

NUD3124, SZNUD3124

Automotive Inductive Load Driver

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 are Pb-Free Devices

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



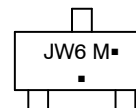
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MARKING DIAGRAMS



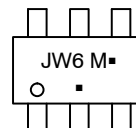
**SOT-23
CASE 318
STYLE 21**



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



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



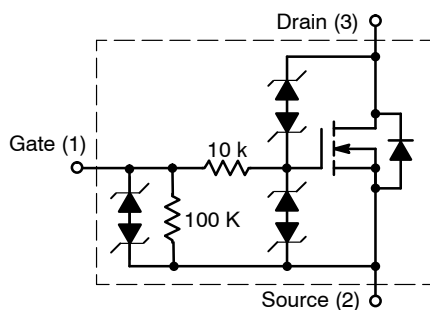
JW6 = Specific Device Code
M = Date Code
▪ = Pb-Free Package
(Note: Microdot may be in either location)

ORDERING INFORMATION

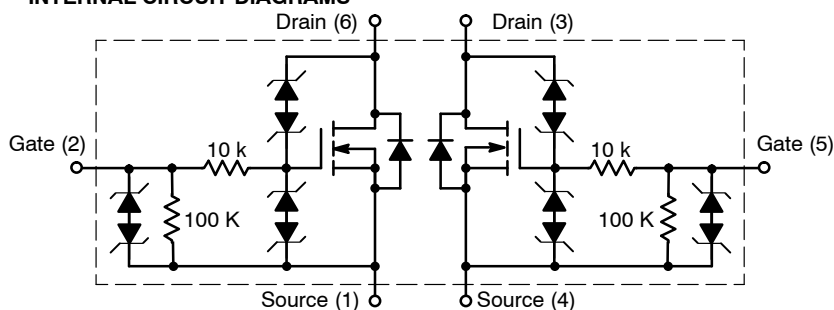
Device	Package	Shipping†
NUD3124LT1G	SOT-23 (Pb-Free)	3000 / Tape & Reel
SZNUD3124LT1G	SOT-23 (Pb-Free)	3000 / Tape & Reel
NUD3124DMT1G	SC-74 (Pb-Free)	3000 / Tape & Reel
SZNUD3124DMT1G	SC-74 (Pb-Free)	3000 / Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

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_{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 $80\ \Omega$ 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: $V_s = 45\text{ V}$, $R_{SOURCE} = 0.5\ \Omega$, $T = 200\text{ ms}$) (For Relay's Coils/Inductive Loads of $80\ \Omega$ or Higher) (T_J Initial = 85°C)	80	V
E_{LD2}	Inductive Switching Transient 1, Drain-to-Source (Waveform: $R_{SOURCE} = 10\ \Omega$, $T = 2.0\text{ ms}$) (For Relay's Coils/Inductive Loads of $80\ \Omega$ or Higher) (T_J Initial = 85°C)	100	V
E_{LD3}	Inductive Switching Transient 2, Drain-to-Source (Waveform: $R_{SOURCE} = 4.0\ \Omega$, $T = 50\ \mu\text{s}$) (For Relay's Coils/Inductive Loads of $80\ \Omega$ 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 $80\ \Omega$ 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.

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 $80\ \Omega$, see Figure 4.

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THERMAL CHARACTERISTICS

Symbol	Rating	Value	Unit
T_A	Operating Ambient Temperature	-40 to 125	°C
T_J	Maximum Junction Temperature	150	°C
T_{STG}	Storage Temperature Range	-65 to 150	°C
P_D	Total Power Dissipation (Note 5) Derating above 25°C	SOT-23 225 1.8	mW
			mW/°C
P_D	Total Power Dissipation (Note 5) Derating above 25°C	SC-74 380 3.0	mW
			mW/°C
$R_{\theta JA}$	Thermal Resistance Junction-to-Ambient (Note 5)	SOT-23 556	°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, ($V_{\text{DS}} = 12\text{ V}$, $V_{\text{GS}} = 3.0\text{ V}$)	t_{PHL} t_{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_{PHL} t_{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.

