# NTR4501N, NVR4501N

# Power MOSFET

## 20 V, 3.2 A, Single N−Channel, SOT−23

### Features

- Leading Planar Technology for Low Gate Charge / Fast Switching
- 2.5 V Rated for Low Voltage Gate Drive
- SOT−23 Surface Mount for Small Footprint
- NVR Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q101 Qualified and PPAP Capable
- These Devices are Pb−Free and are RoHS Compliant

### Applications

- Load/Power Switch for Portables
- Load/Power Switch for Computing
- DC−DC Conversion

**MAXIMUM RATINGS** ($T_J$= 25°C unless otherwise stated)

| Parameter | | | Symbol | Value | Unit |
|---|---|---|---|---|---|
| Drain−to−Source Voltage | | | $V_{DSS}$ | 20 | V |
| Gate−to−Source Voltage | | | $V_{GS}$ | ±12 | V |
| Continuous Drain Current (Note 1) | Steady State | $T_A$ = 25°C | $I_D$ | 3.2 | A |
| | | $T_A$ = 85°C | | 2.4 | A |
| Steady State Power Dissipation (Note 1) | Steady State | | $P_D$ | 1.25 | W |
| Pulsed Drain Current | $t_p$ = 10 μs | | $I_{DM}$ | 10.0 | A |
| Operating Junction and Storage Temperature | | | $T_J$, $T_{stg}$ | −55 to 150 | °C |
| Continuous Source Current (Body Diode) | | | $I_S$ | 1.6 | A |
| Lead Temperature for Soldering Purposes (1/8" from case for 10 s) | | | $T_L$ | 260 | °C |

**THERMAL RESISTANCE RATINGS**

| Parameter | Symbol | Max | Unit |
|---|---|---|---|
| Junction−to−Ambient (Note 1) | $R_{\theta JA}$ | 100 | °C/W |
| Junction−to−Ambient (Note 2) | $R_{\theta JA}$ | 300 | |

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

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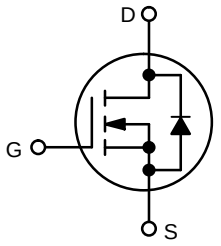
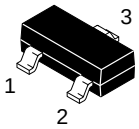
| $V_{(BR)DSS}$ | $R_{DS(on)}$ Typ | $I_D$ Max (Note 1) |
|---|---|---|
| 20 V | 70 mΩ @ 4.5 V | 3.6 A |
| | 88 mΩ @ 2.5 V | 3.1 A |

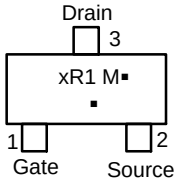
**N−Channel**




**SOT−23**
**CASE 318**
**STYLE 21**

**MARKING DIAGRAM & PIN ASSIGNMENT**




TR1 = Device Code for NTR4501N
VR1 = Device Code for NVR4501N
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† |
|---|---|---|
| NTR4501NT1G | SOT−23 (Pb−Free) | 3000 / Tape & Reel |
| NVR4501NT1G | 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 Specifications Brochure, BRD8011/D.

