NUD3105

Integrated Relay, Inductive Load Driver

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
- Pb−Free Package is Available

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

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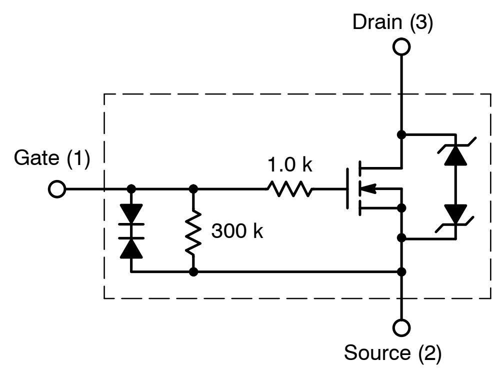
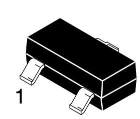
RELAY/INDUCTIVE LOAD DRIVER 0.5 AMPERE, 8.0 VOLT CLAMP

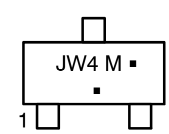
INTERNAL CIRCUIT DIAGRAM



MARKING DIAGRAM



SOT−23 (TO−236) CASE 318



JW4 = Device Code
M = 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†
NUD3105LT1	SOT−23	3000 / Tape & Reel
NUD3105LT1G	SOT−23 (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.

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

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

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

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)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain to Source Sustaining Voltage (Internally Clamped), (I_D = 10 mA)	V_{BRDSS}	6.0	8.0	9.0	V
I_g = 1.0 mA	B_{VGSO}	–	–	8.0	V
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)	I_{DSS}	– –	– –	15 15	μA
Gate Body Leakage Current (V_{GS} = 3.0 V, V_{DS} = 0 V) (V_{GS} = 5.0 V, V_{DS} = 0 V)	I_{GSS}	5.0 –	– –	19 50	μA
ON CHARACTERISTICS					
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)	$V_{GS(th)}$	0.8 0.8	1.2 –	1.4 1.4	V
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)	$R_{DS(on)}$	– – – – –	– – – – –	1.2 1.3 0.9 1.3 0.9	Ω
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)	$I_{DS(on)}$	300 200	400 –	– –	mA
Forward Transconductance (V_{OUT} = 5.0 V, I_{OUT} = 0.25 A)	g_{FS}	350	570	–	mmhos

ELECTRICAL CHARACTERISTICS (T_J = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 5.0 V, V_{GS} = 0 V, f = 10 kHz)	C_{iss}	–	25	–	pF
Output Capacitance (V_{DS} = 5.0 V, V_{GS} = 0 V, f = 10 kHz)	C_{oss}	–	37	–	pF
Transfer Capacitance (V_{DS} = 5.0 V, V_{GS} = 0 V, f = 10 kHz)	C_{rss}	–	8.0	–	pF

