

# NUD3112

## 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 D.C. Relay Coil and Sensitive Logic Circuits
- Optimized to Switch Relays of 12 V Rail
- Capable of Driving Relay Coils Rated up to 6.0 W at 12 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 are Pb-Free Devices

### 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



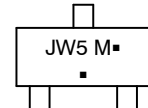
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### MARKING DIAGRAMS



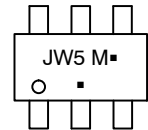
**SOT-23  
CASE 318  
STYLE 21**



JW5 = Specific Device Code  
M = Date Code  
▪ = Pb-Free Package  
(Note: Microdot may be in either location)



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



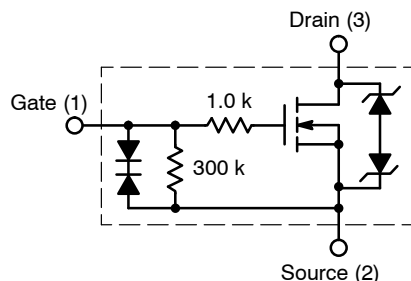
JW5 = Specific Device Code  
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(Note: Microdot may be in either location)

### ORDERING INFORMATION

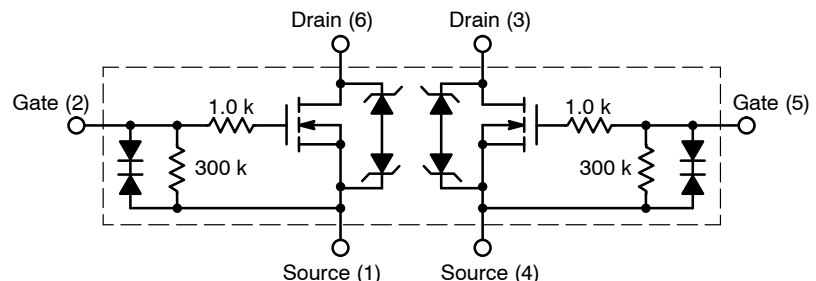
Device	Package	Shipping†
NUD3112LT1G	SOT-23 (Pb-Free)	3000 / Tape & Reel
SZNUD3112LT1G	SOT-23 (Pb-Free)	3000 / Tape & Reel
NUD3112DMT1G	SC-74 (Pb-Free)	3000 / Tape & Reel
SZNUD3112DMT1G	SC-74 (Pb-Free)	3000 / Tape & Reel

†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

# NUD3112

## MAXIMUM RATINGS (T<sub>J</sub> = 25°C unless otherwise specified)

Symbol	Rating	Value	Unit	
V <sub>DSS</sub>	Drain to Source Voltage – Continuous	14	V <sub>dc</sub>	
V <sub>GS</sub>	Gate to Source Voltage – Continuous	6	V <sub>dc</sub>	
I <sub>D</sub>	Drain Current – Continuous	500	mA	
E <sub>z</sub>	Single Pulse Drain-to-Source Avalanche Energy (T <sub>Jinitial</sub> = 25°C)	50	mJ	
T <sub>J</sub>	Junction Temperature	150	°C	
T <sub>A</sub>	Operating Ambient Temperature	-40 to 85	°C	
T <sub>stg</sub>	Storage Temperature Range	-65 to +150	°C	
P <sub>D</sub>	Total Power Dissipation (Note 1) Derating Above 25°C	SOT-23	225	mW
			1.8	mW/°C
P <sub>D</sub>	Total Power Dissipation (Note 1) Derating Above 25°C	SC-74	380	mW
			3.0	mW/°C
R <sub>θJA</sub>	Thermal Resistance Junction-to-Ambient (Note 1)	SOT-23	556	°C/W
		SC-74	329	
ESD	Human Body Model (HBM) According to EIA/JESD22/A114	2000	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. Mounted onto minimum pad board.

