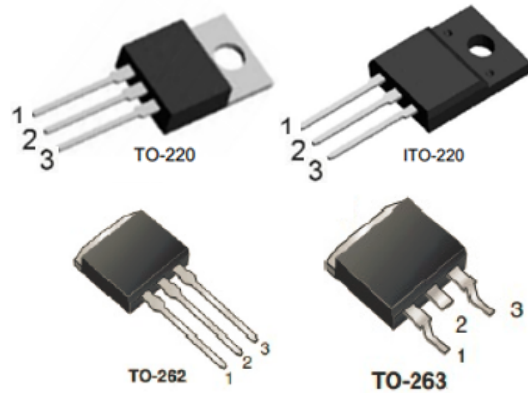


### Features

- $R_{DS(ON)} < 0.80\Omega @ V_{GS}=10V$
- Fast switching capability
- Low gate charge
- Lead free in compliance with EU RoHS directive.
- Green molding compound

### Mechanical Data

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

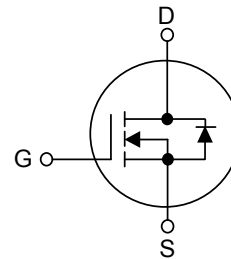


Pin Definition:  
 1. Gate  
 2. Drain  
 3. Source

### Ordering Information

| Part No. | Package | Packing      |
|----------|---------|--------------|
| 12N60T   | TO-220  | 50pcs / Tube |
| 12N60F   | ITO-220 | 50pcs / Tube |
| 12N60K   | TO-262  | 50pcs / Tube |
| 12N60G   | TO-263  | 50pcs / Tube |

### Block Diagram



### Maximum Ratings $T_A = 25^\circ\text{C}$ unless otherwise specified

| PARAMETER                     | SYMBOL                 | RATINGS    | UNIT             |
|-------------------------------|------------------------|------------|------------------|
| Drain-Source Voltage          | $V_{DSS}$              | 600        | V                |
| Gate-Source Voltage           | $V_{GSS}$              | $\pm 30$   | V                |
| Continuous Drain Current      | $I_D$                  | 12         | A                |
| Pulsed Drain Current (Note 2) | $I_{DM}$               | 48         | A                |
| Avalanche Energy              | Single Pulsed (Note 3) | $E_{AS}$   | 790              |
| Power Dissipation             | TO-220/TO-262/TO-263   | $P_D$      | 225              |
|                               | ITO-220                |            | 51               |
| Junction Temperature          | $T_J$                  | +150       | $^\circ\text{C}$ |
| Operating Temperature         | $T_{OPR}$              | -55 ~ +150 | $^\circ\text{C}$ |
| Storage Temperature           | $T_{STG}$              | -55 ~ +150 | $^\circ\text{C}$ |

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  $T_J$

3.  $L = 30\text{mH}$ ,  $I_{AS} = 7.1\text{A}$ ,  $V_{DD} = 50\text{V}$ ,  $R_G = 25\Omega$ , Starting  $T_J = 25^\circ\text{C}$



