RJ0615JSP
-60 V, -10A Silicon P Channel Thermal FET
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
• Built-in the over temperature shut-down circuit.
• High endurance capability against to the short circuit.
• Latch type shut down operation (need 0 voltage recovery).
• Built-in the current limitation circuit.
• Low on-resistance \( R_{DS(on)} \): 53 m\( \Omega \) Typ, 65 m\( \Omega \) Max (\( V_{GS} = -10 \) V)
• High density mounting

Outline

Absolute Maximum Ratings

<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>( V_{DSS} )</td>
<td>−60</td>
<td>V</td>
</tr>
<tr>
<td>Gate to source voltage</td>
<td>( V_{GSS} )</td>
<td>−16</td>
<td>V</td>
</tr>
<tr>
<td>Drain current</td>
<td>( I_D^{\text{Notes}} )</td>
<td>−10</td>
<td>A</td>
</tr>
<tr>
<td>Body-drain diode reverse drain current</td>
<td>( I_{BR} )</td>
<td>−10</td>
<td>A</td>
</tr>
<tr>
<td>Avalanche current</td>
<td>( I_{AP}^{\text{Notes} 2} )</td>
<td>−4.7</td>
<td>A</td>
</tr>
<tr>
<td>Avalanche energy</td>
<td>( E_{AR}^{\text{Notes} 2} )</td>
<td>94.7</td>
<td>mJ</td>
</tr>
<tr>
<td>Channel dissipation</td>
<td>( P_{ch}^{\text{Notes} 1} )</td>
<td>2.5</td>
<td>W</td>
</tr>
<tr>
<td>Channel temperature</td>
<td>( T_{ch} )</td>
<td>150</td>
<td>°C</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>( T_{stg} )</td>
<td>−55 to +150</td>
<td>°C</td>
</tr>
</tbody>
</table>

Notes:
1. Drive operation: When using the glass epoxy board (FR4 40 × 40 × 1.6 mm), \( PW \leq 10 \) s
2. \( T_{ch} = 25 \) °C, \( R_g \geq 50 \) \( \Omega \)
3. It provides by the current limitation lower bound value.
### Typical Operation Characteristics

(Ta = 25°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>$V_{IL} = -8,V, V_{DS} = 0$</td>
</tr>
<tr>
<td></td>
<td>$V_{IL}$</td>
<td>—</td>
<td>—</td>
<td>$-1.2$</td>
<td>V</td>
<td>$V_{IL} = -3.5,V, V_{DS} = 0$</td>
</tr>
<tr>
<td>Input current (Gate non shut down)</td>
<td>$I_{IH1}$</td>
<td>—</td>
<td>—</td>
<td>$-100$</td>
<td>μA</td>
<td>$V_{IL} = -1.2,V, V_{DS} = 0$</td>
</tr>
<tr>
<td></td>
<td>$I_{IH2}$</td>
<td>—</td>
<td>—</td>
<td>$-50$</td>
<td>μA</td>
<td>$V_{IL} = -3.5,V, V_{DS} = 0$</td>
</tr>
<tr>
<td></td>
<td>$I_{IL}$</td>
<td>—</td>
<td>—</td>
<td>$-10$</td>
<td>μA</td>
<td>$V_{IL} = -8,V, V_{DS} = 0$</td>
</tr>
<tr>
<td>Input current (Gate shut down)</td>
<td>$I_{IH(sd)1}$</td>
<td>—</td>
<td>—</td>
<td>$-0.8$</td>
<td>mA</td>
<td>$V_{IL} = -3.5,V, V_{DS} = 0$</td>
</tr>
<tr>
<td></td>
<td>$I_{IH(sd)2}$</td>
<td>—</td>
<td>—</td>
<td>$-0.35$</td>
<td>mA</td>
<td>$V_{IL} = -8,V, V_{DS} = 0$</td>
</tr>
<tr>
<td>Shut down temperature</td>
<td>$T_{SD}$</td>
<td>—</td>
<td>175</td>
<td>—</td>
<td>°C</td>
<td>Channel temperature (dv/dt $V_{GS} \geq 500,V/\mu s$)</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>$V_{GS} = -12,V, V_{DS} = -10,V$</td>
</tr>
<tr>
<td>Drain current (Current limitation value)</td>
<td>$I_{D,lim}$</td>
<td>—</td>
<td>$-10$</td>
<td>—</td>
<td>A</td>
<td>$V_{GS} = -12,V, V_{DS} = -10,V$</td>
</tr>
</tbody>
</table>