SWITCHING CHARACTERISTICS

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

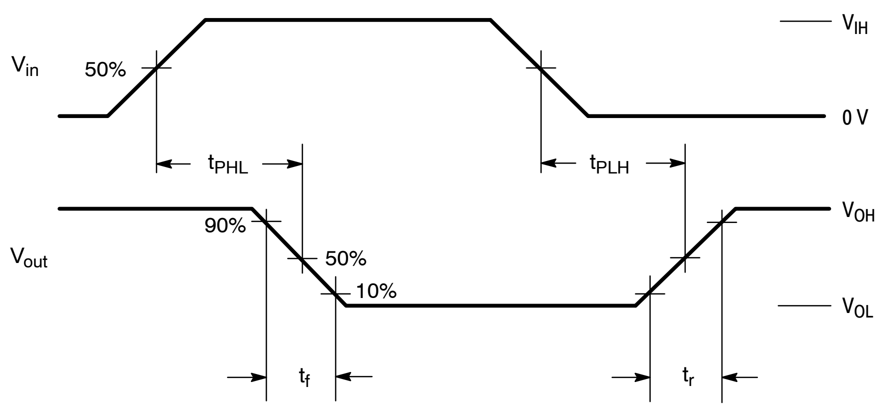


Figure 1. Switching Waveforms

TYPICAL CHARACTERISTICS

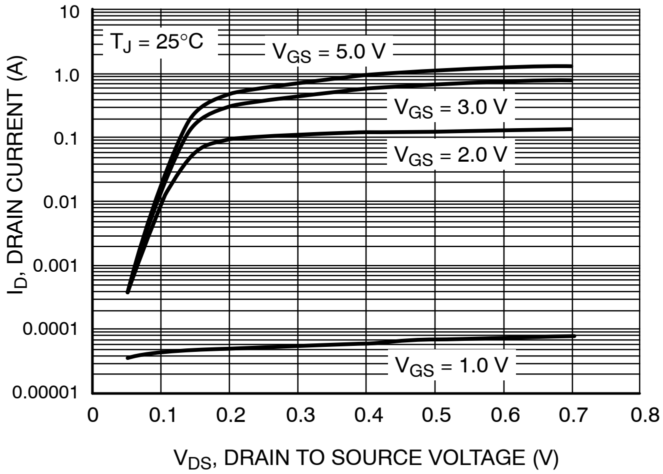


Figure 2. Output Characteristics

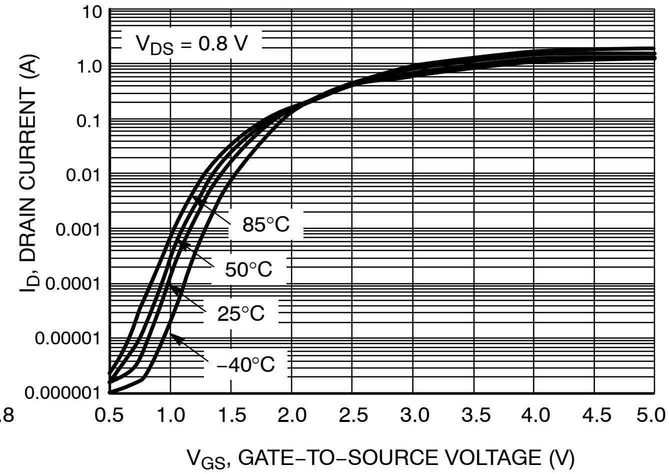


Figure 3. Transfer Function

