



## 3.5Amps, 600 Volts N-CHANNEL POWER MOSFET

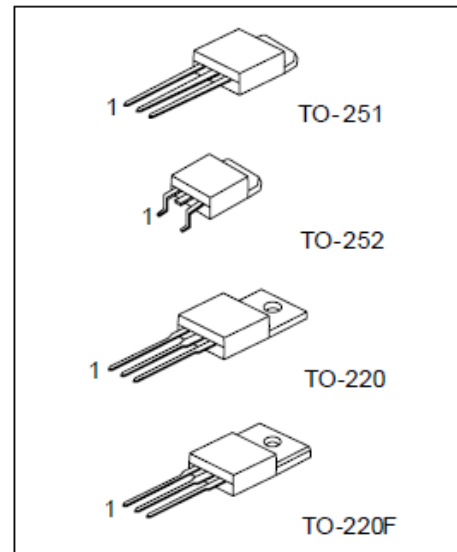
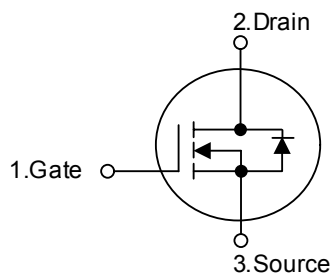
### ■ DESCRIPTION

The YR 4N60 is a high voltage MOSFET 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

- \*  $R_{DS(ON)} = 4.0\Omega @ V_{GS} = 10V$
- \* Ultra low gate charge ( typical 15 nC )
- \* Low reverse transfer Capacitance (  $C_{RSS} = \text{typical } 8.0 \text{ pF}$  )
- \* Fast switching capability
- \* Avalanche energy Specified
- \* Improved dv/dt capability, high ruggedness

### ■ SYMBOL



\*Pb-free plating product number: 4N60

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

| PARAMETER  | SYMBOL    | RATINGS                   | UNIT |
|--|-----------|---------------------------|------|
| Drain-Source Voltage   | $V_{DSS}$ | 600                       | V    |
| Gate-Source Voltage  | $V_{GSS}$ | $\pm 20$                  | V    |
| Avalanche Current - (Note 1)                                 | $I_{AR}$  | 3.5                       | A    |
| Continuous Drain Current                                     | $I_D$     | $T_C = 25^\circ\text{C}$  | A    |
|  |           | $T_C = 100^\circ\text{C}$ | A    |
| Pulsed Drain Current, $T_P$ Limited by $T_{JMAX}$ - (Note 1) | $I_{DM}$  | 16                        | A    |
| Avalanche Energy, Single Pulsed (Note 2)                     | $E_{AS}$  | 260                       | mJ   |
| Avalanche Energy, Repetitive, Limited by $T_{JMAX}$          | $E_{AR}$  | 10.6                      | mJ   |
| Peak Diode Recovery dv/dt (Note 3)                           | dv/dt     | 4.5                       | V/ns |
| Power Dissipation ( $T_C = 25^\circ\text{C}$ )               | $P_D$     | 106                       | W    |
| Junction Temperature   | $T_J$     | +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           | SYMBOL        | MIN | TYP | MAX  | UNIT               |
|---------------------|---------------|-----|-----|------|--------------------|
| Junction-to-Ambient | $\theta_{JA}$ |     |     | 62.5 | $^\circ\text{C/W}$ |
| Junction-to-Case    | $\theta_{JC}$ |     |     | 3    | $^\circ\text{C/W}$ |
| Case-to-Sink        | $\theta_{CS}$ |     | 0.5 |      | $^\circ\text{C/W}$ |

