

## General Description

The series of devices use advanced trench gate super junction technology and design to provide excellent  $R_{DS(ON)}$  with low gate charge. This super junction MOSFET fits the industry's AC-DC SMPS requirements for PFC, AC/DC power conversion, and industrial power applications.

## Features

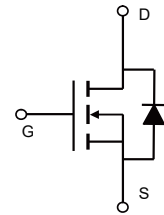
- New technology for high voltage device
- Low on-resistance and low conduction losses
- Small package
- Ultra Low Gate Charge cause lower driving requirements
- 100% Avalanche Tested
- ROHS compliant

## Application

- Power factor correction (PFC)
- Switched mode power supplies(SMPS)
- Uninterruptible Power Supply (UPS)



TO-220F



Schematic

| Parameter                                                             | Symbol          | Q1       | Q2    | Unit          |
|-----------------------------------------------------------------------|-----------------|----------|-------|---------------|
| Drain-Source Voltage ( $V_{GS}=0V$ )                                  | $V_{DS}$        | 650      |       | V             |
| Gate-Source Voltage ( $V_{DS}=0V$ ), AC ( $f>1$ Hz)                   | $V_{GS}$        | $\pm 30$ |       | V             |
| Continuous Drain Current at $T_C=25^\circ C$                          | $I_{D(DC)}$     | 21       | 21*   | A             |
| Continuous Drain Current at $T_C=100^\circ C$                         | $I_{D(DC)}$     | 13.2     | 13.2* | A             |
| Pulsed drain current (Note 1)                                         | $I_{DM(pluse)}$ | 84       | 84*   | A             |
| Maximum Power Dissipation( $T_C=25^\circ C$ )                         | $P_D$           | 188      | 33.8  | W             |
| Derate above $25^\circ C$                                             |                 | 1.5      | 0.27  | W/ $^\circ C$ |
| Single pulse avalanche energy (Note 2)                                | EAS             | 441      |       | mJ            |
| Avalanche current(Note 1)                                             | $I_{AR}$        | 10.5     |       | A             |
| Repetitive Avalanche energy , $t_{AR}$ limited by $T_{Jmax}$ (Note 1) | $E_{AR}$        | 0.7      |       | mJ            |

| Parameter                                                | Symbol         | Q1         | Q2 | Unit |
|----------------------------------------------------------|----------------|------------|----|------|
| Drain Source voltage slope, $V_{DS} \leq 480V$ ,         | $dv/dt$        | 50         |    | V/ns |
| Reverse diode $dv/dt$ , $V_{DS} \leq 480V, I_{SD} < I_D$ | $dv/dt$        | 15         |    | V/ns |
| Operating Junction and Storage Temperature Range         | $T_J, T_{STG}$ | -55...+150 |    | °C   |

\* limited by maximum junction temperature

**Table 2. Thermal Characteristic**

| Parameter                                         | Symbol     | Q1   | Q2   | Unit  |
|---------------------------------------------------|------------|------|------|-------|
| Thermal Resistance, Junction-to-Case (Maximum)    | $R_{thJC}$ | 0.66 | 3.69 | °C /W |
| Thermal Resistance, Junction-to-Ambient (Maximum) | $R_{thJA}$ | 62.5 | 80   | °C /W |

