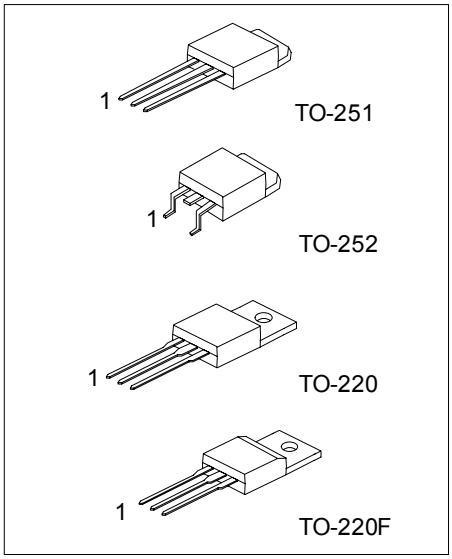
# 2N60

**MOSFET**

## 2A 600V N-CHANNEL MOSFET

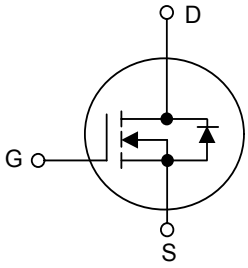



*Pb-free plating product number: 2N60L

### ■ FEATURES

* Typical $R_{DS(ON)}$ = 3.7Ω @$V_{GS}$ = 10V
* Avalanche rugged technology
* Low gate charge (typical 9.0 nC)
* Low Crss (typical 5.0 pF)
* 100% avalanche tested
* Excellent switching characteristics
* Extremely high dv/dt capability

### ■ SYMBOL




### ■ ORDERING INFORMATION

| Order Number | | Package | Pin Assignment | | | Packing |
|---|---|---|---|---|---|---|
| Normal | Lead Free Plating | | 1 | 2 | 3 | |
| 2N60-TA3-0-T | 2N60L-TA3-0-T | TO-220 | G | D | S | Tube |
| 2N60-TF3-0-T | 2N60L-TF3-0-T | TO-220F | G | D | S | Tube |
| 2N60-TM3-0-T | 2N60L-TM3-0-T | TO-251 | G | D | S | Tube |
| 2N60-TN3-0-R | 2N60L-TN3-0-R | TO-252 | G | D | S | Tape Reel |
| 2N60-TN3-0-T | 2N60L-TN3-0-T | TO-252 | G | D | S | Tube |

Note: Pin Assignment: G: Gate D: Drain S: Source

2N60L-TA3-0-R
(1)Packing Type
(2)Pin Assignment
(3)Package Type
(4)Lead Plating

(1) R: Tape Reel
(2) refer to Pin Assignment
(3) TA3: TO-220, TF3: TO-220F, TM3: TO-251, TN3: TO-252
(4) L: Lead Free Plating, Blank: Pb/Sn

## ■ ABSOLUTE MAXIMUM RATINGS ($T_C$ = 25℃, unless otherwise specified)

| PARAMETER | | SYMBOL | RATINGS | UNIT |
|---|---|---|---|---|
| Drain-Source Voltage | | $V_{DSS}$ | 600 | V |
| Gate-Source Voltage | | $V_{GSS}$ | ±30 | V |
| Avalanche Current (Note 3) | | $I_{AR}$ | 2.0 | A |
| Drain Current Continuous | $T_C$ = 25°C | $I_D$ | 2.0 | A |
| | $T_C$ = 100°C | | 1.26 | A |
| Drain Current Pulsed (Note 3) | | $I_{DP}$ | 8.0 | A |
| Avalanche Energy | Repetitive(Note 3) | $E_{AR}$ | 4.5 | mJ |
| | Single Pulse(Note 4) | $E_{AS}$ | 140 | mJ |
| Peak Diode Recovery dv/dt (Note 5) | | dv/dt | 4.5 | V/ns |
| Total Power Dissipation ($T_C$ = 25°C) | | $P_D$ | 45 | W |
| Derate above 25°C | | | 0.36 | W/℃ |
| Junction Temperature | | $T_J$ | +125 | ℃ |
| Operation Temperature | | $T_{OPR}$ | -20 ~ +85 | ℃ |
| Storage Temperature | | $T_{STG}$ | -40 ~ +150 | ℃ |

