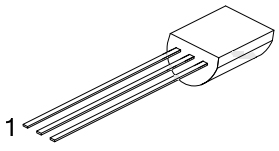
# 1NM60-FDQ

**Power MOSFET**

## 1A, 600V N-CHANNEL SUPER-JUNCTION MOSFET




TO-92

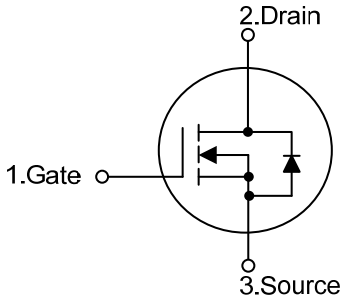
### ■ DESCRIPTION

The UTC **1NM60-FDQ** is a Super Junction MOSFET Structure and is designed to have better characteristics, such as fast switching time, low gate charge, low on-state resistance and have a high rugged avalanche characteristics. This power MOSFET is usually used at high speed switching applications in power supplies, PWM motor controls, high efficient DC to DC converters and bridge circuits.

### ■ FEATURES

* $R_{DS(ON)}$ < 4.8Ω @ $V_{GS}$=10V, $I_D$=0.5A
* Fast switching capability
* Avalanche energy specified
* Improved dv/dt capability, high ruggedness

### ■ SYMBOL



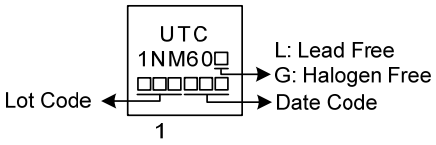

### ■ ORDERING INFORMATION

| Ordering Number | | Package | Pin Assignment | | | Packing |
|---|---|---|---|---|---|---|
| Lead Free | Halogen Free | | 1 | 2 | 3 | |
| 1NM60L-T92-B | 1NM60G-T92-B | TO-92 | G | D | S | Tape Box |
| 1NM60L-T92-K | 1NM60G-T92-K | TO-92 | G | D | S | Bulk |

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

| | |
|---|---|
| 1NM60G-T92-B<br>(1)Packing Type<br>(2)Package Type<br>(3)Green Package | (1) B: Tape Box, K: Bulk<br>(2) T92: TO-92<br>(3) G: Halogen Free and Lead Free, L: Lead Free |

## ■ MARKING



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

| PARAMETER | | SYMBOL | RATINGS | UNIT |
|---|---|---|---|---|
| Drain-Source Voltage | | $V_{DSS}$ | 600 | V |
| Gate-Source Voltage | | $V_{GSS}$ | ±30 | V |
| Continuous Drain Current | | $I_D$ | 1 | A |
| Pulsed Drain Current (Note 2) | | $I_{DM}$ | 3 | A |
| Avalanche Energy (Note 3) | Single Pulsed | $E_{AS}$ | 8.2 | mJ |
| Peak Diode Recovery dv/dt (Note 4) | | dv/dt | 31 | V/ns |
| Power Dissipation ($T_A$=25°C) | | $P_D$ | 1.4 | W |
| Junction Temperature | | $T_J$ | +150 | °C |
| Storage Temperature | | $T_{STG}$ | -55 ~ +150 | °C |

Notes: 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. Repetitive Rating: Pulse width limited by maximum junction temperature.
3. L=10mH, $I_{AS}$=1.7A, $V_{DD}$=50V, $R_G$=25 Ω, Starting $T_J$ = 25°C
4. $I_{SD}$≤1.0A, di/dt≤200A/μs, $V_{DD}$ ≤ $BV_{DSS}$, Starting $T_J$ = 25°C

