

# 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



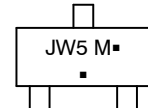
**ON Semiconductor®**

[www.onsemi.com](http://www.onsemi.com)

### MARKING DIAGRAMS



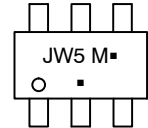
**SOT-23  
CASE 318  
STYLE 21**



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



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



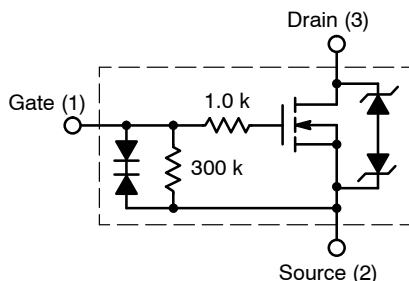
JW5 = Specific Device Code  
M = Date Code  
▪ = Pb-Free Package  
(Note: Microdot may be in either location)

### ORDERING INFORMATION

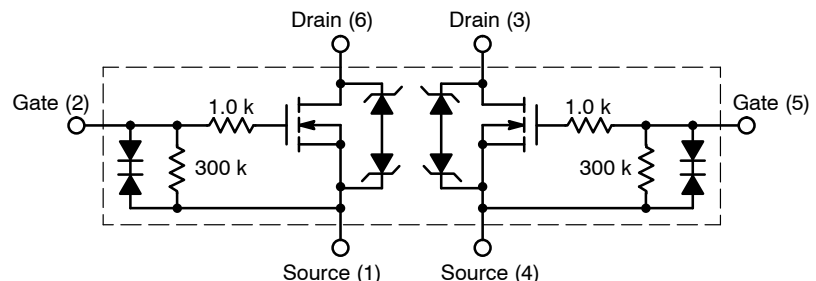
| Device         | Package          | Shipping†          |
|----------------|------------------|--------------------|
| NUD3112LT1G    | SOT-23 (Pb-Free) | 3000 / Tape & Reel |
| SZNUD3112LT1G  | SOT-23 (Pb-Free) | 3000 / Tape & Reel |
| NUD3112DMT1G   | SC-74 (Pb-Free)  | 3000 / Tape & Reel |
| SZNUD3112DMT1G | 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)<br>Derating Above 25°C                      | SOT-23      | 225             | mW    |
|                  |  |             | 1.8             | mW/°C |
| P <sub>D</sub>   | Total Power Dissipation (Note 1)<br>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)<br>(I <sub>D</sub> = 10 mA)   | 14 | 16 | 17 | V  |
| B <sub>VGS0</sub>  | I <sub>g</sub> = 1.0 mA   | -  | -  | 8  | V  |
| I <sub>DSS</sub>   | Drain to Source Leakage Current<br>(V <sub>DS</sub> = 12 V, V <sub>GS</sub> = 0 V, T <sub>A</sub> = 25°C)<br>(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<br>(V <sub>GS</sub> = 3.0 V, V <sub>DS</sub> = 0 V)<br>(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<br>(V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 1.0 mA)<br>(V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 1.0 mA, T <sub>A</sub> = 85°C)   | 0.8<br>0.8 | 1.2<br>- | 1.4<br>1.4 | V     |
| R <sub>DS(on)</sub> | Drain to Source On-Resistance<br>(I <sub>D</sub> = 250 mA, V <sub>GS</sub> = 3.0 V)<br>(I <sub>D</sub> = 500 mA, V <sub>GS</sub> = 3.0 V)<br>(I <sub>D</sub> = 500 mA, V <sub>GS</sub> = 5.0 V)<br>(I <sub>D</sub> = 500 mA, V <sub>GS</sub> = 3.0 V, T <sub>A</sub> = 85°C)<br>(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<br>(V <sub>DS</sub> = 0.25 V, V <sub>GS</sub> = 3.0 V)<br>(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<br>(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<br>( $V_{DS} = 12\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 10\text{ kHz}$ )      | -   | 23  | -   | pF   |
| $C_{oss}$                      | Output Capacitance<br>( $V_{DS} = 12\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 10\text{ kHz}$ )     | -   | 30  | -   | pF   |
| $C_{rss}$                      | Transfer Capacitance<br>( $V_{DS} = 12.0\text{ V}$ , $V_{GS} = 0\text{ V}$ , $f = 10\text{ kHz}$ ) | -   | 7   | -   | pF   |