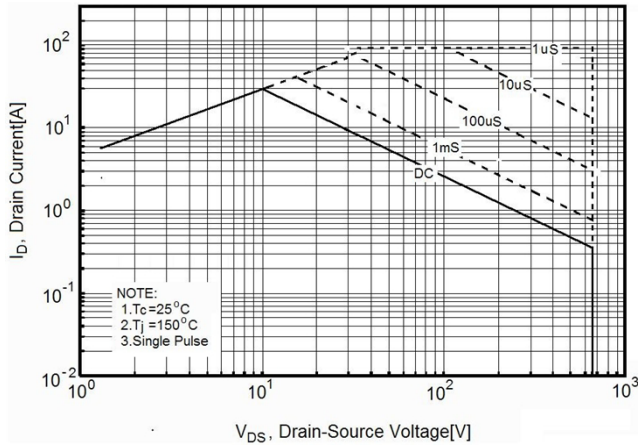
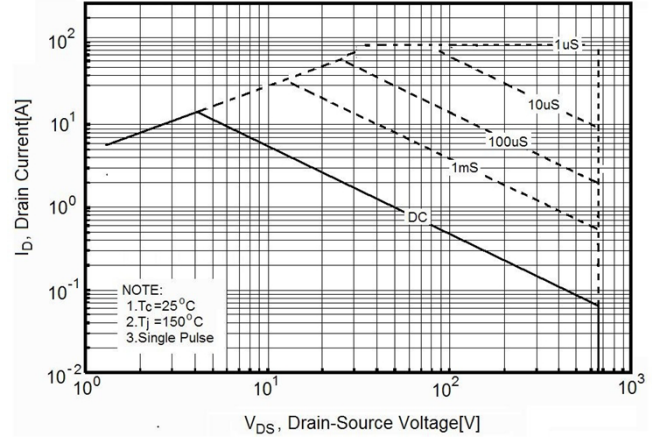
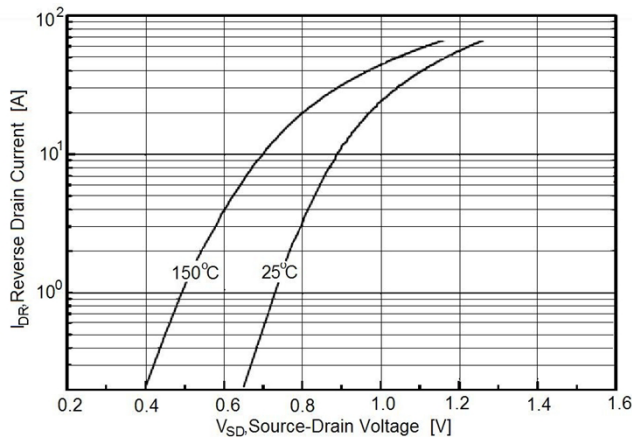
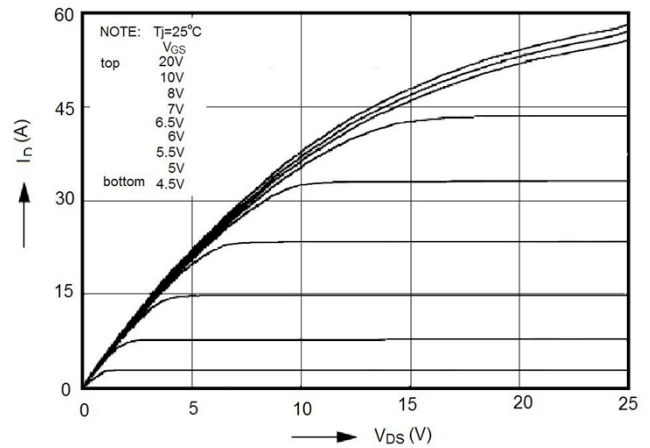
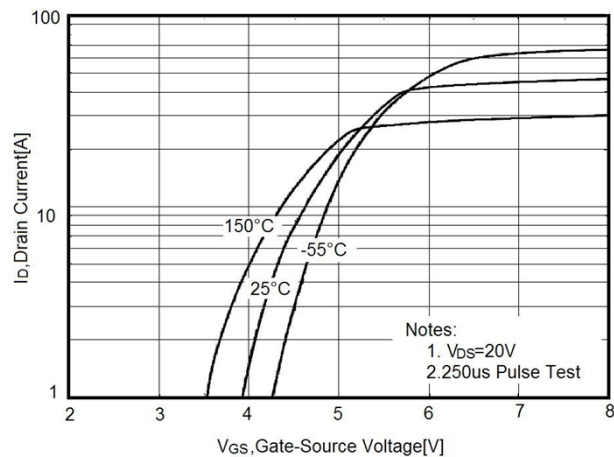
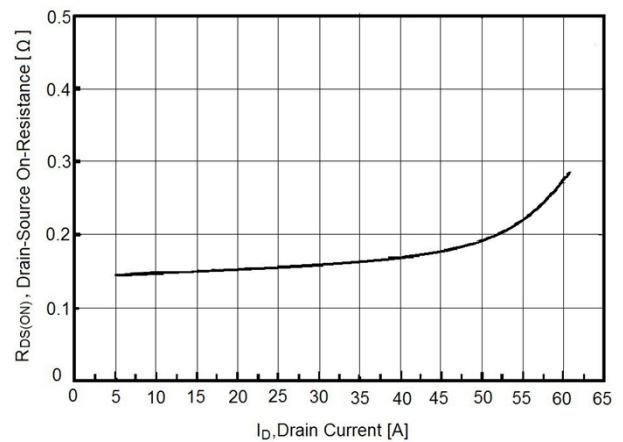
**Table 3. Electrical Characteristics (TA=25°C unless otherwise noted)**