## ■ THERMAL DATA

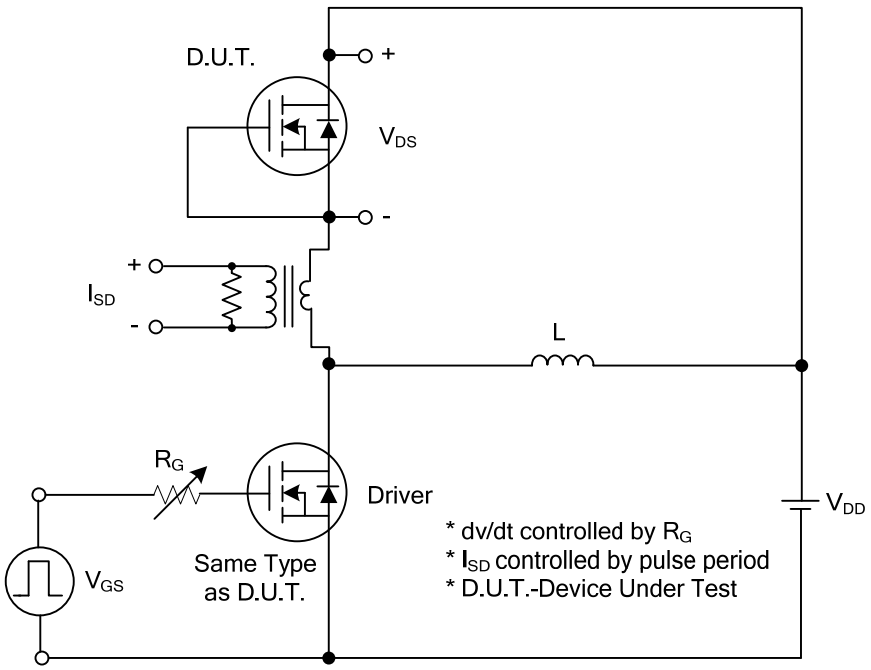
| PARAMETER | SYMBOL | RATINGS | UNIT |
|---|---|---|---|
| Junction to Ambient | $\theta_{JA}$ | 140 | °C/W |
| Junction to Case | $\theta_{JC}$ | 80 | °C/W |

