

# NTR4501N, NVR4501N

## MOSFET – Power, Single, N-Channel, SOT-23

20 V, 3.2 A



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### 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<sub>J</sub> = 25°C unless otherwise stated)

| Parameter   |              | Symbol                            | Value                 | Unit |   |
|---|--------------|-----------------------------------|-----------------------|------|---|
| Drain-to-Source Voltage   |              | V <sub>DSS</sub>                  | 20                    | V    |   |
| Gate-to-Source Voltage  |              | V <sub>GS</sub>                   | ±12                   | V    |   |
| Continuous Drain Current (Note 1)                                 | Steady State | I <sub>D</sub>                    | T <sub>A</sub> = 25°C | 3.2  | A |
|   |              |                                   | T <sub>A</sub> = 85°C | 2.4  | A |
| Steady State Power Dissipation (Note 1)                           |              | P <sub>D</sub>                    | 1.25                  | W    |   |
| Pulsed Drain Current  |              | I <sub>DM</sub>                   | 10.0                  | A    |   |
| Operating Junction and Storage Temperature                        |              | T <sub>J</sub> , T <sub>stg</sub> | -55 to 150            | °C   |   |
| Continuous Source Current (Body Diode)                            |              | I <sub>S</sub>                    | 1.6                   | A    |   |
| Lead Temperature for Soldering Purposes (1/8" from case for 10 s) |              | T <sub>L</sub>                    | 260                   | °C   |   |

### THERMAL RESISTANCE RATINGS

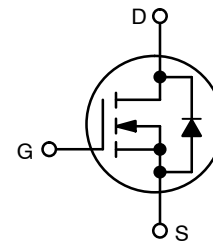
| Parameter                    | Symbol           | Max | Unit |
|------------------------------|------------------|-----|------|
| Junction-to-Ambient (Note 1) | R <sub>θJA</sub> | 100 | °C/W |
| Junction-to-Ambient (Note 2) | R <sub>θJA</sub> | 300 |      |

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.

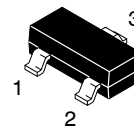
1. Surface-mounted on FR4 board using 1 in sq pad size (Cu area = 1.127 in sq [1 oz] including traces).
2. Surface-mounted on FR4 board using the minimum recommended pad size.

| V <sub>(BR)DSS</sub> | R <sub>DS(on) Typ</sub> | I <sub>D Max</sub> (Note 1) |
|----------------------|-------------------------|-----------------------------|
| 20 V                 | 70 mΩ @ 4.5 V           | 3.6 A                       |
|                      | 88 mΩ @ 2.5 V           | 3.1 A                       |

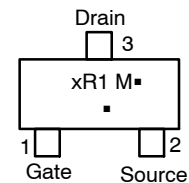
### N-Channel



### MARKING DIAGRAM & PIN ASSIGNMENT



**SOT-23  
CASE 318  
STYLE 21**



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.

# NTR4501N, NVR4501N

## Electrical Characteristics ( $T_J = 25^\circ\text{C}$ unless otherwise specified)

| Parameter   | Symbol            | Test Condition                                  | Min | Typ  | Max       | Units         |
|---|-------------------|---|-----|------|-----------|---------------|
| <b>OFF CHARACTERISTICS</b>                                |                   |   |     |      |           |               |
| Drain-to-Source Breakdown Voltage (Note 3)                | $V_{(BR)DSS}$     | $V_{GS} = 0\text{ V}, I_D = 250\ \mu\text{A}$   | 20  | 24.5 |           | V             |
| Drain-to-Source Breakdown Voltage Temperature Coefficient | $V_{(BR)DSS}/T_J$ |   |     | 22   |           | mV/°C         |
| Zero Gate Voltage Drain Current                           | $I_{DSS}$         | $V_{GS} = 0\text{ V}, T_J = 25^\circ\text{C}$   |     |      | 1.5       | $\mu\text{A}$ |
|   |                   | $V_{DS} = 16\text{ V}, T_J = 85^\circ\text{C}$  |     |      | 10        | $\mu\text{A}$ |
| Gate-to-Source Leakage Current                            | $I_{GSS}$         | $V_{DS} = 0\text{ V}, V_{GS} = \pm 12\text{ V}$ |     |      | $\pm 100$ | nA            |

