Data Sheet

N0439N
N-channel MOSFET
40 V, 90 A, 3.3 mΩ

Features
- Low on-state resistance : \( R_{DS(on)} = 3.3 \, \text{mΩ} \, \text{MAX.} \) (\( V_{GS} = 10 \, \text{V}, \, I_D = 45 \, \text{A} \))
- Low \( C_{iss} \) : \( C_{iss} = 3900 \, \text{pF TYP.} \) (\( V_{DS} = 25 \, \text{V}, \, V_{GS} = 0 \, \text{V} \))
- High current : \( I(D(\text{DC}) = \pm 90 \, \text{A} \))
- RoHS Compliant
- Quality Grade : Standard
- Applications : For high current switching

Ordering Information

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Package</th>
<th>Packing</th>
</tr>
</thead>
<tbody>
<tr>
<td>N0439N-S19-AY</td>
<td>TO-220AB, Pb-free Note1</td>
<td>50 pcs / Magazine (Tube)</td>
</tr>
</tbody>
</table>

Note: 1. Pb-free means that this product does not contain lead in the external electrode.

Absolute Maximum Ratings (\( T_A = 25^°C \))

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Ratings</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drain to Source Voltage (( V_{GS} = 0 , \text{V} ))</td>
<td>( V_{DSS} )</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>Gate to Source Voltage (( V_{DS} = 0 , \text{V} ))</td>
<td>( V_{GSS} )</td>
<td>±20</td>
<td>V</td>
</tr>
<tr>
<td>Drain Current (DC) (( T_C = 25^°C ))</td>
<td>( I_D(\text{DC}) )</td>
<td>±90</td>
<td>A</td>
</tr>
<tr>
<td>Drain Current (pulse) Note2</td>
<td>( I_D(\text{pulse}) )</td>
<td>±360</td>
<td>A</td>
</tr>
<tr>
<td>Total Power Dissipation (( T_C = 25^°C ))</td>
<td>( P_{T1} )</td>
<td>147</td>
<td>W</td>
</tr>
<tr>
<td>Total Power Dissipation (( T_A = 25^°C ))</td>
<td>( P_{T2} )</td>
<td>1.8</td>
<td>W</td>
</tr>
<tr>
<td>Channel Temperature</td>
<td>( T_{ch} )</td>
<td>175</td>
<td>°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>( T_{stg} )</td>
<td>-55 to 175</td>
<td>°C</td>
</tr>
<tr>
<td>Single Avalanche Current Note3</td>
<td>( I_{AS} )</td>
<td>37</td>
<td>A</td>
</tr>
<tr>
<td>Single Avalanche Energy Note3</td>
<td>( E_{AS} )</td>
<td>136</td>
<td>mJ</td>
</tr>
</tbody>
</table>

Note: Continuous heavy condition (e.g. high temperature/voltage/current or high variation of temperature) may affect a reliability even if it is within the absolute maximum ratings. Please consider derating condition for appropriate reliability in reference Renesas Semiconductor Reliability Handbook (Recommendation for Handling and Usage of Semiconductor Devices) and individual reliability data.

Notes: 2. \( T_C=25^°C, \, P_{w} \leq 10 \, \mu\text{s} \), Duty Cycle \( \leq 1\% \)
3. Starting \( T_{ch} = 25^°C, \, R_G = 25 \, \Omega, \, V_{DD} = 25 \, \text{V}, \, V_{GS} = 20 \rightarrow 0 \, \text{V}, \, L = 100 \, \mu\text{H} \)

Thermal Resistance

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Max. Value Note4</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel to Case Thermal Resistance</td>
<td>( R_{(ch-C)} )</td>
<td>1.02</td>
<td>°C/W</td>
</tr>
<tr>
<td>Channel to Ambient Thermal Resistance</td>
<td>( R_{(ch-A)} )</td>
<td>83.3</td>
<td>°C/W</td>
</tr>
</tbody>
</table>

Notes: 4. This data is the designed target maximum value on Renesas's measurement condition. (Not tested)
Electrical Characteristics (\(T_A = 25^\circ C\))