## ■ ELECTRICAL CHARACTERISTICS ($T_C$ =25°C, unless otherwise specified)

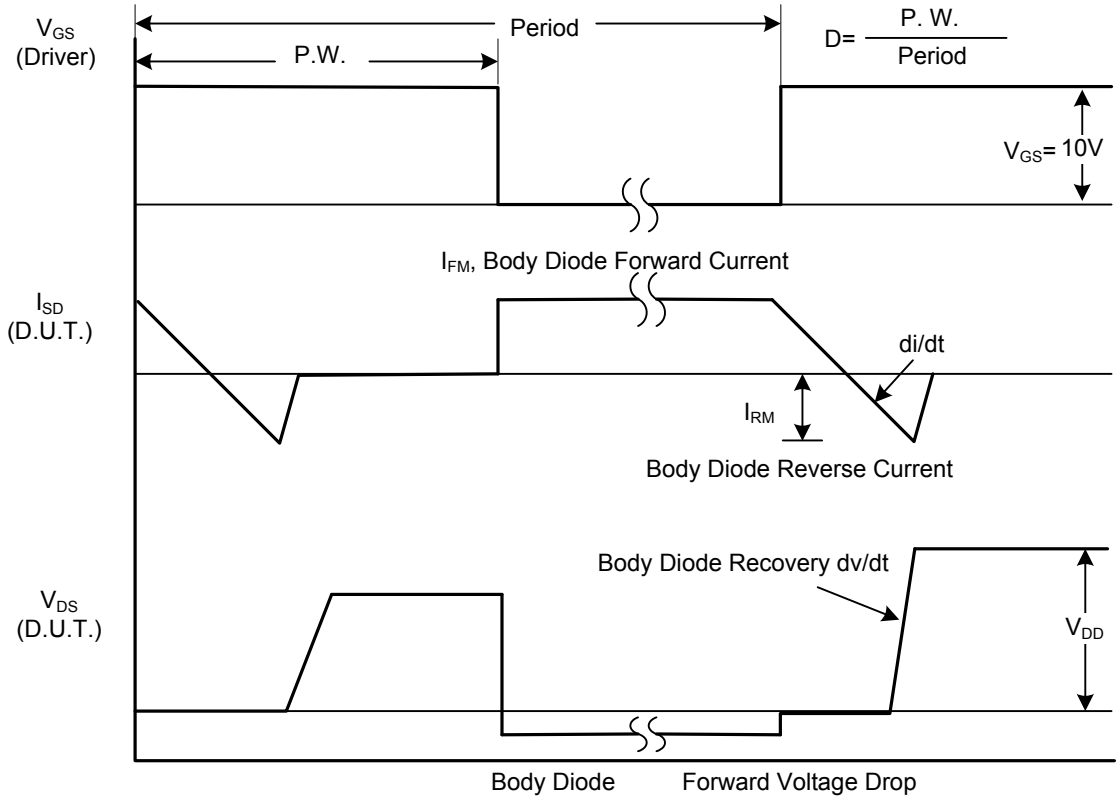
| PARAMETER | | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| Drain-Source Breakdown Voltage | | $BV_{DSS}$ | $V_{GS}$ = 0V, $I_D$ = 250μA | 600 | | | V |
| Drain-Source Leakage Current | | $I_{DSS}$ | $V_{DS}$ = 600V, $V_{GS}$ = 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 |
| **ON CHARACTERISTICS** | | | | | | | |
| Gate Threshold Voltage | | $V_{GS(TH)}$ | $V_{DS}$ = $V_{GS}$, $I_D$ = 250μA | 2.5 | | 4.5 | V |
| Static Drain-Source On-State Resistance | | $R_{DS(ON)}$ | $V_{GS}$ = 10V, $I_D$ =0.5A | | | 4.8 | Ω |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| Input Capacitance | | $C_{ISS}$ | $V_{DS}$ =25V, $V_{GS}$ =0V, f =1MHz | | 83 | | pF |
| Output Capacitance | | $C_{OSS}$ | | | 62.3 | | pF |
| Reverse Transfer Capacitance | | $C_{RSS}$ | | | 8.2 | | pF |
| **SWITCHING CHARACTERISTICS** | | | | | | | |
| Total Gate Charge | | $Q_G$ | $V_{DS}$=100V, $V_{GS}$=10V, $I_D$=1A, $I_G$=3mA (Note 1, 2) | | 9.7 | | nC |
| Gate-Source Charge | | $Q_{GS}$ | | | 3.5 | | nC |
| Gate-Drain Charge | | $Q_{GD}$ | | | 1.5 | | nC |
| Turn-On Delay Time | | $t_{D(ON)}$ | $V_{DD}$ =50V, $V_{GS}$=10V, $I_D$ =1A, $R_G$=25Ω (Note 1, 2) | | 4 | | ns |
| Turn-On Rise Time | | $t_R$ | | | 15 | | ns |
| Turn-Off Delay Time | | $t_{D(OFF)}$ | | | 16 | | ns |
| Turn-Off Fall Time | | $t_F$ | | | 10 | | ns |
| **DRAIN-SOURCE DIODE CHARACTERISTICS** | | | | | | | |
| Maximum Body-Diode Continuous Current | | $I_S$ | | | | 1.0 | A |
| Continuous Drain-Source Current | | $I_{SD}$ | | | | 3.0 | A |
| Drain-Source Diode Forward Voltage | | $V_{SD}$ | $I_S$=1.0A, $V_{GS}$=0V | | | 1.4 | V |
| Reverse Recovery Time | | $t_{rr}$ | $I_F$=1.0A, $V_{DD}$=100V di/dt = 100A/μs | | 136 | | ns |
| Reverse Recovery Charge | | $Q_{rr}$ | | | 0.5 | | μC |

Notes: 1. Pulse Test: Pulse width ≤ 300μs, Duty cycle≤2%.
2. Essentially independent of operating temperature.

