

# NTR3161N

## Power MOSFET

20 V, 3.3 A, Single N-Channel, SOT-23

### Features

- Low  $R_{DS(on)}$
- Low Gate Charge
- Low Threshold Voltage
- Halide-Free
- This is a Pb-Free Device

### Applications

- DC-DC Conversion
- Battery Management
- Load/Power Switch

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

| Parameter                                                         |                          | Symbol         | Value                            | Unit             |
|-------------------------------------------------------------------|--------------------------|----------------|----------------------------------|------------------|
| Drain-to-Source Voltage                                           |                          | $V_{DS}$       | 20                               | V                |
| Gate-to-Source Voltage                                            |                          | $V_{GS}$       | $\pm 8$                          | V                |
| Continuous Drain Current (Note 1)                                 | $t \leq 30$ s            | $I_D$          | $T_A = 25^\circ\text{C}$<br>3.3  | A                |
|                                                                   |                          |                | $T_A = 85^\circ\text{C}$<br>2.3  |                  |
|                                                                   | $t \leq 10$ s            |                | $T_A = 25^\circ\text{C}$<br>4.0  |                  |
| Power Dissipation (Note 1)                                        | Steady State             | $P_D$          | $T_A = 25^\circ\text{C}$<br>0.82 | W                |
|                                                                   | $t \leq 10$ s            |                | 1.25                             |                  |
| Pulsed Drain Current                                              | $t_p = 10$ $\mu\text{s}$ | $I_{DM}$       | 6.4                              | A                |
| Operating Junction and Storage Temperature                        |                          | $T_J, T_{stg}$ | -55 to 150                       | $^\circ\text{C}$ |
| Source Current (Body Diode)                                       |                          | $I_S$          | 0.65                             | A                |
| Lead Temperature for Soldering Purposes (1/8" from case for 10 s) |                          | $T_L$          | 260                              | $^\circ\text{C}$ |

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.

### THERMAL RESISTANCE RATINGS

| Parameter                                   | Symbol          | Max | Unit               |
|---------------------------------------------|-----------------|-----|--------------------|
| Junction-to-Ambient – Steady State (Note 1) | $R_{\theta JA}$ | 260 | $^\circ\text{C/W}$ |
| Junction-to-Ambient – $t \leq 30$ s         | $R_{\theta JA}$ | 153 | $^\circ\text{C/W}$ |
| Junction-to-Ambient – $t < 10$ s (Note 1)   | $R_{\theta JA}$ | 100 | $^\circ\text{C/W}$ |

1. Surface-mounted on FR4 board using 1 in sq pad size (Cu area = 1.127 in sq [2 oz] including traces).

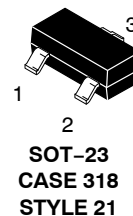
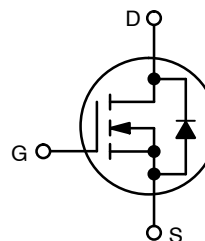


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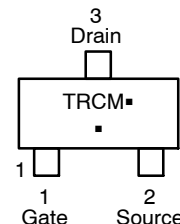
| $V_{(BR)DSS}$ | $R_{DS(on)}$ MAX      | $I_D$ MAX |
|---------------|-----------------------|-----------|
| 20 V          | 50 m $\Omega$ @ 4.5 V | 3.3 A     |
|               | 63 m $\Omega$ @ 2.5 V | 3.0 A     |
|               | 87 m $\Omega$ @ 1.8 V | 2.5 A     |

### SIMPLIFIED SCHEMATIC – N-CHANNEL



SOT-23  
CASE 318  
STYLE 21

### MARKING DIAGRAM/ PIN ASSIGNMENT



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

### ORDERING INFORMATION

| Device      | Package             | Shipping†        |
|-------------|---------------------|------------------|
| NTR3161NT1G | SOT-23<br>(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.

