

## Surface Mount N-Channel Power MOSFET

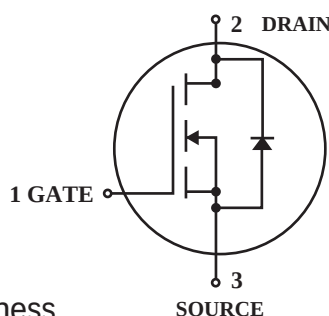
**(Pb)** Lead(Pb)-Free

### Description:

The WEITRON 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:

- \*  $R_{DS(ON)} = 2.5 \text{ Ohms @ } V_{GS} = 10V$
- \* Ultra low gate charge
- \* Low reverse transfer Capacitance
- \* Fast switching capability
- \* Avalanche energy Specified
- \* Improved dv/dt capability, high ruggedness

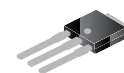


**DRAIN CURRENT**

**4 AMPERES**

**DRAIN SOURCE VOLTAGE**

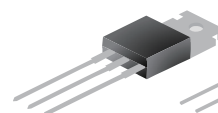
**600 VOLTAGE**



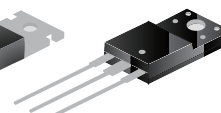
**D-PAK3/(TO-251)**



**D-PAK/(TO-252)**



**TO-220**



**TO-220F**

## Maximum Ratings ( $T_A = 25^\circ\text{C}$ Unless Otherwise Specified)

| Rating                                                                                                                                                                                                                                                                         | Symbol         | Value                                  | Unit             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|----------------------------------------|------------------|
| Drain-Source Voltage                                                                                                                                                                                                                                                           | $V_{DSS}$      | 600                                    | V                |
| Gate-Source Voltage                                                                                                                                                                                                                                                            | $V_{GSS}$      | $\pm 30$                               |                  |
| Avalanche Current - (Note 1)                                                                                                                                                                                                                                                   | $I_{AR}$       | 4.4                                    | A                |
| Continuous Drain Current @ $T_C = 25^\circ\text{C}$<br>@ $T_C = 100^\circ\text{C}$                                                                                                                                                                                             | $I_D$          | 4.0<br>2.8                             |                  |
| Pulsed Drain Current, $T_P$ Limited by $T_{JMAX}$ - (Note 1)                                                                                                                                                                                                                   | $I_{DM}$       | 16                                     |                  |
| Avalanche Energy, Single Pulsed (Note 2)                                                                                                                                                                                                                                       | $E_{AS}$       | 276                                    | 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             |
| Total Power Dissipation<br>4N60P( $T_C = 25^\circ\text{C}$ )<br>4N60F( $T_C = 25^\circ\text{C}$ )<br>4N60I/D( $T_C = 25^\circ\text{C}$ )<br>4N60P( Derate above $25^\circ\text{C}$ )<br>4N60F( Derate above $25^\circ\text{C}$ )<br>4N60I/D( Derate above $25^\circ\text{C}$ ) | $P_D$          | 100<br>33<br>77<br>0.8<br>0.26<br>0.69 | W                |
| Operating Junction and Storage Temperature Range                                                                                                                                                                                                                               | $T_J, T_{stg}$ | -55~+150                               | $^\circ\text{C}$ |

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.

**Electrical Characteristics** ( $T_A = 25^\circ\text{C}$  Unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

**Static**

|                                                                                                                                                                                     |                                |        |        |             |                           |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|--------|--------|-------------|---------------------------|
| Drain-Source Breakdown Voltage @ $V_{GS}=0, I_D=250\mu\text{A}$                                                                                                                     | $BV_{DSS}$                     | 600    | -      | -           | V                         |
| Gate Threshold Voltage @ $V_{DS}=V_{GS}, I_D=250\mu\text{A}$                                                                                                                        | $V_{GS(Th)}$                   | 2.0    | -      | 4.0         |                           |
| Gate-Source Leakage current Forward@ $V_{GS}=30\text{V}, V_{DS}=0\text{V}$<br>ReVerse@ $V_{GS}=-30\text{V}, V_{DS}=0\text{V}$                                                       | $I_{GSS}$                      | -<br>- | -<br>- | 100<br>-100 | nA                        |
| Drain-Source Leakage Current( $T_j=25^\circ\text{C}$ ) @ $V_{DS}=600\text{V}, V_{GS}=0$<br>Drain-Source Leakage Current( $T_j=125^\circ\text{C}$ ) @ $V_{DS}=480\text{V}, V_{GS}=0$ | $I_{DSS}$                      | -<br>- | -<br>- | 10<br>100   | $\mu\text{A}$             |
| Drain-Source On-State Resistance @ $V_{GS}=10\text{V}, I_D=2.0\text{A}$                                                                                                             | $R_{DS(on)}$                   | -      | -      | 2.5         | $\Omega$                  |
| Forward Transconductance @ $V_{DS}=50\text{V}, I_D=2.2\text{A}$ (Note 4)                                                                                                            | $g_{fs}$                       | -      | 4.0    | -           | S                         |
| Breakdown Voltage Temperature Coefficient<br>$I_D=250\mu\text{A}$ , Referenced to $25^\circ\text{C}$                                                                                | $\Delta BV_{DSS} / \Delta T_j$ | -      | 0.6    | -           | $\text{V}/^\circ\text{C}$ |