## ON CHARACTERISTICS

|  |                  |   |      |      |     |            |
|--|------------------|---|------|------|-----|------------|
| Gate Threshold Voltage (Note 3)            | $V_{GS(TH)}$     | $V_{GS} = V_{DS}, I_D = 250\ \mu\text{A}$   | 0.65 |      | 1.2 | V          |
| Negative Threshold Temperature Coefficient | $V_{GS(TH)}/T_J$ |   |      | -2.3 |     | mV/°C      |
| Drain-to-Source On Resistance              | $R_{DS(on)}$     | $V_{GS} = 4.5\text{ V}, I_D = 3.6\text{ A}$ |      | 70   | 80  | m $\Omega$ |
|  |                  | $V_{GS} = 2.5\text{ V}, I_D = 3.1\text{ A}$ |      | 88   | 105 |            |
| Forward Transconductance                   | $g_{FS}$         | $V_{DS} = 5.0\text{ V}, I_D = 3.6\text{ A}$ |      | 9    |     | S          |

## CHARGES AND CAPACITANCES

|                              |              |   |  |     |     |    |
|------------------------------|--------------|---|--|-----|-----|----|
| Input Capacitance            | $C_{iss}$    | $V_{GS} = 0\text{ V}, f = 1.0\text{ MHz}, V_{DS} = 10\text{ V}$   |  | 200 |     | pF |
| Output Capacitance           | $C_{oss}$    |   |  | 80  |     |    |
| Reverse Transfer Capacitance | $C_{rss}$    |   |  | 50  |     |    |
| Total Gate Charge            | $Q_{G(TOT)}$ | $V_{GS} = 4.5\text{ V}, V_{DS} = 10\text{ V}, I_D = 3.6\text{ A}$ |  | 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  | $t_{d(on)}$  | $V_{GS} = 4.5\text{ V}, V_{DS} = 10\text{ V}, I_D = 3.6\text{ A}, R_G = 6.0\ \Omega$ |  | 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  |    |

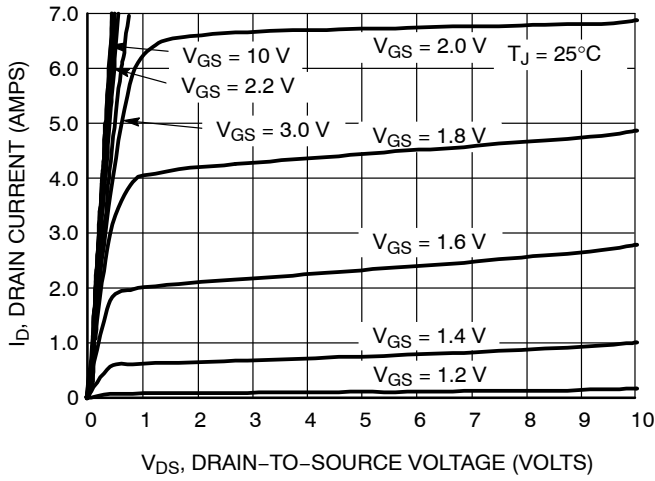
## SOURCE-DRAIN DIODE CHARACTERISTICS

|                         |          |   |  |     |     |    |
|-------------------------|----------|---|--|-----|-----|----|
| Forward Diode Voltage   | $V_{SD}$ | $V_{GS} = 0\text{ V}, I_{SD} = 1.6\text{ A}$                                  |  | 0.8 | 1.2 | V  |
| Reverse Recovery Time   | $t_{RR}$ | $V_{GS} = 0\text{ V}, dI_S/dt = 100\text{ A}/\mu\text{s}, I_S = 1.6\text{ A}$ |  | 7.1 |     | ns |
| Charge Time             | $t_a$    |   |  | 5   |     |    |
| Discharge Time          | $t_b$    |   |  | 1.9 |     |    |
| Reverse Recovery Charge | $Q_{RR}$ |   |  | 3.0 |     |    |

