

# NTR4101P, NTRV4101P

## MOSFET – Power, Single P-Channel, Trench, SOT-23 -20 V

### Features

- Leading -20 V Trench for Low  $R_{DS(on)}$
- -1.8 V Rated for Low Voltage Gate Drive
- SOT-23 Surface Mount for Small Footprint
- NTRV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q101 Qualified and PPAP Capable
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

### Applications

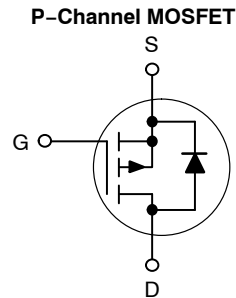
- Load/Power Management for Portables
- Load/Power Management for Computing
- Charging Circuits and Battery Protection

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

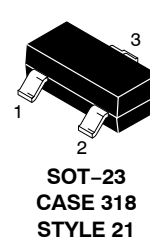
| Parameter                                                                                                                                          |                                   |                            | Symbol               | Value      | Unit               |
|----------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|----------------------------|----------------------|------------|--------------------|
| Drain-to-Source Voltage                                                                                                                            |                                   |                            | $V_{DSS}$            | -20        | V                  |
| Gate-to-Source Voltage                                                                                                                             |                                   |                            | $V_{GS}$             | $\pm 8.0$  | V                  |
| Continuous Drain Current (Note 1)                                                                                                                  | Steady State                      | $T_A = 25^{\circ}\text{C}$ | $I_D$                | -2.4       | A                  |
|                                                                                                                                                    |                                   | $T_A = 85^{\circ}\text{C}$ |                      | -1.7       |                    |
|                                                                                                                                                    | $t \leq 10\text{ s}$              | $T_A = 25^{\circ}\text{C}$ |                      | -3.2       |                    |
| Power Dissipation (Note 1)                                                                                                                         | Steady State                      | $T_A = 25^{\circ}\text{C}$ | $P_D$                | 0.73       | W                  |
|                                                                                                                                                    | $t \leq 10\text{ s}$              |                            |                      | 1.25       |                    |
| Continuous Drain Current (Note 2)                                                                                                                  | Steady State                      | $T_A = 25^{\circ}\text{C}$ | $I_D$                | -1.8       | A                  |
|                                                                                                                                                    |                                   | $T_A = 85^{\circ}\text{C}$ |                      | -1.3       |                    |
| Power Dissipation (Note 2)                                                                                                                         |                                   | $T_A = 25^{\circ}\text{C}$ | $P_D$                | 0.42       | W                  |
| Pulsed Drain Current                                                                                                                               | $t_p = 10\text{ }\mu\text{s}$     |                            | $I_{DM}$             | -18        | A                  |
| ESD Capability (Note 3)                                                                                                                            | C = 100 pF,<br>RS = 1500 $\Omega$ |                            | ESD                  | 225        | V                  |
| Operating Junction and Storage Temperature                                                                                                         |                                   |                            | $T_J$ ,<br>$T_{STG}$ | -55 to 150 | $^{\circ}\text{C}$ |
| Source Current (Body Diode)                                                                                                                        |                                   |                            | $I_S$                | -2.4       | A                  |
| Single Pulse Drain-to-Source Avalanche Energy ( $V_{GS} = -8\text{ V}$ , $I_L = -1.8\text{ Apk}$ , $L = 10\text{ mH}$ , $R_G = 25\text{ }\Omega$ ) |                                   |                            | EAS                  | 16         | mJ                 |
| Lead Temperature for Soldering Purposes (1/8" from case for 10 s)                                                                                  |                                   |                            | $T_L$                | 260        | $^{\circ}\text{C}$ |

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.