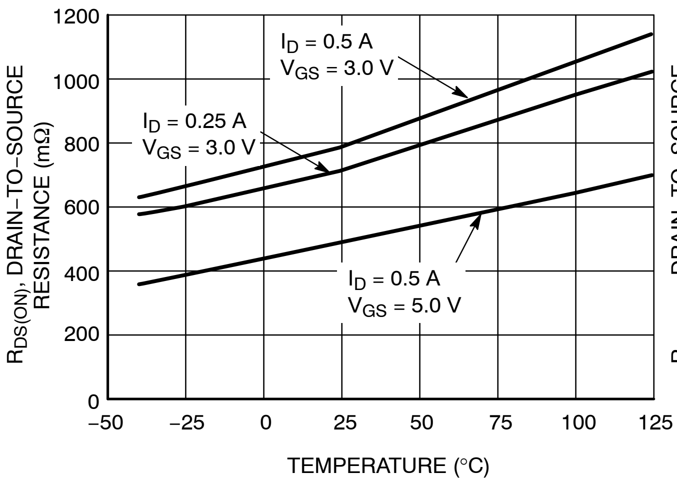


Figure 4. On Resistance Variation vs. Temperature

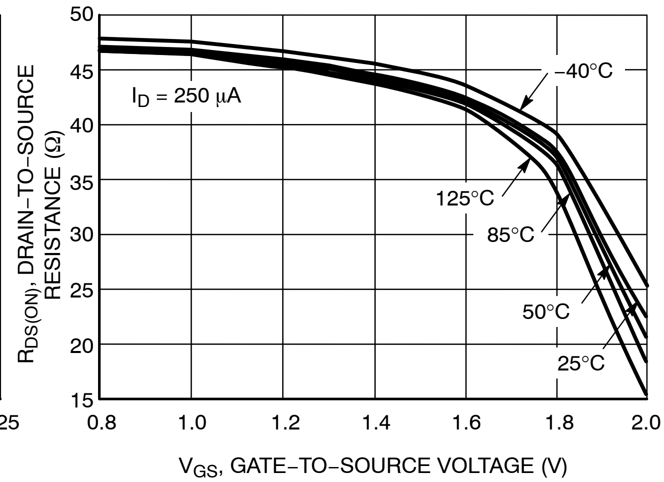


Figure 5. $R_{DS(ON)}$ Variation with Gate−To−Source Voltage

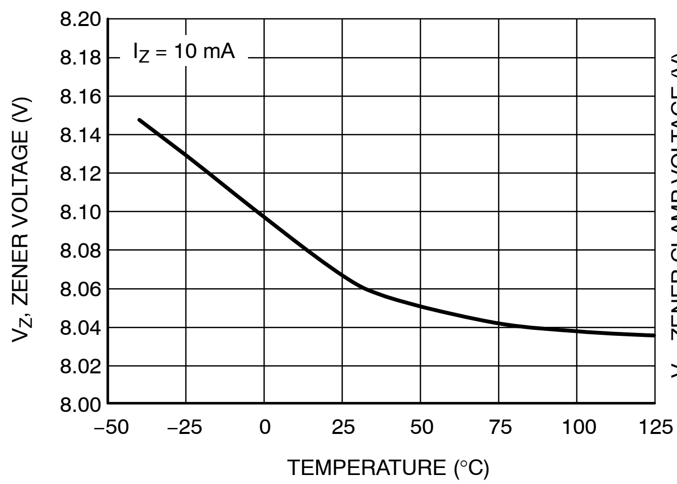


Figure 6. Zener Voltage vs. Temperature

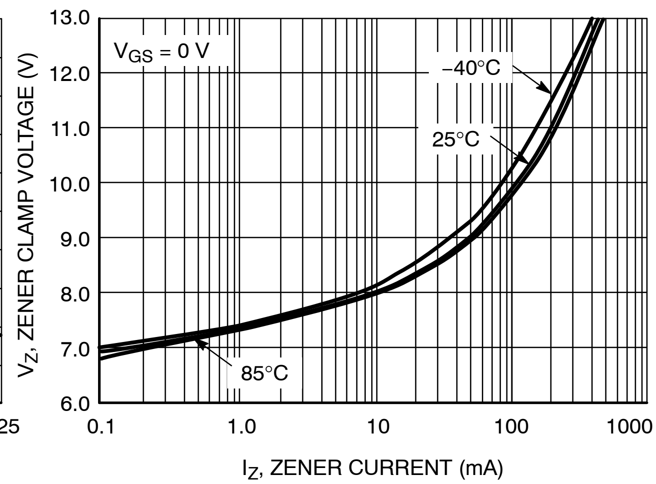


