

Integrated Relay, Inductive Load Driver

NUD3105

This device is used to switch inductive loads such as relays, solenoids incandescent lamps, and small DC motors without the need of a free-wheeling diode. The device integrates all necessary items such as the MOSFET switch, ESD protection, and Zener clamps. It accepts logic level inputs thus allowing it to be driven by a large variety of devices including logic gates, inverters, and microcontrollers.

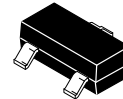
Features

- Provides a Robust Driver Interface Between DC Relay Coil and Sensitive Logic Circuits
- Optimized to Switch Relays from 3.0 V to 5.0 V Rail
- Capable of Driving Relay Coils Rated up to 2.5 W at 5.0 V
- Internal Zener Eliminates the Need of Free-Wheeling Diode
- Internal Zener Clamp Routes Induced Current to Ground for Quieter Systems Operation
- Low $V_{DS(on)}$ Reduces System Current Drain
- 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 and Halide Free

Typical Applications

- Telecom: Line Cards, Modems, Answering Machines, FAX
- Computers and Office: Photocopiers, Printers, Desktop Computers
- Consumer: TVs and VCRs, Stereo Receivers, CD Players, Cassette Recorders
- Industrial: Small Appliances, Security Systems, Automated Test Equipment, Garage Door Openers
- Automotive: 5.0 V Driven Relays, Motor Controls, Power Latches, Lamp Drivers

RELAY/INDUCTIVE LOAD DRIVER 0.5 AMPERE, 8.0 VOLT CLAMP

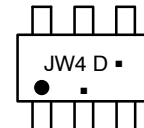
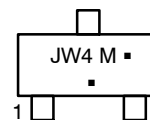


SOT-23
(TO-236)
CASE 318



SC-74
CASE 318F
STYLE 7

MARKING DIAGRAMS



JW4 = Device Code
M = Date Code*
D = Date Code
▪ = Pb-Free Package

(Note: Microdot may be in either location)
*Date Code orientation and/or overbar may vary depending upon manufacturing location.

ORDERING INFORMATION

Device	Package	Shipping [†]
NUD3105LT1G	SOT-23 (Pb-Free)	3000 / Tape & Reel
NUD3105DMT1G	SOT-74 (Pb-Free)	3000 / Tape & Reel
SZNUD3105DMT1G	SOT-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](http://www.onsemi.com/BRD8011/D).

NUD3105

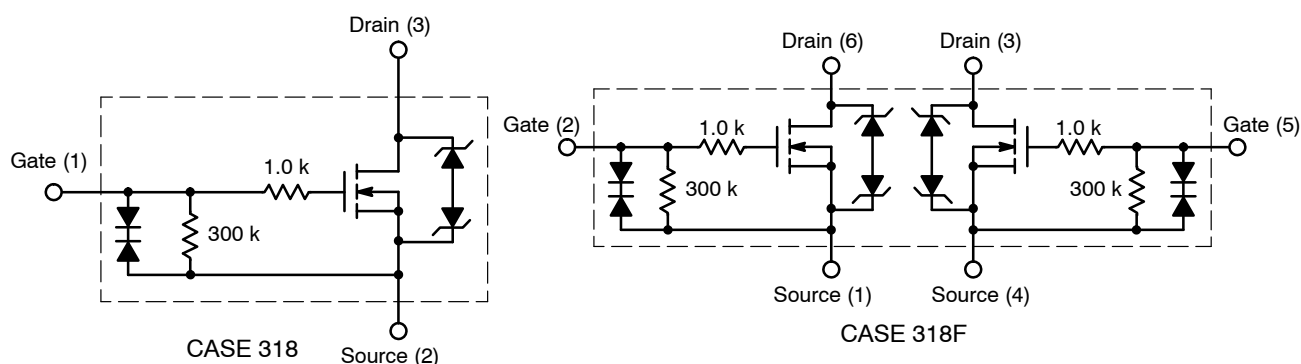


Figure 1. Internal Circuit Diagrams

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

Symbol	Rating	Value	Unit
V_{DS}	Drain to Source Voltage – Continuous	6.0	V_{dc}
V_{GS}	Gate to Source Voltage – Continuous	6.0	V_{dc}
I_D	Drain Current – Continuous	500	mA
E_z	Single Pulse Drain-to-Source Avalanche Energy ($T_{Jinitial} = 25^\circ\text{C}$) (Note 2)	50	mJ
E_{zpk}	Repetitive Pulse Zener Energy Limit ($DC \leq 0.01\%$) ($f = 100\text{ Hz}$, $DC = 0.5$)	4.5	mJ
T_J	Junction Temperature	150	$^\circ\text{C}$
T_A	Operating Ambient Temperature	-40 to 85	$^\circ\text{C}$
T_{stg}	Storage Temperature Range	-65 to +150	$^\circ\text{C}$
P_D	Total Power Dissipation (Note 1) Derating Above 25°C	SOT-23 225 1.8	mW mW/ $^\circ\text{C}$
	Total Power Dissipation (Note 1) Derating Above 25°C	SC-74 380 1.5	mW mW/ $^\circ\text{C}$
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient	SOT-23	556
		SC-74	329
			$^\circ\text{C}/\text{W}$

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. This device contains ESD protection and exceeds the following tests:

Human Body Model 2000 V per MIL-STD-883, Method 3015.