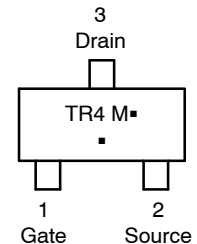
| $V_{(BR)DS}$ | $R_{DS(ON)}$ TYP        | $I_D$ MAX |
|--------------|-------------------------|-----------|
| -20 V        | 70 m $\Omega$ @ -4.5 V  | -3.2 A    |
|              | 90 m $\Omega$ @ -2.5 V  |           |
|              | 112 m $\Omega$ @ -1.8 V |           |



### MARKING DIAGRAM & PIN ASSIGNMENT



SOT-23  
CASE 318  
STYLE 21



TR4 = Device Code  
M = Date Code  
■ = Pb-Free Package

(Note: Microdot may be in either location)

### ORDERING INFORMATION

| Device       | Package             | Shipping†             |
|--------------|---------------------|-----------------------|
| NTR4101PT1G  | SOT-23<br>(Pb-Free) | 3000 / Tape &<br>Reel |
| NTRV4101PT1G |                     |                       |

†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.

# NTR4101P, NTRV4101P

## THERMAL RESISTANCE RATINGS

| Parameter                                   | Symbol          | Max | Unit |
|---------------------------------------------|-----------------|-----|------|
| Junction-to-Ambient – Steady State (Note 1) | $R_{\theta JA}$ | 170 | °C/W |
| Junction-to-Ambient – $t < 10$ s (Note 1)   | $R_{\theta JA}$ | 100 |      |
| Junction-to-Ambient – Steady State (Note 2) | $R_{\theta JA}$ | 300 |      |

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.
3. ESD Rating Information: HBM Class 0

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

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

### OFF CHARACTERISTICS

|                                                                                              |               |     |  |           |               |
|----------------------------------------------------------------------------------------------|---------------|-----|--|-----------|---------------|
| Drain-to-Source Breakdown Voltage (Note 4)<br>( $V_{GS} = 0$ V, $I_D = -250$ $\mu\text{A}$ ) | $V_{(BR)DSS}$ | -20 |  |           | V             |
| Zero Gate Voltage Drain Current (Note 4)<br>( $V_{GS} = 0$ V, $V_{DS} = -16$ V)              | $I_{DSS}$     |     |  | -1.0      | $\mu\text{A}$ |
| Gate-to-Source Leakage Current<br>( $V_{GS} = \pm 8.0$ V, $V_{DS} = 0$ V)                    | $I_{GSS}$     |     |  | $\pm 100$ | nA            |

### ON CHARACTERISTICS

|                                                                                                                                                       |              |      |                 |                  |            |
|-------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|------|-----------------|------------------|------------|
| Gate Threshold Voltage (Note 4)<br>( $V_{GS} = V_{DS}$ , $I_D = -250$ $\mu\text{A}$ )                                                                 | $V_{GS(th)}$ | -0.4 | -0.72           | -1.2             | V          |
| Drain-to-Source On-Resistance<br>( $V_{GS} = -4.5$ V, $I_D = -1.6$ A)<br>( $V_{GS} = -2.5$ V, $I_D = -1.3$ A)<br>( $V_{GS} = -1.8$ V, $I_D = -0.9$ A) | $R_{DS(on)}$ |      | 70<br>90<br>112 | 85<br>120<br>210 | m $\Omega$ |
| Forward Transconductance ( $V_{DS} = -5.0$ V, $I_D = -2.3$ A)                                                                                         | $g_{FS}$     |      | 7.5             |                  | S          |

### CHARGES, CAPACITANCES & GATE RESISTANCE

|                               |                                                                              |                     |  |     |     |    |
|-------------------------------|------------------------------------------------------------------------------|---------------------|--|-----|-----|----|
| Input Capacitance             | (V <sub>GS</sub> = 0 V, f = 1 MHz, V <sub>DS</sub> = -10 V)                  | C <sub>iss</sub>    |  | 675 |     | pF |
| Output Capacitance            |                                                                              | C <sub>oss</sub>    |  | 100 |     |    |
| Reverse Transfer Capacitance  |                                                                              | C <sub>rss</sub>    |  | 75  |     |    |
| Total Gate Charge             | (V <sub>GS</sub> = -4.5 V, V <sub>DS</sub> = -10 V, I <sub>D</sub> = -1.6 A) | Q <sub>G(tot)</sub> |  | 7.5 | 8.5 | nC |
| Gate-to-Source Gate Charge    | (V <sub>DS</sub> = -10 V, I <sub>D</sub> = -1.6 A)                           | Q <sub>GS</sub>     |  | 1.2 |     | nC |
| Gate-to-Drain “Miller” Charge | (V <sub>DS</sub> = -10 V, I <sub>D</sub> = -1.6 A)                           | Q <sub>GD</sub>     |  | 2.2 |     | nC |
| Gate Resistance               |                                                                              | R <sub>G</sub>      |  | 6.5 |     | Ω  |

