RJE0603JPE
Silicon P Channel MOS FET Series
Power Switching

Description
This FET has the over temperature shut-down capability sensing to the junction temperature. This FET has the built-in over temperature shut-down circuit in the gate area. And this circuit operation to shut-down the gate voltage in case of high junction temperature like applying over power consumption, over current etc..

Features
- High endurance capability against to the short circuit.
- Built-in the over temperature shut-down circuit.
- Latch type shut down operation (need 0 voltage recovery).
- Built-in the current limitation circuit.

Outline
RENESAS Package code: PRSS0004AE-B
(Package name: LDPAK (S)-(1) )

Absolute Maximum Ratings
(Ta = 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</td>
<td>VDSS</td>
<td>–60 V</td>
<td></td>
</tr>
<tr>
<td>Gate to source voltage</td>
<td>VGSS</td>
<td>–16 V</td>
<td></td>
</tr>
<tr>
<td>Gate to source voltage</td>
<td>VGSS</td>
<td>2.5 V</td>
<td></td>
</tr>
<tr>
<td>Drain current</td>
<td>ID</td>
<td>–50 Note3</td>
<td>A</td>
</tr>
<tr>
<td>Body-drain diode reverse drain current</td>
<td>IDRE</td>
<td>–50</td>
<td>A</td>
</tr>
<tr>
<td>Avalanche current</td>
<td>IAP Note 2</td>
<td>–15</td>
<td>A</td>
</tr>
<tr>
<td>Avalanche energy</td>
<td>EAR Note 2</td>
<td>964 mJ</td>
<td></td>
</tr>
<tr>
<td>Channel dissipation</td>
<td>Pch Note 1</td>
<td>100 W</td>
<td></td>
</tr>
<tr>
<td>Channel temperature</td>
<td>Tch</td>
<td>150 °C</td>
<td></td>
</tr>
<tr>
<td>Storage temperature</td>
<td>Tstg</td>
<td>–55 to +150 °C</td>
<td></td>
</tr>
</tbody>
</table>

Notes:  
1. Value at Tc = 25°C  
2. Tch = 25°C, Rg ≥ 50 Ω  
3. It provides by the current limitation lower bound value.
## Typical Operation Characteristics

\[(Ta = 25^\circ C)\]

<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>Input voltage</td>
<td>(V_{IH})</td>
<td>–3.5</td>
<td>—</td>
<td>—</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(V_{IL})</td>
<td>—</td>
<td>—</td>
<td>–1.2</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input current</td>
<td>(I_{IH1})</td>
<td>—</td>
<td>—</td>
<td>–100</td>
<td>(\mu A)</td>
<td>(V_i = –8 V, V_{DS} = 0)</td>
</tr>
<tr>
<td>(Gate non shut down)</td>
<td>(I_{IH2})</td>
<td>—</td>
<td>—</td>
<td>–50</td>
<td>(\mu A)</td>
<td>(V_i = –3.5 V, V_{DS} = 0)</td>
</tr>
<tr>
<td>Input current</td>
<td>(I_{IH\text{SD}1})</td>
<td>—</td>
<td>–0.3</td>
<td>—</td>
<td>mA</td>
<td>(V_i = –12 V, V_{DS} = 0)</td>
</tr>
<tr>
<td>(Gate shut down)</td>
<td>(I_{IH\text{SD}2})</td>
<td>—</td>
<td>–0.11</td>
<td>—</td>
<td>mA</td>
<td>(V_i = –4.6 V, V_{DS} = 0)</td>
</tr>
<tr>
<td>Shut down temperature</td>
<td>(T_{SD})</td>
<td>—</td>
<td>175</td>
<td>—</td>
<td>(^\circ C)</td>
<td>Channel temperature</td>
</tr>
<tr>
<td>Gate operation voltage</td>
<td>(V_{op})</td>
<td>–3.5</td>
<td>—</td>
<td>–12</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Drain current</td>
<td>(I_{D\text{limt}})</td>
<td>–50</td>
<td>—</td>
<td>—</td>
<td>A</td>
<td>(V_{GS} = –12 V, V_{DS} = –10 V) (^{Note 4})</td>
</tr>
</tbody>
</table>