Machine Model Method 200 V.

2. Refer to the section covering Avalanche and Energy.

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

Symbol	Characteristic	Min	Typ	Max	Unit
V_{BRDSS}	Drain to Source Sustaining Voltage (Internally Clamped), ($I_D = 10\text{ mA}$)	6.0	8.0	9.0	V
B_{VGS0}	$I_g = 1.0\text{ mA}$	-	-	8.0	V
I_{DSS}	Drain to Source Leakage Current ($V_{DS} = 5.5\text{ V}$, $V_{GS} = 0\text{ V}$, $T_J = 25^\circ\text{C}$)	-	-	15	μA
	($V_{DS} = 5.5\text{ V}$, $V_{GS} = 0\text{ V}$, $T_J = 85^\circ\text{C}$)	-	-	15	μA
I_{GSS}	Gate Body Leakage Current (318) ($V_{GS} = 3.0\text{ V}$, $V_{DS} = 0\text{ V}$) ($V_{GS} = 5.0\text{ V}$, $V_{DS} = 0\text{ V}$)	5.0 -	- -	19 50	μA
	Gate Body Leakage Current (318F) ($V_{GS} = 3.0\text{ V}$, $V_{DS} = 0\text{ V}$) ($V_{GS} = 5.0\text{ V}$, $V_{DS} = 0\text{ V}$)	5.0 -	- -	35 65	μA

NUD3105

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

Symbol	Characteristic	Min	Typ	Max	Unit
ON CHARACTERISTICS					
$V_{GS(th)}$	Gate Threshold Voltage ($V_{GS} = V_{DS}$, $I_D = 1.0\text{ mA}$) ($V_{GS} = V_{DS}$, $I_D = 1.0\text{ mA}$, $T_J = 85^\circ\text{C}$)	0.8 0.8	1.2 –	1.4 1.4	V
$R_{DS(on)}$	Drain to Source On-Resistance ($I_D = 250\text{ mA}$, $V_{GS} = 3.0\text{ V}$) ($I_D = 500\text{ mA}$, $V_{GS} = 3.0\text{ V}$) ($I_D = 500\text{ mA}$, $V_{GS} = 5.0\text{ V}$) ($I_D = 500\text{ mA}$, $V_{GS} = 3.0\text{ V}$, $T_J = 85^\circ\text{C}$) ($I_D = 500\text{ mA}$, $V_{GS} = 5.0\text{ V}$, $T_J = 85^\circ\text{C}$)	– – – – –	– – – – –	1.2 1.3 0.9 1.3 0.9	Ω
$I_{DS(on)}$	Output Continuous Current ($V_{DS} = 0.25\text{ V}$, $V_{GS} = 3.0\text{ V}$) ($V_{DS} = 0.25\text{ V}$, $V_{GS} = 3.0\text{ V}$, $T_J = 85^\circ\text{C}$)	300 200	400 –	– –	mA
g_{FS}	Forward Transconductance ($V_{OUT} = 5.0\text{ V}$, $I_{OUT} = 0.25\text{ A}$)	350	570	–	mmhos

DYNAMIC CHARACTERISTICS

C_{iss}	Input Capacitance ($V_{DS} = 5.0\text{ V}$, $V_{GS} = 0\text{ V}$, $f = 10\text{ kHz}$)	–	25	–	pF
C_{oss}	Output Capacitance ($V_{DS} = 5.0\text{ V}$, $V_{GS} = 0\text{ V}$, $f = 10\text{ kHz}$)	–	37	–	pF
C_{rss}	Transfer Capacitance ($V_{DS} = 5.0\text{ V}$, $V_{GS} = 0\text{ V}$, $f = 10\text{ kHz}$)	–	8.0	–	pF

SWITCHING CHARACTERISTICS

t_{PHL} t_{PLH}	Propagation Delay Times: High to Low Propagation Delay; Figure 1 (5.0 V) Low to High Propagation Delay; Figure 1 (5.0 V)	– –	25 80	– –	nS
t_{PHL} t_{PLH}	High to Low Propagation Delay; Figure 1 (3.0 V) Low to High Propagation Delay; Figure 1 (3.0 V)	– –	44 44	– –	
t_f t_r	Transition Times: Fall Time; Figure 1 (5.0 V) Rise Time; Figure 1 (5.0 V)	– –	23 32	– –	nS
t_f t_r	Fall Time; Figure 1 (3.0 V) Rise Time; Figure 1 (3.0 V)	– –	53 30	– –	