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TYPICAL PERFORMANCE CURVES

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

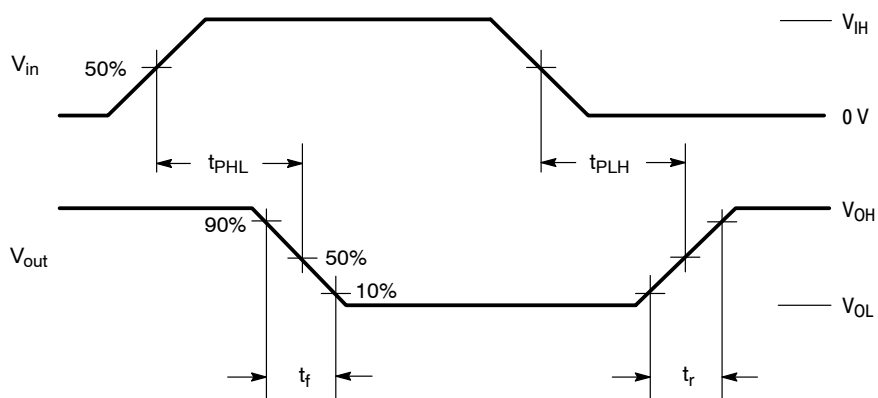


Figure 1. Switching Waveforms

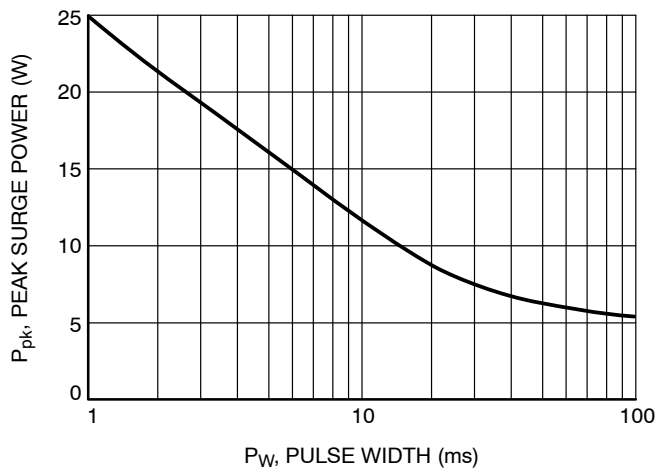


Figure 2. Maximum Non-repetitive Surge Power versus Pulse Width

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.