# NTR3161N

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

| Parameter                                                 | Symbol                                | Test Conditions                                                                                                                               | Min | Typ  | Max       | Units |
|-----------------------------------------------------------|---------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|-----|------|-----------|-------|
| <b>OFF CHARACTERISTICS</b>                                |                                       |                                                                                                                                               |     |      |           |       |
| Drain-to-Source Breakdown Voltage                         | V <sub>(BR)DSS</sub>                  | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA                                                                                                | 20  |      |           | V     |
| Drain-to-Source Breakdown Voltage Temperature Coefficient | V <sub>(BR)DSS</sub> / T <sub>J</sub> | I <sub>D</sub> = 250 μA, Reference to 25°C                                                                                                    |     | 16.2 |           | mV/°C |
| Zero Gate Voltage Drain Current                           | I <sub>DSS</sub>                      | V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 16 V, T <sub>J</sub> = 25°C<br>V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 16 V, T <sub>J</sub> = 125°C |     |      | 1.0<br>10 | μA    |
| Gate-to-Source Leakage Current                            | I <sub>GSS</sub>                      | V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ± 8 V                                                                                                |     |      | 100       | nA    |

## ON CHARACTERISTICS (Note 2)

|                                            |                                      |                                                             |     |      |     |       |
|--------------------------------------------|--------------------------------------|-------------------------------------------------------------|-----|------|-----|-------|
| Gate Threshold Voltage                     | V <sub>GS(TH)</sub>                  | V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 250 μA | 0.4 | 0.6  | 1.0 | V     |
| Negative Threshold Temperature Coefficient | V <sub>GS(TH)</sub> / T <sub>J</sub> |                                                             |     | 2.4  |     | mV/°C |
| Drain-to-Source On-Resistance              | R <sub>DS(on)</sub>                  | V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 3.3 A             |     | 38   | 50  | mΩ    |
|                                            |                                      | V <sub>GS</sub> = 2.5 V, I <sub>D</sub> = 3.0 A             |     | 44   | 63  |       |
|                                            |                                      | V <sub>GS</sub> = 1.8 V, I <sub>D</sub> = 2.5 A             |     | 52   | 87  |       |
| Forward Transconductance                   | g <sub>FS</sub>                      | V <sub>DS</sub> = 5.0 V, I <sub>D</sub> = 3.3 A             |     | 10.5 |     | S     |

## CHARGES, CAPACITANCES AND GATE RESISTANCE

|                              |                     |                                                                            |  |     |  |    |
|------------------------------|---------------------|----------------------------------------------------------------------------|--|-----|--|----|
| Input Capacitance            | C <sub>iss</sub>    | V <sub>GS</sub> = 0 V, f = 1.0 MHz,<br>V <sub>DS</sub> = 10 V              |  | 540 |  | pF |
| Output Capacitance           | C <sub>oss</sub>    |                                                                            |  | 80  |  |    |
| Reverse Transfer Capacitance | C <sub>rss</sub>    |                                                                            |  | 62  |  |    |
| Total Gate Charge            | Q <sub>G(TOT)</sub> | V <sub>GS</sub> = 4.5 V, V <sub>DS</sub> = 10 V,<br>I <sub>D</sub> = 3.3 A |  | 7.3 |  | nC |
| Threshold Gate Charge        | Q <sub>G(TH)</sub>  |                                                                            |  | 0.4 |  |    |
| Gate-to-Source Charge        | Q <sub>GS</sub>     |                                                                            |  | 0.8 |  |    |
| Gate-to-Drain Charge         | Q <sub>GD</sub>     |                                                                            |  | 1.6 |  |    |
| Gate Resistance              | R <sub>G</sub>      |                                                                            |  | 2.4 |  | Ω  |

## SWITCHING CHARACTERISTICS (Note 3)

|                     |                     |                                                                                                  |  |      |  |    |
|---------------------|---------------------|--------------------------------------------------------------------------------------------------|--|------|--|----|
| Turn-On Delay Time  | t <sub>d(on)</sub>  | V <sub>GS</sub> = 4.5 V, V <sub>DD</sub> = 10 V,<br>I <sub>D</sub> = 3.3 A, R <sub>G</sub> = 6 Ω |  | 6.7  |  | ns |
| Rise Time           | t <sub>r</sub>      |                                                                                                  |  | 11.6 |  |    |
| Turn-Off Delay Time | t <sub>d(off)</sub> |                                                                                                  |  | 18.6 |  |    |
| Fall Time           | t <sub>f</sub>      |                                                                                                  |  | 23.2 |  |    |

## DRAIN-SOURCE DIODE CHARACTERISTICS

|                         |                 |                                                                                   |  |      |     |    |
|-------------------------|-----------------|-----------------------------------------------------------------------------------|--|------|-----|----|
| Forward Diode Voltage   | V <sub>SD</sub> | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 1.0 A, T <sub>J</sub> = 25°C              |  | 0.65 | 1.0 | V  |
| Reverse Recovery Time   | t <sub>RR</sub> | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 1.0 A,<br>dI <sub>SD</sub> /dt = 100 A/μs |  | 14.7 |     | ns |
| Charge Time             | t <sub>a</sub>  |                                                                                   |  | 5.2  |     |    |
| Discharge Time          | t <sub>b</sub>  |                                                                                   |  | 9.5  |     |    |
| Reverse Recovery Charge | Q <sub>RR</sub> |                                                                                   |  | 3.3  |     | nC |

2. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%.