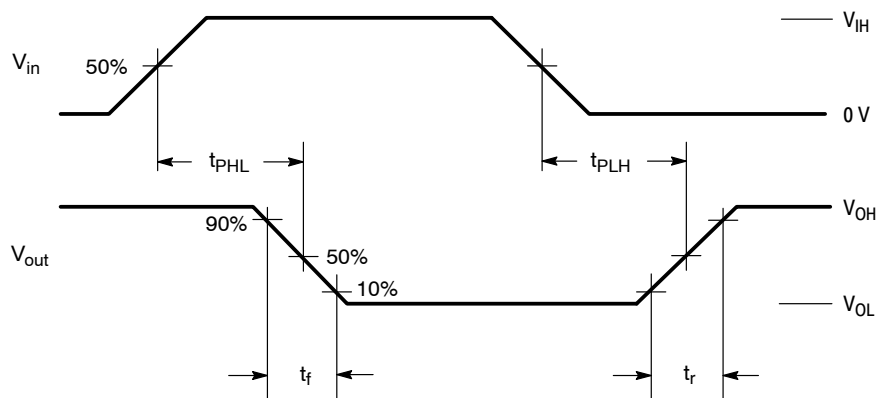


Figure 1. Switching Waveforms

TYPICAL CHARACTERISTICS

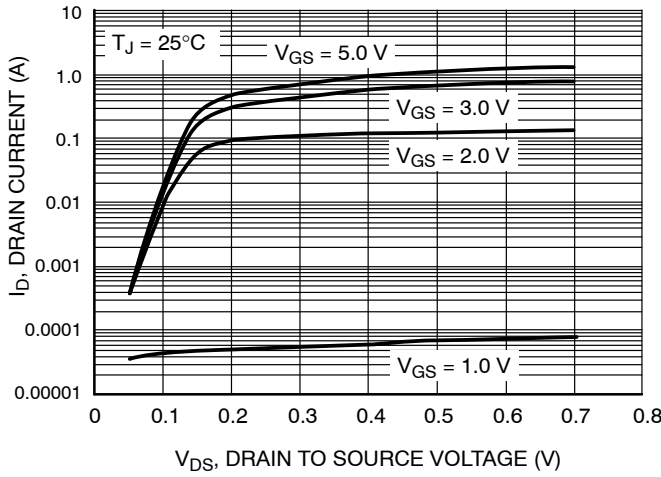


Figure 2. Output Characteristics

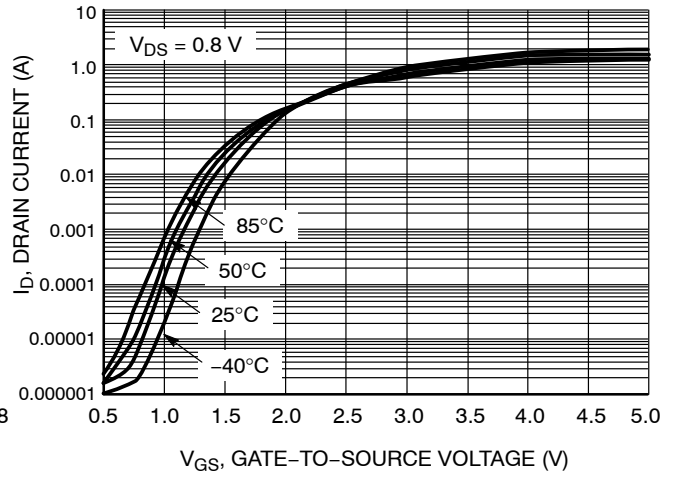


Figure 3. Transfer Function

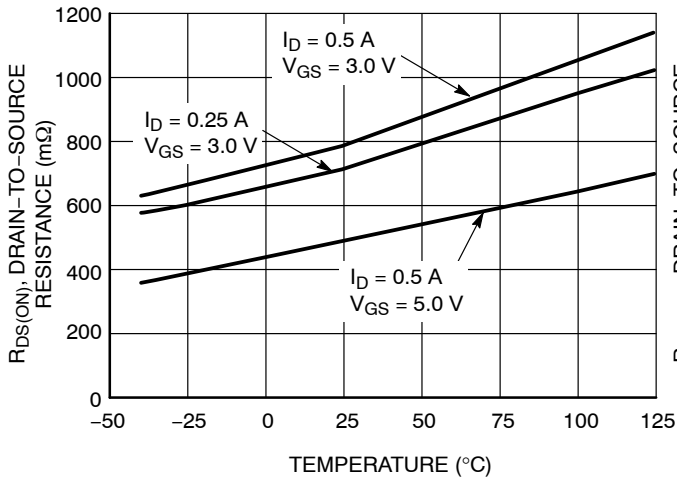


Figure 4. On Resistance Variation vs. Temperature

