

# NTR3162P

## Power MOSFET

-20 V, -3.6 A, Single P-Channel, SOT-23

### Features

- Low  $R_{DS(on)}$  at Low Gate Voltage
- -0.3 V Low Threshold Voltage
- Fast Switching Speed
- This is a Pb-Free Device

### Applications

- Battery Management
- Load Switch in PWM
- Battery Protection

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

| Parameter   |                               | Symbol                   | Value      | Unit             |
|---|-------------------------------|--------------------------|------------|------------------|
| Drain-to-Source Voltage   |                               | $V_{DSS}$                | -20        | V                |
| Gate-to-Source Voltage  |                               | $V_{GS}$                 | $\pm 8$    | V                |
| Continuous Drain Current (Note 1)                                 | Steady State                  | $T_A = 25^\circ\text{C}$ | -2.2       | A                |
|   |                               | $T_A = 85^\circ\text{C}$ | -1.6       |                  |
|   | $t \leq 5\text{ s}$           | $T_A = 25^\circ\text{C}$ | -3.6       |                  |
| Power Dissipation (Note 1)  | Steady State                  | $T_A = 25^\circ\text{C}$ | 0.48       | W                |
|   |                               |                          | 1.25       |                  |
| Pulsed Drain Current  | $t_p = 10\text{ }\mu\text{s}$ | $I_{DM}$                 | -10.7      | A                |
| Operating Junction and Storage Temperature                        |                               | $T_J, T_{stg}$           | -55 to 150 | $^\circ\text{C}$ |
| Source Current (Body Diode)                                       |                               | $I_S$                    | -0.6       | 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 - $t < 10\text{ s}$ (Note 1) | $R_{\theta JA}$ | 100 |                    |

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

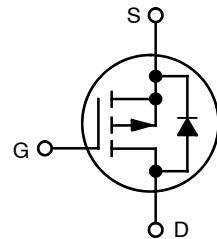


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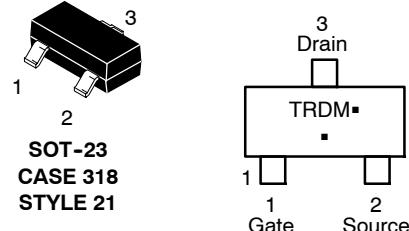
<http://onsemi.com>

| $V_{(BR)DSS}$  | $R_{DS(on)}$ MAX        | $I_D$ MAX |
|----------------|-------------------------|-----------|
| $-20\text{ V}$ | 70 m $\Omega$ @ -4.5 V  | -2.2 A    |
|                | 95 m $\Omega$ @ -2.5 V  | -1.9 A    |
|                | 120 m $\Omega$ @ -1.8 V | -1.7 A    |

### P-CHANNEL MOSFET



### MARKING DIAGRAM/ PIN ASSIGNMENT



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

### ORDERING INFORMATION

| Device      | Package          | Shipping <sup>†</sup> |
|-------------|------------------|-----------------------|
| NTR3162PT1G | SOT-23 (Pb-Free) | 3000 / Tape & Reel    |
| NTR3162PT3G | SOT-23 (Pb-Free) | 10000 / Tape & Reel   |

<sup>†</sup>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.

# NTR3162P

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

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Units |
|-----------|--------|-----------------|-----|-----|-----|-------|
|-----------|--------|-----------------|-----|-----|-----|-------|