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

| PARAMETER                                 | SYMBOL         | TEST CONDITIONS  | MIN | TYP | MAX | UNIT          |
|---|----------------|--|-----|-----|-----|---------------|
| <b>Off Characteristics</b>                |                |  |     |     |     |               |
| Drain-Source Breakdown Voltage            | $BV_{DSS}$     | $V_{GS} = 0\text{ V}, I_D = 250\ \mu\text{A}$                                    | 600 |     |     | V             |
| Drain-Source Leakage Current              | $I_{DSS}$      | $V_{DS} = 600\text{ V}, V_{GS} = 0\text{ V}$                                     |     |     | 10  | $\mu\text{A}$ |
|   |                | $V_{DS} = 480\text{ V}, T_C = 125^\circ\text{C}$                                 |     |     | 100 | $\mu\text{A}$ |
| Gate-Source Leakage Current               | Forward        | $I_{GSS}$  |     |     |     | 100           |
|   | Reverse        |  |     |     |     | -100          |
| Breakdown Voltage Temperature Coefficient | $BV_{DSS}/T_J$ | $I_D = 250\ \mu\text{A}$ , Referenced to $25^\circ\text{C}$                      |     | 0.6 |     | V/            |
| <b>On Characteristics</b>                 |                |  |     |     |     |               |
| Gate Threshold Voltage                    | $V_{GS(TH)}$   | $V_{DS} = V_{GS}, I_D = 250\ \mu\text{A}$  | 2.0 |     | 4.0 | V             |
| Drain-Source On-State Resistance          | $R_{DS(ON)}$   | $V_{GS} = 10\text{ V}, I_D = 1.75\text{ A}$                                      |     | 3.4 | 4.0 | $\Omega$      |
| Forward Transconductance                  | $g_{FS}$       | $V_{DS} = 50\text{ V}, I_D = 1.75\text{ A}$ (Note 4)                             |     | 4.0 |     | S             |
| <b>Dynamic Characteristics</b>            |                |  |     |     |     |               |
| Input Capacitance                         | $C_{ISS}$      | $V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$                    |     | 520 | 670 | pF            |
| Output Capacitance                        | $C_{OSS}$      |  |     | 70  | 90  | pF            |
| Reverse Transfer Capacitance              | $C_{RSS}$      |  |     | 8   | 11  | pF            |
| <b>Switching Characteristics</b>          |                |  |     |     |     |               |
| Turn-On Delay Time                        | $t_{D(ON)}$    | $V_{DD} = 300\text{ V}, I_D = 3.5\text{ A}, R_G = 25\ \Omega$<br>(Note 4, 5)     |     | 13  | 35  | ns            |
| Turn-On Rise Time                         | $t_R$          |  |     | 45  | 100 | ns            |
| Turn-Off Delay Time                       | $t_{D(OFF)}$   |  |     | 25  | 60  | ns            |
| Turn-Off Fall Time                        | $t_F$          |  |     | 35  | 80  | ns            |
| Total Gate Charge                         | $Q_G$          | $V_{DS} = 480\text{ V}, I_D = 3.5\text{ A}, V_{GS} = 10\text{ V}$<br>(Note 4, 5) |     | 15  | 20  | nC            |
| Gate-Source Charge                        | $Q_{GS}$       |  |     | 3.4 |     | nC            |
| Gate-Drain Charge                         | $Q_{DD}$       |  |     | 7.1 |     | nC            |

■ ELECTRICAL CHARACTERISTICS(Cont.)

| PARAMETER  | SYMBOL   | TEST CONDITIONS                               | MIN | TYP | MAX | UNIT          |
|--|----------|---|-----|-----|-----|---------------|
| <b>Source- Drain Diode Ratings and Characteristics</b> |          |   |     |     |     |               |
| Drain-Source Diode Forward Voltage                     | $V_{SD}$ | $V_{GS} = 0\text{ V}, I_S = 3.5\text{ A}$     |     |     | 1.4 | V             |
| Maximum Continuous Drain-Source Diode Forward Current  | $I_S$    |   |     |     | 3.5 | A             |
| Maximum Pulsed Drain-Source Diode Forward Current      | $I_{SM}$ |   |     |     | 16  | A             |
| Reverse Recovery Time                                  | $t_{RR}$ | $V_{GS} = 0\text{ V}, I_S = 3.5\text{ A},$    |     | 250 |     | ns            |
| Reverse Recovery Charge                                | $Q_{RR}$ | $di_F/dt = 100\text{ A}/\mu\text{s}$ (Note 4) |     | 1.5 |     | $\mu\text{C}$ |