## SWITCHING CHARACTERISTICS

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

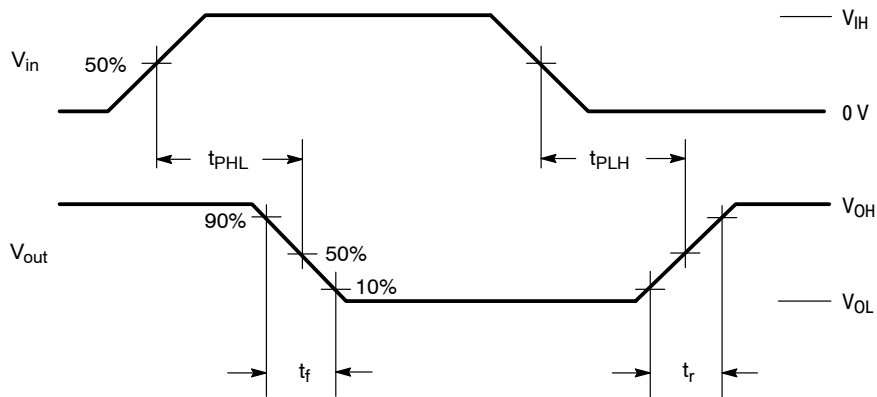


Figure 1. Switching Waveforms

# NUD3112

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

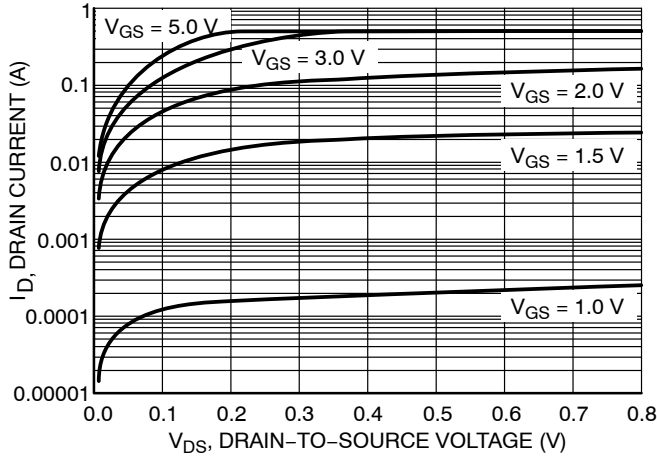


Figure 2. Output Characteristics

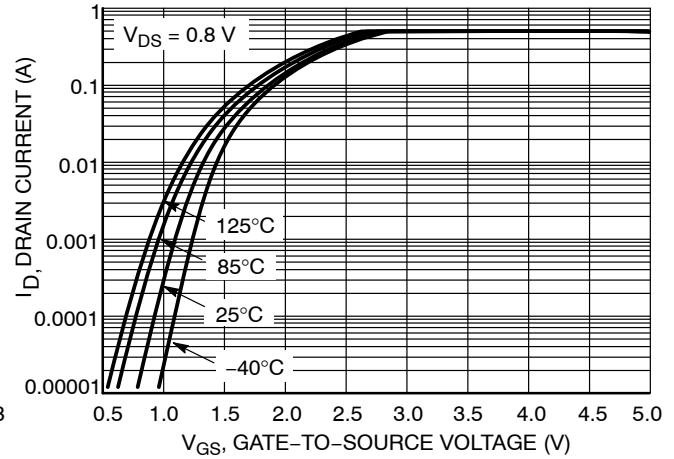