**Electrical Characteristics** ($T_J$ = 25°C unless otherwise specified)

| Parameter | Symbol | Test Condition | | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| Drain−to−Source Breakdown Voltage (Note 3) | $V_{(BR)DSS}$ | $V_{GS}$ = 0 V, $I_D$ = 250 μA | | 20 | 24.5 | | V |
| Drain−to−Source Breakdown Voltage Temperature Coefficient | $V_{(BR)DSS}/T_J$ | | | | 22 | | mV/°C |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | $V_{GS}$ = 0 V | $T_J$ = 25°C | | | 1.5 | μA |
| | | $V_{DS}$ = 16 V | $T_J$ = 85°C | | | 10 | μA |
| Gate−to−Source Leakage Current | $I_{GSS}$ | $V_{DS}$ = 0 V, $V_{GS}$ = ±12 V | | | | ±100 | nA |
| **ON CHARACTERISTICS** | | | | | | | |
| Gate Threshold Voltage (Note 3) | $V_{GS(TH)}$ | $V_{GS}$ = $V_{DS}$, $I_D$ = 250 μA | | 0.65 | | 1.2 | V |
| Negative Threshold Temperature Coefficient | $V_{GS(TH)}/T_J$ | | | | −2.3 | | mV/°C |
| Drain−to−Source On Resistance | $R_{DS(on)}$ | $V_{GS}$ = 4.5 V, $I_D$ = 3.6 A | | | 70 | 80 | mΩ |
| | | $V_{GS}$ = 2.5 V, $I_D$ = 3.1 A | | | 88 | 105 | |
| Forward Transconductance | $g_{FS}$ | $V_{DS}$ = 5.0 V, $I_D$ = 3.6 A | | | 9 | | S |
| **CHARGES AND CAPACITANCES** | | | | | | | |
| Input Capacitance | $C_{iss}$ | $V_{GS}$ = 0 V, f = 1.0 MHz, $V_{DS}$ = 10 V | | | 200 | | pF |
| Output Capacitance | $C_{oss}$ | | | | 80 | | |
| Reverse Transfer Capacitance | $C_{rss}$ | | | | 50 | | |
| Total Gate Charge | $Q_{G(TOT)}$ | $V_{GS}$ = 4.5 V, $V_{DS}$ = 10 V, $I_D$ = 3.6 A | | | 2.4 | 6.0 | nC |
| Gate−to−Source Gate Charge | $Q_{GS}$ | | | | 0.5 | | |
| Gate−to−Drain Charge | $Q_{GD}$ | | | | 0.6 | | |
| **SWITCHING CHARACTERISTICS** (Note 4) | | | | | | | |
| Turn−On Delay Time | $t_{d(on)}$ | $V_{GS}$ = 4.5 V, $V_{DS}$ = 10 V, $I_D$ = 3.6 A, $R_G$ = 6.0 Ω | | | 6.5 | 13 | ns |
| Rise Time | $t_r$ | | | | 12 | 24 | |
| Turn−Off Delay Time | $t_{d(off)}$ | | | | 12 | 24 | |
| Fall Time | $t_f$ | | | | 3 | 6 | |
| **SOURCE−DRAIN DIODE CHARACTERISTICS** | | | | | | | |
| Forward Diode Voltage | $V_{SD}$ | $V_{GS}$ = 0 V, $I_{SD}$ = 1.6 A | | | 0.8 | 1.2 | V |
| Reverse Recovery Time | $t_{RR}$ | $V_{GS}$ = 0 V, $d_{IS}/d_t$ = 100 A/μs, $I_S$ = 1.6 A | | | 7.1 | | ns |
| Charge Time | $t_a$ | | | | 5 | | |
| Discharge Time | $t_b$ | | | | 1.9 | | |
| Reverse Recovery Charge | $Q_{RR}$ | | | | 3.0 | | nC |

3. Pulse Test: Pulse width ≤ 300 μs, duty cycle ≤ 2%.
4. Switching characteristics are independent of operating junction temperatures.