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>MIN.</th>
<th>TYP.</th>
<th>MAX.</th>
<th>Unit</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero Gate Voltage Drain Current</td>
<td>(I_{DSS})</td>
<td>1</td>
<td>(\mu A)</td>
<td></td>
<td></td>
<td>(V_{DS} = 40) V, (V_{GS} = 0) V</td>
</tr>
<tr>
<td>Gate Leakage Current</td>
<td>(I_{GSS})</td>
<td>±100</td>
<td>nA</td>
<td></td>
<td></td>
<td>(V_{GS} = \pm 20) V, (V_{DS} = 0) V</td>
</tr>
<tr>
<td>Gate to Source Threshold Voltage</td>
<td>(V_{GS(th)})</td>
<td>2.0</td>
<td>3.0</td>
<td>4.0</td>
<td>V</td>
<td>(V_{GS} = V_{DS}, I_C = 250) (\mu A)</td>
</tr>
<tr>
<td>Forward Transfer Admittance Note(5)</td>
<td>(</td>
<td>y_{fs}</td>
<td>)</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drain to Source On-state Resistance Note(5)</td>
<td>(R_{DSS(on)})</td>
<td>2.75</td>
<td>3.30</td>
<td>m(\Omega)</td>
<td></td>
<td>(V_{GS} = 10) V, (I_D = 45) A</td>
</tr>
<tr>
<td>Input Capacitance</td>
<td>(C_{iss})</td>
<td>3900</td>
<td>pF</td>
<td></td>
<td></td>
<td>(V_{DS} = 25) V, (I_D = 250) mA</td>
</tr>
<tr>
<td>Output Capacitance</td>
<td>(C_{oss})</td>
<td>530</td>
<td>pF</td>
<td></td>
<td></td>
<td>(V_{GS} = 0) V, (I_D = 250) mA</td>
</tr>
<tr>
<td>Reverse Transfer Capacitance</td>
<td>(C_{rss})</td>
<td>200</td>
<td>pF</td>
<td></td>
<td></td>
<td>(f = 1) MHz</td>
</tr>
<tr>
<td>Turn-on Delay Time</td>
<td>(t_{(on)})</td>
<td>25</td>
<td>ns</td>
<td></td>
<td></td>
<td>(V_{DD} = 20) V, (I_D = 45) A</td>
</tr>
<tr>
<td>Rise Time</td>
<td>(t_r)</td>
<td>12</td>
<td>ns</td>
<td></td>
<td></td>
<td>(V_{GS} = 10) V, (I_D = 45) A</td>
</tr>
<tr>
<td>Turn-off Delay Time</td>
<td>(t_{(off)})</td>
<td>65</td>
<td>ns</td>
<td></td>
<td></td>
<td>(R_G = 0) (\Omega)</td>
</tr>
<tr>
<td>Fall Time</td>
<td>(t_f)</td>
<td>8</td>
<td>ns</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Gate Charge</td>
<td>(Q_G)</td>
<td>68</td>
<td>nC</td>
<td></td>
<td></td>
<td>(V_{DD} = 32) V, (I_D = 30) mA</td>
</tr>
<tr>
<td>Gate to Source Charge</td>
<td>(Q_{GS})</td>
<td>18</td>
<td>nC</td>
<td></td>
<td></td>
<td>(V_{GS} = 10) V, (I_D = 30) mA</td>
</tr>
<tr>
<td>Gate to Drain Charge</td>
<td>(Q_{GD})</td>
<td>18</td>
<td>nC</td>
<td></td>
<td></td>
<td>(I_D = 90) A</td>
</tr>
<tr>
<td>Body Diode Forward Voltage Note(5)</td>
<td>(V_{F(S-D)})</td>
<td>1.5</td>
<td>V</td>
<td></td>
<td></td>
<td>(I_D = 90) A, (V_{GS} = 0) V</td>
</tr>
<tr>
<td>Reverse Recovery Time</td>
<td>(t_{rr})</td>
<td>47</td>
<td>ns</td>
<td></td>
<td></td>
<td>(I_D = 90) A, (V_{GS} = 0) V</td>
</tr>
<tr>
<td>Reverse Recovery Charge</td>
<td>(Q_{rr})</td>
<td>68</td>
<td>nC</td>
<td></td>
<td></td>
<td>(dI/dt = 100) A/(\mu s)</td>
</tr>
</tbody>
</table>

Notes: 5. Pulsed test

TEST CIRCUIT 1 AVALANCHE CAPABILITY

TEST CIRCUIT 2 SWITCHING TIME

TEST CIRCUIT 3 GATE CHARGE
Typical Characteristics

**DERATING FACTOR OF FORWARD BIAS SAFE OPERATING AREA**

![Derating Factor Graph](attachment:image1)