Figure 3. Transfer Function

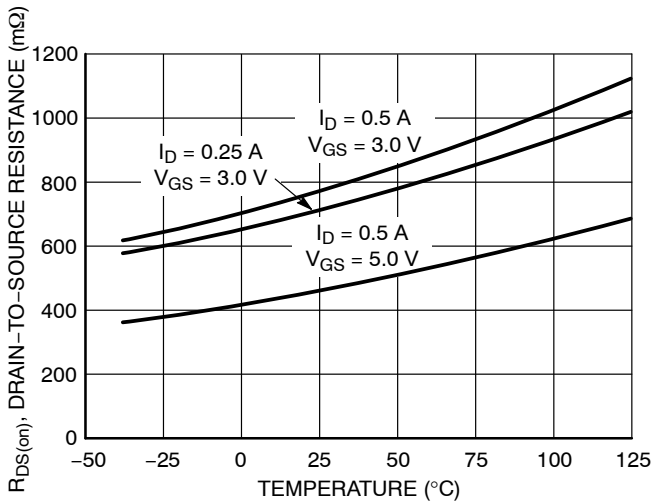


Figure 4. On-Resistance Variation vs. Temperature

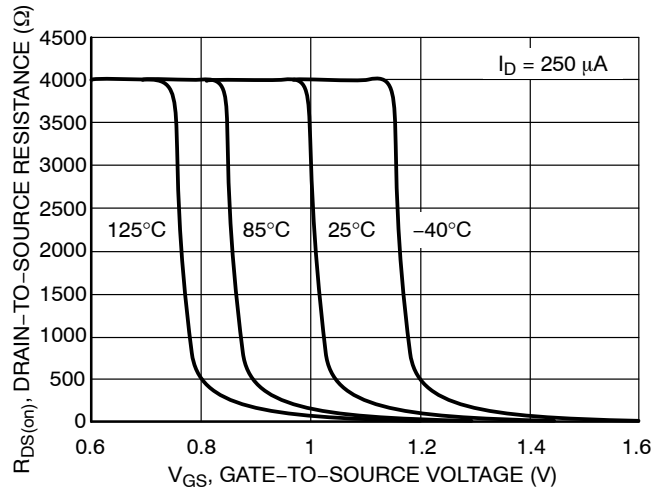


Figure 5.  $R_{DS(ON)}$  Variation vs. Gate-to-Source Voltage

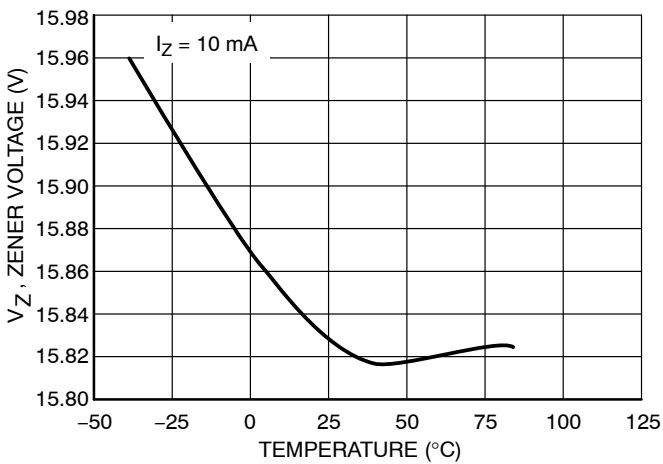


Figure 6. Zener Voltage vs. Temperature