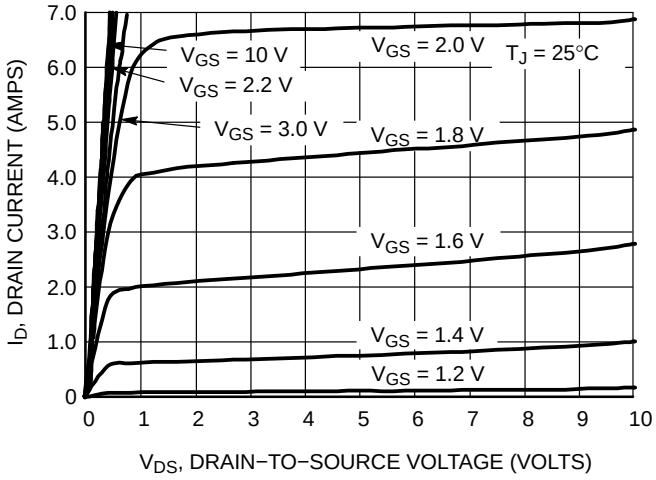



**Figure 1. On−Region Characteristics**

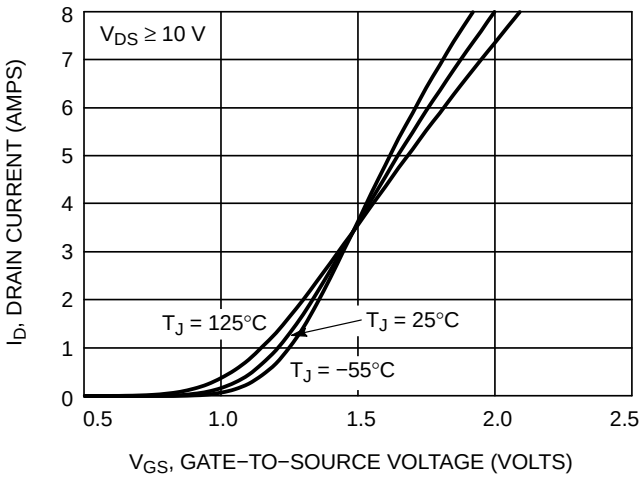



**Figure 2. Transfer Characteristics**

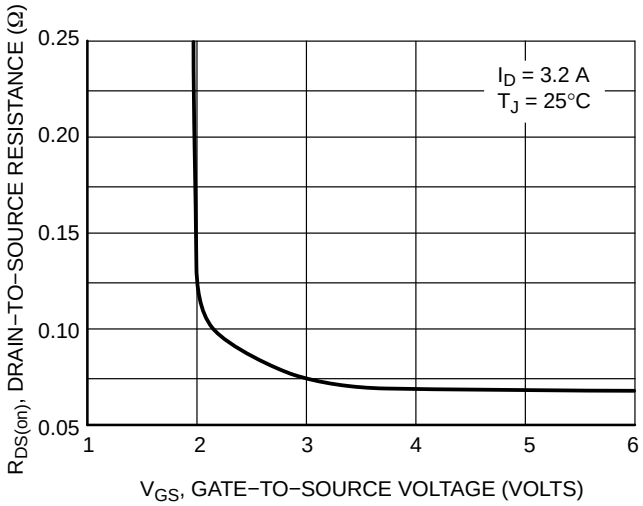



**Figure 3. On−Resistance versus Gate−to−Source Voltage**

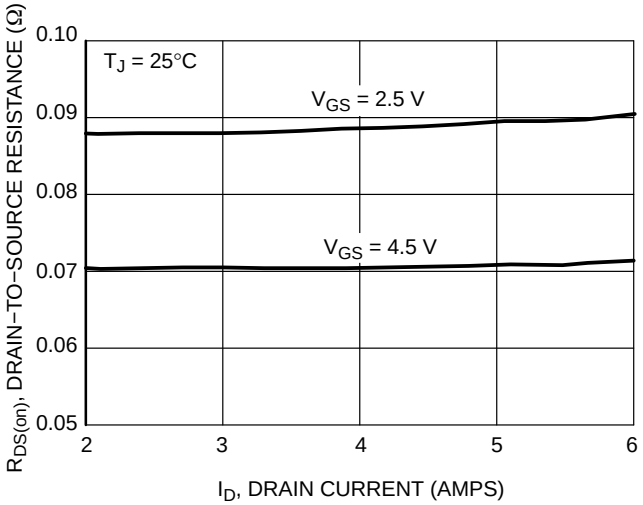



**Figure 4. On−Resistance versus Drain Current and Gate Voltage**

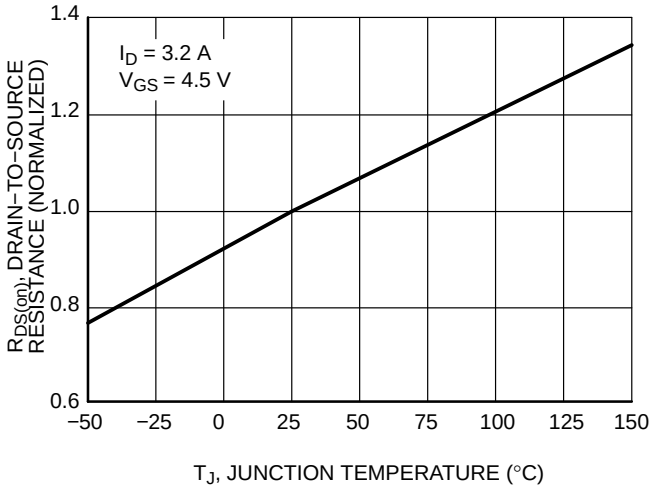



**Figure 5. On−Resistance Variation with Temperature**

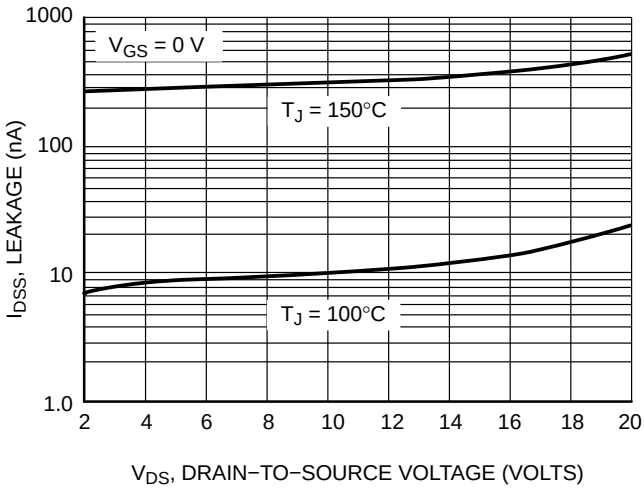



