

## 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

- 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)

$V_{DS\ min@T_{jmax}}$	650	V
$R_{DS(ON)TYP}$	350	mΩ
$I_D$	10	A
$Q_g$	13	nC



Schematic diagram

### Package Marking And Ordering Information

Device	Device Package	Marking
NCE60N390F	TO-220F	NCE60N390F



Table 1. Absolute Maximum Ratings ( $T_c=25^{\circ}C$ )

Parameter	Symbol	Value	Unit
Drain-Source Voltage ( $V_{GS}=0V$ )	$V_{DS}$	600	V
Gate-Source Voltage ( $V_{DS}=0V$ ) AC ( $f>1\ Hz$ )	$V_{GS}$	$\pm 30$	V
Gate-Source Voltage ( $V_{DS}=0V$ ) DC	$V_{GS}$	$\pm 20$	V
Continuous Drain Current at $T_c=25^{\circ}C$	$I_{D(DC)}$	10	A
Continuous Drain Current at $T_c=100^{\circ}C$	$I_{D(DC)}$	7	A
Pulsed drain current (Note 1)	$I_{DM(pluse)}$	30	A
Maximum Power Dissipation( $T_c=25^{\circ}C$ )	$P_D$	32.1	W
Derate above $25^{\circ}C$		0.214	W/ $^{\circ}C$
Avalanche current (Note 1)	$I_{AS}$	2	A
Drain Source voltage slope, $V_{DS} \leq 480\ V$ ,	$dv/dt$	50	V/ns
Reverse diode $dv/dt$ , $V_{DS} \leq 480\ V, I_{SD} < I_D$	$dv/dt$	15	V/ns
Operating Junction and Storage Temperature Range	$T_J, T_{STG}$	-55...+175	$^{\circ}C$

\* limited by maximum junction temperature

**Table 2. Thermal Characteristic**

Parameter	Symbol	Value	Unit
Thermal Resistance, Junction-to-Case (Maximum)	$R_{thJC}$	4.67	$^{\circ}\text{C}/\text{W}$
Thermal Resistance, Junction-to-Ambient (Maximum)	$R_{thJA}$	62	$^{\circ}\text{C}/\text{W}$

**Table 3. Electrical Characteristics (TA=25 $^{\circ}\text{C}$  unless otherwise noted)**

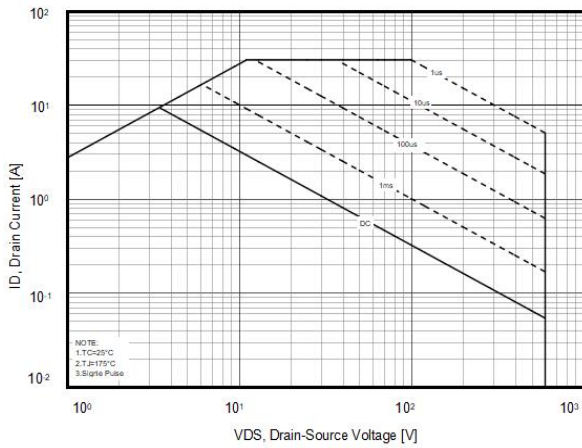
Parameter	Symbol	Condition	Min	Typ	Max	Unit
On/off states						
Drain-Source Breakdown Voltage	BV <sub>DSS</sub>	V <sub>GS</sub> =0V I <sub>D</sub> =250μA	600			V
Zero Gate Voltage Drain Current(Tc=25℃)	I <sub>DSS</sub>	V <sub>DS</sub> =600V,V <sub>GS</sub> =0V			1	μA
Zero Gate Voltage Drain Current(Tc=125℃)	I <sub>DSS</sub>	V <sub>DS</sub> =600V,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			±200	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> =5A		350	390	mΩ
Dynamic Characteristics						
Input Capacitance	C <sub>iss</sub>	V <sub>DS</sub> =50V,V <sub>GS</sub> =0V, F=1.0MHz		440		pF
Output Capacitance	C <sub>oss</sub>			32		pF
Reverse Transfer Capacitance	C <sub>rss</sub>			6		pF
Total Gate Charge	Q <sub>g</sub>	V <sub>DS</sub> =450V,I <sub>D</sub> =5A, V <sub>GS</sub> =10V		13		nC
Gate-Source Charge	Q <sub>gs</sub>			4.5		nC
Gate-Drain Charge	Q <sub>gd</sub>			3		nC
Gate plateau voltage	V <sub>gp</sub>			5.5		V
Intrinsic gate resistance	R <sub>G</sub>	f = 1 MHz open drain		42		Ω
Switching times						
Turn-on Delay Time	t <sub>d(on)</sub>	V <sub>DD</sub> =380V,I <sub>D</sub> =5A, R <sub>G</sub> =1.7Ω,V <sub>GS</sub> =10V		16		nS
Turn-on Rise Time	t <sub>r</sub>			9		nS
Turn-Off Delay Time	t <sub>d(off)</sub>			32		nS
Turn-Off Fall Time	t <sub>f</sub>			16		nS
Source- Drain Diode Characteristics						
Source-drain current(Body Diode)	I <sub>SD</sub>	T <sub>C</sub> =25℃			10	A
Pulsed Source-drain current(Body Diode)	I <sub>SDM</sub>				30	A
Forward On Voltage	V <sub>SD</sub>	T <sub>j</sub> =25℃,I <sub>SD</sub> =10A,V <sub>GS</sub> =0V		0.9	1.2	V
Reverse Recovery Time	t <sub>rr</sub>	T <sub>j</sub> =25℃,I <sub>F</sub> =5A, di/dt=100A/μs		220		nS
Reverse Recovery Charge	Q <sub>rr</sub>			1.9		uC
Peak Reverse Recovery Current	I <sub>rrm</sub>			17		A