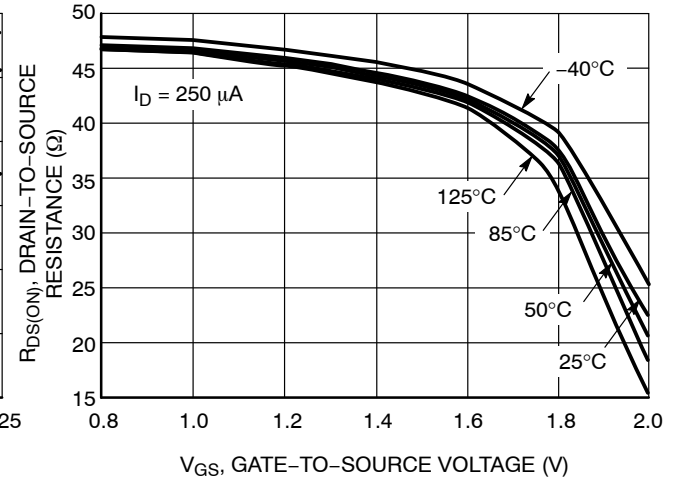


Figure 5. $R_{DS(ON)}$ Variation with Gate-to-Source Voltage

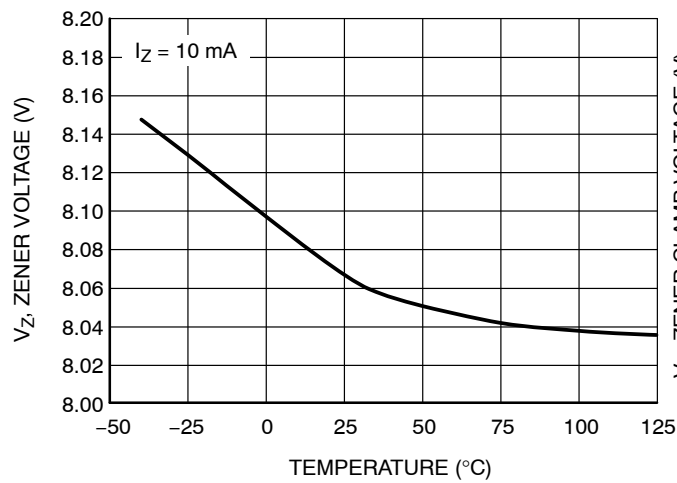


Figure 6. Zener Voltage vs. Temperature

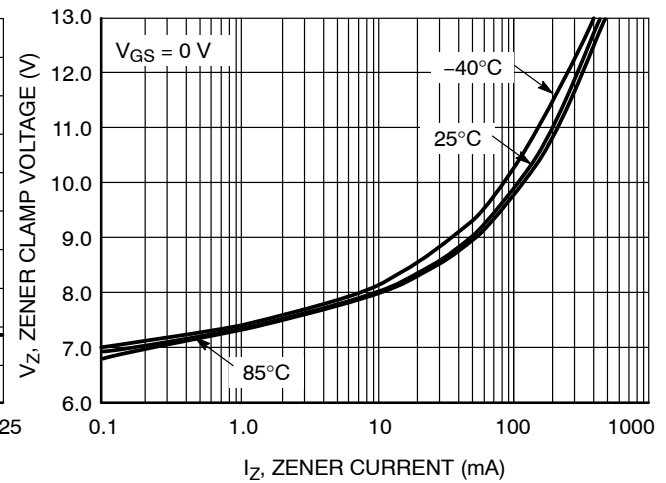


Figure 7. Zener Clamp Voltage vs. Zener Current

TYPICAL CHARACTERISTICS (continued)

