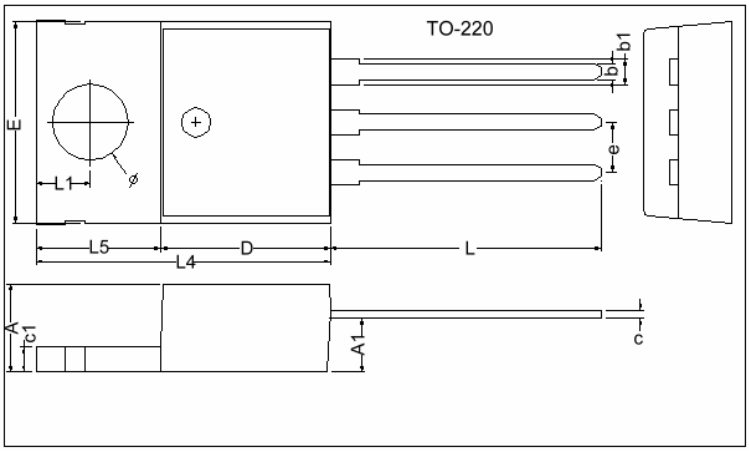
# N-Channel MOSFET

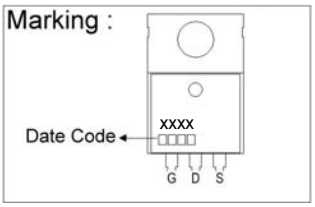
| | |
|---|---|
| $BV_{DSS}$ | 600/650V |
| $R_{DS(ON)}$ | 5Ω |
| $I_D$ | 2A |

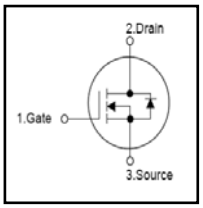
## Features

* $R_{DS(ON)}$ = 5Ω@$V_{GS}$ = 10V
* Ultra Low gate charge (typical 9.0nC)
* Low reverse transfer capacitance ($C_{RSS}$ = typical 5.0 pF)
* Fast switching capability
* Improved dv/dt capability, high ruggedness

## Package Dimensions




| REF. | Millimeter | | REF. | Millimeter | |
|---|---|---|---|---|---|
| | Min. | Max. | | Min. | Max. |
| A | 4.40 | 4.80 | c1 | 1.25 | 1.45 |
| b | 0.76 | 1.00 | b1 | 1.17 | 1.47 |
| c | 0.36 | 0.50 | L | 13.25 | 14.25 |
| D | 8.60 | 9.00 | e | 2.54 REF. | |
| E | 9.80 | 10.4 | L1 | 2.60 | 2.89 |
| L4 | 14.7 | 15.3 | Ø | 3.71 | 3.96 |
| L5 | 6.20 | 6.60 | A1 | 2.60 | 2.80 |

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

| PARAMETER | | SYMBOL | RATINGS | UNIT |
|---|---|---|---|---|
| Drain-Source Voltage | 2N60-A | $V_{DSS}$ | 600 | V |
| | 2N60-B | | 650 | V |
| Gate-Source Voltage | | $V_{GSS}$ | ±30 | V |
| Avalanche Current (Note 1) | | $I_{AR}$ | 2.0 | A |
| Drain Current Continuous | | $I_D$ | 2.0 | A |
| Drain Current Pulsed (Note 1) | | $I_{DP}$ | 8.0 | A |
| Avalanche Energy | Single Pulsed (Note 2) | $E_{AS}$ | 140 | mJ |
| | Repetitive (Note 1) | $E_{AR}$ | 4.5 | mJ |
| Peak Diode Recovery dv/dt (Note 3) | | dv/dt | 4.5 | V/ns |
| Total Power Dissipation | TO-220 | $P_D$ | 54 | W |
| | TO-220F | | 23 | W |
| | TO-251 | | 44 | W |
| | TO-252 | | 44 | W |
| Junction Temperature | | $T_J$ | +150 | ℃ |
| Operating Temperature | | $T_{OPR}$ | -55 ~ +150 | ℃ |
| Storage Temperature | | $T_{STG}$ | -55 ~ +150 | ℃ |

Note: 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.

