

## 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

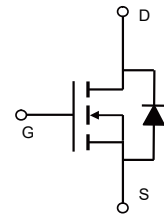
- New technology for high voltage device
- Low on-resistance and low conduction losses
- small package
- Ultra Low Gate Charge cause lower driving requirements
- 100% Avalanche Tested
- ROHS compliant

## Application

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



TO-220



Schematic

| Parameter                                                                  | Symbol          | Q1          | Q2           | Unit               |
|----------------------------------------------------------------------------|-----------------|-------------|--------------|--------------------|
| Drain-Source Voltage ( $V_{GS}=0V$ )                                       | $V_{DS}$        | 650         |              | V                  |
| Gate-Source Voltage ( $V_{DS}=0V$ ), AC( $f>1Hz$ )                         | $V_{GS}$        | $\pm 30$    |              | V                  |
| Continuous Drain Current at $T_C=25^\circ C$                               | $I_{D(DC)}$     | 11.5        | 11.5*        | A                  |
| Continuous Drain Current at $T_C=100^\circ C$                              | $I_{D(DC)}$     | 7           | 7*           | A                  |
| Pulsed drain current (Note 1)                                              | $I_{DM(pluse)}$ | 46          | 46*          | A                  |
| Maximum Power Dissipation( $T_C=25^\circ C$ )<br>Derate above $25^\circ C$ | $P_D$           | 101<br>0.81 | 32.6<br>0.26 | W<br>W/ $^\circ C$ |
| Single pulse avalanche energy (Note2)                                      | EAS             | 144         |              | mJ                 |
| Avalanche current(Note 1)                                                  | $I_{AR}$        | 6           |              | A                  |
| Repetitive Avalanche energy , $t_{AR}$ limited by $T_{jmax}$ (Note 1)      | $E_{AR}$        | 0.5         |              | mJ                 |

| Parameter                                                | Symbol         | NCE65T360D<br>NCE65T360 | NCE65T360F | 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)    | $R_{thJC}$ | 1.24 | 3.83 | °C /W |
| Thermal Resistance, Junction-to-Ambient (Maximum) | $R_{thJA}$ | 62   | 80   | °C /W |

