DATA SHEET
www.onsemi.com

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.

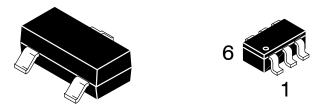
Features

- 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

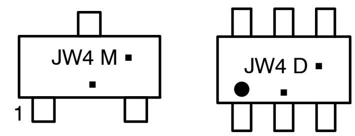
RELAY/INDUCTIVE LOAD DRIVER
0.5 AMPERE, 8.0 VOLT CLAMP



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.

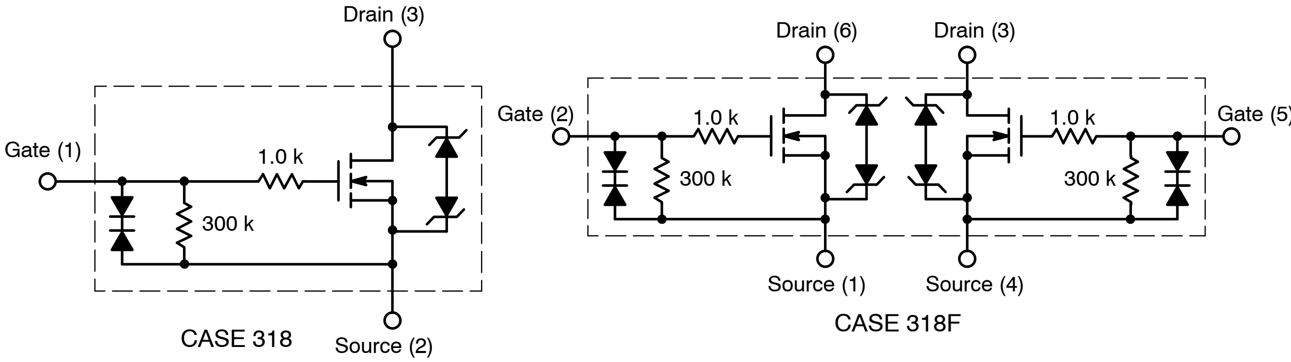


Figure 1. Internal Circuit Diagrams

MAXIMUM RATINGS (T_J = 25°C unless otherwise specified)

Symbol	Rating	Value	Unit
V_{DSS}	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°C) (Note 2)	50	mJ
E_{zpk}	Repetitive Pulse Zener Energy Limit (DC ≤ 0.01%) (f = 100 Hz, DC = 0.5)	4.5	mJ
T_J	Junction Temperature	150	°C
T_A	Operating Ambient Temperature	−40 to 85	°C
T_{stg}	Storage Temperature Range	−65 to +150	°C
P_D	Total Power Dissipation (Note 1) SOT−23 Derating Above 25°C	225 1.8	mW mW/°C
	Total Power Dissipation (Note 1) SC−74 Derating Above 25°C	380 1.5	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction−to−Ambient SOT−23 SC−74	556 329	°C/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°C unless otherwise noted)