Figure 7. Zener Clamp Voltage vs. Zener Current

TYPICAL CHARACTERISTICS

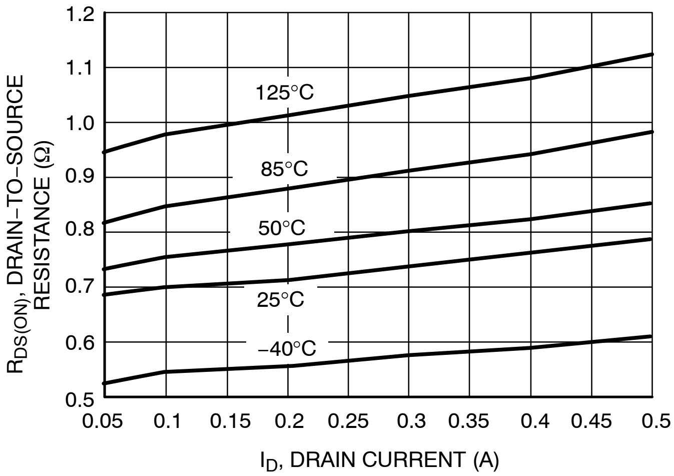


Figure 8. On−Resistance vs. Drain Current and Temperature

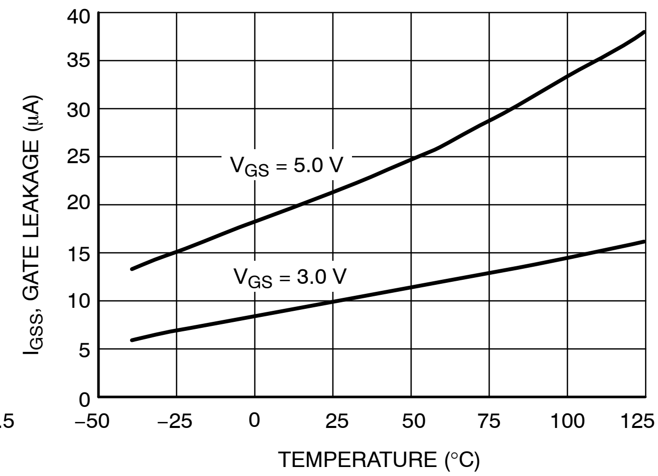


Figure 9. Gate Leakage vs. Temperature

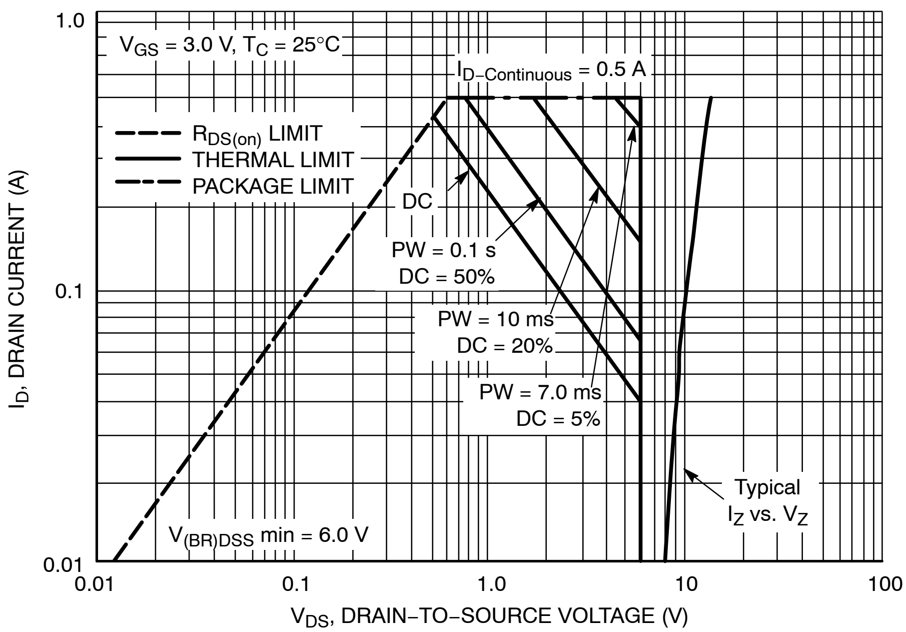


