# 4N60 Series

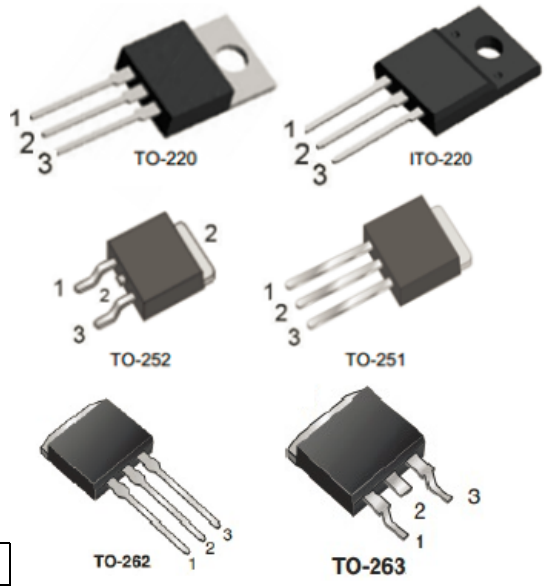
## N-CHANNEL POWER MOSFET

### Features

- $R_{DS(ON)}$<2.4Ω @ $V_{GS}$=10V
- Fast switching capability
- Lead free in compliance with EU RoHS directive.
- Green molding compound

### Mechanical Data

- Case: TO-251,TO-252,TO-220,ITO-220
  TO-262,TO-263 Package



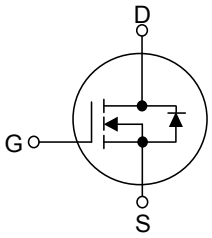

Pin Definition:

1. Gate
2. Drain
3. Source

### Ordering Information

| Part No. | Package | Packing |
|---|---|---|
| 4N60P | TO-251 | 75pcs / Tube |
| 4N60D | TO-252 | 75pcs / Tube |
| 4N60T | TO-220 | 50pcs / Tube |
| 4N60F | ITO-220 | 50pcs / Tube |
| 4N60K | TO-262 | 50pcs / Tube |
| 4N60G | TO-263 | 50pcs / Tube |

**Block Diagram**




### Maximum Ratings $T_A$ = 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 | | $I_D$ | 4.0 | A |
| Pulsed Drain Current (Note 2) | | $I_{DM}$ | 16 | A |
| Avalanche Energy | Single Pulsed (Note 3) | $E_{AS}$ | 217 | mJ |
| Power Dissipation | TO-220/TO-262/TO-263 | $P_D$ | 106 | W |
| | ITO-220 | | 44 | W |
| | TO-251/TO-252 | | 77 | W |
| Junction Temperature | | $T_J$ | +150 | °C |
| Operating Temperature | | $T_{OPR}$ | -55 ~ +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 = 30mH, $I_{AS}$ = 3.7A, $V_{DD}$ = 50V, $R_G$ = 25 Ω, Starting $T_J$ = 25°C

## THERMAL DATA

| PARAMETER | | SYMBOL | RATING | UNIT |
|---|---|---|---|---|
| Junction to Ambient | TO-220/ITO-220<br>TO-262/TO-263 | $\theta_{JA}$ | 62.5 | °C/W |
| | TO-251/ TO-252 | | 110 | |
| Junction to Case | TO-220<br>TO-262/TO-263 | $\theta_{JC}$ | 2.35 | °C/W |
| | ITO-220 | | 5.5 | |
| | TO-251/ TO-252 | | 2.9 | |

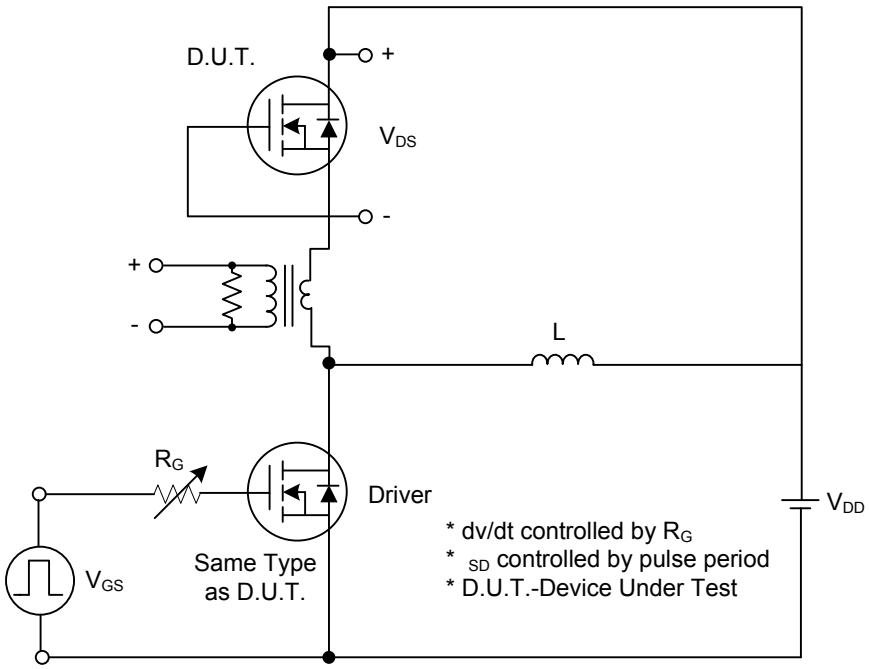
## ELECTRICAL CHARACTERISTICS ($T_C$=25°C, unless otherwise specified)