## THERMAL DATA

| PARAMETER | PACKAGE | SYMBOL | RATINGS | UNIT |
|---|---|---|---|---|
| Junction-to-Ambient | TO-220 | $\theta_{JA}$ | 62.5 | ℃/W |
| | TO-220F | | 62.5 | |
| | TO-251 | | 50 | |
| | TO-252 | | 50 | |
| Junction-to-Case | TO-220 | $\theta_{Jc}$ | 2.32 | ℃/W |
| | TO-220F | | 5.5 | |
| | TO-251 | | 2.87 | |
| | TO-252 | | 2.87 | |

## ELECTRICAL CHARACTERISTICS ($T_J$=25℃, unless otherwise specified)

| PARAMETER | | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| Drain-Source Breakdown Voltage | 2N60-A | $BV_{DSS}$ | $V_{GS}$ = 0V, $I_D$ = 250μA | 600 | | | V |
| | 2N60-B | | | 650 | | | V |
| Drain-Source Leakage Current | | $I_{DSS}$ | $V_{DS}$ = 600V, $V_{GS}$ = 0V | | | 10 | μA |
| Gate-Source Leakage Current | Forward | $I_{GSS}$ | $V_{GS}$ = 30V, $V_{DS}$ = 0V | | | 100 | nA |
| | Reverse | | $V_{GS}$ = -30V, $V_{DS}$ = 0V | | | -100 | nA |
| Breakdown Voltage Temperature Coefficient | | $\triangle BV_{DSS}/\triangle T_J$ | $I_D$ = 250 μA, Referenced to 25°C | | 0.4 | | V/℃ |
| **ON CHARACTERISTICS** | | | | | | | |
| Gate Threshold Voltage | | $V_{GS(TH)}$ | $V_{DS}$ = $V_{GS}$, $I_D$ = 250μA | 2.0 | | 4.0 | V |
| Static Drain-Source On-State Resistance | | $R_{DS(ON)}$ | $V_{GS}$ = 10V, $I_D$ =1A | | 3.8 | 5 | Ω |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| Input Capacitance | | $C_{ISS}$ | $V_{DS}$ =25V, $V_{GS}$ =0V, f =1MHz | | 270 | 350 | pF |
| Output Capacitance | | $C_{OSS}$ | | | 40 | 50 | pF |
| Reverse Transfer Capacitance | | $C_{RSS}$ | | | 5 | 7 | pF |

## ELECTRICAL CHARACTERISTICS(Cont.)

| PARAMETER | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **SWITCHING CHARACTERISTICS** | | | | | | |
| Turn-On Delay Time | $t_{D\ (ON)}$ | $V_{DD}$ =300V, $I_D$ =2.4A, $R_G$=25Ω (Note 4, 5) | | 10 | 30 | ns |
| Turn-On Rise Time | $t_R$ | | | 25 | 60 | ns |
| Turn-Off Delay Time | $t_{D(OFF)}$ | | | 20 | 50 | ns |
| Turn-Off Fall Time | $t_F$ | | | 25 | 60 | ns |
| Total Gate Charge | $Q_G$ | $V_{DS}$=480V, $V_{GS}$=10V, $I_D$=2.4A (Note 4, 5) | | 9.0 | 11 | nC |
| Gate-Source Charge | $Q_{GS}$ | | | 1.6 | | nC |
| Gate-Drain Charge | $Q_{GD}$ | | | 4.3 | | nC |
| **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, di/dt = 100 A/μs (Note4) | | 180 | | ns |
| Reverse Recovery Charge | $Q_{RR}$ | | | 0.72 | | μC |