**Dynamic**

|                                                                                       |           |   |     |    |    |
|---------------------------------------------------------------------------------------|-----------|---|-----|----|----|
| Input Capacitance @ $V_{GS}=0\text{V}, V_{DS}=25\text{V}, f=1.0\text{MHz}$            | $C_{iss}$ | - | 672 | -  | pF |
| Output Capacitance @ $V_{GS}=0\text{V}, V_{DS}=25\text{V}, f=1.0\text{MHz}$           | $C_{oss}$ | - | 66  | -  |    |
| Reverse Transfer Capacitance @ $V_{GS}=0\text{V}, V_{DS}=25\text{V}, f=1.0\text{MHz}$ | $C_{rss}$ | - | 4.7 | 11 |    |

**Switching**

|                                                                                        |              |   |      |   |    |
|----------------------------------------------------------------------------------------|--------------|---|------|---|----|
| Turn-on Delay Time<br>$V_{DD}=300\text{V}, I_D=4.4\text{A}, R_G=25\Omega$ (Note 4, 5)  | $t_{d(on)}$  | - | 27   | - | ns |
| Turn-on Rise Time<br>$V_{DD}=300\text{V}, I_D=4.4\text{A}, R_G=25\Omega$ (Note 4, 5)   | $t_r$        | - | 19   | - |    |
| Turn-off Delay Time<br>$V_{DD}=300\text{V}, I_D=4.4\text{A}, R_G=25\Omega$ (Note 4, 5) | $t_{d(off)}$ | - | 160  | - |    |
| Turn-off Fall Time<br>$V_{DD}=300\text{V}, I_D=4.4\text{A}, R_G=25\Omega$ (Note 4, 5)  | $t_f$        | - | 22   | - |    |
| Total Gate Charge<br>$V_{DS}=480\text{V}, V_{GS}=10\text{V}, I_D=4.4$ (Note 4, 5)      | $Q_g$        | - | 19.8 | - | nC |
| Gate-Source Charge<br>$V_{DS}=480\text{V}, V_{GS}=10\text{V}, I_D=4.4$ (Note 4, 5)     | $Q_{gs}$     | - | 4.0  | - |    |
| Gate-Drain Change<br>$V_{DS}=480\text{V}, V_{GS}=10\text{V}, I_D=4.4$ (Note 4, 5)      | $Q_{gd}$     | - | 7.2  | - |    |

## Electrical Characteristics (T<sub>A</sub> = 25°C Unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

### Source-Drain Diode Characteristics

|                                                                                                        |                 |   |     |      |    |
|--------------------------------------------------------------------------------------------------------|-----------------|---|-----|------|----|
| Drain-Source Diode Forward Voltage @V <sub>GS</sub> =0V, I <sub>S</sub> =4.0A                          | V <sub>SD</sub> | - | -   | 1.4  | V  |
| Maximum Continuous Drain-Source Diode Forward Current                                                  | I <sub>S</sub>  | - | -   | 4.4  | A  |
| Maximum Pulsed Drain-Source Diode Forward Current                                                      | I <sub>SM</sub> | - | -   | 16.0 | A  |
| Reverse Recovery Time @V <sub>GS</sub> =0V, I <sub>S</sub> =4A, dI <sub>F</sub> /dt=100A/μs (Note 4)   | T <sub>rr</sub> | - | 300 | -    | ns |
| Reverse Recovery Charge @V <sub>GS</sub> =0V, I <sub>S</sub> =4A, dI <sub>F</sub> /dt=100A/μs (Note 4) | Q <sub>rr</sub> | - | 3.4 | -    | μC |

