

## 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.

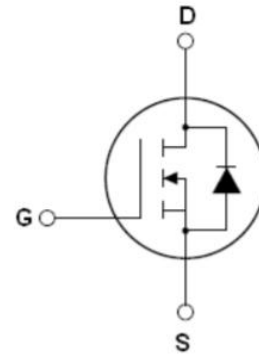
### Features

- 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

$V_{DS\ min@T_{jmax}}$	650	V
$R_{DS(ON)TYP.}$	880	m $\Omega$
$I_D$	4.3	A
$Q_g$	8.5	nC



Schematic diagram

### Package Marking And Ordering Information

Device	Device Package	Marking
NCE60N1K0I	TO-251	NCE60N1K0I



TO-251

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

Parameter	Symbol	Value	Unit
Drain-Source Voltage ( $V_{GS}=0V$ )	$V_{DS}$	600	V
Gate-Source Voltage ( $V_{DS}=0V$ ), AC ( $f>1\text{ Hz}$ )	$V_{GS}$	$\pm 30$	V
Gate-Source Voltage ( $V_{DS}=0V$ ), DC	$V_{GS}$	$\pm 20$	V
Continuous Drain Current at $T_c=25^\circ\text{C}$	$I_{D(DC)}$	4.3	A
Continuous Drain Current at $T_c=100^\circ\text{C}$	$I_{D(DC)}$	3.0	A
Pulsed drain current (Note 1)	$I_{DM(pluse)}$	12.9	A
Maximum Power Dissipation( $T_c=25^\circ\text{C}$ )	$P_D$	47	W
Derate above $25^\circ\text{C}$		0.31	W/ $^\circ\text{C}$
Single pulse avalanche current (Note 2)	$I_{AS}$	1	A
Repetitive Avalanche energy, $t_{AR}$ limited by $T_{jmax}$ (Note 1)	$E_{AR}$	0.9	mJ
Reverse diode dv/dt, $V_{DS} \leq 480\text{ V}, I_{SD} < I_D$	dv/dt	15	V/ns
Drain Source voltage slope, $V_{DS} \leq 480\text{ V}$	dv/dt	50	V/ns
Operating Junction and Storage Temperature Range	$T_J, T_{STG}$	-55...+175	$^\circ\text{C}$

**Table 2. Thermal Characteristic**

Parameter	Symbol	Value	Unit
Thermal Resistance, Junction-to-Case (Maximum)	$R_{thJC}$	3.19	$^{\circ}\text{C}/\text{W}$
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)**

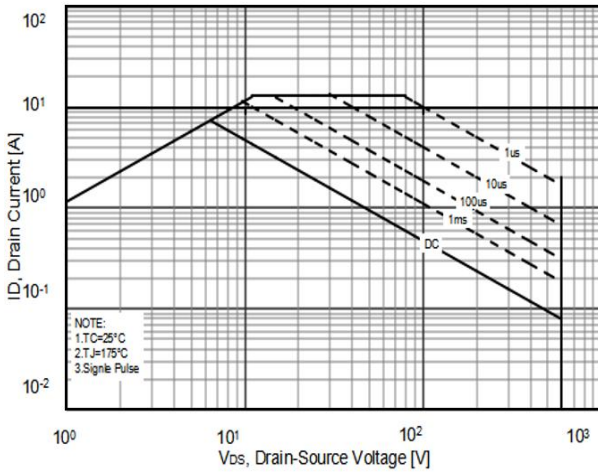
Parameter	Symbol	Condition	Min	Typ	Max	Unit
<b>On/off states</b>						
Drain-Source Breakdown Voltage	$BV_{DSS}$	$V_{GS}=0V, I_D=250\mu A$	600			V
Zero Gate Voltage Drain Current(Tc=25 $^{\circ}\text{C}$ )	$I_{DSS}$	$V_{DS}=600V, V_{GS}=0V$			1	$\mu A$
Zero Gate Voltage Drain Current(Tc=125 $^{\circ}\text{C}$ )	$I_{DSS}$	$V_{DS}=600V, V_{GS}=0V$			50	$\mu A$
Gate-Body Leakage Current	$I_{GSS}$	$V_{GS}=\pm 20V, V_{DS}=0V$			$\pm 200$	nA
Gate Threshold Voltage	$V_{GS(th)}$	$V_{DS}=V_{GS}, I_D=250\mu A$	3		4	V
Drain-Source On-State Resistance	$R_{DS(ON)}$	$V_{GS}=10V, I_D=2A$		880	1000	m $\Omega$
<b>Dynamic Characteristics</b>						
Gate Resistance	$R_g$	F=1MHZ, D-S short		40		$\Omega$
Input Capacitance	$C_{iss}$	$V_{DS}=50V, V_{GS}=0V,$ F=1MHz		252		pF
Output Capacitance	$C_{oss}$			1.82		pF
Reverse Transfer Capacitance	$C_{rss}$			0.78		pF
Total Gate Charge	$Q_g$	$V_{DS}=400V, I_D=2A,$ $V_{GS}=10V$		8.5	10.5	nC
Gate-Source Charge	$Q_{gs}$			1.6		nC
Gate-Drain Charge	$Q_{gd}$			3		nC
Gate plateau voltage	$V_{gp}$			4.8		V
<b>Switching times</b>						
Turn-on Delay Time	$t_{d(on)}$	$V_{DD}=380V, I_D=2A,$ $R_G=4\Omega, V_{GS}=10V$		8		nS
Turn-on Rise Time	$t_r$			10		nS
Turn-Off Delay Time	$t_{d(off)}$			18		nS
Turn-Off Fall Time	$t_f$			15		nS
<b>Source- Drain Diode Characteristics</b>						
Source-drain current(Body Diode)	$I_{SD}$	$T_C=25^{\circ}\text{C}$			4.3	A
Pulsed-Source-drain current(Body Diode)	$I_{SDM}$				12.9	A
Forward on voltage	$V_{SD}$	$T_j=25^{\circ}\text{C}, I_{SD}=4.3A, V_{GS}=0V$		0.9	1.1	V
Reverse Recovery Time	$t_{rr}$	$T_j=25^{\circ}\text{C}, I_F=2A,$ $di/dt=100A/\mu s$		150		nS
Reverse Recovery Charge	$Q_{rr}$			0.87		$\mu C$
Peak reverse recovery current	$I_{rrm}$			11.6		A