Note: 1. Repetitive Rating : Pulse width limited by $T_J$
2. L=64mH, $I_{AS}$=2.0A, $V_{DD}$=50V, $R_G$=25 Ω, Starting $T_J$ = 25°C
3. $I_{SD}$ ≤ 2.4A, di/dt ≤200A/μs, $V_{DD}$ ≤ $BV_{DSS}$, Starting $T_J$ = 25°C
4. Pulse Test: Pulse width ≤ 300μs, Duty cycle ≤ 2%
5. Essentially independent of operating temperature

## TEST CIRCUITS AND WAVEFORMS

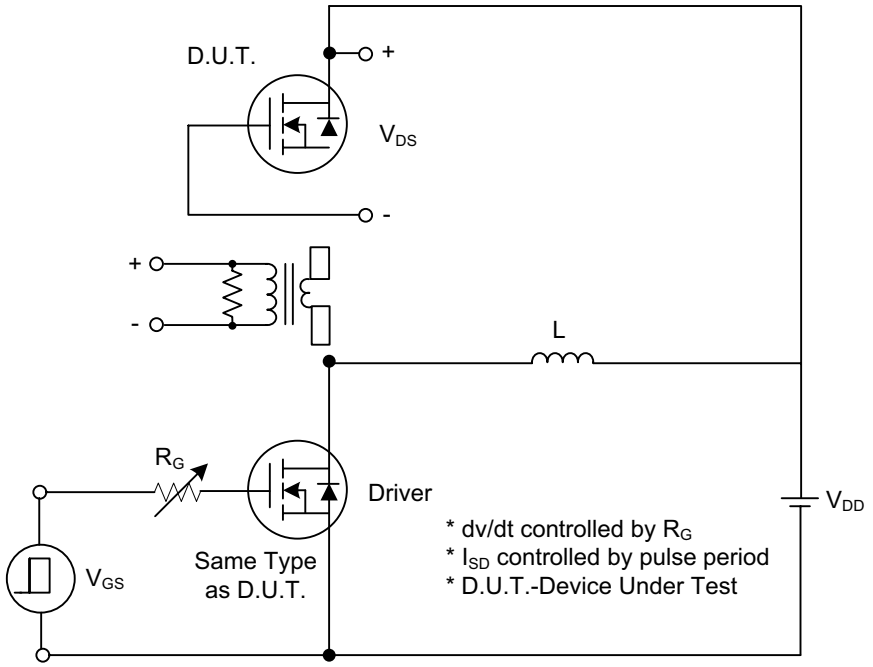