## THERMAL DATA

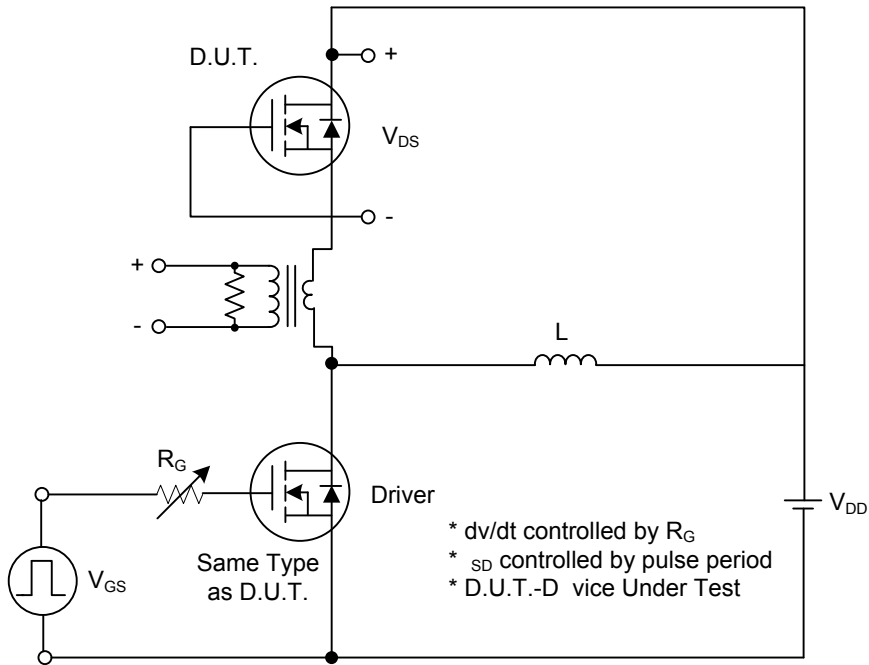
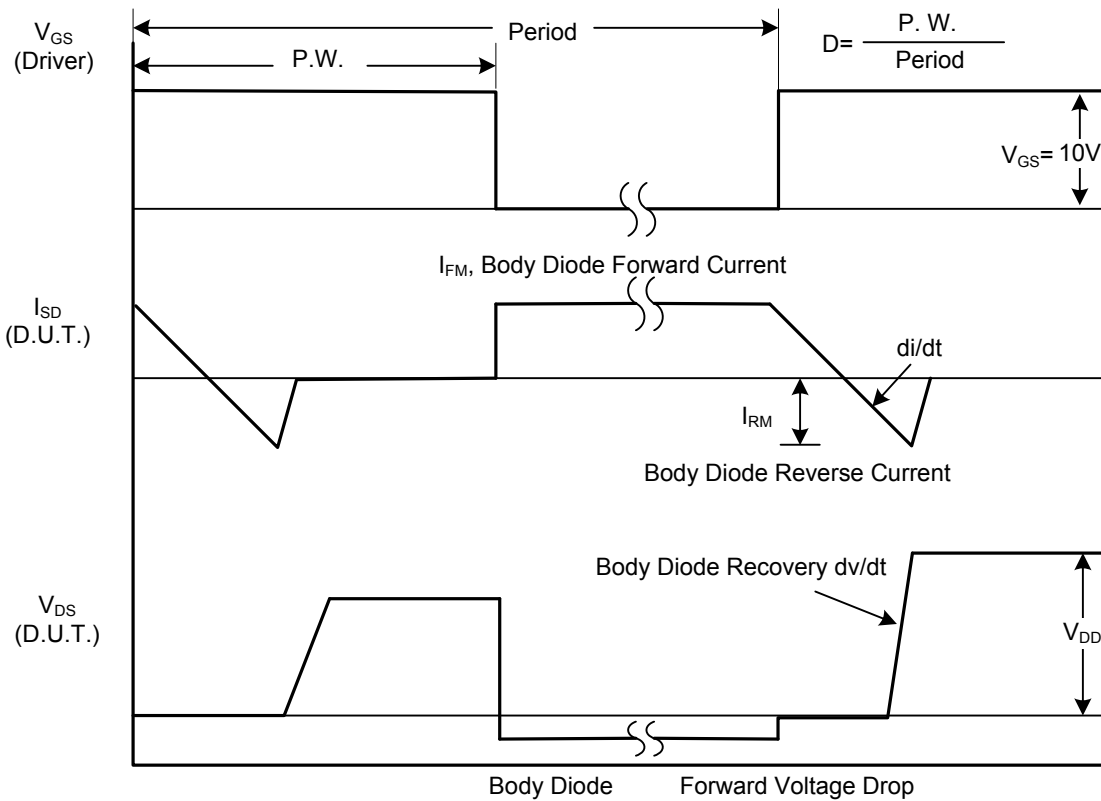
| PARAMETER           |                                 | SYMBOL        | RATING | UNIT                        |
|---------------------|---------------------------------|---------------|--------|-----------------------------|
| Junction to Ambient | TO-220/ITO-220<br>TO-262/TO-263 | $\theta_{JA}$ | 62.5   | $^{\circ}\text{C}/\text{W}$ |
| Junction to Case    | TO-220/TO-262/TO-263            | $\theta_{JC}$ | 0.56   | $^{\circ}\text{C}/\text{W}$ |
|                     | ITO-220                         |               | 2.6    |                             |