## ■ TEST CIRCUITS AND WAVEFORMS

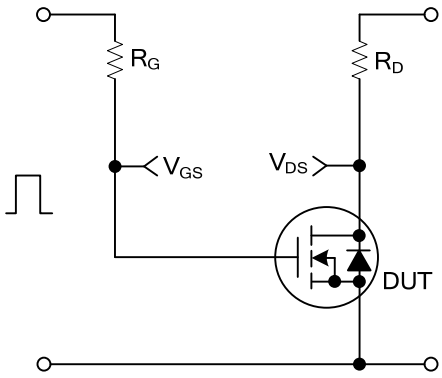



**Peak Diode Recovery dv/dt Test Circuit**

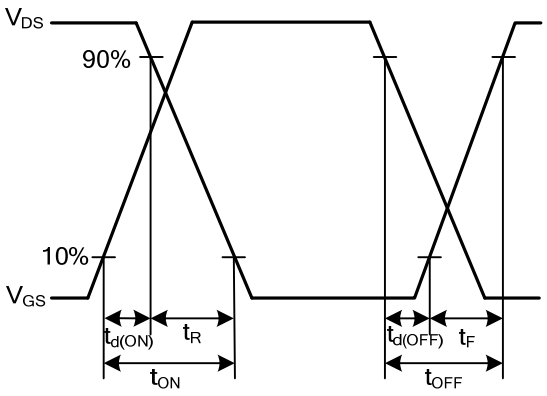



**Peak Diode Recovery dv/dt Waveforms**

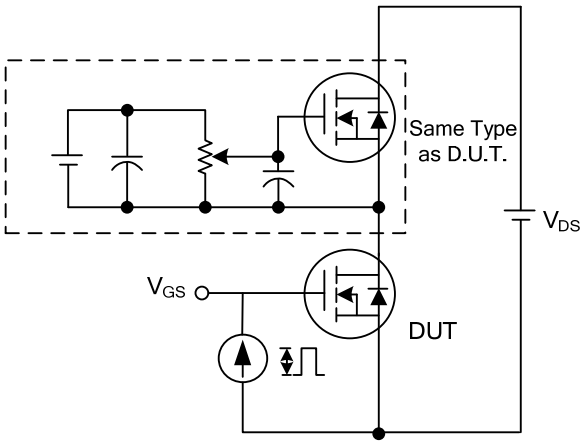
■ TEST CIRCUITS AND WAVEFORMS (Cont.)