### Thermal Data

|                     |         |                 |   |   |      |      |
|---------------------|---------|-----------------|---|---|------|------|
| Junction-to-Ambient | 4N60P   | θ <sub>JA</sub> | - | - | 62.5 | °C/W |
|                     | 4N60F   |                 |   |   | 120  |      |
|                     | 4N60I/D |                 |   |   | 112  |      |
| Junction-to-Case    | 4N60P   | θ <sub>JC</sub> | - | - | 1.25 | °C/W |
|                     | 4N60F   |                 |   |   | 3.79 |      |
|                     | 4N60I/D |                 |   |   | 2.2  |      |

Note: 1. Repetitive Rating : Pulse width limited by T<sub>J</sub>  
 2. L = 30mH, I<sub>AS</sub> = 3.81A, V<sub>DD</sub> = 175V, R<sub>G</sub> = 25 Ω, Starting T<sub>J</sub> = 25°C  
 3. I<sub>SD</sub> ≤ 4.4A, di/dt ≤ 200A/μs, V<sub>DD</sub> ≤ B<sub>V</sub>DSS, Starting T<sub>J</sub> = 25°C  
 4. Pulse Test: Pulse width ≤ 300μs, Duty cycle ≤ 2%  
 5. Essentially independent of operating temperature

## Ordering Information

| Order Number | Package       | Pin Assignment |   |   | Packing |
|--------------|---------------|----------------|---|---|---------|
|              |               | 1              | 2 | 3 |         |
| 4N60P        | TO-220        | G              | D | S | Tube    |
| 4N60F        | TO-220F       | G              | D | S | Tube    |
| 4N60I        | D-PAK3/TO-251 | G              | D | S | Tube    |
| 4N60D        | D-PAK/TO-252  | G              | D | S | Tube    |