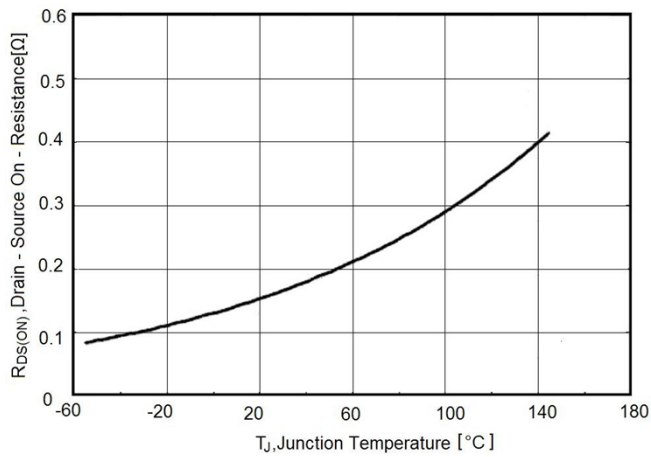
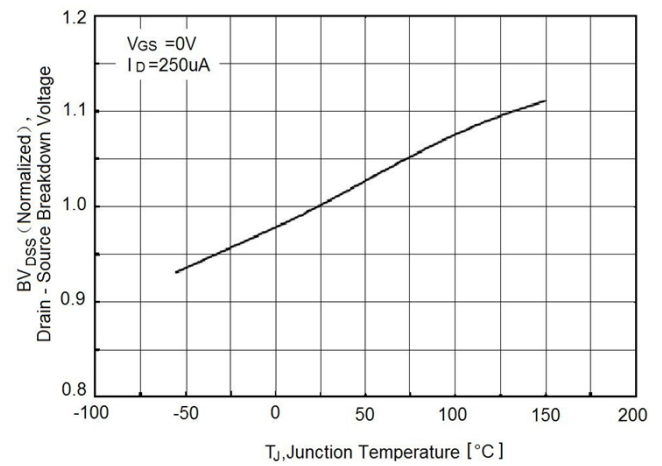
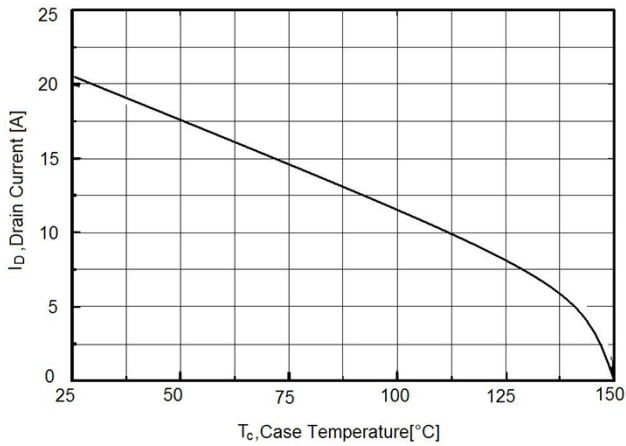
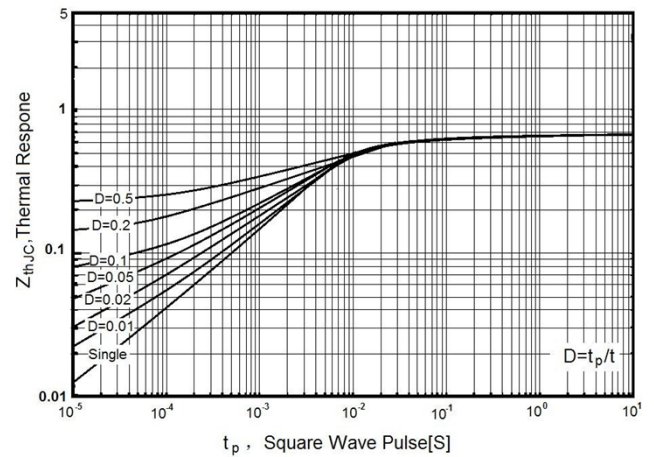
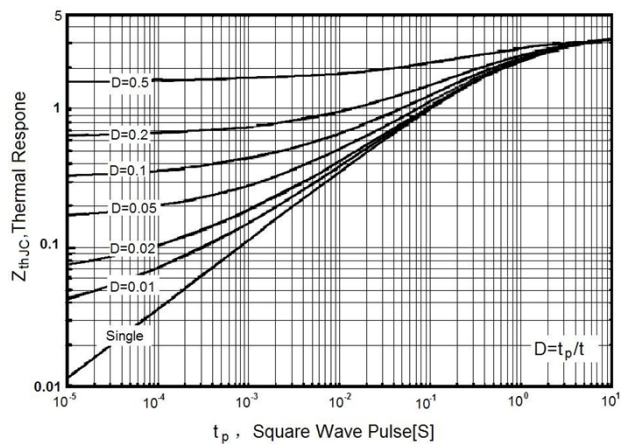
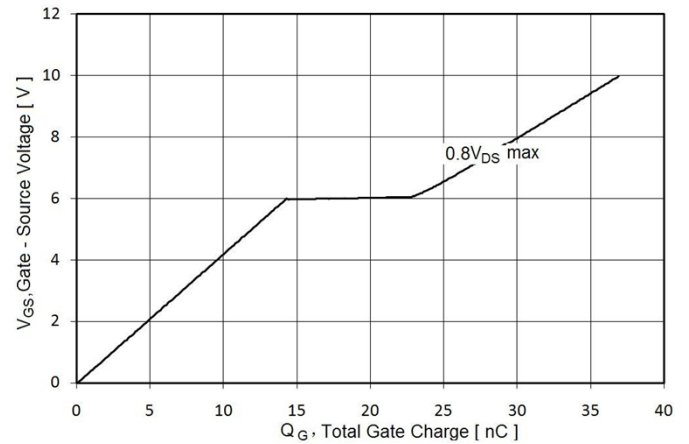
| Parameter                                | Symbol              | Condition                                                                             | Min | Typ  | Max  | Unit |
|------------------------------------------|---------------------|---------------------------------------------------------------------------------------|-----|------|------|------|
| On/off states                            |                     |                                                                                       |     |      |      |      |
| Drain-Source Breakdown Voltage           | BV <sub>DSS</sub>   | V <sub>GS</sub> =0V I <sub>D</sub> =250μA                                             | 650 |      |      | V    |
| Zero Gate Voltage Drain Current(Tc=25℃)  | I <sub>DSS</sub>    | V <sub>DS</sub> =650V,V <sub>GS</sub> =0V                                             |     | 0.05 | 1    | μA   |
| Zero Gate Voltage Drain Current(Tc=125℃) | I <sub>DSS</sub>    | V <sub>DS</sub> =650V,V <sub>GS</sub> =0V                                             |     |      | 100  | μA   |
| Gate-Body Leakage Current                | I <sub>GSS</sub>    | V <sub>GS</sub> =±20V,V <sub>DS</sub> =0V                                             |     |      | ±100 | nA   |
| Gate Threshold Voltage                   | V <sub>GS(th)</sub> | V <sub>DS</sub> =V <sub>GS</sub> ,I <sub>D</sub> =250μA                               | 3   | 3.5  | 4    | V    |
| Drain-Source On-State Resistance         | R <sub>DS(ON)</sub> | V <sub>GS</sub> =10V, I <sub>D</sub> =10.5A                                           |     | 150  | 190  | mΩ   |