| 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 | | | 1 | 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 | 2.0 | | 4.0 | V |
| Static Drain-Source On-State Resistance | | $R_{DS(ON)}$ | $V_{GS}$=10V,$I_D$ = 2.0A | | 1.9 | 2.4 | Ω |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| Input Capacitance | | $C_{ISS}$ | $V_{DS}$ = 25V, $V_{GS}$ = 0V,<br>f = 1MHz | | 550 | | pF |
| Output Capacitance | | $C_{OSS}$ | | | 80 | | pF |
| Reverse Transfer Capacitance | | $C_{RSS}$ | | | 30 | | pF |
| **SWITCHING CHARACTERISTICS** | | | | | | | |
| Turn-On Delay Time | | $t_{D(ON)}$ | $V_{DD}$ = 300V, $I_D$ = 4.0A,<br>$R_G$ = 25Ω (Note 1, 2) | | 35 | | ns |
| Turn-On Rise Time | | $t_R$ | | | 80 | | ns |
| Turn-Off Delay Time | | $t_{D(OFF)}$ | | | 160 | | ns |
| Turn-Off Fall Time | | $t_F$ | | | 120 | | ns |
| Total Gate Charge | | $Q_G$ | $V_{DS}$= 480V,$I_D$= 4.0A,<br>$V_{GS}$= 10V (Note 1, 2) | | 80 | | nC |
| Gate-Source Charge | | $Q_{GS}$ | | | 5 | | nC |
| Gate-Drain Charge | | $Q_{GD}$ | | | 20 | | nC |
| **SOURCE- DRAIN DIODE RATINGS AND CHARACTERISTICS** | | | | | | | |
| Drain-Source Diode Forward Voltage | | $V_{SD}$ | $V_{GS}$=0V,$I_S$=4A | | | 1.4 | V |
| Maximum Continuous Drain-Source Diode Forward Current | | $I_S$ | | | | 4 | A |
| Maximum Pulsed Drain-Source Diode Forward Current | | $I_{SM}$ | | | | 16 | A |
| Reverse Recovery Time | | $t_{rr}$ | $V_{GS}$ = 0 V, $I_S$ = 4A,<br>$dI_F/dt$ = 100 A/ μs (Note 1) | | 400 | | ns |
| Reverse Recovery Charge | | $Q_{RR}$ | | | 1.7 | | μC |

