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## Contact us

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Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China

# NCV8403, NCV8403A

# Self-Protected Low Side Driver with Temperature and Current Limit

## 42 V, 14 A, Single N–Channel, SOT–223

NCV8403/A is a three terminal protected Low-Side Smart Discrete device. The protection features include overcurrent, overtemperature, ESD and integrated Drain-to-Gate clamping for overvoltage protection. This device offers protection and is suitable for harsh automotive environments.

### Features

- Short Circuit Protection
- Thermal Shutdown with Automatic Restart
- Over Voltage Protection
- Integrated Clamp for Inductive Switching
- ESD Protection
- dV/dt Robustness
- Analog Drive Capability (Logic Level Input)
- NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

### Typical Applications

- Switch a Variety of Resistive, Inductive and Capacitive Loads
- Can Replace Electromechanical Relays and Discrete Circuits
- Automotive / Industrial

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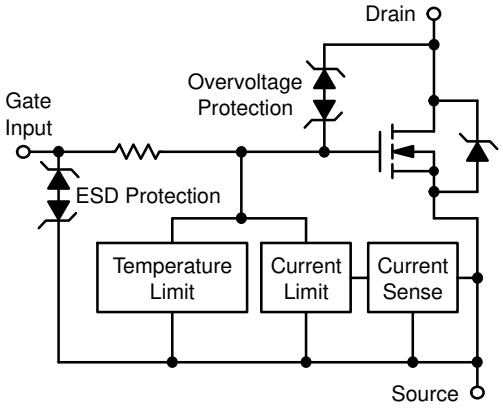
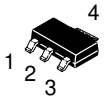
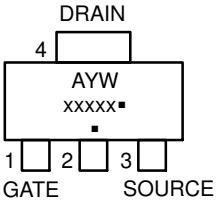
| $V_{DSS}$ (Clamped) | $R_{DS(on)}$ TYP | $I_D$ MAX (Limited) |
|---|---|---|
| 42 V | 53 mΩ @ 10 V | 15 A |

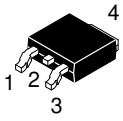



**MARKING DIAGRAM**

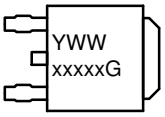



**SOT−223**
**CASE 318E**
**STYLE 3**




**DPAK**
**CASE 369C**




A = Assembly Location
Y = Year
W, WW = Work Week
xxxxx = V8403 or 8403A
G or ▪ = Pb−Free Package

(Note: Microdot may be in either location)

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 10 of this data sheet.

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

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Drain−to−Source Voltage Internally Clamped | $V_{DSS}$ | 42 | Vdc |
| Gate−to−Source Voltage | $V_{GS}$ | ±14 | Vdc |
| Drain Current Continuous | $I_D$ | Internally Limited | |
| Total Power Dissipation<br>@ $T_A$ = 25°C (Note 1)<br>@ $T_A$ = 25°C (Note 2) | $P_D$ | <br>1.13<br>1.56 | W |
| Thermal Resistance − SOT−223 Version<br>Junction−to−Case<br>Junction−to−Ambient (Note 1)<br>Junction−to−Ambient (Note 2)<br>Thermal Resistance − DPAK Version<br>Junction−to−Case<br>Junction−to−Ambient (Note 1)<br>Junction−to−Ambient (Note 2) | <br>$R_{\theta JC}$<br>$R_{\theta JA}$<br>$R_{\theta JA}$<br><br>$R_{\theta JC}$<br>$R_{\theta JA}$<br>$R_{\theta JA}$ | <br>12<br>110<br>80<br><br>2.5<br>95<br>50 | °C/W |
| Single Pulse Inductive Load Switching Energy ($V_{DD}$ = 25 Vdc, $V_{GS}$ = 5.0 V, $I_L$ = 2.8 A, L = 120 mH, $R_G$ = 25 Ω) | $E_{AS}$ | 470 | mJ |
| Load Dump Voltage ($V_{GS}$ = 0 and 10 V, $R_I$ = 2.0 Ω, $R_L$ = 4.5 Ω, $t_d$ = 400 ms) | $V_{LD}$ | 55 | V |
| Operating Junction Temperature | $T_J$ | −40 to 150 | °C |
| Storage Temperature | $T_{stg}$ | −55 to 150 | °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.

1. Surface mounted onto minimum pad size (0.412″ square) FR4 PCB, 1 oz cu.
2. Mounted onto 1″ square pad size (1.127″ square) FR4 PCB, 1 oz cu.