| Dynamic Characteristics                  |                     |                                                                                       |     |      |      |      |
| Forward Transconductance                 | g <sub>FS</sub>     | V <sub>DS</sub> = 20V, I <sub>D</sub> = 10.5A                                         |     | 16   |      | S    |
| Input Capacitance                        | C <sub>iss</sub>    | V <sub>DS</sub> =50V,V <sub>GS</sub> =0V,<br>F=1.0MHz                                 |     | 2250 |      | PF   |
| Output Capacitance                       | C <sub>oss</sub>    |                                                                                       |     | 83   |      | PF   |
| Reverse Transfer Capacitance             | C <sub>rss</sub>    |                                                                                       |     | 1.6  |      | PF   |
| Total Gate Charge                        | Q <sub>g</sub>      | V <sub>DS</sub> =480V,I <sub>D</sub> =21A,<br>V <sub>GS</sub> =10V                    |     | 36   |      | nC   |
| Gate-Source Charge                       | Q <sub>gs</sub>     |                                                                                       |     | 14   |      | nC   |
| Gate-Drain Charge                        | Q <sub>gd</sub>     |                                                                                       |     | 8.5  |      | nC   |
| Switching times                          |                     |                                                                                       |     |      |      |      |
| Turn-on Delay Time                       | t <sub>d(on)</sub>  | V <sub>DD</sub> =380V,I <sub>D</sub> =11A,<br>R <sub>G</sub> =4Ω,V <sub>GS</sub> =10V |     | 11   |      | nS   |