3. Switching characteristics are independent of operating junction temperatures.

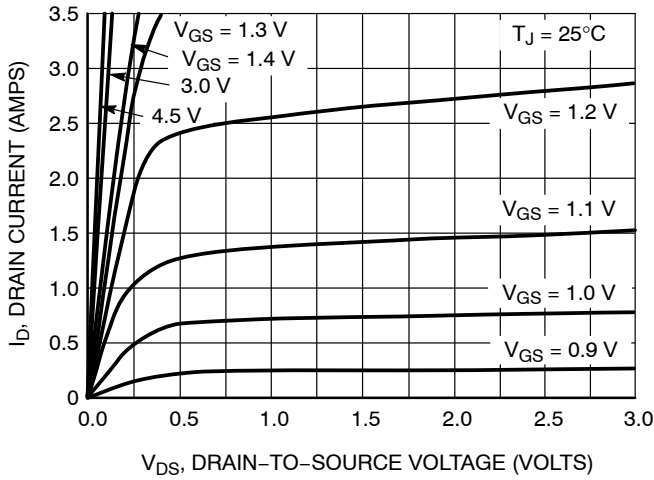


Figure 1. On-Region Characteristics

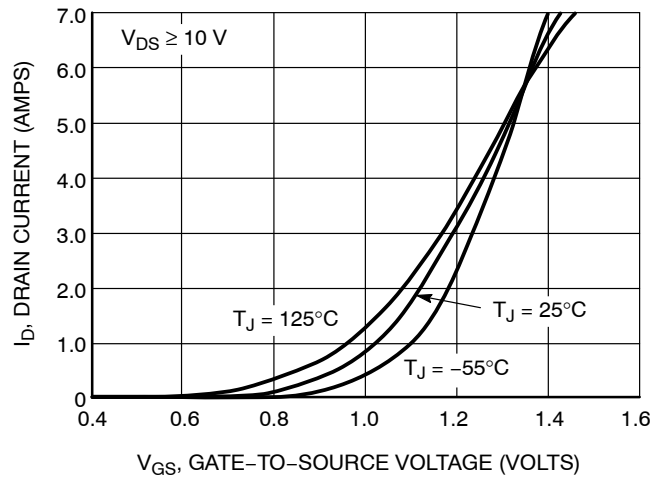


Figure 2. Transfer Characteristics

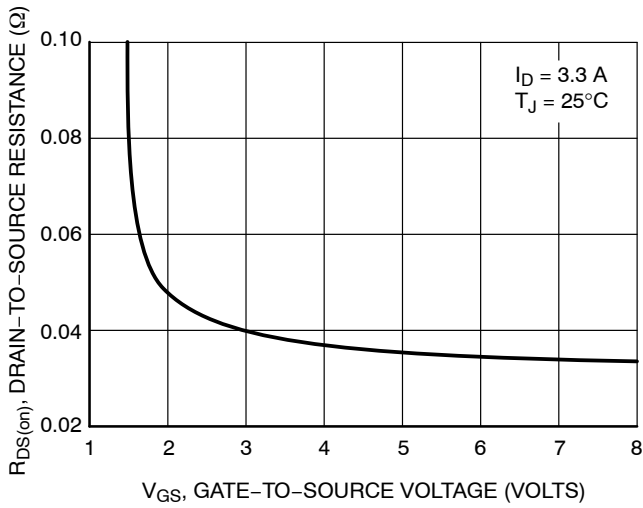


Figure 3. On-Resistance versus Gate-to-Source Voltage

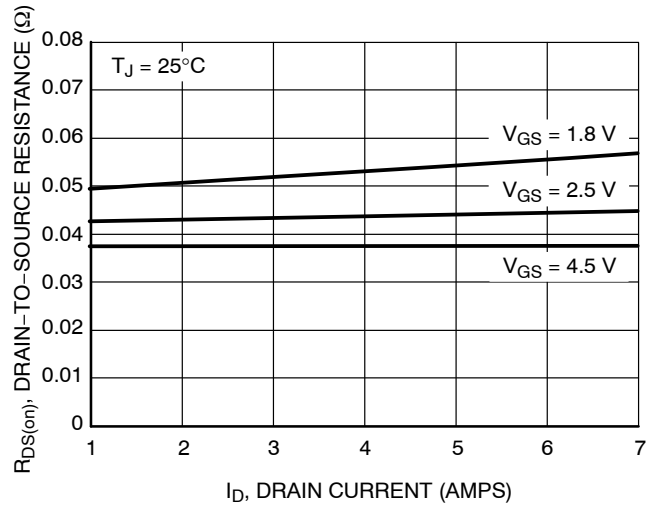


Figure 4. On-Resistance versus Drain Current and Gate Voltage