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

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

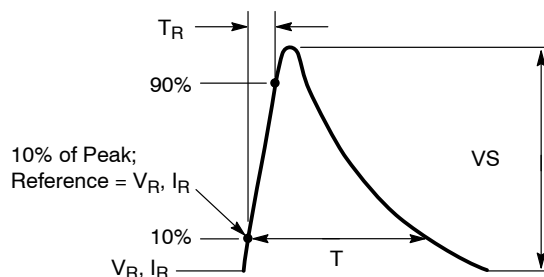


Figure 3. Load Dump Waveform Definition

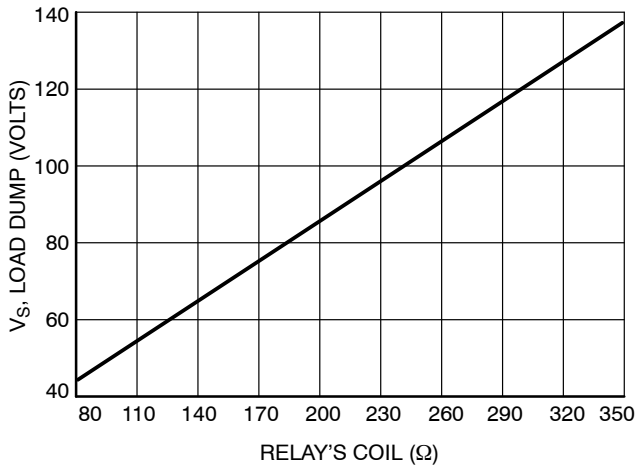


Figure 4. Load Dump Capability versus Relay's Coil dc Resistance

