# N-Channel Super Junction Power MOSFET Ⅳ

## 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.

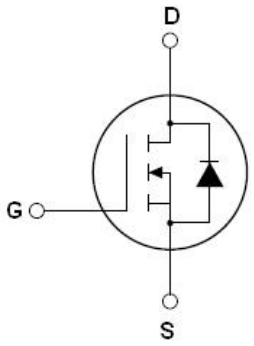
## Features

- Optimized body diode reverse recovery performance
- 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）
- LLC Half-bridge

| | | |
|---|---|---|
| $V_{DS\ min@Tjmax}$ | 650 | V |
| $R_{DS(ON)TYP}$ | 180 | mΩ |
| ID | 18 | A |
| Qg | 22.8 | nC |




Schematic diagram

✧ **Intrinsic fast-recovery body diode**

## Package Marking And Ordering Information

| Device | Device Package | Marking |
|---|---|---|
| NCE60NF200F | TO-220F | NCE60NF200F |


TO-220F

## Table 1. Absolute Maximum Ratings ($T_C$=25℃)

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Drain-Source Voltage (VGS=0V） | $V_{DS}$ | 600 | V |
| Gate-Source Voltage (VDS=0V) AC (f>1 Hz) | $V_{GS}$ | ±30 | V |
| Gate-Source Voltage (VDS=0V) DC | $V_{GS}$ | ±20 | V |
| Continuous Drain Current at Tc=25°C | $I_{D\ (DC)}$ | 18 | A |
| Continuous Drain Current at Tc=100°C | $I_{D\ (DC)}$ | 12.6 | A |
| Pulsed drain current (Note 1) | $I_{DM\ (pluse)}$ | 54 | A |
| Maximum Power Dissipation(Tc=25°C)<br>Derate above 25°C | $P_D$ | 33.4<br>0.22 | W<br>W/°C |
| Avalanche current(Note 1) | $I_{AS}$ | 3.5 | A |
| Drain Source voltage slope, $V_{DS}$ ≤480 V, | dv/dt | 50 | V/ns |
| Reverse diode dv/dt， $V_{DS}$ ≤480 V,$I_{SD}$<$I_D$ | dv/dt | 50 | V/ns |
| Operating Junction and Storage Temperature Range | $T_J$,$T_{STG}$ | -55...+175 | °C |

* limited by maximum junction temperature

## Table 2. Thermal Characteristic

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Thermal Resistance，Junction-to-Case（Maximum） | $R_{thJC}$ | 4.49 | °C /W |
| Thermal Resistance，Junction-to-Ambient （Maximum） | $R_{thJA}$ | 62 | °C /W |

## Table 3. Electrical Characteristics (TA=25℃unless otherwise noted)

| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **On/off states** | | | | | | |
| Drain-Source Breakdown Voltage | $BV_{DSS}$ | $V_{GS}$=0V $I_D$=250μA | 600 | | | V |
| Zero Gate Voltage Drain Current(Tc=25℃) | $I_{DSS}$ | $V_{DS}$=600V,$V_{GS}$=0V | | | 10 | μA |
| Zero Gate Voltage Drain Current(Tc=125℃) | $I_{DSS}$ | $V_{DS}$=600V,$V_{GS}$=0V | | | 300 | μA |
| Gate-Body Leakage Current | $I_{GSS}$ | $V_{GS}$=±20V,$V_{DS}$=0V | | | ±200 | nA |
| Gate Threshold Voltage | $V_{GS(th)}$ | $V_{DS}$=$V_{GS}$,$I_D$=250μA | 3.5 | 4.2 | 5.0 | V |
| Drain-Source On-State Resistance | $R_{DS(ON)}$ | $V_{GS}$=10V, $I_D$=9A | | 180 | 200 | mΩ |
| **Dynamic Characteristics** | | | | | | |
| Input Capacitance | $C_{lss}$ | $V_{DS}$=50V,$V_{GS}$=0V, F=1.0MHz | | 1157 | | pF |
| Output Capacitance | $C_{oss}$ | | | 60 | | pF |
| Reverse Transfer Capacitance | $C_{rss}$ | | | 1.5 | | pF |
| Total Gate Charge | $Q_g$ | $V_{DS}$=400V,$I_D$=9A, $V_{GS}$=10V | | 22.8 | | nC |
| Gate-Source Charge | $Q_{gs}$ | | | 9.1 | | nC |
| Gate-Drain Charge | $Q_{gd}$ | | | 6 | | nC |
| Gate plateau voltage | Vgp | | | 6.5 | | V |
| Intrinsic gate resistance | $R_G$ | f = 1 MHz open drain | | 20 | | Ω |
| **Switching times** | | | | | | |
| Turn-on Delay Time | $t_{d(on)}$ | $V_{DD}$=380V,$I_D$=9A, $R_G$=2Ω,$V_{GS}$=10V | | 25 | | nS |
| Turn-on Rise Time | $t_r$ | | | 16 | | nS |
| Turn-Off Delay Time | $t_{d(off)}$ | | | 75 | | nS |
| Turn-Off Fall Time | $t_f$ | | | 9 | | nS |
| **Source- Drain Diode Characteristics** | | | | | | |
| Source-drain current(Body Diode) | $I_{SD}$ | $T_C$=25°C | | | 18 | A |
| Pulsed Source-drain current(Body Diode) | $I_{SDM}$ | | | | 54 | A |
| Forward On Voltage | $V_{SD}$ | Tj=25°C,$I_{SD}$=18A,$V_{GS}$=0V | | 1.0 | 1.2 | V |
| Reverse Recovery Time | $t_{rr}$ | Tj=25°C,$I_F$=9A, di/dt=100A/μs | | 90 | | nS |
| Reverse Recovery Charge | $Q_{rr}$ | | | 0.32 | | uC |
| Peak Reverse Recovery Current | $I_{rrm}$ | | | 7 | | A |