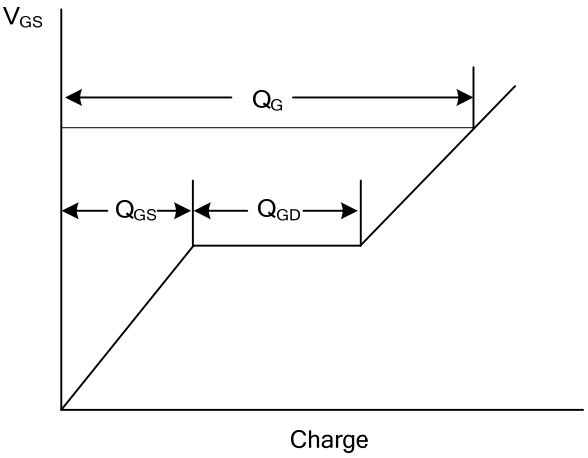

**itching Test Circuit**



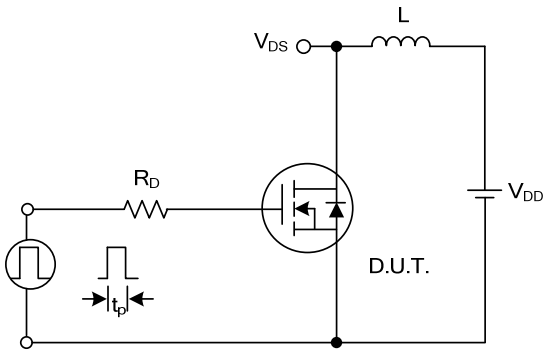

**Switching Waveforms**



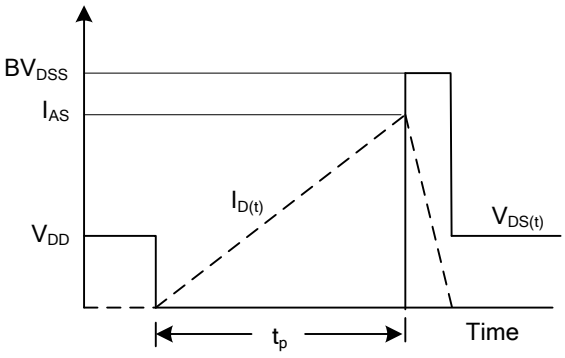

**Gate Charge Test Circuit**




**Gate Charge Waveform**



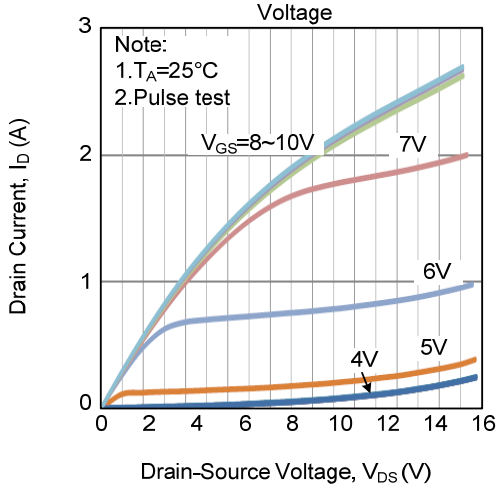

**Unclamped Inductive Switching Test Circuit**



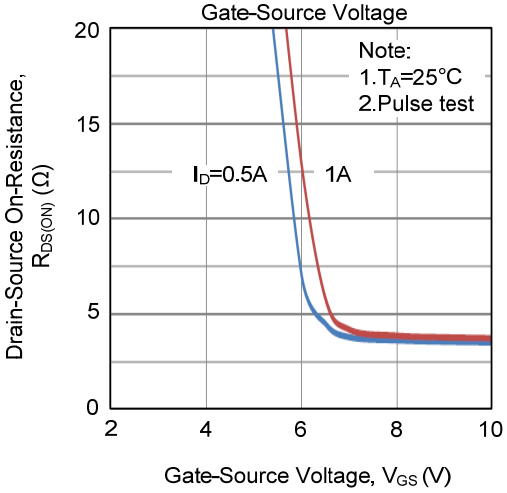

**Unclamped Inductive Switching Waveforms**

## ■ TYPICAL CHARACTERISTICS

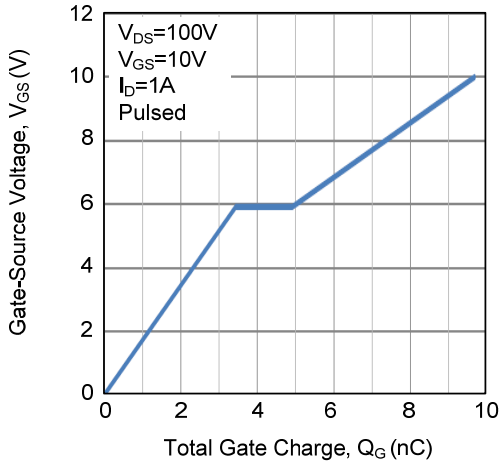