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

ELECTRICAL CHARACTERISTICS (T_J = 25°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 mA) (V_{GS} = V_{DS}, I_D = 1.0 mA, T_J = 85°C)	0.8 0.8	1.2 –	1.4 1.4	V
$R_{DS(on)}$	Drain to Source On−Resistance (I_D = 250 mA, V_{GS} = 3.0 V) (I_D = 500 mA, V_{GS} = 3.0 V) (I_D = 500 mA, V_{GS} = 5.0 V) (I_D = 500 mA, V_{GS} = 3.0 V, T_J = 85°C) (I_D = 500 mA, V_{GS} = 5.0 V, T_J = 85°C)	– – – – –	– – – – –	1.2 1.3 0.9 1.3 0.9	Ω
$I_{DS(on)}$	Output Continuous Current (V_{DS} = 0.25 V, V_{GS} = 3.0 V) (V_{DS} = 0.25 V, V_{GS} = 3.0 V, T_J = 85°C)	300 200	400 –	– –	mA
g_{FS}	Forward Transconductance (V_{OUT} = 5.0 V, I_{OUT} = 0.25 A)	350	570	–	mmhos
DYNAMIC CHARACTERISTICS					
C_{iss}	Input Capacitance (V_{DS} = 5.0 V,V_{GS} = 0 V, f = 10 kHz)	–	25	–	pF
C_{oss}	Output Capacitance (V_{DS} = 5.0 V, V_{GS} = 0 V, f = 10 kHz)	–	37	–	pF
C_{rss}	Transfer Capacitance (V_{DS} = 5.0 V, V_{GS} = 0 V, f = 10 kHz)	–	8.0	–	pF
SWITCHING CHARACTERISTICS					
 t_{PHL} t_{PLH} 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) High to Low Propagation Delay; Figure 1 (3.0 V) Low to High Propagation Delay; Figure 1 (3.0 V)	 – – – –	 25 80 44 44	 – – – –	nS
 t_f tr t_f t_r	Transition Times: Fall Time; Figure 1 (5.0 V) Rise Time; Figure 1 (5.0 V) Fall Time; Figure 1 (3.0 V) Rise Time; Figure 1 (3.0 V)	 – – – –	 23 32 53 30	 – – – –	nS