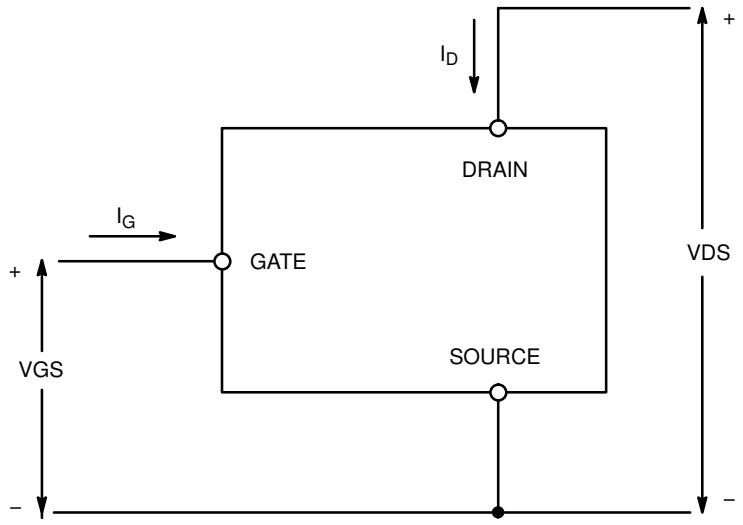



**Figure 1. Voltage and Current Convention**

**MOSFET ELECTRICAL CHARACTERISTICS** ($T_J$ = 25°C unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| Drain−to−Source Clamped Breakdown Voltage<br>($V_{GS}$ = 0 Vdc, $I_D$ = 250 μAdc)<br>($V_{GS}$ = 0 Vdc, $I_D$ = 250 μAdc, $T_J$ = −40°C to 150°C) (Note 3) | $V_{(BR)DSS}$ | <br>42<br>40 | <br>46<br>45 | <br>51<br>51 | <br>Vdc<br>Vdc |
| Zero Gate Voltage Drain Current<br>($V_{DS}$ = 32 Vdc, $V_{GS}$ = 0 Vdc)<br>($V_{DS}$ = 32 Vdc, $V_{GS}$ = 0 Vdc, $T_J$ = 150°C) (Note 3) | $I_{DSS}$ | <br>−<br>− | <br>0.6<br>2.5 | <br>5.0<br>− | μAdc |
| Gate Input Current<br>($V_{GS}$ = 5.0 Vdc, $V_{DS}$ = 0 Vdc) | $I_{GSS}$ | − | 50 | 125 | μAdc |
| **ON CHARACTERISTICS** | | | | | |
| Gate Threshold Voltage<br>($V_{DS}$ = $V_{GS}$, $I_D$ = 1.2 mAdc)<br>Threshold Temperature Coefficient (Negative) | $V_{GS(th)}$ | <br>1.0<br>− | <br>1.7<br>5.0 | <br>2.2<br>− | <br>Vdc<br>mV/°C |
| Static Drain−to−Source On−Resistance (Note 4)<br>($V_{GS}$ = 10 Vdc, $I_D$ = 3.0 Adc, $T_J$ @ 25°C)<br>($V_{GS}$ = 10 Vdc, $I_D$ = 3.0 Adc, $T_J$ @ 150°C) (Note 3) | $R_{DS(on)}$ | <br>−<br>− | <br>53<br>95 | <br>68<br>123 | mΩ |
| Static Drain−to−Source On−Resistance (Note 4)<br>($V_{GS}$ = 5.0 Vdc, $I_D$ = 3.0 Adc, $T_J$ @ 25°C)<br>($V_{GS}$ = 5.0 Vdc, $I_D$ = 3.0 Adc, $T_J$ @ 150°C) (Note 3) | $R_{DS(on)}$ | <br>−<br>− | <br>63<br>105 | <br>76<br>135 | mΩ |
| Source−Drain Forward On Voltage<br>($I_S$ = 7.0 A, $V_{GS}$ = 0 V) | $V_{SD}$ | − | 0.95 | 1.1 | V |

**SWITCHING CHARACTERISTICS** (Note 3)

| | | | | | | |
|---|---|---|---|---|---|---|
| Turn−ON Time (10% $V_{IN}$ to 90% $I_D$) | $V_{IN}$ = 0 V to 5 V, $V_{DD}$ = 25 V<br>$I_D$ = 1.0 A, Ext $R_G$ = 2.5 Ω | $t_{ON}$ | | 44 | | μs |
| Turn−OFF Time (90% $V_{IN}$ to 10% $I_D$) | | $t_{OFF}$ | | 84 | | |
| Turn−ON Time (10% $V_{IN}$ to 90% $I_D$) | $V_{IN}$ = 0 V to 10 V, $V_{DD}$ = 25 V,<br>$I_D$ = 1.0 A, Ext $R_G$ = 2.5 Ω | $t_{ON}$ | | 15 | | |
| Turn−OFF Time (90% $V_{IN}$ to 10% $I_D$) | | $t_{OFF}$ | | 116 | | |
| Slew−Rate ON (20% $V_{DS}$ to 50% $V_{DS}$) | $V_{in}$ = 0 to 10 V, $V_{DD}$ = 12 V,<br>$R_L$ = 4.7 Ω | $-dV_{DS}/dt_{ON}$ | | 2.43 | | V/μs |
| Slew−Rate OFF (80% $V_{DS}$ to 50% $V_{DS}$) | | $dV_{DS}/dt_{OFF}$ | | 0.83 | | |

**SELF PROTECTION CHARACTERISTICS** ($T_J$ = 25°C unless otherwise noted) (Note 5)

| | | | | | | |
|---|---|---|---|---|---|---|
| Current Limit | $V_{GS}$ = 5.0 V, $V_{DS}$ = 10 V<br>$V_{GS}$ = 5.0 V, $T_J$ = 150°C (Note 3) | $I_{LIM}$ | 10<br>5.0 | 15<br>10 | 20<br>15 | Adc |
| Current Limit | $V_{GS}$ = 10 V, $V_{DS}$ = 10 V<br>$V_{GS}$ = 10 V, $T_J$ = 150°C (Note 3) | $I_{LIM}$ | 12<br>8.0 | 17<br>13 | 22<br>18 | Adc |
| Temperature Limit (Turn−off) | $V_{GS}$ = 5.0 Vdc (Note 3) | $T_{LIM(off)}$ | 150 | 175 | 200 | °C |
| Thermal Hysteresis | $V_{GS}$ = 5.0 Vdc | $\Delta T_{LIM(on)}$ | − | 15 | − | °C |
| Temperature Limit (Turn−off) | $V_{GS}$ = 10 Vdc (Note 3) | $T_{LIM(off)}$ | 150 | 165 | 185 | °C |
| Thermal Hysteresis | $V_{GS}$ = 10 Vdc | $\Delta T_{LIM(on)}$ | − | 15 | − | °C |

**GATE INPUT CHARACTERISTICS** (Note 3)

| | | | | | | |
|---|---|---|---|---|---|---|
| Device ON Gate Input Current | $V_{GS}$ = 5 V $I_D$ = 1.0 A | $I_{GON}$ | | 50 | | μA |
| | $V_{GS}$ = 10 V $I_D$ = 1.0 A | | | 400 | | |
| Current Limit Gate Input Current | $V_{GS}$ = 5 V, $V_{DS}$ = 10 V | $I_{GCL}$ | | 0.1 | | mA |
| | $V_{GS}$ = 10 V, $V_{DS}$ = 10 V | | | 0.6 | | |
| Thermal Limit Fault Gate Input Current | $V_{GS}$ = 5 V, $V_{DS}$ = 10 V | $I_{GTL}$ | | 0.45 | | mA |
| | $V_{GS}$ = 10 V, $V_{DS}$ = 10 V | | | 1.5 | | |

**ESD ELECTRICAL CHARACTERISTICS** ($T_J$ = 25°C unless otherwise noted) (Note 3)

| | | | | | | |
|---|---|---|---|---|---|---|
| Electro−Static Discharge Capability | Human Body Model (HBM) | ESD | 4000 | − | − | V |
| Electro−Static Discharge Capability | Machine Model (MM) | ESD | 400 | − | − | V |

3. Not subject to production testing.
4. Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2%.
5. Fault conditions are viewed as beyond the normal operating range of the part.