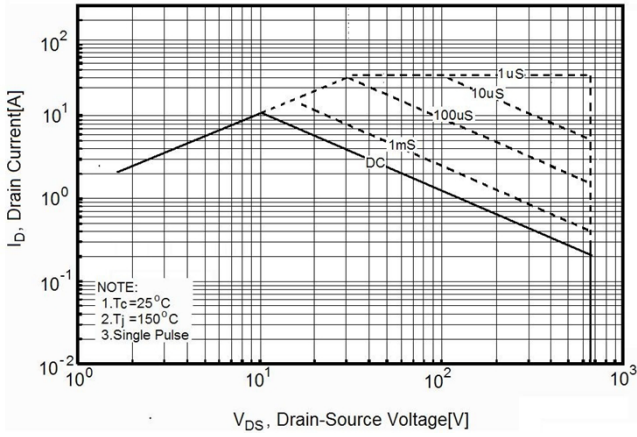
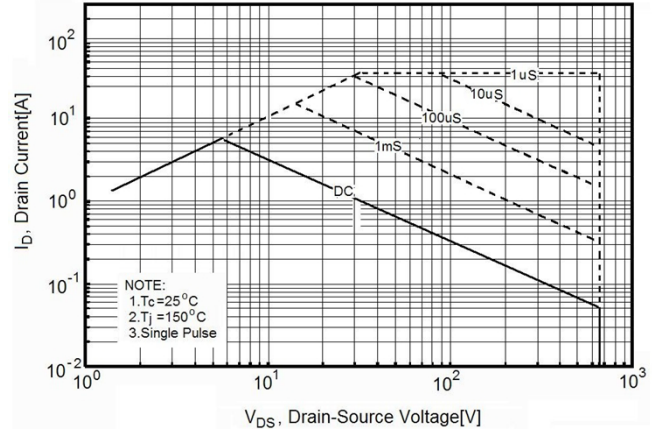
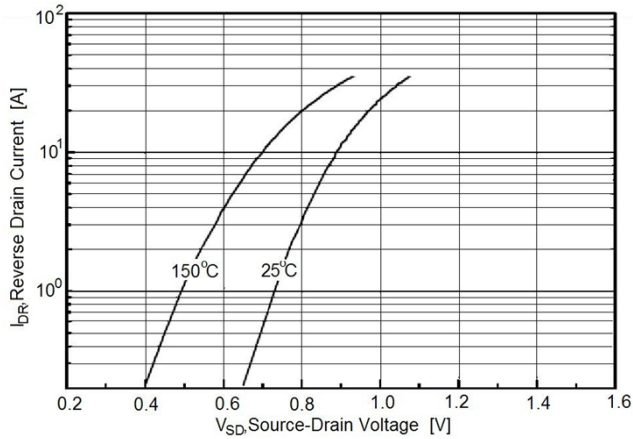
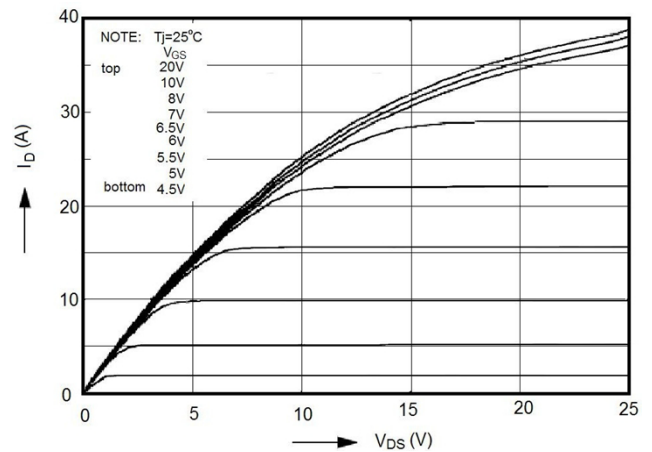
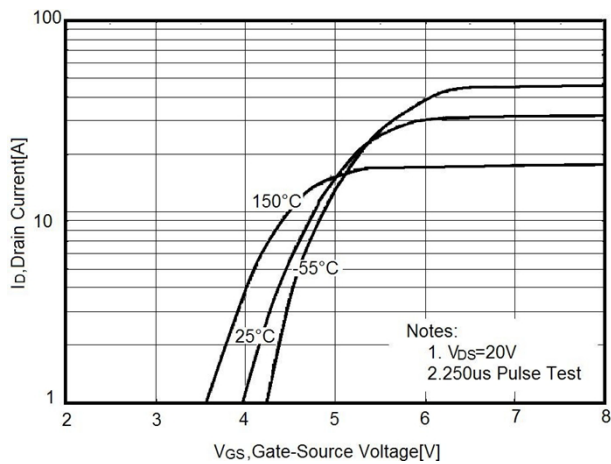
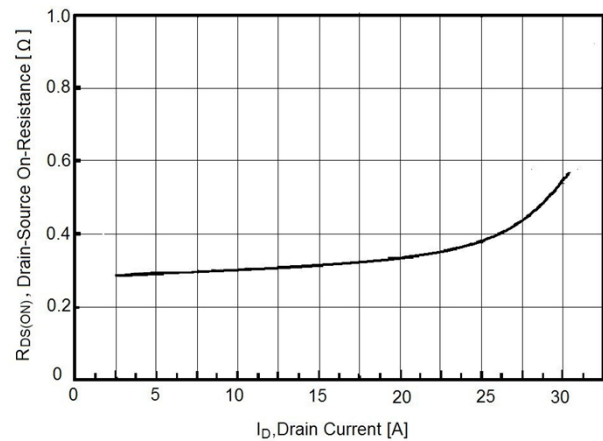
**Table 3. Electrical Characteristics (TA=25°C unless otherwise noted)**