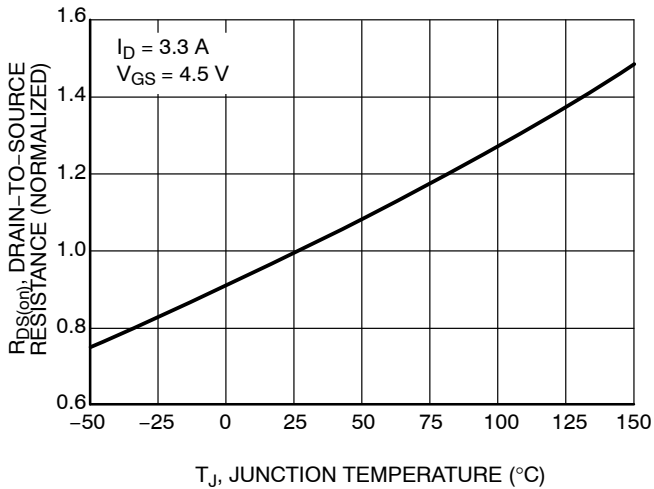


Figure 5. On-Resistance Variation with Temperature

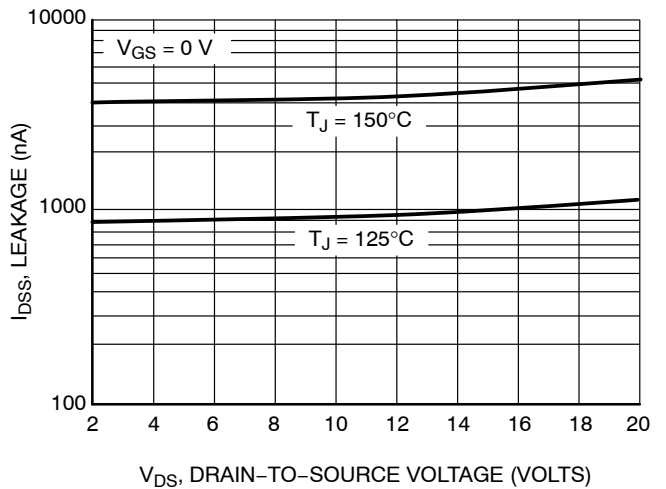


Figure 6. Drain-to-Source Leakage Current versus Voltage

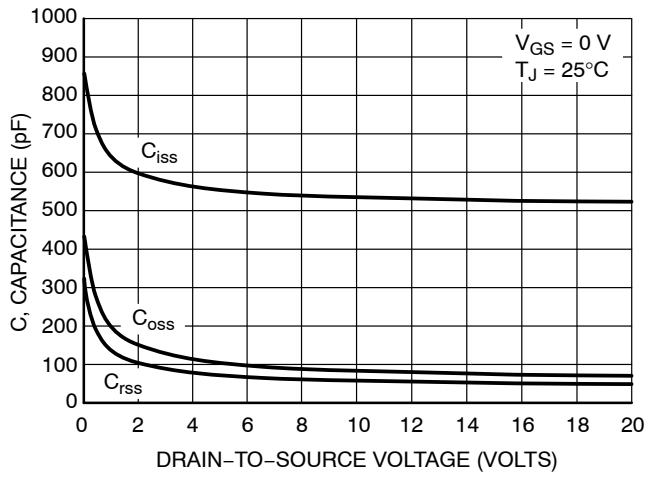


Figure 7. Capacitance Variation

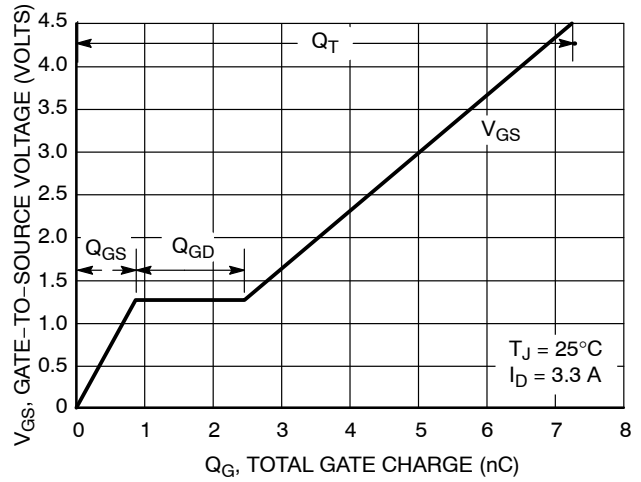


Figure 8. Gate-to-Source and Drain-to-Source Voltage versus Total Gate Charge