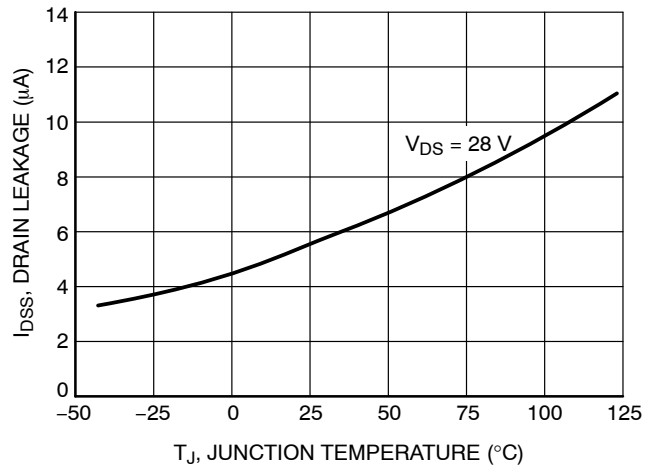


Figure 5. Drain-to-Source Leakage versus Junction Temperature

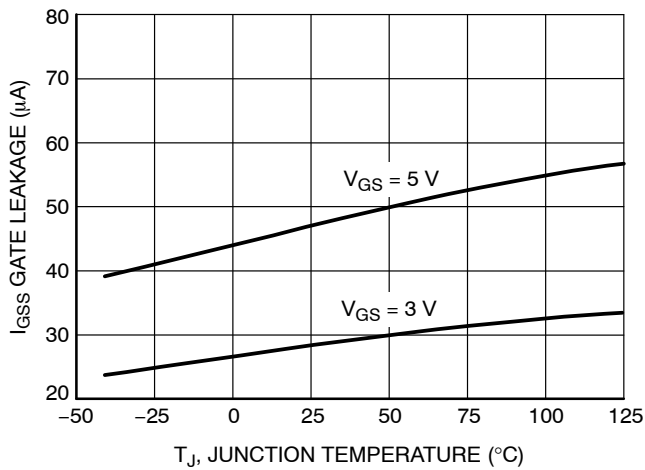


Figure 6. Gate-to-Source Leakage versus Junction Temperature

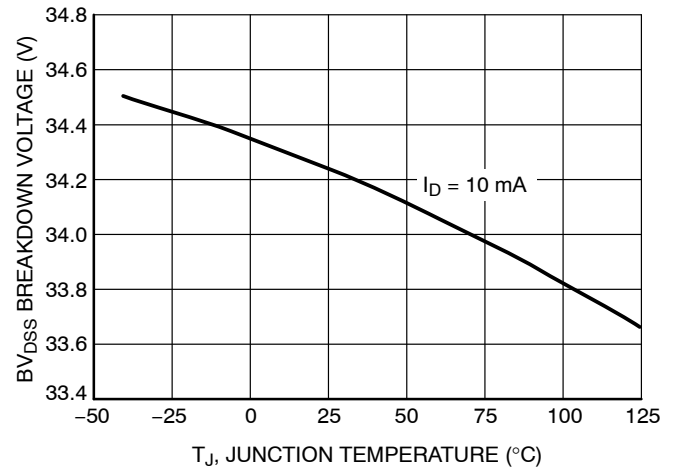


Figure 7. Breakdown Voltage versus Junction Temperature

