Silicon Carbide (SiC) MOSFET – EliteSiC, 60 mohm, 900 V, M2, TO-247-4L

NTH4L060N090SC1

**Features**
- Typ. $R_{DS(on)} = 60 \, \text{m}\Omega \, @ \, V_{GS} = 15 \, \text{V}$
- Typ. $R_{DS(on)} = 43 \, \text{m}\Omega \, @ \, V_{GS} = 18 \, \text{V}$
- Ultra Low Gate Charge (typ. $Q_G = 87 \, \text{nC}$)
- Low Effective Output Capacitance (typ. $C_{oss} = 113 \, \text{pF}$)
- 100% UIL Tested
- This Device is Halide Free and RoHS Compliant with exemption 7a, Pb-Free 2LI (on second level interconnection)

**Typical Applications**
- UPS
- DC–DC Converter
- Boost Inverter

**MAXIMUM RATINGS** ($T_J = 25^\circ \text{C}$ unless otherwise noted)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drain–to–Source Voltage</td>
<td>$V_{DSS}$</td>
<td>900</td>
<td>V</td>
</tr>
<tr>
<td>Gate–to–Source Voltage</td>
<td>$V_{GS}$</td>
<td>+22/–8</td>
<td>V</td>
</tr>
<tr>
<td>Recommended Operation Values of Gate–to–Source Voltage</td>
<td>$V_{GSOp}$</td>
<td>−5/+15</td>
<td>V</td>
</tr>
<tr>
<td>Continuous Drain Current $R_{JUC}$ Steady State</td>
<td>$T_J = 25^\circ \text{C}$</td>
<td>$I_D$</td>
<td>46</td>
</tr>
<tr>
<td>Power Dissipation $R_{JUC}$</td>
<td>$P_D$</td>
<td>221</td>
<td>W</td>
</tr>
<tr>
<td>Continuous Drain Current $R_{JUC}$ Steady State</td>
<td>$T_J = 100^\circ \text{C}$</td>
<td>$I_D$</td>
<td>32</td>
</tr>
<tr>
<td>Power Dissipation $R_{JUC}$</td>
<td>$P_D$</td>
<td>110</td>
<td>W</td>
</tr>
<tr>
<td>Pulsed Drain Current (Note 2)</td>
<td>$T_A = 25^\circ \text{C}$</td>
<td>$I_{DM}$</td>
<td>211</td>
</tr>
<tr>
<td>Operating Junction and Storage Temperature Range</td>
<td>$T_J$, $T_{stg}$</td>
<td>−55 to +175</td>
<td>°C</td>
</tr>
<tr>
<td>Source Current (Body Diode)</td>
<td>$I_S$</td>
<td>22</td>
<td>A</td>
</tr>
<tr>
<td>Single Pulse Drain–to–Source Avalanche Energy ($L_{ddg} = 18 , \text{A}, , L = 1 , \text{mH}$) (Note 3)</td>
<td>$E_{AS}$</td>
<td>162</td>
<td>mJ</td>
</tr>
</tbody>
</table>

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

**THERMAL RESISTANCE MAXIMUM RATINGS**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>Junction–to–Case (Note 1)</td>
<td>$R_{JUC}$</td>
<td>0.68</td>
<td>°C/W</td>
</tr>
<tr>
<td>Junction–to–Ambient (Note 1)</td>
<td>$R_{JUA}$</td>
<td>40</td>
<td>°C/W</td>
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</table>

1. The entire application environment impacts the thermal resistance values shown, they are not constants and are only valid for the particular conditions noted.
2. Repetitive rating, limited by max junction temperature.
3. $E_{AS}$ of 162 mJ is based on starting $T_J = 25^\circ \text{C}$; $L = 1 \, \text{mH}$, $I_{AS} = 18 \, \text{A}$, $V_{DD} = 100 \, \text{V}, V_{GS} = 15 \, \text{V}$.