- Notes:
1. Repetitive Rating : Pulse width limited by  $T_J$
  2.  $L = 25\text{mH}, I_{AS} = 3.5\text{A}, V_{DD} = 50\text{V}, R_G = 25\ \Omega$ , Starting  $T_J = 25^\circ\text{C}$
  3.  $I_{SD} \leq 3.5\text{A}, di/dt \leq 200\text{A}/\mu\text{s}, V_{DD} \leq BV_{DSS}$ , Starting  $T_J = 25^\circ\text{C}$
  4. Pulse Test: Pulse width  $\leq 300\mu\text{s}$ , Duty cycle  $\leq 2\%$
  5. Essentially independent of operating temperature

■ TEST CIRCUITS AND WAVEFORMS

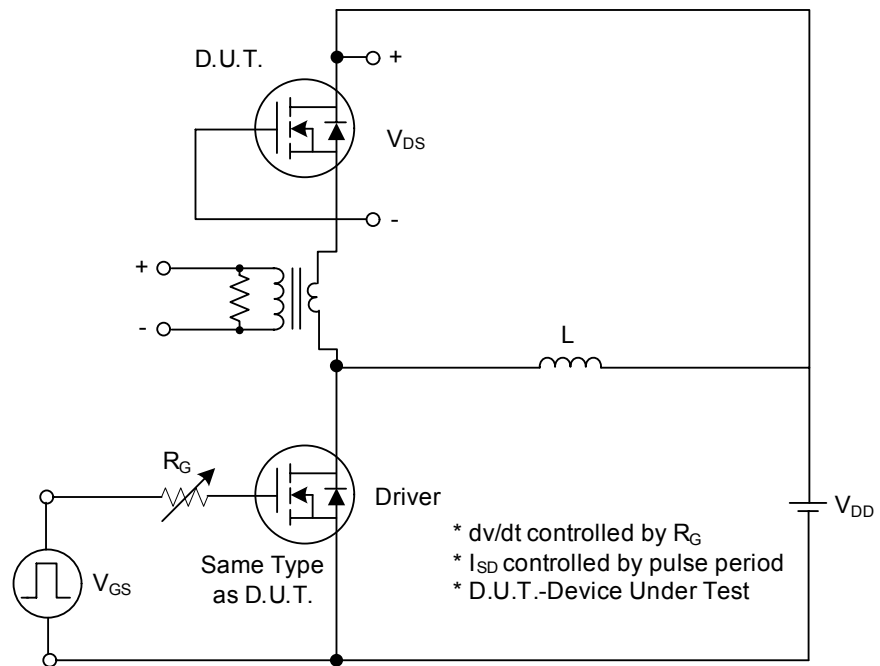


Fig. 1A Peak Diode Recovery  $dv/dt$  Test Circuit

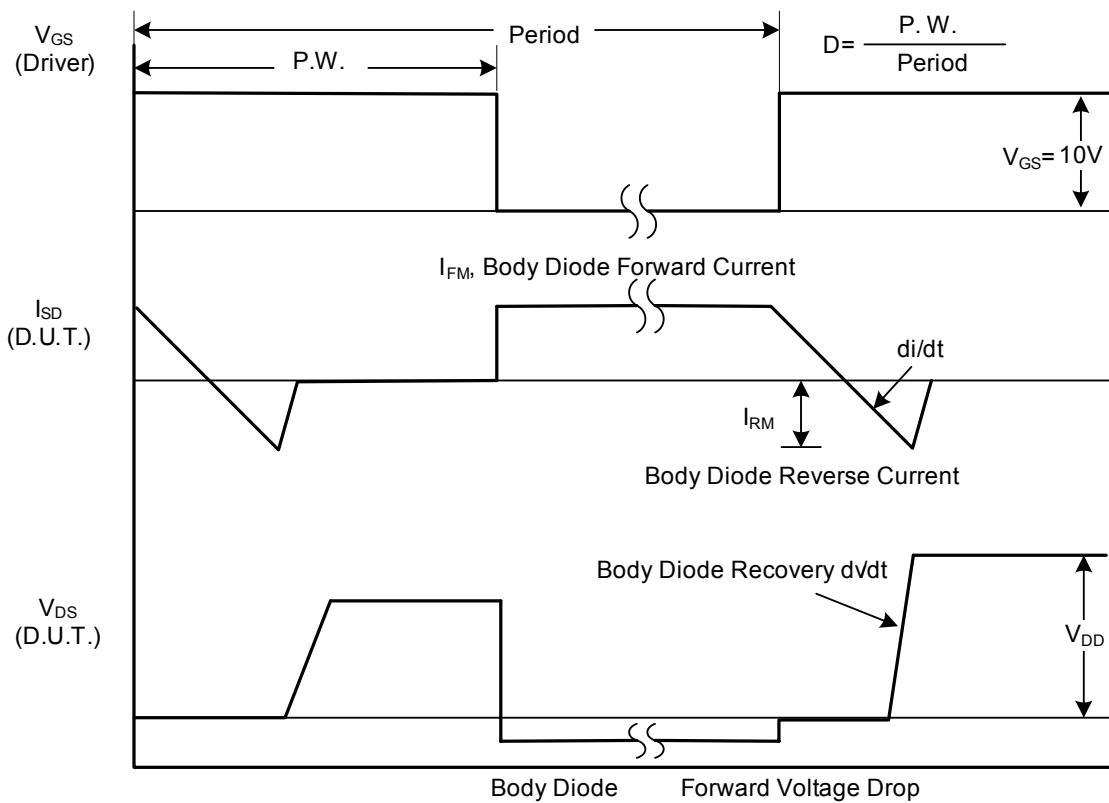


Fig. 1B Peak Diode Recovery  $dv/dt$  Waveforms

■ TEST CIRCUITS AND WAVEFORMS (Cont.)