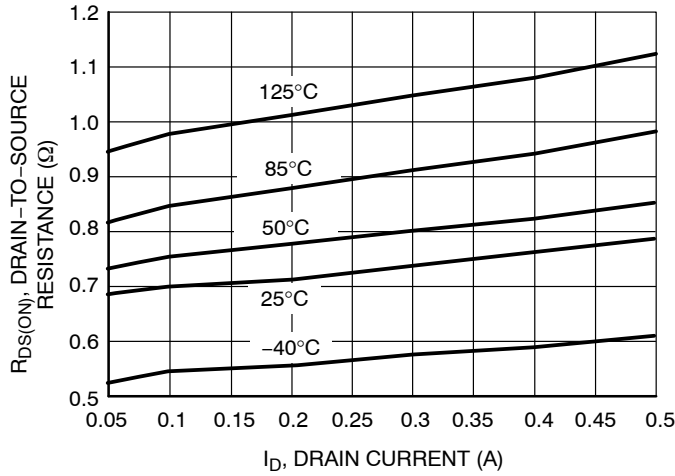


Figure 8. On-Resistance vs. Drain Current and Temperature

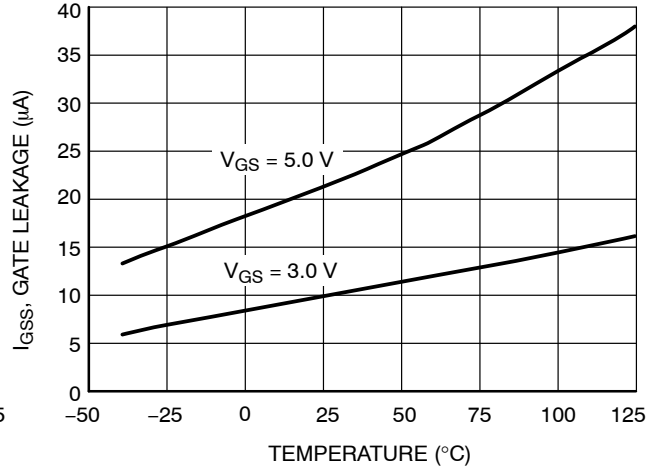


Figure 9. Gate Leakage vs. Temperature

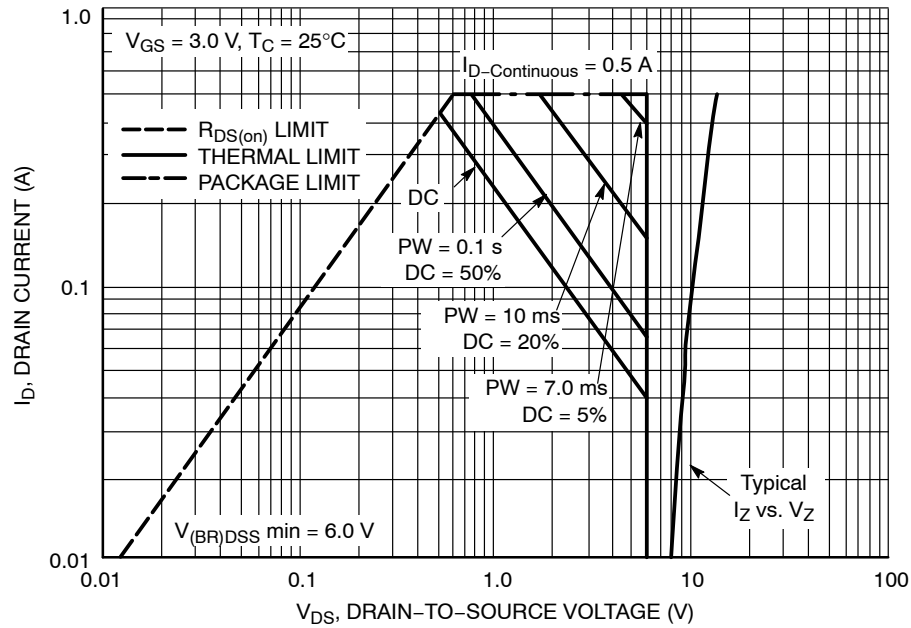


Figure 10. Safe Operating Area

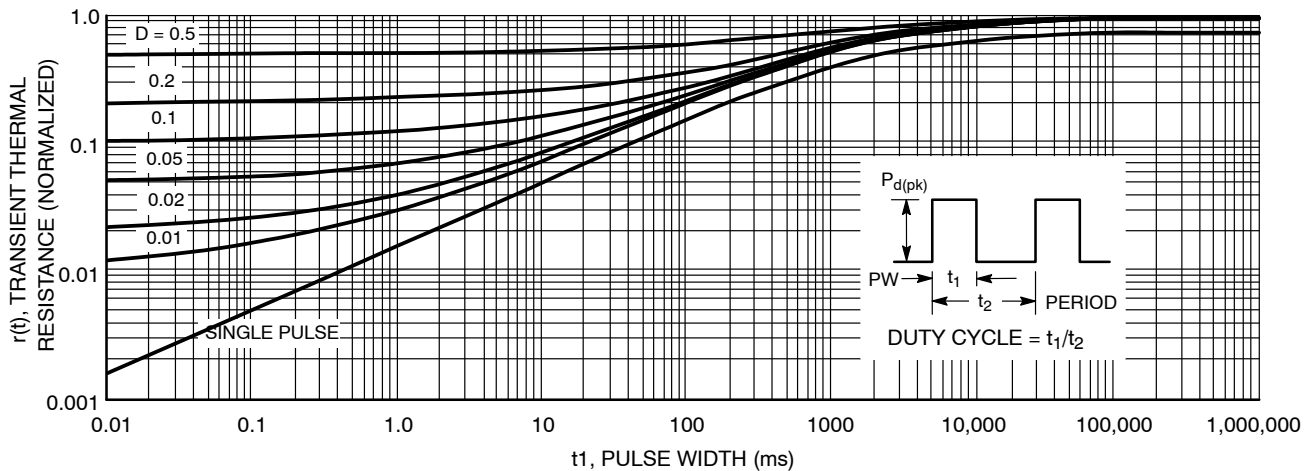


Figure 11. Transient Thermal Response

Designing with this Data Sheet

1. Determine the maximum inductive load current (at max V_{CC} , min coil resistance & usually minimum temperature) that the NUD3105 will have to drive and make sure it is less than the max rated current.
2. For pulsed operation, use the Transient Thermal Response of Figure 11 and the instructions with it to determine the maximum limit on transistor power dissipation for the desired duty cycle and temperature range.
3. Use Figures 10 and 11 with the SOA notes to insure that instantaneous operation does not push the device beyond the limits of the SOA plot.
4. Verify that the circuit driving the gate will meet the $V_{GS(th)}$ from the Electrical Characteristics table.