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

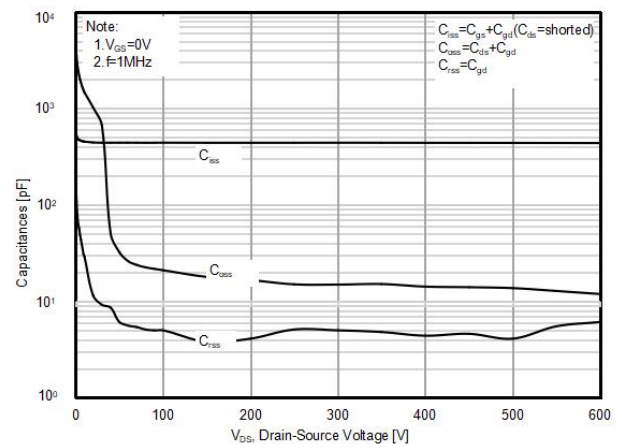
2.  $T_J=25^{\circ}\text{C}, V_{DD}=50\text{V}, V_G=10\text{V}, R_G=25\Omega$

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS (curves)

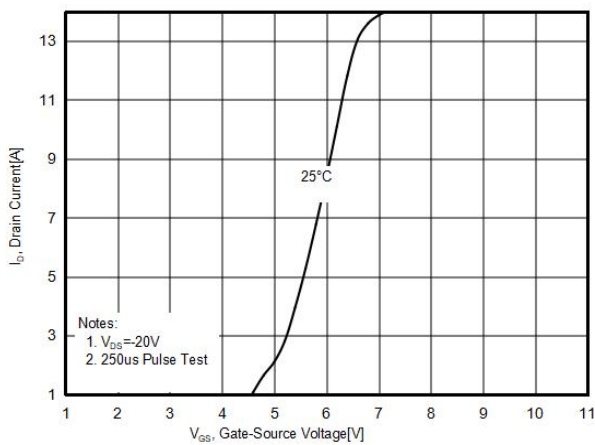
**Figure1. Safe operating area**



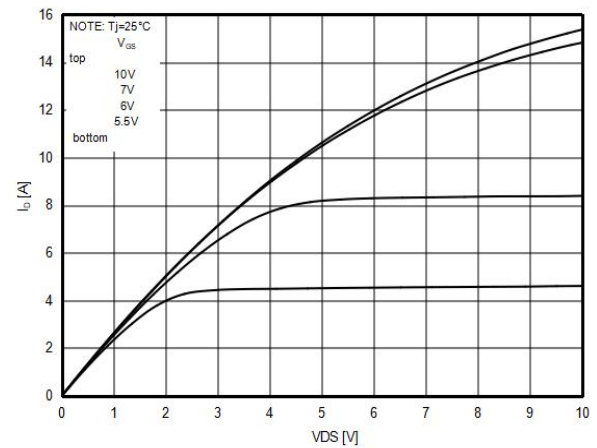