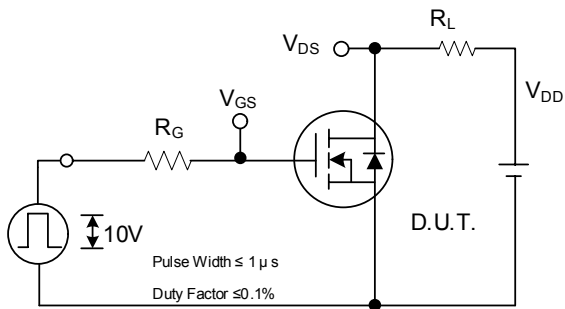


Fig. 2A Switching Test Circuit

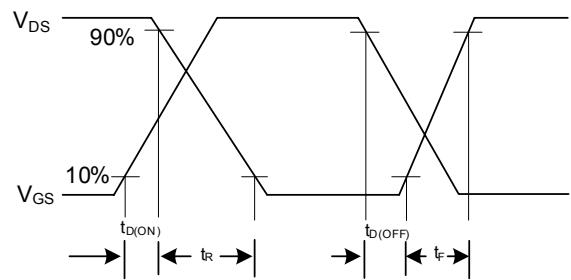


Fig. 2B Switching Waveforms

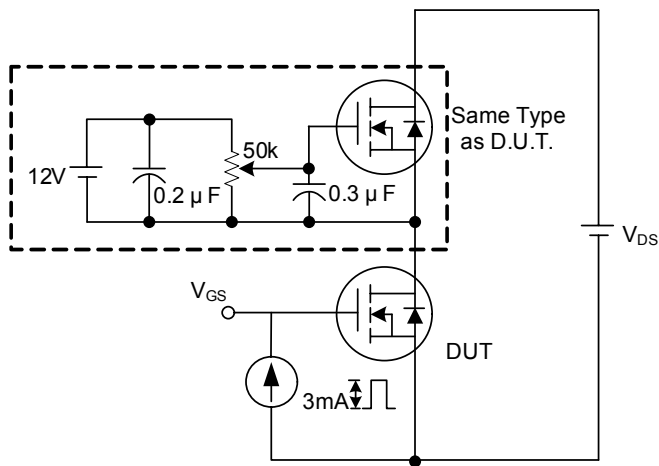


Fig. 3A Gate Charge Test Circuit

