High Performance Schottky Rectifier, 400 A

FEATURES
• 150 °C TJ operation
• Center tap module
• Very low forward voltage drop
• High frequency operation
• Guard ring for enhanced ruggedness and long term reliability
• UL approved file E222165
• Designed and qualified for industrial level
• Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

DESCRIPTION / APPLICATIONS
The VS-400CNQ045PbF center tap, high current, Schottky rectifier module has been optimized for very low forward voltage drop, with moderate leakage. The proprietary barrier technology allows for reliable operation up to 150 °C junction temperature. Typical applications are in switching power supplies, converters, freewheeling diodes, welding, and reverse battery protection.

MAJOR RATINGS AND CHARACTERISTICS

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>CHARACTERISTICS</th>
<th>VALUES</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>I_F(AV)</td>
<td>Rectangular waveform</td>
<td>400 A</td>
<td>A</td>
</tr>
<tr>
<td>V_R</td>
<td></td>
<td>45 V</td>
<td>V</td>
</tr>
<tr>
<td>Package</td>
<td>TO-244</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Circuit configuration</td>
<td>Two diodes common cathode</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I_FSM</td>
<td>t_p = 5 μs sine</td>
<td>29 000 A</td>
<td>A</td>
</tr>
<tr>
<td>V_F</td>
<td>200 A_pk. TJ = 125 °C (per leg)</td>
<td>0.52 V</td>
<td>V</td>
</tr>
<tr>
<td>T_J</td>
<td>Range</td>
<td>-55 to +150 °C</td>
<td>°C</td>
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</tbody>
</table>

VOLTAGE RATINGS

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>VS-400CNQ045PbF</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum DC reverse voltage</td>
<td>V_R</td>
<td>45 V</td>
<td></td>
</tr>
<tr>
<td>Maximum working peak reverse voltage</td>
<td>V_RRM</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>TEST CONDITIONS</th>
<th>VALUES</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum average forward current per leg</td>
<td>I_F(AV)</td>
<td>50 % duty cycle at T_C = 114 °C, rectangular waveform</td>
<td>200</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>per device</td>
<td>400</td>
<td></td>
</tr>
<tr>
<td>Maximum peak one cycle non-repetitive surge current per leg</td>
<td>I_FSM</td>
<td>5 μs sine or 3 μs rect. pulse</td>
<td>29 000</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Following any rated load condition and with rated V_RRM applied</td>
<td>3400</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 ms sine or 6 ms rect. pulse</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-repetitive avalanche energy per leg</td>
<td>E_A</td>
<td>T_J = 25 °C, I_A = 19 A, L = 1 mH</td>
<td>180</td>
<td>mJ</td>
</tr>
<tr>
<td>Repetitive avalanche current per leg</td>
<td>I_AR</td>
<td>Current decaying linearly to zero in 1 μs</td>
<td>40</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Frequency limited by T_J maximum V_A = 1.5 x V_R typical</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Revision: 09-May-17
Document Number: 94204

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## ELECTRICAL SPECIFICATIONS

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>TEST CONDITIONS</th>
<th>VALUES</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum forward voltage drop per leg</td>
<td>$V_{FM}$ (1)</td>
<td>200 A $T_J = 25 , ^\circ C$</td>
<td>0.57</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>400 A $T_J = 25 , ^\circ C$</td>
<td>0.73</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>200 A $T_J = 125 , ^\circ C$</td>
<td>0.52</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>400 A $T_J = 125 , ^\circ C$</td>
<td>0.7</td>
<td>V</td>
</tr>
<tr>
<td>Maximum reverse leakage current per leg</td>
<td>$I_{RM}$ (1)</td>
<td>$T_J = 25 , ^\circ C$</td>
<td>20</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_R = \text{Rated } V_R$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$T_J = 125 , ^\circ C$</td>
<td>1.2</td>
<td>A</td>
</tr>
<tr>
<td>Threshold voltage</td>
<td>$V_{F(TO)}$</td>
<td>$T_J = T_J \text{ maximum}$</td>
<td>0.32</td>
<td>V</td>
</tr>
<tr>
<td>Forward slope resistance</td>
<td>$r_t$</td>
<td>$T_J = T_J \text{ maximum}$</td>
<td>0.81</td>
<td>mΩ</td>
</tr>
<tr>
<td>Maximum junction capacitance per leg</td>
<td>$C_T$</td>
<td>$V_R = 5 , V_{DC}$ (test signal range 100 kHz to 1 MHz), 25 °C</td>
<td>10 300</td>
<td>pF</td>
</tr>
<tr>
<td>Typical series inductance per leg</td>
<td>$L_S$</td>
<td>From top of terminal hole to mounting plane</td>
<td>5.0</td>
<td>nH</td>
</tr>
<tr>
<td>Maximum voltage rate of change</td>
<td>$dV/dt$</td>
<td>Rated $V_R$</td>
<td>10 000</td>
<td>V/μs</td>
</tr>
</tbody>
</table>