### SWITCHING CHARACTERISTICS (Note 5)

|                     |                                                                                 |              |  |      |    |
|---------------------|---------------------------------------------------------------------------------|--------------|--|------|----|
| Turn-On Delay Time  | $(V_{GS} = -4.5$ V, $V_{DS} = -10$ V,<br>$I_D = -1.6$ A, $R_G = 6.0$ $\Omega$ ) | $t_{d(on)}$  |  | 7.5  | ns |
| Rise Time           |                                                                                 | $t_r$        |  | 12.6 |    |
| Turn-Off Delay Time |                                                                                 | $t_{d(off)}$ |  | 30.2 |    |
| Fall Time           |                                                                                 | $t_f$        |  | 21.0 |    |

### DRAIN-SOURCE DIODE CHARACTERISTICS

|                         |                                                                           |          |  |       |      |    |
|-------------------------|---------------------------------------------------------------------------|----------|--|-------|------|----|
| Forward Diode Voltage   | $(V_{GS} = 0$ V, $I_S = -2.4$ A)                                          | $V_{SD}$ |  | -0.82 | -1.2 | V  |
| Reverse Recovery Time   | $(V_{GS} = 0$ V,<br>$dI_{SD}/dt = 100$ A/ $\mu\text{s}$ , $I_S = -1.6$ A) | $t_{rr}$ |  | 12.8  | 15   | ns |
| Charge Time             |                                                                           | $t_a$    |  | 9.9   |      | ns |
| Discharge Time          |                                                                           | $t_b$    |  | 3.0   |      | ns |
| Reverse Recovery Charge |                                                                           | $Q_{rr}$ |  | 1008  |      | nC |

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.

4. Pulse Test: Pulse Width  $\leq 300$   $\mu\text{s}$ , Duty Cycle  $\leq 2\%$ .
5. Switching characteristics are independent of operating junction temperature.

