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- Patented free-floating silicon technology
- Low on-state and switching losses
- Designed for traction, energy and industrial applications
- Optimum power handling capability
- Interdigitated amplifying gate

### Blocking

#### Maximum rated values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>5STP 25M5200</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. surge peak forward and reverse blocking voltage</td>
<td>(V_{DSM}, V_{RSM})</td>
<td>(t_p = 10\ ms, f = 5\ Hz, T_{vj} = 5...125\ °C,\ Note 1)</td>
<td>5200</td>
<td>V</td>
</tr>
<tr>
<td>Max repetitive peak forward and reverse blocking voltage</td>
<td>(V_{DRM}, V_{RRM})</td>
<td>(f = 50\ Hz, t_p = 10\ ms, t_{p1} = 250\ \mu s, T_{vj} = 5...125\ °C,\ Note 1, Note 2)</td>
<td>5200</td>
<td>V</td>
</tr>
<tr>
<td>Max crest working forward and reverse voltages</td>
<td>(V_{DWM}, V_{RWM})</td>
<td></td>
<td>3470</td>
<td>V</td>
</tr>
<tr>
<td>Critical rate of rise of commutating voltage</td>
<td>(dv/dt_{crit})</td>
<td>Exp. to 0.67\cdot V_{DRM}, T_{vj} = 125\ °C</td>
<td>2000</td>
<td>V/\mu s</td>
</tr>
</tbody>
</table>

#### Characteristic values

<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>Forward leakage current</td>
<td>(I_{DRM})</td>
<td>(V_{DRM}, T_{vj} = 125\ °C)</td>
<td>400</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse leakage current</td>
<td>(I_{RRM})</td>
<td>(V_{RRM}, T_{vj} = 125\ °C)</td>
<td>400</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note 1: Voltage de-rating factor of 0.11% per °C is applicable for \(T_{vj}\) below +5 °C.

Note 2: Recommended minimum ratio of \(V_{DRM}/V_{DWM}\) or \(V_{RRM}/V_{RWM} = 2\). See App. Note 5SYA 2051.

### Mechanical data

#### Maximum rated values

<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>Mounting force</td>
<td>(F_M)</td>
<td>Device unclamped</td>
<td>63</td>
<td>70</td>
<td>84</td>
<td>kN</td>
</tr>
<tr>
<td>Acceleration</td>
<td>(a)</td>
<td>Device unclamped</td>
<td>50</td>
<td></td>
<td></td>
<td>m/s²</td>
</tr>
<tr>
<td>Acceleration</td>
<td>(a)</td>
<td>Device clamped</td>
<td>100</td>
<td></td>
<td></td>
<td>m/s²</td>
</tr>
</tbody>
</table>

#### Characteristic values

<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>Weight</td>
<td>(m)</td>
<td></td>
<td>1.85</td>
<td></td>
<td></td>
<td>kg</td>
</tr>
<tr>
<td>Housing thickness</td>
<td>(H)</td>
<td>(F_M = 70\ kN, T_a = 25\ °C)</td>
<td>34.75</td>
<td>35.40</td>
<td></td>
<td>mm</td>
</tr>
<tr>
<td>Surface creepage distance</td>
<td>(D_S)</td>
<td></td>
<td>45</td>
<td></td>
<td></td>
<td>mm</td>
</tr>
<tr>
<td>Air strike distance</td>
<td>(D_a)</td>
<td></td>
<td>21</td>
<td></td>
<td></td>
<td>mm</td>
</tr>
</tbody>
</table>

1) Maximum rated values indicate limits beyond which damage to the device may occur.

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### On-state

#### Maximum rated values

<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>Average on-state current</td>
<td>$I_{(AVM)}$</td>
<td>Half sine wave, $T_c = 70 , ^\circ\text{C}$</td>
<td>2400</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RMS on-state current</td>
<td>$I_{(RMS)}$</td>
<td></td>
<td>3770</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak non-repetitive surge current</td>
<td>$I_{SM}$</td>
<td>$t_p = 10 , \text{ms}, , T_vj = 125 , ^\circ\text{C}, , \text{sine half wave}, \quad \text{V}<em>D = \text{V}</em>{R=0} = 0 , \text{V}, , \text{after surge}$</td>
<td>50.5·10³</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limiting load integral</td>
<td>$I_l^2$</td>
<td>$V_R = 0.6 \times \text{V}_{R,\text{RM}}, , \text{after surge}$</td>
<td>12.8·10⁶</td>
<td>A²s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak non-repetitive surge current</td>
<td>$I_{SM}$</td>
<td>$t_p = 10 , \text{ms}, , T_vj = 125 , ^\circ\text{C}, , \text{sine half wave}$</td>
<td>37.0·10³</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limiting load integral</td>
<td>$I_l^2$</td>
<td>$V_R = 0.6 \times \text{V}_{R,\text{RM}}, , \text{after surge}$</td>
<td>6.85·10⁶</td>
<td>A²s</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Characteristic values