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

2. Tj=25℃,VDD=50V,VG=10V, $R_G$=25Ω

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS (curves)

**Figure1. Safe operating area**

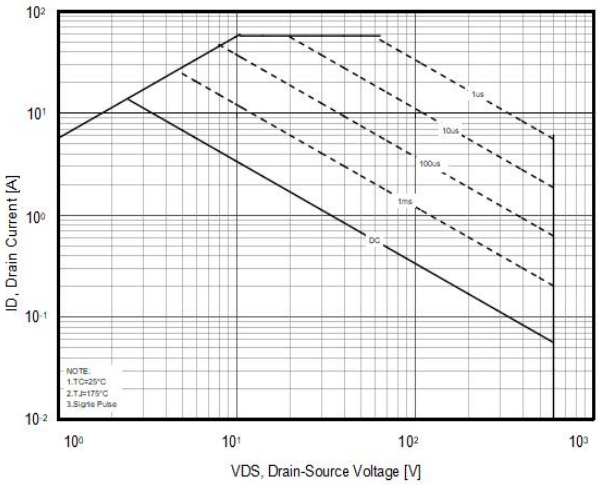



**Figure2. Capacitance**

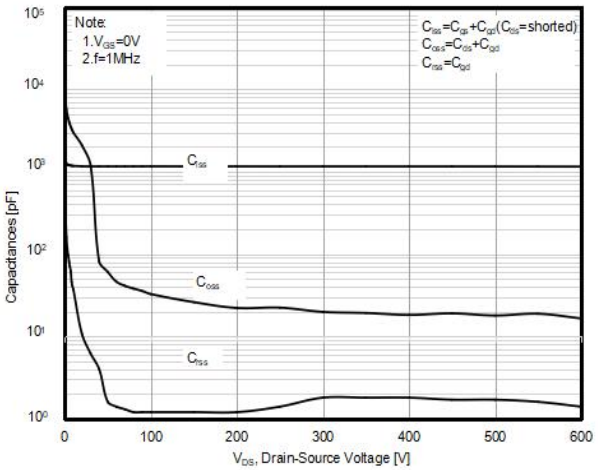



**Figure3. Transfer characteristics**

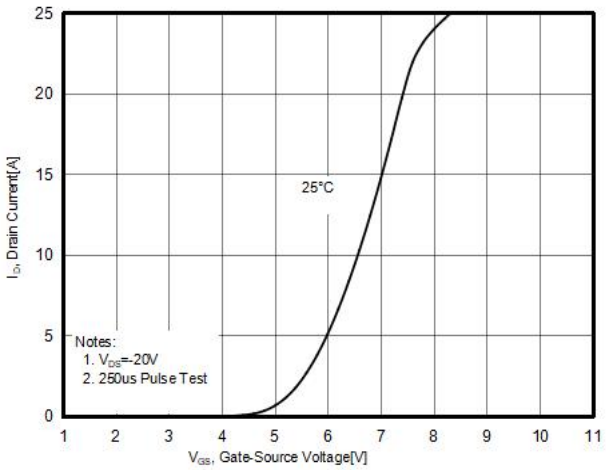