## TYPICAL PERFORMANCE CURVES

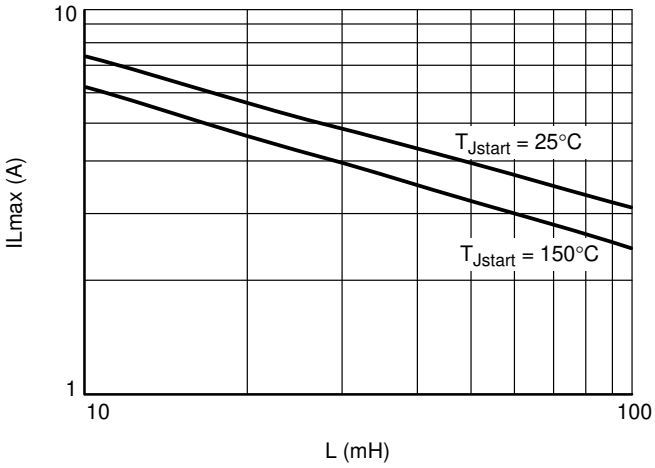



**Figure 2. Single Pulse Maximum Switch−off Current vs. Load Inductance**

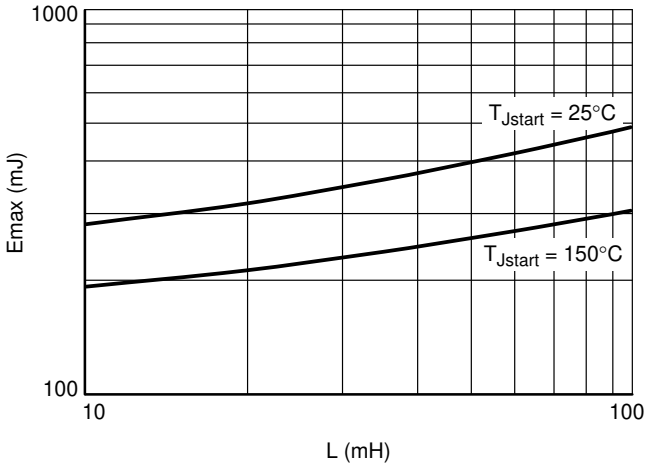



**Figure 3. Single−Pulse Maximum Switching Energy vs. Load Inductance**

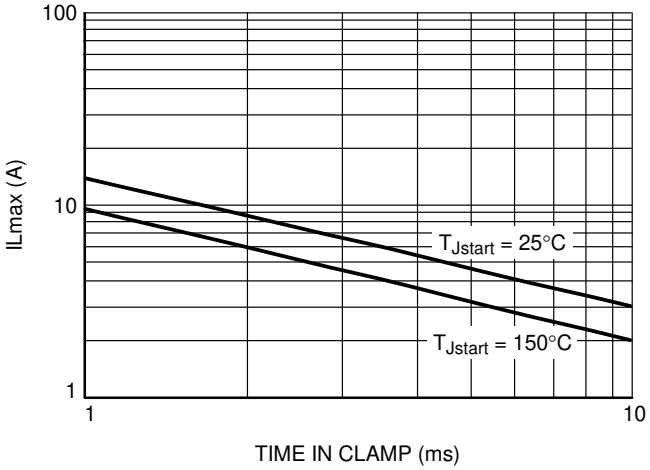



**Figure 4. Single Pulse Maximum Inductive Switch−off Current vs. Time in Clamp**

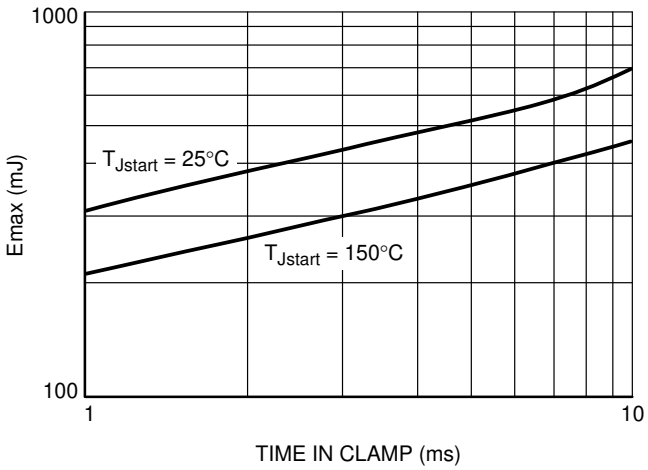



**Figure 5. Single−Pulse Maximum Inductive Switching Energy vs. Time in Clamp**

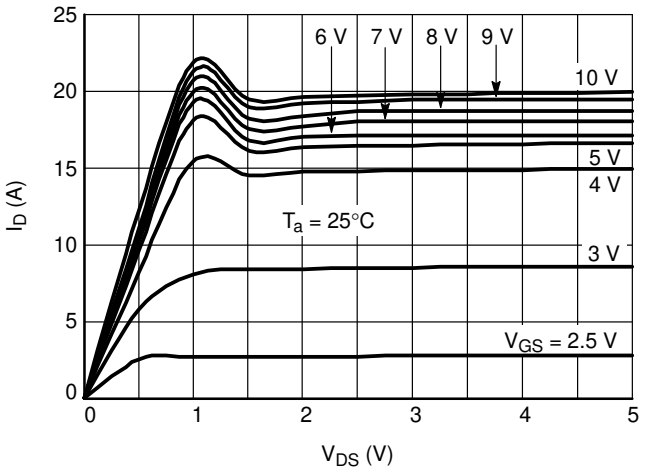



**Figure 6. On−state Output Characteristics**

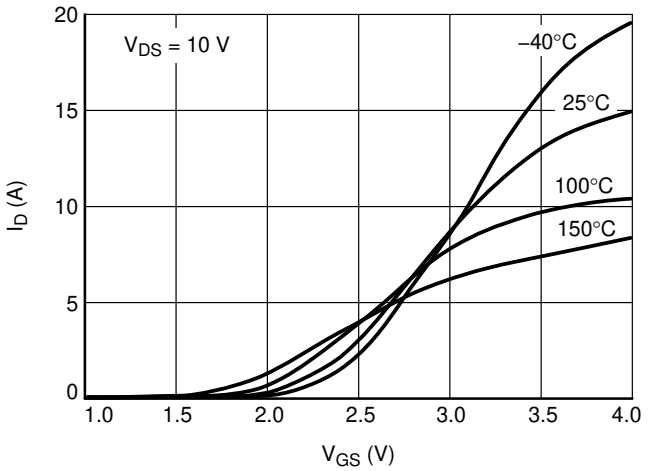