5. Using the max output current calculated in step 1, check Figure 7 to insure that the range of Zener clamp voltage over temperature will satisfy all system & EMI requirements.
6. Use I_{GSS} and I_{DSS} from the Electrical Characteristics table to ensure that "OFF" state leakage over temperature and voltage extremes does not violate any system requirements.
7. Review circuit operation and insure none of the device max ratings are being exceeded.

APPLICATIONS DIAGRAMS

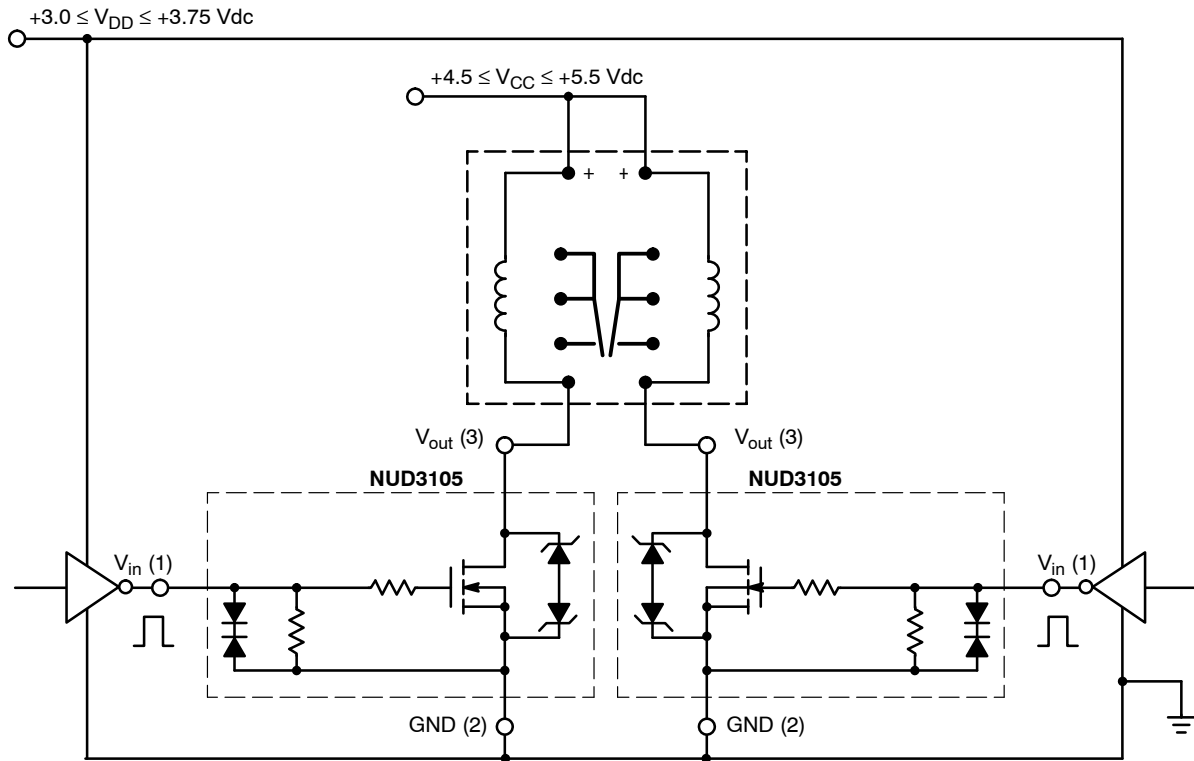


Figure 12. A 200 mW, 5.0 V Dual Coil Latching Relay Application with 3.0 V Level Translating Interface

Max Continuous Current Calculation

for TX2-5V Relay, $R_1 = 178 \, \Omega$ Nominal @ $R_A = 25^\circ\text{C}$

Assuming $\pm 10\%$ Make Tolerance,

$R_1 = 178 \, \Omega * 0.9 = 160 \, \Omega$ Min @ $T_A = 25^\circ\text{C}$

T_C for Annealed Copper Wire is $0.4\%/^\circ\text{C}$

$R_1 = 160 \, \Omega * [1 + (0.004) * (-40^\circ - 25^\circ)] = 118 \, \Omega$ Min @ -40°C

$I_O \text{ Max} = (5.5 \text{ V Max} - 0.25\text{V}) / 118 \, \Omega = 45 \text{ mA}$