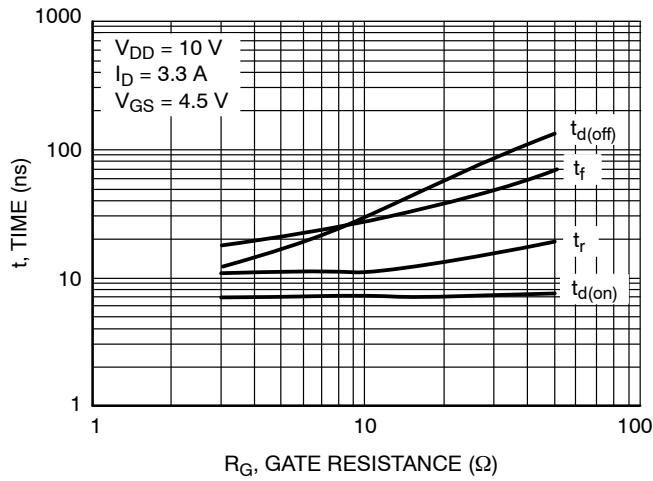


Figure 9. Resistive Switching Time Variation versus Gate Resistance

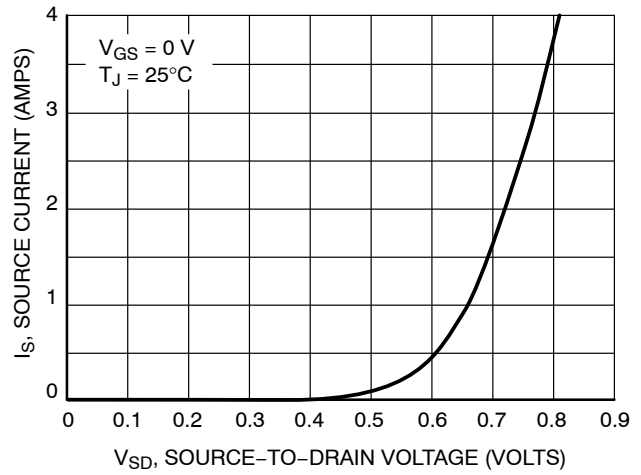
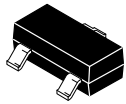


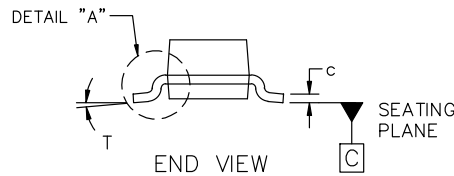
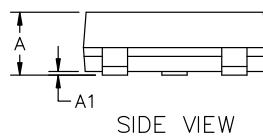
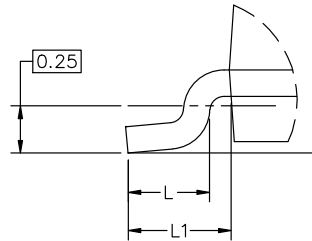
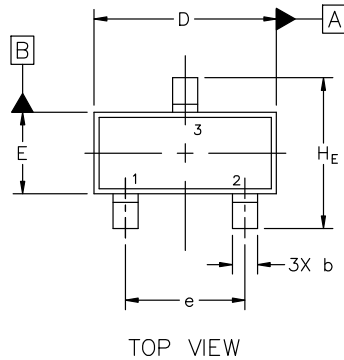
Figure 10. Diode Forward Voltage versus Current



