



## Standard Recovery Diodes, 165 A to 230 A (INT-A-PAK Power Modules)



INT-A-PAK

### FEATURES

- High voltage
- Electrically isolated by DBC ceramic ( $Al_2O_3$ )
- 3500  $V_{RMS}$  isolating voltage
- Industrial standard package
- High surge capability
- Glass passivated chips
- Modules uses high voltage power diodes in four basic configurations
- Simple mounting
- UL approved file E78996 
- Designed and qualified for multiple level
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



RoHS  
COMPLIANT

| PRODUCT SUMMARY |  |
|-----------------|--|
| $I_{F(AV)}$     | 165 A to 230 A   |
| Type            | Modules - Diode, High Voltage  |
| Package         | INT-A-PAK  |
| Circuit         | Single diode, Two diodes common cathode, Two diodes common cathode, Two diodes doubler circuit |

### APPLICATIONS

- DC motor control and drives
- Battery chargers
- Welders
- Power converters

| MAJOR RATINGS AND CHARACTERISTICS |                 |             |           |           |                |
|-----------------------------------|-----------------|-------------|-----------|-----------|----------------|
| SYMBOL                            | CHARACTERISTICS | VSK.166..   | VSK.196.. | VSK.236.. | UNITS          |
| $I_{F(AV)}$                       |                 | 165         | 195       | 230       | A              |
|                                   | $T_C$           | 100         | 100       | 100       | $^{\circ}C$    |
| $I_{F(RMS)}$                      |                 | 260         | 305       | 360       | A              |
| $I_{FSM}$                         | 50 Hz           | 4000        | 4750      | 5500      |                |
|                                   | 60 Hz           | 4200        | 4980      | 5765      |                |
| $I^2t$                            | 50 Hz           | 80          | 113       | 151       | $kA^2s$        |
|                                   | 60 Hz           | 73          | 103       | 138       |                |
| $I^2\sqrt{t}$                     |                 | 798         | 1130      | 1516      | $kA^2\sqrt{s}$ |
| $V_{RRM}$                         |                 | 400 to 1600 |           |           | V              |
| $T_J$                             | Range           | -40 to +150 |           |           | $^{\circ}C$    |

### ELECTRICAL SPECIFICATIONS

| VOLTAGE RATINGS                        |              |  |  |                                    |
|--|--------------|--|--|------------------------------------|
| TYPE NUMBER                            | VOLTAGE CODE | $V_{RRM}$ , MAXIMUM REPETITIVE PEAK REVERSE VOLTAGE<br>V | $V_{RSM}$ , MAXIMUM NON-REPETITIVE PEAK REVERSE VOLTAGE<br>V | $I_{RRM}$ AT 150 $^{\circ}C$<br>mA |
| VS-VSK.166<br>VS-VSK.196<br>VS-VSK.236 | 04           | 400  | 500  | 20                                 |
|  | 08           | 800  | 900  |                                    |
|  | 12           | 1200   | 1300   |                                    |
|  | 14           | 1400   | 1500   |                                    |
|  | 16           | 1600   | 1700   |                                    |