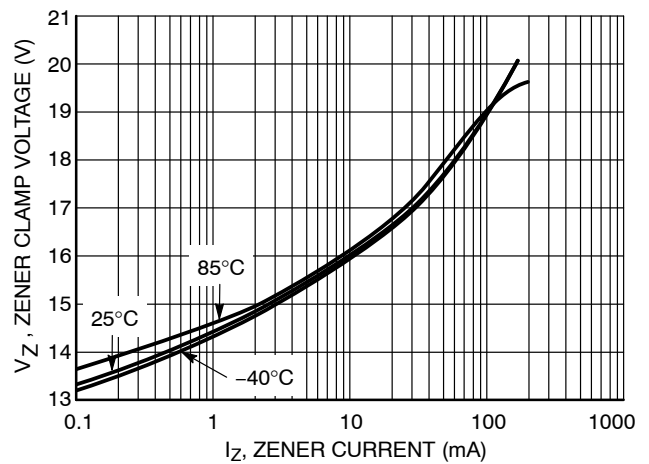
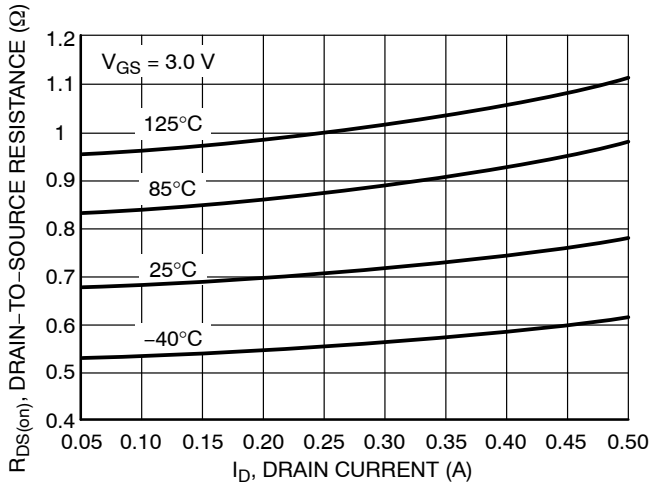


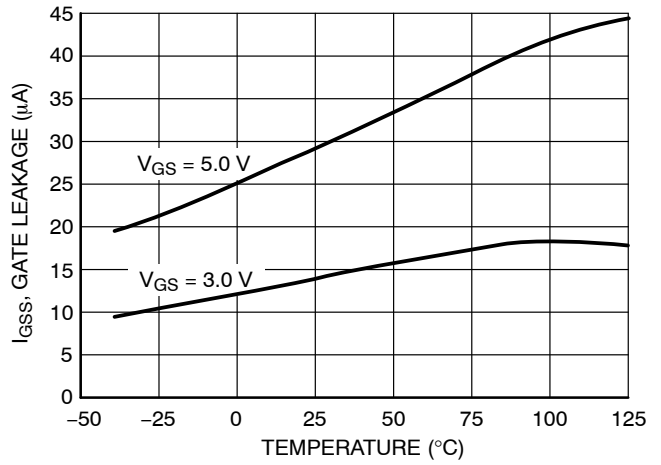
Figure 7. Zener Clamp Voltage vs. Zener Current

# NUD3112

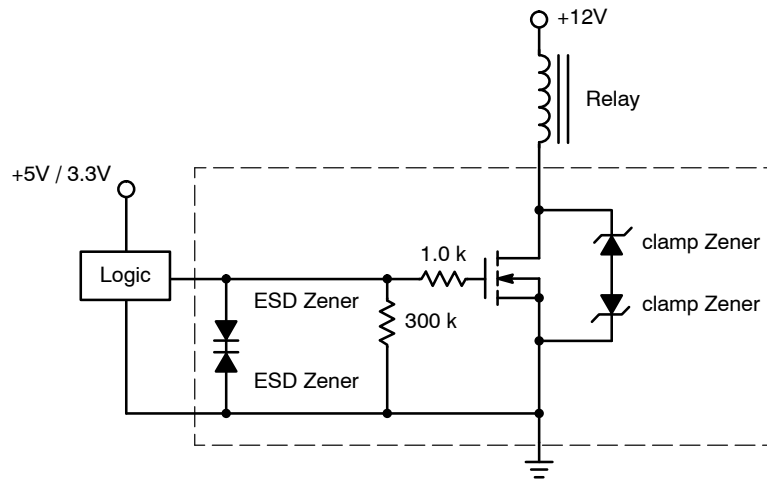
## TYPICAL PERFORMANCE CURVES ( $T_J = 25^\circ\text{C}$ unless otherwise specified)