Drain Current vs. Drain-Source Voltage



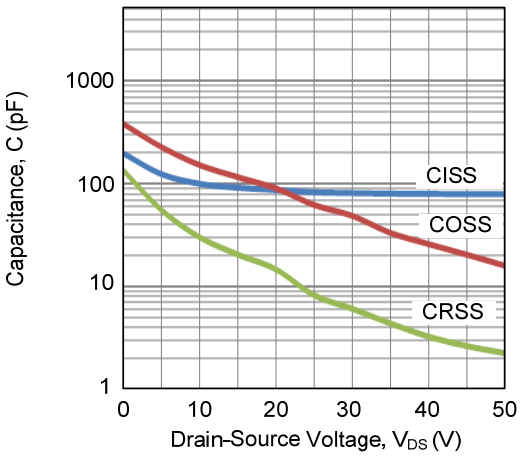

Drain-Source On-Resistance vs. Gate-Source Voltage



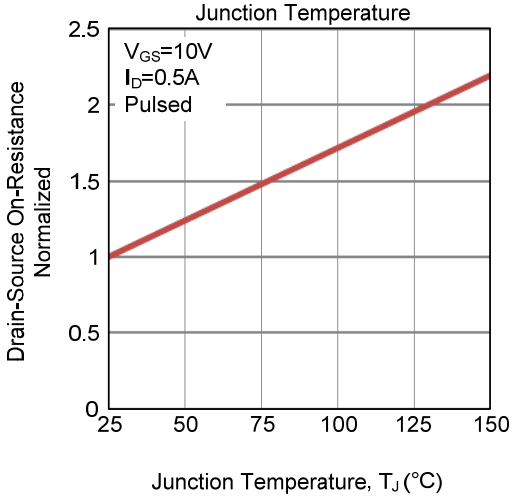

Gate Charge Characteristics



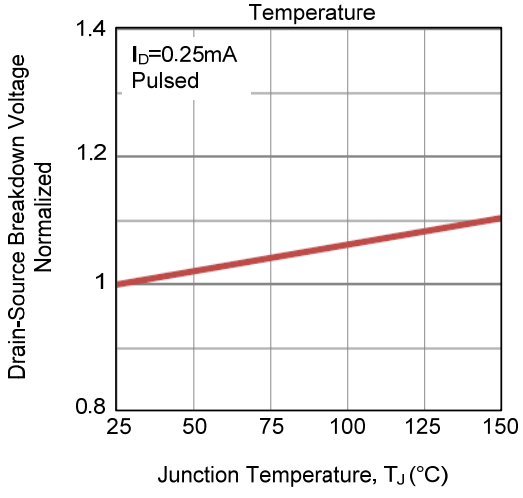

Capacitance Characteristics




Drain-Source On-Resistance vs. Junction Temperature

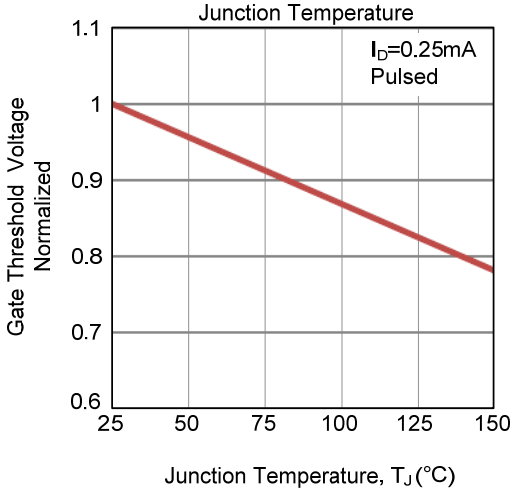



Breakdown Voltage vs. Junction Temperature

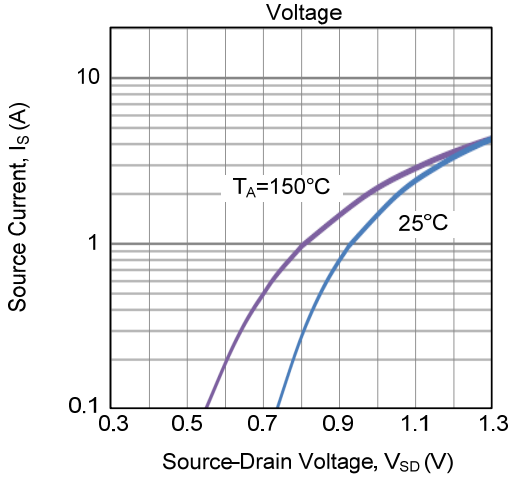