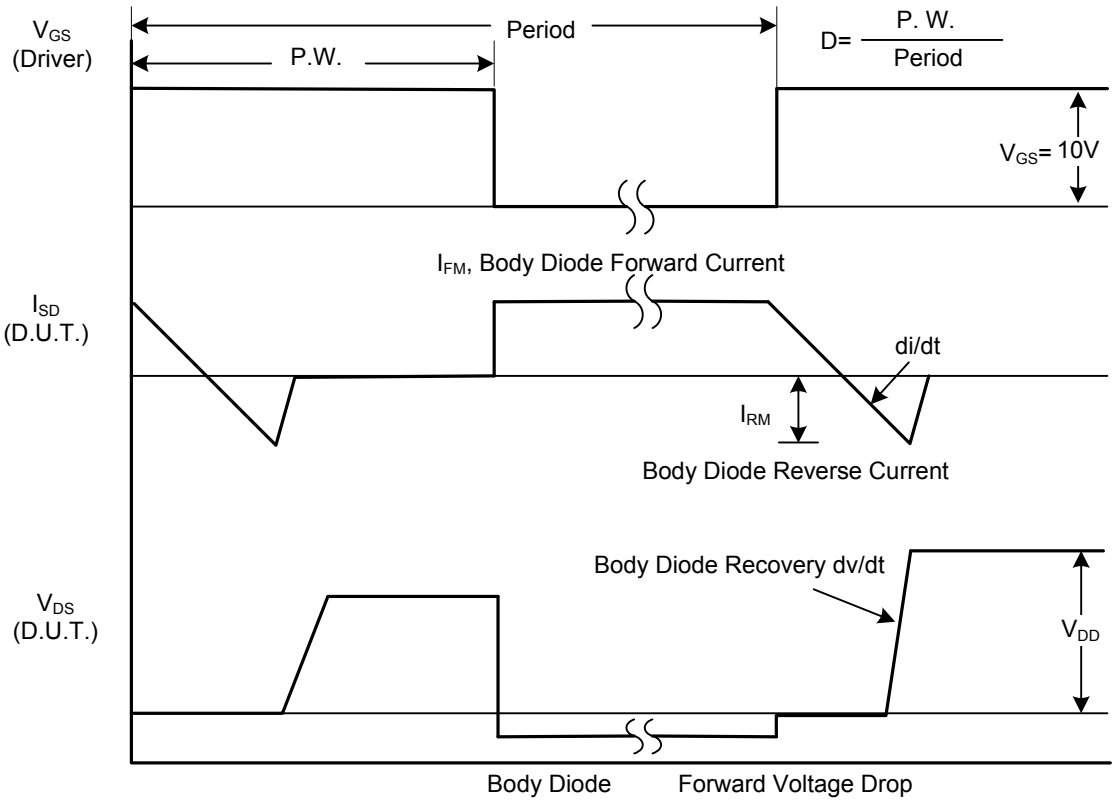
Notes: 1. Pulse Test: Pulse width≤300μs, Duty cycle≤2%

2. Essenti ly independent of operating temperature

## TEST CIRCUITS AND WAVEFORMS

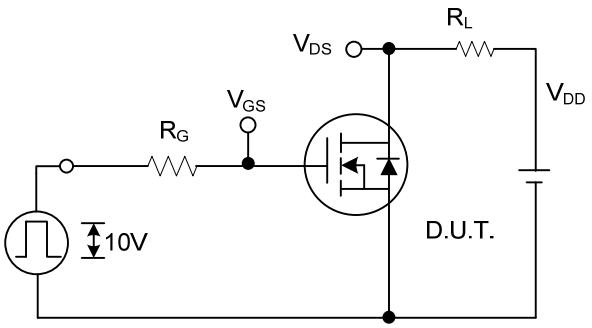



**Peak Diode Recovery dv/dt Test Circuit**

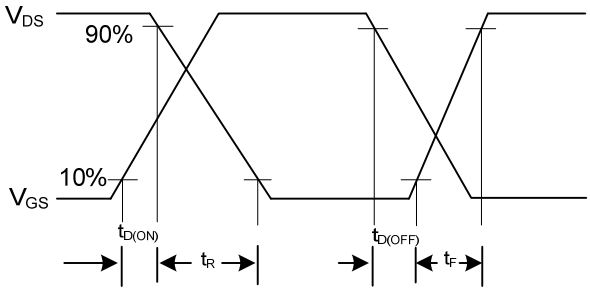



**Peak Diode Recovery dv/dt Waveforms**

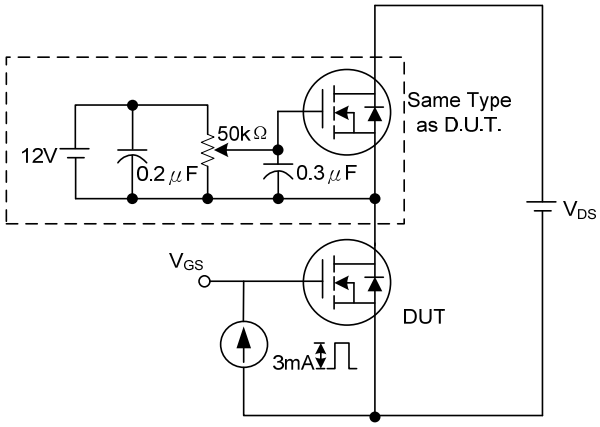
## TEST CIRCUITS AND WAVEFORMS(Cont.)