Note:1. Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.
2. The device is guaranteed to meet performance specification within 0℃~+70℃ operating temperature range and assured by design from -20℃~+85℃.
3. Repetitive Rating: Pulse width limited by maximum junction temperature
4. L=64mH, $I_{AS}$=2.0A, $V_{DD}$=50V, $R_G$=25 Ω, Starting $T_J$ = 25°C
5. $I_{SD}$≤ 2.4A, di/dt ≤ 200A/μs, $V_{DD}$ ≤ $BV_{DSS}$, Starting $T_J$ = 25°C

## ■ ELECTRICAL CHARACTERISTICS ($T_J$ =25℃, unless Otherwise specified.)

| PARAMETER | | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| **Off Characteristics** | | | | | | | |
| Drain-Source Breakdown Voltage | | $BV_{DSS}$ | $V_{GS}$ = 0V, $I_D$ = 250μA | 600 | | | V |
| Zero Gate Voltage Drain Current | | $I_{DSS}$ | $V_{DS}$ = 600V, $V_{GS}$ = 0V | | | 10 | μA |
| | | | $V_{DS}$ = 480V, $T_C$ = 125°C | | | 100 | |
| Gate-Body Leakage Current | Forward | $I_{GSS}$ | $V_{GS}$ = 30V, $V_{DS}$ = 0V | | | 100 | nA |
| | Reverse | | $V_{GS}$ = -30V, $V_{DS}$ = 0V | | | -100 | |
| Breakdown Voltage Temperature Coefficient | | $\triangle BV_{DSS}/\triangle T_J$ | $I_D$ = 250 μA | | 0.4 | | V/℃ |
| **On Characteristics** | | | | | | | |
| Gate Threshold Voltage | | $V_{GS(th)}$ | $V_{DS}$ = $V_{GS}$, $I_D$ = 250μA | 3.0 | | 5.0 | V |
| Static Drain-Source On-Resistance | | $R_{DS(on)}$ | $V_{GS}$ = 10V, $I_D$ =1A | | 3.7 | 4.7 | Ω |
| Forward Transconductance | | $g_{FS}$ | $V_{DS}$ = 50V, $I_D$ = 1A (Note 1) | | 2.25 | | S |
| **Dynamic Characteristics** | | | | | | | |
| Input Capacitance | | $C_{ISS}$ | $V_{DS}$ =25V, $V_{GS}$ =0V, f =1MHz | | 270 | 350 | pF |
| Output Capacitance | | $C_{OSS}$ | | | 40 | 50 | |
| Reverse Transfer Capacitance | | $C_{RSS}$ | | | 5 | 7 | |
| **Switching Characteristics** | | | | | | | |
| Turn-On Delay Time | | $t_{DLY(on)}$ | $V_{DD}$ =300V, $I_D$ =2.4A, $R_G$=25Ω (Note 1,2) | | 10 | 30 | ns |
| Rise Time | | $t_R$ | | | 25 | 60 | |
| Turn-Off Delay Time | | $t_{DLY(off)}$ | | | 20 | 50 | |
| Fall Time | | $t_F$ | | | 25 | 60 | |
| Total Gate Charge | | $Q_G$ | $V_{DS}$=480V, $V_{GS}$=10V, $I_D$=2.4A (Note 1, 2) | | 9.0 | 11 | nC |
| Gate-Source Charge | | $Q_{GS}$ | | | 1.6 | | |
| Gate-Drain Charge | | $Q_{GD}$ | | | 4.3 | | |

Note: 1. Pulse Test: Pulse Width ≤300μs, Duty Cycle≤2%
2. Essentially Independent of Operating Temperature