**Figure4. Output characteristics**

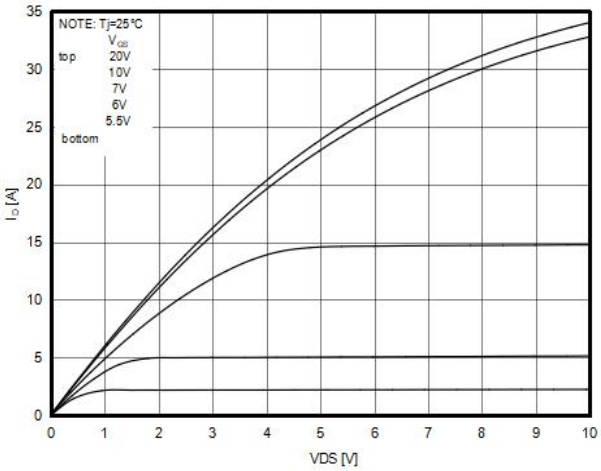



**Figure5. $R_{DS(ON)}$ vs Junction Temperature**

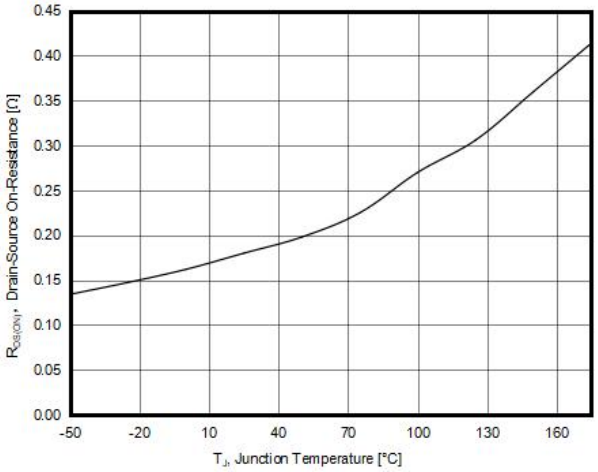



**Figure6. $BV_{DSS}$ vs Junction Temperature**

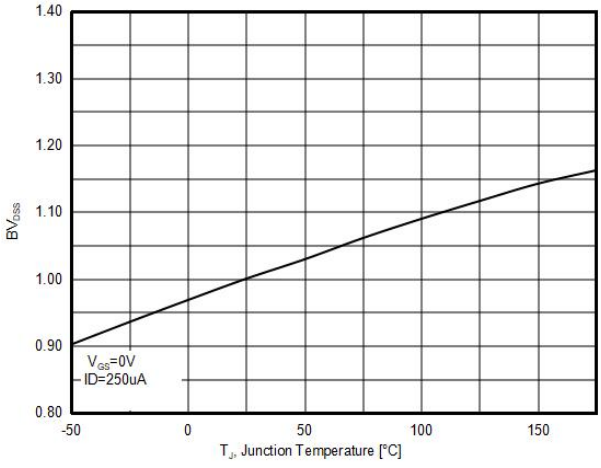


**Figure7. Maximum $I_D$ vs Junction Temperature**

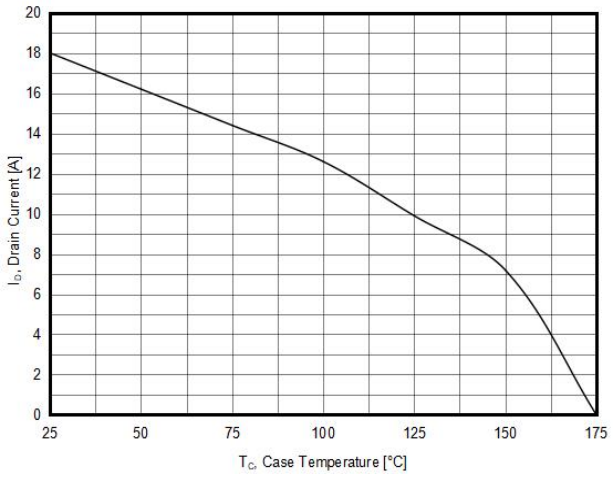



**Figure8. Gate charge waveforms**

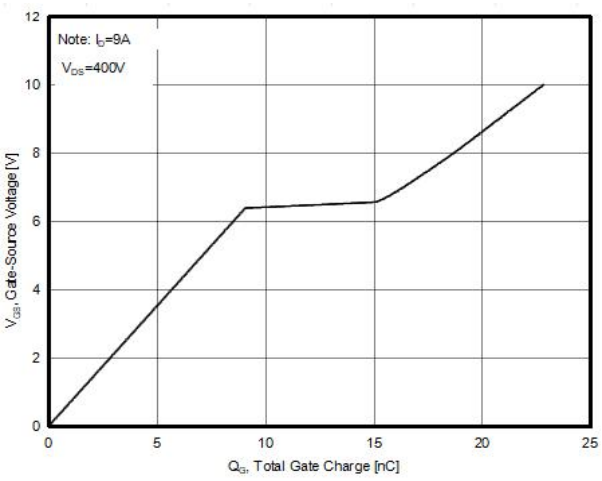