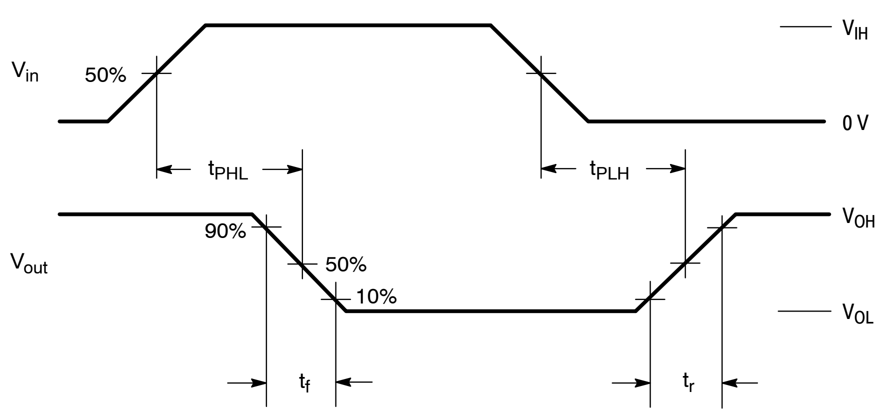


Figure 1. Switching Waveforms

TYPICAL CHARACTERISTICS

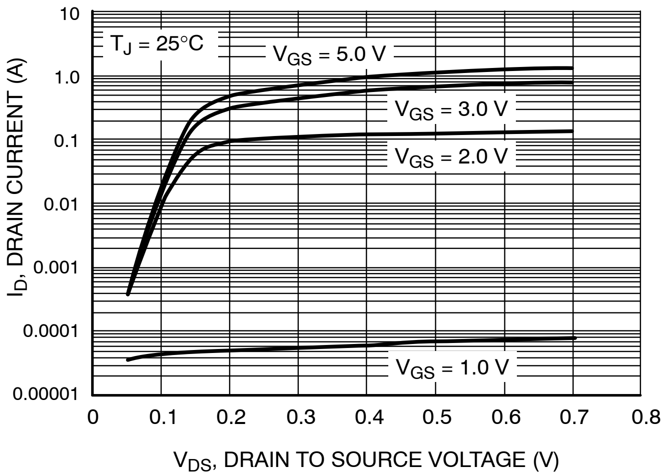


Figure 2. Output Characteristics

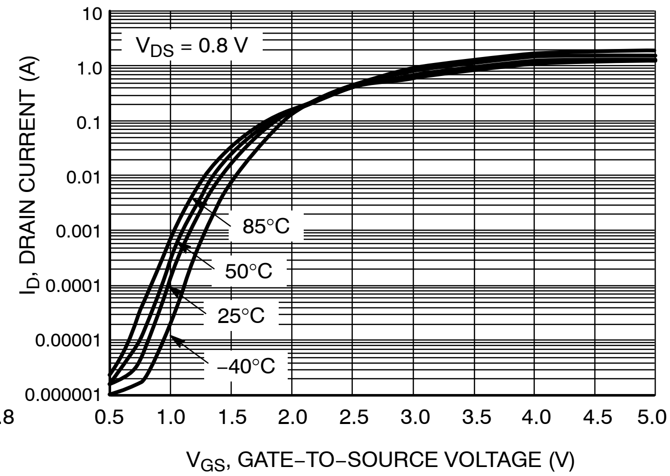


Figure 3. Transfer Function

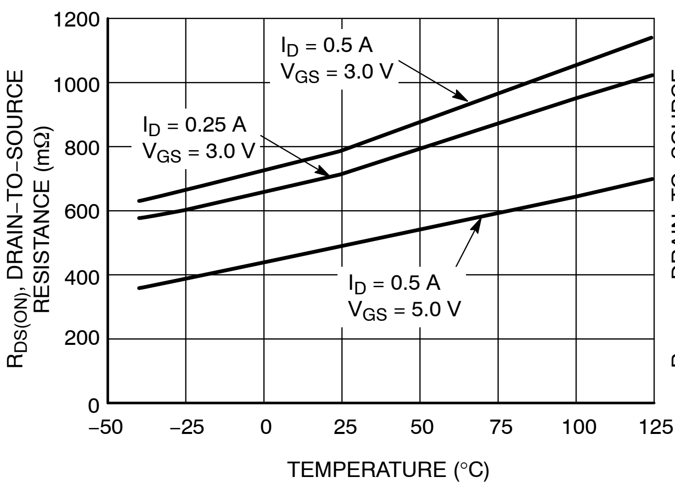


Figure 4. On Resistance Variation vs. Temperature

