# NCV8440

# Protected Power MOSFET

## 2.6 A, 52 V, N−Channel, Logic Level, Clamped MOSFET w/ ESD Protection

**ON Semiconductor®**

**http://onsemi.com**

### Benefits

- High Energy Capability for Inductive Loads
- Low Switching Noise Generation

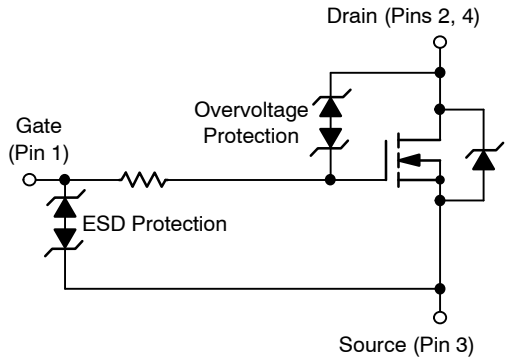
### Features

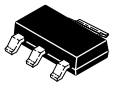
- Diode Clamp Between Gate and Source
- ESD Protection − HBM 5000 V
- Active Over−Voltage Gate to Drain Clamp
- Scalable to Lower or Higher $R_{DS(on)}$
- Internal Series Gate Resistance
- These are Pb−Free Devices

### Applications

- Automotive and Industrial Markets:
  Solenoid Drivers, Lamp Drivers, Small Motor Drivers
- NCV Prefix for Automotive and Other Applications Requiring Site and Control Changes

| $V_{DSS}$ (Clamped) | $R_{DS(ON)}$ TYP | $I_D$ MAX |
|---|---|---|
| 52 V | 95 mΩ @ 10 V | 2.6 A |

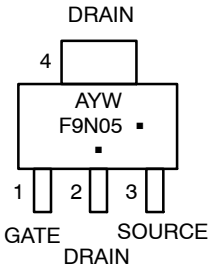


**SOT−223**
**CASE 318E**
**STYLE 3**

1 = Gate
2 = Drain
3 = Source

**MARKING DIAGRAM**




A = Assembly Location
Y = Year
W = Work Week
▪ = Pb−Free Package

(Note: Microdot may be in either location)

**ORDERING INFORMATION**

| Device | Package | Shipping† |
|---|---|---|
| NCV8440STT1G | SOT−223 (Pb−Free) | 1000/Tape & Reel |
| NCV8440STT3G | SOT−223 (Pb−Free) | 4000/Tape & Reel |

†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.

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

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Drain−to−Source Voltage Internally Clamped | $V_{DSS}$ | 52−59 | V |
| Gate−to−Source Voltage − Continuous | $V_{GS}$ | ±15 | V |
| Drain Current<br>− Continuous @ $T_A$ = 25°C<br>− Single Pulse ($t_p$ = 10 μs) (Note 1) | $I_D$<br><br>$I_{DM}$ | <br>2.6<br>10 | A |
| Total Power Dissipation @ $T_A$ = 25°C (Note 1) | $P_D$ | 1.69 | W |
| Operating and Storage Temperature Range | $T_J$, $T_{stg}$ | −55 to 150 | °C |
| Single Pulse Drain−to−Source Avalanche Energy ($V_{DD}$ = 50 V, $I_{D(pk)}$ = 1.17 A, $V_{GS}$ = 10 V, L = 160 mH, $R_G$ = 25 Ω) | $E_{AS}$ | 110 | mJ |
| Thermal Resistance,<br>Junction−to−Ambient (Note 1)<br>Junction−to−Ambient (Note 2) | <br>$R_{\theta JA}$<br>$R_{\theta JA}$ | <br>74<br>169 | °C/W |
| Maximum Lead Temperature for Soldering Purposes, 1/8″ from Case for 10 Seconds | $T_L$ | 260 | °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.

1. When surface mounted to a FR4 board using 1″ pad size, (Cu area 1.127 $in^2$).
2. When surface mounted to a FR4 board using minimum recommended pad size, (Cu area 0.412 $in^2$).