**Figure 7. Transfer Characteristics**

## TYPICAL PERFORMANCE CURVES

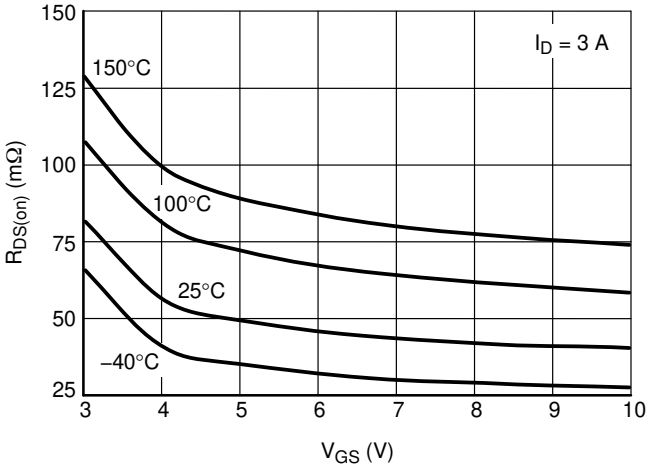



**Figure 8. $R_{DS(on)}$ vs. Gate–Source Voltage**

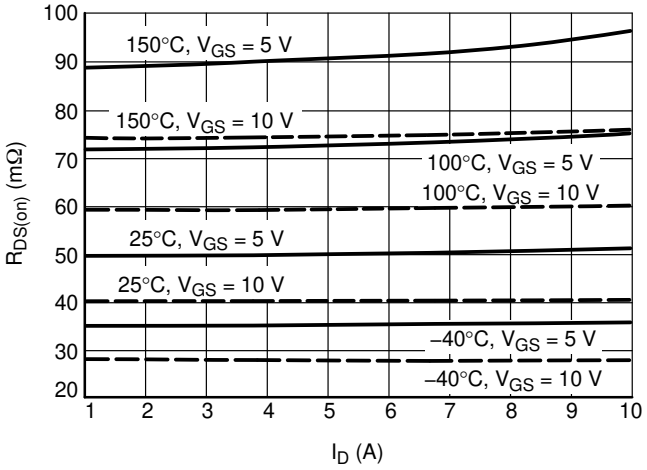



**Figure 9. $R_{DS(on)}$ vs. Drain Current**

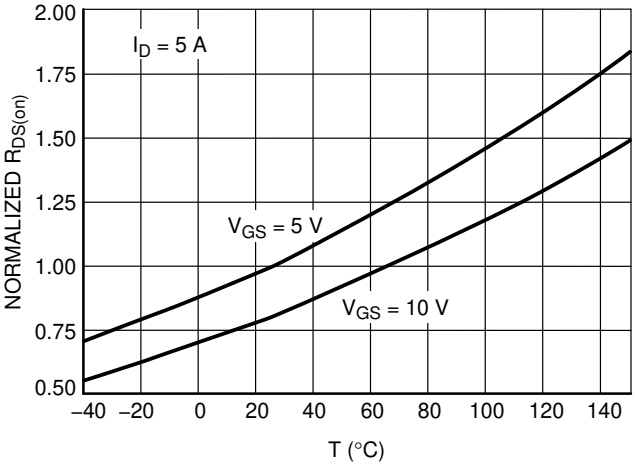



**Figure 10. Normalized $R_{DS(on)}$ vs. Temperature**

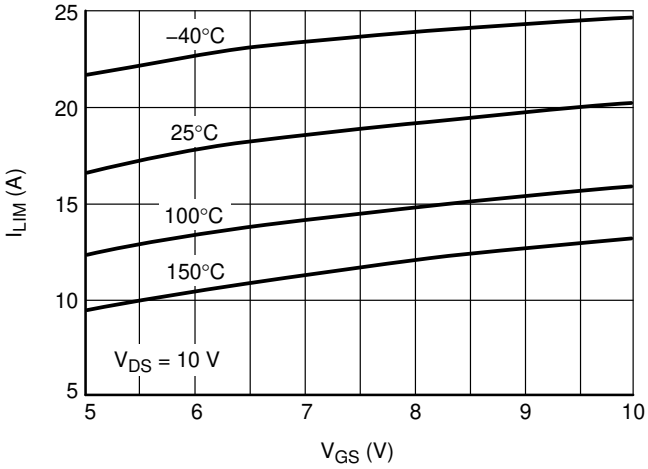



**Figure 11. Current Limit vs. Gate–Source Voltage**

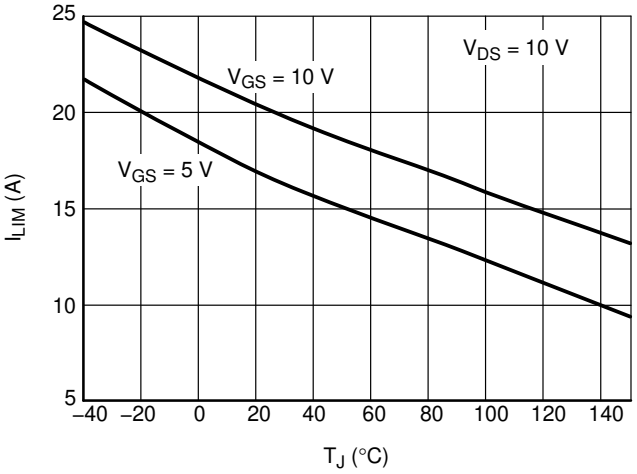



**Figure 12. Current Limit vs. Junction Temperature**

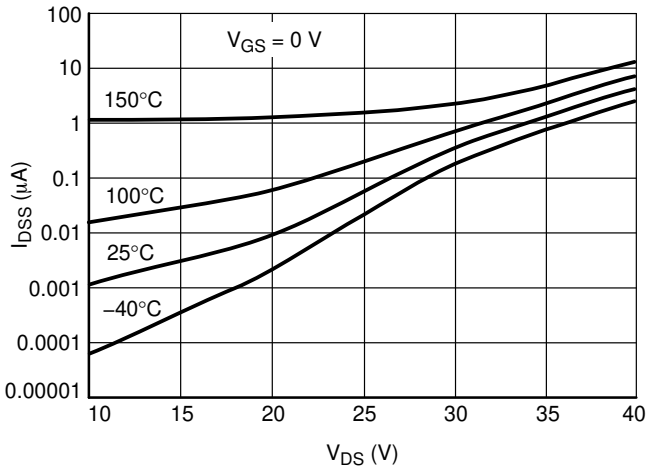



**Figure 13. Drain–to–Source Leakage Current**

## TYPICAL PERFORMANCE CURVES

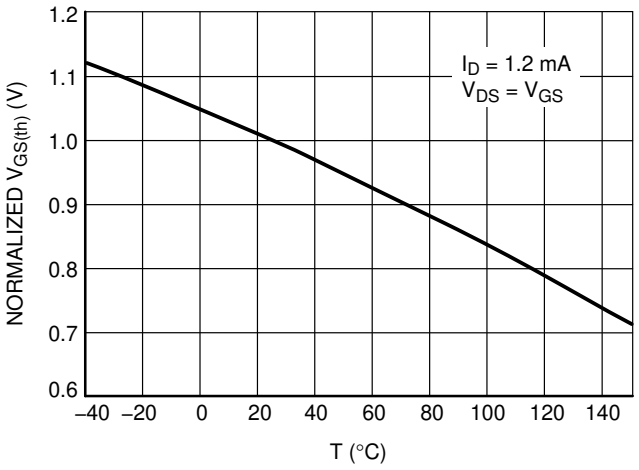



