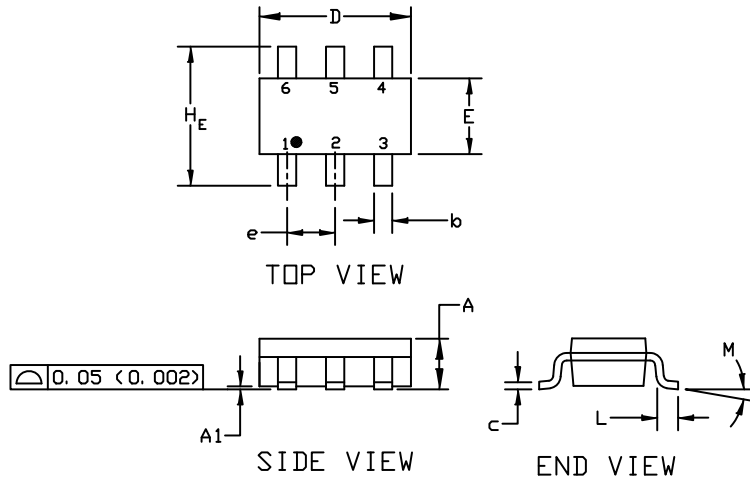
MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



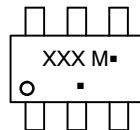
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SC-74 CASE 318F ISSUE P

DATE 07 OCT 2021



GENERIC MARKING DIAGRAM*



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

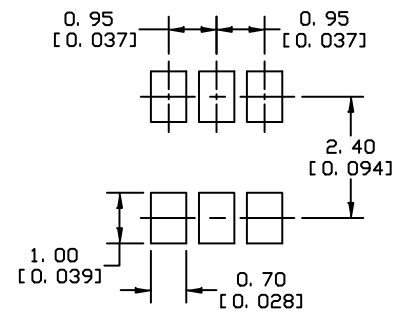
(Note: Microdot may be in either location)

*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 _E	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, SOLDERM/D.

SOLDERING FOOTPRINT

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

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