| FORWARD CONDUCTION   |               |  |                           |         |         |         |                    |
|--|---------------|--|---------------------------|---------|---------|---------|--------------------|
| PARAMETER  | SYMBOL        | TEST CONDITIONS  |                           | VSK.166 | VSK.196 | VSK.236 | UNITS              |
| Maximum average on-state current at case temperature           | $I_{F(AV)}$   | 180° conduction, half sine wave  |                           | 165     | 195     | 230     | A                  |
|  |               |  |                           | 100     | 100     | 100     | °C                 |
| Maximum RMS on-state current                                   | $I_{F(RMS)}$  |  |                           | 260     | 305     | 360     | A                  |
| Maximum peak, one-cycle on-state, non-repetitive surge current | $I_{FSM}$     | t = 10 ms  | No voltage reapplied      | 4000    | 4750    | 5500    |                    |
|  |               | t = 8.3 ms   | No voltage reapplied      | 4200    | 4980    | 5765    |                    |
|  |               | t = 10 ms  | 100 % $V_{RRM}$ reapplied | 3350    | 4000    | 4630    |                    |
|  |               | t = 8.3 ms   | 100 % $V_{RRM}$ reapplied | 3500    | 4200    | 4850    |                    |
| Maximum $I^2t$ for fusing                                      | $I^2t$        | t = 10 ms  | No voltage reapplied      | 80      | 113     | 151     | kA <sup>2</sup> s  |
|  |               | t = 8.3 ms   | No voltage reapplied      | 73      | 103     | 138     |                    |
|  |               | t = 10 ms  | 100 % $V_{RRM}$ reapplied | 56      | 80      | 107     |                    |
|  |               | t = 8.3 ms   | 100 % $V_{RRM}$ reapplied | 52      | 73      | 98      |                    |
| Maximum $I^2\sqrt{t}$ for fusing                               | $I^2\sqrt{t}$ | t = 0.1 ms to 10 ms, no voltage reapplied  |                           | 798     | 1130    | 1516    | kA <sup>2</sup> √s |
| Low level value of threshold voltage                           | $V_{F(TO)1}$  | $(16.7\% \times \pi \times I_{F(AV)} < I < \pi \times I_{F(AV)})$ , $T_J$ maximum  |                           | 0.73    | 0.69    | 0.7     | V                  |
| High level value of threshold voltage                          | $V_{F(TO)2}$  | $(I > \pi \times I_{F(AV)})$ , $T_J$ maximum   |                           | 0.88    | 0.78    | 0.83    |                    |
| Low level value on-state slope resistance                      | $r_{t1}$      | $(16.7\% \times \pi \times I_{F(AV)} < I < \pi \times I_{F(AV)})$ , $T_J$ maximum  |                           | 1.5     | 1.3     | 1.2     | mΩ                 |
| High level value on-state                                      | $r_{t2}$      | $(I > \pi \times I_{F(AV)})$ , $T_J$ maximum   |                           | 1.26    | 1.2     | 1.07    |                    |
| Maximum forward voltage drop                                   | $V_{FM}$      | $I_{FM} = \pi \times I_{F(AV)}$ , $T_J = 25\text{ °C}$ , 180° conduction<br>Average power = $V_{F(TO)} \times I_{F(AV)} + r_f \times (I_{F(RMS)})^2$ |                           | 1.43    | 1.38    | 1.46    | V                  |

| BLOCKING   |           |  |  |         |         |         |       |
|--|-----------|--|--|---------|---------|---------|-------|
| PARAMETER  | SYMBOL    | TEST CONDITIONS  |  | VSK.166 | VSK.196 | VSK.236 | UNITS |
| Maximum peak reverse and off-state leakage current | $I_{RRM}$ | $T_J = 150\text{ °C}$                                  |  | 20      |         |         | mA    |
| RMS insulation voltage                             | $V_{INS}$ | 50 Hz, circuit to base, all terminals shorted, t = 1 s |  | 3500    |         |         | V     |

| THERMAL AND MECHANICAL SPECIFICATIONS                     |                                  |  |             |         |         |       |
|---|----------------------------------|--|-------------|---------|---------|-------|
| PARAMETER   | SYMBOL                           | TEST CONDITIONS  | VALUES      |         |         | UNITS |
|   |                                  |  | VSK.166     | VSK.196 | VSK.236 |       |
| Maximum junction operating and storage temperature range  | $T_J, T_{Stg}$                   |  | -40 to +150 |         |         | °C    |
| Maximum thermal resistance, junction to case per junction | $R_{thJC}$                       | DC operation   | 0.2         | 0.16    | 0.14    | K/W   |
| Maximum thermal resistance, case to heatsink per module   | $R_{thCS}$                       | Mounting surface smooth, flat and greased  | 0.05        |         |         |       |
| Mounting torque ± 10 %                                    | IAP to heatsink<br>busbar to IAP | A mounting compound is recommended and the torque should be rechecked after a period of 3 hours to allow for the spread of the compound. Lubricated threads. | 4 to 6      |         |         | Nm    |
| Approximate weight  |                                  |  | 200         |         |         | g     |
|   |                                  |  | 7.1         |         |         | oz.   |
| Case style  |                                  |  | INT-A-PAK   |         |         |       |



