

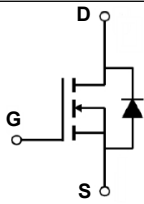
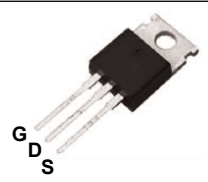
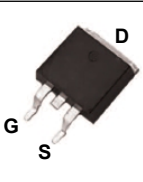
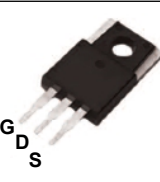
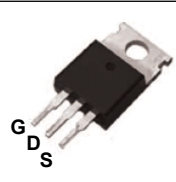
## Features

- $V_{DS}=60V, I_D=180A$   
 $R_{ds(on)}(typ)=2.8m\Omega @ V_{GS}=10V$
- 100% Avalanche Tested
- 100% Rg Tested
- Lead-Free (RoHS Compliant)

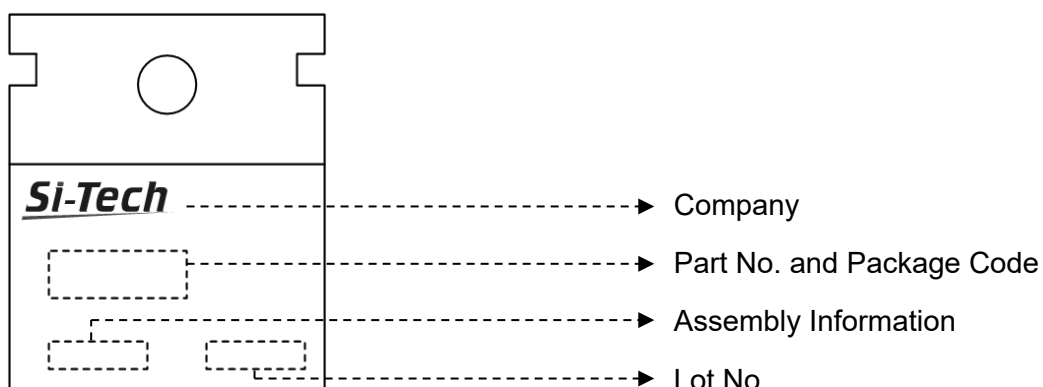
## Applications

- DC Motor Control
- DC-DC Converters
- BMS
- SMPS
- Automotive Environment

## Internal Circuit and Pin Description

|                                                                                   |                                                                                   |                                                                                   |                                                                                    |                                                                                     |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|  |  |  |  |  |
| Package                                                                           | TO-220                                                                            | TO-263                                                                            | TO-220N                                                                            | TO-220P                                                                             |
| Package Code                                                                      | R                                                                                 | S                                                                                 | RN                                                                                 | RP                                                                                  |

## Package Marking



## Absolute Maximum Ratings ( $T_C=25^\circ C$ unless otherwise noted)

| Symbol    | Parameter                                      | Value       | Units         |
|-----------|------------------------------------------------|-------------|---------------|
| $V_{DSS}$ | Drain-Source Voltage                           | 60          | V             |
| $I_D$     | Continuous Drain Current ( $T_C=25^\circ C$ )  | 180         | A             |
|           | Continuous Drain Current ( $T_C=100^\circ C$ ) | 114         | A             |
| $I_{DM}$  | Pulsed Drain Current (Note 1)                  | 720         | A             |
| $V_{GS}$  | Gate-Source Voltage                            | $\pm 25$    | V             |
| $E_{AS}$  | Single Pulsed Avalanche Energy (Note 2)        | 900         | mJ            |
| $P_D$     | Maximum Power Dissipation ( $T_C=25^\circ C$ ) | 227         | W             |
|           | Derating Factor above $25^\circ C$             | 1.82        | W/ $^\circ C$ |
| $T_J$     | Operating Junction Temperature Range           | -55 to +150 | $^\circ C$    |
| $T_{STG}$ | Storage Temperature Range                      | -55 to +150 | $^\circ C$    |