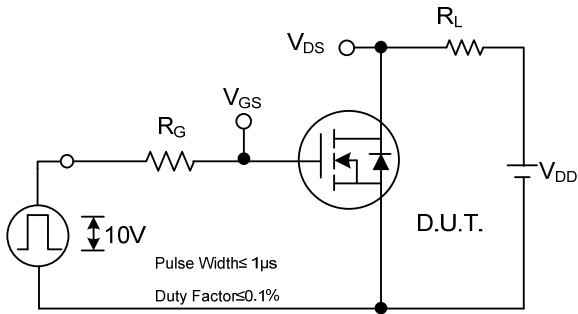
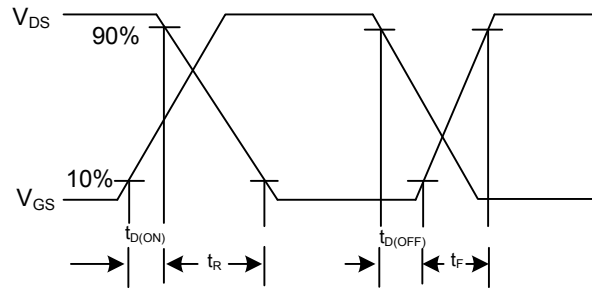
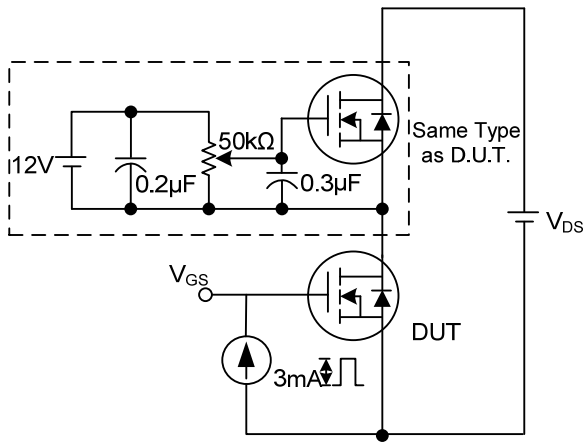
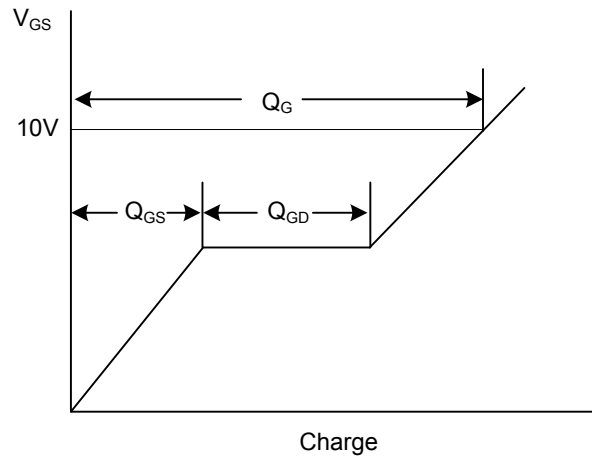
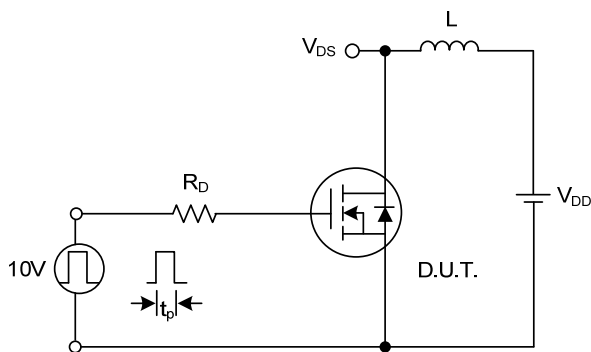
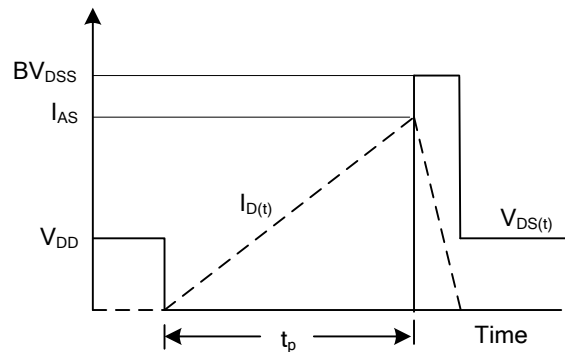
## ELECTRICAL CHARACTERISTICS ( $T_C=25^{\circ}\text{C}$ , unless otherwise specified)