| <b>ΔR CONDUCTION PER JUNCTION</b> |   |       |       |       |       |  |       |       |       |       |       |
|-----------------------------------|---|-------|-------|-------|-------|--|-------|-------|-------|-------|-------|
| DEVICES                           | SINUSOIDAL CONDUCTION AT T <sub>J</sub> MAXIMUM |       |       |       |       | RECTANGULAR CONDUCTION AT T <sub>J</sub> MAXIMUM |       |       |       |       | UNITS |
|                                   | 180°  | 120°  | 90°   | 60°   | 30°   | 180°   | 120°  | 90°   | 60°   | 30°   |       |
| VSK.166                           | 0.025   | 0.03  | 0.038 | 0.055 | 0.089 | 0.018  | 0.031 | 0.041 | 0.057 | 0.089 | K/W   |
| VSK.196                           | 0.016   | 0.019 | 0.024 | 0.034 | 0.053 | 0.012  | 0.02  | 0.026 | 0.035 | 0.054 |       |
| VSK.236                           | 0.009   | 0.010 | 0.014 | 0.018 | 0.025 | 0.008  | 0.012 | 0.015 | 0.019 | 0.025 |       |

**Note**

- Table shows the increment of thermal resistance R<sub>thJC</sub> when devices operate at different conduction angles than DC