SCALE 4:1

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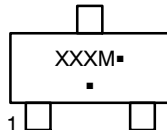


| MILLIMETERS |      |      |      |
|-------------|------|------|------|
| DIM         | MIN  | NOM  | MAX  |
| A           | 0.89 | 1.00 | 1.11 |
| A1          | 0.01 | 0.06 | 0.10 |
| b           | 0.37 | 0.44 | 0.50 |
| c           | 0.08 | 0.14 | 0.20 |
| D           | 2.80 | 2.90 | 3.04 |
| E           | 1.20 | 1.30 | 1.40 |
| e           | 1.78 | 1.90 | 2.04 |
| L           | 0.30 | 0.43 | 0.55 |
| L1          | 0.35 | 0.54 | 0.69 |
| HE          | 2.10 | 2.40 | 2.64 |
| T           | 0°   | ---  | 10°  |

NOTES:

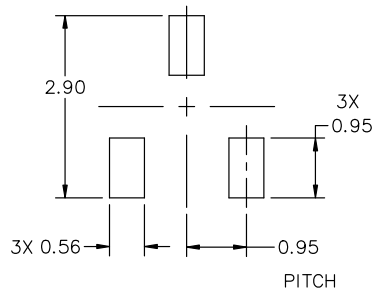
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2018.
2. CONTROLLING DIMENSIONS: MILLIMETERS.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF THE BASE MATERIAL.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

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 onsemi Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

STYLES ON PAGE 2

|                  |                                      |                                                                                                                                                                                     |
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**CASE 318**  
**ISSUE AU**

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|                                                         |                                                       |                                                             |                                                             |                                                             |                                                             |
|---------------------------------------------------------|-------------------------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------|
| STYLE 1 THRU 5:<br>CANCELLED                            | STYLE 6:<br>PIN 1. BASE<br>2. EMITTER<br>3. COLLECTOR | STYLE 7:<br>PIN 1. EMITTER<br>2. BASE<br>3. COLLECTOR       | STYLE 8:<br>PIN 1. ANODE<br>2. NO CONNECTION<br>3. CATHODE  |                                                             |                                                             |
| STYLE 9:<br>PIN 1. ANODE<br>2. ANODE<br>3. CATHODE      | STYLE 10:<br>PIN 1. DRAIN<br>2. SOURCE<br>3. GATE     | STYLE 11:<br>PIN 1. ANODE<br>2. CATHODE<br>3. CATHODE-ANODE | STYLE 12:<br>PIN 1. CATHODE<br>2. CATHODE<br>3. ANODE       | STYLE 13:<br>PIN 1. SOURCE<br>2. DRAIN<br>3. GATE           | STYLE 14:<br>PIN 1. CATHODE<br>2. GATE<br>3. ANODE          |
| STYLE 15:<br>PIN 1. GATE<br>2. CATHODE<br>3. ANODE      | STYLE 16:<br>PIN 1. ANODE<br>2. CATHODE<br>3. CATHODE | STYLE 17:<br>PIN 1. NO CONNECTION<br>2. ANODE<br>3. CATHODE | STYLE 18:<br>PIN 1. NO CONNECTION<br>2. CATHODE<br>3. ANODE | STYLE 19:<br>PIN 1. CATHODE<br>2. ANODE<br>3. CATHODE-ANODE | STYLE 20:<br>PIN 1. CATHODE<br>2. ANODE<br>3. GATE          |
| STYLE 21:<br>PIN 1. GATE<br>2. SOURCE<br>3. DRAIN       | STYLE 22:<br>PIN 1. RETURN<br>2. OUTPUT<br>3. INPUT   | STYLE 23:<br>PIN 1. ANODE<br>2. ANODE<br>3. CATHODE         | STYLE 24:<br>PIN 1. GATE<br>2. DRAIN<br>3. SOURCE           | STYLE 25:<br>PIN 1. ANODE<br>2. CATHODE<br>3. GATE          | STYLE 26:<br>PIN 1. CATHODE<br>2. ANODE<br>3. NO CONNECTION |
| STYLE 27:<br>PIN 1. CATHODE<br>2. CATHODE<br>3. CATHODE | STYLE 28:<br>PIN 1. ANODE<br>2. ANODE<br>3. ANODE     |                                                             |                                                             |                                                             |                                                             |

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