**Notes:**
4. Pulse test

## Electrical Characteristics

\[(Ta = 25^\circ C)\]

<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>Drain current</td>
<td>(I_{D1})</td>
<td>—</td>
<td>—</td>
<td>–100</td>
<td>A</td>
<td>(V_{GS} = –3.5 V, V_{DS} = –10 V)</td>
</tr>
<tr>
<td></td>
<td>(I_{D2})</td>
<td>—</td>
<td>—</td>
<td>–10</td>
<td>mA</td>
<td>(V_{GS} = –1.2 V, V_{DS} = –10 V)</td>
</tr>
<tr>
<td></td>
<td>(I_{D3})</td>
<td>–50</td>
<td>—</td>
<td>—</td>
<td>A</td>
<td>(V_{GS} = –12 V, V_{DS} = –10 V) (^{Note 5})</td>
</tr>
<tr>
<td>Drain to source breakdown voltage</td>
<td>(V_{BR\text{DSS}})</td>
<td>–60</td>
<td>—</td>
<td>—</td>
<td>V</td>
<td>(I_D = –10 mA, V_{GS} = 0)</td>
</tr>
<tr>
<td>Gate to source breakdown voltage</td>
<td>(V_{BR\text{GSS}})</td>
<td>–16</td>
<td>—</td>
<td>—</td>
<td>V</td>
<td>(I_D = –800 \mu A, V_{DS} = 0)</td>
</tr>
<tr>
<td></td>
<td>(V_{BR\text{GSS}})</td>
<td>2.5</td>
<td>—</td>
<td>—</td>
<td>V</td>
<td>(I_D = 100 \mu A, V_{DS} = 0)</td>
</tr>
<tr>
<td>Gate to source leak current</td>
<td>(I_{GS})</td>
<td>—</td>
<td>—</td>
<td>–200</td>
<td>(\mu A)</td>
<td>(V_{GS} = –8 V, V_{DS} = 0)</td>
</tr>
<tr>
<td></td>
<td>(I_{GSS})</td>
<td>—</td>
<td>—</td>
<td>–800</td>
<td>(\mu A)</td>
<td>(V_{GS} = –16 V, V_{DS} = 0)</td>
</tr>
<tr>
<td></td>
<td>(I_{GSS})</td>
<td>—</td>
<td>—</td>
<td>100</td>
<td>(\mu A)</td>
<td>(V_{GS} = –2.4 V, V_{DS} = 0)</td>
</tr>
<tr>
<td>Input current (shut down)</td>
<td>(I_{GSO\text{P1}})</td>
<td>—</td>
<td>–0.8</td>
<td>—</td>
<td>mA</td>
<td>(V_{GS} = –12 V, V_{DS} = 0)</td>
</tr>
<tr>
<td></td>
<td>(I_{GSO\text{P2}})</td>
<td>—</td>
<td>–0.11</td>
<td>—</td>
<td>mA</td>
<td>(V_{GS} = –4.6 V, V_{DS} = 0)</td>
</tr>
<tr>
<td>Zero gate voltage drain current</td>
<td>(I_{DSS})</td>
<td>—</td>
<td>—</td>
<td>–10</td>