## ■ ELECTRICAL CHARACTERISTICS(Cont.)

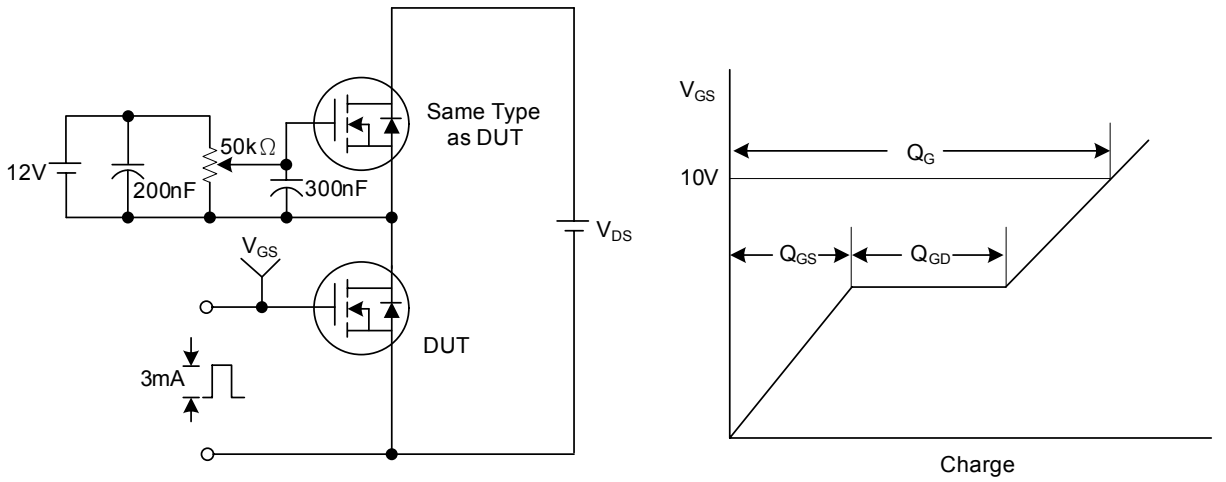
| PARAMETER | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **Drain-Source Diode Characteristics** | | | | | | |
| Drain-Source Diode Forward Voltage | $V_{SD}$ | $V_{GS}$ = 0 V, $I_{SD}$ = 2.0 A | | | 1.4 | V |
| Continuous Drain-Source Current | $I_{SD}$ | | | | 2.0 | A |
| Pulsed Drain-Source Current | $I_{SM}$ | | | | 8.0 | A |
| Reverse Recovery Time | $t_{rr}$ | $V_{GS}$ = 0 V, $I_{SD}$ = 2.4A, | | 180 | | ns |
| Reverse Recovery Charge | $Q_{rr}$ | di/dt = 100 A/μs (Note) | | 0.72 | | μC |