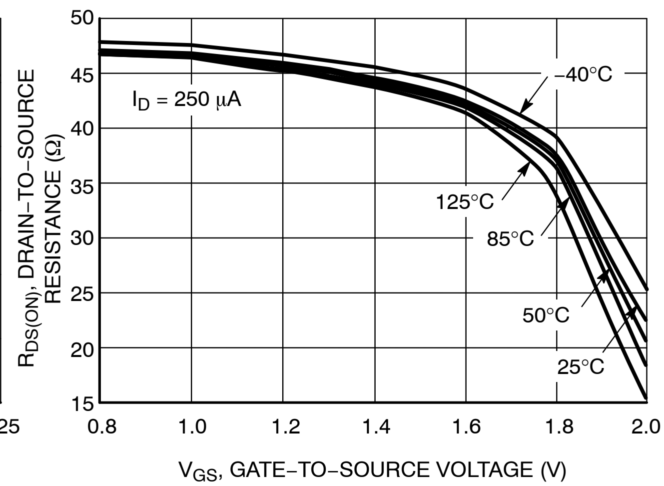


Figure 5. $R_{DS(ON)}$ Variation with Gate−To−Source Voltage

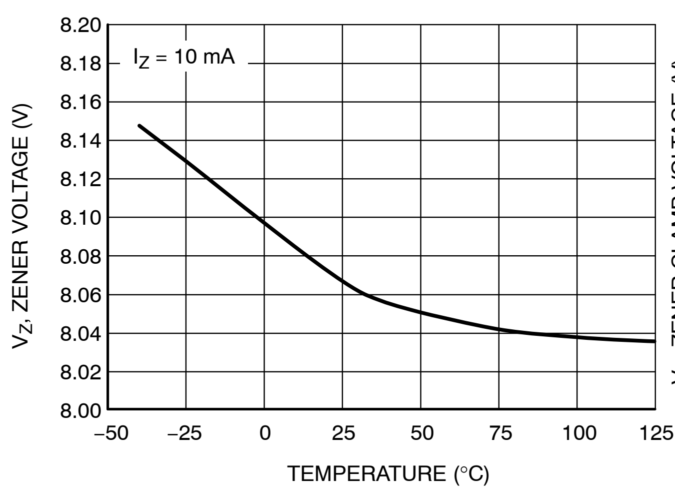


Figure 6. Zener Voltage vs. Temperature

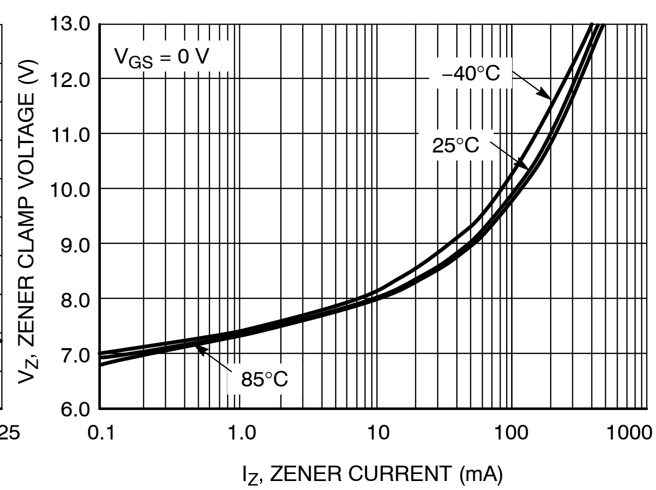


Figure 7. Zener Clamp Voltage vs. Zener Current

TYPICAL CHARACTERISTICS (continued)