## Test Circuits And Waveforms

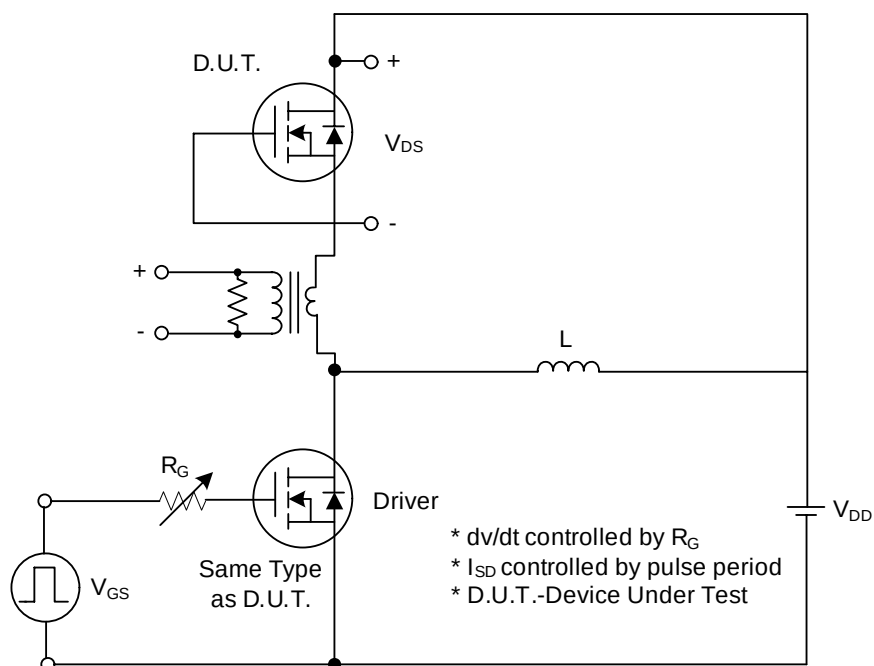


Fig. 1A Peak Diode Recovery dv/dt Test Circuit

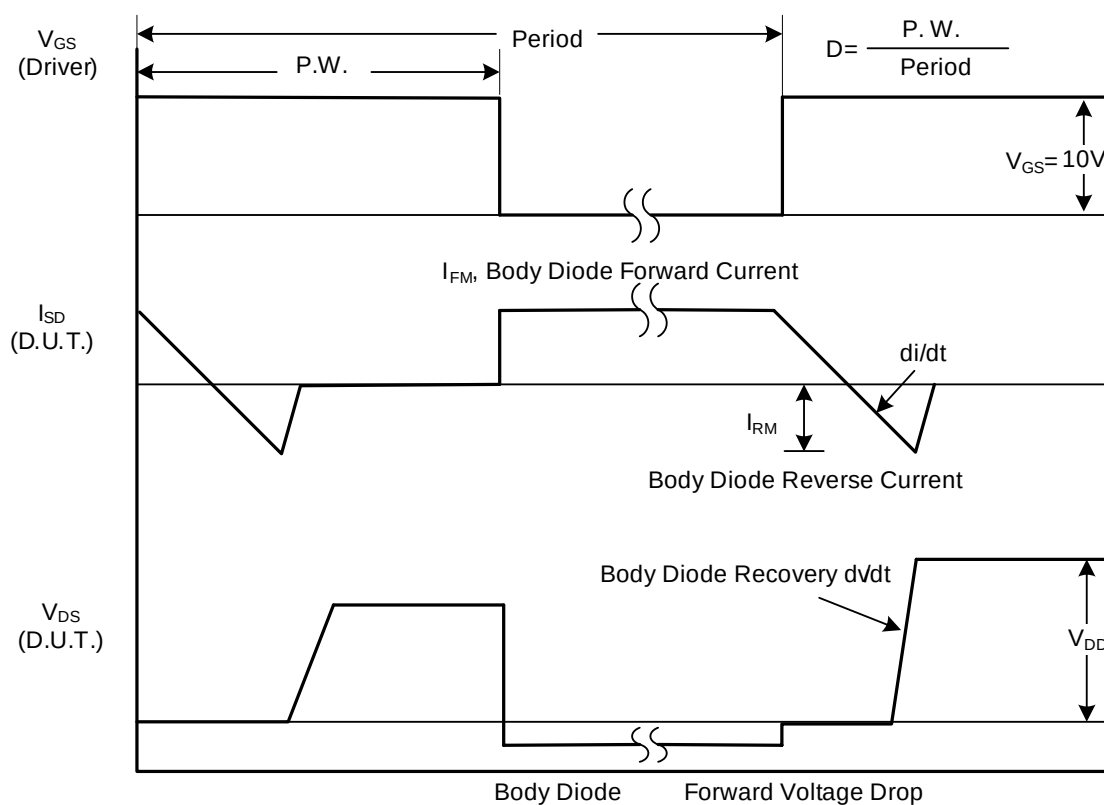


Fig. 1B Peak Diode Recovery dv/dt Waveforms

## Test Circuits And Waveforms(cont.)

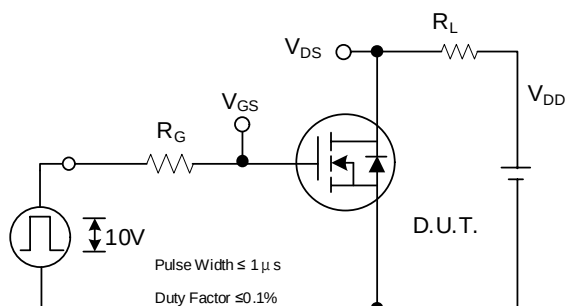


Fig. 2A Switching Test Circuit

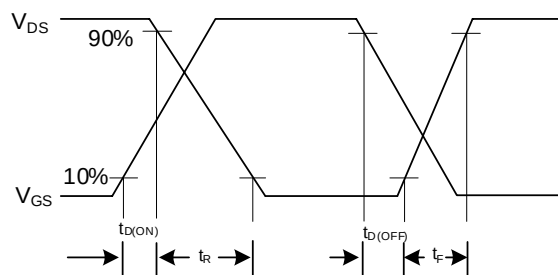


Fig. 2B Switching Waveforms

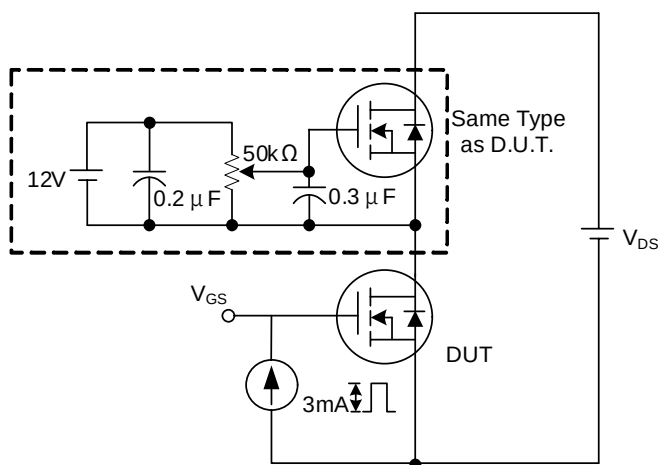


Fig. 3A Gate Charge Test Circuit