Figure 10. Safe Operating Area

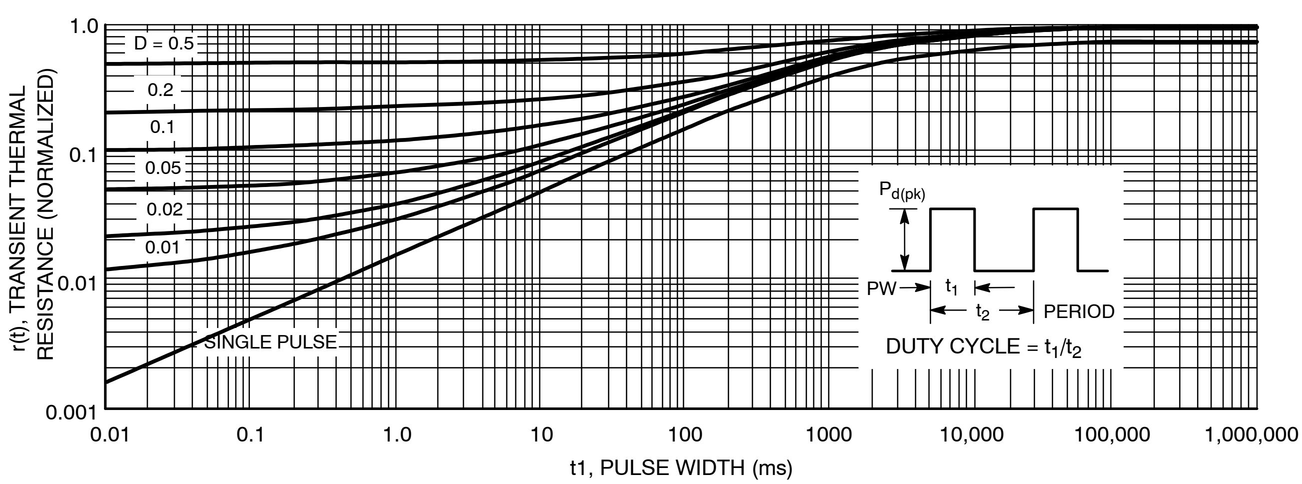


Figure 11. Transient Thermal Response

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

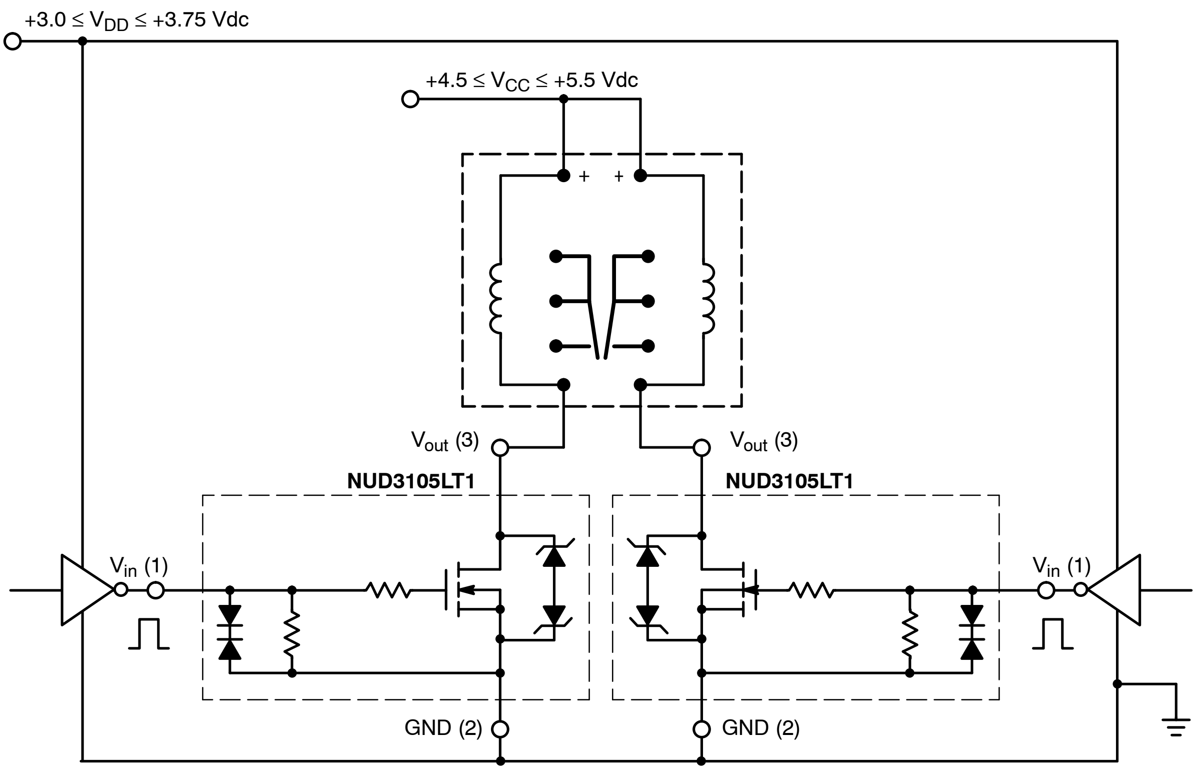


Figure 12. A 200 mW, 5.0 V Dual Coil Latching Relay Application with 3.0 V Level Translating Interface