# NTR4101P, NTRV4101P

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

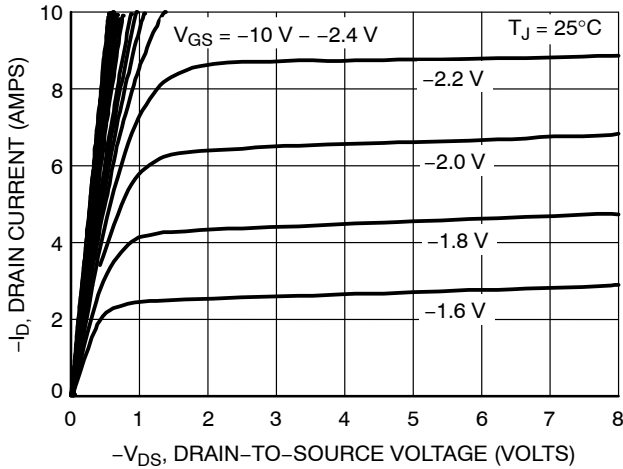


Figure 1. On-Region Characteristics

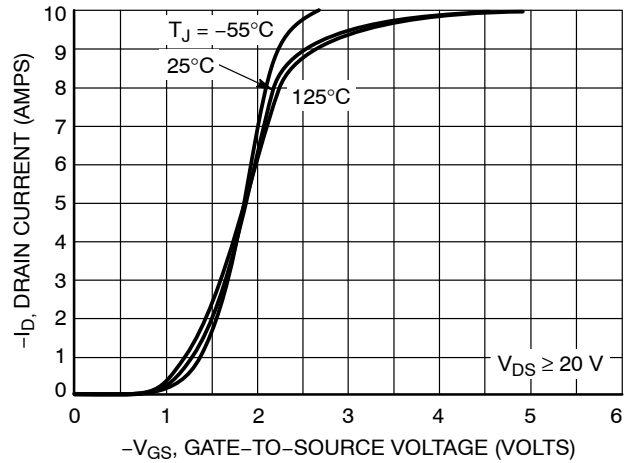


Figure 2. Transfer Characteristics

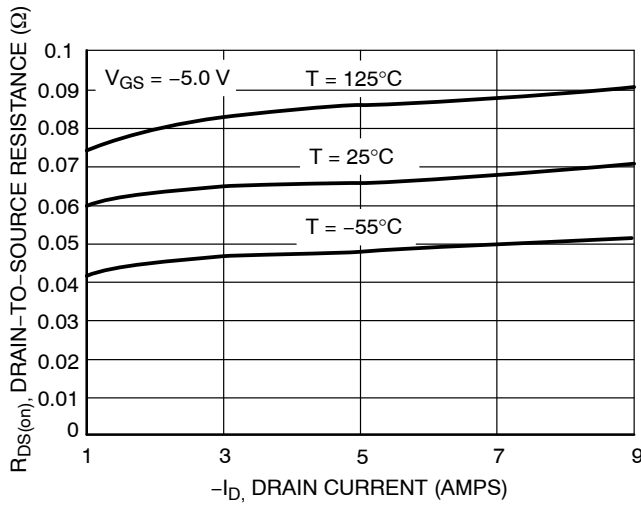


Figure 3. On-Resistance vs. Drain Current and Temperature

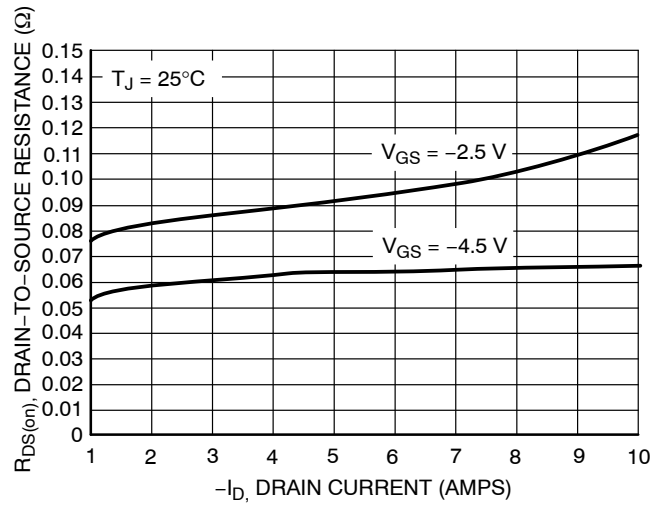


Figure 4. On-Resistance vs. Drain Current and Temperature

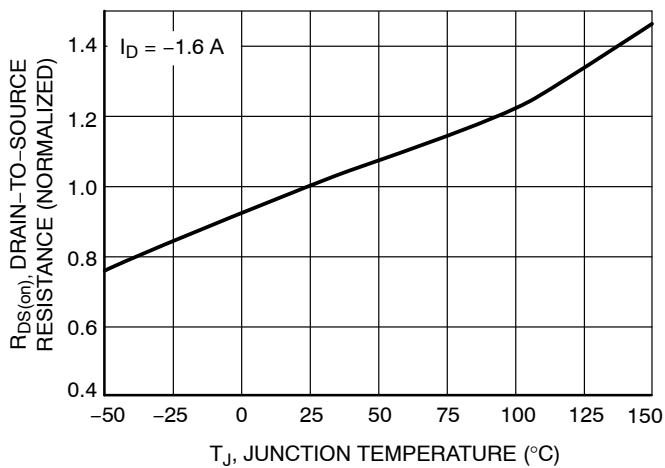


Figure 5. On-Resistance Variation with Temperature

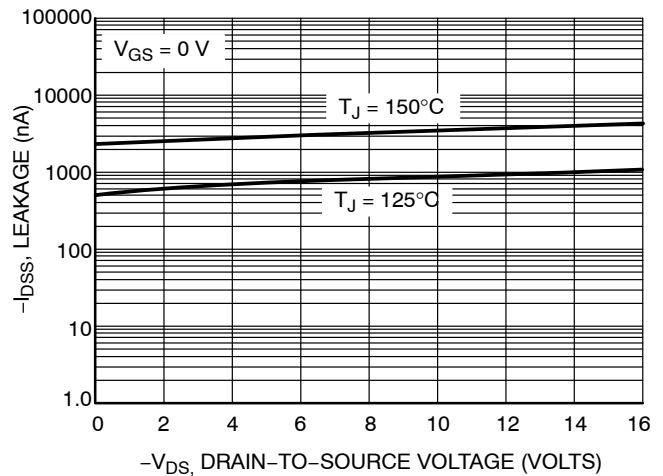


