N-Channel Super Junction Power MOSFET

**General Description**

The series of devices use advanced trench gate superjunction 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)

**Package Marking And Ordering Information**

<table>
<thead>
<tr>
<th>Device</th>
<th>Device Package</th>
<th>Marking</th>
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<tbody>
<tr>
<td>NCE65T180</td>
<td>TO-220</td>
<td>NCE65T180</td>
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<tr>
<td>NCE65T180F</td>
<td>TO-220F</td>
<td>NCE65T180F</td>
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<tr>
<td>NCE65T180D</td>
<td>TO-263</td>
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**Table 1. Absolute Maximum Ratings ($T_C=25°C$)**

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<th>NCE65T180F</th>
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<tbody>
<tr>
<td>Drain-Source Voltage ($V_{GS}=0V$)</td>
<td>$V_{DS}$</td>
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<td></td>
<td></td>
<td>V</td>
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<tr>
<td>Gate-Source Voltage ($V_{DS}=0V$), AC (f&gt;1 Hz)</td>
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<td>±30</td>
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<td></td>
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<td>Continuous Drain Current at $T_C=25°C$</td>
<td>$I_{D(DC)}$</td>
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<td>21*</td>
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<td>Continuous Drain Current at $T_C=100°C$</td>
<td>$I_{D(DC)}$</td>
<td>13.2</td>
<td>13.2*</td>
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<tr>
<td>Pulsed drain current (Note 1)</td>
<td>$I_{DM\text{ (pluse)}}$</td>
<td>84</td>
<td>84*</td>
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<td>Maximum Power Dissipation ($T_C=25°C$)</td>
<td>$P_D$</td>
<td>188</td>
<td>33.8</td>
<td>0.27</td>
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<td>Derate above 25°C</td>
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<td>1.5</td>
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<td></td>
<td>W/°C</td>
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<td>Single pulse avalanche energy (Note 2)</td>
<td>$E_{AS}$</td>
<td>441</td>
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<td></td>
<td>mJ</td>
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<td>Avalanche current (Note 1)</td>
<td>$I_{AR}$</td>
<td>10.5</td>
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<td>Repetitive Avalanche energy, $t_{AR}$ limited by $T_{J\text{ max}}$ (Note 1)</td>
<td>$E_{AR}$</td>
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### Table 2. Thermal Characteristic

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<td>Thermal Resistance, Junction-to-Case (Maximum)</td>
<td>$R_{thJC}$</td>
<td>0.66</td>
<td>3.69</td>
<td>°C/W</td>
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<td>Thermal Resistance, Junction-to-Ambient (Maximum)</td>
<td>$R_{thJA}$</td>
<td>62.5</td>
<td>80</td>
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### Table 3. Electrical Characteristics (TA=25°C unless otherwise noted)