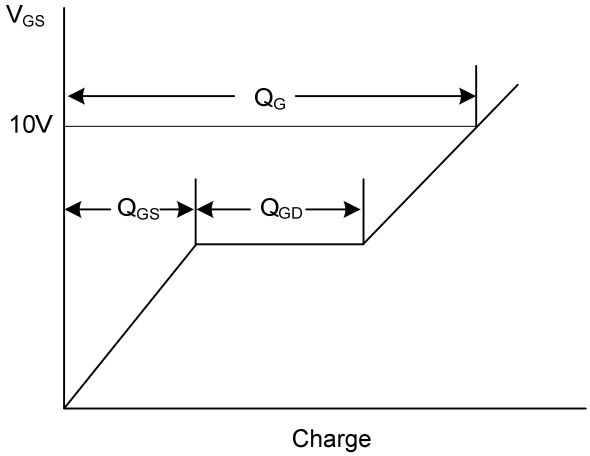

**Switching Test Circuit**



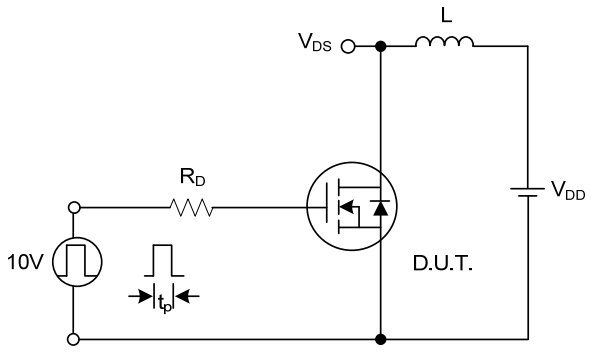

**Switching Waveforms**



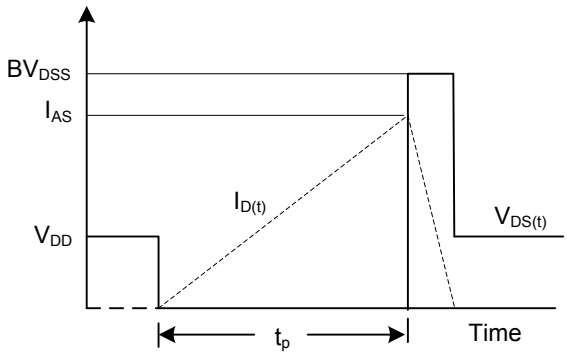

**Gate Charge Test Circuit**




**Gate Charge Waveform**



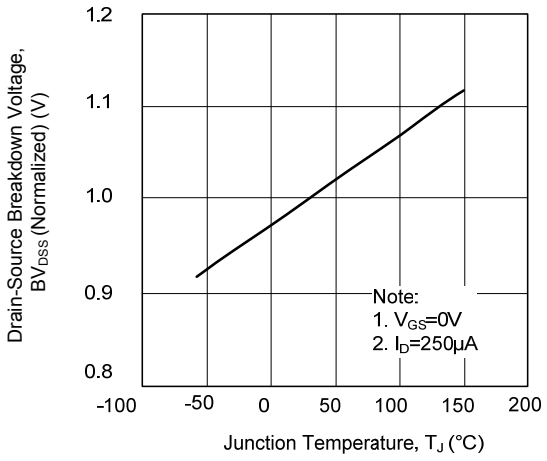

**Unclamped Inductive Switching Test Circuit**



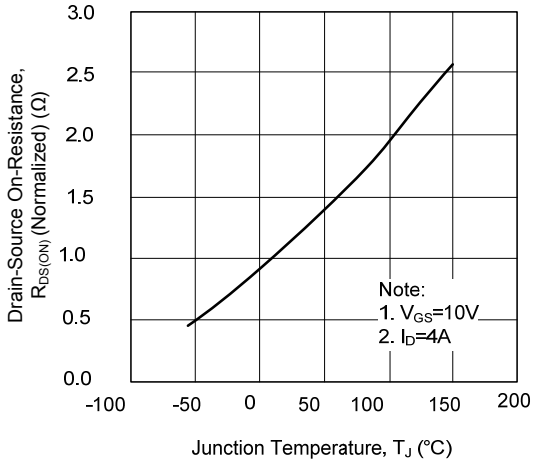

**Unclamped Inductive Switching Waveforms**

## TYPICAL CHARACTERISTICS

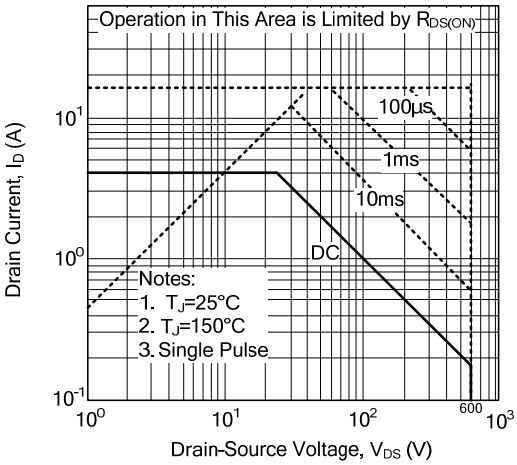
Breakdown Voltage Variation vs. Temperature