Figure 6. Drain-to-Source Leakage Current vs. Voltage

# NTR4101P, NTRV4101P

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

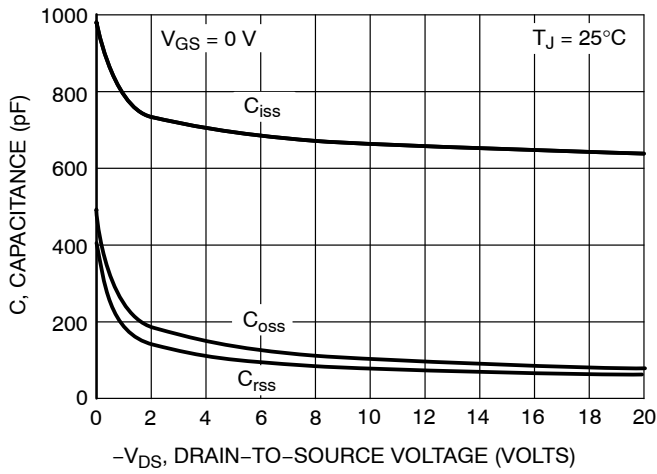


Figure 7. Capacitance Variation

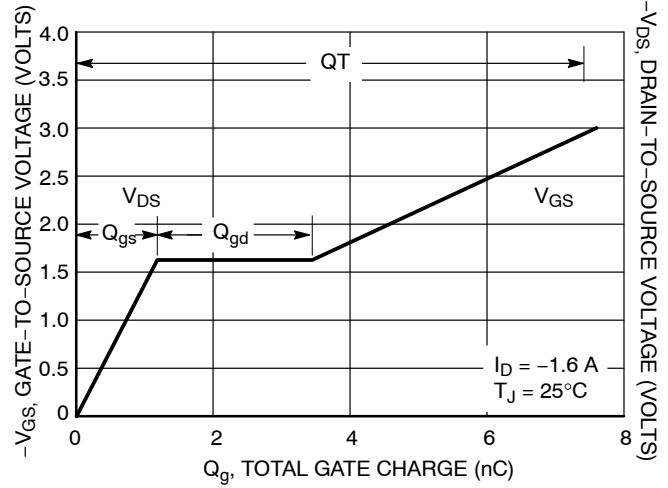


Figure 8. Gate-to-Source and Drain-to-Source Voltage vs. Total Gate Charge

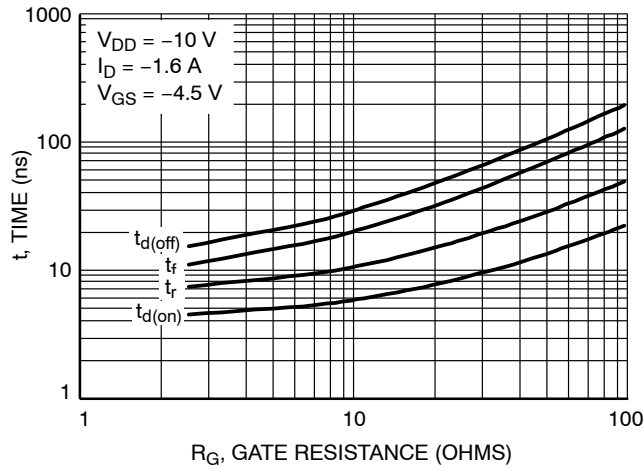


Figure 9. Resistive Switching Time Variation vs. Gate Resistance

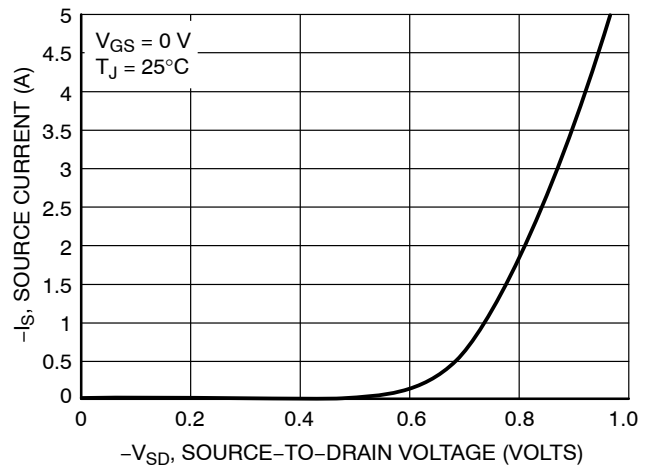


Figure 10. Diode Forward Voltage vs. Current

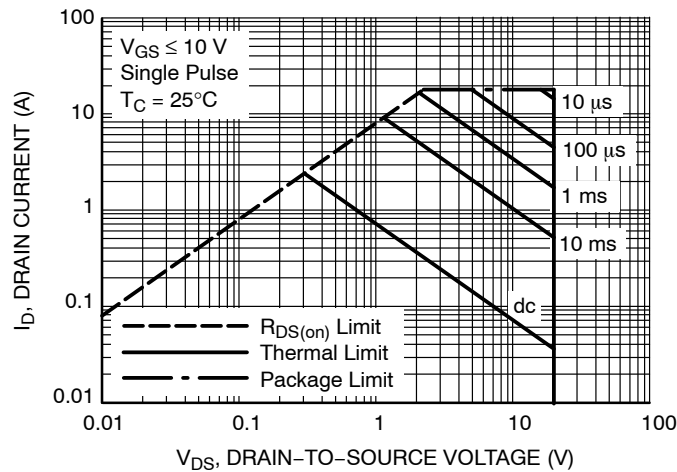