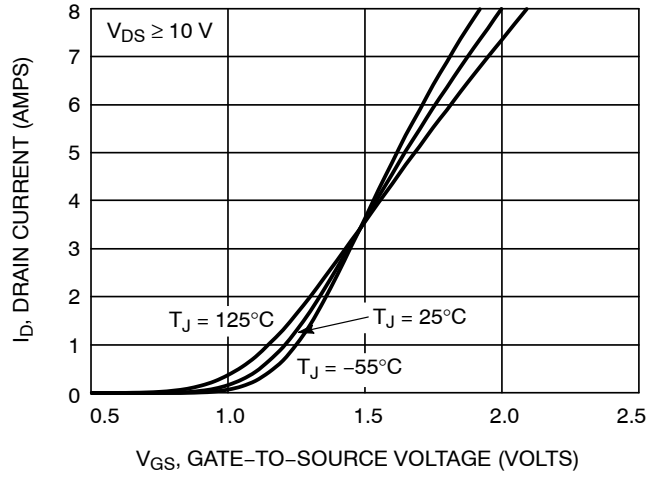
3. Pulse Test: Pulse width  $\leq 300\ \mu\text{s}$ , duty cycle  $\leq 2\%$ .

4. Switching characteristics are independent of operating junction temperatures.

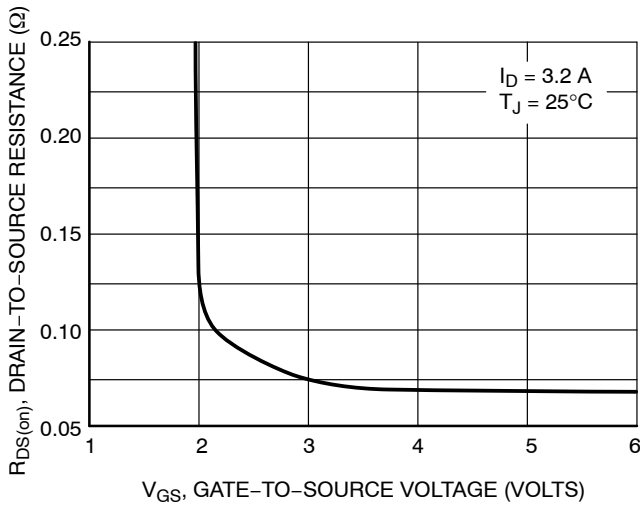
# NTR4501N, NVR4501N



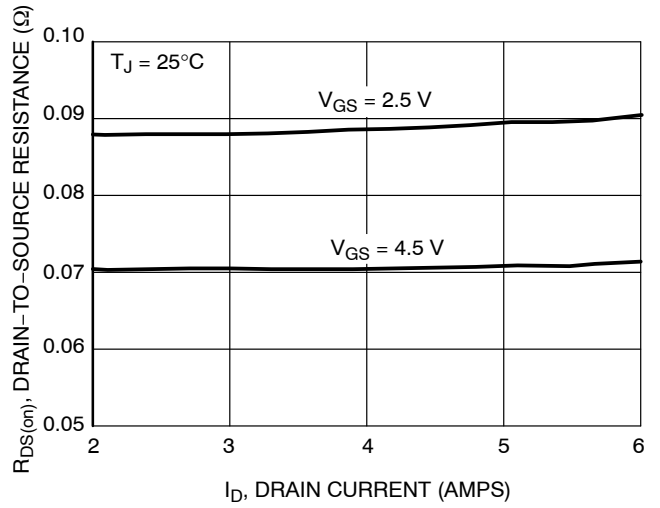
**Figure 1. On-Region Characteristics**



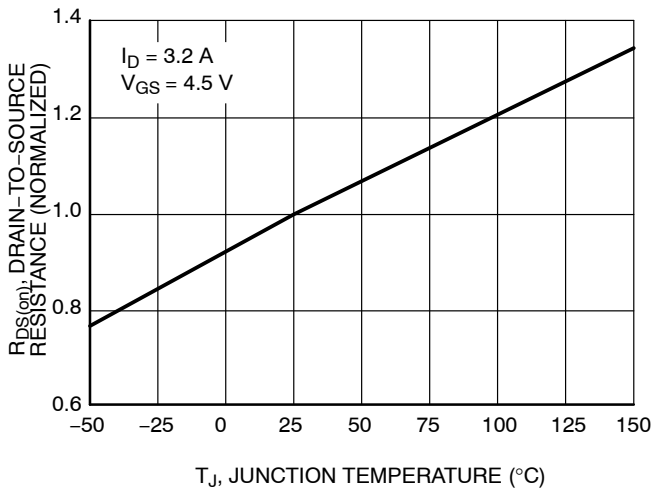
**Figure 2. Transfer Characteristics**



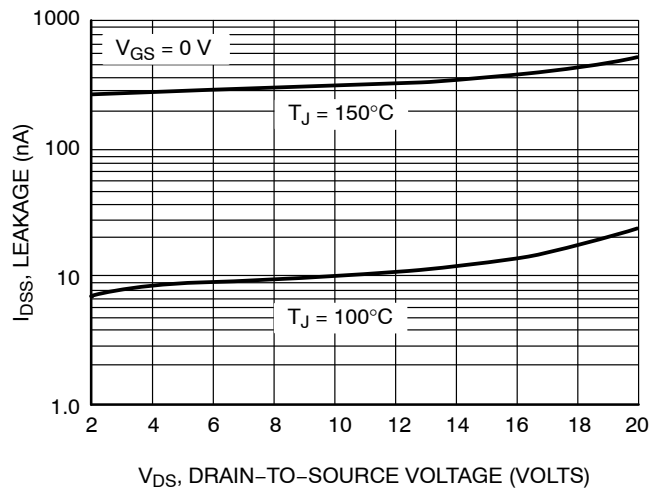
**Figure 3. On-Resistance versus Gate-to-Source Voltage**