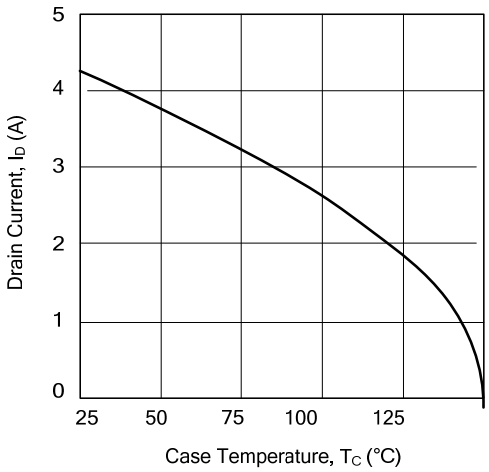

On-Resistance Junction Temperature



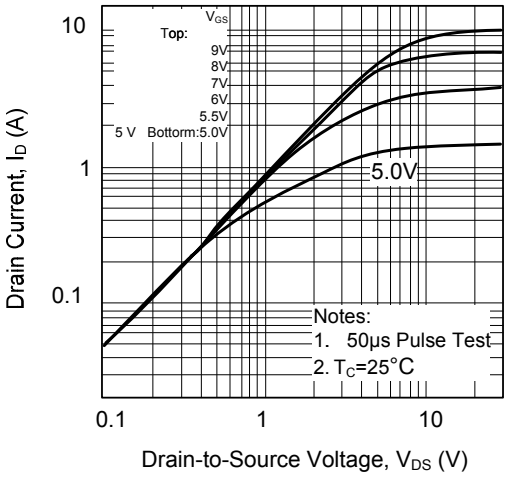

Safe Operating Area - 600V



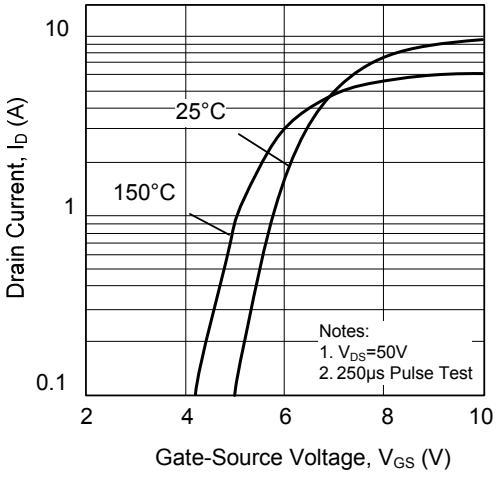

Maximum Drain Current vs. Case Temperature




On-State Characteristics

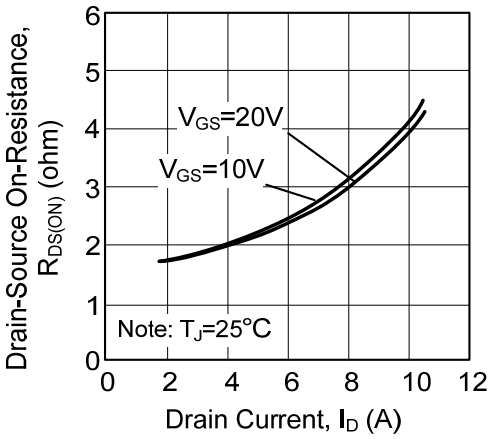



Transfer Characteristics

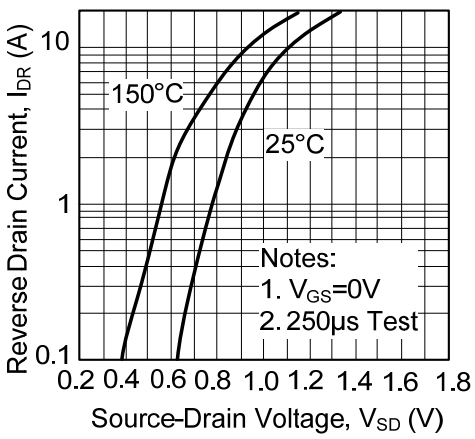


TYPICAL CHARACTERISTICS(Cont.)