### OFF CHARACTERISTICS

|   |                                 |  |     |      |              |                            |
|---|---------------------------------|--|-----|------|--------------|----------------------------|
| Drain-to-Source Breakdown Voltage                         | $V_{(\text{BR})\text{DSS}}$     | $V_{\text{GS}} = 0 \text{ V}, I_D = -250 \mu\text{A}$  | -20 |      |              | V                          |
| Drain-to-Source Breakdown Voltage Temperature Coefficient | $V_{(\text{BR})\text{DSS}}/T_J$ | $I_D = -250 \mu\text{A}$ , Reference to $25^\circ\text{C}$   |     | 14.5 |              | $\text{mV}/^\circ\text{C}$ |
| Zero Gate Voltage Drain Current                           | $I_{\text{DSS}}$                | $V_{\text{GS}} = 0 \text{ V}, V_{\text{DS}} = -16 \text{ V}, T_J = 25^\circ\text{C}$<br>$V_{\text{GS}} = 0 \text{ V}, V_{\text{DS}} = -16 \text{ V}, T_J = 85^\circ\text{C}$ |     |      | -1.0<br>-5.0 | $\mu\text{A}$              |
| Gate-to-Source Leakage Current                            | $I_{\text{GSS}}$                | $V_{\text{DS}} = 0 \text{ V}, V_{\text{GS}} = \pm 8 \text{ V}$   |     |      | $\pm 100$    | nA                         |

### ON CHARACTERISTICS (Note 3)

|  |                                |   |      |      |      |                            |
|--|--------------------------------|---|------|------|------|----------------------------|
| Gate Threshold Voltage                     | $V_{\text{GS}(\text{TH})}$     | $V_{\text{GS}} = V_{\text{DS}}, I_D = -250 \mu\text{A}$ | -0.3 | -0.6 | -1.0 | V                          |
| Negative Threshold Temperature Coefficient | $V_{\text{GS}(\text{TH})}/T_J$ |   |      | 2.5  |      | $\text{mV}/^\circ\text{C}$ |
| Drain-to-Source On-Resistance              | $R_{\text{DS}(\text{on})}$     | $V_{\text{GS}} = -4.5 \text{ V}, I_D = -2.2 \text{ A}$  |      | 48   | 70   | $\text{m}\Omega$           |
|  |                                | $V_{\text{GS}} = -2.5 \text{ V}, I_D = -1.9 \text{ A}$  |      | 57   | 95   |                            |
|  |                                | $V_{\text{GS}} = -1.8 \text{ V}, I_D = -1.7 \text{ A}$  |      | 72   | 120  |                            |
|  |                                | $V_{\text{GS}} = -1.5 \text{ V}, I_D = -1.0 \text{ A}$  |      | 88   |      |                            |
| Forward Transconductance                   | $g_{\text{FS}}$                | $V_{\text{DS}} = -5.0 \text{ V}, I_D = -2.2 \text{ A}$  |      | 9.0  |      | S                          |

### CHARGES, CAPACITANCES AND GATE RESISTANCE

|                              |                            |   |  |      |  |          |
|------------------------------|----------------------------|---|--|------|--|----------|
| Input Capacitance            | $C_{\text{iss}}$           | $V_{\text{GS}} = 0 \text{ V}, f = 1.0 \text{ MHz}, V_{\text{DS}} = -10 \text{ V}$     |  | 940  |  | pF       |
| Output Capacitance           | $C_{\text{oss}}$           |   |  | 140  |  |          |
| Reverse Transfer Capacitance | $C_{\text{rss}}$           |   |  | 100  |  |          |
| Total Gate Charge            | $Q_{\text{G}(\text{TOT})}$ | $V_{\text{GS}} = -4.5 \text{ V}, V_{\text{DS}} = -10 \text{ V}, I_D = -3.6 \text{ A}$ |  | 10.3 |  | nC       |
| Threshold Gate Charge        | $Q_{\text{G}(\text{TH})}$  |   |  | 0.5  |  |          |
| Gate-to-Source Charge        | $Q_{\text{GS}}$            |   |  | 1.4  |  |          |
| Gate-to-Drain Charge         | $Q_{\text{GD}}$            |   |  | 2.7  |  |          |
| Gate Resistance              | $R_G$                      |   |  | 6.0  |  | $\Omega$ |

### SWITCHING CHARACTERISTICS (Note 4)

|                     |                            |   |  |     |  |    |
|---------------------|----------------------------|---|--|-----|--|----|
| Turn-On Delay Time  | $t_{\text{d}(\text{on})}$  | $V_{\text{GS}} = -4.5 \text{ V}, V_{\text{DD}} = -10 \text{ V}, I_D = -3.6 \text{ A}, R_G = 6 \Omega$ |  | 8.0 |  | ns |
| Rise Time           | $t_r$                      |   |  | 15  |  |    |
| Turn-Off Delay Time | $t_{\text{d}(\text{off})}$ |   |  | 31  |  |    |
| Fall Time           | $t_f$                      |   |  | 50  |  |    |