## Thermal Characteristics

| Symbol        | Parameter                            | Value | Units                |
|---------------|--------------------------------------|-------|----------------------|
| $R_{th\ j-c}$ | Thermal Resistance, Junction to case | 0.55  | $^{\circ}\text{C/W}$ |

## Electrical Characteristics ( $T_c=25^{\circ}\text{C}$ unless otherwise noted)

| Symbol       | Parameter                        | Test Conditions                       | Min. | Typ. | Max. | Units     |
|--------------|----------------------------------|---------------------------------------|------|------|------|-----------|
| $BV_{DSS}$   | Drain-Source Breakdown Voltage   | $V_{GS}=0V, I_D=250\mu A$             | 60   | -    | -    | V         |
| $I_{DSS}$    | Drain-Source Leakage Current     | $V_{DS}=57V, V_{GS}=0V$               | -    | -    | 1    | $\mu A$   |
| $I_{GSS}$    | Gate Leakage Current, Forward    | $V_{GS}=25V, V_{DS}=0V$               | -    | -    | 100  | nA        |
|              | Gate Leakage Current, Reverse    | $V_{GS}=-25V, V_{DS}=0V$              | -    | -    | -100 | nA        |
| $V_{GS(th)}$ | Gate Threshold Voltage           | $V_{GS}=V_{DS}, I_D=250\mu A$         | 2.4  | 3    | 3.6  | V         |
| $R_{DS(on)}$ | Drain-Source On-State Resistance | $V_{GS}=10V, I_D=40A$                 | 2.2  | 2.8  | 3.4  | $m\Omega$ |
| $Q_g$        | Total Gate Charge                | $V_{DD}=40V$                          | -    | 170  | -    | nC        |
| $Q_{gs}$     | Gate-Source Charge               | $V_{GS}=10V$                          | -    | 31   | -    | nC        |
| $Q_{gd}$     | Gate-Drain Charge                | $I_D=40A$ (Note 3)                    | -    | 61   | -    | nC        |
| $t_{d(on)}$  | Turn-on Delay Time               | $V_{DD}=37.5V, V_{GS}=10V$            | -    | 29   | -    | ns        |
| $t_r$        | Turn-on Rise Time                | $I_D=45A, R_G=4.7\Omega$              | -    | 71   | -    | ns        |
| $t_{d(off)}$ | Turn-off Delay Time              | $T_c=25^{\circ}\text{C}$              | -    | 49   | -    | ns        |
| $t_f$        | Turn-off Fall Time               | (Note 3)                              | -    | 36   | -    | ns        |
| $R_g$        | Gate Resistance                  | $V_{DS}=0V, V_{GS}=0V, f=1\text{MHz}$ | -    | 1    | -    | $\Omega$  |
| $C_{iss}$    | Input Capacitance                | $V_{DS}=25V$                          | -    | 6647 | -    | pF        |
| $C_{oss}$    | Output Capacitance               | $V_{GS}=0V$                           | -    | 1068 | -    | pF        |
| $C_{rss}$    | Reverse Transfer Capacitance     | $f=1\text{MHz}$                       | -    | 711  | -    | pF        |