**Figure9. Static drain-source on resistance**

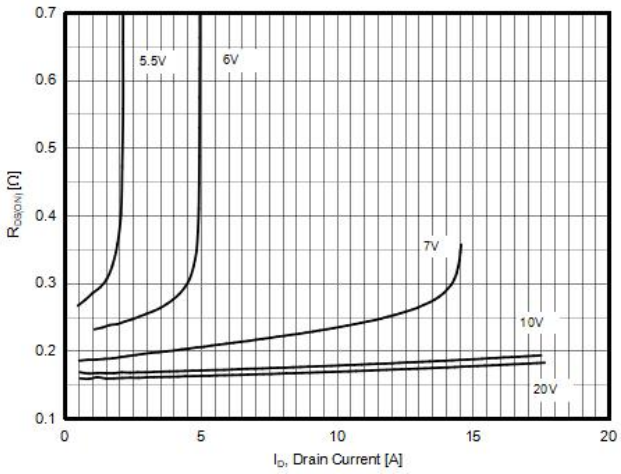
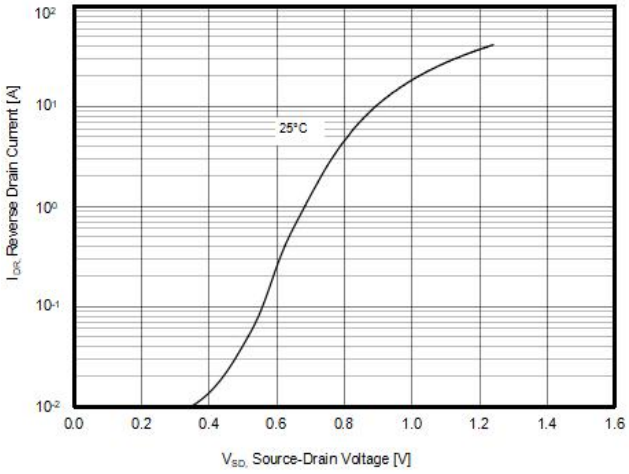
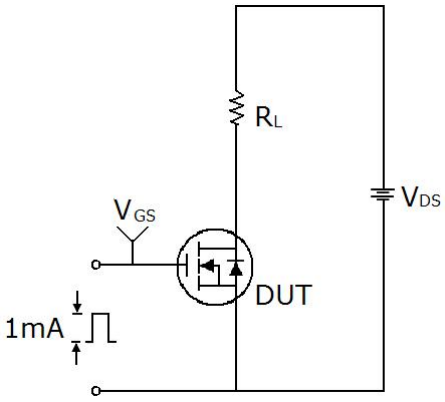


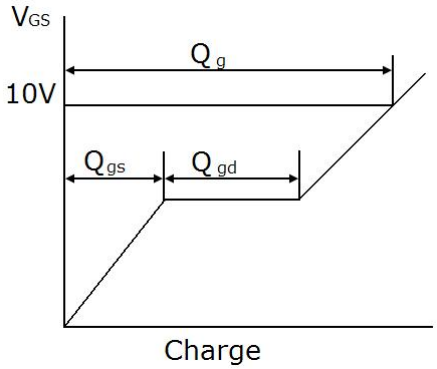

**Figure10. Source-Drain Diode Forward Voltage**



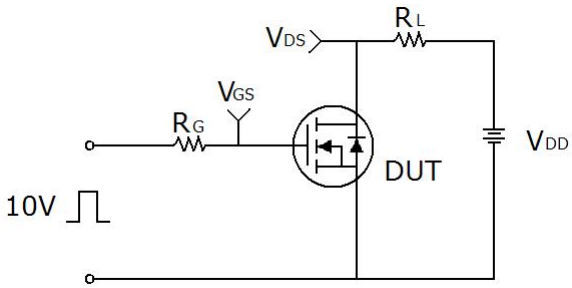
# Test circuit

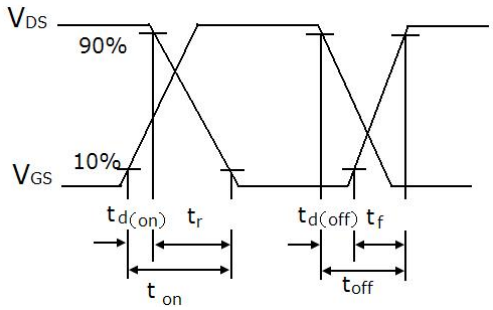
**1）Gate charge test circuit & Waveform**