Notes: 4. Pulse test

### Electrical Characteristics

(Ta = 25°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>$-4$</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>$-10$</td>
<td>—</td>
<td>—</td>
<td>A</td>
<td>$V_{GS} = -12,V, V_{DS} = -10,V$</td>
</tr>
<tr>
<td>Drain to source breakdown voltage</td>
<td>$V_{BR,DSS}$</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>$V_{BR,GSS}$</td>
<td>$-16$</td>
<td>—</td>
<td>—</td>
<td>V</td>
<td>$I_{D} = -800,\mu A, V_{DS} = 0$</td>
</tr>
<tr>
<td>Gate to source leak current</td>
<td>$I_{GS1}$</td>
<td>—</td>
<td>—</td>
<td>$-100$</td>
<td>μA</td>
<td>$V_{GS} = -8,V, V_{DS} = 0$</td>
</tr>
<tr>
<td></td>
<td>$I_{GS2}$</td>
<td>—</td>
<td>—</td>
<td>$-50$</td>
<td>μA</td>
<td>$V_{GS} = -3.5,V, V_{DS} = 0$</td>
</tr>
<tr>
<td></td>
<td>$I_{GS3}$</td>
<td>—</td>
<td>—</td>
<td>$-10$</td>
<td>μA</td>
<td>$V_{GS} = -1.2,V, V_{DS} = 0$</td>
</tr>
<tr>
<td></td>
<td>$I_{GS4}$</td>
<td>—</td>
<td>—</td>
<td>$100$</td>
<td>μA</td>
<td>$V_{GS} = 2.4,V, V_{DS} = 0$</td>
</tr>
<tr>
<td>Input current (shut down)</td>
<td>$I_{GS(OP)1}$</td>
<td>—</td>
<td>$-0.8$</td>
<td>—</td>
<td>mA</td>
<td>$V_{GS} = -8,V, V_{DS} = 0$</td>
</tr>
<tr>
<td></td>
<td>$I_{GS(OP)2}$</td>
<td>—</td>
<td>$-0.35$</td>
<td>—</td>
<td>mA</td>
<td>$V_{GS} = -3.5,V, V_{DS} = 0$</td>
</tr>
<tr>
<td>Zero gate voltage drain current</td>
<td>$I_{DS1}$</td>
<td>—</td>
<td>—</td>
<td>$-10$</td>
<td>μA</td>
<td>$V_{DS} = -60,V, V_{GS} = 0$</td>
</tr>
<tr>
<td>Zero gate voltage drain current</td>
<td>$I_{DS2}$</td>
<td>—</td>
<td>—</td>
<td>$-10$</td>
<td>μA</td>
<td>$V_{DS} = -48,V, V_{GS} = 0, Ta = 125,°C$</td>
</tr>
<tr>
<td>Gate to source cutoff voltage</td>
<td>$V_{GS(,off)}$</td>
<td>$-2.2$</td>
<td>—</td>
<td>$-3.4$</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>70</td>
<td>95</td>
<td>mΩ</td>
<td>$I_{D} = -5,A, V_{GS} = -6,V$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$R_{DS(on)}$</td>
<td>53</td>
<td>65</td>
<td>mΩ</td>
<td>$I_{D} = -5,A, V_{GS} = -10,V$</td>
<td></td>
</tr>
<tr>
<td>Output capacitance</td>
<td>$C_{oss}$</td>
<td>356</td>
<td>—</td>
<td>—</td>
<td>pF</td>
<td>$V_{DS} = -10,V, f = 1MHz$</td>
</tr>
<tr>
<td>Turn-on delay time</td>
<td>$t_{(on)}$</td>
<td>4.4</td>
<td>—</td>
<td>—</td>
<td>μs</td>
<td>$V_{GS} = -10,V, I_{D} = 5,A, R_{L} = 6,Ω$</td>
</tr>
<tr>
<td>Rise time</td>
<td>$t_{r}$</td>
<td>4.5</td>
<td>—</td>
<td>—</td>
<td>μs</td>
<td>$V_{GS} = -10,V, I_{D} = 5,A, R_{L} = 6,Ω$</td>
</tr>
<tr>
<td>Turn-off delay time</td>
<td>$t_{(off)}$</td>
<td>2.0</td>
<td>—</td>
<td>—</td>
<td>μs</td>
<td></td>
</tr>
<tr>
<td>Fall time</td>
<td>$t_{f}$</td>
<td>1.6</td>
<td>—</td>
<td>—</td>
<td>μs</td>
<td></td>
</tr>
<tr>
<td>Body-drain diode forward voltage</td>
<td>$V_{DF}$</td>
<td>—</td>
<td>$-0.87$</td>
<td>—</td>
<td>V</td>
<td>$I_{F} = -10,A, V_{GS} = 0$</td>
</tr>
<tr>
<td>Body-drain diode reverse recovery time</td>
<td>$t_{cr}$</td>
<td>90</td>
<td>—</td>
<td>—</td>
<td>ns</td>
<td>$I_{F} = -10,A, V_{GS} = 0$</td>
</tr>
<tr>
<td>Over load shut down operation time</td>
<td>$t_{os1}$</td>
<td>2.6</td>
<td>—</td>
<td>—</td>
<td>ms</td>
<td>$V_{GS} = -6,V, V_{DD} = -16,V$</td>
</tr>
</tbody>
</table>