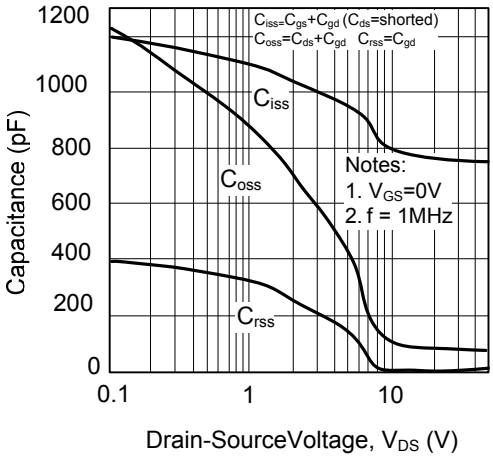
On-Resistance Variation vs. Drain Current and Gate Voltage



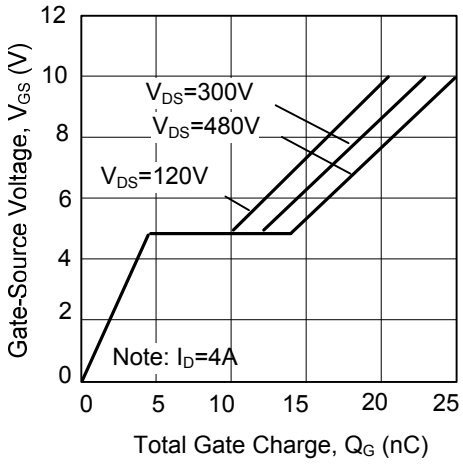

On State Current vs. Allowable Case Temperature



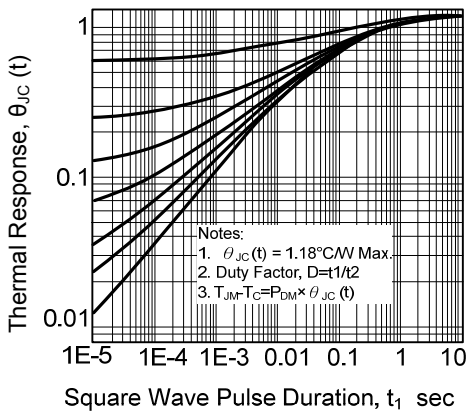

Capacitance Characteristics (Non-Repetitive)