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

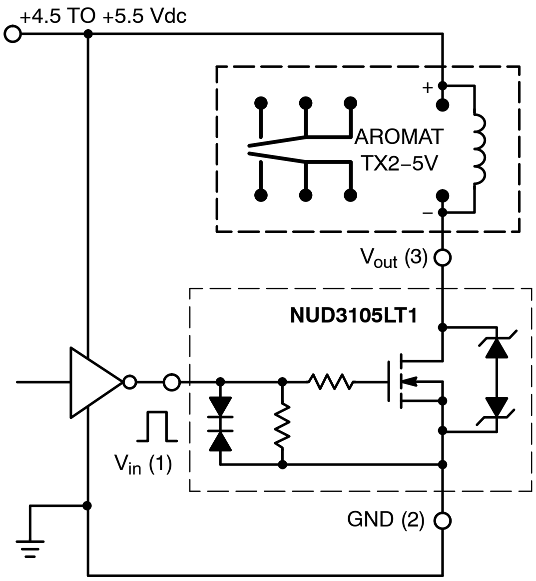


Figure 13. A 140 mW, 5.0 V Relay with TTL Interface

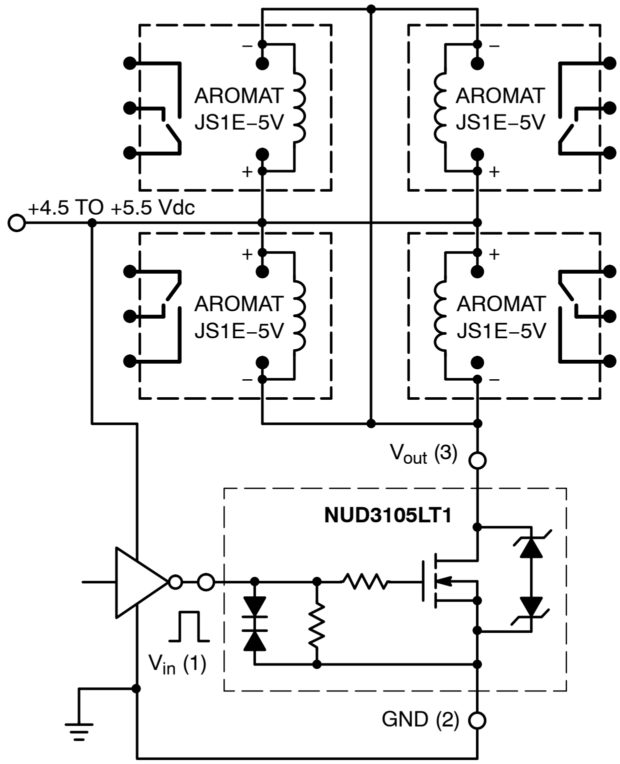
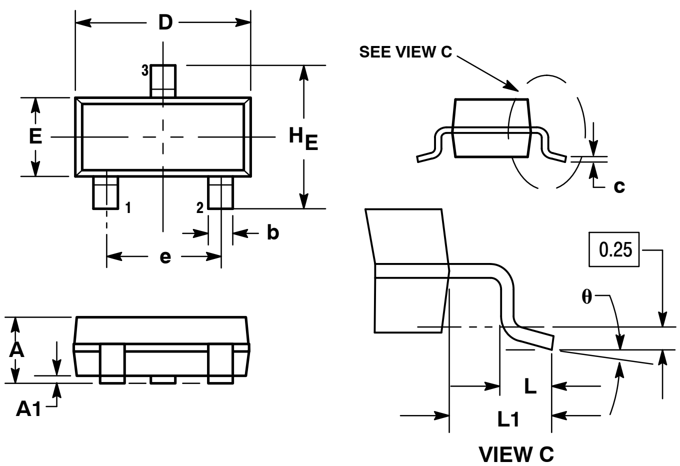


Figure 14. A Quad 5.0 V, 360 mW Coil Relay Bank

PACKAGE DIMENSIONS

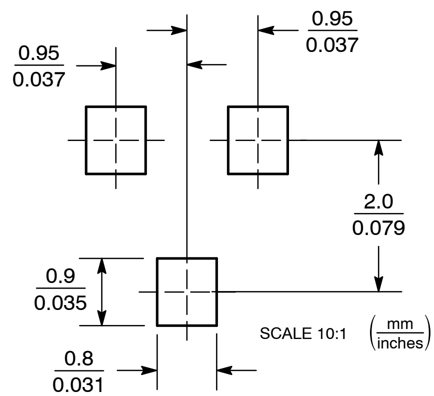
SOT−23 (TO−236)
CASE 318−08
ISSUE AN



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. 318−01 THRU −07 AND −09 OBSOLETE, NEW STANDARD 318−08.

	MILLIMETERS			INCHES		
DIM	MIN	NOM	MAX	MIN	NOM	MAX
A	0.89	1.00	1.11	0.035	0.040	0.044
A1	0.01	0.06	0.10	0.001	0.002	0.004
b	0.37	0.44	0.50	0.015	0.018	0.020
c	0.09	0.13	0.18	0.003	0.005	0.007
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	0.081
L	0.10	0.20	0.30	0.004	0.008	0.012
L1	0.35	0.54	0.69	0.014	0.021	0.029
H_E	2.10	2.40	2.64	0.083	0.094	0.104

SOLDERING 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.

PUBLICATION ORDERING INFORMATION

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