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

100
10
1
0.1
0.01
−0.1
−0.01
−1
−10
−100

Drain to Source Voltage \( V_{DS} \) (V)

Drain Current \( I_D \) (A)

Maximum Safe Operation Area

Ta = 25°C
Thermal shut down operation area

Operation in this area is limited \( R_{DS(on)} \)

Drain to Source Voltage \( V_{DS} \) (V)

Pulse Test

Power vs. Temperature Derating

Test condition.
When using the glass epoxy board.
(FR4 40 x 40 x 1.6 mm), \( (PW \leq 10\,\text{s}) \)

Channel Dissipation \( P_{ch} \) (W)

Case Temperature \( T_c \) (°C)

Typical Output Characteristics

Typical Transfer Characteristics

Gate to Source Voltage \( V_{GS} \) (V)

Drain Current \( I_D \) (A)

Drain Source Saturation Voltage vs.
Gate to Source Voltage

Static Drain to Source On State Resistance vs. Drain Current

Gate to Source Voltage \( V_{GS} \) (V)

Drain to Source Saturation Voltage \( V_{DS(on)} \) (mV)

Static Drain to Source On State Resistance \( R_{DS(on)} \) (mΩ)

Test condition.
When using the glass epoxy board.
(FR4 40 x 40 x 1.6 mm)

Note 7:
When using the glass epoxy board.
(FR4 40 x 40 x 1.6 mm)
shutdown case temperature vs. gate to source voltage

normalized transient thermal impedance vs. pulse width

avalanche test circuit

avalanche waveform

\[ \frac{1}{2} L \cdot I_{AP}^2 \cdot \frac{V_{DSS}}{V_{DSS} - V_{DD}} \]
Switching Time Test Circuit

- **Vin Monitor**
- **D.U.T.**
- **Vin**
- **Vout Monitor**
- **Vin**
- **Vout**
- **R_L**
- **V_DD**
- **50 Ω**

Switching Time Waveform

- **Vin**
- **Vout**
- **td(on)**
- **td(off)**
- **tr**

Vin Monitor

- **Vin**
- **–10 V**

Vout Monitor

- **Vout**
- **90%**
- **10%**

D.U.T.

- **D.U.T.**
- **Vin**
- **Vout**
- **R_L**
- **V_DD**
- **–30 V**

Switching Time Waveform

- **Vin**
- **10%**
- **90%**
- **Vout**
- **10%**
- **90%**

- **td(on)**
- **td(off)**
- **tr**
RJE0615JSP

Package Dimensions

<table>
<thead>
<tr>
<th>Package Name</th>
<th>JEITA Package Code</th>
<th>RENESAS Code</th>
<th>Previous Code</th>
<th>MASS[Typ.]</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOP-8</td>
<td>P-SOP-8.35 × 4.9-1.27</td>
<td>PRS0038DD-D</td>
<td>FP-0RXV</td>
<td>0.985g</td>
</tr>
</tbody>
</table>

![Diagram of package dimensions]

**Terminal cross section**

(H6/Pd/Au plating)

- **D**: 4.90 ± 0.3
- **E**: 3.35
- **A**: 0.15
- **A1**: 0.14 ± 0.25
- **A1**: 1.75
- **B P**: 0.34 ± 0.48
- **B1**: 0.20 ± 0.25
- **C1**: —
- **F**: 0° ± 0°
- **H E**: 5.80 ± 6.10 ± 6.20
- **B**: 1.27
- **X**: 0.25
- **Y**: 0.1
- **Z**: 0.75
- **L**: 0.40 ± 0.60 ± 1.27
- **L1**: 1.08

**NOTE:**

1. DIMENSIONS ***“A”*** AND ***“E”*** DO NOT INCLUDE MOLD FLASH.
2. DIMENSION ***“F”*** DOES NOT INCLUDE Trim OFFSET.
3. Index mark (Marking) A1
4. Index mark (Marking) A2
5. Index mark (Marking) A3

**Ordering Information**

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Quantity</th>
<th>Shipping Container</th>
</tr>
</thead>
<tbody>
<tr>
<td>RJE0615JSP-00-J0</td>
<td>2500 pcs</td>
<td>Taping</td>
</tr>
</tbody>
</table>
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