Note: Pulse Test: Pulse Width ≤300μs, Duty Cycle≤2%

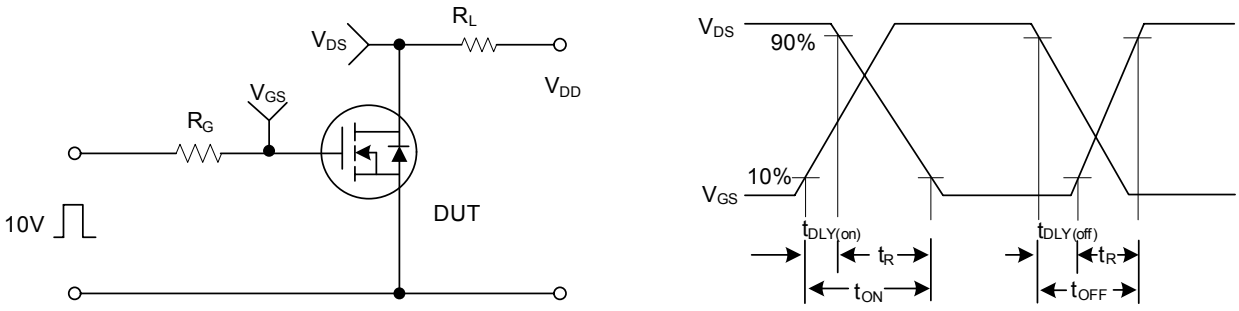
## ■ THERMAL DATA

| PARAMETER | PACKAGE | SYMBOL | RATINGS | UNIT |
|---|---|---|---|---|
| Thermal Resistance Junction-Ambient | TO-251 | $\theta_{JA}$ | 112 | ℃/W |
| | TO-252 | | 112 | |
| | TO-220 | | 54 | |
| | TO-220F | | 54 | |
| Thermal Resistance Junction-Case | TO-251 | $\theta_{Jc}$ | 12 | |
| | TO-252 | | 12 | |
| | TO-220 | | 4 | |
| | TO-220F | | 4 | |