| 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                                  |         | $I_{DSS}$    | $V_{DS}=600\text{V}, V_{GS}=0\text{V}$                                   |     |      | 1    | $\mu\text{A}$ |
| Gate- Source Leakage Current                                  | Forward | $I_{GSS}$    | $V_{GS}=30\text{V}, V_{DS}=0\text{V}$                                    |     |      | 100  | nA            |
|   | Reverse |              | $V_{GS}=-30\text{V}, V_{DS}=0\text{V}$                                   |     |      | -100 | nA            |
| <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             |
| Static Drain-Source On-State Resistance                       |         | $R_{DS(ON)}$ | $V_{GS}=10\text{V}, I_D=6\text{A}$                                       |     | 0.60 | 0.80 | $\Omega$      |
| <b>DYNAMIC CHARACTERISTICS</b>                                |         |              |  |     |      |      |               |
| Input Capacitance   |         | $C_{ISS}$    | $V_{DS}=25\text{V}, V_{GS}=0\text{V}, f=1.0\text{MHz}$                   |     | 1480 |      | pF            |
| Output Capacitance  |         | $C_{OSS}$    |  |     | 200  |      | pF            |
| Reverse Transfer Capacitance                                  |         | $C_{RSS}$    |  |     | 25   |      | pF            |
| <b>SWITCHING CHARACTERISTICS</b>                              |         |              |  |     |      |      |               |
| Turn-On Delay Time  |         | $t_{D(ON)}$  | $V_{DD}=300\text{V}, I_D=12\text{A},$<br>$R_G=25\Omega$ (Note 1, 2)      |     | 30   |      | ns            |
| Turn-On Rise Time   |         | $t_R$        |  |     | 115  |      | ns            |
| Turn-Off Delay Time   |         | $t_{D(OFF)}$ |  |     | 95   |      | ns            |
| Turn-Off Fall Time  |         | $t_F$        |  |     | 85   |      | ns            |
| Total Gate Charge   |         | $Q_G$        | $V_{DS}=480\text{V}, I_D=12\text{A},$<br>$V_{GS}=10\text{V}$ (Note 1, 2) |     | 42   |      | nC            |
| Gate-Source Charge  |         | $Q_{GS}$     |  |     | 8.6  |      | nC            |
| Gate-Drain Charge   |         | $Q_{GD}$     |  |     | 21   |      | nC            |
| <b>DRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS</b> |         |              |  |     |      |      |               |
| Drain-Source Diode Forward Voltage                            |         | $V_{SD}$     | $V_{GS}=0\text{V}, I_S=12\text{A}$                                       |     |      | 1.4  | V             |
| Maximum Continuous Drain-Source Diode Forward Current         |         | $I_S$        |  |     |      | 12   | A             |
| Maximum Pulsed Drain-Source Diode Forward Current             |         | $I_{SM}$     |  |     |      | 48   | A             |
| Reverse Recovery Time   |         | $t_{rr}$     | $V_{GS}=0\text{V}, I_S=12\text{A},$                                      |     | 570  |      | ns            |
| Reverse Recovery Charge                                       |         | $Q_{RR}$     | $di/dt=100\text{A}/\mu\text{s}$ (Note 1)                                 |     | 5.5  |      | $\mu\text{C}$ |