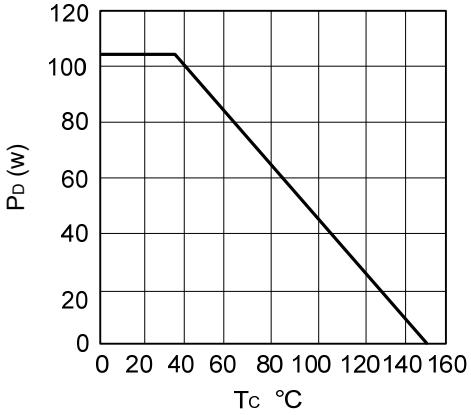

Gate Charge Characteristics



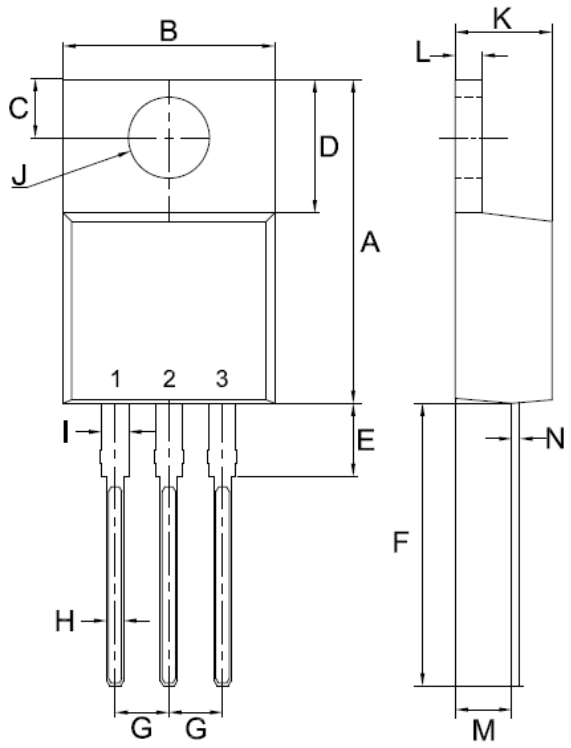

Transient Thermal Response Curve




Power Dissipation

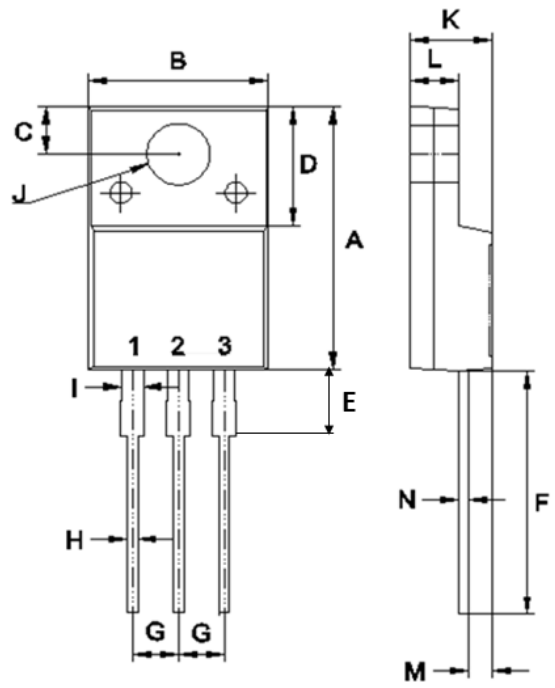


## TO-220 Mechanical Drawing



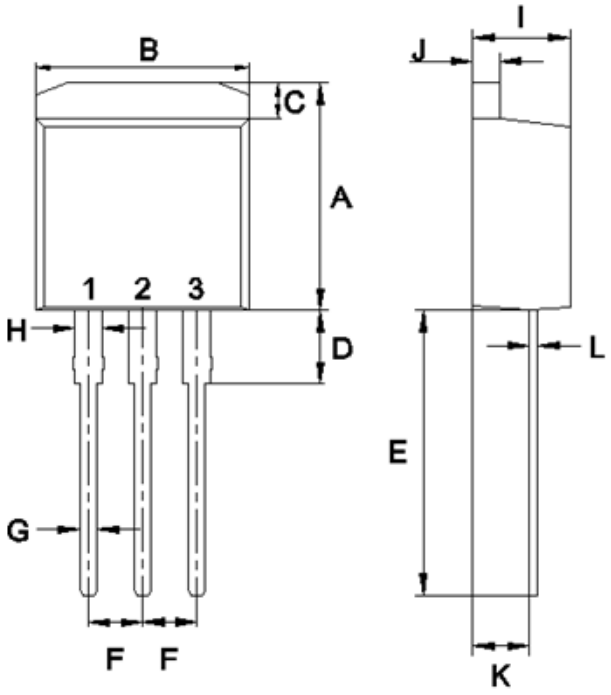

| TO-220AB Unit:mm | | |
|---|---|---|
| DIM | MIN | MAX |
| A | 14.80 | 15.80 |
| B | 9.57 | 10.57 |
| C | 2.54 | 2.94 |
| D | 5.80 | 6.80 |
| E | 2.95 | 3.95 |
| F | 12.70 | 13.40 |
| G | 2.34 | 2.74 |
| H | 0.51 | 1.11 |
| I | 0.97 | 1.57 |
| J | 3.54ϕ | 4.14ϕ |
| K | 4.27 | 4.87 |
| L | 1.07 | 1.47 |
| M | 2.03 | 2.92 |
| N | 0.30 | 0.64 |

## ITO-220 Mechanical Drawing



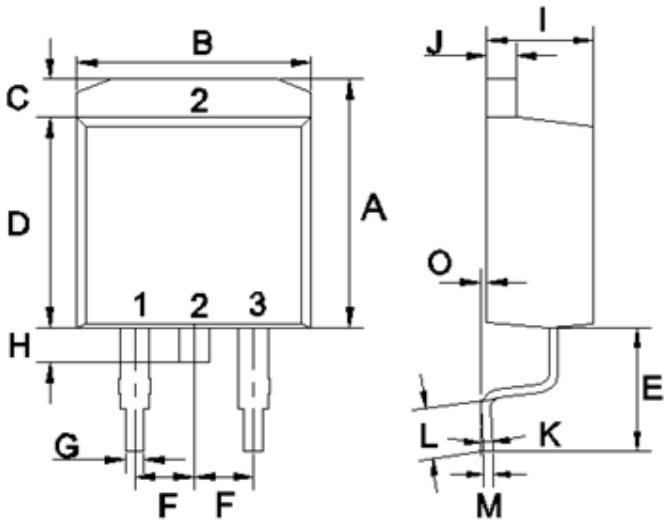

| ITO-220AB Unit:mm | | |
|---|---|---|
| DIM | MIN | MAX |
| A | 14.50 | 15.50 |
| B | 9.50 | 10.50 |
| C | 2.50 | 2.90 |
| D | 6.30 | 7.30 |
| E | 3.30 | 4.30 |
| F | 13.00 | 14.00 |
| G | 2.35 | 2.75 |
| H | 0.30 | 0.90 |
| I | 0.90 | 1.50 |
| J | 3.20 | 3.80 |
| K | 4.24 | 4.84 |
| L | 2.52 | 2.92 |
| M | 1.09 | 1.49 |
| N | 0.47 | 0.64 |