**MARKING DIAGRAM**

**ORDERING INFORMATION**

<table>
<thead>
<tr>
<th>Device</th>
<th>Package</th>
<th>Shipping</th>
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<tbody>
<tr>
<td>NTH4L060N090SC1</td>
<td>TO-247-4L</td>
<td>30 Units / Tube</td>
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</table>
# ELECTRICAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
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<tbody>
<tr>
<td><strong>OFF CHARACTERISTICS</strong></td>
<td></td>
<td></td>
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<tr>
<td>Drain–to–Source Breakdown Voltage</td>
<td>( V_{(BR)DSS} )</td>
<td>( V_{GS} = 0 ) ( V ), ( I_D = 1 ) mA</td>
<td>900</td>
<td></td>
<td></td>
<td>V</td>
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<tr>
<td>Drain–to–Source Breakdown Voltage Temperature</td>
<td>( V_{(BR)DSS/TJ} )</td>
<td>( I_D = 1 ) mA, referenced to 25°C</td>
<td>574</td>
<td></td>
<td></td>
<td>mV/°C</td>
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<tr>
<td>Zero Gate Voltage Drain Current</td>
<td>( I_{DSS} )</td>
<td>( V_{GS} = 0 ) ( V ), ( V_{DS} = 900 ) ( V ), ( T_J = 25°C )</td>
<td>100</td>
<td></td>
<td></td>
<td>μA</td>
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<tr>
<td></td>
<td></td>
<td>( V_{GS} = 0 ) ( V ), ( V_{DS} = 900 ) ( V ), ( T_J = 175°C )</td>
<td>250</td>
<td></td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td>Gate–to–Source Leakage Current</td>
<td>( I_{GSS} )</td>
<td>( V_{GS} = +22/−8 ) ( V ), ( V_{DS} = 0 ) ( V )</td>
<td>±1</td>
<td></td>
<td></td>
<td>μA</td>
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<td><strong>ON CHARACTERISTICS</strong></td>
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<td></td>
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<tr>
<td>Gate Threshold Voltage</td>
<td>( V_{GS(th)} )</td>
<td>( V_{GS} = V_{DS} ), ( I_D = 5 ) mA</td>
<td>1.8</td>
<td>2.7</td>
<td>4.3</td>
<td>V</td>
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<tr>
<td>Recommended Gate Voltage</td>
<td>( V_{GOP} )</td>
<td></td>
<td>-5</td>
<td>+15</td>
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<td>V</td>
</tr>
<tr>
<td>Drain–to–Source On Resistance</td>
<td>( R_{DS(on)} )</td>
<td>( V_{GS} = 15 ) ( V ), ( I_D = 20 ) ( A ), ( T_J = 25°C )</td>
<td>60</td>
<td>84</td>
<td></td>
<td>mΩ</td>
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<tr>
<td></td>
<td></td>
<td>( V_{GS} = 18 ) ( V ), ( I_D = 20 ) ( A ), ( T_J = 25°C )</td>
<td>43</td>
<td></td>
<td></td>
<td>mΩ</td>
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<tr>
<td></td>
<td></td>
<td>( V_{GS} = 15 ) ( V ), ( I_D = 20 ) ( A ), ( T_J = 175°C )</td>
<td>76</td>
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<td></td>
<td>mΩ</td>
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<tr>
<td>Forward Transconductance</td>
<td>( g_{FS} )</td>
<td>( V_{DS} = 20 ) ( V ), ( I_D = 20 ) ( A )</td>
<td>17</td>
<td></td>
<td></td>
<td>S</td>
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<td><strong>CHARGES, CAPACITANCES &amp; GATE RESISTANCE</strong></td>
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<tr>
<td>Input Capacitance</td>
<td>( C_{ISS} )</td>
<td>( V_{GS} = 0 ) ( V ), ( f = 1 ) MHz, ( V_{DS} = 450 ) ( V )</td>
<td>1770</td>
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<td></td>
<td>pF</td>
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<tr>
<td>Output Capacitance</td>
<td>( C_{OSS} )</td>
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<td>113</td>
<td></td>
<td></td>
<td>pF</td>
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<tr>
<td>Reverse Transfer Capacitance</td>
<td>( C_{RSS} )</td>
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<td>11</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td>Total Gate Charge</td>
<td>( Q_{G(tot)} )</td>
<td>( V_{GS} = -5/15 ) ( V ), ( V_{DS} = 720 ) ( V ), ( I_D = 10 ) ( A )</td>
<td>87</td>
<td></td>
<td></td>
<td>nC</td>
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<tr>
<td>Threshold Gate Charge</td>
<td>( Q_{G(th)} )</td>
<td></td>
<td>17</td>
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<td>nC</td>
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<tr>
<td>Gate–to–Source Charge</td>
<td>( Q_{GS} )</td>
<td></td>
<td>27</td>
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<td>nC</td>
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<td>Gate–to–Drain Charge</td>
<td>( Q_{GD} )</td>
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<td>26</td>
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<tr>
<td>Gate Resistance</td>
<td>( R_G )</td>
<td>( f = 1 ) MHz</td>
<td>3.0</td>
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<td>Ω</td>
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<td><strong>SWITCHING CHARACTERISTICS</strong></td>
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<tr>
<td>Turn-On Delay Time</td>
<td>( t_{(on)} )</td>
<td>( V_{GS} = -5/15 ) ( V ), ( V_{DS} = 720 ) ( V ), ( I_D = 20 ) ( A ), ( R_G = 2.5 ) ( Ω ), Inductive Load</td>
<td>17</td>
<td>31</td>
<td></td>
<td>ns</td>
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<tr>
<td>Rise Time</td>
<td>( t_r )</td>
<td></td>
<td>15</td>
<td>27</td>
<td></td>
<td>ns</td>
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<tr>
<td>Turn–Off Delay Time</td>
<td>( t_{(off)} )</td>
<td></td>
<td>29</td>
<td>47</td>
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<td>ns</td>
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<tr>
<td>Fall Time</td>
<td>( t_f )</td>
<td></td>
<td>11</td>
<td>20</td>
<td></td>
<td>ns</td>
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<tr>
<td>Turn-On Switching Loss</td>
<td>( E_{ON} )</td>
<td></td>
<td>183</td>
<td></td>
<td></td>
<td>μJ</td>
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<tr>
<td>Turn-Off Switching Loss</td>
<td>( E_{OFF} )</td>
<td></td>
<td>52</td>
<td></td>
<td></td>
<td>μJ</td>
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<tr>
<td>Total Switching Loss</td>
<td>( E_{TOT} )</td>
<td></td>
<td>235</td>
<td></td>
<td></td>
<td>μJ</td>
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<td><strong>DRAIN–SOURCE DIODE CHARACTERISTICS</strong></td>
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<tr>
<td>Continuous Drain–to–Source Diode Forward Current</td>
<td>( I_{SD} )</td>
<td>( V_{GS} = -5 ) ( V ), ( T_J = 25°C )</td>
<td>22</td>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Pulsed Drain–to–Source Diode Forward Current (Note 2)</td>
<td>( I_{SDM} )</td>
<td>( V_{GS} = -5 ) ( V ), ( T_J = 25°C )</td>
<td>184</td>
<td></td>
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<td>A</td>
</tr>
<tr>
<td>Forward Diode Voltage</td>
<td>( V_{SD} )</td>
<td>( V_{GS} = -5 ) ( V ), ( I_{SD} = 10 ) ( A ), ( T_J = 25°C )</td>
<td>3.9</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Reverse Recovery Time</td>
<td>( t_{RR} )</td>
<td>( V_{GS} = -5/15 ) ( V ), ( I_{SD} = 30 ) ( A ), ( dI_{SD}/dt = 1000 ) ( A/μs ), ( V_{DS} = 720 ) ( V )</td>
<td>18</td>
<td></td>
<td></td>
<td>ns</td>
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<tr>
<td>Reverse Recovery Charge</td>
<td>( Q_{RR} )</td>
<td></td>
<td>84</td>
<td></td>
<td></td>
<td>nC</td>
</tr>
<tr>
<td>Reverse Recovery Energy</td>
<td>( E_{REC} )</td>
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<td>1.0</td>
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<td></td>
<td>μJ</td>
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<tr>
<td>Peak Reverse Recovery Current</td>
<td>( I_{RRM} )</td>
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<td>9.0</td>
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<td>A</td>
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<tr>
<td>Charge Time</td>
<td>( t_q )</td>
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<td>Discharge Time</td>
<td>( t_b )</td>
<td></td>
<td>8.0</td>
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</table>