### DRAIN-SOURCE DIODE CHARACTERISTICS

|                         |                 |  |  |     |     |    |
|-------------------------|-----------------|--|--|-----|-----|----|
| Forward Diode Voltage   | $V_{\text{SD}}$ | $V_{\text{GS}} = 0 \text{ V}, I_S = -1.0 \text{ A}, T_J = 25^\circ\text{C}$                                |  | 0.7 | 1.2 | V  |
| Reverse Recovery Time   | $t_{\text{RR}}$ | $V_{\text{GS}} = 0 \text{ V}, I_D = -1.0 \text{ A}, \frac{dI_{\text{SD}}}{dt} = 100 \text{ A}/\mu\text{s}$ |  | 25  |     | ns |
| Charge Time             | $t_a$           |  |  | 8.0 |     |    |
| Discharge Time          | $t_b$           |  |  | 17  |     |    |
| Reverse Recovery Charge | $Q_{\text{RR}}$ |  |  | 11  |     | nC |

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

3. Pulse Test: Pulse Width  $\leq 300 \mu\text{s}$ , Duty Cycle  $\leq 2\%$ .

4. Switching characteristics are independent of operating junction temperatures.

P-CHANNEL TYPICAL CHARACTERISTICS

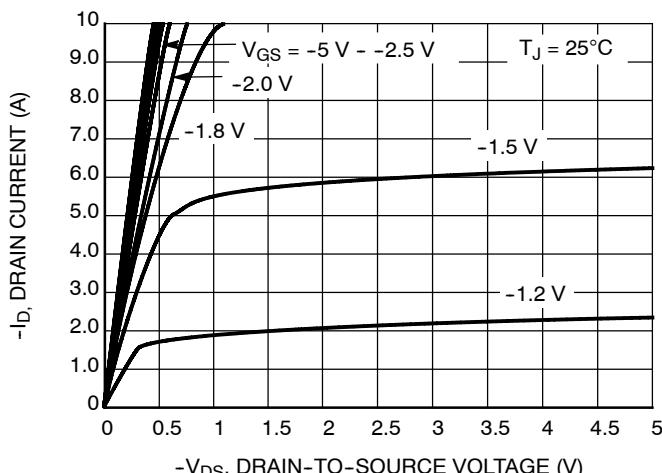


Figure 1. On-Region Characteristics

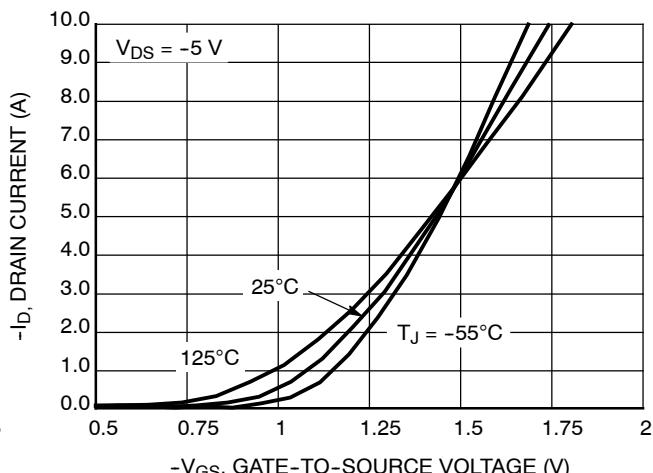


Figure 2. Transfer Characteristics

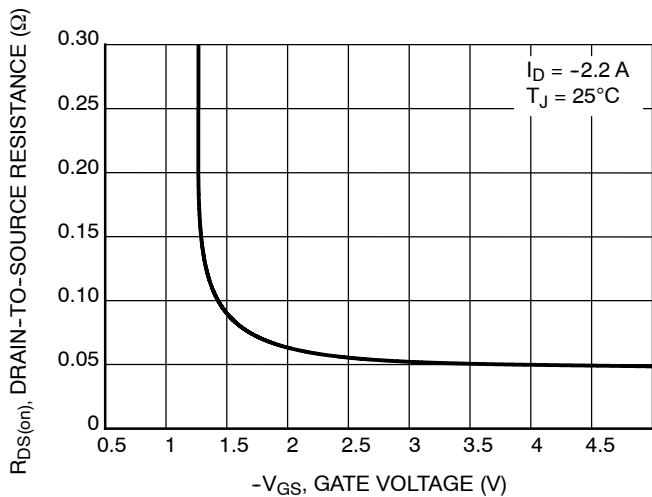