## TO-262 Mechanical Drawing



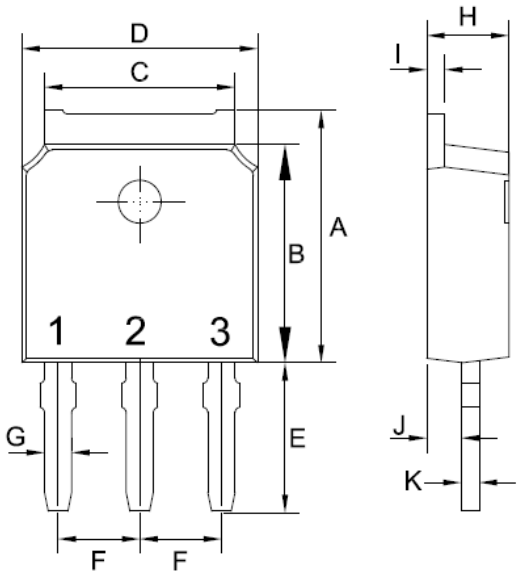

| TO-262(I²PAK) Unit:mm | | |
|---|---|---|
| DIM | MIN | MAX |
| A | 10.14 | 11.14 |
| B | 9.57 | 10.57 |
| C | 1.44 | 1.84 |
| D | 2.95 | 3.95 |
| E | 12.70 | 13.40 |
| F | 2.34 | 2.74 |
| G | 0.51 | 1.11 |
| H | 0.97 | 1.57 |
| I | 4.27 | 4.87 |
| J | 1.07 | 1.47 |
| K | 2.03 | 2.92 |
| L | 0.30 | 0.46 |

## TO-263 Mechanical Drawing



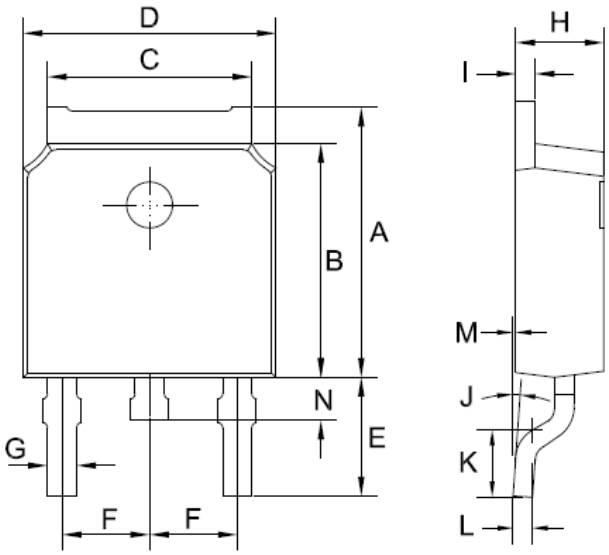

| TO-263 (D² PAK) Unit:mm | | |
|---|---|---|
| DIM | MIN | MAX |
| A | 10.44 | 10.84 |
| B | 9.81 | 10.21 |
| C | 1.44 | 1.84 |
| D | 8.80 | 9.20 |
| E | 4.46 | 4.66 |
| F | 2.44 | 2.64 |
| G | 0.61 | 1.01 |
| H | 0.70 | 1.30 |
| I | 4.27 | 4.87 |
| J | 1.07 | 1.47 |
| K | 0° | 8° |
| L | 2.10 | 2.50 |
| M | 0.30 | 0.46 |
| O | 0 | 0.25 |

## TO-251 Mechanical Drawing




| TO-251 (IPAK) Unit:mm | | |
|---|---|---|
| DIM | MIN | MAX |
| A | 6.85 | 7.25 |
| B | 5.90 | 6.30 |
| C | 5.13 | 5.53 |
| D | 6.40 | 6.80 |
| E | 3.95 | 4.35 |
| F | 2.19 | 2.39 |
| G | 0.45 | 0.85 |
| H | 2.20 | 2.40 |
| I | 0.41 | 0.61 |
| J | 0.71 | 1.31 |
| K | 0.41 | 0.61 |

## TO-252 Mechanical Drawing




| TO-252 (DPAK) Unit:mm | | |
|---|---|---|
| DIM | MIN | MAX |
| A | 6.85 | 7.25 |
| B | 5.90 | 6.30 |
| C | 5.13 | 5.53 |
| D | 6.40 | 6.80 |
| E | 2.90 | 3.30 |
| F | 2.19 | 2.39 |
| G | 0.45 | 0.85 |
| H | 2.20 | 2.40 |
| I | 0.41 | 0.61 |
| J | 0° | 8° |
| K | 1.45 | 1.85 |
| L | 0.41 | 0.61 |
| M | 0.00 | 0.12 |
| N | 0.60 | 1.00 |