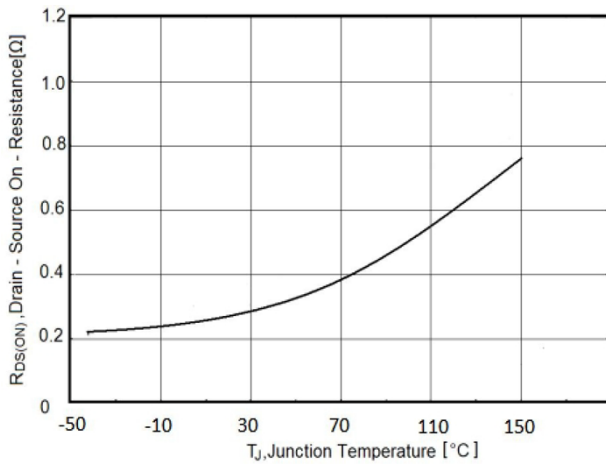
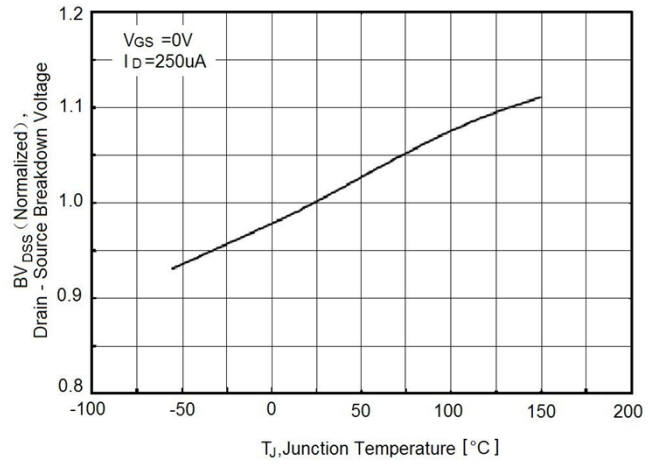
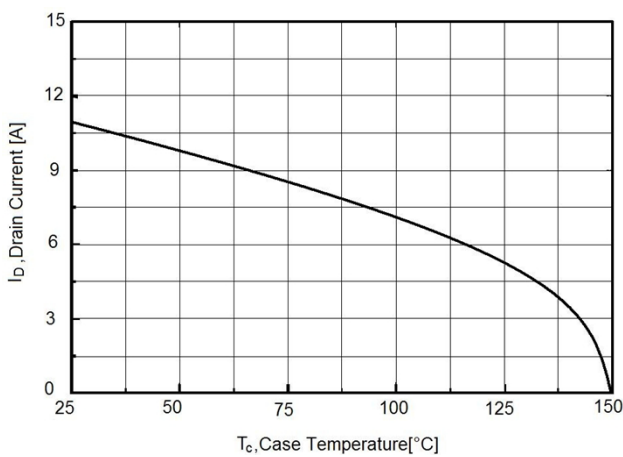
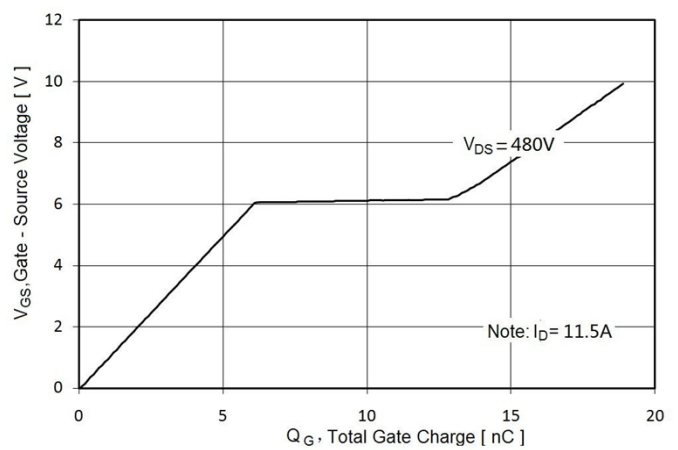
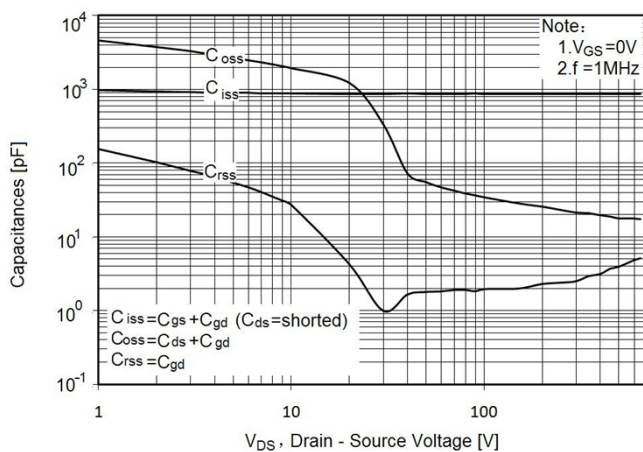
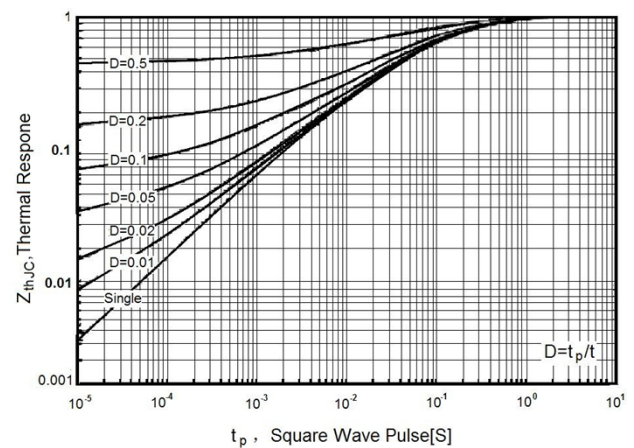
| Parameter                                             | Symbol       | Condition                                                                       | Min | Typ        | Max        | Unit       |
|-------------------------------------------------------|--------------|---------------------------------------------------------------------------------|-----|------------|------------|------------|
| On/off states                                         |              |                                                                                 |     |            |            |            |
| Drain-Source Breakdown Voltage                        | $BV_{DSS}$   | $V_{GS}=0V, I_D=250\mu A$                                                       | 650 |            |            | V          |
| Zero Gate Voltage Drain Current( $T_c=25^{\circ}C$ )  | $I_{DSS}$    | $V_{DS}=650V, V_{GS}=0V$                                                        |     | 0.05       | 1          | $\mu A$    |
| Zero Gate Voltage Drain Current( $T_c=125^{\circ}C$ ) | $I_{DSS}$    | $V_{DS}=650V, V_{GS}=0V$                                                        |     |            | 100        | $\mu A$    |
| Gate-Body Leakage Current                             | $I_{GSS}$    | $V_{GS}=\pm 20V, V_{DS}=0V$                                                     |     |            | $\pm 100$  | nA         |
| Gate Threshold Voltage                                | $V_{GS(th)}$ | $V_{DS}=V_{GS}, I_D=250\mu A$                                                   | 3   | 3.5        | 4          | V          |
| Drain-Source On-State Resistance                      | $R_{DS(ON)}$ | $V_{GS}=10V, I_D=7A, T_J=25^{\circ}C$<br>$V_{GS}=10V, I_D=7A, T_J=150^{\circ}C$ |     | 290<br>770 | 360<br>910 | m $\Omega$ |
| Dynamic Characteristics                               |              |                                                                                 |     |            |            |            |
| Input Capacitance                                     | $C_{iss}$    | $V_{DS}=50V, V_{GS}=0V,$<br>$F=1.0MHz$                                          |     | 870        |            | pF         |
| Output Capacitance                                    | $C_{oss}$    |                                                                                 |     | 54         |            | pF         |
| Reverse Transfer Capacitance                          | $C_{rss}$    |                                                                                 |     | 1.8        |            | pF         |