**Figure 6. Drain−to−Source Leakage Current versus Voltage**

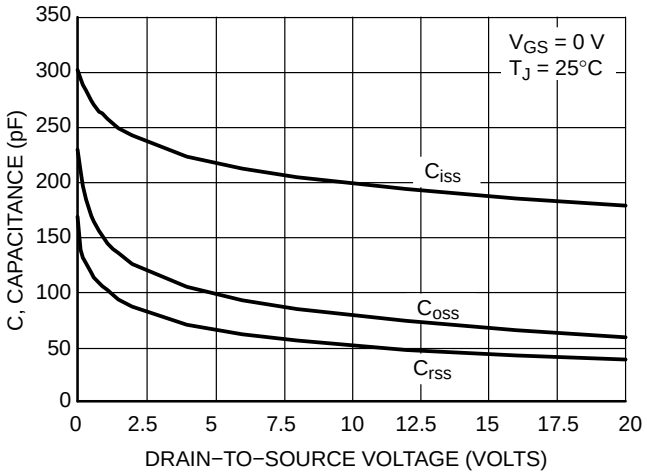



**Figure 7. Capacitance Variation**

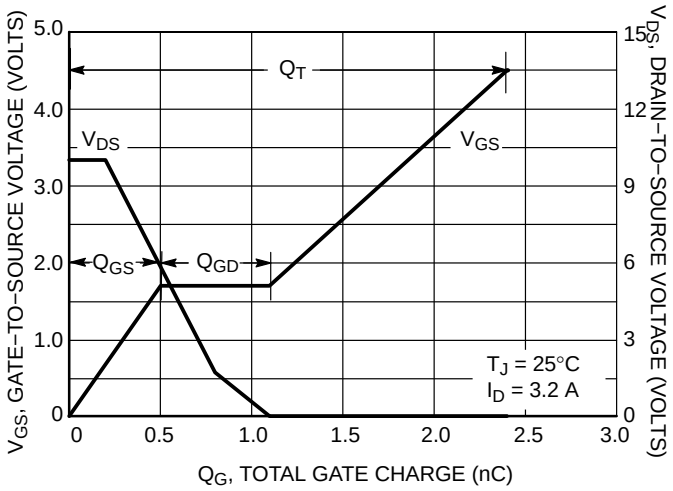



**Figure 8. Gate−to−Source and Drain−to−Source Voltage versus Total Charge**

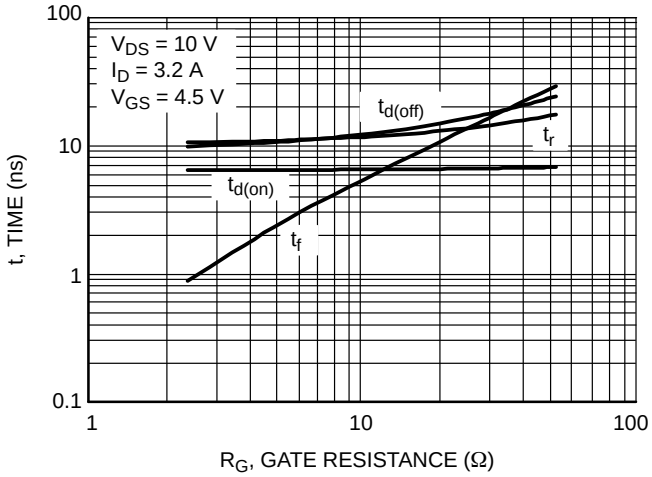



**Figure 9. Resistive Switching Time Variation versus Gate Resistance**

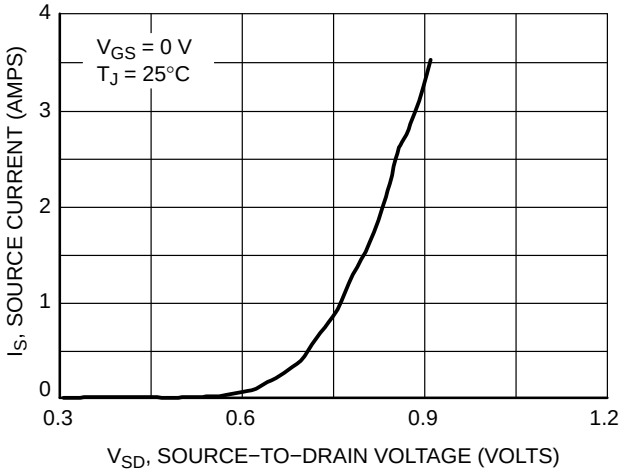



**Figure 10. Diode Forward Voltage versus Current**

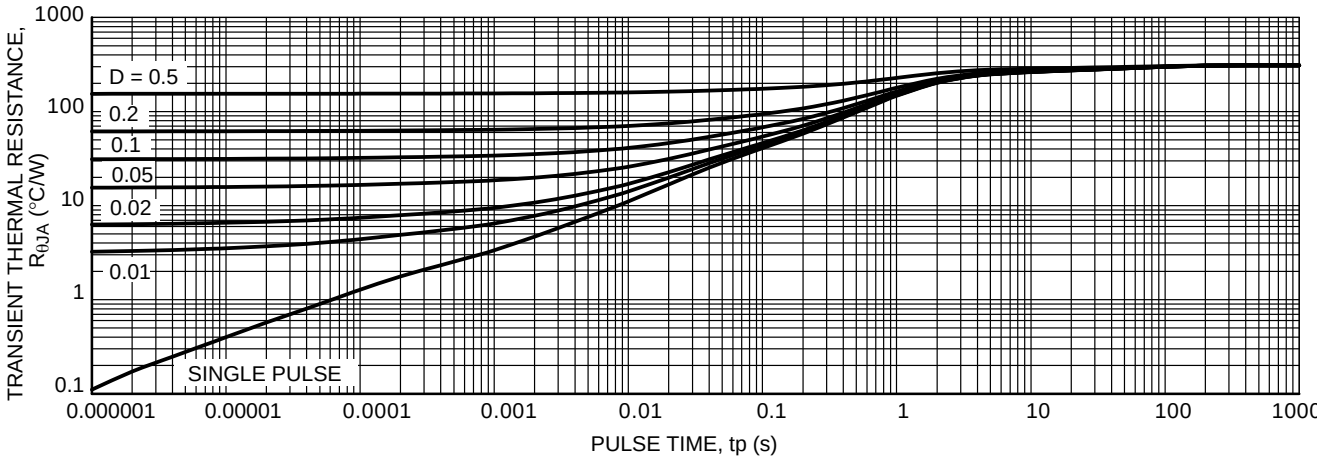