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



**Figure 9. Gate Leakage vs. Temperature**

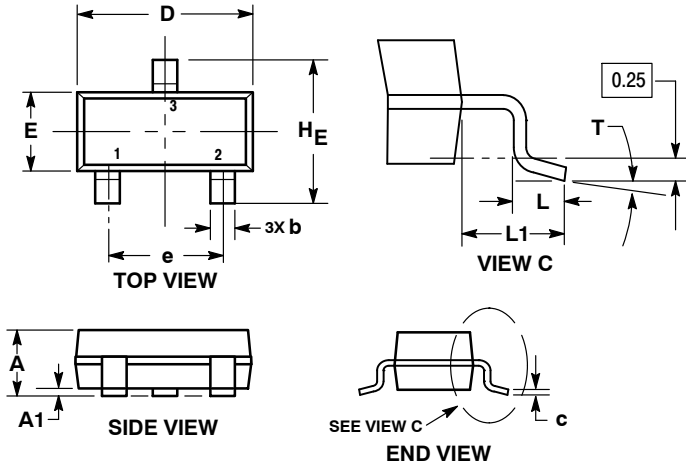


**Figure 10. Typical Application Circuit**

# NUD3112

## PACKAGE DIMENSIONS

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



### NOTES:

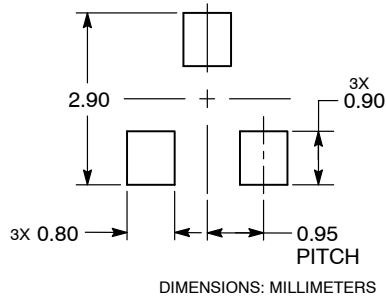
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF THE BASE MATERIAL.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

| 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°   |

### STYLE 21:

- PIN 1. GATE
- SOURCE
- DRAIN

### RECOMMENDED SOLDERING FOOTPRINT\*

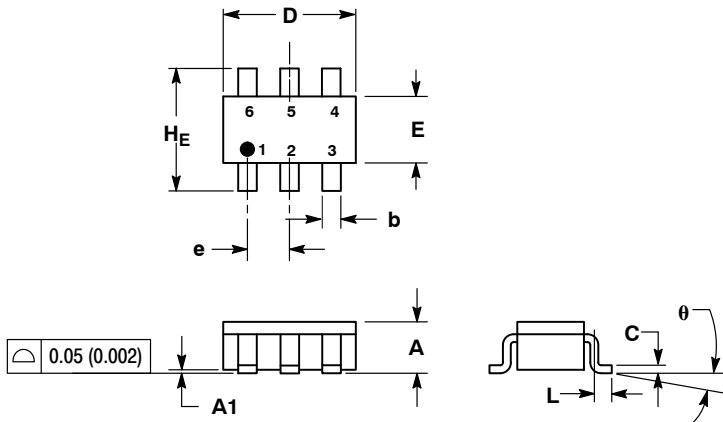


\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

# NUD3112

## PACKAGE DIMENSIONS

SC-74  
CASE 318F-05  
ISSUE N

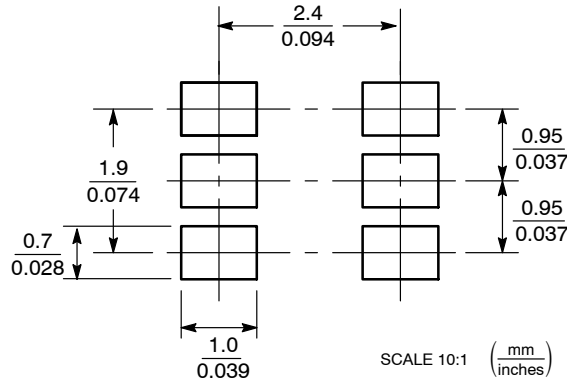


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.
  3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
  4. 318F-01, -02, -03, -04 OBSOLETE. NEW STANDARD 318F-05.

| 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°   |

- STYLE 7:  
PIN 1. SOURCE 1  
2. GATE 1  
3. DRAIN 2  
4. SOURCE 2  
5. GATE 2  
6. DRAIN 1

### 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.

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