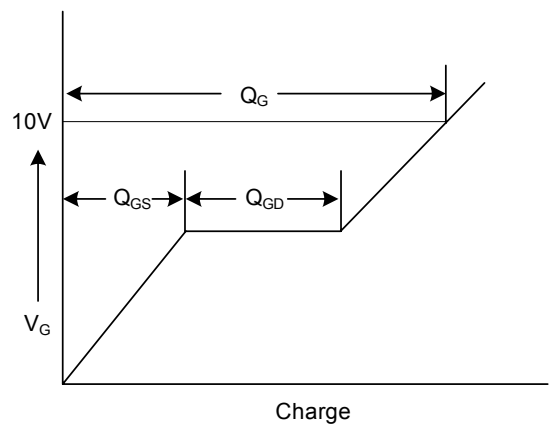


Fig. 3B Gate Charge Waveform

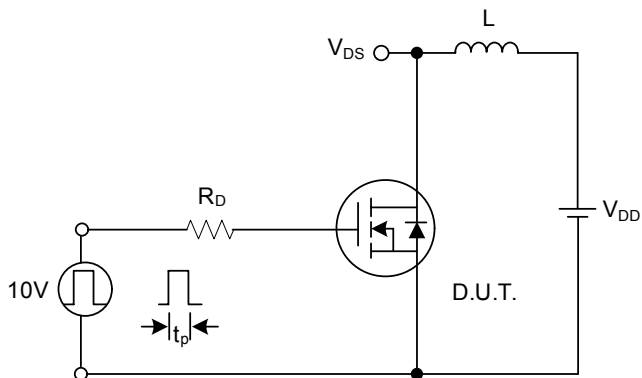


Fig. 4A Unclamped Inductive Switching Test Circuit

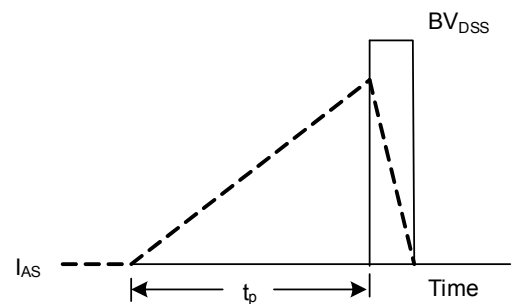
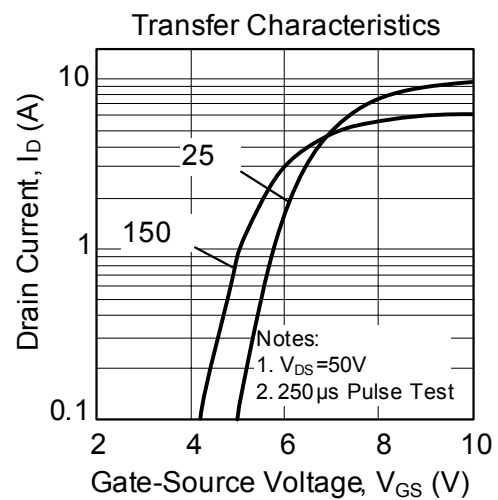