**Figure 14. Normalized Threshold Voltage vs. Temperature**

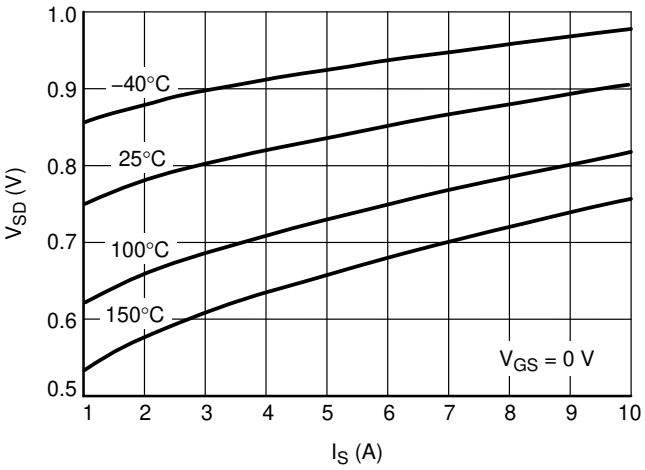



**Figure 15. Source–Drain Diode Forward Characteristics**

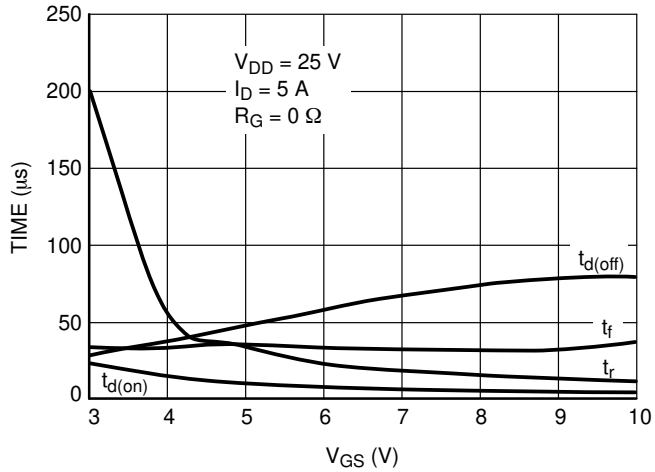



**Figure 16. Resistive Load Switching Time vs. Gate–Source Voltage**

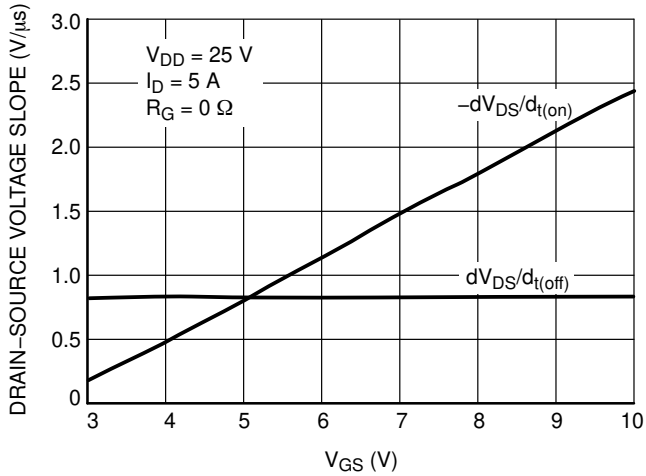



**Figure 17. Resistive Load Switching Drain–Source Voltage Slope vs. Gate–Source Voltage**

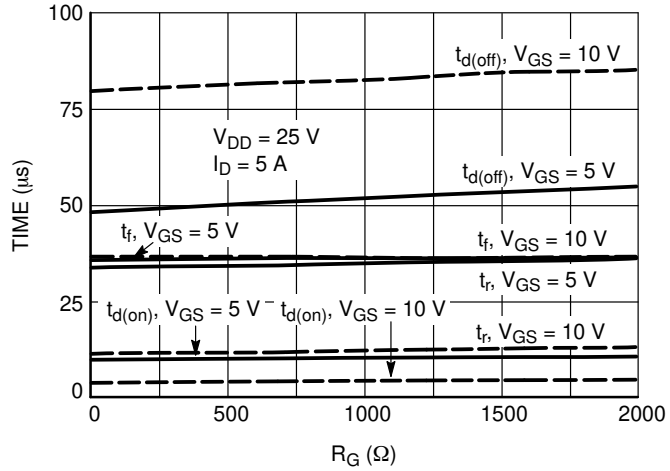



**Figure 18. Resistive Load Switching Time vs. Gate Resistance**

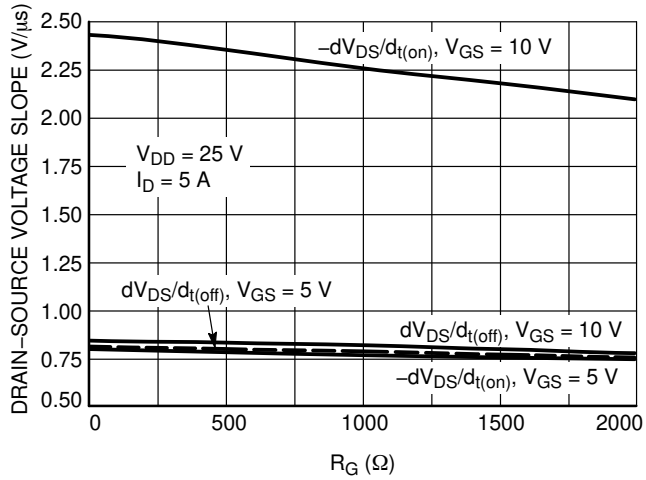



**Figure 19. Drain–Source Voltage Slope during Turn On and Turn Off vs. Gate Resistance**

## TYPICAL PERFORMANCE CURVES

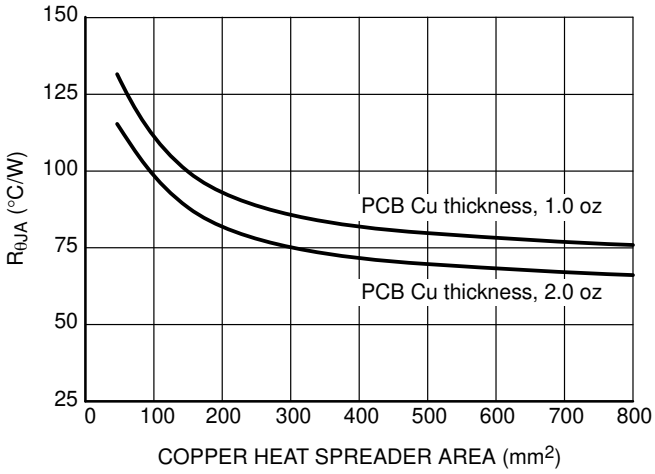