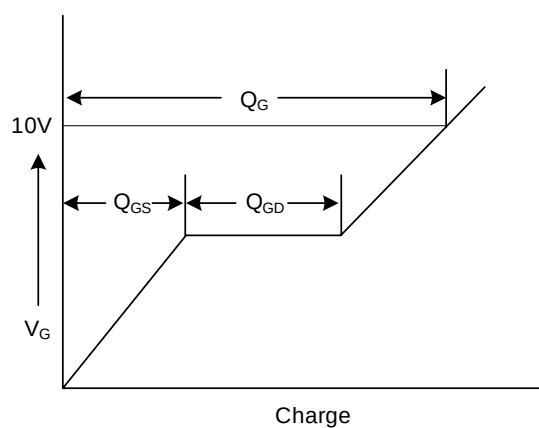


Fig. 3B Gate Charge Waveform

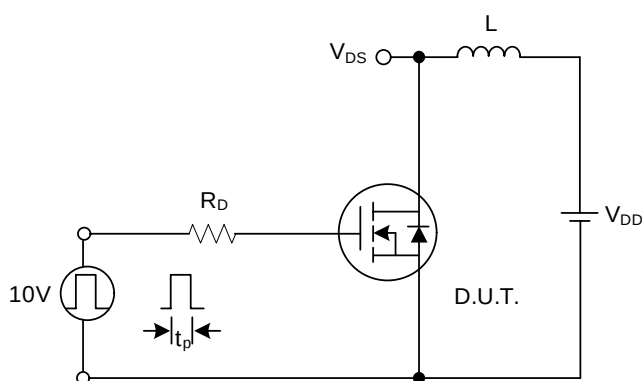


Fig. 4A Unclamped Inductive Switching Test Circuit

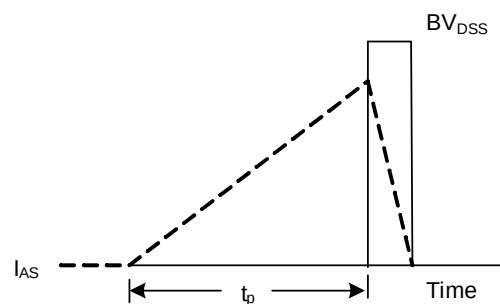
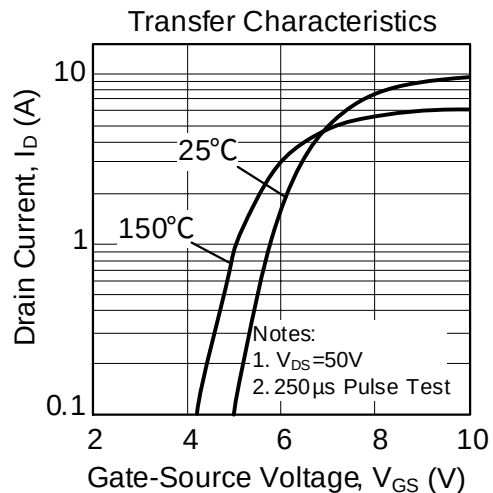
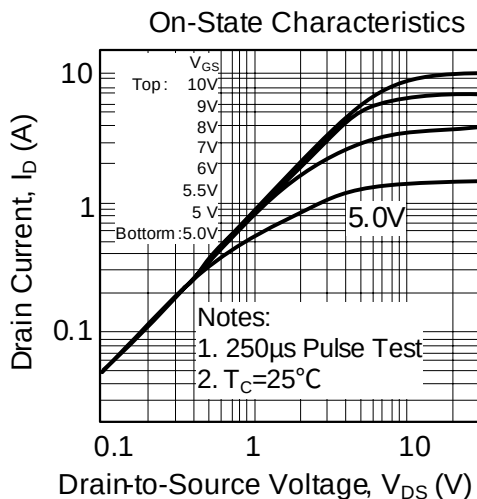
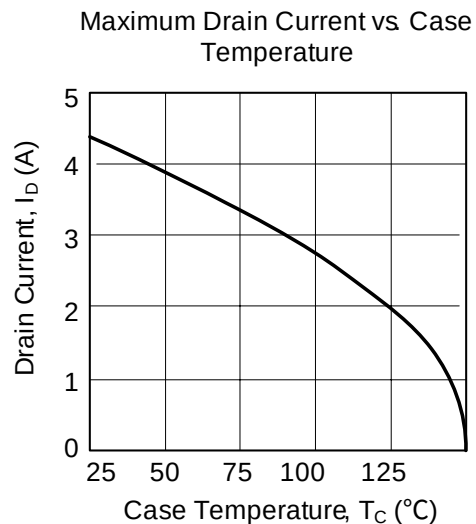
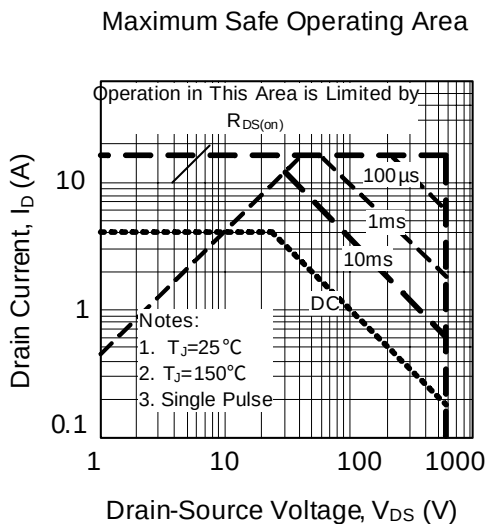
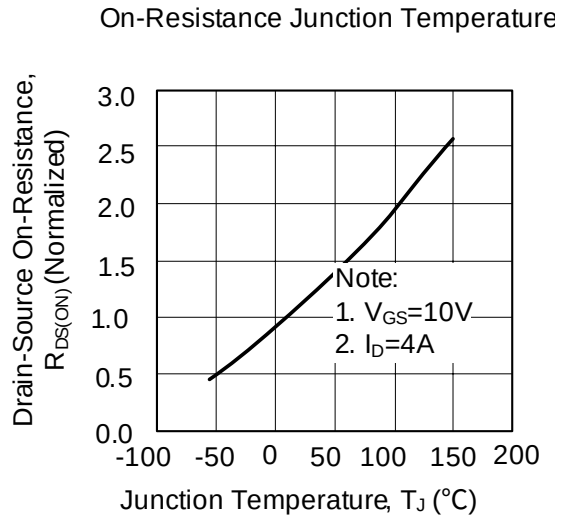
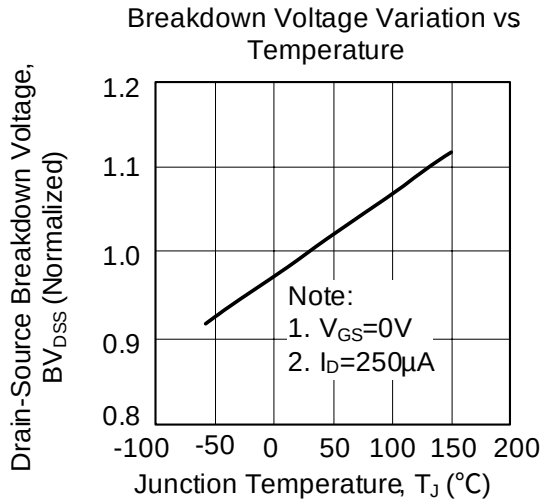