**TOTAL POWER DISSIPATION vs. CASE TEMPERATURE**

![Total Power Dissipation Graph](attachment:image2)

**FORWARD BIAS SAFE OPERATING AREA**

![Forward Bias Graph](attachment:image3)

**DRAIN CURRENT(DC) vs. CASE TEMPERATURE**

![Drain Current Graph](attachment:image4)

**TRANSIENT THERMAL RESISTANCE vs. PULSE WIDTH**

![Transient Thermal Resistance Graph](attachment:image5)

**Notes:**
6. Designed target value on Renesas measurement condition. (Tc = 25°C, unless otherwise specified)
7. This data is the designed value on Renesas’s measurement condition. Renesas recommends that operating conditions are designed according to a document “Power MOSFET/IGBT Attention of Handling Semiconductor Devices (R07ZZ0010)”.
8. This data is the designed target maximum value on Renesas’s measurement condition.
DRAIN TO SOURCE ON-STATE RESISTANCE vs. CHANNEL TEMPERATURE

\[ R_{\text{ds(on)}} - \text{Drain to Source On-state Resistance} \quad \text{m} \Omega \]

\[ T_{\text{ch}} - \text{Channel Temperature} \quad ^{\circ} \text{C} \]

\[ V_{\text{GS}} = 10 \text{V} \]

\[ I_{\text{D}} = 45 \text{A} \]

\[ V_{\text{DS}} \]

CAPACITANCE vs. DRAIN TO SOURCE VOLTAGE

\[ C_{\text{iss}}, C_{\text{oss}}, C_{\text{rss}} - \text{Capacitance} \quad \text{pF} \]

\[ V_{\text{GS}} = 0 \text{V} \]

\[ f = 1 \text{MHz} \]

SWITCHING CHARACTERISTICS

\[ t_{\text{on}}, t_{\text{off}}, t_{\text{f}}, t_{\text{r}} - \text{Switching Time} \quad \text{ns} \]

\[ V_{\text{DD}} = 20 \text{V} \]

\[ V_{\text{GS}} = 10 \text{V} \]

\[ R_{\text{G}} = 0 \Omega \]

\[ I_{\text{D}} \]

DYNAMIC INPUT/OUTPUT CHARACTERISTICS

\[ I_{\text{D}} - \text{Drain Current} \quad \text{A} \]

\[ V_{\text{DD}} = 32 \text{V} \]

\[ V_{\text{GS}} = 20 \text{V} \]

\[ V_{\text{GS}} = 8 \text{V} \]

\[ I_{\text{D}} = 90 \text{A} \]

QG - Gate Charge - nC

SOURCE TO DRAIN DIODE FORWARD VOLTAGE

\[ I_{\text{F}} - \text{Diode Forward Current} \quad \text{A} \]

\[ V_{\text{F(S-D)}} - \text{Source to Drain Voltage} \quad \text{V} \]

\[ V_{\text{GS}} = 0 \text{V} \]

\[ V_{\text{GS}} = 10 \text{V} \]

\[ V_{\text{F(S-D)}} \]

REVERSE RECOVERY TIME vs. DRAIN CURRENT

\[ t_{\text{rr}} - \text{Reverse Recovery Time} \quad \text{ns} \]

\[ \frac{\text{di}}{\text{dt}} = 100 \text{A/} \mu\text{s} \]

\[ V_{\text{DS}} = 0 \text{V} \]

\[ I_{\text{F}} - \text{Drain Current} \quad \text{A} \]

\[ \frac{\text{di}}{\text{dt}} = 100 \text{A/} \mu\text{s} \]

\[ V_{\text{GS}} = 0 \text{V} \]
## Package Drawings (Unit: mm)

<table>
<thead>
<tr>
<th>JEDEC Package Code</th>
<th>RENESAS Code</th>
<th>Previous Code</th>
<th>MASS (Typ) [g]</th>
</tr>
</thead>
<tbody>
<tr>
<td>TO-220AB</td>
<td>PRSS0004AU-A</td>
<td>TO-220ABB</td>
<td>2.1</td>
</tr>
</tbody>
</table>

Unit: mm

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### Equivalent Circuit / Pin Assignment

- **Source**
- **Body**
- **Diode**
- **Gate**
- **Drain**
- **Source**

2, 4 Drain

1 Gate

3 Source
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