Single P-channel MOSFET

KFJ9B0438ZL
Datasheet

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1. GENERAL DESCRIPTION
Single P-channel MOSFET for automotive.

2. FEATURES
- Drain-source On-state Resistance: RDS(on) typ = 20 mΩ (VGS = - 10 V)
- CSP (Chip Size Package)
- Halogen-free / RoHS compliant (EU RoHS / UL-94 V-0 / MSL: Level 1)
- AEC-Q101 Qualified

3. MARKING SYMBOL: 5R

4. PACKAGING
Embossed type (Thermo-compression sealing): 10,000 pcs / reel (standard)

5. ABSOLUTE MAXIMUM RATINGS  Ta = 25 °C

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drain-source Voltage</td>
<td>VDS</td>
<td>- 40</td>
<td>V</td>
</tr>
<tr>
<td>Gate-source Voltage</td>
<td>VGS</td>
<td>- 20 / + 10</td>
<td>V</td>
</tr>
<tr>
<td>Drain Current</td>
<td>DC1</td>
<td>- 5.2</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>DC2</td>
<td>- 7.8</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>DC3</td>
<td>- 9.4</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Pulsed</td>
<td>- 62.4</td>
<td>A</td>
</tr>
<tr>
<td>Total Power Dissipation</td>
<td>PD1</td>
<td>0.71</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>PD2</td>
<td>1.60</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>PD3</td>
<td>2.31</td>
<td>W</td>
</tr>
<tr>
<td>Operating Junction and</td>
<td>Tj, Tstg</td>
<td>- 55 to + 150</td>
<td>°C</td>
</tr>
<tr>
<td>Storage Temperature Range</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6. THERMAL CHARACTERISTICS  Ta = 25 °C

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal Resistance (ch-a)</td>
<td>Rth1</td>
<td>175</td>
<td>°C / W</td>
</tr>
<tr>
<td></td>
<td>Rth2</td>
<td>79</td>
<td>°C / W</td>
</tr>
<tr>
<td></td>
<td>Rth3</td>
<td>54</td>
<td>°C / W</td>
</tr>
</tbody>
</table>

Note  *1 Mounted on FR4 board (25.4 mm x 25.4 mm x 1.0 mm).
      FR4 board partially covered with copper pad (79.2 mm² area, 36 µm thickness).
*2 Mounted on FR4 board (25.4 mm x 25.4 mm x 1.0 mm).
      FR4 board fully covered with copper pad (616 mm² area, 36 µm thickness).
*3 Mounted on ceramic board (70 mm x 70 mm x 1.0 mm).
*4 t = 10 µs, Duty Cycle ≤ 1 %.
## 7. ELECTRICAL CHARACTERISTICS  \( Ta = 25 \degree C \pm 3 \degree C \)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drain-source Breakdown Voltage</td>
<td>VDSS</td>
<td>( ID = -1 \text{ mA}, VGS = 0 \text{ V} )</td>
<td>- 40</td>
<td>-</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>Zero Gate Voltage Drain Current</td>
<td>IDSS</td>
<td>( VDSS = -40 \text{ V}, VGS = 0 \text{ V} )</td>
<td>-</td>
<td>- 1</td>
<td>-</td>
<td>( \mu \text{A} )</td>
</tr>
<tr>
<td>Gate-source Leakage Current</td>
<td>IGSS</td>
<td>( VGS = -16 \text{ V}, VDS = 0 \text{ V} )</td>
<td>-</td>
<td>- 10</td>
<td>-</td>
<td>( \mu \text{A} )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( VGS = +8 \text{ V}, VDS = 0 \text{ V} )</td>
<td>-</td>
<td>10</td>
<td>-</td>
<td>( \mu \text{A} )</td>
</tr>
<tr>
<td>Gate-source Threshold Voltage</td>
<td>Vth</td>
<td>( ID = -12.9 \text{ mA}, VDS = -10 \text{ V} )</td>
<td>- 1</td>
<td>- 2</td>
<td>- 3</td>
<td>V</td>
</tr>
<tr>
<td>Drain-source On-state Resistance</td>
<td>RDS(on)</td>
<td>( ID = -2 \text{ A}, VGS = -10 \text{ V} )</td>
<td>14</td>
<td>20</td>
<td>26</td>
<td>m( \Omega )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( ID = -2 \text{ A}, VGS = -4.5 \text{ V} )</td>
<td>16</td>
<td>23</td>
<td>38</td>
<td>m( \Omega )</td>
</tr>
<tr>
<td>Body Diode Forward Voltage</td>
<td>( VF(s-d) )</td>
<td>( IF = -2 \text{ A}, VGS = 0 \text{ V} )</td>
<td>- 0.77</td>
<td>- 1.2</td>
<td>- 1.2</td>
<td>V</td>
</tr>
<tr>
<td>Input Capacitance (^*1)</td>
<td>Ciss</td>
<td>( VDS = -20 \text{ V}, VGS = 0 \text{ V} )</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>p( F )</td>
</tr>
<tr>
<td>Output Capacitance (^*1)</td>
<td>Coss</td>
<td>( f = 1 \text{ MHz} )</td>
<td>-</td>
<td>220</td>
<td>-</td>
<td>p( F )</td>
</tr>
<tr>
<td>Reverse Transfer Capacitance (^*1)</td>
<td>Crss</td>
<td>( VDSS = -20 \text{ V}, VGS = 0 \text{ V} )</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>p( F )</td>
</tr>
<tr>
<td>Turn-on Delay Time (^*1, 2)</td>
<td>td(on)</td>
<td>( VDD = -20 \text{ V}, VGS = 0 \text{ to } -10 \text{ V} )</td>
<td>-</td>
<td>22</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>Rise Time (^*1, 2)</td>
<td>tr</td>
<td>( ID = -3.9 \text{ A} )</td>
<td>-</td>
<td>35</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>Turn-off Delay Time (^*1, 2)</td>
<td>td(off)</td>
<td>( VDD = -20 \text{ V}, VGS = -10 \text{ to } 0 \text{ V} )</td>
<td>-</td>
<td>250</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>Fall Time (^*1, 2)</td>
<td>tf</td>
<td>( ID = -3.9 \text{ A} )</td>
<td>-</td>
<td>100</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>Total Gate Charge (^*1)</td>
<td>Qg1</td>
<td>( VDD = -20 \text{ V}, VGS = -4.5 \text{ V} )</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>n( C )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( ID = -7.8 \text{ A} )</td>
<td>-</td>
<td>30</td>
<td>-</td>
<td>n( C )</td>
</tr>
<tr>
<td>Gate-source Charge (^*1)</td>
<td>Qgs</td>
<td>( VDD = -20 \text{ V}, VGS = -10 \text{ V} )</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>n( C )</td>
</tr>
<tr>
<td>Gate-drain Charge (^*1)</td>
<td>Qgd</td>
<td>( ID = -7.8 \text{ A} )</td>
<td>-</td>
<td>10</td>
<td>-</td>
<td>n( C )</td>
</tr>
</tbody>
</table>