<td>(\mu A)</td>
<td>(V_{DS} = –60 V, V_{GS} = 0)</td>
</tr>
<tr>
<td>Gate to source cutoff voltage</td>
<td>(V_{GSO(ef)})</td>
<td>–3.4</td>
<td>—</td>
<td>–4.6</td>
<td>V</td>
<td>(V_{DS} = –10 V, I_D = –1 mA)</td>
</tr>
<tr>
<td>Static drain to source on state resistance</td>
<td>(R_{DS(on)})</td>
<td>—</td>
<td>16</td>
<td>30</td>
<td>m(\Omega)</td>
<td>(I_D = –25 A, V_{GS} = –6 V) (^{Note 5})</td>
</tr>
<tr>
<td></td>
<td>(R_{DS(on)})</td>
<td>—</td>
<td>12</td>
<td>15</td>
<td>m(\Omega)</td>
<td>(I_D = –25 A, V_{GS} = –10 V) (^{Note 5})</td>
</tr>
<tr>
<td>Output capacitance</td>
<td>(C_{oss})</td>
<td>—</td>
<td>1400</td>
<td>—</td>
<td>pF</td>
<td>(V_{DS} = –10 V, V_{GS} = 0, f = 1\text{MHz})</td>
</tr>
<tr>
<td>Turn-on delay time</td>
<td>(t_{(on)})</td>
<td>—</td>
<td>77.2</td>
<td>—</td>
<td>(\mu s)</td>
<td>(V_{GS} = –10 V, I_D = –25 A, R_L = 1.2 \Omega)</td>
</tr>
<tr>
<td>Rise time</td>
<td>(t_r)</td>
<td>—</td>
<td>72.7</td>
<td>—</td>
<td>(\mu s)</td>
<td>(I_F = –50 A, V_{GS} = 0)</td>
</tr>
<tr>
<td>Turn-off delay time</td>
<td>(t_{(off)})</td>
<td>—</td>
<td>7.7</td>
<td>—</td>
<td>(\mu s)</td>
<td>(I_F = –50 A, V_{GS} = 0)</td>
</tr>
<tr>
<td>Fall time</td>
<td>(t_f)</td>
<td>—</td>
<td>7.7</td>
<td>—</td>
<td>(\mu s)</td>
<td>(\text{di}V/\text{dt} = 50 \text{A}/\mu \text{s})</td>
</tr>
<tr>
<td>Body-drain diode forward voltage</td>
<td>(V_{DF})</td>
<td>—</td>
<td>–0.92</td>
<td>—</td>
<td>V</td>
<td>(I_F = –50 A, V_{GS} = 0)</td>
</tr>
<tr>
<td>Body-drain diode reverse recovery time</td>
<td>(t_{rr})</td>
<td>—</td>
<td>133</td>
<td>—</td>
<td>ns</td>
<td>(I_F = –50 A, V_{GS} = 0)</td>
</tr>
<tr>
<td>Over load shut down operation time</td>
<td>(t_{os1})</td>
<td>—</td>
<td>6.3</td>
<td>—</td>
<td>ms</td>
<td>(V_{GS} = –5 V, V_{DD} = –16 V)</td>
</tr>
</tbody>
</table>