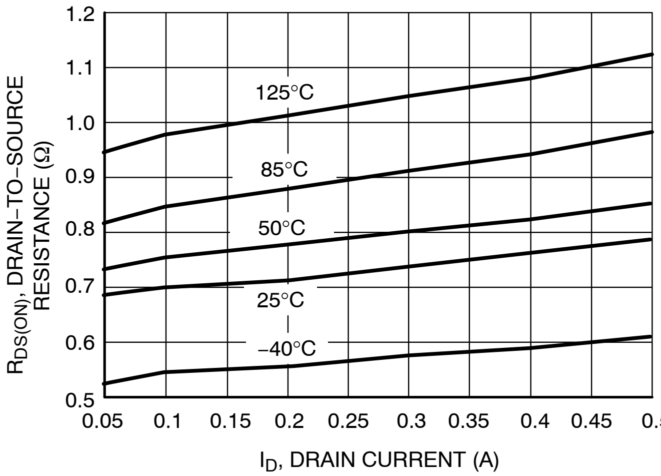


Figure 8. On−Resistance vs. Drain Current and Temperature

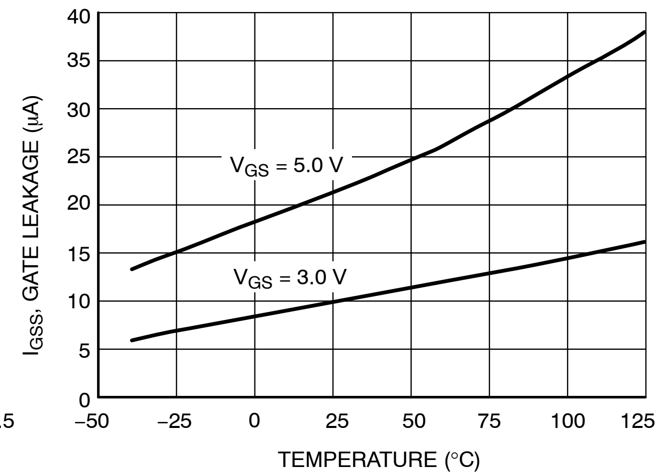


Figure 9. Gate Leakage vs. Temperature

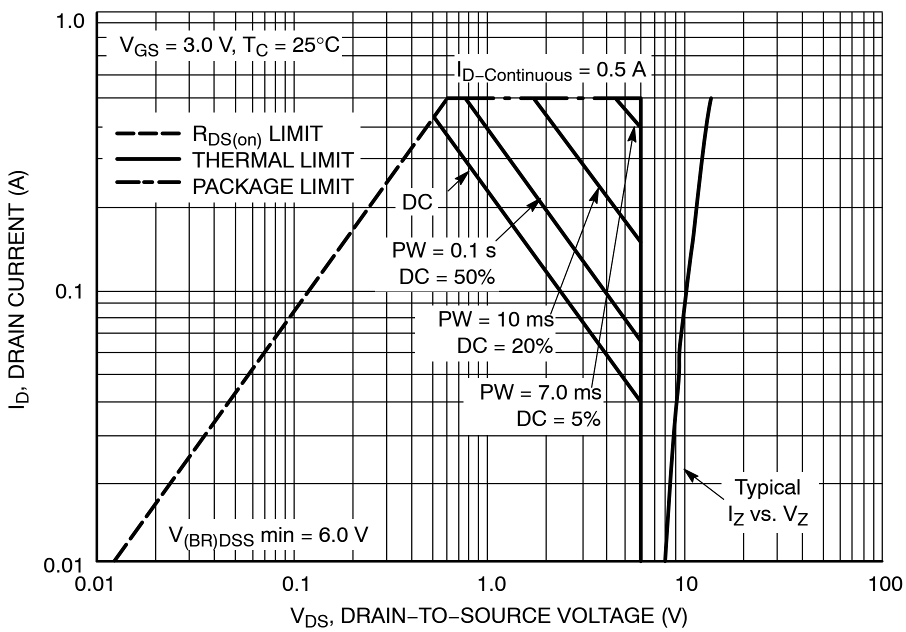


Figure 10. Safe Operating Area