**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**

# NTR4501N, NVR4501N

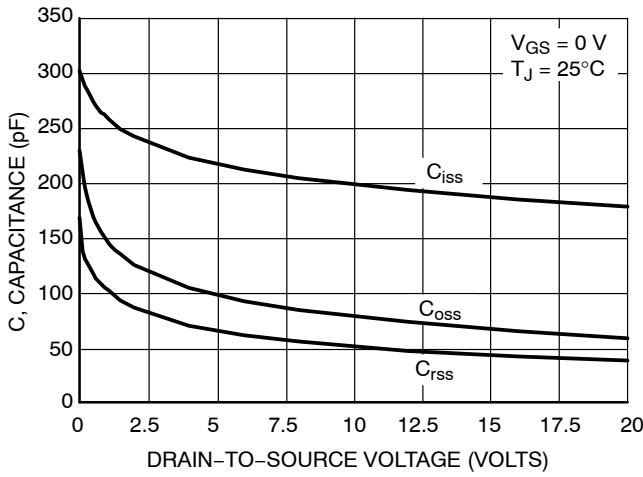


Figure 7. Capacitance Variation

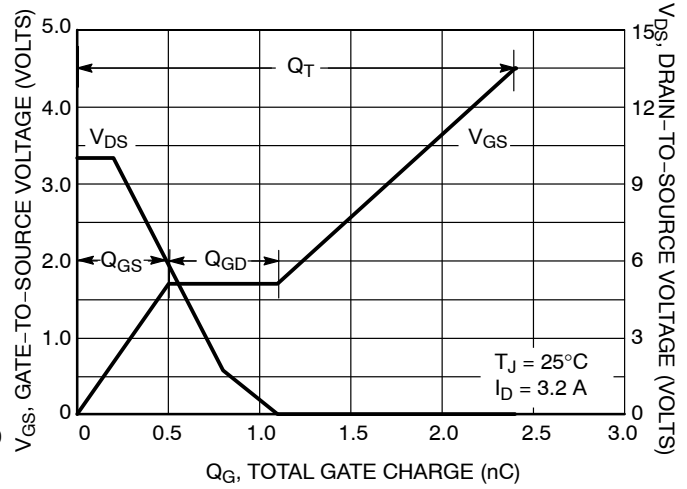


Figure 8. Gate-to-Source and Drain-to-Source Voltage versus Total Charge

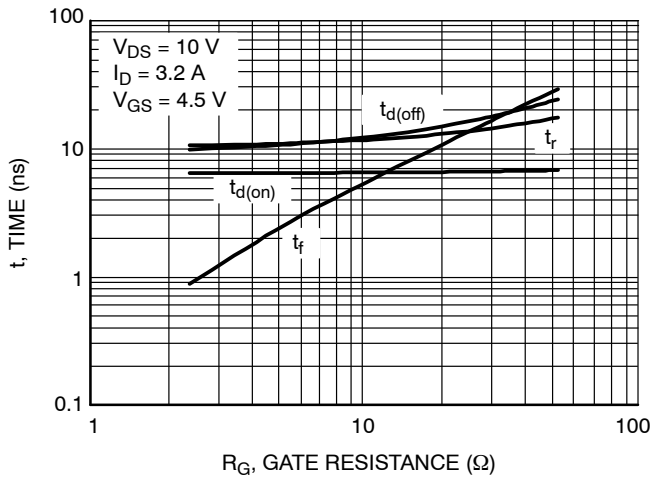