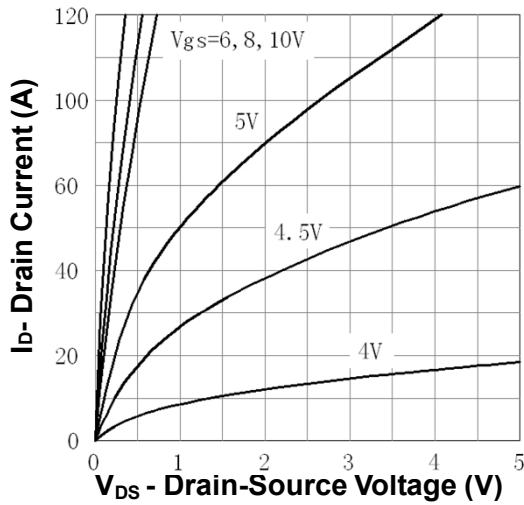
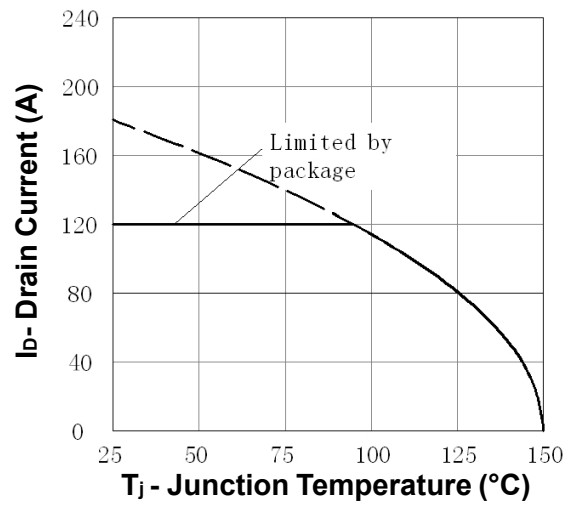
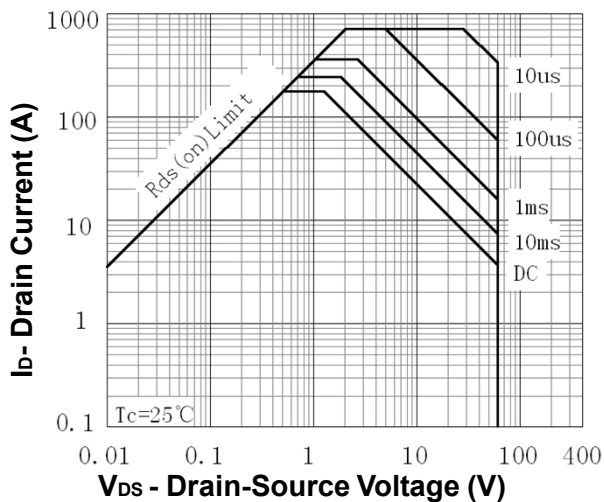
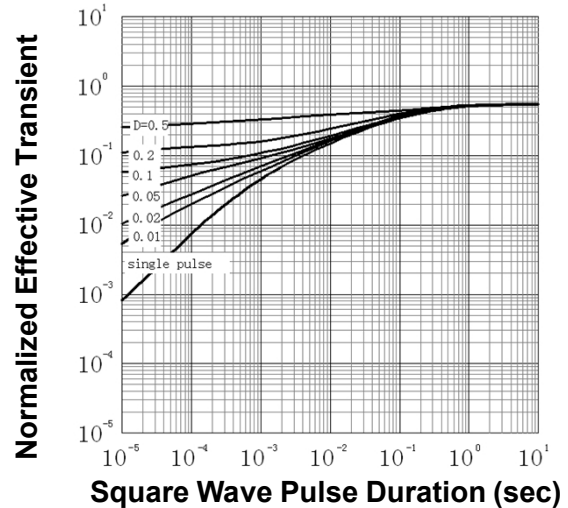
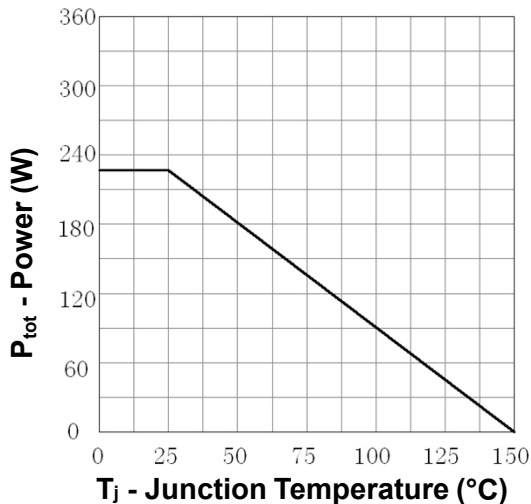
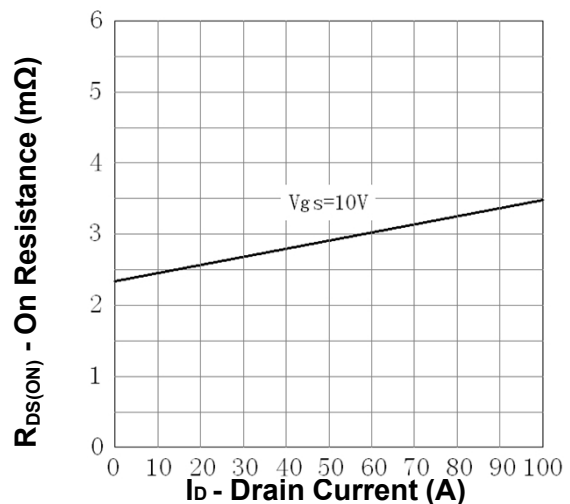
## Source-Drain Diode Characteristics ( $T_c=25^{\circ}\text{C}$ unless otherwise noted)