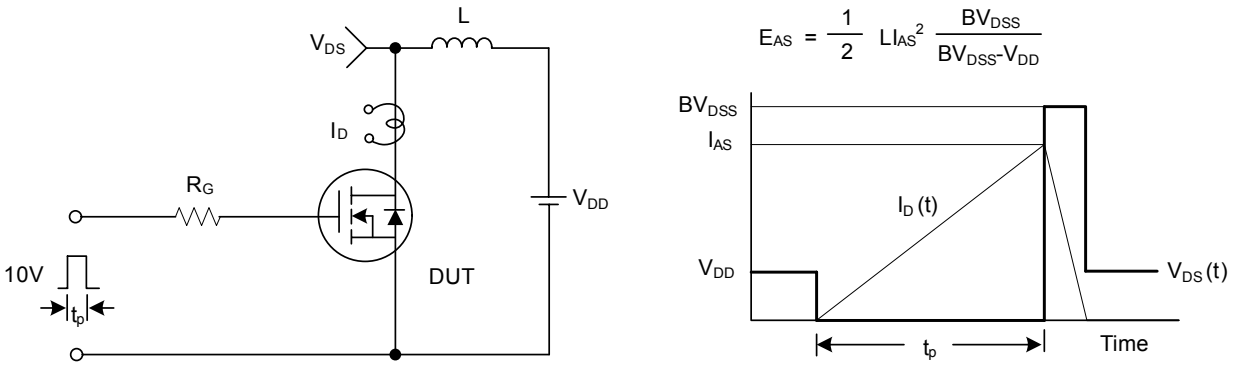
## ■ TEST CIRCUIT AND WAVEFORM




Gate Charge Test Circuit & Waveform

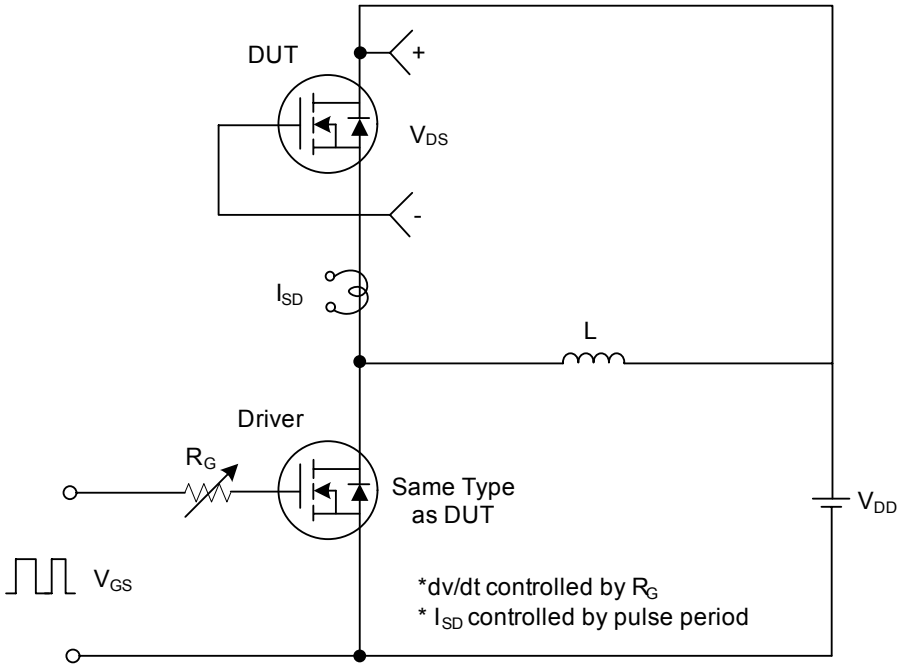


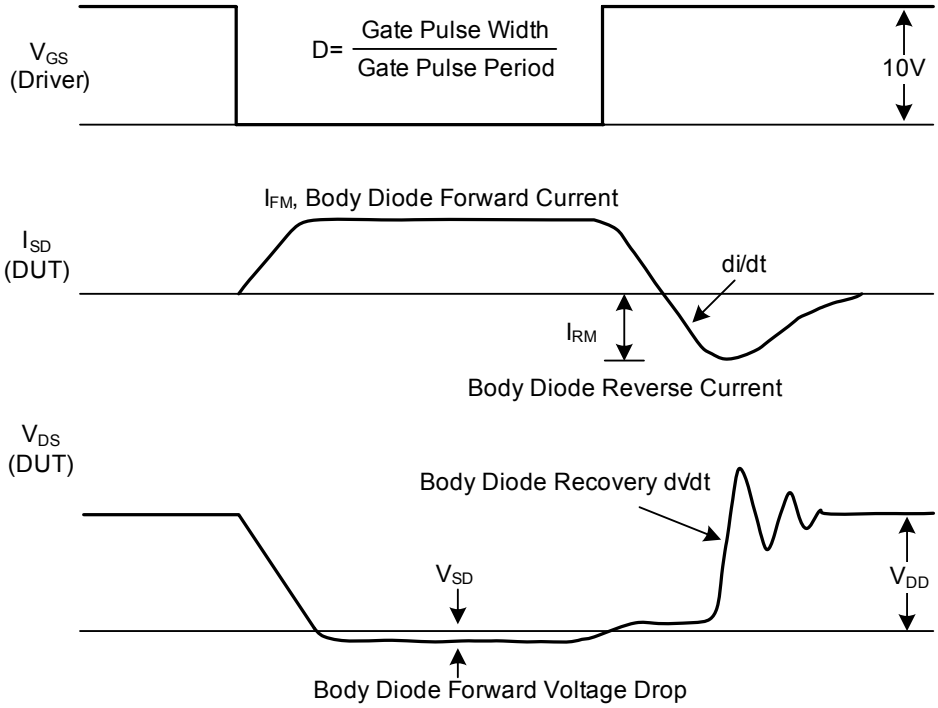

Resistive Switching Test Circuit & Waveforms




Unclamped Inductive Switching Test Circuit & Waveforms

## ■ TEST CIRCUIT AND WAVEFORM(Cont.)




Peak Diode Recovery dv/dt Test Circuit & Waveforms

## ■ TYPICAL CHARACTERISTICS

Figure 1. On-Region Characteristics