**Figure 20. $R_{\theta JA}$ vs. Copper Area – SOT−223**

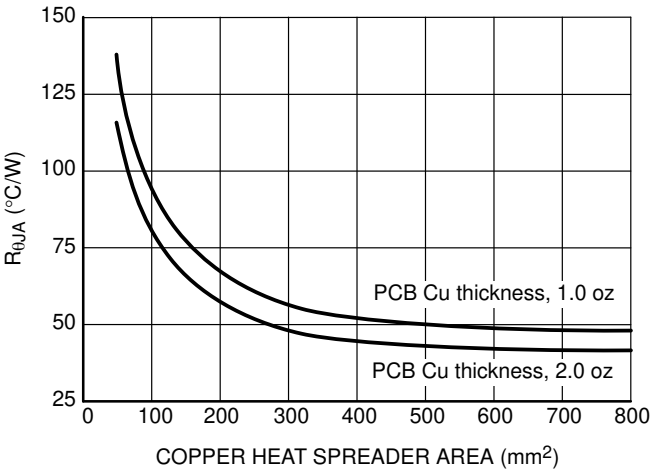



**Figure 21. $R_{\theta JA}$ vs. Copper Area – DPAK**

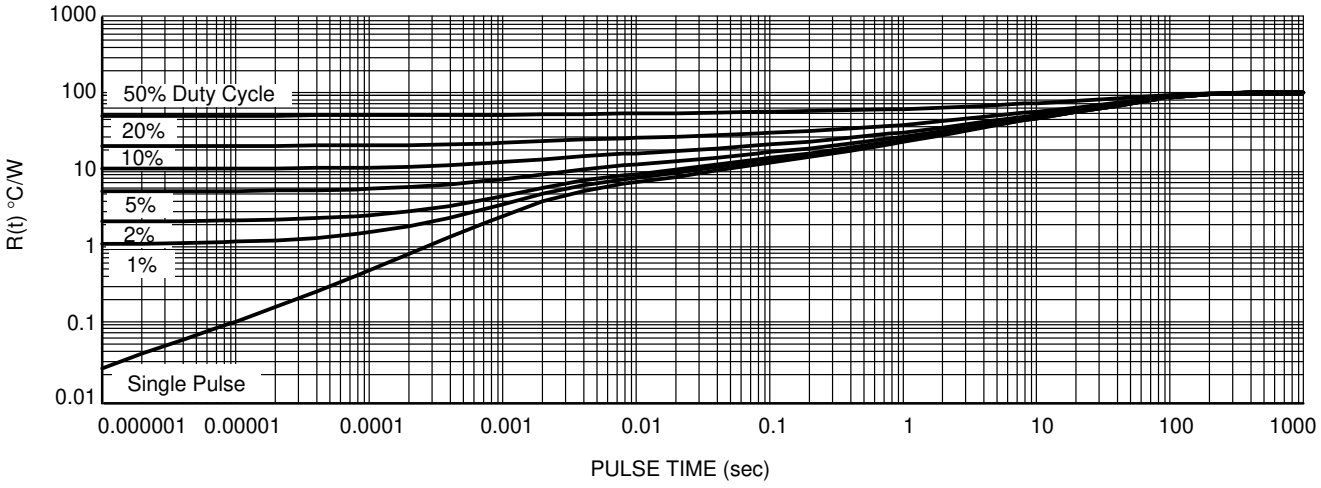



**Figure 22. Transient Thermal Resistance – SOT−223 Version**

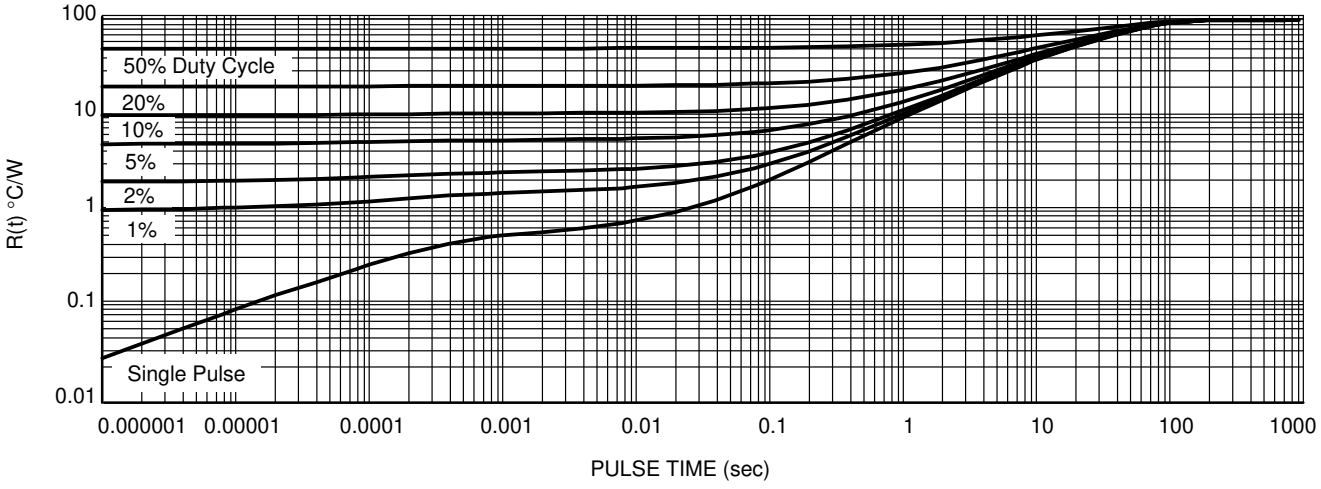



**Figure 23. Transient Thermal Resistance – DPAK Version**

## TEST CIRCUITS AND WAVEFORMS

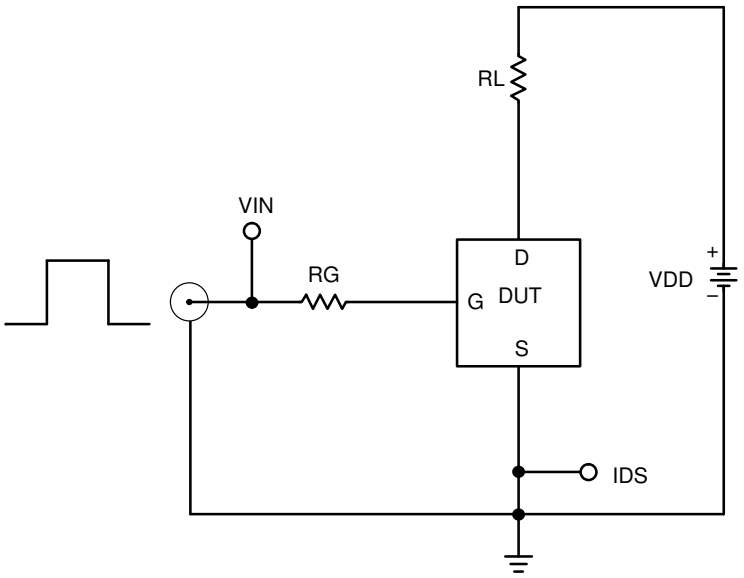



**Figure 24. Resistive Load Switching Test Circuit**

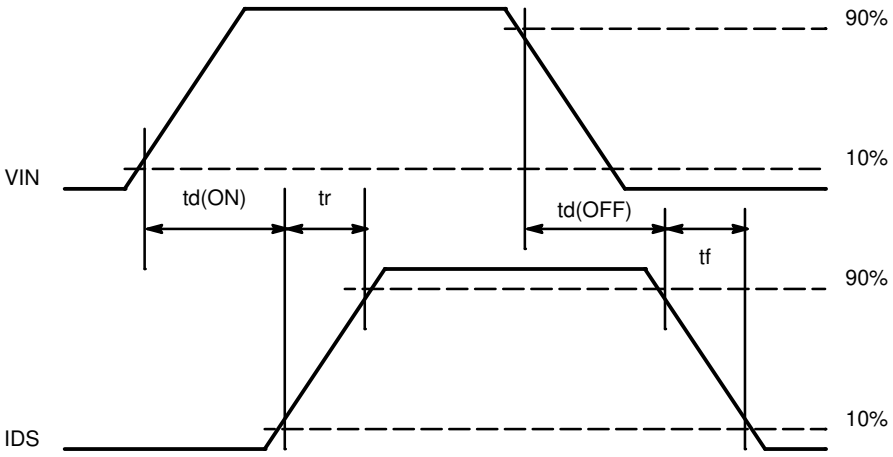



**Figure 25. Resistive Load Switching Waveforms**

## TEST CIRCUITS AND WAVEFORMS

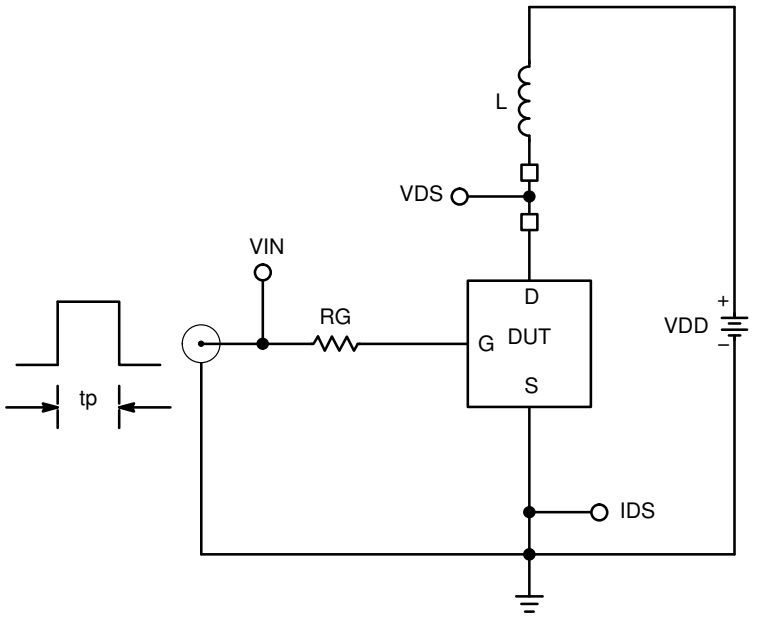



**Figure 26. Inductive Load Switching Test Circuit**

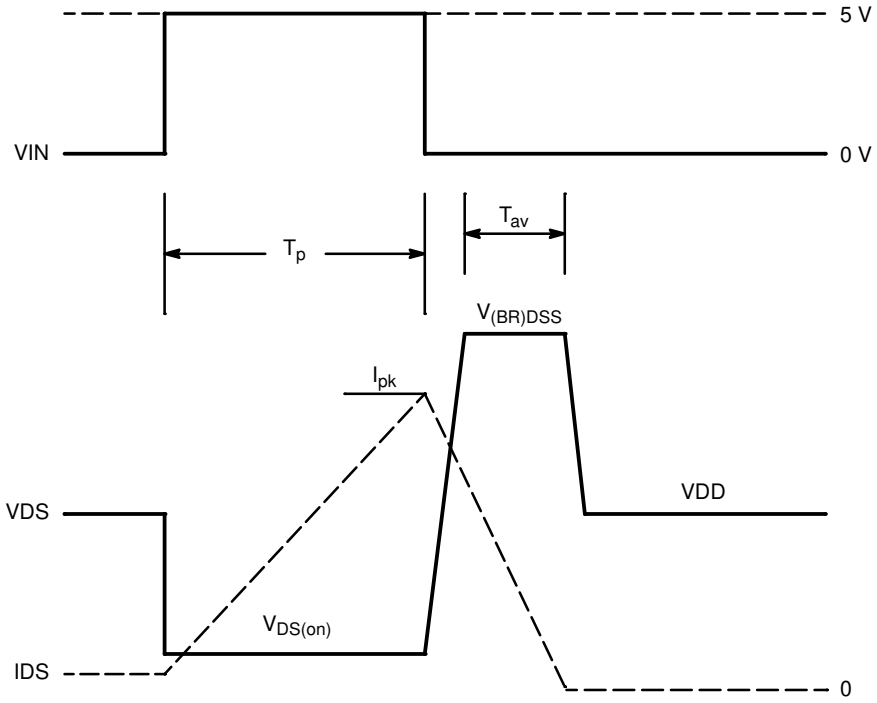