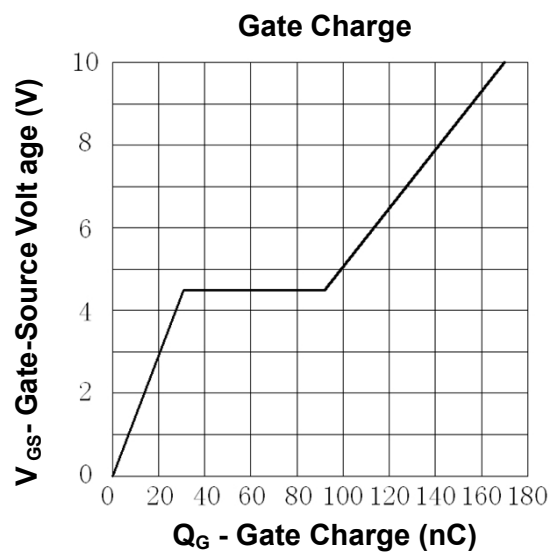
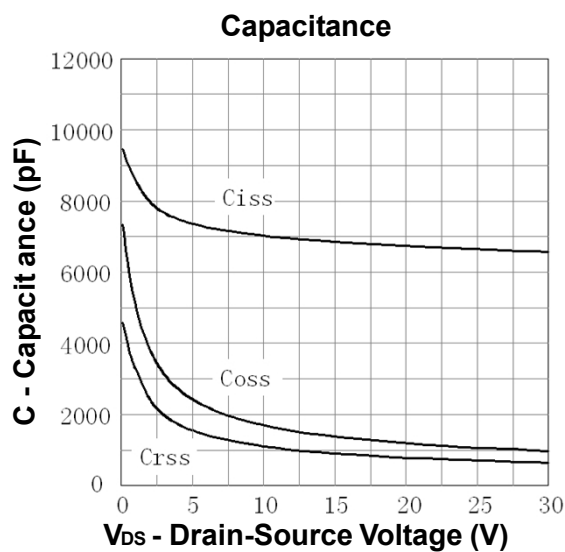
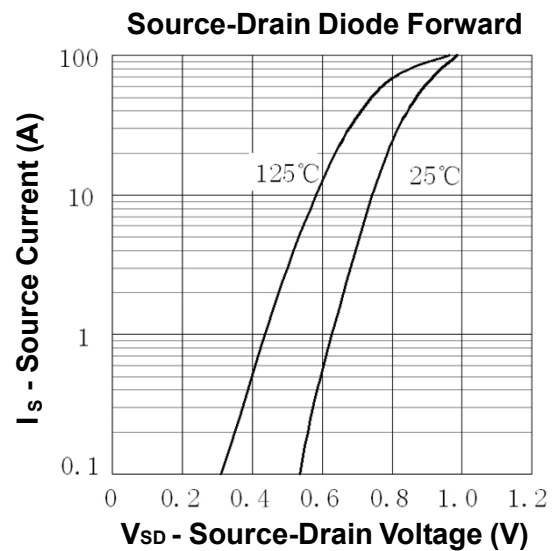
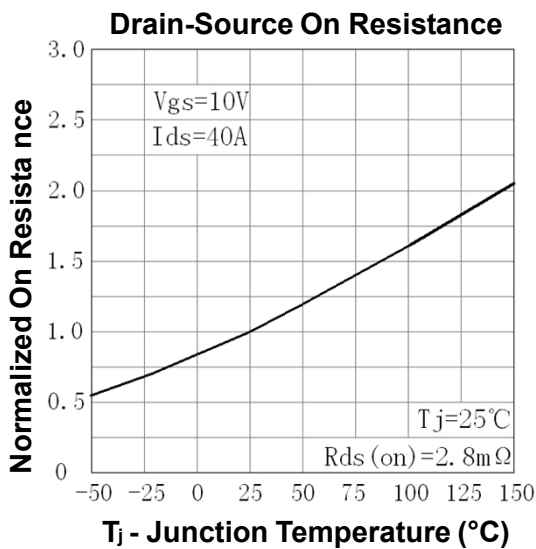
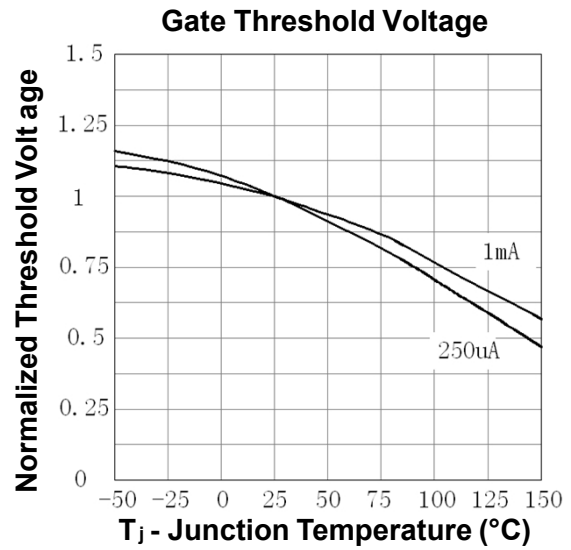
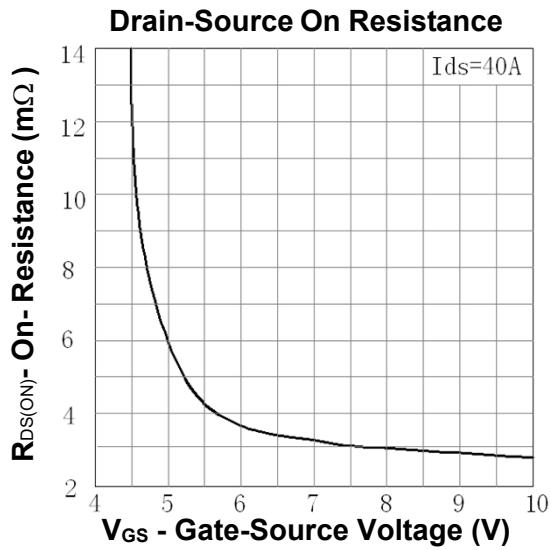
| Symbol   | Parameter                                    | Test Conditions        | Min. | Typ. | Max. | Units |
|----------|----------------------------------------------|------------------------|------|------|------|-------|
| $I_S$    | Continuous Source Diode Forward Current      |                        | -    | -    | 180  | A     |
| $I_{SM}$ | Pulsed Source Diode Forward Current (Note 1) |                        | -    | -    | 720  | A     |
| $V_{SD}$ | Forward On Voltage                           | $V_{GS}=0V, I_S=45A$   | -    | 0.84 | 1    | V     |
| $t_{rr}$ | Reverse Recovery Time                        | $V_{GS}=0V, I_S=45A$   | -    | 58   | -    | ns    |
| $Q_{rr}$ | Reverse Recovery Charge                      | $dI_F/dt = 100A/\mu s$ | -    | 120  | -    | nC    |