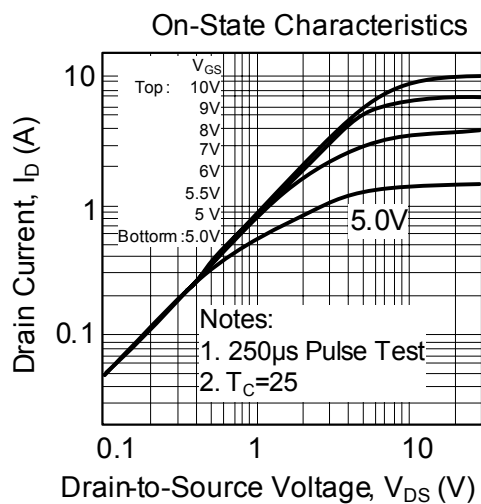
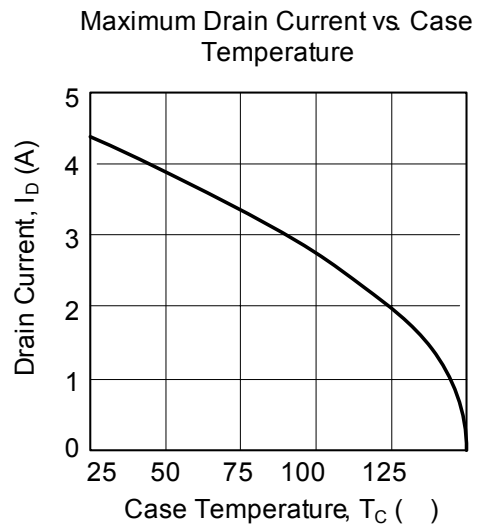
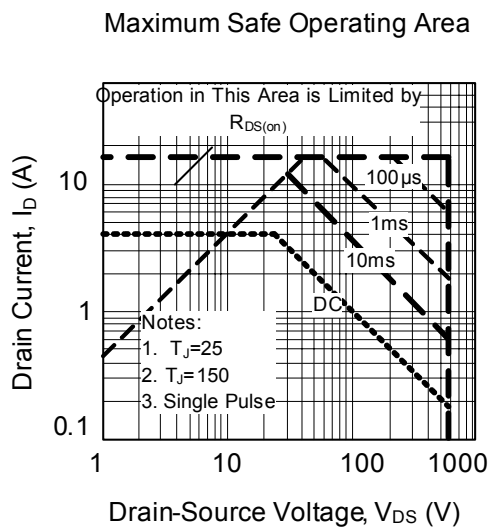
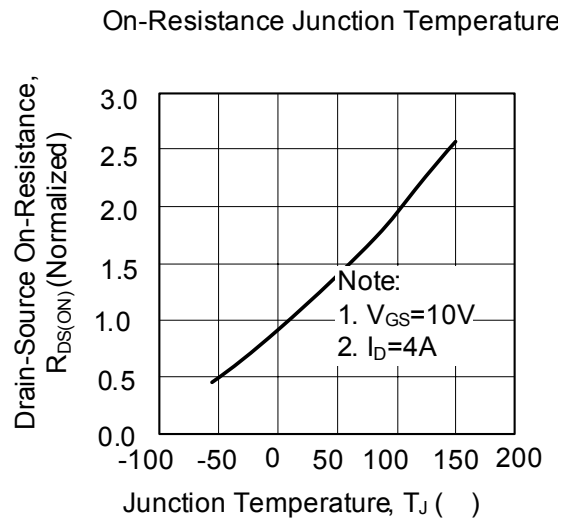
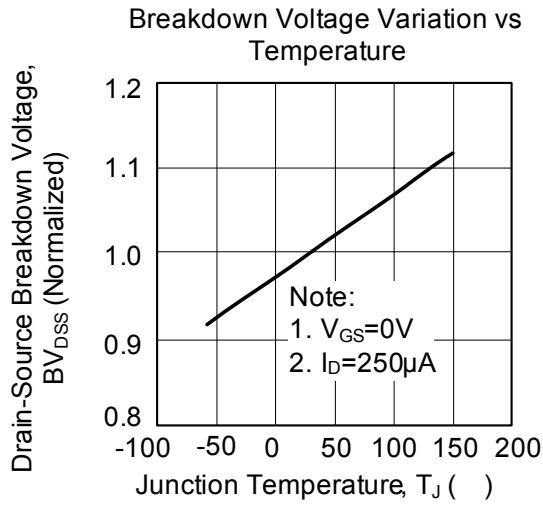