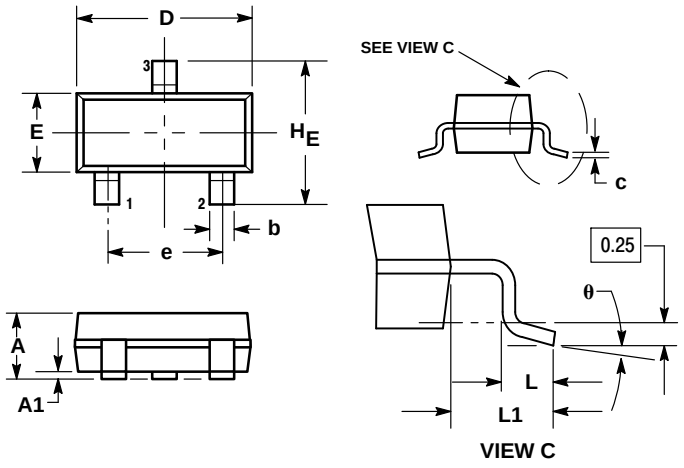



**Figure 11. Thermal Response**

## PACKAGE DIMENSIONS

**SOT−23 (TO−236)**
CASE 318−08
ISSUE AP

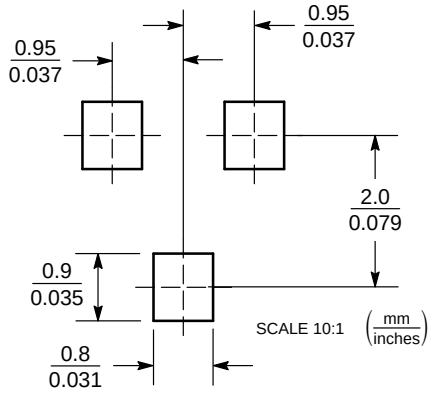



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

| | 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 |
| θ | 0° | −−− | 10° | 0° | −−− | 10° |

STYLE 21:
PIN 1. GATE
2. SOURCE
3. DRAIN

## 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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