**Figure2. Capacitance**



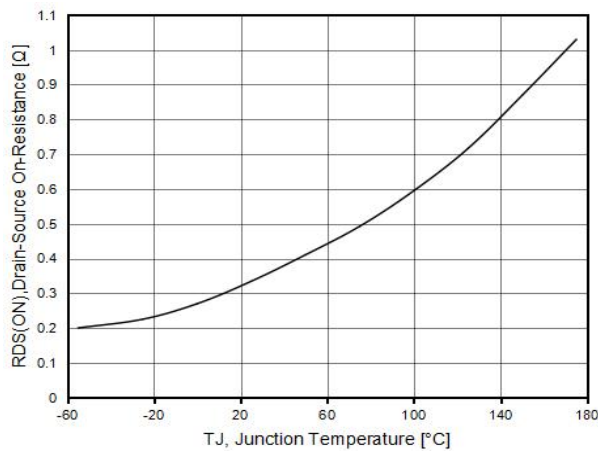
**Figure3. Transfer characteristics**



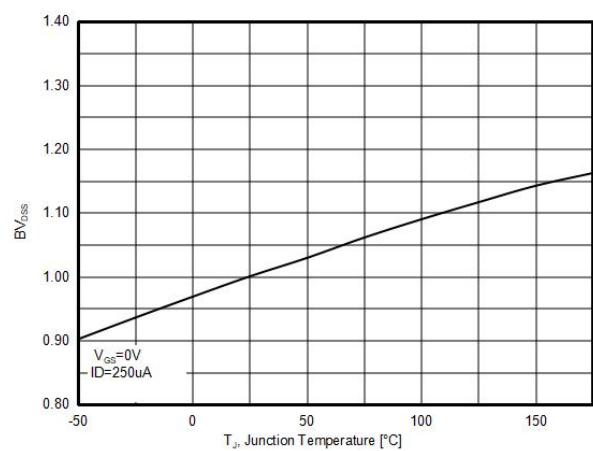
**Figure4. Output characteristics**



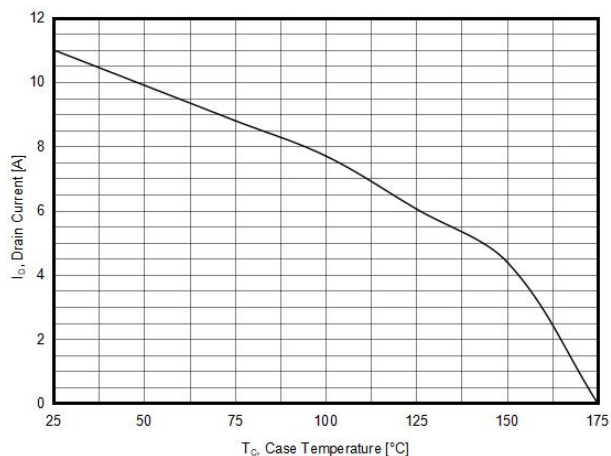
**Figure5.  $R_{DS(ON)}$  vs Junction Temperature**



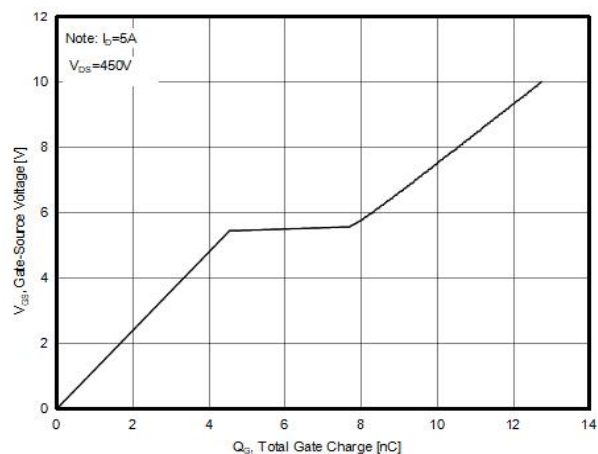
**Figure6.  $BV_{DSS}$  vs Junction Temperature**