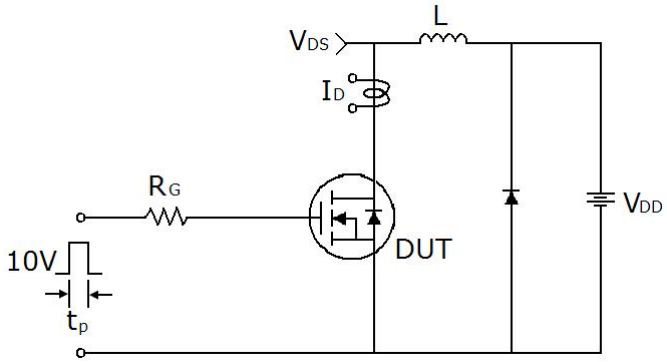



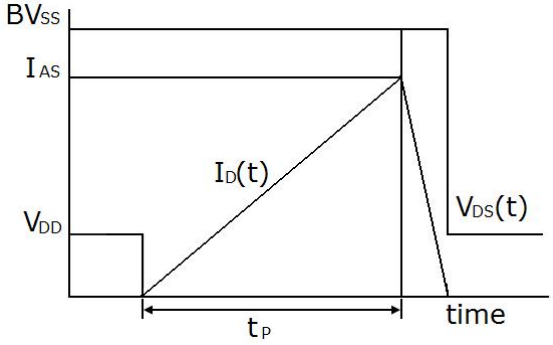

**2）Switch Time Test Circuit：**



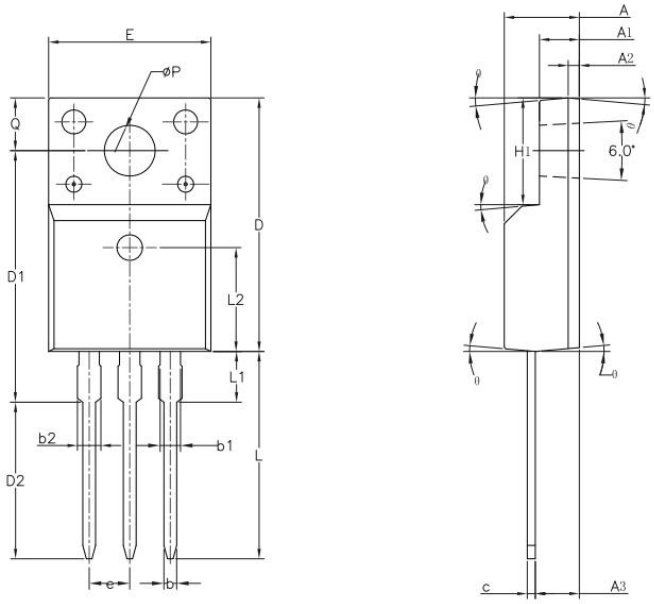




**3）Unclamped Inductive Switching Test Circuit & Waveforms**



# TO-220F-P Package Information




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | Min. | Max. | Min. | Max. |
| A | 4.50 | 4.83 | 0.177 | 0.190 |
| A1 | 2.34 | 2.74 | 0.092 | 0.108 |
| A2 | 0.70 REF | | 0.028 REF | |
| A3 | 2.56 | 2.93 | 0.101 | 0.115 |
| b | 0.70 | 0.90 | 0.028 | 0.035 |
| b1 | 1.18 | 1.38 | 0.046 | 0.054 |
| b2 | -- | 1.47 | -- | 0.058 |
| c | 0.45 | 0.60 | 0.018 | 0.024 |
| D | 15.67 | 16.07 | 0.616 | 0.631 |
| D1 | 15.55 | 15.95 | 0.611 | 0.627 |
| D2 | 9.60 | 10.00 | 0.377 | 0.393 |
| E | 9.96 | 10.36 | 0.391 | 0.407 |
| e | 2.54 BSC | | 0.100 BSC | |
| H1 | 6.48 | 6.88 | 0.255 | 0.270 |
| L | 12.68 | 13.28 | 0.498 | 0.522 |
| L1 | -- | 3.50 | -- | 0.138 |
| L2 | 6.50 REF | | 0.255 REF | |
| ⌀ P | 3.08 | 3.28 | 0.121 | 0.129 |
| Q | 3.20 | 3.40 | 0.126 | 0.134 |
| θ1 | 1.0° | 5.0° | 1.00° | 5.00° |

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