**Fig. 1A Peak Diode Recovery dv/dt Test Circuit**

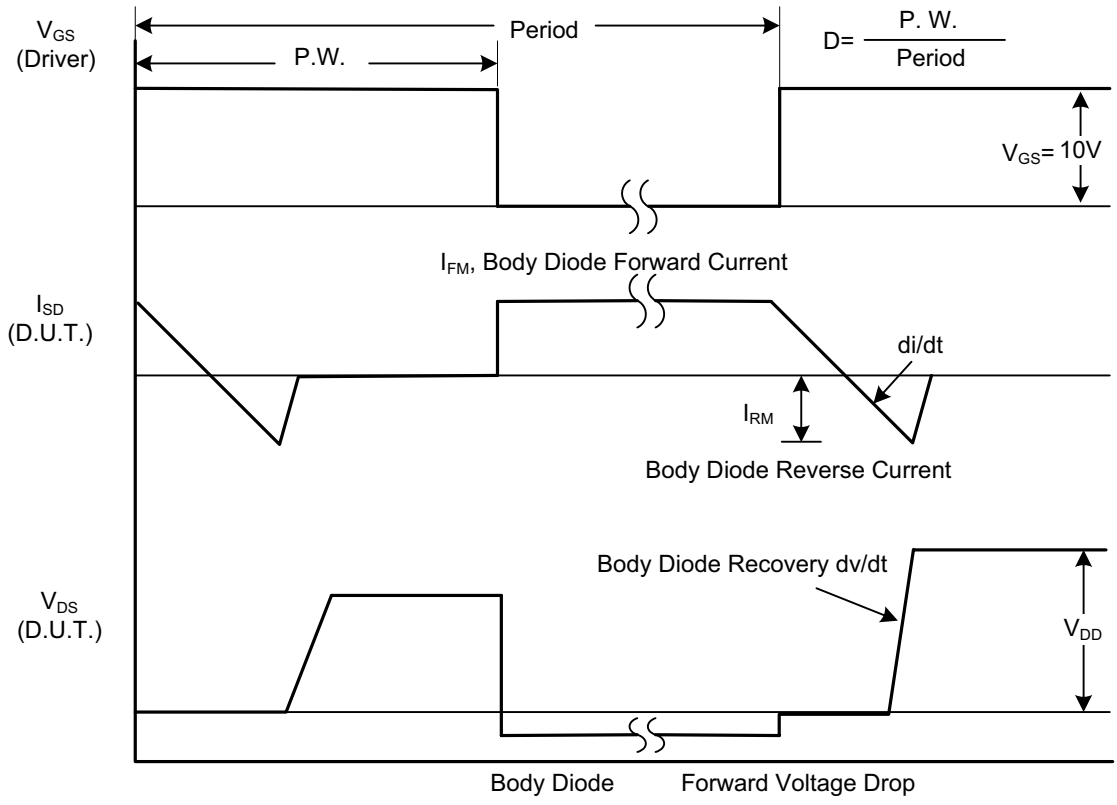



**Fig. 1B Peak Diode Recovery dv/dt Waveforms**

## TEST CIRCUITS AND WAVEFORMS (Cont.)

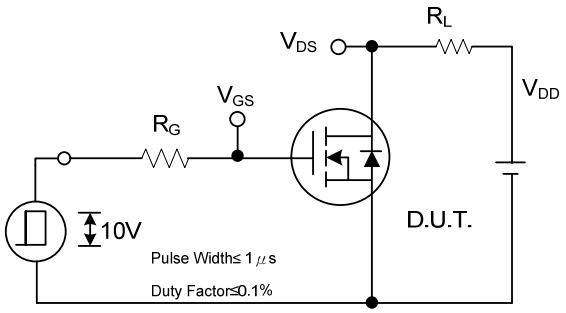



**Fig. 2A Switching Test Circuit**

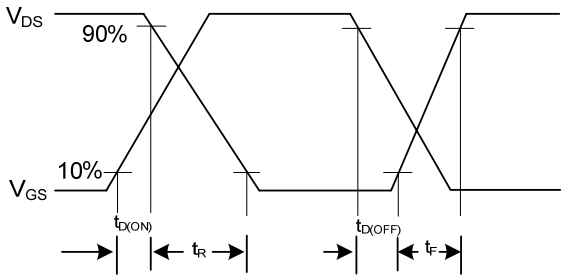