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

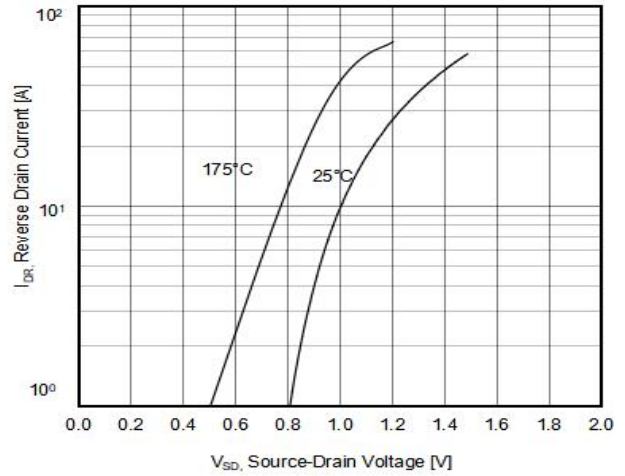
2.  $T_j=25^{\circ}\text{C}, V_{DD}=50V, V_G=10V, R_G=25\Omega$

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS (curves)

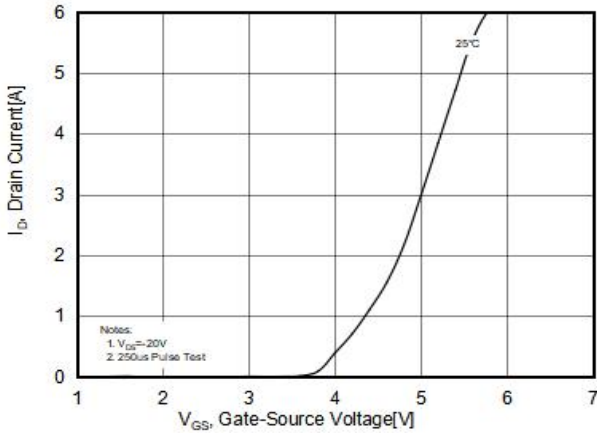
**Figure1. Safe operating area**



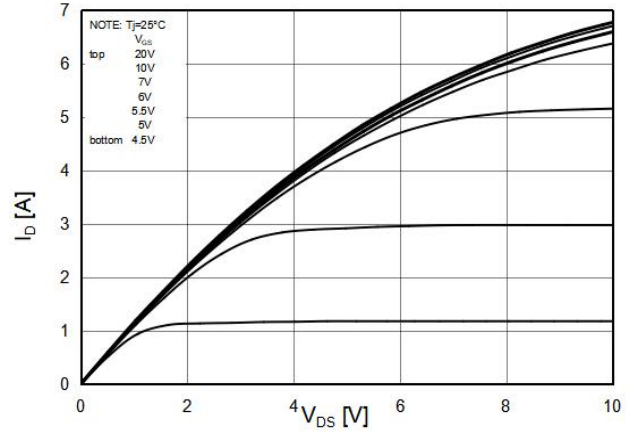
**Figure2. Source-Drain Diode Forward Voltage**