| Turn-on Rise Time                        | t <sub>r</sub>      |                                                                                       |     | 6    |      | nS   |
| Turn-Off Delay Time                      | t <sub>d(off)</sub> |                                                                                       |     | 61   |      | nS   |
| Turn-Off Fall Time                       | t <sub>f</sub>      |                                                                                       |     | 4.5  |      | nS   |
| Source- Drain Diode Characteristics      |                     |                                                                                       |     |      |      |      |
| Source-drain current(Body Diode)         | I <sub>SD</sub>     | T <sub>C</sub> =25℃                                                                   |     |      | 21   | A    |
| Pulsed Source-drain current(Body Diode)  | I <sub>SDM</sub>    |                                                                                       |     |      | 84   | A    |
| Forward on voltage                       | V <sub>SD</sub>     | T <sub>J</sub> =25℃,I <sub>SD</sub> =21A,V <sub>GS</sub> =0V                          |     | 0.9  | 1.3  | V    |
| Reverse Recovery Time                    | t <sub>rr</sub>     | T <sub>J</sub> =25℃,I <sub>F</sub> =21A,di/dt=100A/μs                                 |     | 310  |      | nS   |
| Reverse Recovery Charge                  | Q <sub>rr</sub>     |                                                                                       |     | 5    |      | uC   |
| Peak Reverse Recovery Current            | I <sub>rrm</sub>    |                                                                                       |     | 28   |      | A    |