Figure 3. On-Resistance vs. Gate-to-Source Voltage

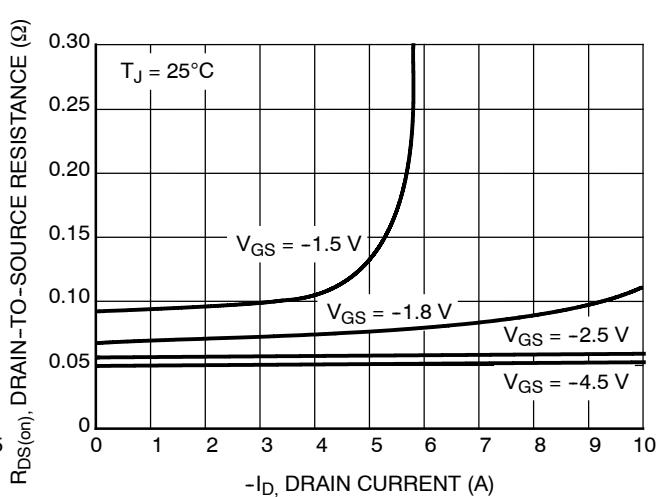


Figure 4. On-Resistance vs. Drain Current and Gate Voltage

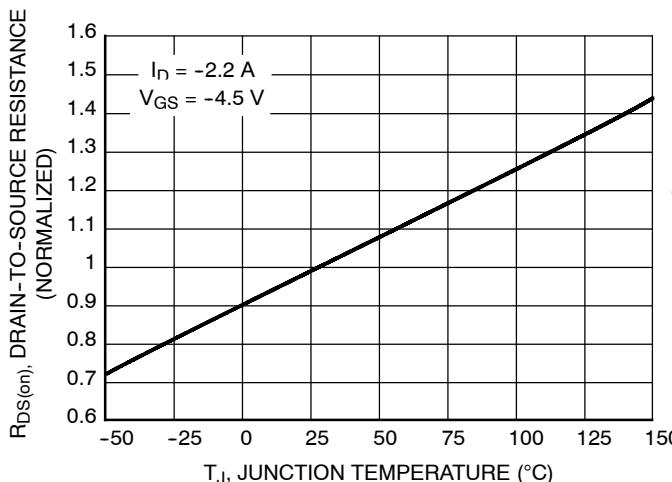


Figure 5. On-Resistance Variation with Temperature

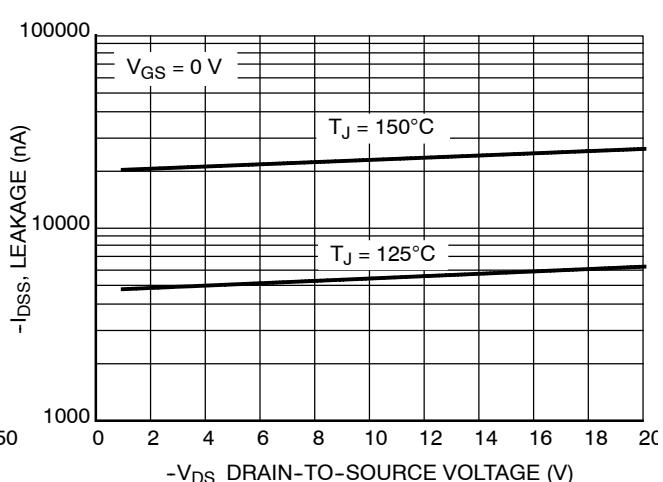
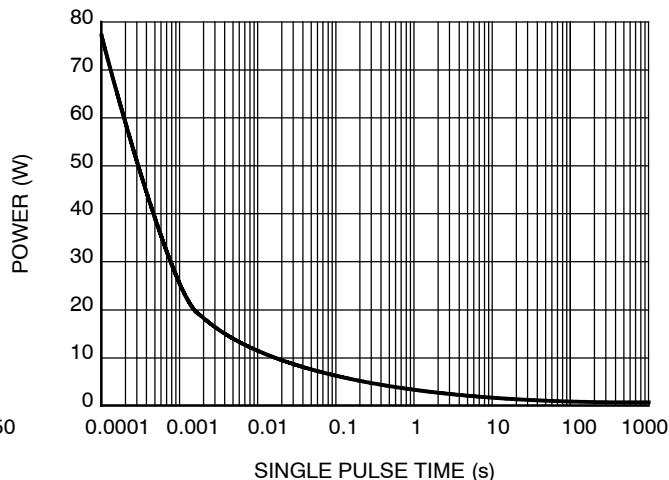
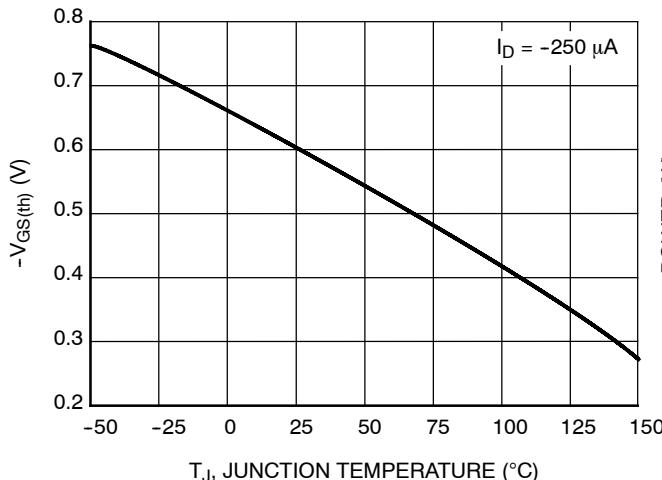
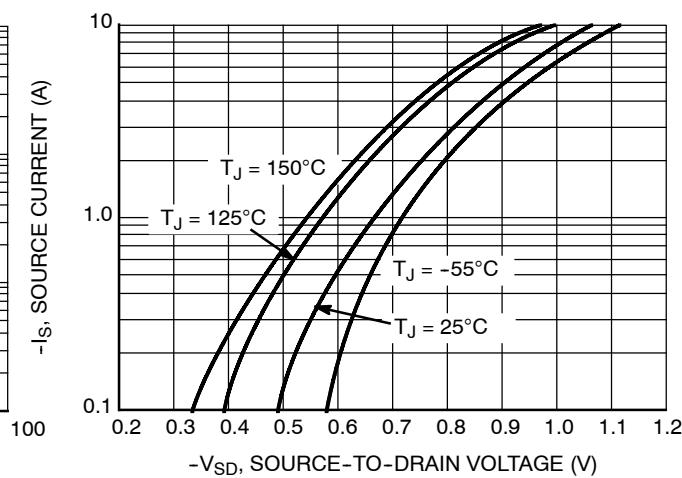
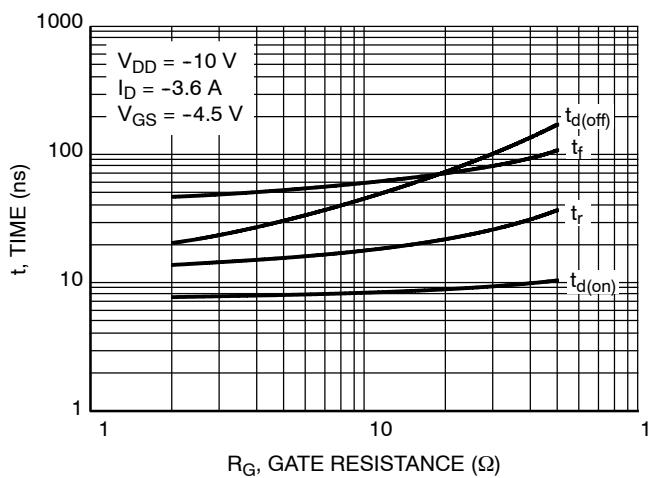
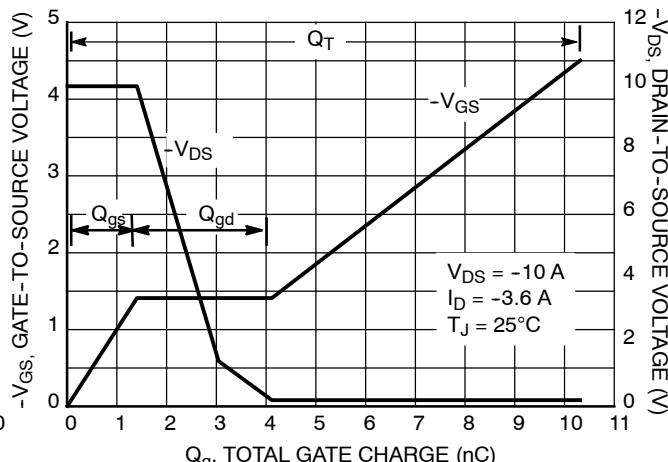
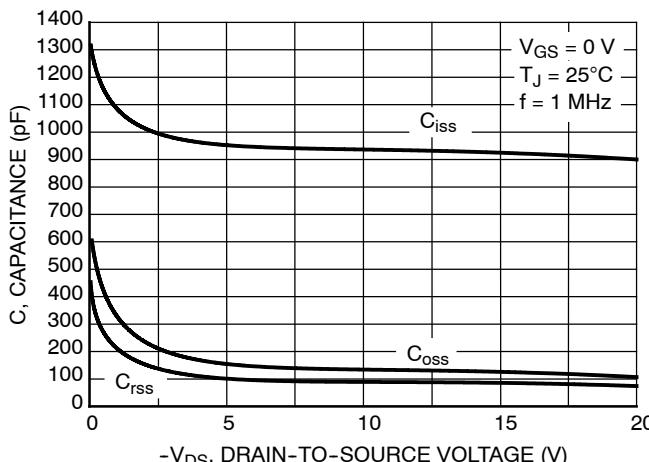
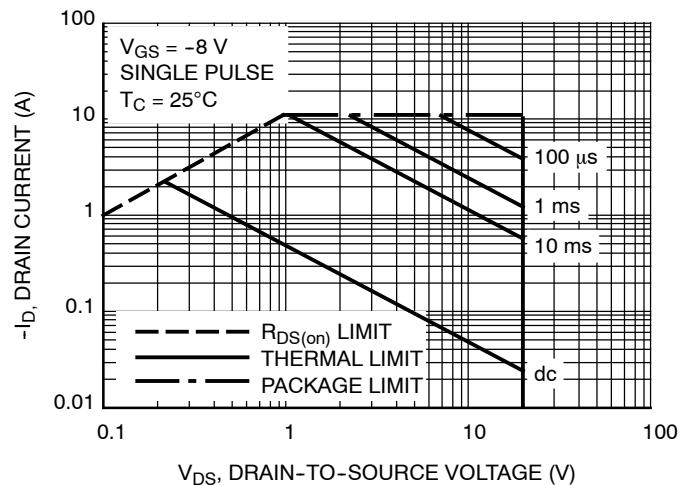