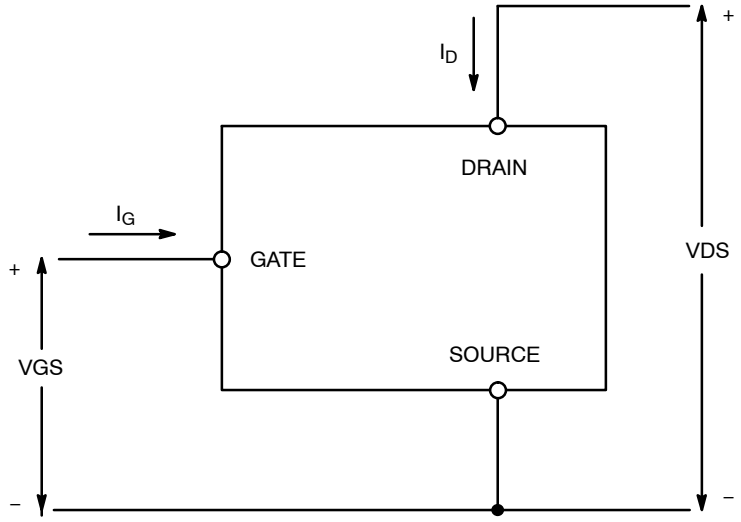



**Figure 1. Voltage and Current Convention**

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

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| Drain−to−Source Breakdown Voltage (Note 3)<br>($V_{GS}$ = 0 V, $I_D$ = 1.0 mA, $T_J$ = 25°C)<br>($V_{GS}$ = 0 V, $I_D$ = 1.0 mA, $T_J$ = −40°C to 125°C) (Note 4)<br>Temperature Coefficient (Negative) | $V_{(BR)DSS}$ | <br>52<br>50.8 | <br>55<br>54<br>−9.3 | <br>59<br>59.5 | <br>V<br>V<br>mV/°C |
| Zero Gate Voltage Drain Current<br>($V_{DS}$ = 40 V, $V_{GS}$ = 0 V)<br>($V_{DS}$ = 40 V, $V_{GS}$ = 0 V, $T_J$ = 125°C) (Note 4) | $I_{DSS}$ | | | <br>10<br>25 | μA |
| Gate−Body Leakage Current<br>($V_{GS}$ = ±8 V, $V_{DS}$ = 0 V)<br>($V_{GS}$ = ±14 V, $V_{DS}$ = 0 V) | $I_{GSS}$ | | <br>±35 | ±10 | μA |
| **ON CHARACTERISTICS** (Note 3) | | | | | |
| Gate Threshold Voltage (Note 3)<br>($V_{DS}$ = $V_{GS}$, $I_D$ = 100 μA)<br>Threshold Temperature Coefficient (Negative) | $V_{GS(th)}$ | 1.1 | 1.5<br>−4.1 | 1.9 | V<br>mV/°C |
| Static Drain−to−Source On−Resistance (Note 3)<br>($V_{GS}$ = 3.5 V, $I_D$ = 0.6 A)<br>($V_{GS}$ = 4.0 V, $I_D$ = 1.5 A)<br>($V_{GS}$ = 10 V, $I_D$ = 2.6 A) | $R_{DS(on)}$ | | <br>135<br>150<br>95 | <br>180<br>160<br>110 | mΩ |
| Forward Transconductance (Note 3) ($V_{DS}$ = 15 V, $I_D$ = 2.6 A) | $g_{FS}$ | | 3.8 | | Mhos |
| **DYNAMIC CHARACTERISTICS** | | | | | |
| Input Capacitance | $V_{DS}$ = 35 V, $V_{GS}$ = 0 V, f = 10 kHz | $C_{iss}$ | | 155 | | pF |
| Output Capacitance | | $C_{oss}$ | | 60 | | |
| Transfer Capacitance | | $C_{rss}$ | | 25 | | |
| Input Capacitance | $V_{DS}$ = 25 V, $V_{GS}$ = 0 V, f = 10 kHz | $C_{iss}$ | | 170 | | pF |
| Output Capacitance | | $C_{oss}$ | | 70 | | |
| Transfer Capacitance | | $C_{rss}$ | | 30 | | |

3. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%.
4. Not subject to production testing.
5. Switching characteristics are independent of operating junction temperatures.