**Figure 27. Inductive Load Switching Waveforms**

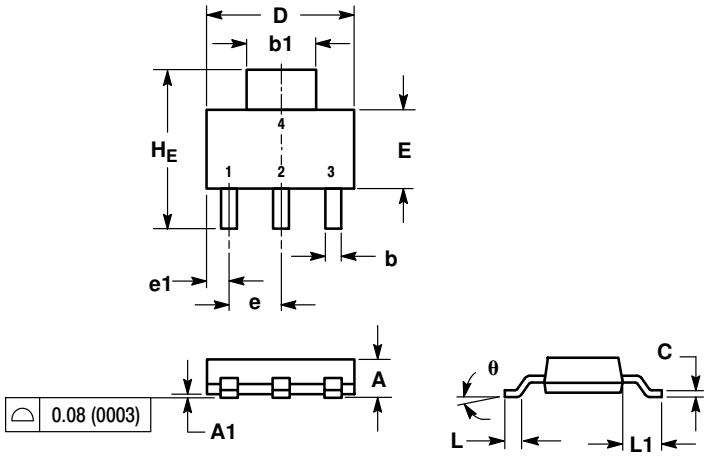
## ORDERING INFORMATION

| Device | Package | Shipping† |
|---|---|---|
| NCV8403STT1G | SOT−223<br>(Pb−Free) | 1000 / Tape & Reel |
| NCV8403STT3G | SOT−223<br>(Pb−Free) | 4000 / Tape & Reel |
| NCV8403DTRKG | DPAK<br>(Pb−Free) | 2500 / Tape & Reel |
| NCV8403ASTT1G | SOT−223<br>(Pb−Free) | 1000 / Tape & Reel |
| NCV8403ASTT3G | SOT−223<br>(Pb−Free) | 4000 / Tape & Reel |
| NCV8403ADTRKG | DPAK<br>(Pb−Free) | 2500 / Tape & Reel |
| NCV8403AMNT2G<br>(In Development) | DFN6<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 Specifications Brochure, BRD8011/D.