**Notes:**
5. Pulse test
6. Including the junction temperature rise of the over loaded condition.
Main Characteristics

- **Power vs. Temperature Derating**
  - Channel Dissipation: Pch (W)
  - Case Temperature: Tc (°C)

- **Maximum Safe Operation Area**
  - Drain to Source Voltage: VDS (V)
  - Drain Current: ID (A)

- **Typical Output Characteristics**
  - Drain Current: ID (A)
  - Drain to Source Voltage: VDS (V)
  - VGS = −4.5 V
  - VGS = −4 V
  - VGS = −6 V

- **Typical Transfer Characteristics**
  - Drain Current: ID (A)
  - Gate to Source Voltage: VGS (V)

- **Drain Source Saturation Voltage vs. Gate to Source Voltage**
  - Drain to Source Saturation Voltage: VDS(on) (mV)
  - Static Drain to Source On State Resistance: RDS(on) (mΩ)

- **Operation in this area is limited RDS(on)**

- **Thermal shut down operation area**

- **Static Drain to Source On State Resistance vs. Drain Current**
  - Drain Current: ID (A)
  - Drain to Source Voltage: VDS (V)
  - VGS = −10 V
**Static Drain to Source On State Resistance vs. Temperature**

- **Graph:**
  - Case Temperature $T_c$ ($^\circ$C)
  - Static Drain to Source On State Resistance $R_{DS(on)}$ (mΩ)
  - Lines for $I_D = -5$ A, $-10$ A, $-25$ A
  - Pulse Test $V_{GS} = -10$ V

**Body-Drain Diode Reverse Recovery Time**

- **Graph:**
  - Reverse Drain Current $I_{DR}$ (A)
  - Reverse Drain Recovery Time $t_{rr}$ (ns)
  - Lines for $V_{DS} = -10$ V, $-25$ V, $-40$ V

**Switching Characteristics**

- **Graph:**
  - Drain Current $I_D$ (A)
  - Switching Time $t$ ($\mu$s)
  - $V_{GS} = 0$ V, $5$ V
  - $f = 1$ MHz

**Typical Capacitance vs. Drain to Source Voltage**

- **Graph:**
  - Capacitance $C$ (pF)
  - Drain to Source Voltage $V_{DS}$ (V)
  - $V_{GS} = 0$ V
  - $f = 1$ MHz

**Gate to Source Voltage vs. Shutdown Time of Load-Short Test**

- **Graph:**
  - Gate to Source Voltage $V_{GS}$ (V)
  - Shutdown Time of Load-Short Test $P_W$ (s)
  - $V_{SD} = -16$ V

**Reverse Drain Current vs. Source to Drain Voltage**

- **Graph:**
  - Source to Drain Voltage $V_{SD}$ (V)
  - Reverse Drain Current $I_{DR}$ (A)
  - $V_{GS} = 0$ V, $5$ V

**Shutdown Time of Load-Short Test**

- **Graph:**
  - Shutdown Time of Load-Short Test $P_W$ (s)
  - $V_{SD} = -16$ V
Switching Time Test Circuit

Vin Monitor

D.U.T.

Vout Monitor

Vin 

10 V

50 Ω

RL

VDD

−30 V

Vin

10% Vin

−10 V

RL

VDD

= −30 V

trtd(on) 90% 10% Vin

Vout

90% 10% Vout

tf

td(off)

td(on)

Switching Time Test Circuit Waveform

Normalized Transient Thermal Impedance vs. Pulse Width

Normalized Transient Thermal Impedance γ(t)

PDM PW T D = PW T ch- c(t) = γ s (t) ch- c = 1.25° C/W, Tc = 25°C

θ = 1° C/W, Tc = 25°C

Tc = 25°C

θ

θ

PDM

D = PW T

T

PW

10 μ 100 μ 1 m 10 m 100 m 1 10

Pulse Width PW (S)

Normalized Transient Thermal Impedance

γ

0.3

0.03

0.1

0.01

0.3

0.03

0.1

0.01

1

100

−2

−4

−6

−8

−10

100

120

140

160

180

200

Gate to Source Voltage VGS (V)

Shutdown Case Temperature vs. Gate to Source Voltage

Shutdown Case Temperature Tc (°C)

0

100

120

140

160

180

200

Gate to Source Voltage VGS (V)

Iq = −5 A

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RENESAS
### Package Dimensions

<table>
<thead>
<tr>
<th>Package Name</th>
<th>JEITA Package Code</th>
<th>RENESAS Code</th>
<th>Previous Code</th>
<th>MASSTyp</th>
<th>Unit: mm</th>
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<tbody>
<tr>
<td>LEFMR20S-1T</td>
<td>SC-60</td>
<td>PR03000ARE-1B</td>
<td>LPK060111/12PR00111</td>
<td>1.30g</td>
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</tr>
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</table>

![Package Dimensions Diagram]

### Ordering Information

<table>
<thead>
<tr>
<th>Orderable Part No.</th>
<th>Quantity</th>
<th>Shipping Container</th>
</tr>
</thead>
<tbody>
<tr>
<td>RJE0603JPE-00-J3</td>
<td>1000 pcs</td>
<td>Taping (Sinistorse)</td>
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</tbody>
</table>
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