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

| Characteristic | | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **SWITCHING CHARACTERISTICS** (Note 5) | | | | | | |
| Turn−On Delay Time | $V_{GS}$ = 4.5 V, $V_{DD}$ = 40 V, $I_D$ = 2.6 A, $R_D$ = 15.4 Ω | $t_{d(on)}$ | | 375 | | ns |
| Rise Time | | $t_r$ | | 1525 | | |
| Turn−Off Delay Time | | $t_{d(off)}$ | | 1530 | | |
| Fall Time | | $t_f$ | | 1160 | | |
| Turn−On Delay Time | $V_{GS}$ = 4.5 V, $V_{DD}$ = 40 V, $I_D$ = 1.0 A, $R_D$ = 40 Ω | $t_{d(on)}$ | | 325 | | ns |
| Rise Time | | $t_r$ | | 1275 | | |
| Turn−Off Delay Time | | $t_{d(off)}$ | | 1860 | | |
| Fall Time | | $t_f$ | | 1150 | | |
| Turn−On Delay Time | $V_{GS}$ = 10 V, $V_{DD}$ = 15 V, $I_D$ = 2.6 A, $R_D$ = 5.8 Ω | $t_{d(on)}$ | | 190 | | ns |
| Rise Time | | $t_r$ | | 710 | | |
| Turn−Off Delay Time | | $t_{d(off)}$ | | 2220 | | |
| Fall Time | | $t_f$ | | 1180 | | |
| Gate Charge | $V_{GS}$ = 4.5 V, $V_{DS}$ = 40 V, $I_D$ = 2.6 A (Note 3) | $Q_T$ | | 4.5 | | nC |
| | | $Q_1$ | | 0.9 | | |
| | | $Q_2$ | | 2.6 | | |
| Gate Charge | $V_{GS}$ = 4.5 V, $V_{DS}$ = 15 V, $I_D$ = 1.5 A (Note 3) | $Q_T$ | | 3.9 | | nC |
| | | $Q_1$ | | 1.0 | | |
| | | $Q_2$ | | 1.7 | | |
| **SOURCE−DRAIN DIODE CHARACTERISTICS** | | | | | | |
| Forward On−Voltage | $I_S$ = 2.6 A, $V_{GS}$ = 0 V (Note 3)<br>$I_S$ = 2.6 A, $V_{GS}$ = 0 V, $T_J$ = 125°C | $V_{SD}$ | | 0.81<br>0.66 | 1.5 | V |
| Reverse Recovery Time | $I_S$ = 1.5 A, $V_{GS}$ = 0 V, $dI_s/dt$ = 100 A/μs (Note 3) | $t_{rr}$ | | 730 | | ns |
| | | $t_a$ | | 200 | | |
| | | $t_b$ | | 530 | | |
| Reverse Recovery Stored Charge | | $Q_{RR}$ | | 6.3 | | μC |
| **ESD CHARACTERISTICS** (Note 4) | | | | | | |
| Electro−Static Discharge Capability | Human Body Model (HBM) | ESD | 5000 | | | V |
| | Machine Model (MM) | | 500 | | | |

3. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%.
4. Not subject to production testing.
5. Switching characteristics are independent of operating junction temperatures.