## ■ TYPICAL CHARACTERISTICS (Cont.)

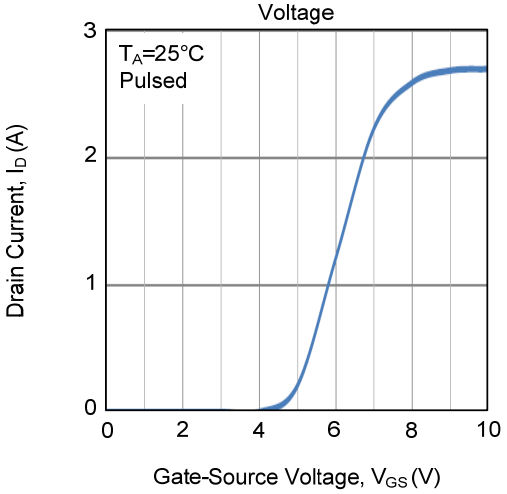
Gate Threshold Voltage vs. Junction Temperature



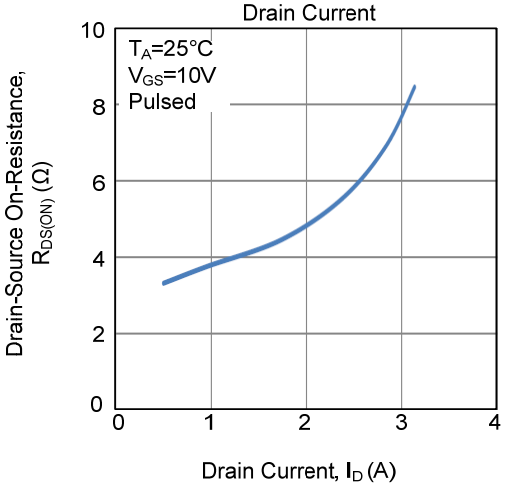

Source Current vs. Source-Drain Voltage



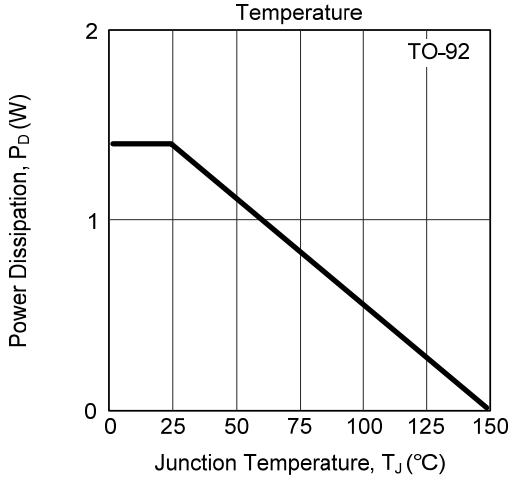

Drain Current vs. Gate-Source Voltage



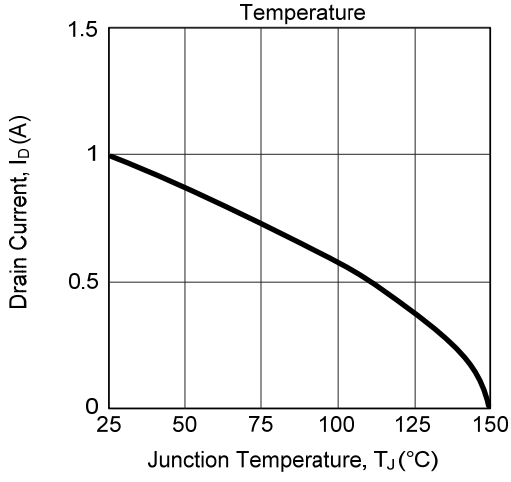

Drain-Source On-Resistance vs. Drain Current




Power Dissipation vs. Junction Temperature




Drain Current vs. Junction Temperature



## ■ TYPICAL CHARACTERISTICS (Cont.)