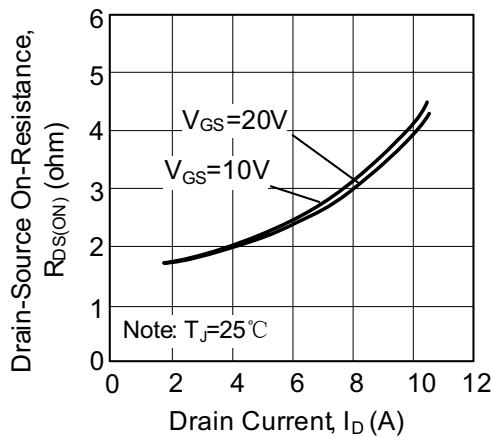
Fig. 4B Unclamped Inductive Switching Waveforms

## Typical Characteristics

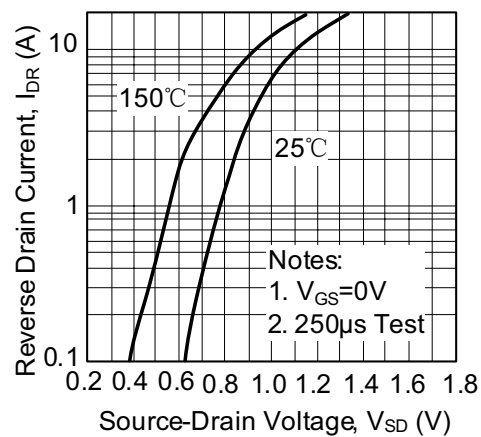


## Typical Characteristics

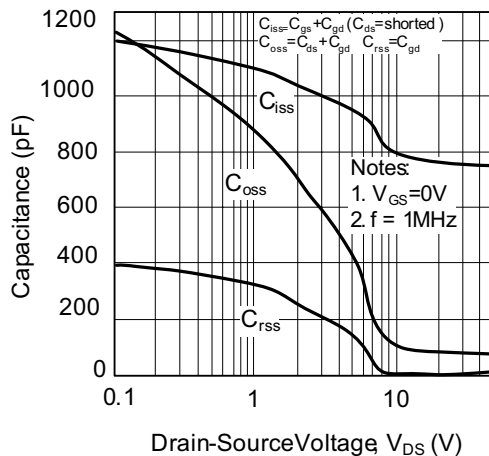
On-Resistance Variation vs Drain Current and Gate Voltage