### Notes:

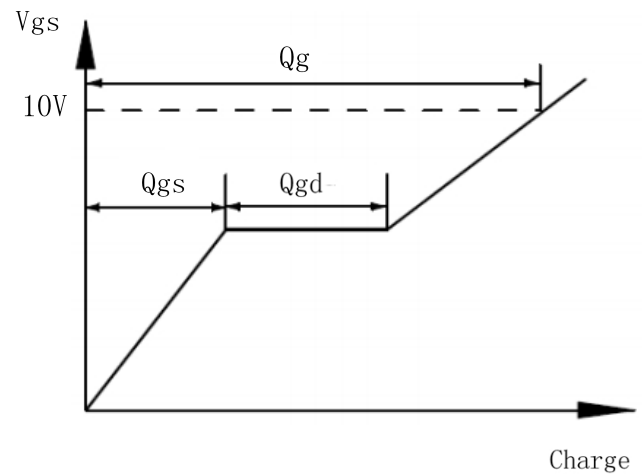
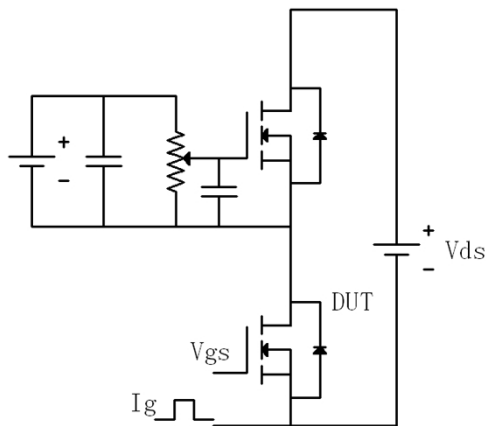
1. Repetitive Rating: Pulse width limited by maximum junction temperature
2.  $L=0.5mH, V_{DD}=48V, R_G=25\Omega$ , Starting  $T_J=25^{\circ}\text{C}$
3. Pulse Width  $\leq 300\mu s$ ; Duty Cycle  $\leq 2\%$

## Typical Characteristics

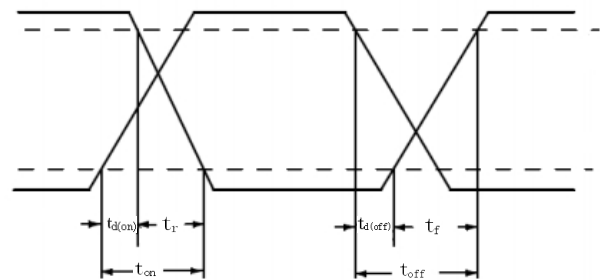
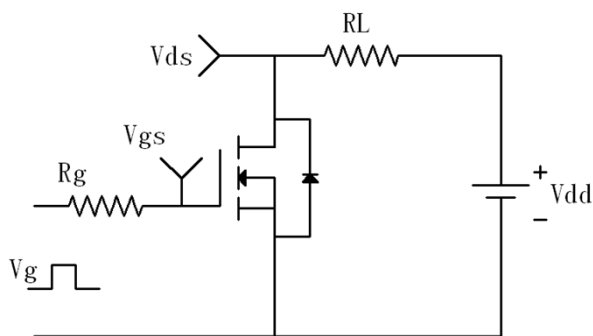
**Output Characteristics**

**Drain Current**

**Safe Operation Area**

**Thermal Transient Impedance**

**Power Dissipation**

**Drain-Source On Resistance**




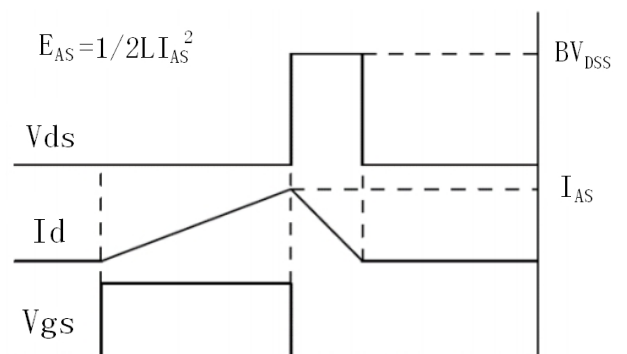
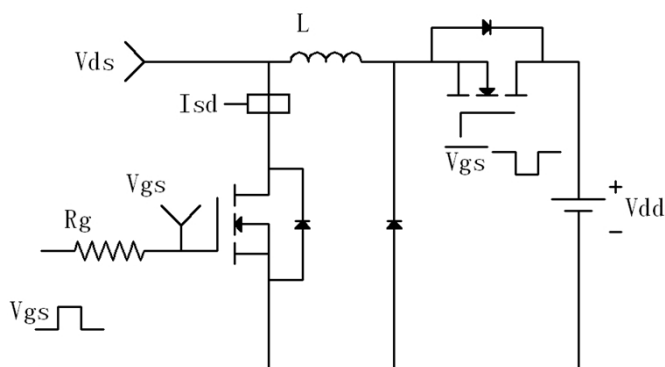
## Gate Charge Test Circuit and Waveforms