Note  Measuring methods are based on JAPANESE INDUSTRIAL STANDARD JIS C 7030 Measuring methods for transistors.

\(^*1\) Guaranteed by design, not subject to production testing.

\(^*2\) Measurement circuit for Turn-on Delay Time / Rise Time / Turn-off Delay Time / Fall Time.

## 8. ELECTROSTATIC DISCHARGE CHARACTERISTIC  \( Ta = 25 \degree C \pm 3 \degree C \)

<table>
<thead>
<tr>
<th>Standard</th>
<th>Test Type</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Class</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>AEC-Q101-001</td>
<td>Human Body Model</td>
<td>HBM</td>
<td>( C = 100 \text{ pF}, R = 1.5 \text{ k( \Omega )} )</td>
<td>H2</td>
<td>&gt; 2 to &lt; 4</td>
<td>k( V )</td>
</tr>
</tbody>
</table>

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**Diagram:**

![Electrical schematic diagram](image)

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9. TECHNICAL DATA (Reference)

**ID - VDS**

- **Drain Current, ID (A)**
  - **Drain-source Voltage, VDS (V)**

- **Ta = 25 ºC**
  - **VGS = -10 V**
  - **VGS = 4.5 V**

**ID - VGS**

- **Drain Current, ID (A)**
  - **Gate-source Voltage, VGS (V)**

- **Ta = 125 ºC**
  - **85 ºC**
  - **25 ºC**
  - **-40 ºC**

**IF - VF(s-d)**

- **Body Diode Forward Current, IF (A)**
  - **Body Diode Forward Voltage, VF(s-d) (V)**

- **Ta = 25 ºC**
  - **VGS = 0 V**

**RDS(on) - ID**

- **Drain-source On-state Resistance, RDS(on) (mΩ)**
  - **Drain Current, ID (A)**

- **Ta = 25 ºC**
  - **VGS = -10 V**

**RDS(on) - VGS**

- **Drain-source On-state Resistance, RDS(on) (mΩ)**
  - **Gate-source Voltage, VGS (V)**

- **Ta = 125 ºC**
  - **85 ºC**
  - **25 ºC**
  - **-40 ºC**

**IGS - VGS**

- **Gate-source Leakage Current, IGS (A)**
  - **Gate-source Voltage, VGS (V)**

- **Ta = 125 ºC**
  - **85 ºC**
  - **25 ºC**
  - **-40 ºC**

- **1.E-10**
  - **1.E-09**
  - **1.E-08**
  - **1.E-07**
  - **1.E-06**
  - **1.E-05**
  - **1.E-04**
  - **1.E-03**
  - **1.E-02**
  - **1.E-01**
  - **1.0**
  - **10.0**
  - **100.0**