<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>On-state voltage</td>
<td>$V_I$</td>
<td>$I_T = 3000 , \text{A}, , T_vj = 125 , ^\circ\text{C}$</td>
<td>1.60</td>
<td>V</td>
<td>1.70</td>
<td></td>
</tr>
<tr>
<td>Threshold voltage</td>
<td>$V_{(T0)}$</td>
<td></td>
<td>0.990</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slope resistance</td>
<td>$r_T$</td>
<td>$I_T = 1300 , \text{A} - 4000 , \text{A}, , T_vj = 125 , ^\circ\text{C}$</td>
<td>0.237</td>
<td>mΩ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Holding current</td>
<td>$I_H$</td>
<td>$T_vj = 25 , ^\circ\text{C}$</td>
<td>125</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$T_vj = 125 , ^\circ\text{C}$</td>
<td>60</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Latching current</td>
<td>$I_L$</td>
<td>$T_vj = 25 , ^\circ\text{C}$</td>
<td>500</td>
<td>mA</td>
<td>250</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$T_vj = 125 , ^\circ\text{C}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</table>

### Switching

#### Maximum rated values

<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>Critical rate of rise of on-state current</td>
<td>$\frac{\text{d}I}{\text{d}t}_{\text{crit}}$</td>
<td>$T_vj = 125 , ^\circ\text{C}, , I_T = 3000 , \text{A}, , V_D \leq 0.67 \times \text{V}<em>{\text{DRM}}, , I</em>{GM} = 2 , \text{A}, , t_r = 0.5 , \mu\text{s}$</td>
<td>250</td>
<td>A/μs</td>
<td>1000</td>
<td>A/μs</td>
</tr>
<tr>
<td>Circuit-commutated turn-off time</td>
<td>$t_q$</td>
<td>$T_vj = 125 , ^\circ\text{C}, , I_T = 2000 , \text{A}, , V_R = 200 , \text{V}, , \frac{\text{d}I}{\text{d}t} = -1.5 , \text{A/μs}, , V_D \leq 0.67 \times \text{V}_{\text{DRM}}, , \frac{\text{d}V_D}{\text{d}t} = 20 , \text{V/μs}$</td>
<td>500</td>
<td>μs</td>
<td></td>
<td></td>
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</table>

#### Characteristic values

<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>Reverse recovery charge</td>
<td>$Q_r$</td>
<td>$T_vj = 125 , ^\circ\text{C}, , I_T = 2000 , \text{A}, , V_R = 200 , \text{V}, , \frac{\text{d}I}{\text{d}t} = -1.5 , \text{A/μs}$</td>
<td>3200</td>
<td>μAAs</td>
<td>4400</td>
<td>μAAs</td>
</tr>
<tr>
<td>Reverse recovery current</td>
<td>$I_{RM}$</td>
<td></td>
<td>50</td>
<td>A</td>
<td>71</td>
<td>A</td>
</tr>
<tr>
<td>Gate turn-on delay time</td>
<td>$t_{gd}$</td>
<td>$T_vj = 25 , ^\circ\text{C}, , V_D = 0.4 \times \text{V}<em>{\text{RM}}, , I</em>{GM} = 2 , \text{A}, , t_r = 0.5 , \mu\text{s}$</td>
<td>50</td>
<td>A</td>
<td>90</td>
<td>A</td>
</tr>
</tbody>
</table>
**Triggering**

*Maximum rated values* 

<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>Peak forward gate voltage</td>
<td>$V_{FGM}$</td>
<td></td>
<td>12</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak forward gate current</td>
<td>$I_{FGM}$</td>
<td></td>
<td>10</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak reverse gate voltage</td>
<td>$V_{RGM}$</td>
<td></td>
<td>10</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average gate power loss</td>
<td>$P_{G(AV)}$</td>
<td></td>
<td></td>
<td>see Fig. 7</td>
<td></td>
<td>W</td>
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**Characteristic values**

<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>Gate-trigger voltage</td>
<td>$V_{GT}$</td>
<td>$T_{vj} = 25 , ^\circ C$</td>
<td>2.6</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gate-trigger current</td>
<td>$I_{GT}$</td>
<td>$T_{vj} = 25 , ^\circ C$</td>
<td>400</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gate non-trigger voltage</td>
<td>$V_{GD}$</td>
<td>$V_D = 0.4 \cdot V_{DRM}$, $T_{vjmax} = 125 , ^\circ C$</td>
<td>0.3</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gate non-trigger current</td>
<td>$I_{GD}$</td>
<td>$V_D = 0.4 \cdot V_{DRM}$, $T_{vjmax} = 125 , ^\circ C$</td>
<td>10</td>
<td>mA</td>
<td></td>
<td></td>
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</tbody>
</table>

---

**Thermal**

*Maximum rated values* 

<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>Operating junction temperature range</td>
<td>$T_{vj}$</td>
<td></td>
<td>125</td>
<td>°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>$T_{stg}$</td>
<td></td>
<td>-40</td>
<td>140</td>
<td>°C</td>
<td></td>
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</table>