## Switching Time Test Circuit & Waveforms

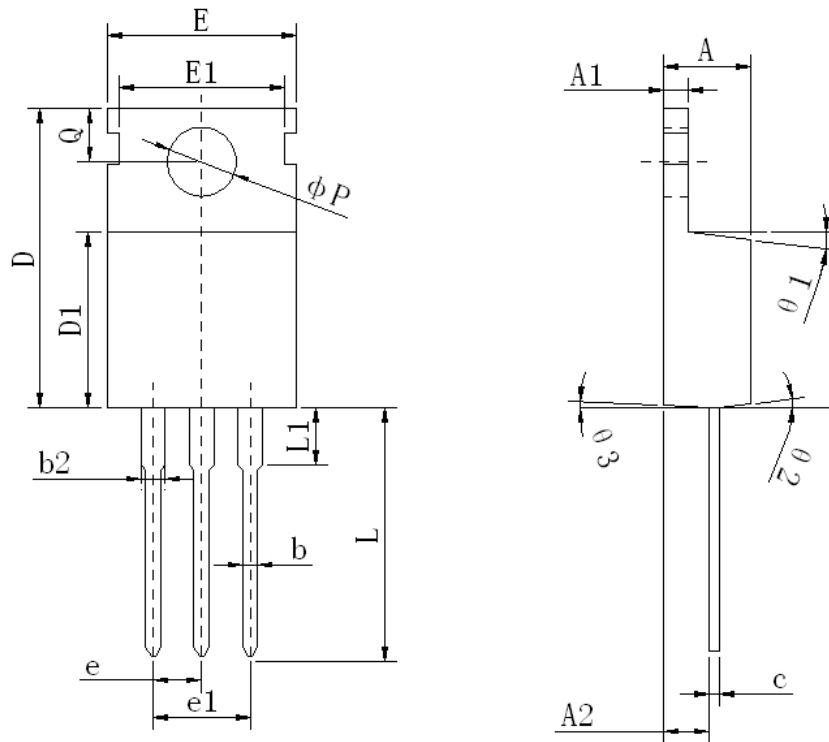


## Avalanche Test Circuit& Waveforms



## Package Outline

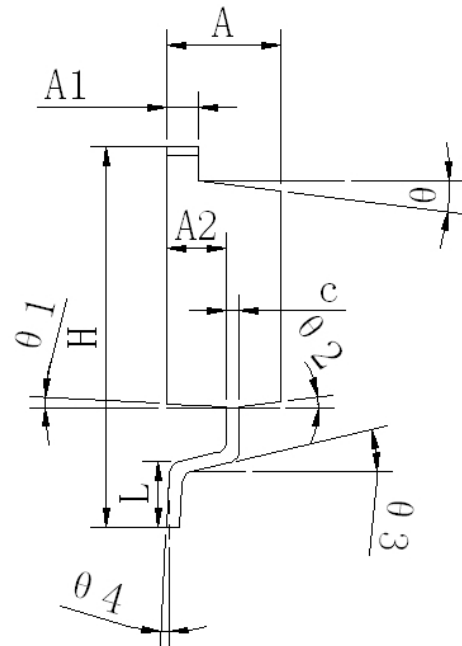
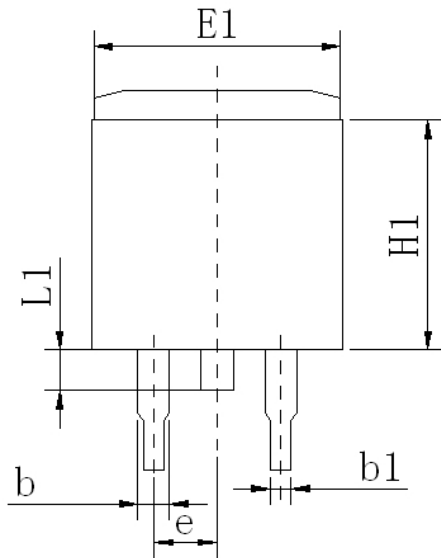
TO220