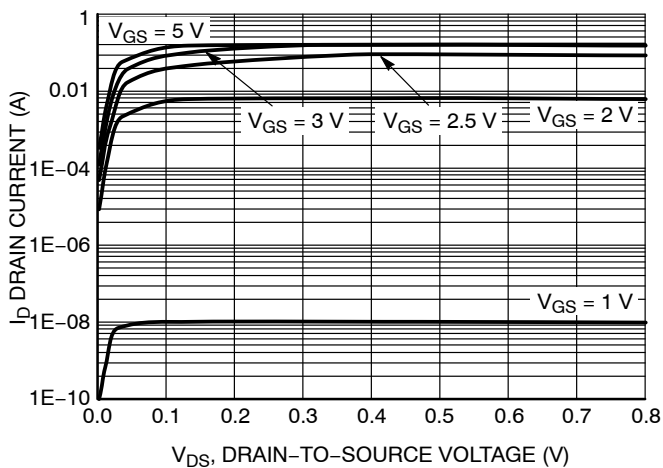


Figure 8. Output Characteristics

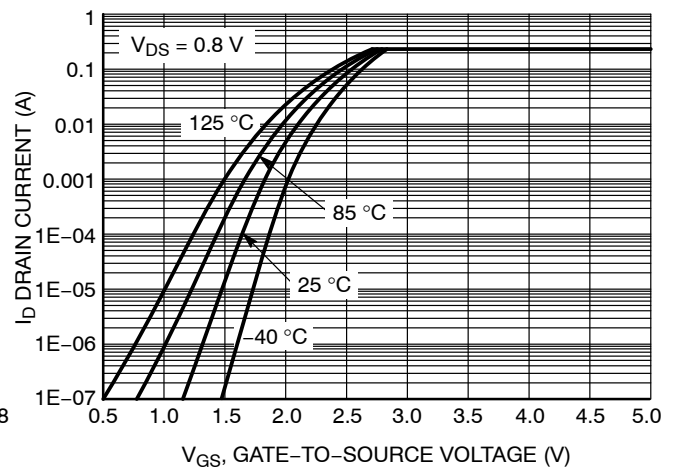
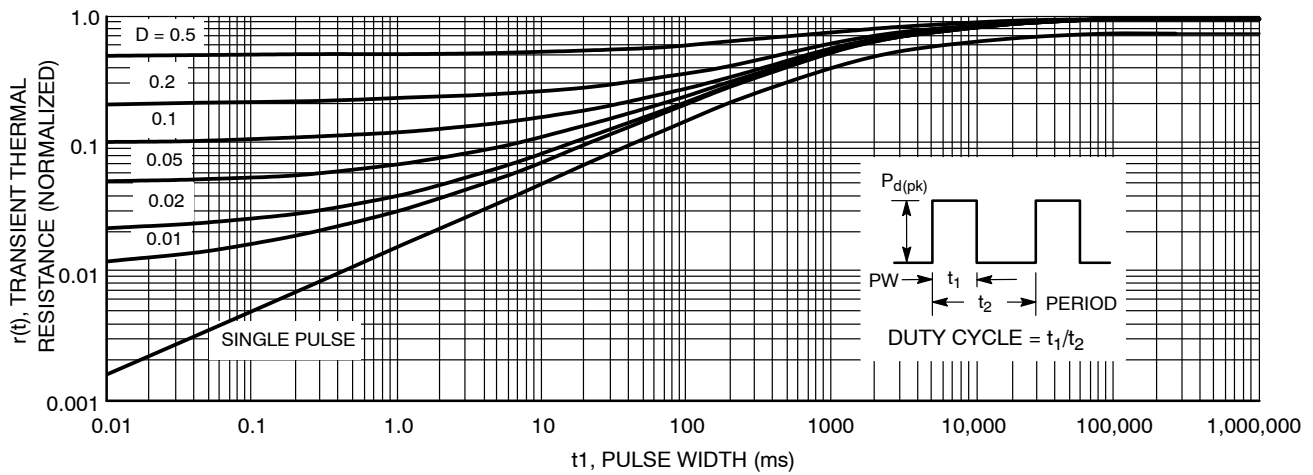
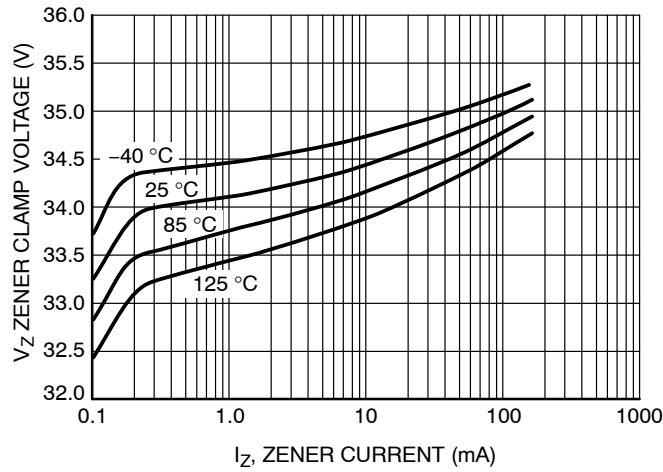
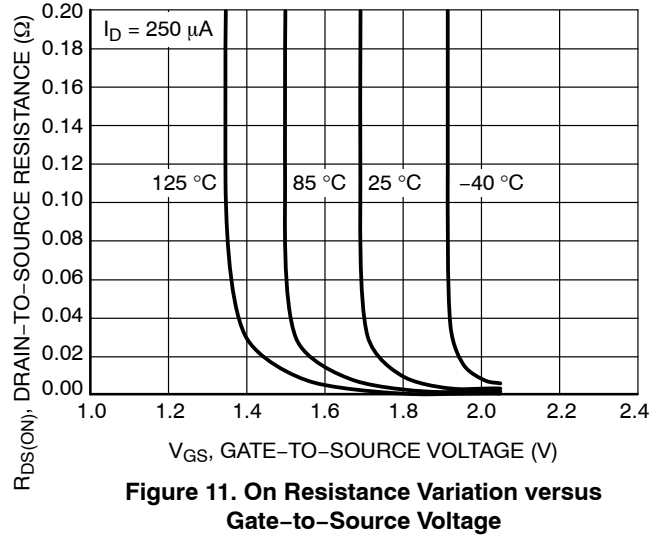
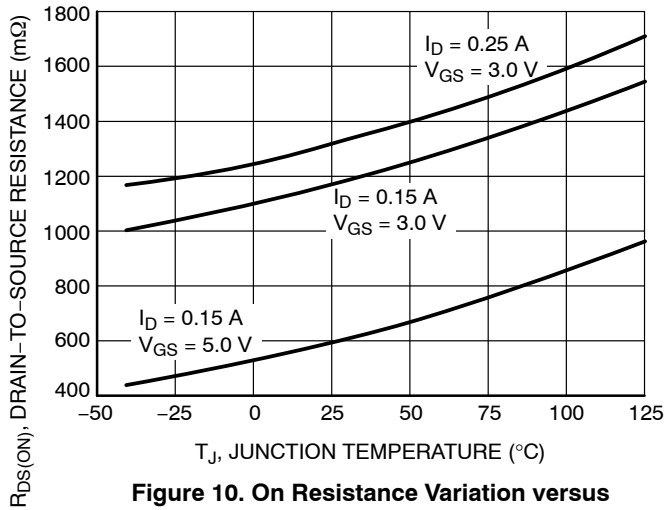