## TYPICAL ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = 25°C unless otherwise noted)

Symbol	Characteristic	Min	Typ	Max	Unit
--------	----------------	-----	-----	-----	------

### OFF CHARACTERISTICS

V <sub>BRDSS</sub>	Drain to Source Sustaining Voltage (Internally Clamped) (I <sub>D</sub> = 10 mA)	14	16	17	V
B <sub>VGSO</sub>	I <sub>g</sub> = 1.0 mA	-	-	8	V
I <sub>DSS</sub>	Drain to Source Leakage Current (V <sub>DS</sub> = 12 V, V <sub>GS</sub> = 0 V, T <sub>A</sub> = 25°C) (V <sub>DS</sub> = 12 V, V <sub>GS</sub> = 0 V, T <sub>A</sub> = 85°C)	-	-	20	μA
		-	-	40	
I <sub>GSS</sub>	Gate Body Leakage Current (V <sub>GS</sub> = 3.0 V, V <sub>DS</sub> = 0 V) (V <sub>GS</sub> = 5.0 V, V <sub>DS</sub> = 0 V)	-	-	35	μA
		-	-	65	

### ON CHARACTERISTICS

V <sub>GS(th)</sub>	Gate Threshold Voltage (V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 1.0 mA) (V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 1.0 mA, T <sub>A</sub> = 85°C)	0.8 0.8	1.2 -	1.4 1.4	V
R <sub>DS(on)</sub>	Drain to Source On-Resistance (I <sub>D</sub> = 250 mA, V <sub>GS</sub> = 3.0 V) (I <sub>D</sub> = 500 mA, V <sub>GS</sub> = 3.0 V) (I <sub>D</sub> = 500 mA, V <sub>GS</sub> = 5.0 V) (I <sub>D</sub> = 500 mA, V <sub>GS</sub> = 3.0 V, T <sub>A</sub> = 85°C) (I <sub>D</sub> = 500 mA, V <sub>GS</sub> = 5.0 V, T <sub>A</sub> = 85°C)	-	-	1.2	Ω
		-	-	1.3	
		-	-	0.9	
		-	-	1.3	
		-	-	0.9	
I <sub>DS(on)</sub>	Output Continuous Current (V <sub>DS</sub> = 0.25 V, V <sub>GS</sub> = 3.0 V) (V <sub>DS</sub> = 0.25 V, V <sub>GS</sub> = 3.0 V, T <sub>A</sub> = 85°C)	300	400	-	mA
		200	-	-	
g <sub>FS</sub>	Forward Transconductance (V <sub>OUT</sub> = 12.0 V, I <sub>OUT</sub> = 0.25 A)	350	490	-	mmhos

# NUD3112

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

Symbol	Characteristic	Min	Typ	Max	Unit
<b>DYNAMIC CHARACTERISTICS</b>					
$C_{iss}$	Input Capacitance ( $V_{DS} = 12\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 10\text{ kHz}$ )	-	23	-	pF
$C_{oss}$	Output Capacitance ( $V_{DS} = 12\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 10\text{ kHz}$ )	-	30	-	pF
$C_{rss}$	Transfer Capacitance ( $V_{DS} = 12.0\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 10\text{ kHz}$ )	-	7	-	pF

## SWITCHING CHARACTERISTICS

Symbol	Characteristic	Min	Typ	Max	Units
$t_{PHL}$ $t_{PLH}$	Propagation Delay Times: High to Low Propagation Delay; Figure 1 ( $V_{DS} = 12\text{ V}$ , $V_{GS} = 5.0\text{ V}$ ) Low to High Propagation Delay; Figure 1 ( $V_{DS} = 12\text{ V}$ , $V_{GS} = 5.0\text{ V}$ )	- -	21 91	- -	nS
$t_f$ $t_r$	Transition Times: Fall Time; Figure 1 ( $V_{DS} = 12\text{ V}$ , $V_{GS} = 5.0\text{ V}$ ) Rise Time; Figure 1 ( $V_{DS} = 12\text{ V}$ , $V_{GS} = 5.0\text{ V}$ )	- -	36 61	- -	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.