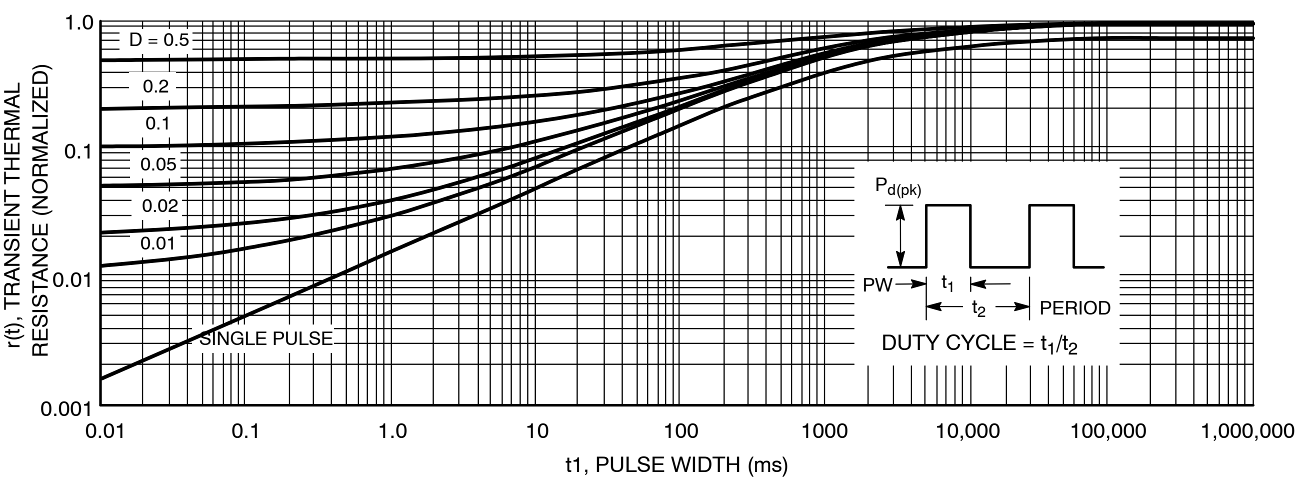


Figure 11. Transient Thermal Response

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

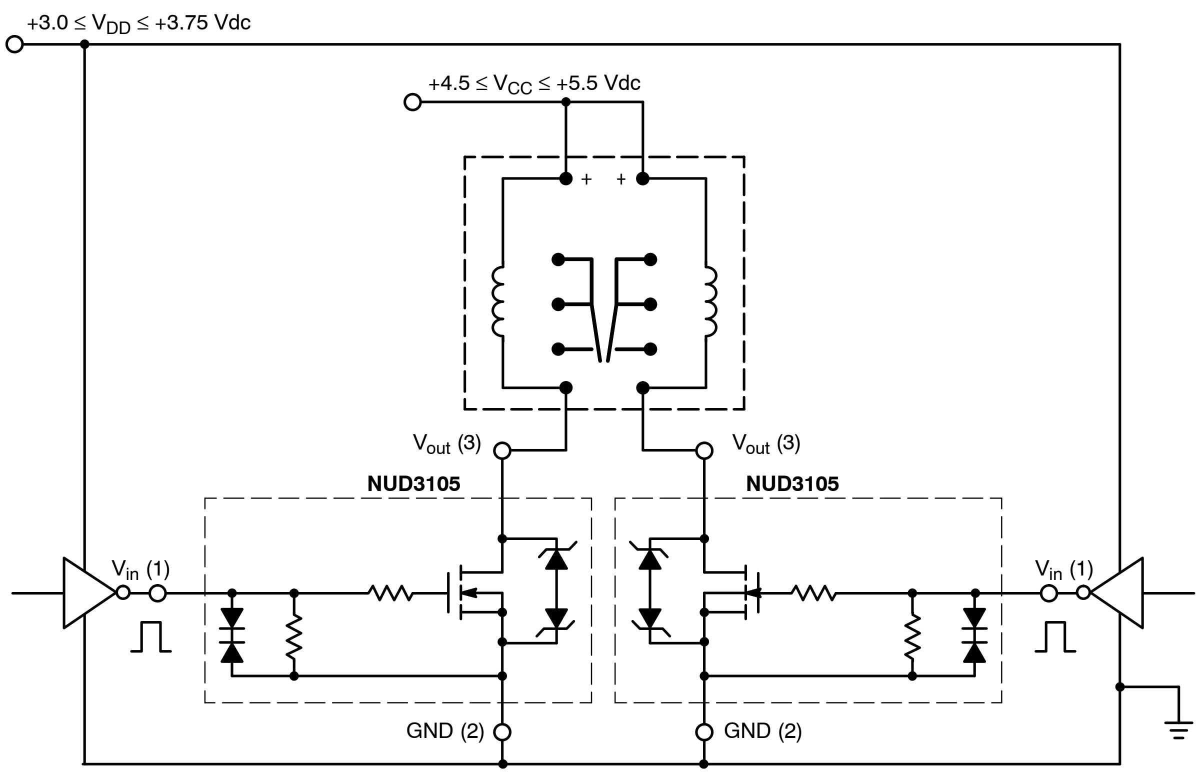


Figure 12. A 200 mW, 5.0 V Dual Coil Latching Relay Application with 3.0 V Level Translating Interface