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<th>Parameter</th>
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<th>Condition</th>
<th>Min</th>
<th>Typ</th>
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<td>On/off states</td>
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<td>Drain-Source Breakdown Voltage</td>
<td>$BV_{DSS}$</td>
<td>$V_{GS}=0V, I_{D}=250\mu A$</td>
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<td></td>
<td>V</td>
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<tr>
<td>Zero Gate Voltage Drain Current(Tc=25°C)</td>
<td>$I_{DSS}$</td>
<td>$V_{DS}=650V, V_{GS}=0V$</td>
<td>0.05</td>
<td>1</td>
<td></td>
<td>μA</td>
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<tr>
<td>Zero Gate Voltage Drain Current(Tc=125°C)</td>
<td>$I_{DSS}$</td>
<td>$V_{DS}=650V, V_{GS}=0V$</td>
<td>100</td>
<td></td>
<td></td>
<td>μA</td>
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<td>Gate-Body Leakage Current</td>
<td>$I_{GS}$</td>
<td>$V_{GS}=\pm 20V, V_{DS}=0V$</td>
<td>±100</td>
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<td></td>
<td>nA</td>
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<td>Gate Threshold Voltage</td>
<td>$V_{GS(qs)}$</td>
<td>$V_{DS}=480V, I_{D}=21A, V_{GS}=10V$</td>
<td>3</td>
<td>3.5</td>
<td>4</td>
<td>V</td>
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<tr>
<td>Drain-Source On-State Resistance</td>
<td>$R_{DS(ON)}$</td>
<td>$V_{GS}=10V, I_{D}=10.5A$</td>
<td>150</td>
<td>180</td>
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<td>mΩ</td>
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<td>Dynamic Characteristics</td>
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<td>Forward Transconductance</td>
<td>$g_{fs}$</td>
<td>$V_{DS}=20V, I_{D}=10.5A$</td>
<td>16</td>
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<td></td>
<td>S</td>
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<td>Input Capacitance</td>
<td>$C_{RS}$</td>
<td>$V_{DS}=50V, V_{GS}=0V, F=1.0MHz$</td>
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<td>PF</td>
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<td>Output Capacitance</td>
<td>$C_{oss}$</td>
<td>$V_{DS}=50V, V_{GS}=0V, F=1.0MHz$</td>
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<td>Reverse Transfer Capacitance</td>
<td>$C_{oss}$</td>
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<td>Total Gate Charge</td>
<td>$Q_{g}$</td>
<td>$V_{DS}=480V, I_{D}=21A, V_{GS}=10V$</td>
<td>36</td>
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<td>Gate-Source Charge</td>
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<td>Gate-Drain Charge</td>
<td>$Q_{gd}$</td>
<td>$V_{DS}=480V, I_{D}=21A, V_{GS}=10V$</td>
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<td>Switching times</td>
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<tr>
<td>Turn-on Delay Time</td>
<td>$t_{D(on)}$</td>
<td>$V_{DD}=380V, I_{D}=11A, R_{G}=4\Omega, V_{GS}=10V$</td>
<td>11</td>
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<td>Turn-on Rise Time</td>
<td>$t_{r}$</td>
<td>$V_{DD}=380V, I_{D}=11A, R_{G}=4\Omega, V_{GS}=10V$</td>
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<td>nS</td>
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<tr>
<td>Turn-Off Delay Time</td>
<td>$t_{D(off)}$</td>
<td>$V_{DD}=380V, I_{D}=11A, R_{G}=4\Omega, V_{GS}=10V$</td>
<td>61</td>
<td></td>
<td></td>
<td>nS</td>
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<tr>
<td>Turn-Off Fall Time</td>
<td>$t_{f}$</td>
<td>$V_{DD}=380V, I_{D}=11A, R_{G}=4\Omega, V_{GS}=10V$</td>
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<td></td>
<td>nS</td>
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<td>Source-Drain Diode Characteristics</td>
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<tr>
<td>Source-drain current(Body Diode)</td>
<td>$I_{SD}$</td>
<td>$T_{C}=25^\circ C$</td>
<td>21</td>
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<td>Pulsed Source-drain current(Body Diode)</td>
<td>$I_{SDM}$</td>
<td>$T_{C}=25^\circ C, I_{SD}=21A, V_{GS}=0V$</td>
<td>84</td>
<td></td>
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<td>A</td>
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<td>Forward on voltage</td>
<td>$V_{SD}$</td>
<td>$T_{C}=25^\circ C, I_{SD}=21A, V_{GS}=0V$</td>
<td>0.9</td>
<td>1.3</td>
<td></td>
<td>V</td>
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<td>Reverse Recovery Time</td>
<td>$t_{rr}$</td>
<td>$T_{C}=25^\circ C, I_{D}=21A, di/dt=100A/\mu s$</td>
<td>310</td>
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<td>nS</td>
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<td>Reverse Recovery Charge</td>
<td>$Q_{rr}$</td>
<td>$T_{C}=25^\circ C, I_{D}=21A, di/dt=100A/\mu s$</td>
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<td></td>
<td>uC</td>
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<td>Peak Reverse Recovery Current</td>
<td>$I_{rmm}$</td>
<td>$T_{C}=25^\circ C, I_{D}=21A, di/dt=100A/\mu s$</td>
<td>28</td>
<td></td>
<td></td>
<td>A</td>
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Notes:
1. Repetitive Rating: Pulse width limited by maximum junction temperature
2. $T_{F}=25^\circ C, V_{DD}=50V, V_{G}=10V, R_{G}=25\Omega$
TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS (curves)

Figure 1. Safe operating area for TO-220/TO-263

Figure 2. Safe operating area for TO-220F

Figure 3. Source-Drain Diode Forward Voltage

Figure 4. Output characteristics

Figure 5. Transfer characteristics

Figure 6. Static drain-source on resistance
Figure 13. Capacitance

Note:
1. \( V_{DS} = 0 \text{V} \)
2. \( f = 1 \text{MHz} \)

For example:
- \( C_{oss} = C_{gs} + C_{gd} \) (\( C_{gs} \) = shorted)
- \( C_{oss} = C_{gs} + C_{gd} \)
- \( C_{oss} = C_{gd} \)

\( V_{DS} \), Drain - Source Voltage [V]
Test circuit

1) Gate charge test circuit & Waveform

2) Switch Time Test Circuit:

3) Unclamped Inductive Switching Test Circuit & Waveforms
TO-220-3L-C Package Information

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<td>A</td>
<td>4.400 0.173</td>
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<tr>
<td>A1</td>
<td>2.250 0.089</td>
<td>2.550 0.100</td>
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<td>b</td>
<td>0.710 0.028</td>
<td>0.910 0.036</td>
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<td>b1</td>
<td>1.170 0.046</td>
<td>1.370 0.054</td>
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<td>0.330 0.013</td>
<td>0.650 0.026</td>
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<td>c1</td>
<td>1.200 0.047</td>
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<td>D</td>
<td>9.910 0.390</td>
<td>10.250 0.404</td>
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<td>E</td>
<td>8.950 0.352</td>
<td>9.750 0.384</td>
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<td>E1</td>
<td>12.650 0.498</td>
<td>12.950 0.510</td>
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<td>e</td>
<td>2.540 0.100 TYP.</td>
<td>0.100 TYP.</td>
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<td>e1</td>
<td>4.980 0.196</td>
<td>5.180 0.204</td>
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<td>F</td>
<td>2.650 0.104</td>
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<td>H</td>
<td>7.900 0.311</td>
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<td>2.850 0.112</td>
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# TO-263-3L Package Information

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<td>2.340</td>
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<td>2.560</td>
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<td>E2</td>
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<td>e</td>
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<td>3.030</td>
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