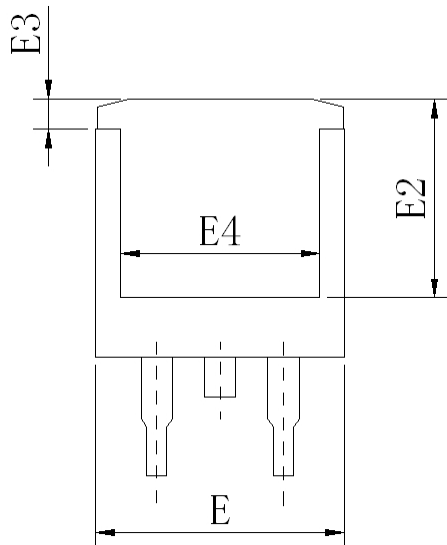
UNIT:mm

| SYMBOL     | MIN      | NOM   | MAX   |
|------------|----------|-------|-------|
| A          | 4.47     | 4.57  | 4.67  |
| A1         | 1.27     | 1.30  | 1.33  |
| A2         | 2.35     | 2.40  | 2.45  |
| b          | 0.76     | 0.80  | 0.89  |
| b2         | 1.23     | 1.27  | 1.38  |
| c          | 0.47     | 0.50  | 0.53  |
| D          | 15.60    | 15.70 | 15.80 |
| D1         | 9.10     | 9.20  | 9.30  |
| E          | 9.70     | 9.90  | 10.10 |
| E1         | -        | 8.70  | -     |
| e          | 2.54 BSC |       |       |
| e1         | 5.08 BSC |       |       |
| L          | 12.83    | 13.00 | 13.17 |
| L1         | 3.00     | 3.10  | 3.20  |
| P          | 3.57     | 3.60  | 3.63  |
| Q          | 2.75     | 2.80  | 2.85  |
| $\theta 1$ | 5°       | 7°    | 9°    |
| $\theta 2$ | 1°       | 3°    | 5°    |
| $\theta 3$ | 1°       | 3°    | 5°    |

TO263



UNIT:mm



| SYMBOL | MIN      | NOM   | MAX   |
|--------|----------|-------|-------|
| A      | 4.47     | 4.57  | 4.67  |
| A1     | 1.25     | 1.30  | 1.35  |
| A2     | 2.34     | 2.40  | 2.46  |
| b      | 1.22     | 1.27  | 1.32  |
| b1     | 0.75     | 0.80  | 0.85  |
| c      | 0.45     | 0.50  | 0.55  |
| E      | 9.90     | 10.00 | 10.10 |
| E1     | 9.78     | 9.88  | 9.98  |
| E2     | 7.95     | 8.00  | 8.05  |
| E3     | 1.10     | 1.20  | 1.30  |
| E4     | 7.95     | 8.00  | 8.05  |
| e      | 2.54 BSC |       |       |
| H      | 15.00    | 15.20 | 15.40 |
| H1     | 10.30    | 10.40 | 10.50 |
| L      | 2.20     | 2.40  | 2.60  |
| L1     | 1.50     | 1.60  | 1.70  |
| θ      | 5°       | 7°    | 9°    |
| θ1     | 1°       | 3°    | 5°    |
| θ2     | 5°       | 7°    | 9°    |
| θ3     | 11°      | 13°   | 15°   |
| θ4     | 0°       | 2°    | 5°    |