Max Continuous Current Calculation

for TX2−5V Relay, R1 = 178 Ω Nominal @ R_A = 25°C

Assuming ±10% Make Tolerance,
R1 = 178 Ω * 0.9 = 160 Ω Min @ T_A = 25°C

T_C for Annealed Copper Wire is 0.4%/°C

R1 = 160 Ω * [1+(0.004) * (−40°−25°)] = 118 Ω Min @ −40°C

I_O Max = (5.5 V Max − 0.25V) /118 Ω = 45 mA

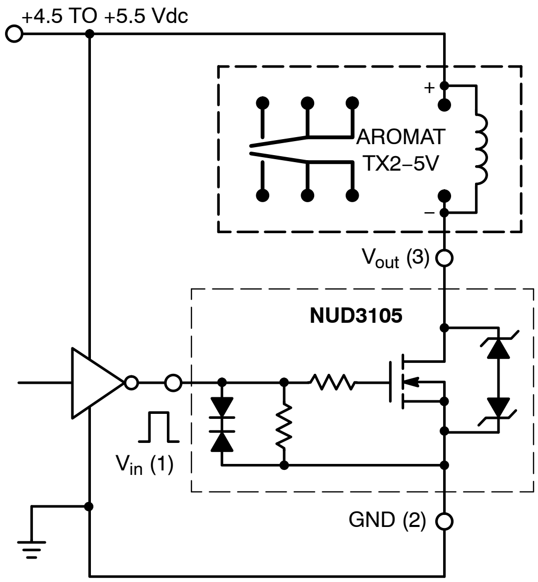


Figure 13. A 140 mW, 5.0 V Relay with TTL Interface

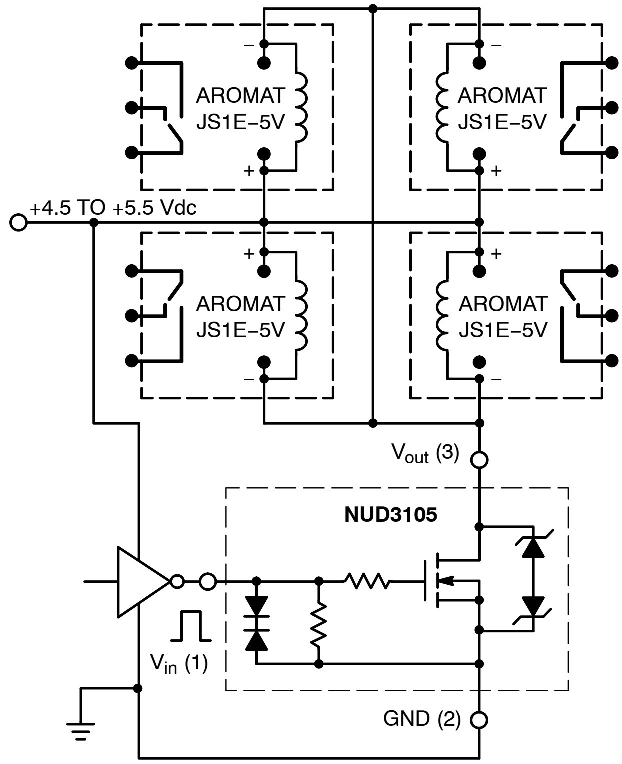
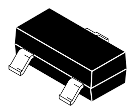


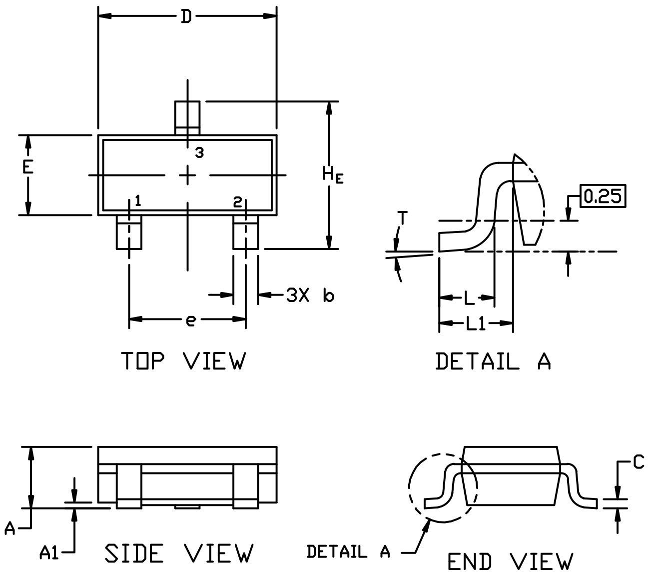
Figure 14. A Quad 5.0 V, 360 mW Coil Relay Bank



SCALE 4:1

SOT−23 (TO−236)
CASE 318
ISSUE AT

DATE 01 MAR 2023

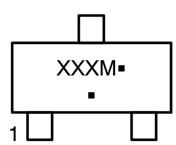


NOTES:

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.