## TYPICAL PERFORMANCE CURVES

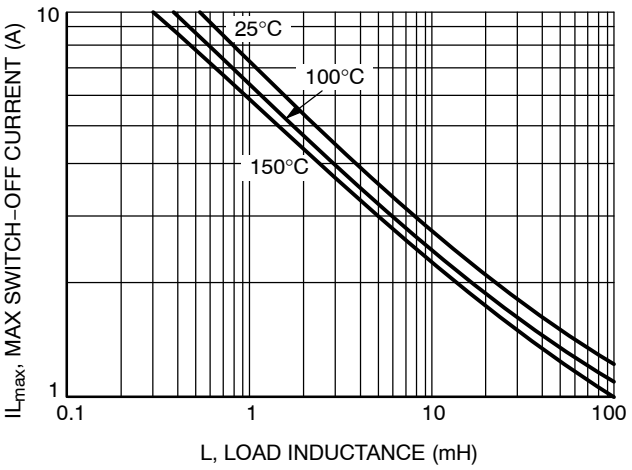



**Figure 1. Single Pulse Maximum Switch−off Current vs. Load Inductance**

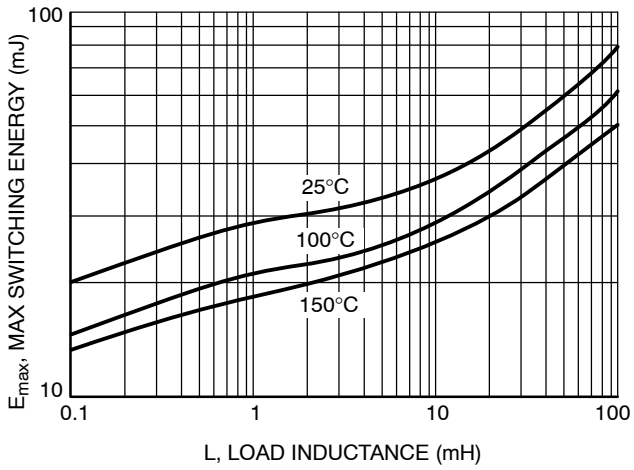



**Figure 2. Single Pulse Maximum Switching Energy vs. Load Inductance**

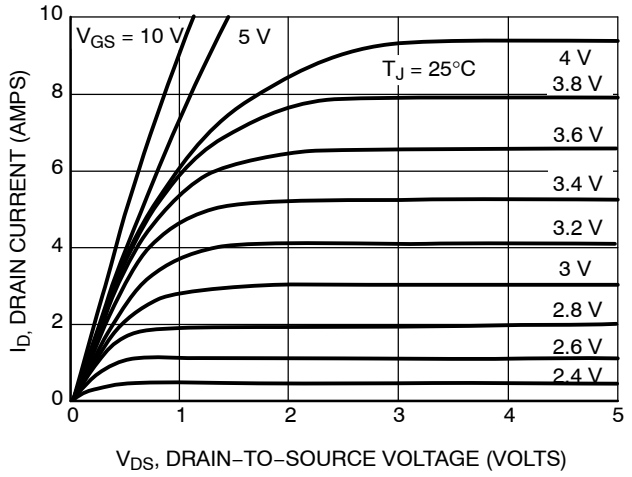



**Figure 3. On−State Output Characteristics**

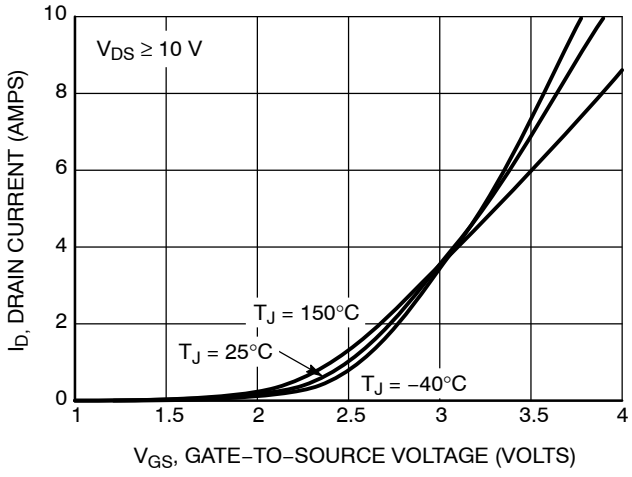



**Figure 4. Transfer Characteristics**

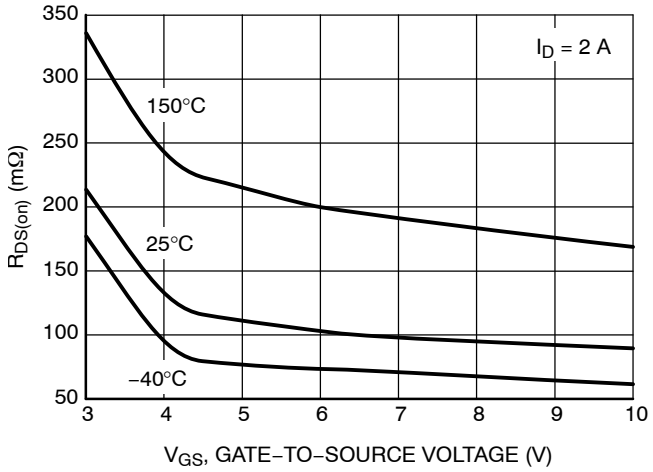



**Figure 5. $R_{DS(on)}$ vs. Gate−Source Voltage**

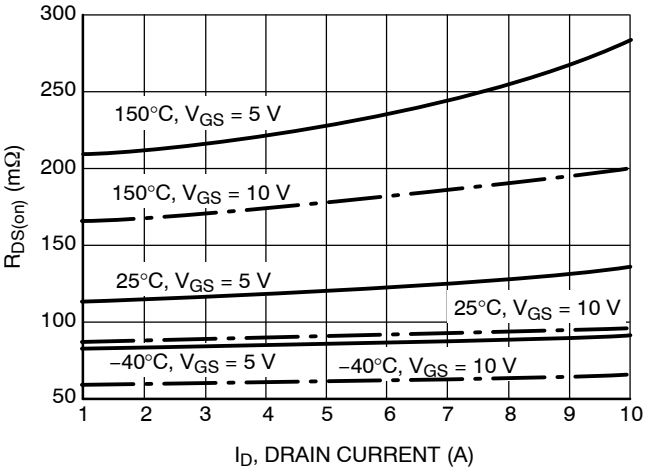