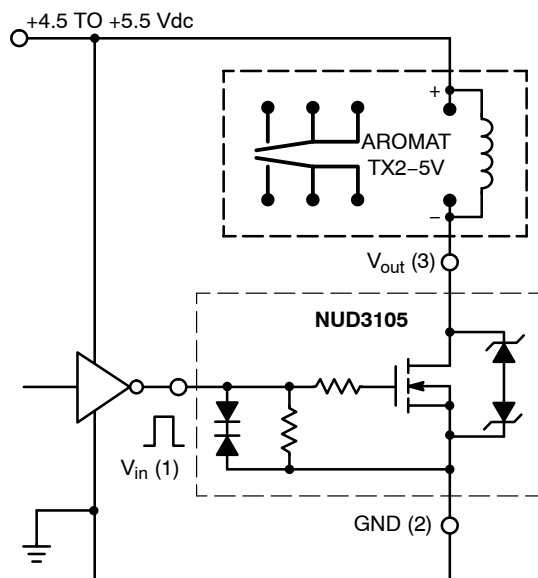


Figure 13. A 140 mW, 5.0 V Relay with TTL Interface

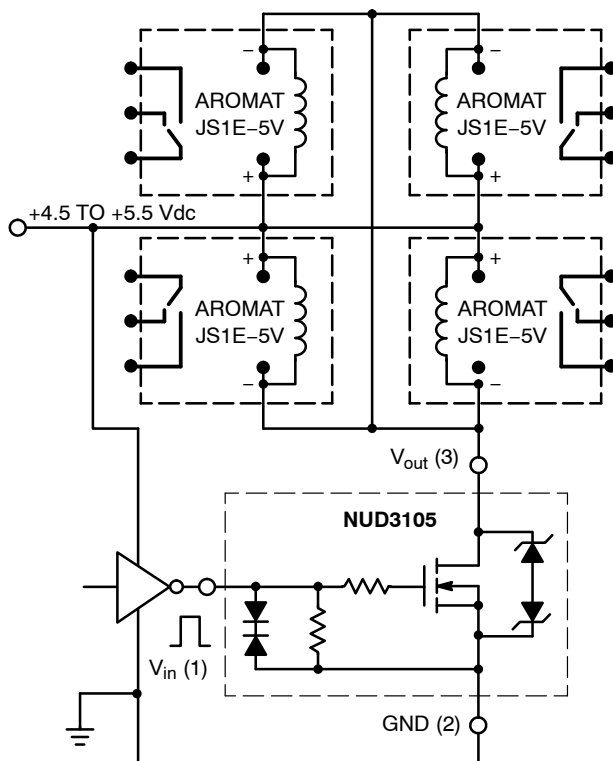
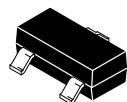


Figure 14. A Quad 5.0 V, 360 mW Coil Relay Bank

MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



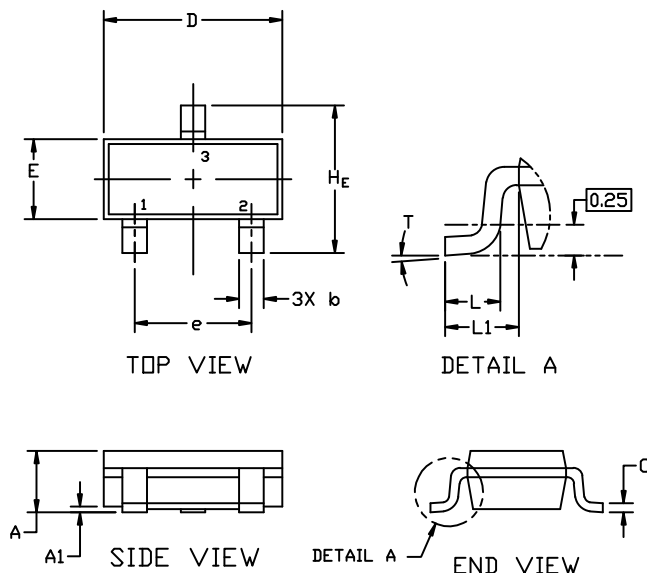
SCALE 4:1

SOT-23 (TO-236)

CASE 318

ISSUE AT

DATE 01 MAR 2023

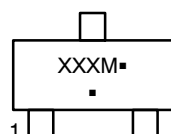


NOTES:

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.