| Total Gate Charge                                     | $Q_g$        | $V_{DS}=480V, I_D=11.5A,$<br>$V_{GS}=10V$                                       |     | 19         |            | nC         |
| Gate-Source Charge                                    | $Q_{gs}$     |                                                                                 |     | 6          |            | nC         |
| Gate-Drain Charge                                     | $Q_{gd}$     |                                                                                 |     | 6.5        |            | nC         |
| Switching times                                       |              |                                                                                 |     |            |            |            |
| Turn-on Delay Time                                    | $t_{d(on)}$  | $V_{DD}=380V, I_D=5.5A,$<br>$R_G=3\Omega, V_{GS}=10V$                           |     | 11         |            | nS         |
| Turn-on Rise Time                                     | $t_r$        |                                                                                 |     | 8          |            | nS         |
| Turn-Off Delay Time                                   | $t_{d(off)}$ |                                                                                 |     | 58         | 70         | nS         |
| Turn-Off Fall Time                                    | $t_f$        |                                                                                 |     | 9          | 14         | nS         |
| Source- Drain Diode Characteristics                   |              |                                                                                 |     |            |            |            |
| Source-drain current(Body Diode)                      | $I_{SD}$     | $T_c=25^{\circ}C$                                                               |     |            | 11.5       | A          |
| Pulsed Source-drain current(Body Diode)               | $I_{SDM}$    |                                                                                 |     |            | 46         | A          |
| Forward on voltage                                    | $V_{SD}$     | $T_J=25^{\circ}C, I_{SD}=11.5A, V_{GS}=0V$                                      |     | 0.9        | 1.2        | V          |
| Reverse Recovery Time                                 | $t_{rr}$     | $T_J=25^{\circ}C, I_F=5.8A,$<br>$di/dt=100A/\mu s$                              |     | 220        |            | nS         |
| Reverse Recovery Charge                               | $Q_{rr}$     |                                                                                 |     | 2.2        |            | $\mu C$    |
| Peak Reverse Recovery Current                         | $I_{rrm}$    |                                                                                 |     | 19         |            | A          |