Notes: 1. Pulse Test: Pulse width  $\leq 300\mu\text{s}$ , Duty cycle  $\leq 2\%$ .

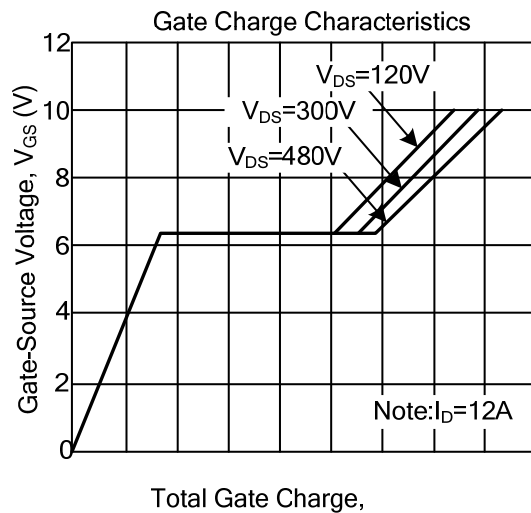
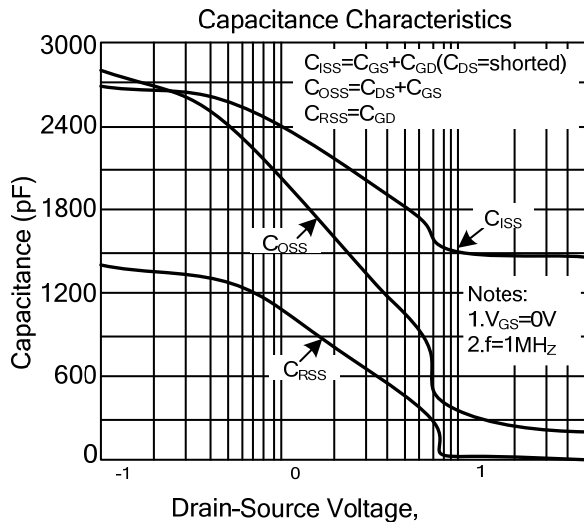
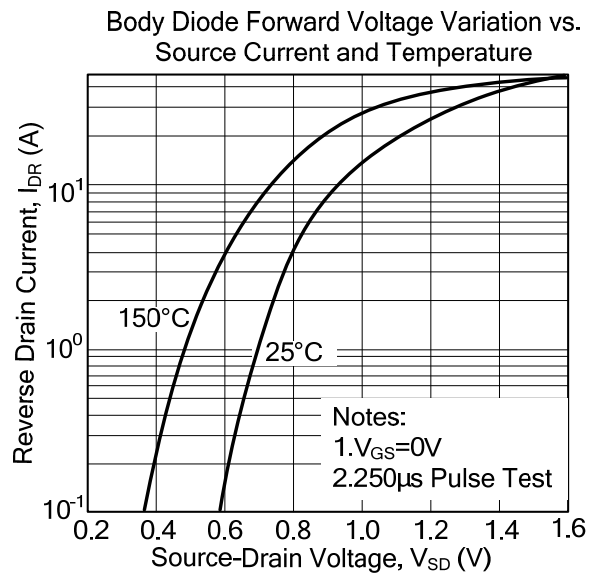