## PACKAGE DIMENSIONS

**SOT−223 (TO−261)**
CASE 318E−04
ISSUE N

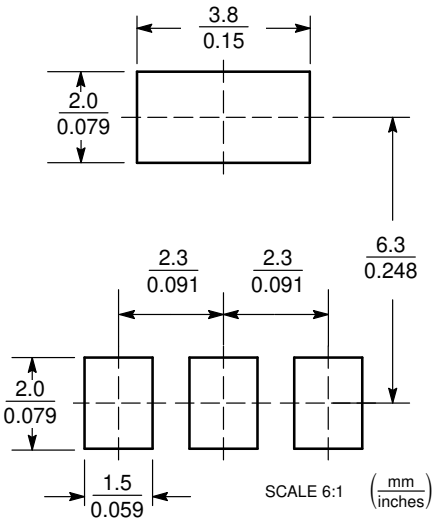



NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCH.

| | MILLIMETERS | | | INCHES | | |
|---|---|---|---|---|---|---|
| DIM | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 1.50 | 1.63 | 1.75 | 0.060 | 0.064 | 0.068 |
| A1 | 0.02 | 0.06 | 0.10 | 0.001 | 0.002 | 0.004 |
| b | 0.60 | 0.75 | 0.89 | 0.024 | 0.030 | 0.035 |
| b1 | 2.90 | 3.06 | 3.20 | 0.115 | 0.121 | 0.126 |
| c | 0.24 | 0.29 | 0.35 | 0.009 | 0.012 | 0.014 |
| D | 6.30 | 6.50 | 6.70 | 0.249 | 0.256 | 0.263 |
| E | 3.30 | 3.50 | 3.70 | 0.130 | 0.138 | 0.145 |
| e | 2.20 | 2.30 | 2.40 | 0.087 | 0.091 | 0.094 |
| e1 | 0.85 | 0.94 | 1.05 | 0.033 | 0.037 | 0.041 |
| L | 0.20 | −−− | −−− | 0.008 | −−− | −−− |
| L1 | 1.50 | 1.75 | 2.00 | 0.060 | 0.069 | 0.078 |
| $H_E$ | 6.70 | 7.00 | 7.30 | 0.264 | 0.276 | 0.287 |
| θ | 0° | − | 10° | 0° | − | 10° |

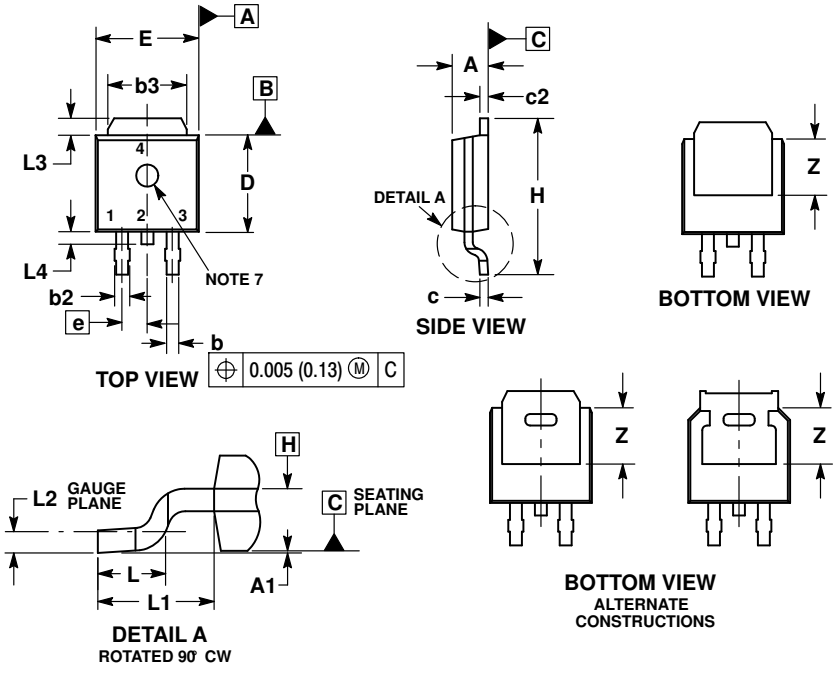
STYLE 3:
PIN 1. GATE
2. DRAIN
3. SOURCE
4. DRAIN

### SOLDERING FOOTPRINT



## PACKAGE DIMENSIONS

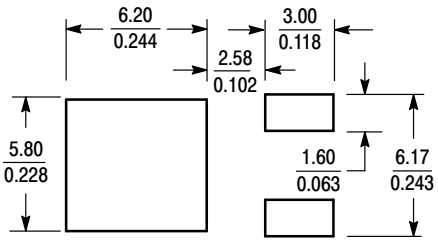
### DPAK (SINGLE GAUGE)
CASE 369C
ISSUE F




NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCHES.
3. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS b3, L3 and Z.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.006 INCHES PER SIDE.
5. DIMENSIONS D AND E ARE DETERMINED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
6. DATUMS A AND B ARE DETERMINED AT DATUM PLANE H.
7. OPTIONAL MOLD FEATURE.

| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 0.086 | 0.094 | 2.18 | 2.38 |
| A1 | 0.000 | 0.005 | 0.00 | 0.13 |
| b | 0.025 | 0.035 | 0.63 | 0.89 |
| b2 | 0.028 | 0.045 | 0.72 | 1.14 |
| b3 | 0.180 | 0.215 | 4.57 | 5.46 |
| c | 0.018 | 0.024 | 0.46 | 0.61 |
| c2 | 0.018 | 0.024 | 0.46 | 0.61 |
| D | 0.235 | 0.245 | 5.97 | 6.22 |
| E | 0.250 | 0.265 | 6.35 | 6.73 |
| e | 0.090 BSC | | 2.29 BSC | |
| H | 0.370 | 0.410 | 9.40 | 10.41 |
| L | 0.055 | 0.070 | 1.40 | 1.78 |
| L1 | 0.114 REF | | 2.90 REF | |
| L2 | 0.020 BSC | | 0.51 BSC | |
| L3 | 0.035 | 0.050 | 0.89 | 1.27 |
| L4 | ––– | 0.040 | ––– | 1.01 |
| Z | 0.155 | ––– | 3.93 | ––– |

### SOLDERING FOOTPRINT*




SCALE 3:1 $\left(\frac{\text{mm}}{\text{inches}}\right)$

*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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