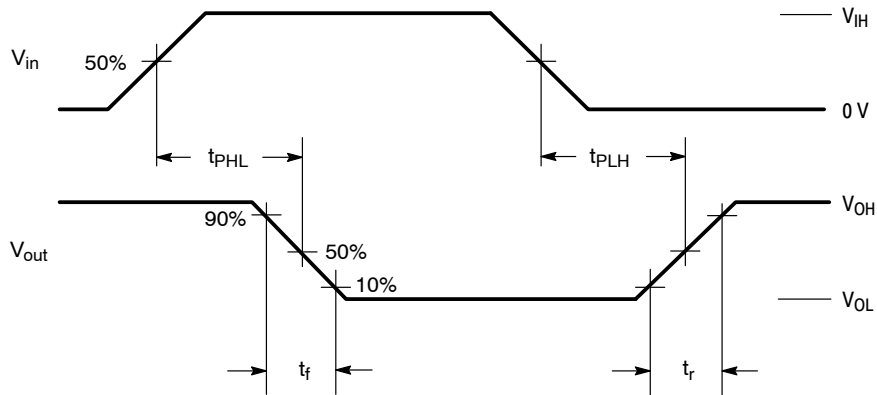


Figure 1. Switching Waveforms

# NUD3112

TYPICAL PERFORMANCE CURVES ( $T_J = 25^\circ\text{C}$  unless otherwise specified)