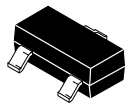


Figure 11. Maximum Rated Forward Biased Safe Operating Area

# MECHANICAL CASE OUTLINE

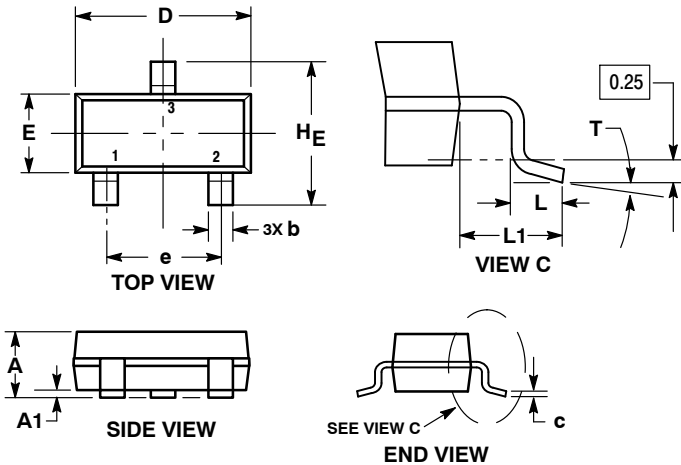
## PACKAGE DIMENSIONS



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

DATE 30 JAN 2018

SCALE 4:1

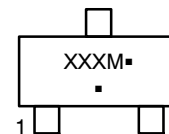


#### NOTES:

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°   |

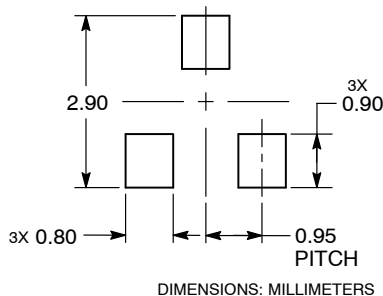
### GENERIC MARKING DIAGRAM\*



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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