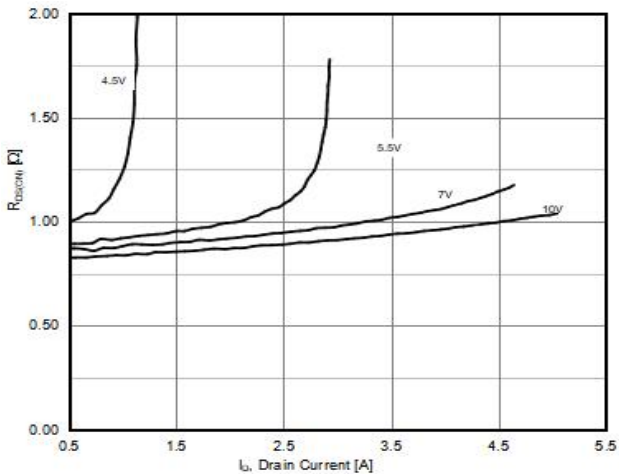
**Figure3. Transfer characteristics**



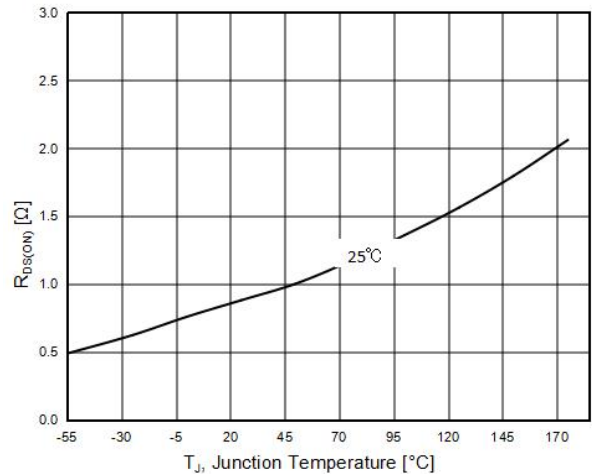
**Figure4. Output characteristics**



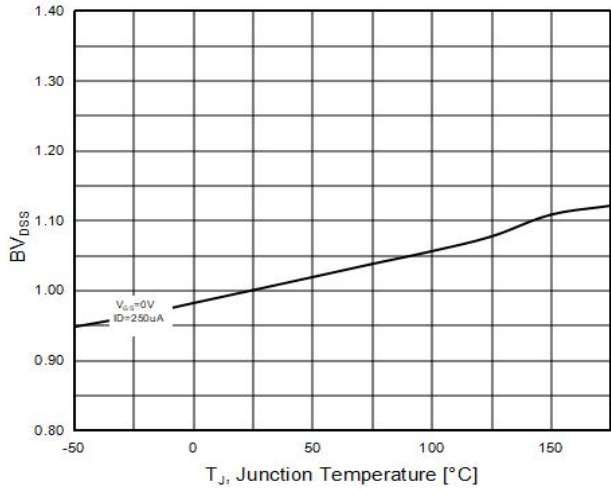
**Figure5. Static drain-source on resistance**



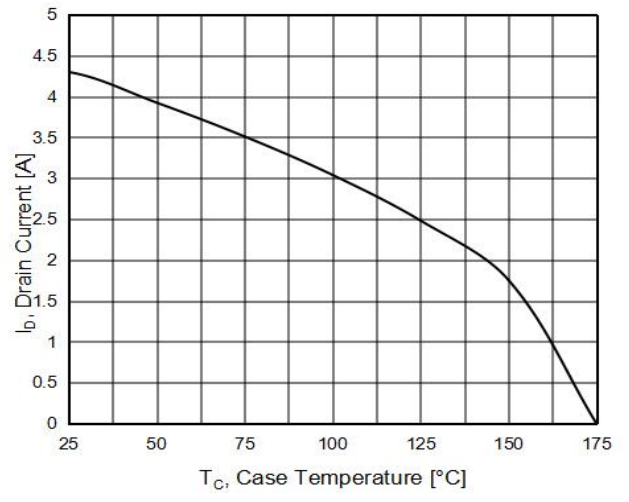
**Figure6.  $R_{DS(ON)}$  vs Junction Temperature**