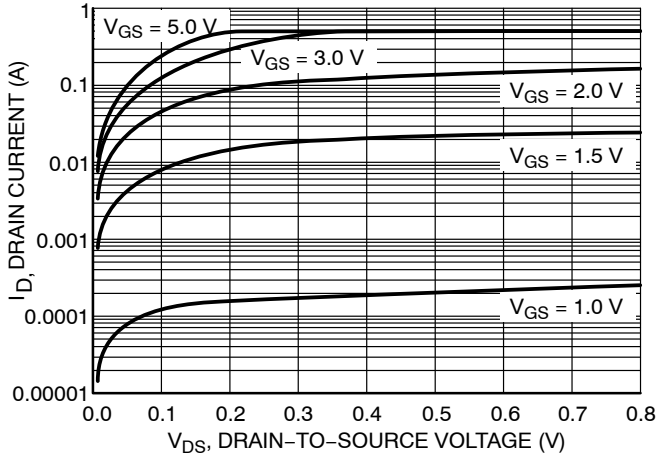


Figure 2. Output Characteristics

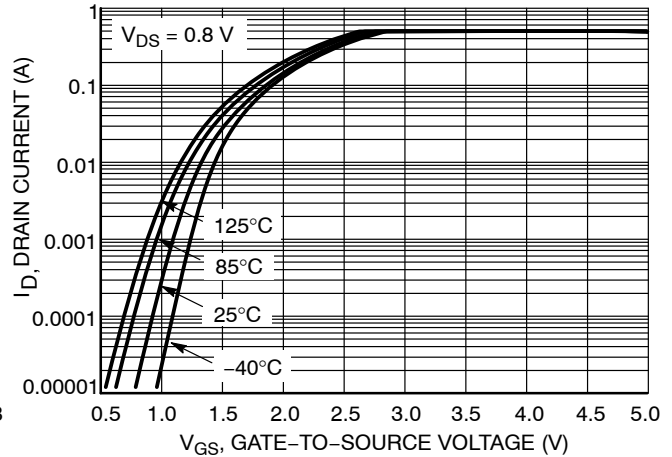


Figure 3. Transfer Function

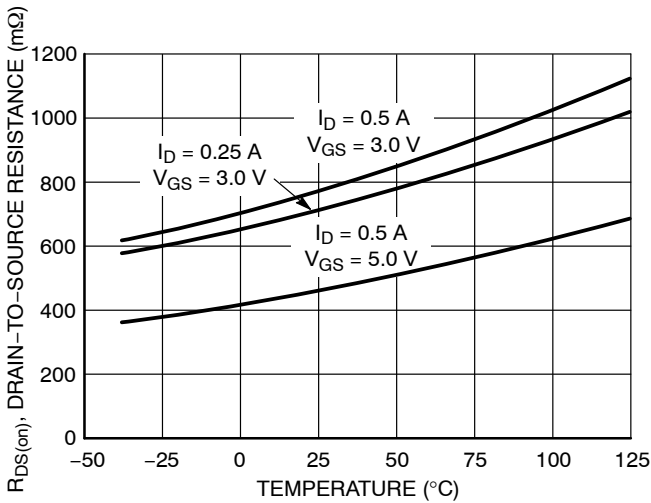


Figure 4. On-Resistance Variation vs. Temperature

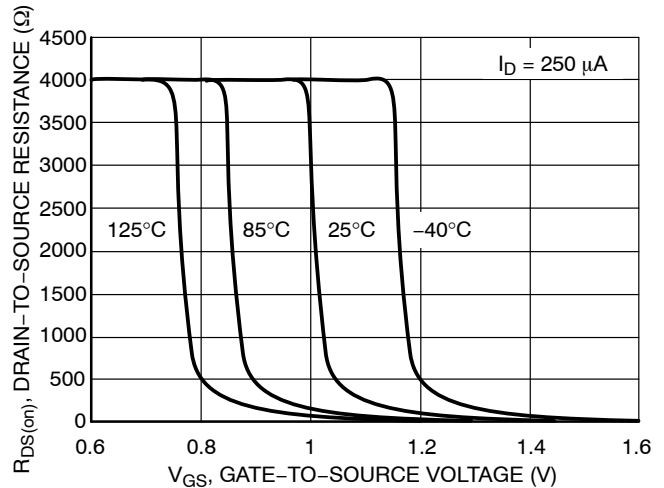


Figure 5.  $R_{DS(ON)}$  Variation vs. Gate-to-Source Voltage

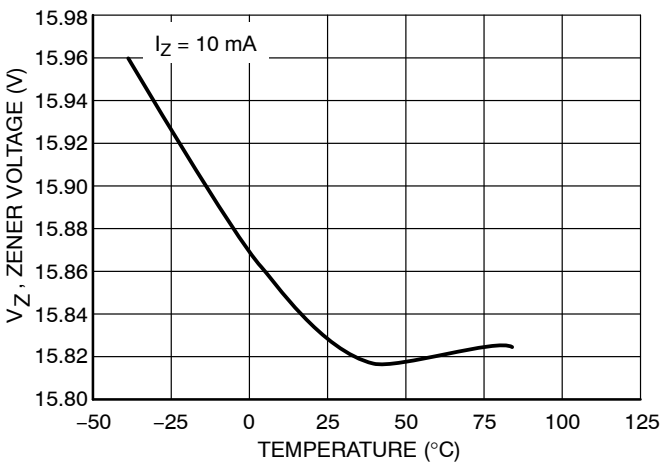


Figure 6. Zener Voltage vs. Temperature

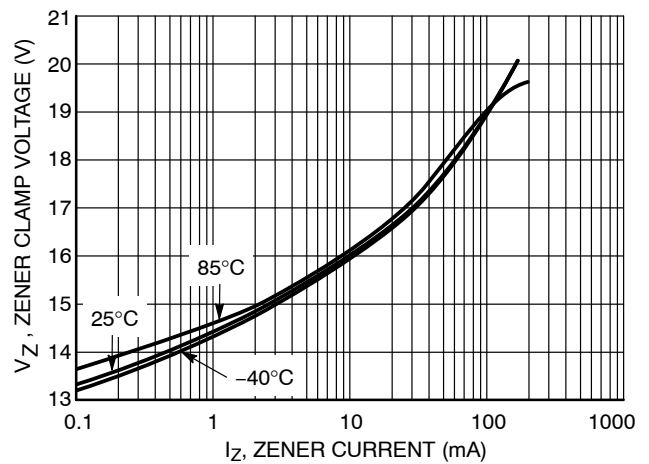


Figure 7. Zener Clamp Voltage vs. Zener Current

# NUD3112

## TYPICAL PERFORMANCE CURVES ( $T_J = 25^\circ\text{C}$ unless otherwise specified)

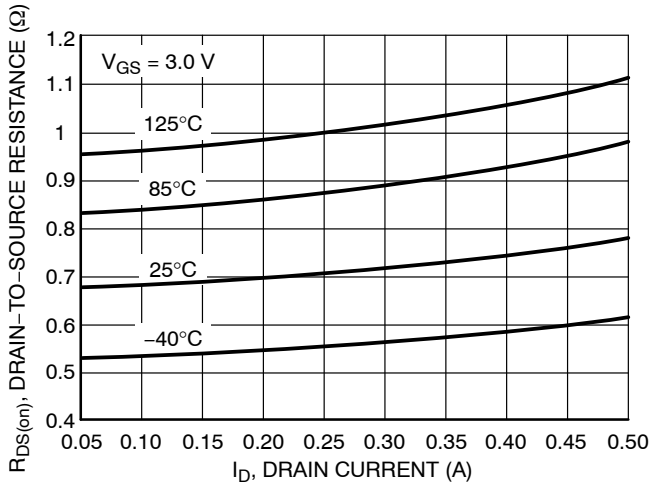