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.
TYPICAL CHARACTERISTICS

Figure 1. On-Region Characteristics

Figure 2. Normalized On-Resistance vs. Drain Current and Gate Voltage

Figure 3. On-Resistance Variation with Temperature

Figure 4. On-Resistance vs. Gate-to-Source Voltage

Figure 5. Transfer Characteristics

Figure 6. Diode Forward Voltage vs. Current
TYPICAL CHARACTERISTICS (continued)

Figure 7. Gate-to-Source Voltage vs. Total Charge

Figure 8. Capacitance vs. Drain-to-Source Voltage

Figure 9. Unclamped Inductive Switching Capability

Figure 10. Maximum Continuous Drain Current vs. Case Temperature

Figure 11. Safe Operating Area

Figure 12. Single Pulse Maximum Power Dissipation
Figure 13. Junction-to-Ambient Thermal Response

Notes:
- $Z_{th,IC}(t) = r(t) \times R_{th,IC}$
- $R_{th,IC} = 0.68 \, ^\circ{C}/W$
- Peak $T_J = P_{DAM} \times Z_{th,IC}(t) + T_C$
- Duty Cycle, $D = t_1 / t_2$
MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS

TO-247-4LD
CASE 340CJ
ISSUE A

DATE 16 SEP 2019

NOTES:
A. NO INDUSTRY STANDARD APPLIES TO THIS PACKAGE.
B. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD
   FLASH, AND TIE BAR EXTRUSIONS.
C. ALL DIMENSIONS ARE IN MILLIMETERS.
D. DRAWING CONFORMS TO ASME Y14.5-2009.

<table>
<thead>
<tr>
<th>DIM</th>
<th>MILLIMETERS</th>
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<tbody>
<tr>
<td>A</td>
<td>MIN 4.80</td>
</tr>
<tr>
<td>A1</td>
<td>MIN 2.10</td>
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<tr>
<td>A2</td>
<td>MIN 1.80</td>
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<tr>
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<td>MIN 1.07</td>
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<tr>
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<td>b2</td>
<td>MIN 2.02</td>
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