**Figure 6. $R_{DS(on)}$ vs. Drain Current**

## TYPICAL PERFORMANCE CURVES

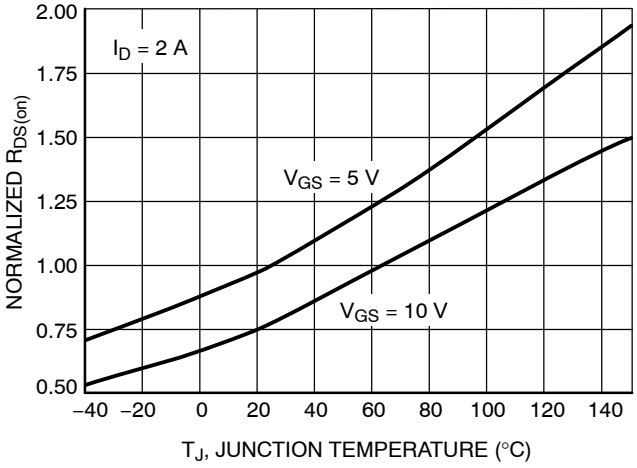



**Figure 7. Normalized $R_{DS(on)}$ vs. Temperature**

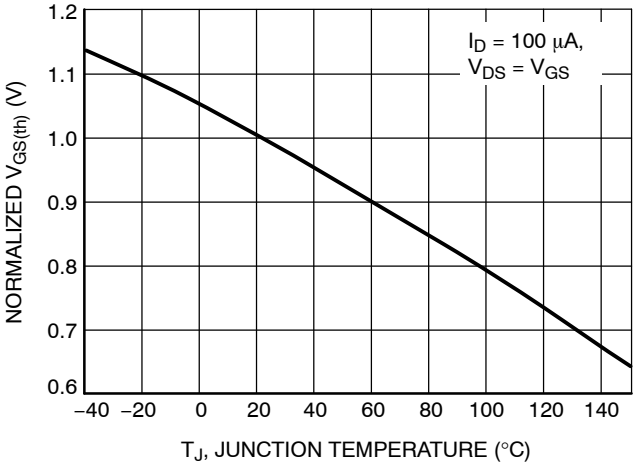



**Figure 8. Normalized Threshold Voltage vs. Temperature**

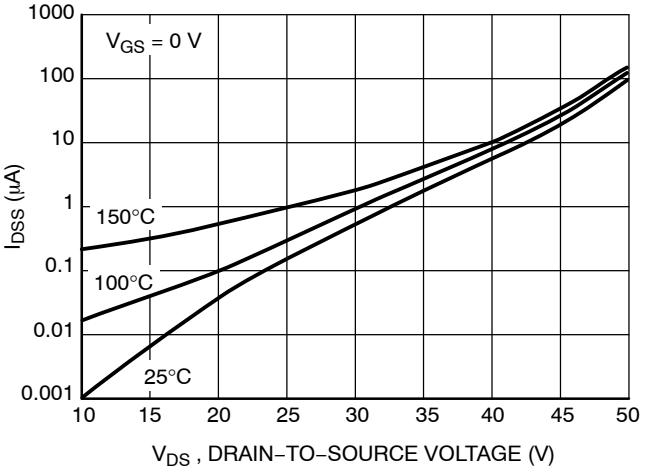



**Figure 9. Drain−to−Source Leakage Current**

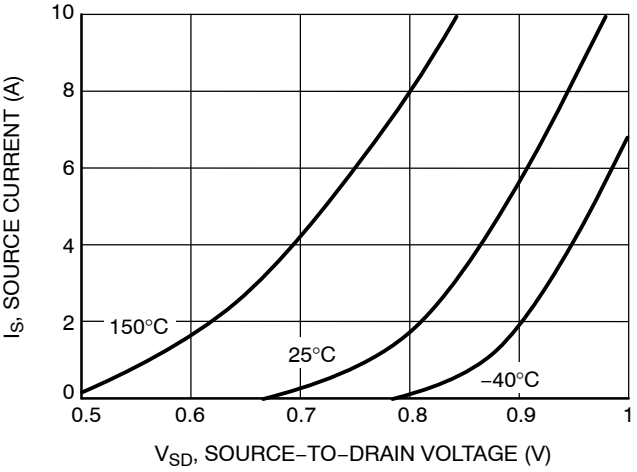



**Figure 10. Source−Drain Diode Forward Characteristics**

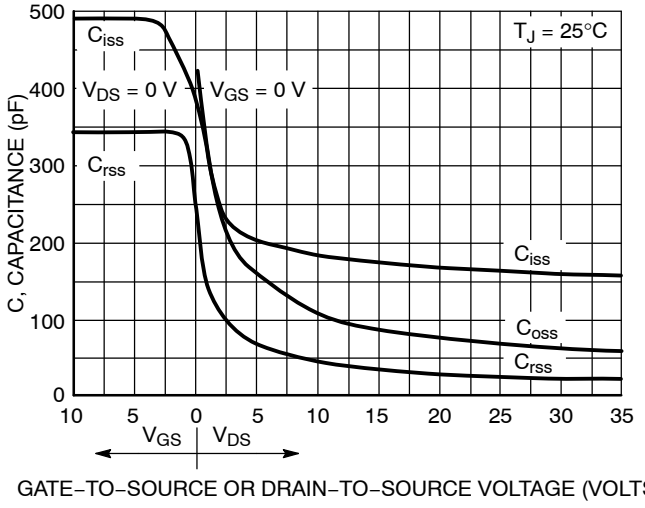