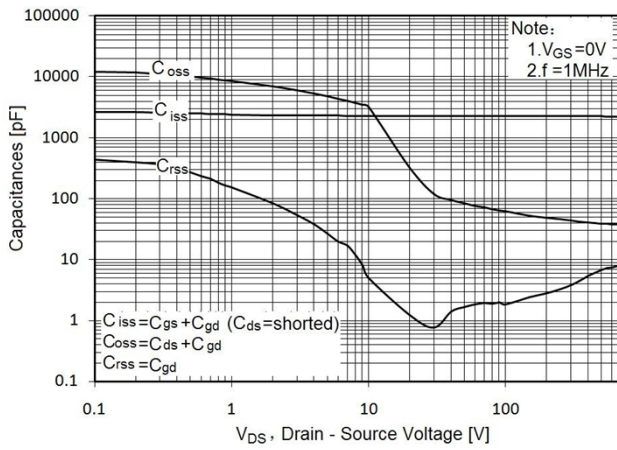
Notes 1. Repetitive Rating: Pulse width limited by maximum junction temperature

2.  $T_J=25^\circ C, V_{DD}=50V, V_G=10V, R_G=25\Omega$

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS (curves)

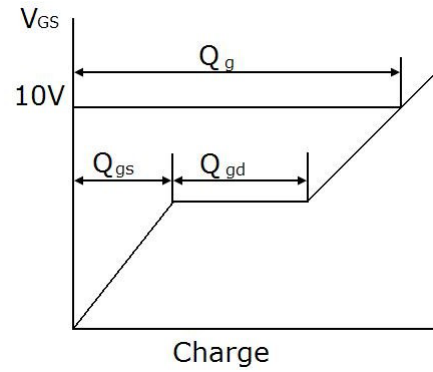
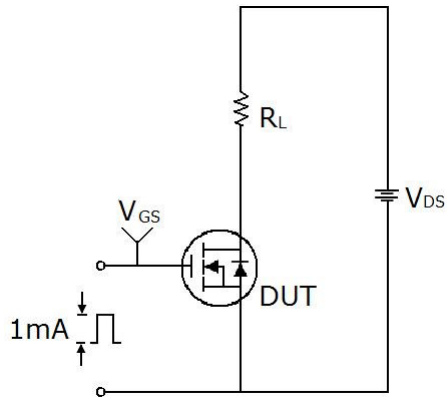
**Figure1. Safe operating area for TO-220/TO-263**

**Figure2. Safe operating area for TO-220F**

**Figure3. Source-Drain Diode Forward Voltage**

**Figure4. Output characteristics**

**Figure5. Transfer characteristics**

**Figure6. Static drain-source on resistance**


**Figure7.  $R_{DS(ON)}$  vs Junction Temperature**

**Figure8.  $BV_{DSS}$  vs Junction Temperature**

**Figure9. Maximum  $I_D$  vs Junction Temperature**

**Figure10. Transient Thermal Impedance for TO-220**

**Figure11. Transient Thermal Impedance for TO-220F**

**Figure12. Gate charge waveforms**


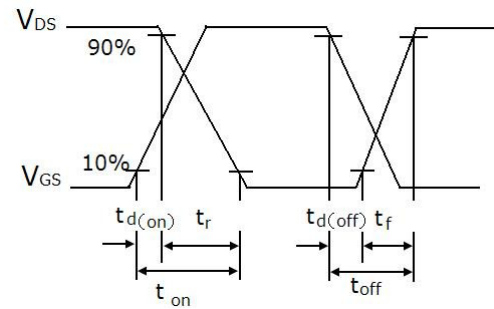
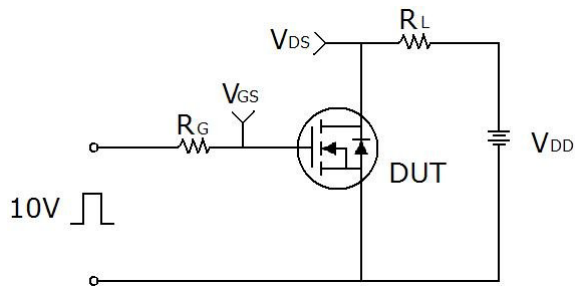
**Figure13. Capacitance**


## Test circuit

### 1) Gate charge test circuit & Waveform



### 2) Switch Time Test Circuit:



### 3) Unclamped Inductive Switching Test Circuit & Waveforms