**Characteristic values**

<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>Thermal resistance junction to case</td>
<td>$R_{th(j-c)}$</td>
<td>Double-side cooled $F_m = 63...84 , kN$</td>
<td>9</td>
<td>K/kW</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$R_{th(j-c)}A$</td>
<td>Anode-side cooled $F_m = 63...84 , kN$</td>
<td>18</td>
<td>K/kW</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$R_{th(j-c)}C$</td>
<td>Cathode-side cooled $F_m = 63...84 , kN$</td>
<td>18</td>
<td>K/kW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal resistance case to heatsink</td>
<td>$R_{th(c-h)}$</td>
<td>Double-side cooled $F_m = 63...84 , kN$</td>
<td>1.5</td>
<td>K/kW</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$R_{th(c-h)}$</td>
<td>Single-side cooled $F_m = 63...84 , kN$</td>
<td>3</td>
<td>K/kW</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

Analytical function for transient thermal impedance:

$$Z_{th(j-c)}(t) = \sum_{i=1}^{n} R_i (1 - e^{-t/\tau_i})$$

<table>
<thead>
<tr>
<th>R (K/kW)</th>
<th>1.0</th>
<th>2.0</th>
<th>3.0</th>
<th>4.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>R(K/kW)</td>
<td>6.107</td>
<td>2.018</td>
<td>0.816</td>
<td>0.059</td>
</tr>
<tr>
<td>$\tau_i$ (s)</td>
<td>0.9190</td>
<td>0.0855</td>
<td>0.0068</td>
<td>0.0011</td>
</tr>
</tbody>
</table>

Fig. 1 Transient thermal impedance (junction-to-case) vs. time
Max. on-state characteristic model:
\[ V_{T25} = A_{TVj} + B_{TVj} \cdot I_T + C_{TVj} \cdot \ln(I_T + 1) + D_{TVj} \cdot \sqrt{I_T} \]
Valid for \( I_T = 800 - 55000 \) A

<table>
<thead>
<tr>
<th>( A_{T25} )</th>
<th>( B_{T25} )</th>
<th>( C_{T25} )</th>
<th>( D_{T25} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>179.2 \cdot 10^{-3}</td>
<td>88.54 \cdot 10^{-6}</td>
<td>128.0 \cdot 10^{-3}</td>
<td>3.364 \cdot 10^{-3}</td>
</tr>
</tbody>
</table>

Max. on-state characteristic model:
\[ V_{T125} = A_{TVj} + B_{TVj} \cdot I_T + C_{TVj} \cdot \ln(I_T + 1) + D_{TVj} \cdot \sqrt{I_T} \]
Valid for \( I_T = 200 - 55000 \) A

<table>
<thead>
<tr>
<th>( A_{T125} )</th>
<th>( B_{T125} )</th>
<th>( C_{T125} )</th>
<th>( D_{T125} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>464.3 \cdot 10^{-3}</td>
<td>126.9 \cdot 10^{-6}</td>
<td>45.00 \cdot 10^{-3}</td>
<td>9.025 \cdot 10^{-3}</td>
</tr>
</tbody>
</table>

Fig. 2  On-state voltage characteristics

Fig. 3  On-state voltage characteristics

Fig. 4  On-state power dissipation vs. mean on-state current, turn-on losses excluded

Fig. 5  Max. permissible case temperature vs. mean on-state current, switching losses ignored
Fig. 6  Recommended gate current waveform

Fig. 7  Max. peak gate power loss

Fig. 8  Reverse recovery charge vs. decay rate of on-state current

Fig. 9  Peak reverse recovery current vs. decay rate of on-state current
Turn-on and Turn-off losses

Fig. 10 Turn-on energy, half sinusoidal waves

Fig. 11 Turn-on energy, rectangular waves

Fig. 12 Typical turn-off energy, half sinusoidal waves

Fig. 13 Typical turn-off energy, rectangular waves

Fig. 14 Current and voltage waveforms at turn-off

Fig. 15 Relationships for power loss

Total power loss for repetitive waveforms:

\[ P_{TOT} = P_T + W_{on} \cdot f + W_{off} \cdot f \]

where

\[ P_T = \frac{1}{T} \int_0^T \dot{I}_T \cdot V_T(I_T) \, dt \]
Fig. 16 Device Outline Drawing

Related documents:
- SSYA 2020: Design of RC-Snubbers for Phase Control Applications
- SSYA 2049: Voltage definitions for phase control and bi-directionally controlled thyristors
- SSYA 2051: Voltage ratings of high power semiconductors
- SSYA 2034: Gate-drive recommendations for phase control and bi-directionally controlled thyristors
- SSYA 2036: Recommendations regarding mechanical clamping of Press-Pack High Power Semiconductors
- SSYA 2102: Surge currents for Phase Control Thyristors
- 5SZK 9118: General Environmental Conditions for High Power Semiconductors


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