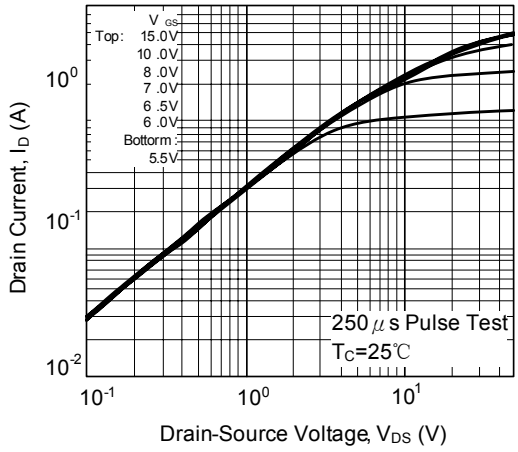



Figure 2. Transfer Characteristics

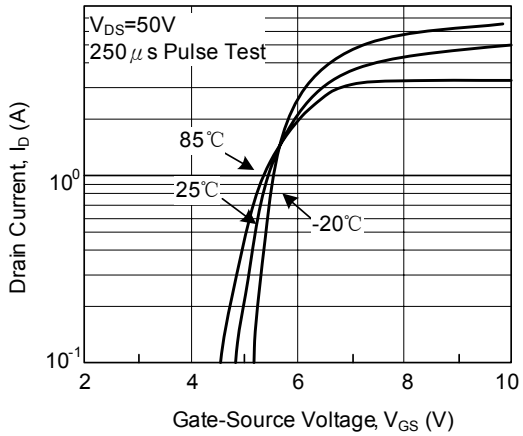



Figure 3. On-Resistance Variation vs Drain Current and Gate Voltage

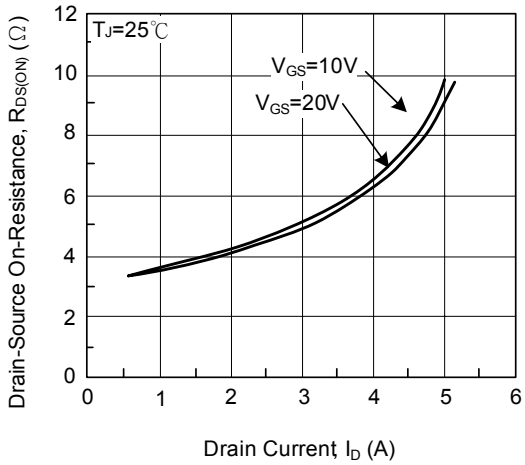



Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

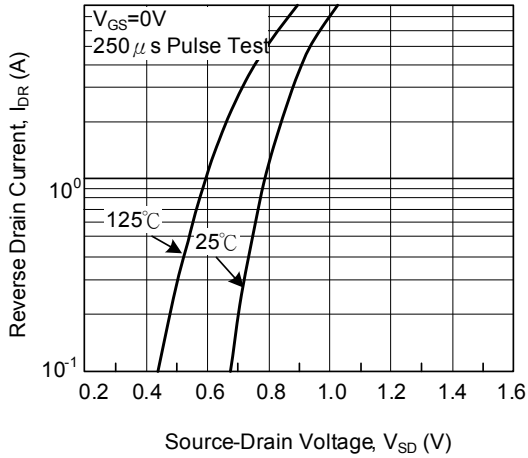



Figure 5. Capacitance vs Drain-Source Voltage

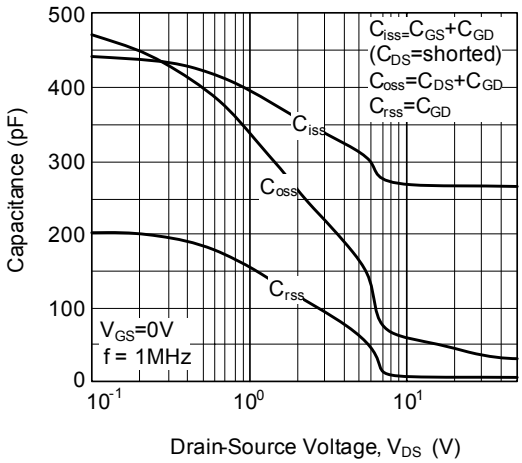
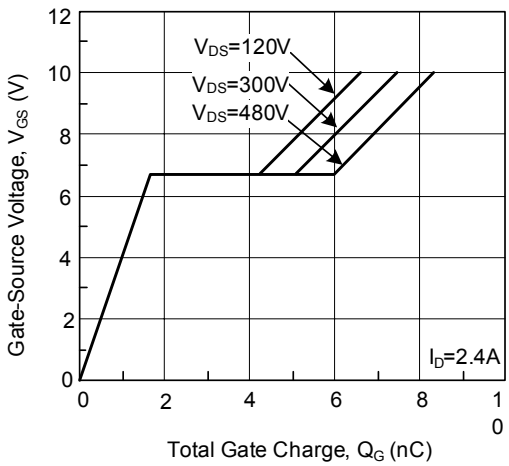