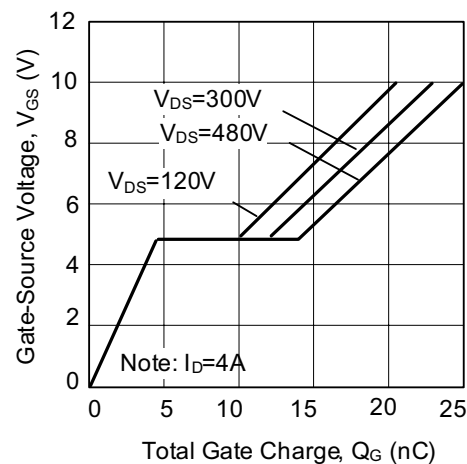
On State Current vs. Allowable Case Temperature



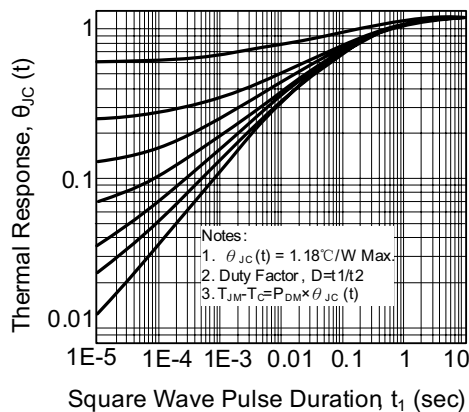
Capacitance Characteristics (Non-Repetitive)