Figure 8. On-Resistance vs. Drain Current and Temperature

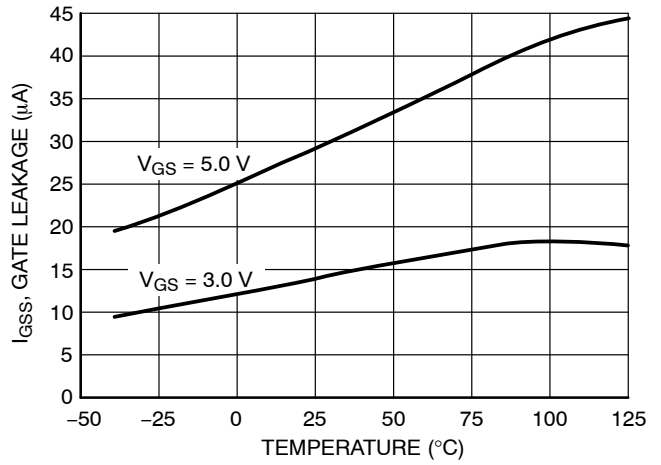


Figure 9. Gate Leakage vs. Temperature

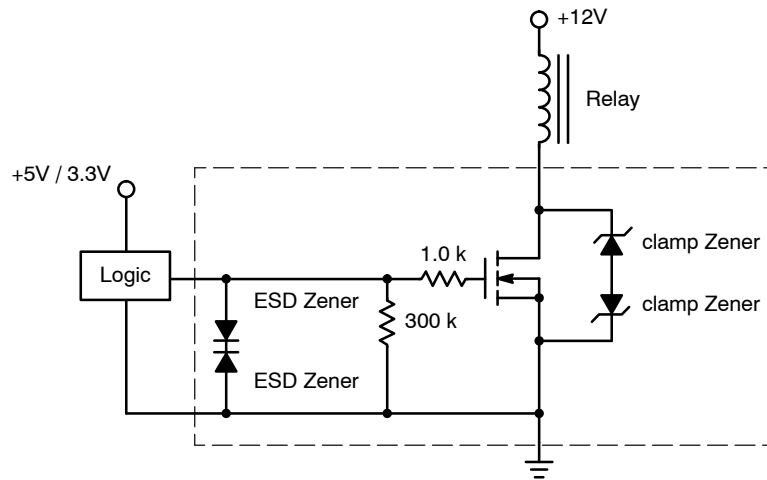


Figure 10. Typical Application Circuit

# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

ON Semiconductor®



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

DATE 30 JAN 2018

SCALE 4:1



**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°

**RECOMMENDED SOLDERING FOOTPRINT**



**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.

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

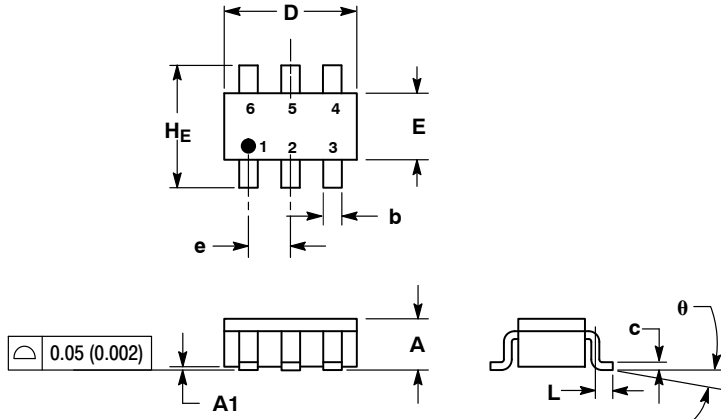
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### SC-74 CASE 318F-05 ISSUE N