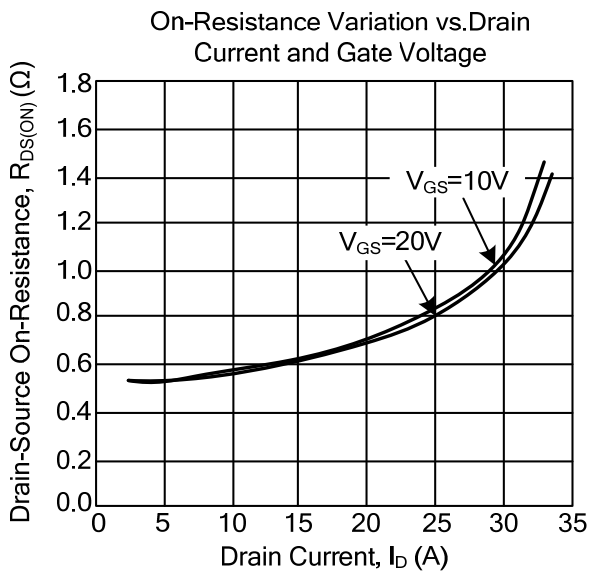
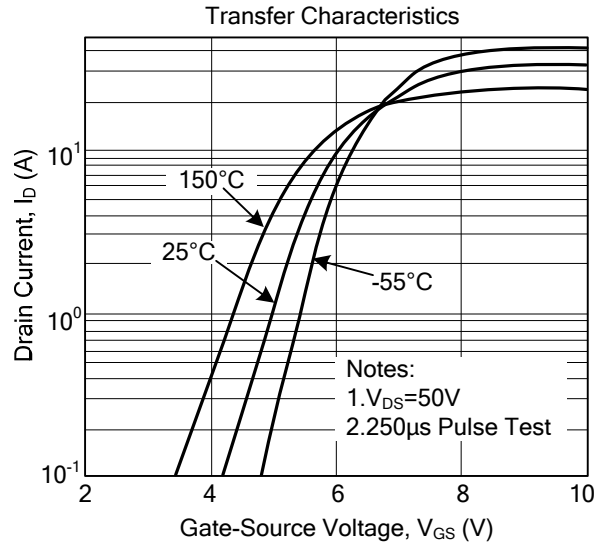
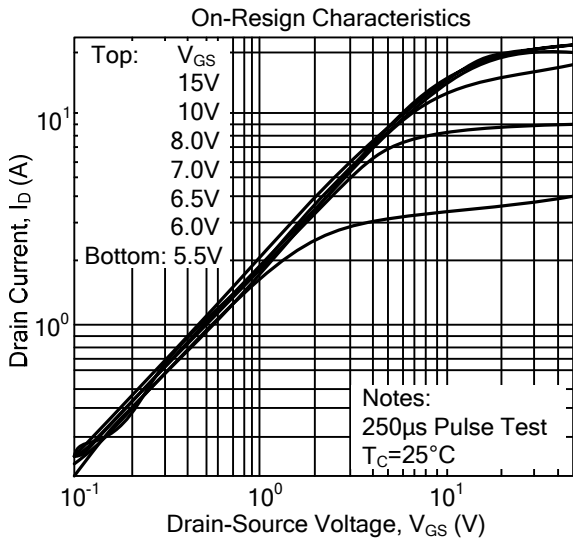
2. Essentially independent of operating temperature.