Figure 9. Transfer Function

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NUD3124, SZNUD3124

APPLICATIONS INFORMATION

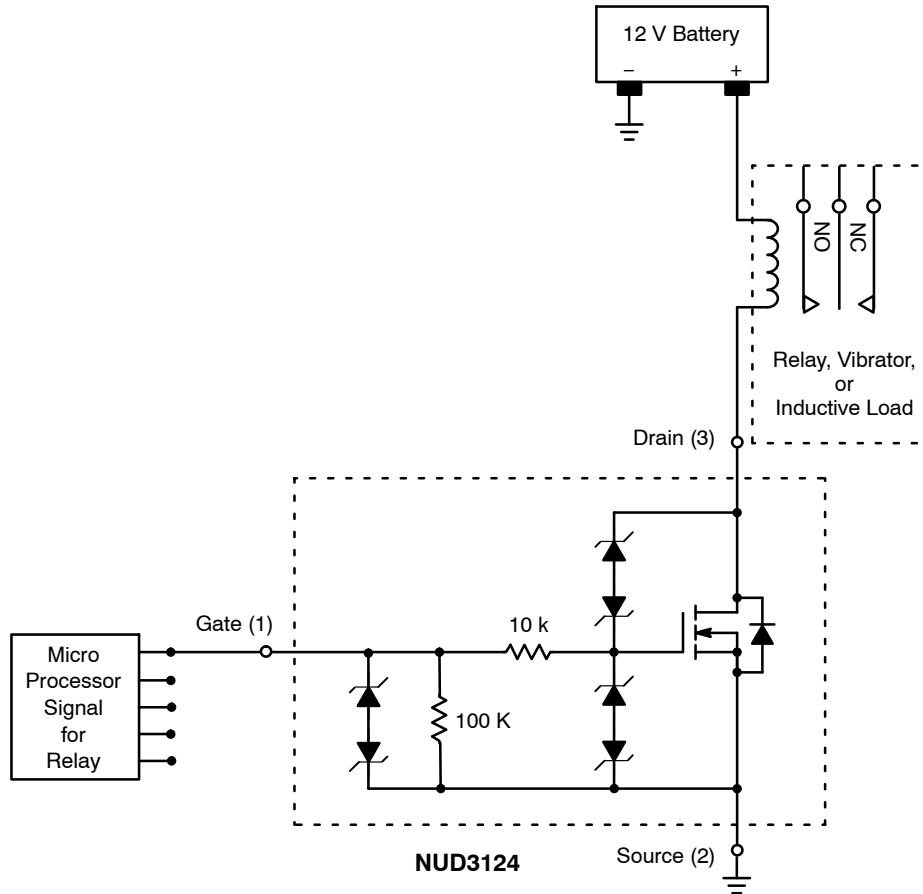


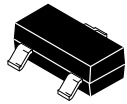
Figure 14. Applications Diagram

MECHANICAL CASE OUTLINE

PACKAGE DIMENSIONS

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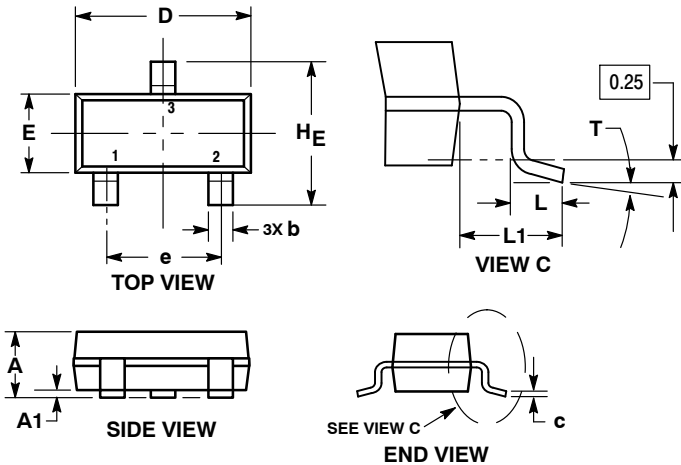
ON



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

DATE 30 JAN 2018

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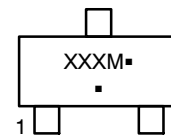


NOTES:

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
HE	2.10	2.40	2.64	0.083	0.094	0.104
T	0°	---	10°	0°	---	10°

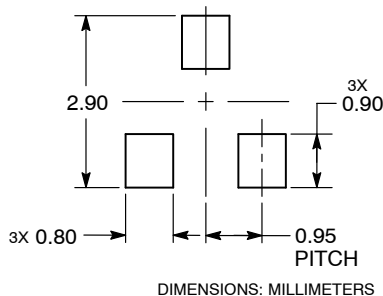
GENERIC MARKING DIAGRAM*



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.

RECOMMENDED SOLDERING FOOTPRINT



DIMENSIONS: MILLIMETERS

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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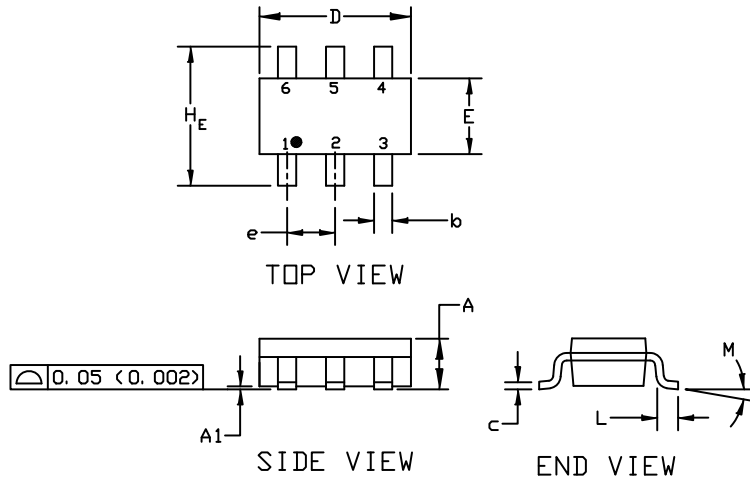
MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



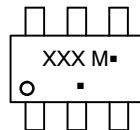
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SC-74 CASE 318F ISSUE P

DATE 07 OCT 2021



GENERIC MARKING DIAGRAM*



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

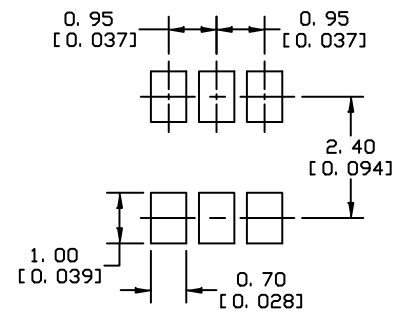
(Note: Microdot may be in either location)

*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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