DATE 08 JUN 2012

SCALE 2:1

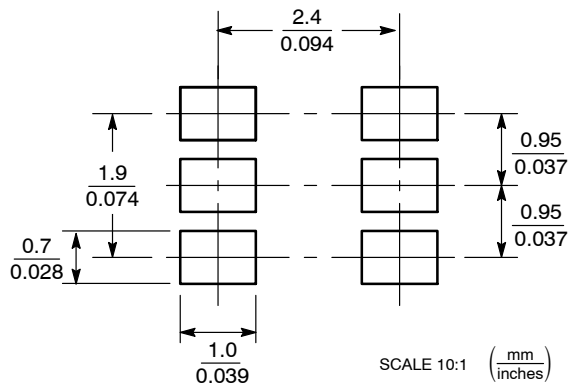


**NOTES:**

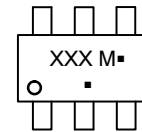
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. 318F-01, -02, -03, -04 OBSOLETE. NEW STANDARD 318F-05.

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
L	0.20	0.40	0.60	0.008	0.016	0.024
HE	2.50	2.75	3.00	0.099	0.108	0.118
θ	0°	-	10°	0°	-	10°

**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.

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

- |  |   |  |   |  |  |
|--|---|--|---|--|--|
| <p><b>STYLE 1:</b><br/>PIN 1. CATHODE<br/>2. ANODE<br/>3. CATHODE<br/>4. CATHODE<br/>5. ANODE<br/>6. CATHODE</p>     | <p><b>STYLE 2:</b><br/>PIN 1. NO CONNECTION<br/>2. COLLECTOR<br/>3. EMITTER<br/>4. NO CONNECTION<br/>5. COLLECTOR<br/>6. BASE</p> | <p><b>STYLE 3:</b><br/>PIN 1. EMITTER 1<br/>2. BASE 1<br/>3. COLLECTOR 2<br/>4. EMITTER 2<br/>5. BASE 2<br/>6. COLLECTOR 1</p> | <p><b>STYLE 4:</b><br/>PIN 1. COLLECTOR 2<br/>2. EMITTER 1/EMITTER 2<br/>3. COLLECTOR 1<br/>4. EMITTER 3<br/>5. BASE 1/BASE 2/COLLECTOR 3<br/>6. BASE 3</p> | <p><b>STYLE 5:</b><br/>PIN 1. CHANNEL 1<br/>2. ANODE<br/>3. CHANNEL 2<br/>4. CHANNEL 3<br/>5. CATHODE<br/>6. CHANNEL 4</p> | <p><b>STYLE 6:</b><br/>PIN 1. CATHODE<br/>2. ANODE<br/>3. CATHODE<br/>4. CATHODE<br/>5. CATHODE<br/>6. CATHODE</p> |
| <p><b>STYLE 7:</b><br/>PIN 1. SOURCE 1<br/>2. GATE 1<br/>3. DRAIN 2<br/>4. SOURCE 2<br/>5. GATE 2<br/>6. DRAIN 1</p> | <p><b>STYLE 8:</b><br/>PIN 1. EMITTER 1<br/>2. BASE 2<br/>3. COLLECTOR 2<br/>4. EMITTER 2<br/>5. BASE 1<br/>6. COLLECTOR 1</p>    | <p><b>STYLE 9:</b><br/>PIN 1. EMITTER 2<br/>2. BASE 2<br/>3. COLLECTOR 1<br/>4. EMITTER 1<br/>5. BASE 1<br/>6. COLLECTOR 2</p> | <p><b>STYLE 10:</b><br/>PIN 1. ANODE/CATHODE<br/>2. BASE<br/>3. EMITTER<br/>4. COLLECTOR<br/>5. ANODE<br/>6. CATHODE</p>                                    | <p><b>STYLE 11:</b><br/>PIN 1. EMITTER<br/>2. BASE<br/>3. ANODE/CATHODE<br/>4. ANODE<br/>5. CATHODE<br/>6. COLLECTOR</p>   |  |

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