Figure 9. Resistive Switching Time Variation versus Gate Resistance

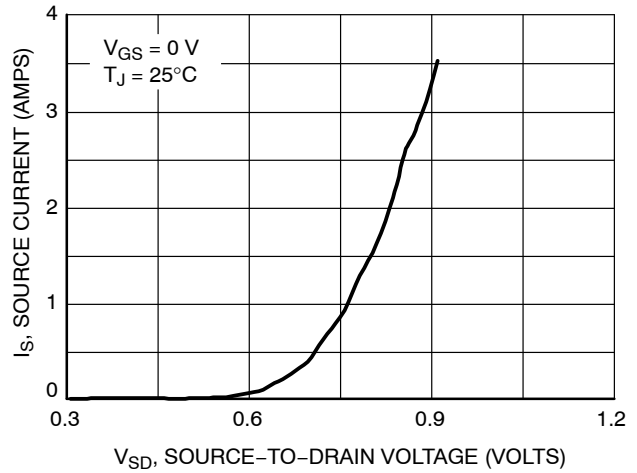


Figure 10. Diode Forward Voltage versus Current

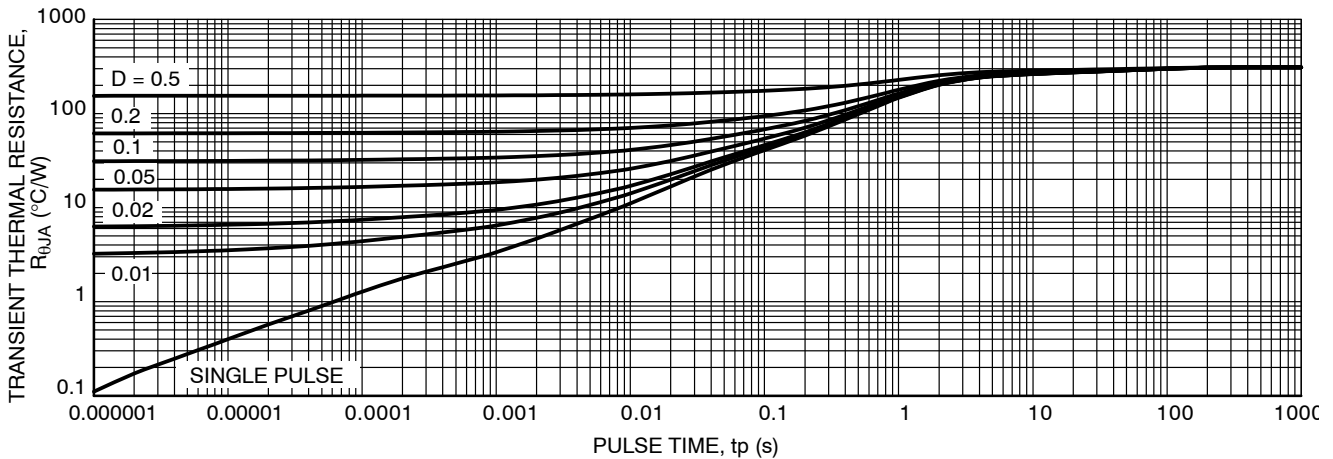


Figure 11. Thermal Response

# 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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