**Fig. 2B Switching Waveforms**

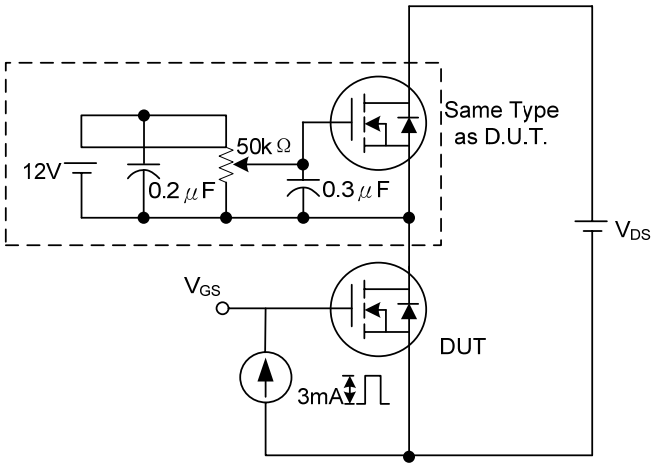



**Fig. 3A Gate Charge Test Circuit**

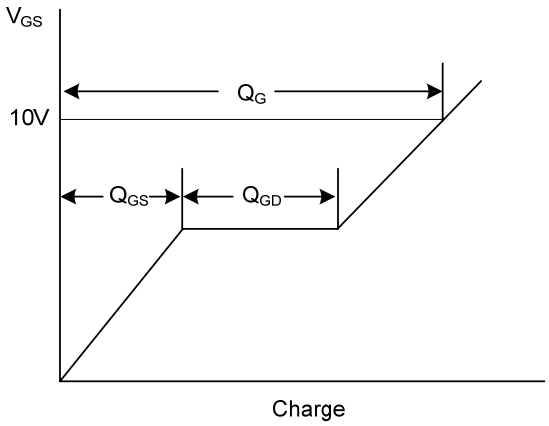



**Fig. 3B Gate Charge Waveform**

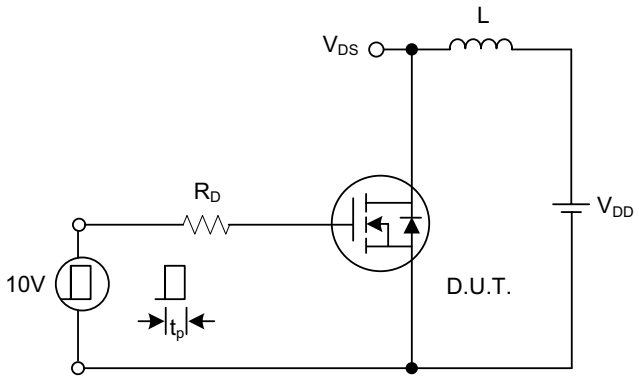



**Fig. 4A Unclamped Inductive Switching Test Circuit**

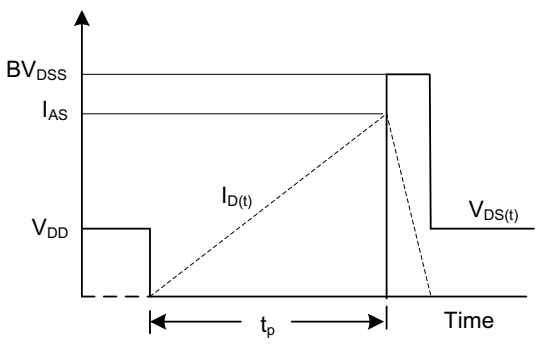
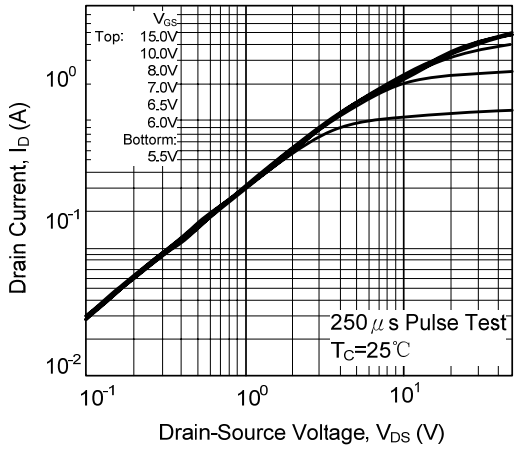