**TEST CIRCUITS AND WAVEFORMS**

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

**Peak Diode Recovery dv/dt Waveforms**

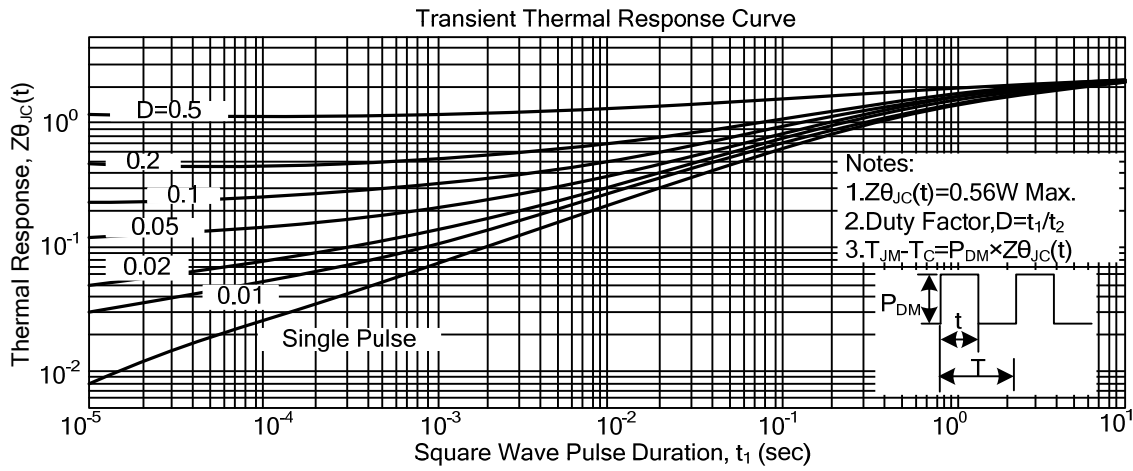
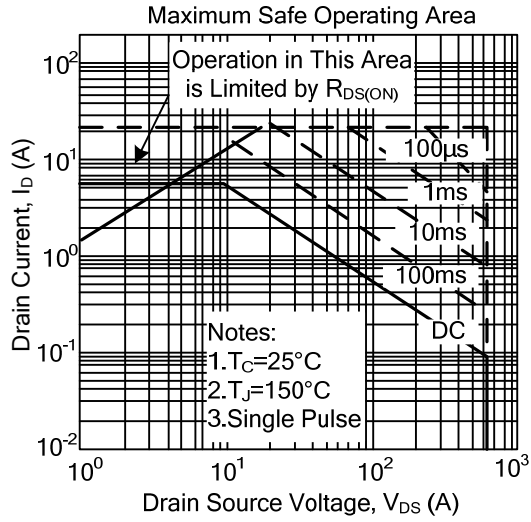
**TEST CIRCUITS AND WAVEFORMS(Cont.)**