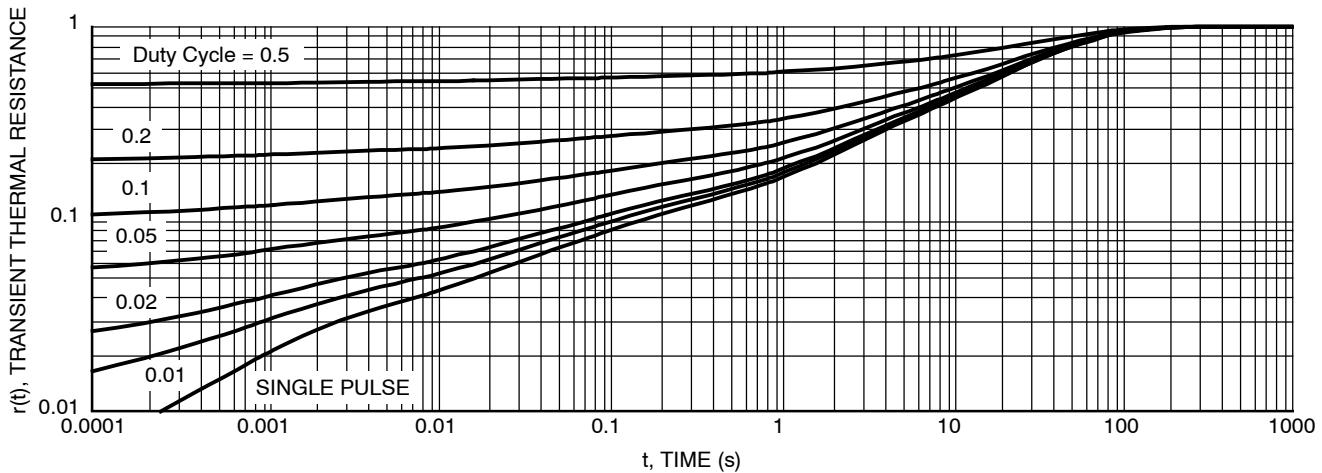
Figure 6. Drain-to-Source Leakage Current vs. Voltage