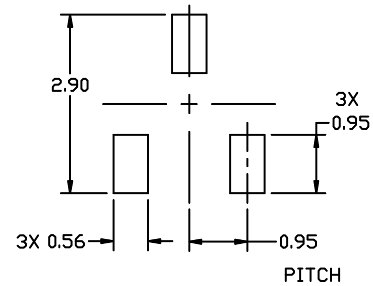
	MILLIMETERS			INCHES		
DIM	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.89	1.00	1.11	0.035	0.039	0.044
A1	0.01	0.06	0.10	0.000	0.002	0.004
b	0.37	0.44	0.50	0.015	0.017	0.020
c	0.08	0.14	0.20	0.003	0.006	0.008
D	2.80	2.90	3.04	0.110	0.114	0.120
E	1.20	1.30	1.40	0.047	0.051	0.055
e	1.78	1.90	2.04	0.070	0.075	0.080
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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DESCRIPTION:	**SOT−23 (TO−236)**	**PAGE 1 OF 2**

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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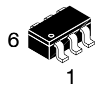
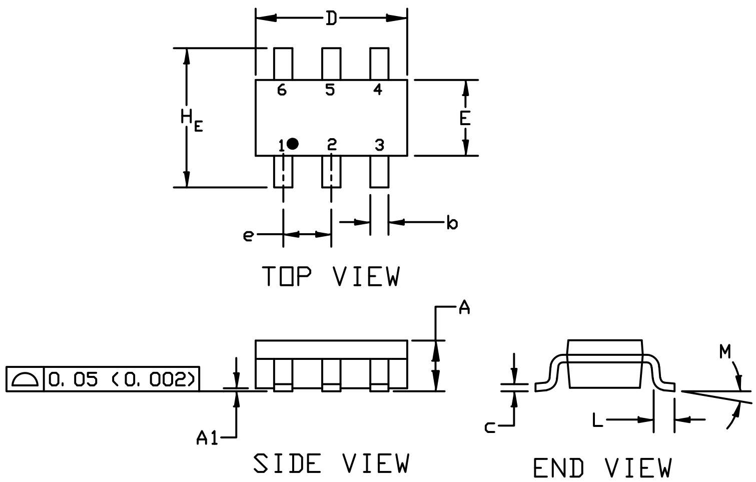
DESCRIPTION:	SOT−23 (TO−236)	PAGE 2 OF 2



SCALE 2:1

SC−74
CASE 318F
ISSUE P

DATE 07 OCT 2021



NOTES:
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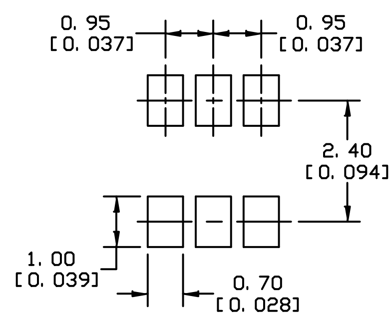
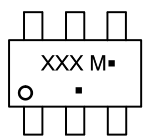
	MILLIMETERS			INCHES		
DIM	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.90	1.00	1.10	0.035	0.039	0.043
A1	0.01	0.06	0.10	0.001	0.002	0.004
b	0.25	0.37	0.50	0.010	0.015	0.020
c	0.10	0.18	0.26	0.004	0.007	0.010
D	2.90	3.00	3.10	0.114	0.118	0.122
E	1.30	1.50	1.70	0.051	0.059	0.067
e	0.85	0.95	1.05	0.034	0.037	0.041
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, SOLDERRM/D.

SOLDERING FOOTPRINT

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.

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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