**Switching Test Circuit**

**Switching Waveforms**

**Gate Charge Test Circuit**

**Gate Charge Waveform**

**Unclamped Inductive Switching Test Circuit**

**Unclamped Inductive Switching Waveforms**



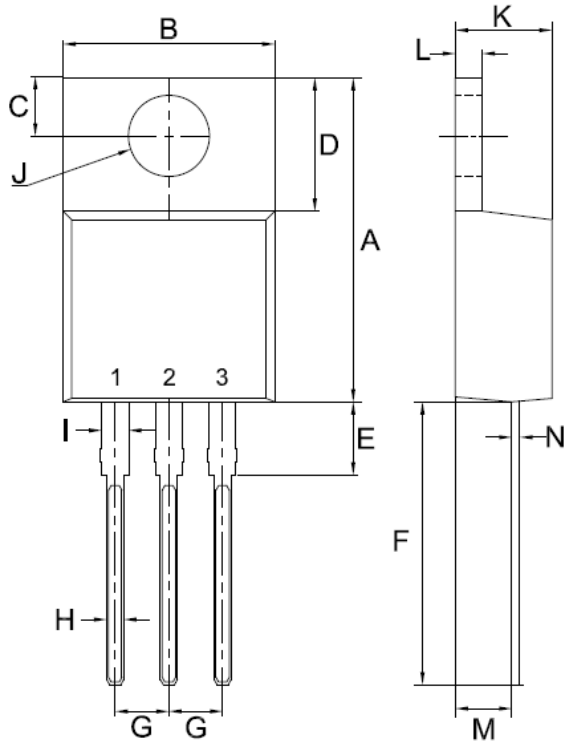
## TYPICAL CHARACTERISTICS



## TYPICAL CHARACTERISTICS

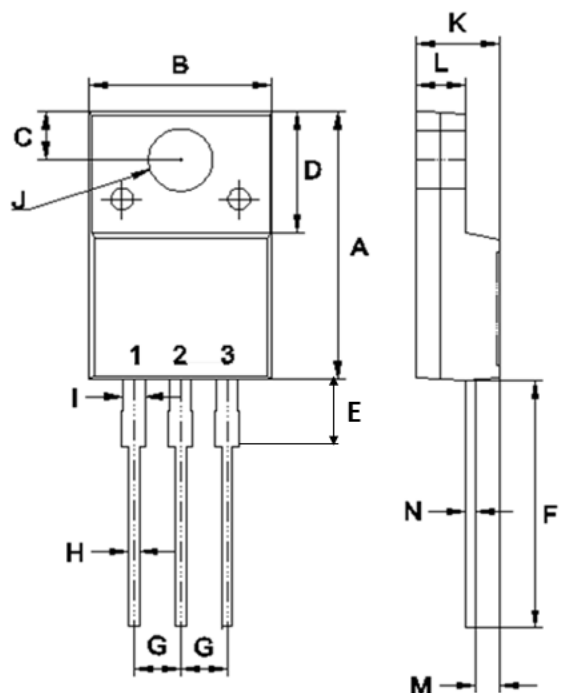


## TO-220 Mechanical Drawing



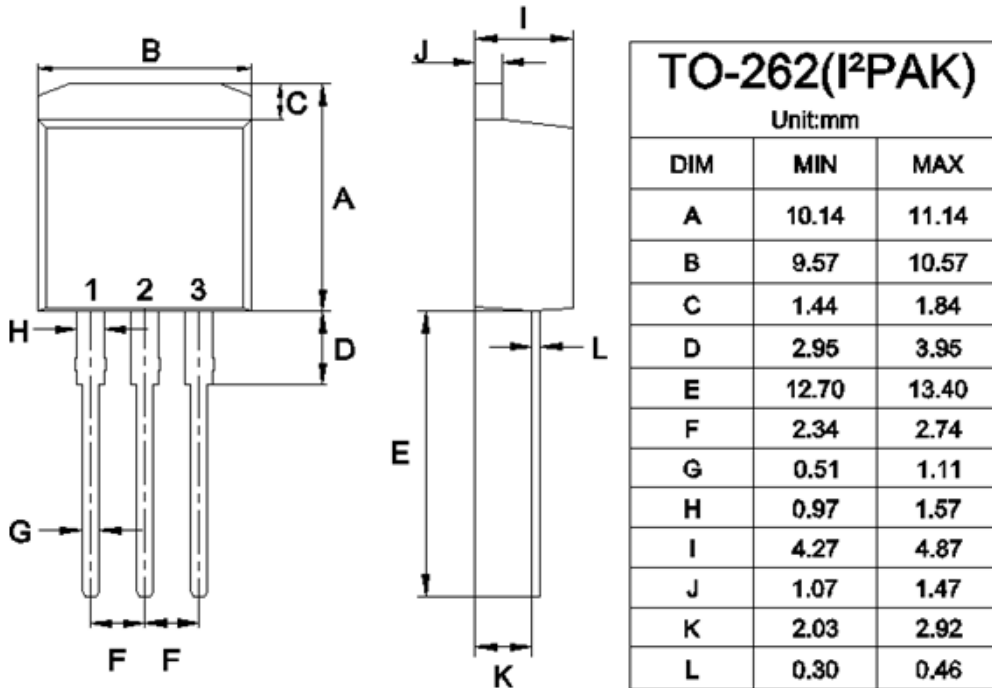
| TO-220AB |             |             |
|----------|-------------|-------------|
| Unit:mm  |             |             |
| DIM      | MIN         | MAX         |
| A        | 14.80       | 15.80       |
| B        | 9.57        | 10.57       |
| C        | 2.54        | 2.94        |
| D        | 5.80        | 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        | 3.54 $\phi$ | 4.14 $\phi$ |
| 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-263 Mechanical Drawing