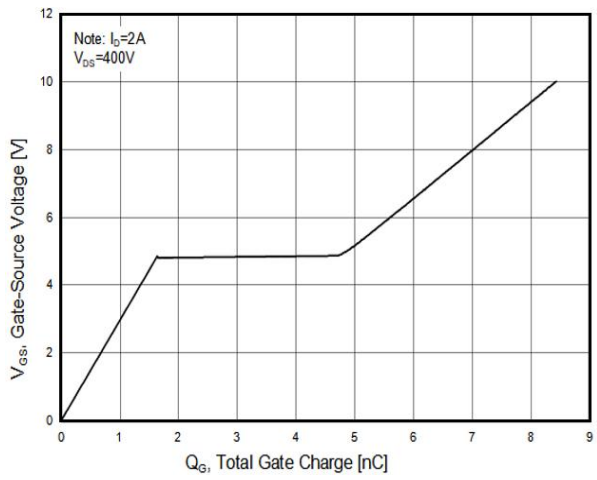
**Figure7. BV<sub>DSS</sub> vs Junction Temperature**



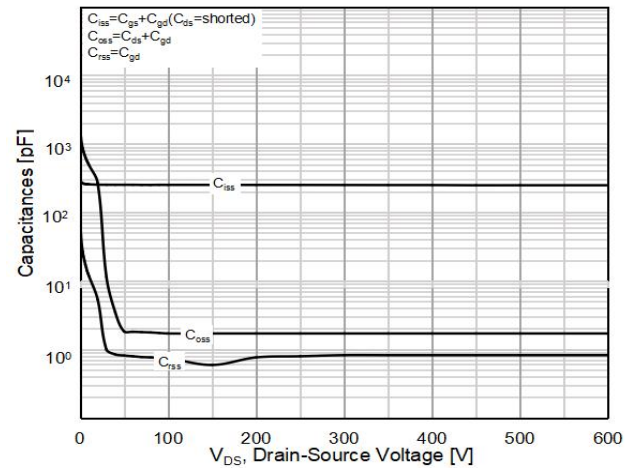
**Figure8. Maximum I<sub>D</sub> vs Junction Temperature**



**Figure9. Gate charge waveforms**



**Figure10. Capacitance**

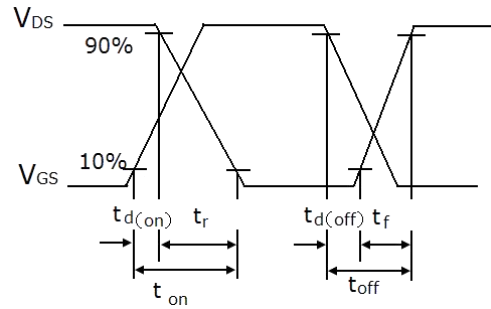


## Test circuit

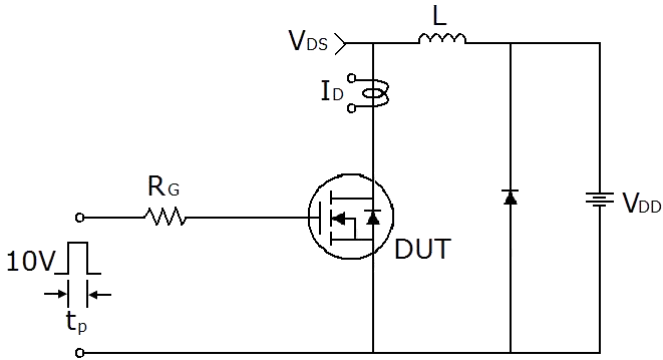
### 1) Gate charge test circuit & Waveform