Figure 6. Gate Charge vs Gate Charge Voltage



## ■ TYPICAL CHARACTERISTICS(Cont.)

Figure 7. Breakdown Voltage vs Temperature

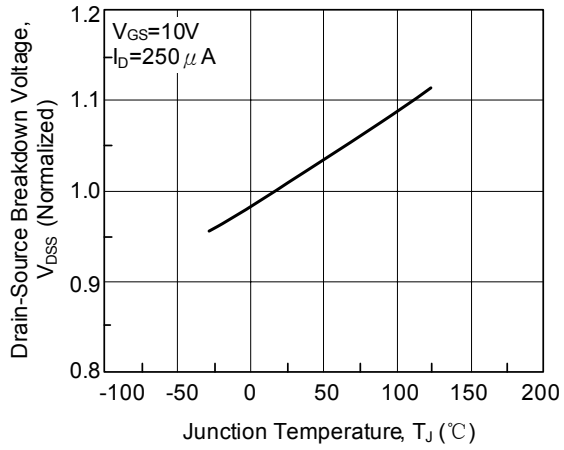



Figure 8. On-Resistance vs Temperature

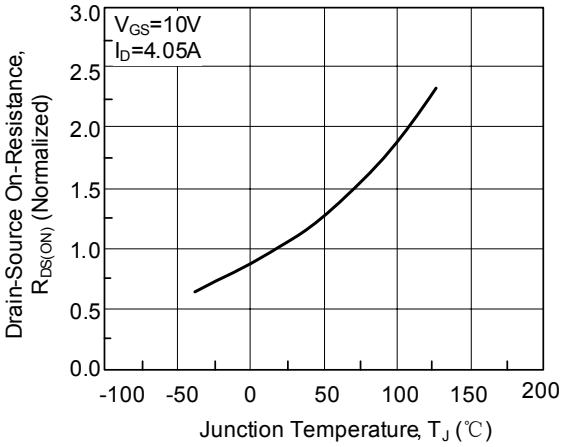



Figure 9. Max. Safe Operating Area

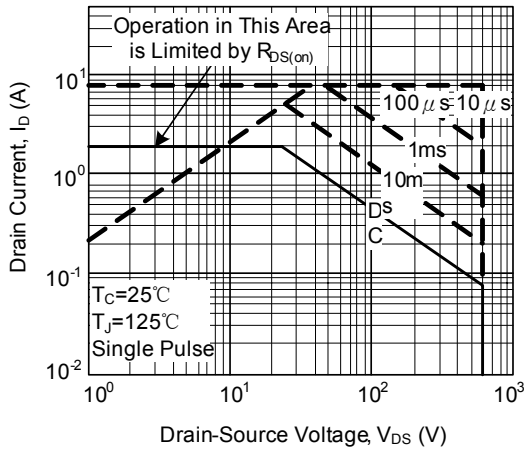



Figure 10. Max. Drain Current vs Case Temperature

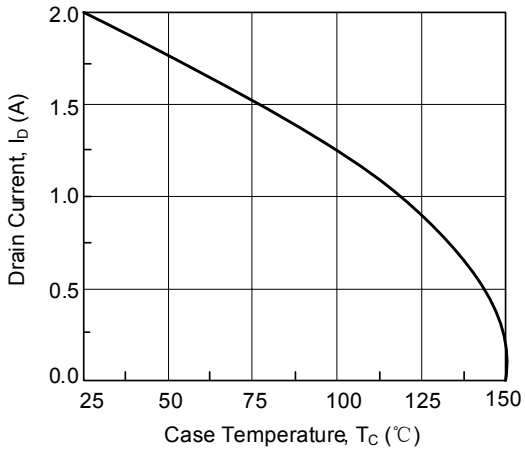



Figure 11. Thermal Response