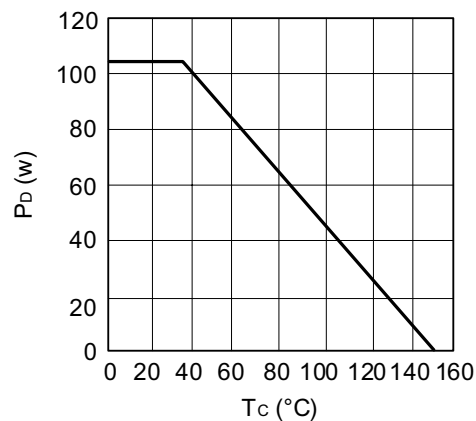
Gate Charge Characteristics



Transient Thermal Response Curve

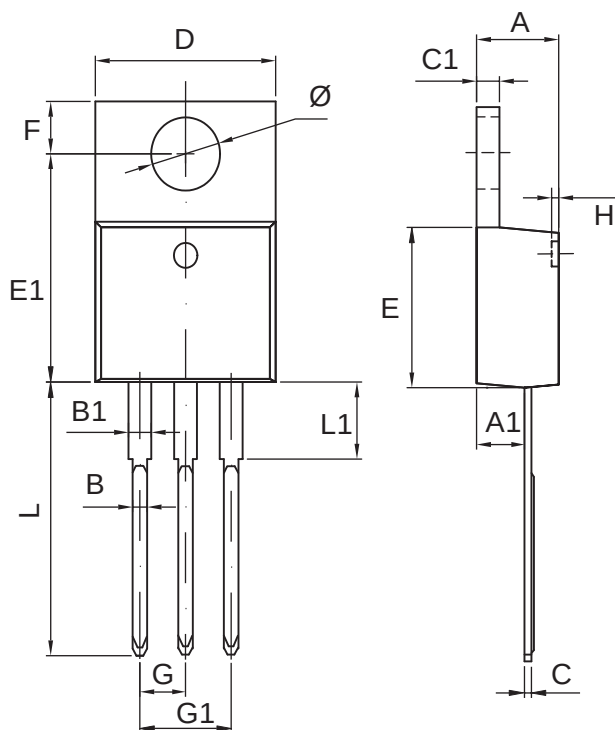


Power Dissipation



## TO-220 Outline Dimensions

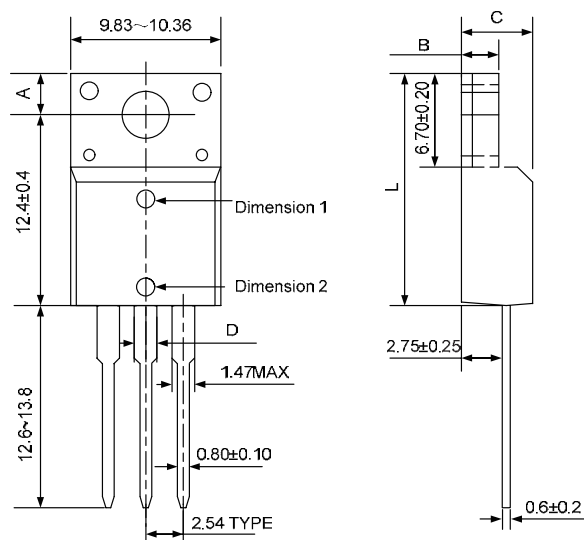
Unit:mm



| TO-220 |          |        |
|--------|----------|--------|
| Dim    | Min      | Max    |
| A      | 4.47     | 4.67   |
| A1     | 2.52     | 2.82   |
| B      | 0.71     | 0.91   |
| B1     | 1.17     | 1.37   |
| C      | 0.31     | 0.53   |
| C1     | 1.17     | 1.37   |
| D      | 10.01    | 10.31  |
| E      | 8.50     | 8.90   |
| E1     | 12.06    | 12.446 |
| G      | 2.54 TYP |        |
| G1     | 4.98     | 5.18   |
| F      | 2.59     | 2.89   |
| H      | 0.00     | 0.30   |
| L      | 13.4     | 13.8   |
| L1     | 3.56     | 3.96   |
| Φ      | 3.73     | 3.93   |

## TO-220F Outline Dimensions

Unit:mm

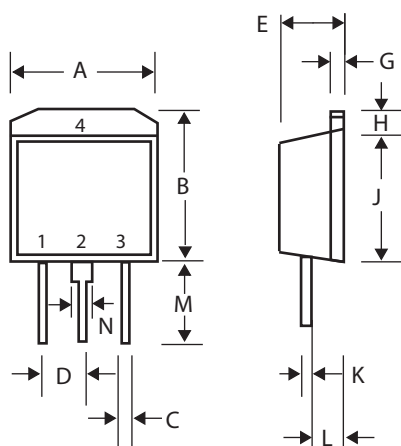


| TO-220F |             |             |
|---------|-------------|-------------|
| Symbol  | Dimension 1 | Dimension 2 |
| A       | 3.3±0.15    | 2.70±0.75   |
| B       | 2.55±0.20   | 3.0±0.20    |
| C       | 4.72±0.2    | 4.5±0.20    |
| D       | 1.47MAX     | 1.75MAX     |
| L       | 15.75±0.30  | 15±0.30     |



## TO-251 Outline Dimensions

unit:mm

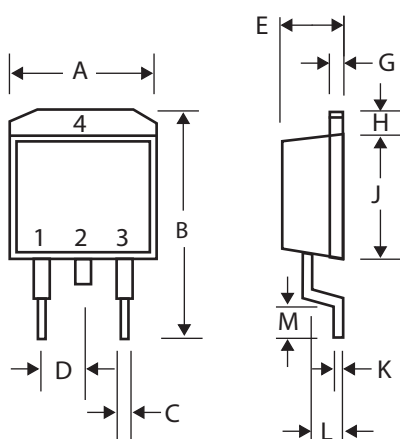


| TO-251 |      |      |
|--------|------|------|
| Dim    | Min  | Max  |
| A      | 6.40 | 6.80 |
| B      | 6.80 | 7.20 |
| C      | 0.50 | 0.80 |
| D      | -    | 2.30 |
| E      | 2.20 | 2.50 |
| G      | 0.45 | 0.55 |
| H      | 1.00 | 1.60 |
| J      | 5.40 | 5.80 |
| K      | 0.45 | 0.69 |
| L      | 0.90 | 1.50 |
| M      | 6.50 | -    |
| N      | -    | 0.90 |

1. Emitter
2. Base
3. Collector

## TO-252 Outline Dimensions

unit:mm



| TO-252 |      |       |
|--------|------|-------|
| Dim    | Min  | Max   |
| A      | 6.40 | 6.80  |
| B      | 9.00 | 10.00 |
| C      | 0.50 | 0.80  |
| D      | -    | 2.30  |
| E      | 2.20 | 2.50  |
| G      | 0.45 | 0.55  |
| H      | 1.00 | 1.60  |
| J      | 5.40 | 5.80  |
| K      | 0.30 | 0.64  |
| L      | 0.70 | 1.70  |
| M      | 0.90 | 1.50  |