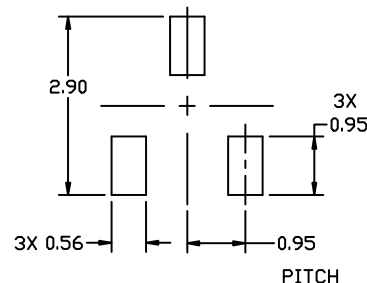
DIM	MILLIMETERS			INCHES		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.89	1.00	1.11	0.035	0.039	0.044
A1	0.01	0.06	0.10	0.000	0.002	0.004
b	0.37	0.44	0.50	0.015	0.017	0.020
c	0.08	0.14	0.20	0.003	0.006	0.008
D	2.80	2.90	3.04	0.110	0.114	0.120
E	1.20	1.30	1.40	0.047	0.051	0.055
e	1.78	1.90	2.04	0.070	0.075	0.080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

DOCUMENT NUMBER:	98ASB42226B	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red.
DESCRIPTION:	SOT-23 (TO-236)	PAGE 1 OF 2

onsemi and onsemi are trademarks of Semiconductor Components Industries, LLC dba onsemi or its subsidiaries in the United States and/or other countries. onsemi reserves the right to make changes without further notice to any products herein. onsemi makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does onsemi assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. onsemi does not convey any license under its patent rights nor the rights of others.

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				

DOCUMENT NUMBER:	98ASB42226B	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red.
DESCRIPTION:	SOT-23 (TO-236)	PAGE 2 OF 2

onsemi and onsemi are trademarks of Semiconductor Components Industries, LLC dba onsemi or its subsidiaries in the United States and/or other countries. onsemi reserves the right to make changes without further notice to any products herein. onsemi makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does onsemi assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. onsemi does not convey any license under its patent rights nor the rights of others.

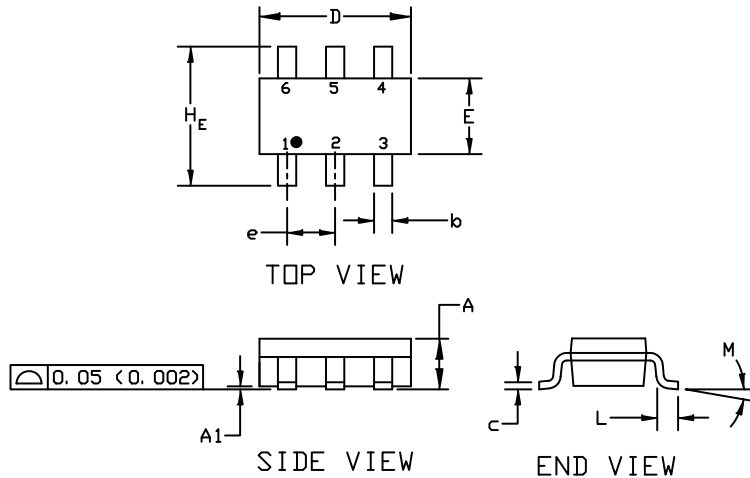
MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



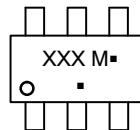
SCALE 2:1

SC-74 CASE 318F ISSUE P

DATE 07 OCT 2021



GENERIC MARKING DIAGRAM*



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

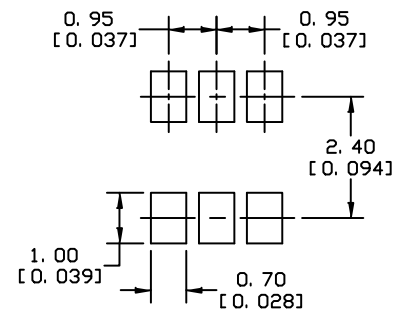
(Note: Microdot may be in either location)

*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 _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	

DOCUMENT NUMBER:	98ASB42973B	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red.
DESCRIPTION:	SC-74	PAGE 1 OF 1

onsemi and onsemi are trademarks of Semiconductor Components Industries, LLC dba onsemi or its subsidiaries in the United States and/or other countries. onsemi reserves the right to make changes without further notice to any products herein. onsemi makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does onsemi assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. onsemi does not convey any license under its patent rights nor the rights of others.

onsemi, **Onsemi**, and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "**onsemi**" or its affiliates and/or subsidiaries in the United States and/or other countries. **onsemi** owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of **onsemi**'s product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. **onsemi** reserves the right to make changes at any time to any products or information herein, without notice. The information herein is provided "as-is" and **onsemi** makes no warranty, representation or guarantee regarding the accuracy of the information, product features, availability, functionality, or suitability of its products for any particular purpose, nor does **onsemi** assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using **onsemi** products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by **onsemi**. "Typical" parameters which may be provided in **onsemi** data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. **onsemi** does not convey any license under any of its intellectual property rights nor the rights of others. **onsemi** products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use **onsemi** products for any such unintended or unauthorized application, Buyer shall indemnify and hold **onsemi** and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that **onsemi** was negligent regarding the design or manufacture of the part. **onsemi** is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:

Email Requests to: orderlit@onsemi.com

onsemi Website: www.onsemi.com

TECHNICAL SUPPORT

North American Technical Support:

Voice Mail: 1 800-282-9855 Toll Free USA/Canada

Phone: 011 421 33 790 2910

Europe, Middle East and Africa Technical Support:

Phone: 00421 33 790 2910

For additional information, please contact your local Sales Representative