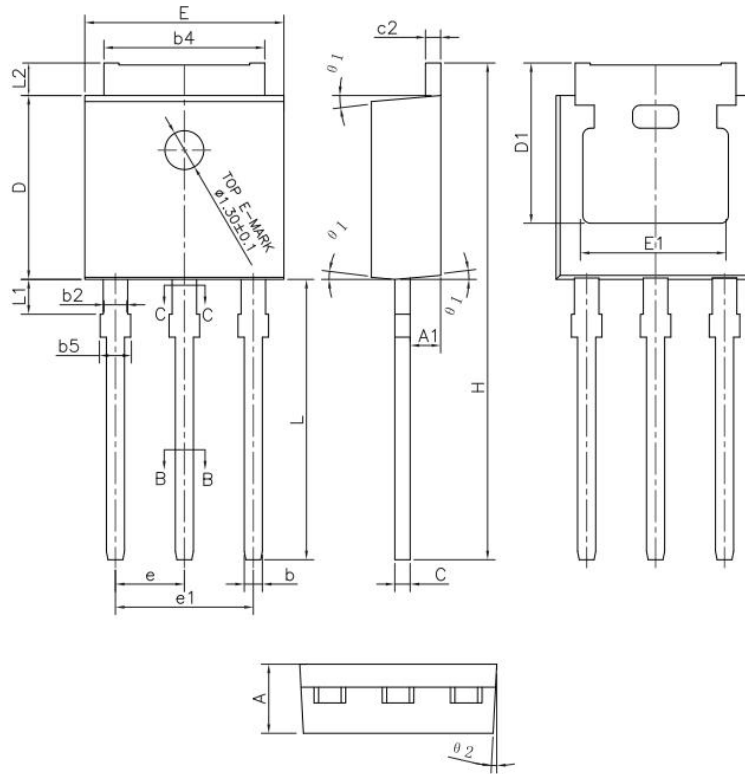
### 2) Switch Time Test Circuit:



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

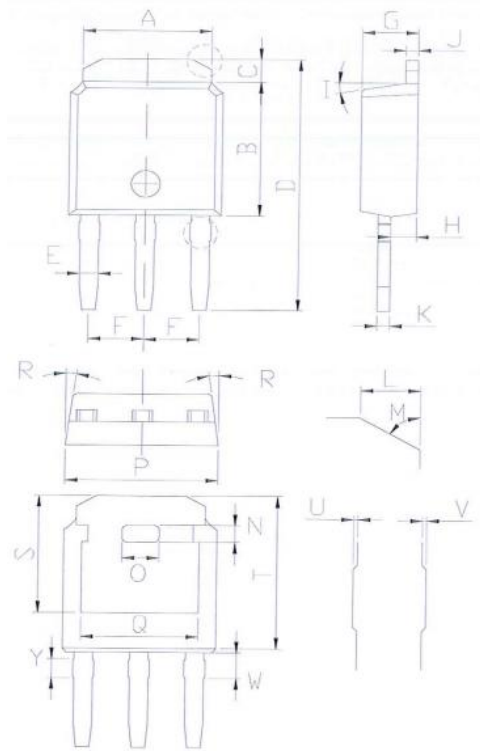


## TO-251-P Package Information



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	2.20	2.35	0.087	0.093
A1	0.90	1.10	0.035	0.043
b	0.56	0.69	0.022	0.027
b1	0.55	0.65	0.022	0.026
b2	0.77	0.90	0.030	0.035
b3	0.76	0.86	0.030	0.034
b4	5.23	5.43	0.206	0.214
c	0.46	0.59	0.018	0.023
c1	0.45	0.55	0.018	0.022
c2	0.46	0.59	0.018	0.023
D	6.00	6.20	0.236	0.244
D1	5.20	-	0.205	-
E	6.50	6.70	0.256	0.264
E1	4.60	5.00	0.181	0.197
e	2.24	2.34	0.088	0.092
e1	4.47	4.67	0.176	0.184
H	16.18	16.78	0.637	0.661
L	9.00	9.60	0.354	0.378
L1	0.95	1.35	0.037	0.053
L2	0.90	1.25	0.035	0.049

## TO-251-L Package Information



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	5.04	5.64	0.198	0.222
B	5.70	6.30	0.224	0.248
C	0.75	1.35	0.030	0.053
D	11.01	11.61	0.433	0.457
E	0.61	0.91	0.024	0.036
F	2.13	2.43	0.084	0.096
G	2.00	2.60	0.079	0.102
H	0.76	1.36	0.030	0.054
J	0.36	0.66	0.014	0.026
K	0.37	0.67	0.015	0.026
L	0.50	1.10	0.020	0.043
N	0.45	1.05	0.018	0.041
O	1.50	2.10	0.059	0.083
P	6.30	6.90	0.248	0.272
Q	4.55	5.15	0.179	0.203
S	5.00	5.60	0.197	0.220
T	6.60	7.20	0.260	0.283
W	0.90	1.40	0.035	0.055
Y	0.60	1.10	0.024	0.043

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