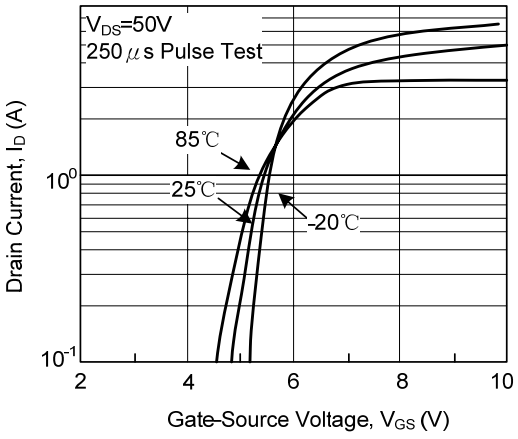

**Fig. 4B Unclamped Inductive Switching Waveforms**

## TYPICAL CHARACTERISTICS

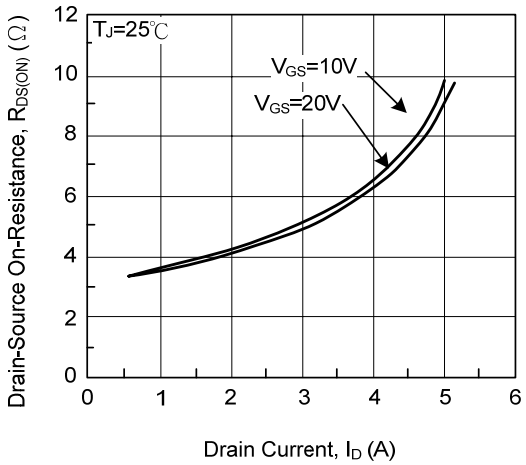
On-Region Characteristics



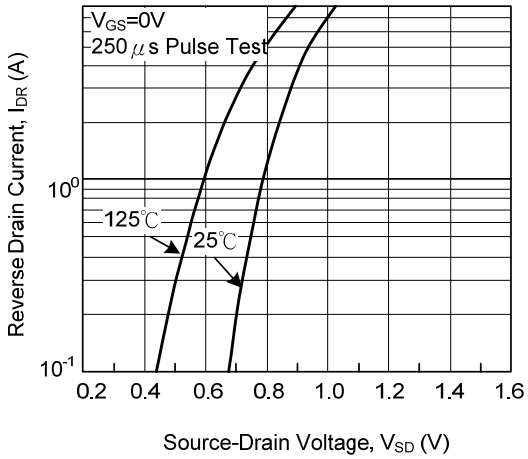

Transfer Characteristics



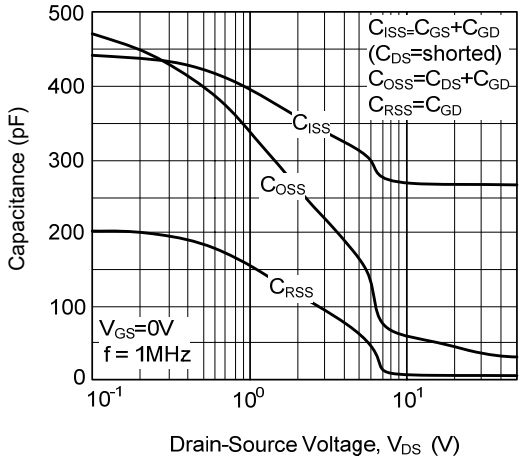

On-Resistance Variation vs. Drain Current and Gate Voltage



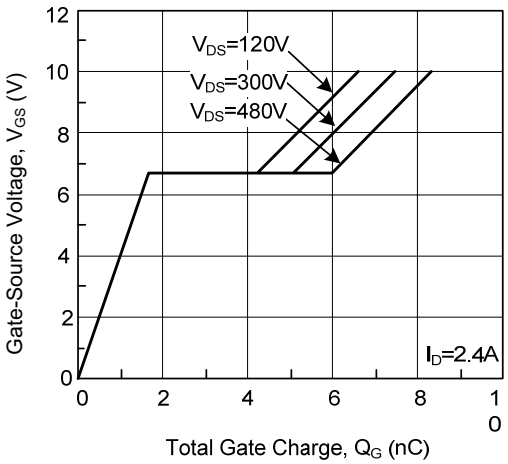

Body Diode Forward Voltage Variation vs. Source Current and Temperature