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

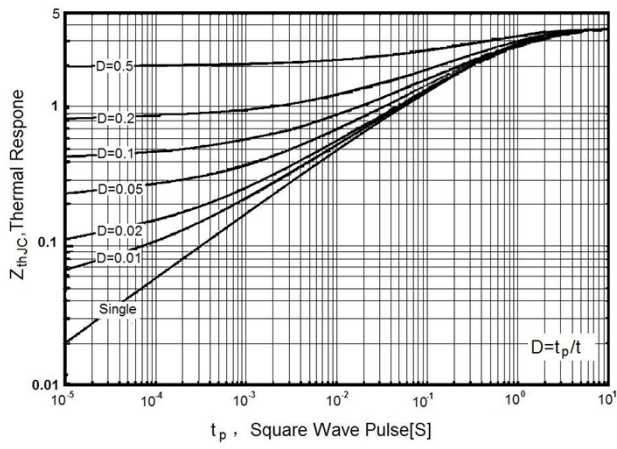
2.  $T_J=25^\circ C, V_{DD}=50V, V_G=10V, R_G=25\Omega$

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS (curves)

**Figure1. Safe operating area**

**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**


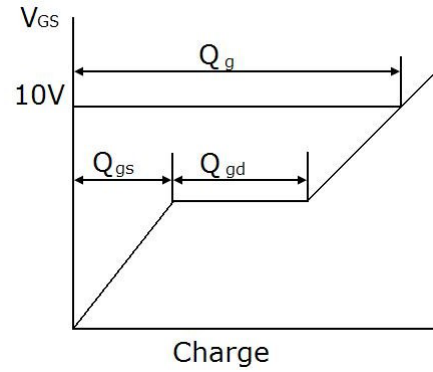
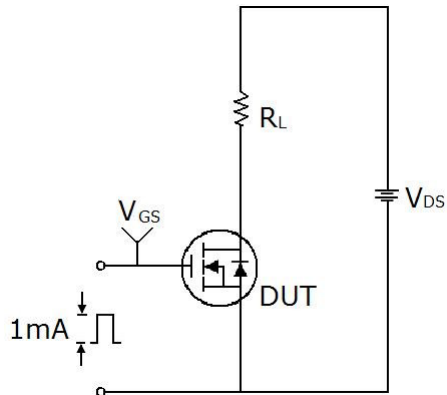
**Figure7.  $R_{DS(ON)}$  vs Junction Temperature**

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

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

**Figure10. Gate charge waveforms**

**Figure11. Capacitance**

**Figure12. Transient Thermal Impedance**


**Figure13. Transient Thermal Impedance for TO-220F**

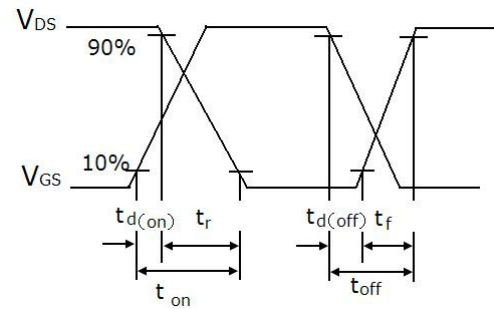
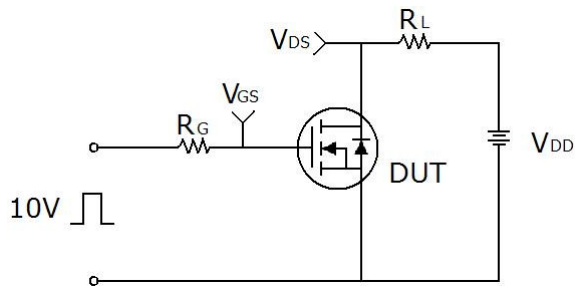


## Test circuit

### 1) Gate charge test circuit & Waveform



### 2) Switch Time Test Circuit:



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