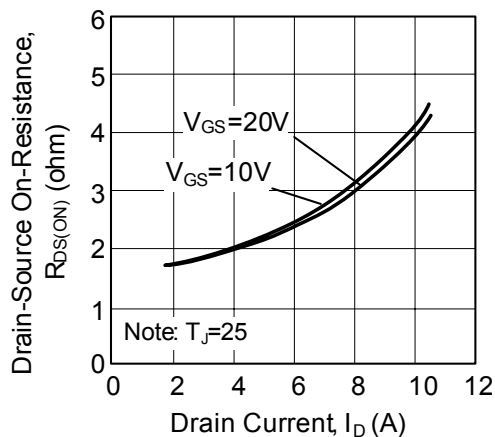
Fig. 4B Unclamped Inductive Switching Waveforms

■ TYPICAL CHARACTERISTICS

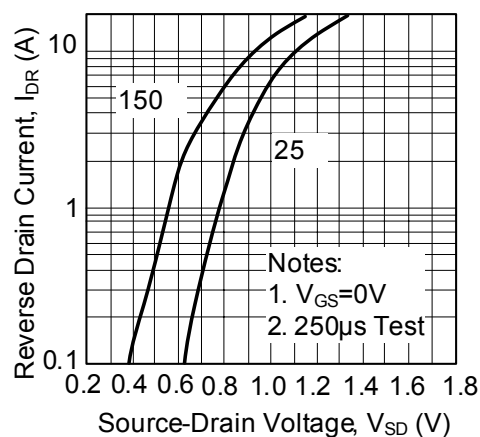


## ■ TYPICAL CHARACTERISTICS(Cont.)

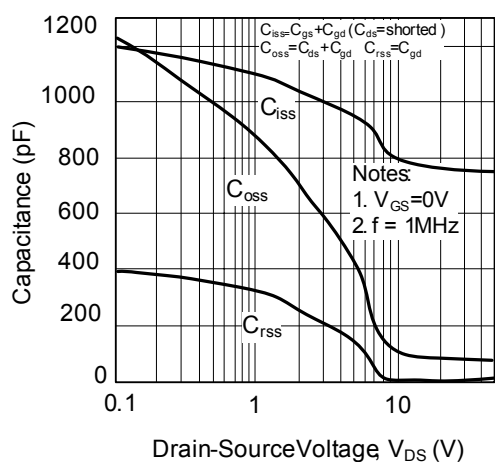
### On-Resistance Variation vs Drain Current and Gate Voltage



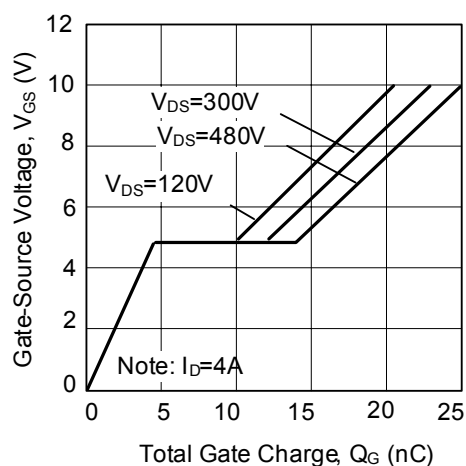
### On State Current vs. Allowable Case Temperature



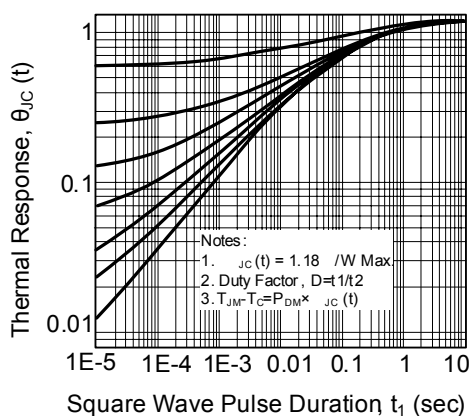
### Capacitance Characteristics (Non-Repetitive)



### Gate Charge Characteristics



### Transient Thermal Response Curve



### Power Dissipation