- **1.2**
  - **1.4**
  - **1.6**
  - **1.8**
  - **2.0**
  - **2.2**
  - **2.4**
  - **2.6**
  - **2.8**
  - **3.0**

- **0.0**
  - **0.2**
  - **0.4**
  - **0.6**
  - **0.8**
  - **1.0**
  - **1.2**

- **0.00**
  - **0.05**
  - **0.10**
  - **0.15**
  - **0.20**
  - **0.25**
  - **0.30**
  - **0.35**
  - **0.40**
  - **0.45**
  - **0.50**

- **0.00**
  - **0.05**
  - **0.10**
  - **0.15**
  - **0.20**
  - **0.25**
  - **0.30**
  - **0.35**
  - **0.40**
  - **0.45**
  - **0.50**

- **0.00**
  - **0.05**
  - **0.10**
  - **0.15**
  - **0.20**
  - **0.25**
  - **0.30**
  - **0.35**
  - **0.40**
  - **0.45**
  - **0.50**

- **0.00**
  - **0.05**
  - **0.10**
  - **0.15**
  - **0.20**
  - **0.25**
  - **0.30**
  - **0.35**
  - **0.40**
  - **0.45**
  - **0.50**

- **0.00**
  - **0.05**
  - **0.10**
  - **0.15**
  - **0.20**
  - **0.25**
  - **0.30**
  - **0.35**
  - **0.40**
  - **0.45**
  - **0.50**

- **0.00**
  - **0.05**
  - **0.10**
  - **0.15**
  - **0.20**
  - **0.25**
  - **0.30**
  - **0.35**
  - **0.40**
  - **0.45**
  - **0.50**

- **0.00**
  - **0.05**
  - **0.10**
  - **0.15**
  - **0.20**
  - **0.25**
  - **0.30**
  - **0.35**
  - **0.40**
  - **0.45**
  - **0.50**
**TECHNICAL DATA (Reference)**

**IDS - VDS**

<table>
<thead>
<tr>
<th>Drain-source Voltage, - VDS (V)</th>
<th>0</th>
<th>20</th>
<th>40</th>
<th>60</th>
</tr>
</thead>
<tbody>
<tr>
<td>1E-12</td>
<td>1E-11</td>
<td>1E-10</td>
<td>1E-9</td>
<td>1E-8</td>
</tr>
</tbody>
</table>

**Gate-source Voltage**

<table>
<thead>
<tr>
<th>-VGS (V)</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
</tr>
</thead>
<tbody>
<tr>
<td>1E-12</td>
<td>1E-11</td>
<td>1E-10</td>
<td>1E-9</td>
<td>1E-8</td>
<td>1E-7</td>
<td>1E-6</td>
<td>1E-5</td>
<td>1E-4</td>
</tr>
</tbody>
</table>

**Rth - tsr**

<table>
<thead>
<tr>
<th>Pulse Width, tsr (s)</th>
<th>0.001</th>
<th>0.01</th>
<th>0.1</th>
<th>1</th>
<th>10</th>
<th>100</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>100</td>
<td>1000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Dynamic Input / Output Characteristics**

<table>
<thead>
<tr>
<th>Total Gate Charge, Qg (nC)</th>
<th>0</th>
<th>10</th>
<th>30</th>
<th>50</th>
<th>60</th>
<th>70</th>
</tr>
</thead>
<tbody>
<tr>
<td>1E-12</td>
<td>1E-11</td>
<td>1E-10</td>
<td>1E-9</td>
<td>1E-8</td>
<td>1E-7</td>
<td>1E-6</td>
</tr>
</tbody>
</table>

**Safe Operating Area**

<table>
<thead>
<tr>
<th>Drain-source Voltage, - VDS (V)</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
</tr>
</thead>
</table>

**Note**

*1 Pulse measurement.

*2 Mounted on FR4 board (25.4 mm x 25.4 mm x 1.0 mm).
FR4 board partially covered with copper pad (79.2 mm² area, 36 μm thickness).

*3 Mounted on FR4 board (25.4 mm x 25.4 mm x 1.0 mm).
FR4 board fully covered with copper pad (816 mm² area, 36 μm thickness).

*4 Mounted on ceramic board (70 mm x 70 mm x 1.0 mm).
10. OUTLINE

(Top View)

Unit: mm

(Front View)

(Bottom View)

11. LAND & STENCIL PATTERN (Reference)

Unit: mm

Important notice:
Solder Mask Defined (SMD) pattern is strongly recommended for pad design.
Please check the information in the Nuvoton WL-CSP Application Notes about mounting process.
12. REVISION HISTORY

<table>
<thead>
<tr>
<th>Date</th>
<th>Revision</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2021.11.19</td>
<td>1.00</td>
<td>1. Initially issued.</td>
</tr>
</tbody>
</table>

1. Initially issued.
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