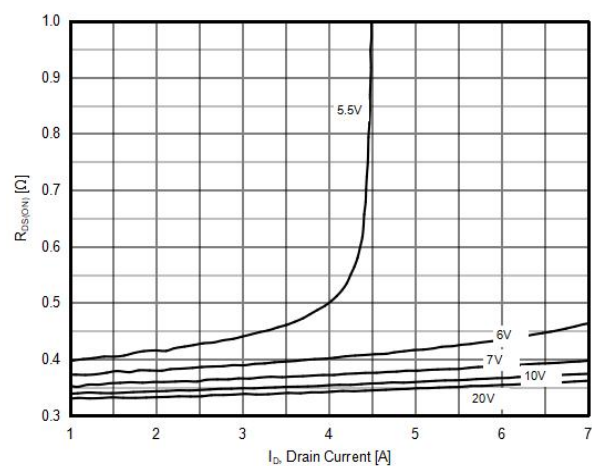
**Figure7. Maximum  $I_D$  vs Junction Temperature**



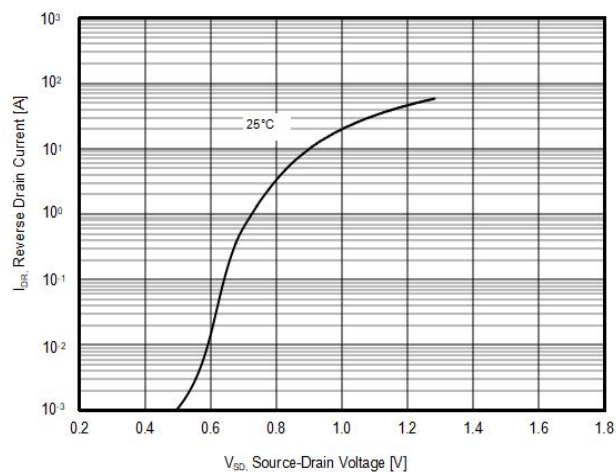
**Figure8. Gate charge waveforms**



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

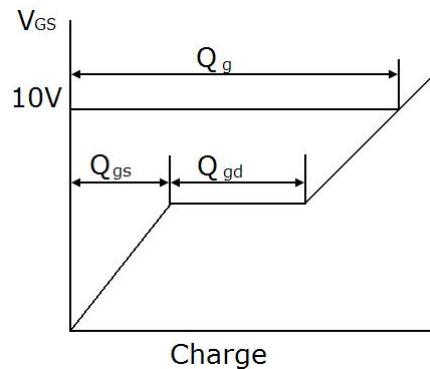


**Figure10. Source-Drain Diode Forward Voltage**



## Test circuit

### 1) Gate charge test circuit & Waveform



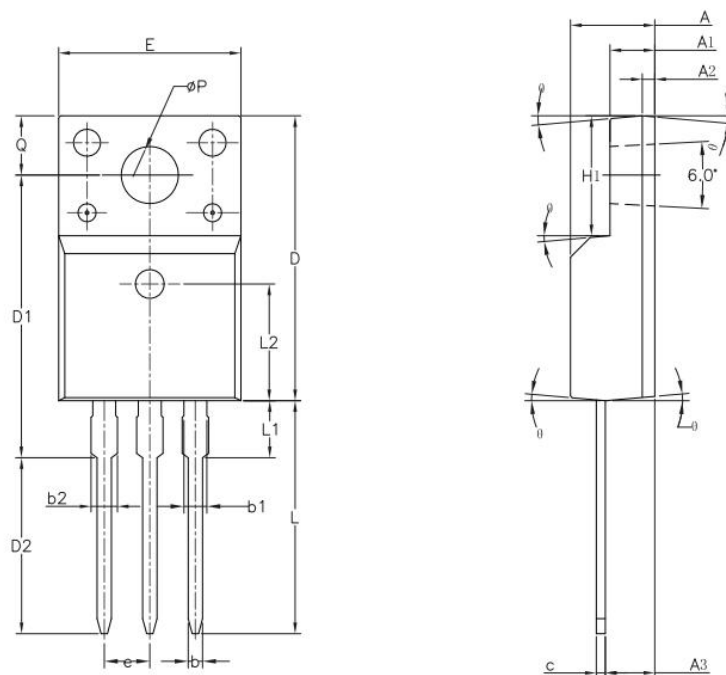
### 2) Switch Time Test Circuit:



### 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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