Capacitance vs. Drain-Source Voltage

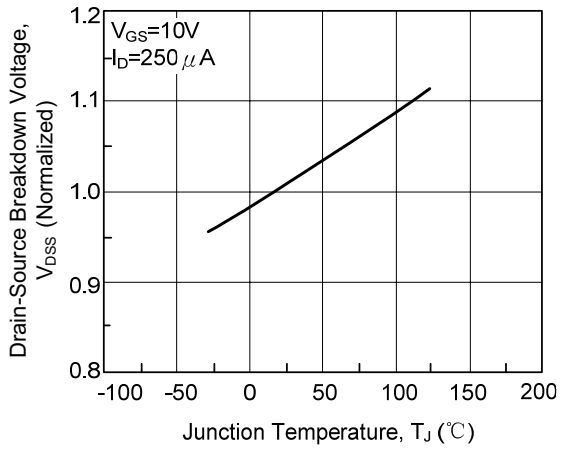



Gate Charge vs. Gate Charge Voltage

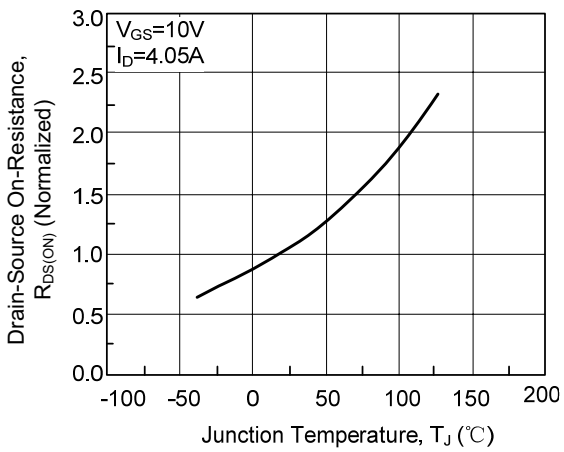


## TYPICAL CHARACTERISTICS(Cont.)

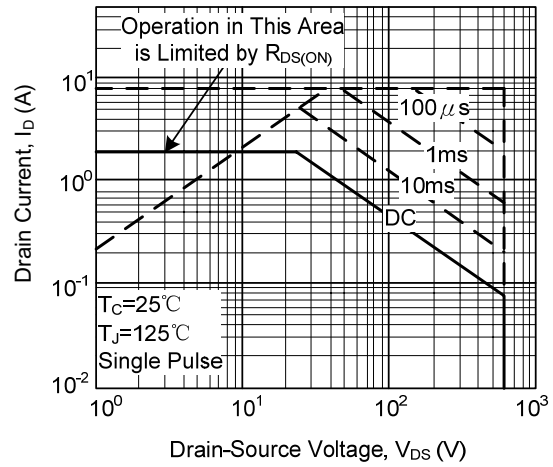
Breakdown Voltage vs. Temperature



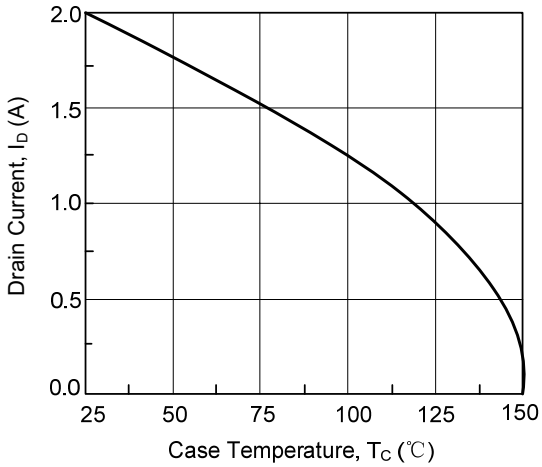

On-Resistance vs. Temperature




Max. Safe Operating Area




Max. Drain Current vs. Case Temperature




Thermal Response