**Figure 11. Capacitance Variation**

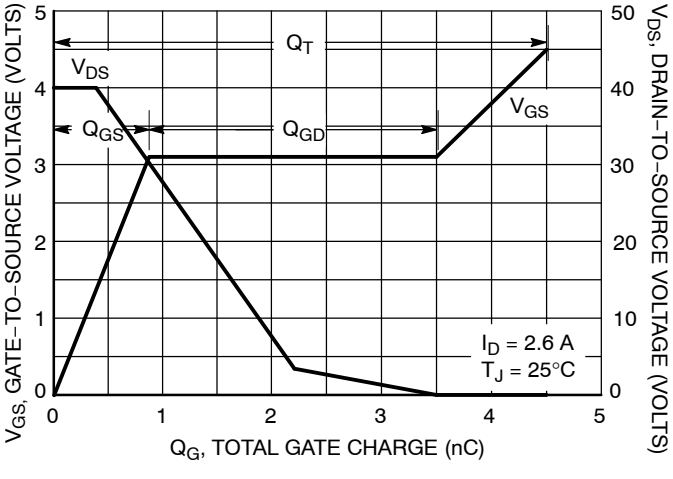



**Figure 12. Gate−to−Source Voltage vs. Total Gate Charge**

## TYPICAL PERFORMANCE CURVES

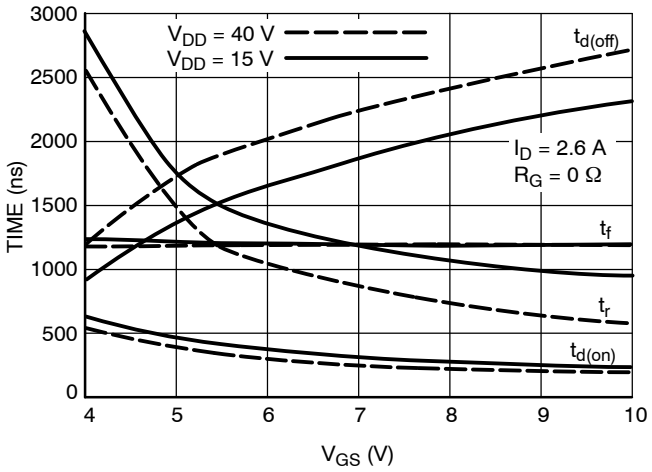



**Figure 13. Resistive Load Switching Time vs. Gate−Source Voltage**

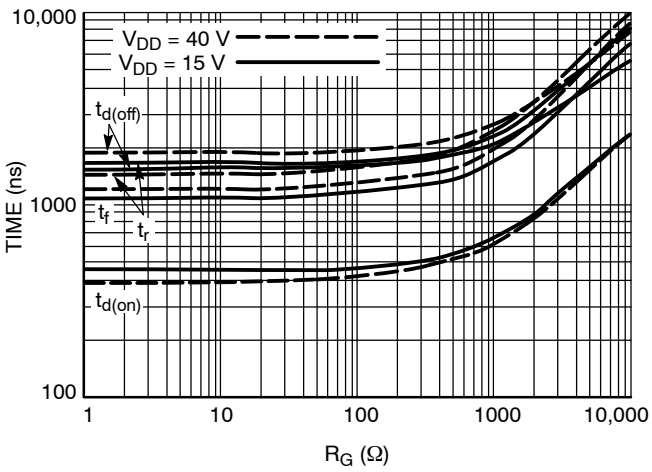



**Figure 14. Resistive Load Switching Time vs. Gate Resistance ($V_{GS}$ = 5 V, $I_D$ = 2.6 A)**

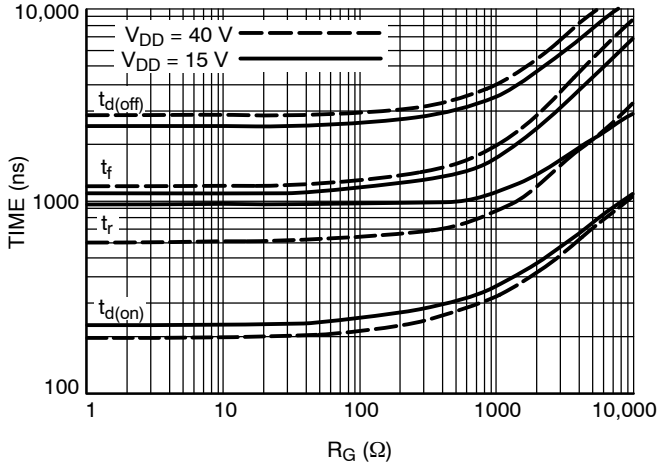



**Figure 15. Resistive Load Switching Time vs. Gate Resistance ($V_{GS}$ = 10 V, $I_D$ = 2.6 A)**

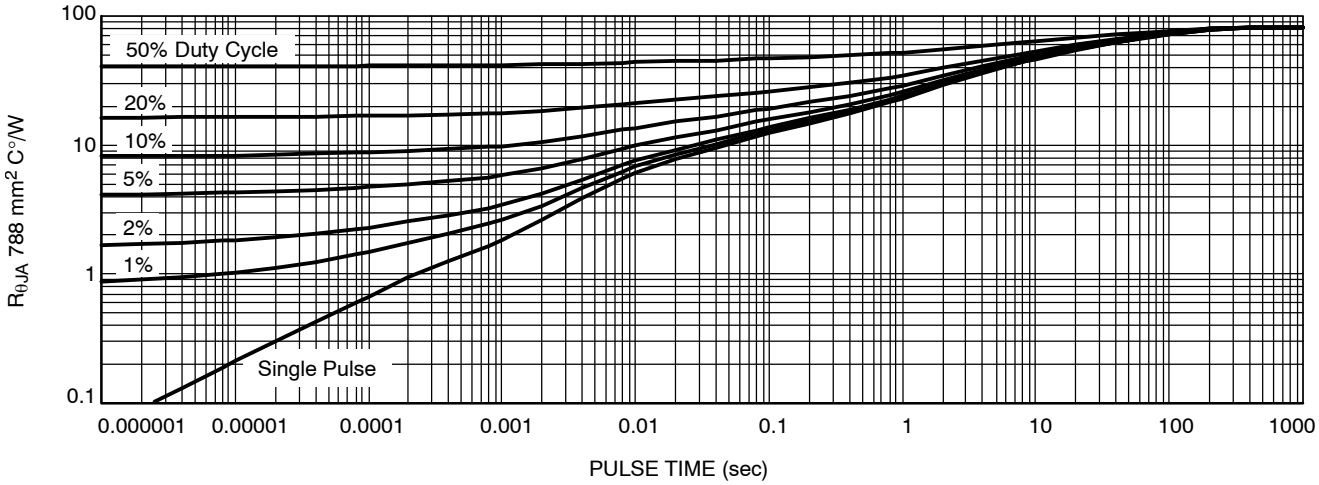