**Note**

(1) Pulse width < 300 μs, duty cycle < 2 %

## THERMAL - MECHANICAL SPECIFICATIONS

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>MIN.</th>
<th>TYP.</th>
<th>MAX.</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum junction and storage temperature range</td>
<td>$T_J, T_{Stg}$</td>
<td>-55</td>
<td>-</td>
<td>150</td>
<td>°C</td>
</tr>
<tr>
<td>Thermal resistance, junction to case per leg</td>
<td>$R_{JUC}$</td>
<td>-</td>
<td>-</td>
<td>0.19</td>
<td>°C/W</td>
</tr>
<tr>
<td>Thermal resistance, junction to case per module</td>
<td>$R_{JCS}$</td>
<td>-</td>
<td>0.10</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Thermal resistance, case to heatsink</td>
<td>$R_{ICS}$</td>
<td>-</td>
<td>0.10</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>-</td>
<td>68</td>
<td>-</td>
<td>g</td>
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<tr>
<td></td>
<td>-</td>
<td>2.4</td>
<td>-</td>
<td>oz.</td>
<td></td>
</tr>
<tr>
<td>Mounting torque</td>
<td>-</td>
<td>35.4 (4)</td>
<td>53.1 (6)</td>
<td>lbf · in</td>
<td></td>
</tr>
<tr>
<td>Mounting torque center hole</td>
<td>-</td>
<td>30 (3.4)</td>
<td>40 (4.6)</td>
<td>N · m</td>
<td></td>
</tr>
<tr>
<td>Terminal torque</td>
<td>-</td>
<td>30 (3.4)</td>
<td>-</td>
<td>44.2 (5)</td>
<td>lbf · in</td>
</tr>
<tr>
<td>Vertical pull</td>
<td>-</td>
<td>-</td>
<td>80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2&quot; lever pull</td>
<td>-</td>
<td>-</td>
<td>35</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Fig. 1 - Maximum Forward Voltage Drop Characteristics (Per Leg)

Fig. 2 - Typical Values of Reverse Current vs. Reverse Voltage (Per Leg)

Fig. 3 - Typical Junction Capacitance vs. Reverse Voltage (Per Leg)

Fig. 4 - Maximum Thermal Impedance $Z_{thJC}$ Characteristics (Per Leg)
**Fig. 5 - Maximum Allowable Case Temperature vs. Average Forward Current (Per Leg)**

- Allowable Case Temperature (°C)
  - 160
  - 150
  - 140
  - 130
  - 120
  - 110
  - 100
  - 90
  - 80
- Average Forward Current (A)
  - 0
  - 50
  - 100
  - 150
  - 200
  - 250
  - 300
- Square wave (D = 0.50) 80 % rated \(V_R\) applied

**Fig. 6 - Forward Power Loss Characteristics (Per Leg)**

- Average Power Loss (W)
  - 200
  - 180
  - 160
  - 140
  - 120
  - 100
  - 90
  - 70
  - 50
  - 30
  - 10
- Average Forward Current (A)
  - 0
  - 50
  - 100
  - 150
  - 200
  - 250
  - 300
- DC

**Fig. 7 - Maximum Non-Repetitive Surge Current (Per Leg)**

- Non-Repetitive Surge Current (A)
  - 100000
  - 10000
  - 1000
  - 100
  - 10
- Square Wave Pulse Duration (µs)
  - 100
  - 1000
  - 10000
- At any rated load condition and with rated \(V_{RRM}\) applied following surge

**Fig. 8 - Unclamped Inductive Test Circuit**

- D.U.T. (Device Under Test)
- \(R_g = 25 \Omega\)
- \(V_d = 25 \text{ V}\)
- \(V_{VFM} \times \text{IF}(\text{AV})\)

**Note**

(1) Formula used: \(T_C = T_J - (P_d + P_{dREV}) \times R_{thJC}\)
- \(P_d = \text{forward power loss} = \text{IF}(\text{AV}) \times V_{VFM} \times \text{IF}(\text{AV})/D\) (see fig. 6);
- \(P_{dREV} = \text{inverse power loss} = V_{R1} \times I_R (1 - D); I_R \text{ at } V_{R1} = 80\% \text{ rated } V_R\)
### ORDERING INFORMATION TABLE

<table>
<thead>
<tr>
<th>Device code</th>
<th>VS-</th>
<th>40</th>
<th>0</th>
<th>C</th>
<th>N</th>
<th>Q</th>
<th>045</th>
<th>PbF</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>8</td>
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<td></td>
</tr>
</tbody>
</table>

- **1**: Vishay Semiconductors product
- **2**: Average current rating (x 10)
- **3**: Product silicon identification
- **4**: C = circuit configuration
- **5**: N = not isolated
- **6**: Q = Schottky rectifier diode
- **7**: Voltage rating (045 = 45 V)
- **8**: Lead (Pb)-free

### LINKS TO RELATED DOCUMENTS

<table>
<thead>
<tr>
<th>Dimensions</th>
<th><a href="http://www.vishay.com/doc?95021">www.vishay.com/doc?95021</a></th>
</tr>
</thead>
</table>
TO-244

DIMENSIONS in millimeters (inches)

35 (1.37) REF.

13 (0.51)

9.6 (0.37) MIN.

93 (3.66) MAX.

21 (0.82)

20 (0.78)

17.5 (0.69)

16.5 (0.65)

12.6 (0.5)

40 (1.57)

80 (3.15)

Ø 7.2 (Ø 0.28)
(2 places)

1/4 - 20 UNC

9.6 (0.37) MIN.

93 (3.66) MAX.

Ø 5.2 (Ø 0.20)

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