# NTR3162P



**Figure 13. Maximum Rated Forward Biased Safe Operating Area**

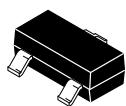


**Figure 14. Thermal Response**

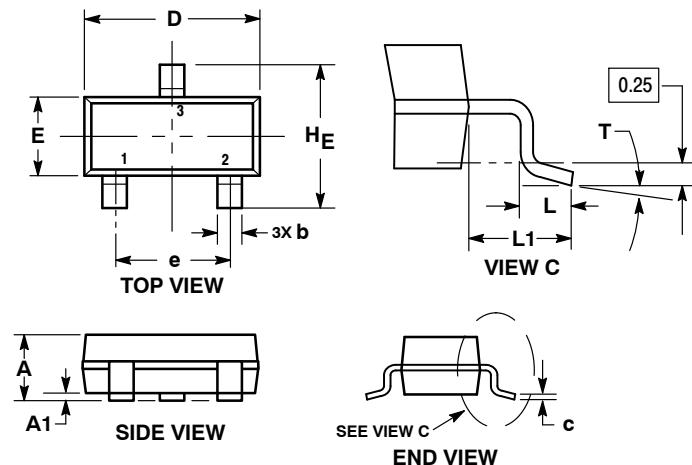
# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

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SCALE 4:1



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

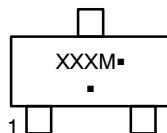
DATE 30 JAN 2018

#### 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 |
| H <sub>E</sub> | 2.10        | 2.40 | 2.64 | 0.083  | 0.094 | 0.104 |
| T              | 0°          | ---  | 10°  | 0°     | ---   | 10°   |

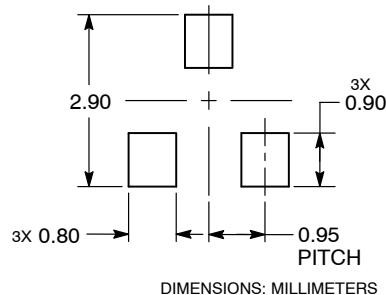
### GENERIC MARKING DIAGRAM\*



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.

### RECOMMENDED SOLDERING FOOTPRINT



DIMENSIONS: MILLIMETERS

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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