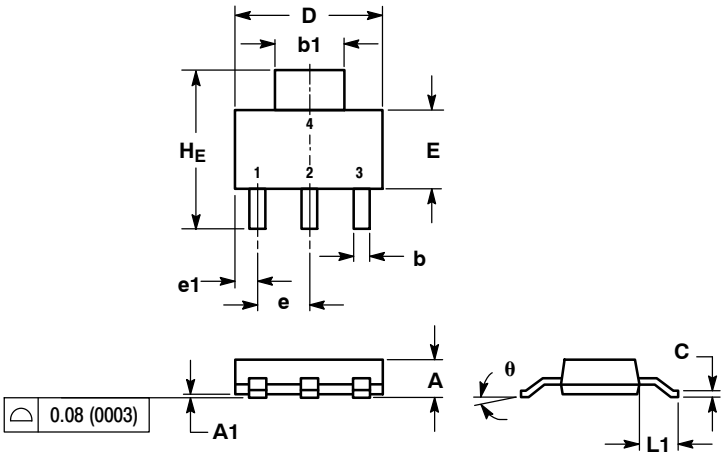



**Figure 16. Transient Thermal Resistance**

## PACKAGE DIMENSIONS

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

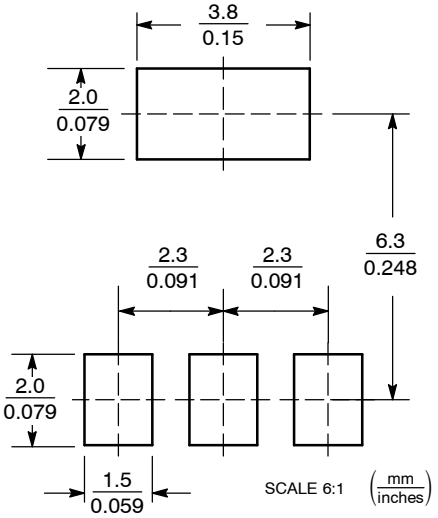



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

| | 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 |
| 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*




*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.



### PUBLICATION ORDERING INFORMATION

**LITERATURE FULFILLMENT**:
Literature Distribution Center for ON Semiconductor
P.O. Box 5163, Denver, Colorado 80217 USA
**Phone**: 303−675−2175 or 800−344−3860 Toll Free USA/Canada
**Fax**: 303−675−2176 or 800−344−3867 Toll Free USA/Canada
**Email**: orderlit@onsemi.com

**N. American Technical Support**: 800−282−9855 Toll Free USA/Canada
**Europe, Middle East and Africa Technical Support:**
Phone: 421 33 790 2910
**Japan Customer Focus Center**
Phone: 81−3−5773−3850

**ON Semiconductor Website**: **www.onsemi.com**

**Order Literature**: http://www.onsemi.com/orderlit

For additional information, please contact your local Sales Representative