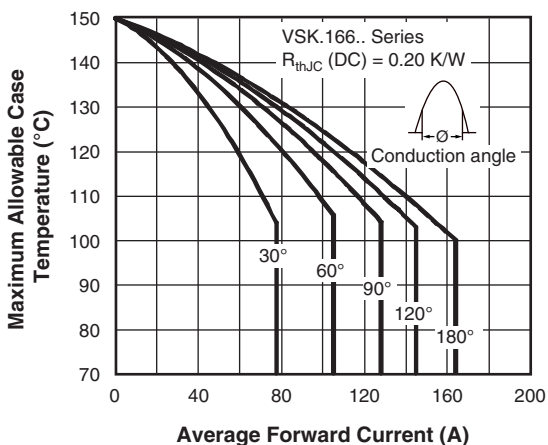


Fig. 1 - Current Ratings Characteristics

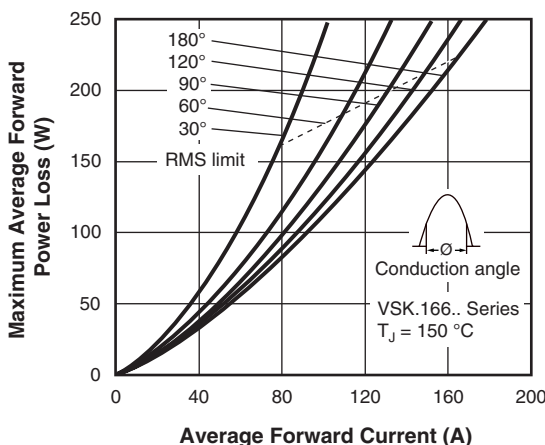


Fig. 3 - On-State Power Loss Characteristics



Fig. 2 - Current Ratings Characteristics



Fig. 4 - On-State Power Loss Characteristics



Fig. 5 - Maximum Non-Repetitive Surge Current



Fig. 6 - Maximum Non-Repetitive Surge Current



Fig. 7 - On-State Power Loss Characteristics



Fig. 8 - On-State Power Loss Characteristics





Fig. 9 - On-State Power Loss Characteristics



Fig. 10 - Current Ratings Characteristics

Fig. 12 - On-State Power Loss Characteristics

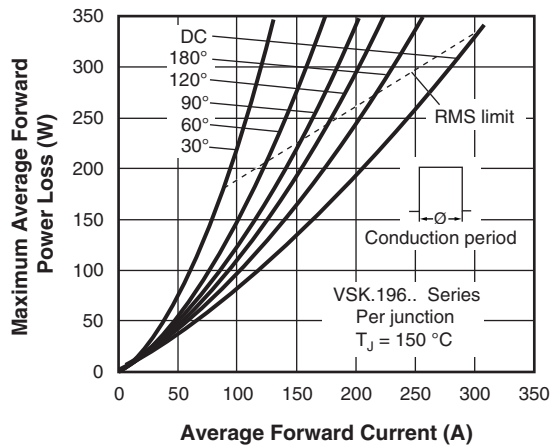
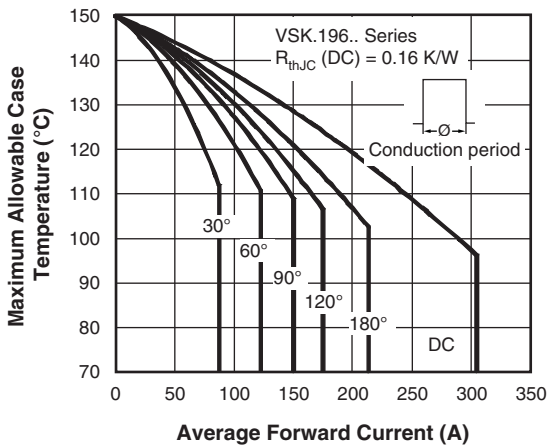


Fig. 11 - Current Ratings Characteristics

Fig. 13 - On-State Power Loss Characteristics

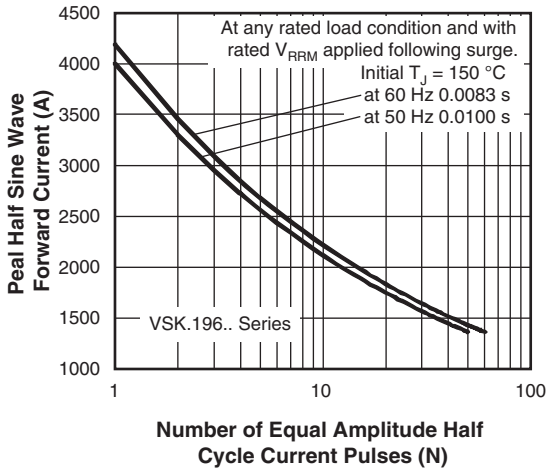


Fig. 14 - Maximum Non-Repetitive Surge Current

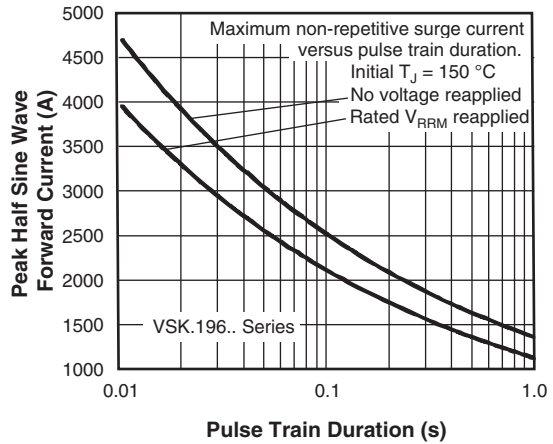


Fig. 15 - Maximum Non-Repetitive Surge Current



Fig. 16 - On-State Power Loss Characteristics



Fig. 17 - On-State Power Loss Characteristics





Fig. 18 - On-State Power Loss Characteristics



Fig. 19 - Current Ratings Characteristics



Fig. 21 - On-State Power Loss Characteristics



Fig. 20 - Current Ratings Characteristics



Fig. 22 - On-State Power Loss Characteristics





Fig. 23 - Maximum Non-Repetitive Surge Current

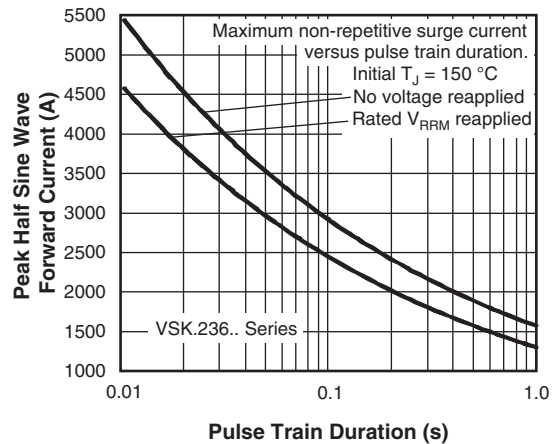


Fig. 24 - Maximum Non-Repetitive Surge Current

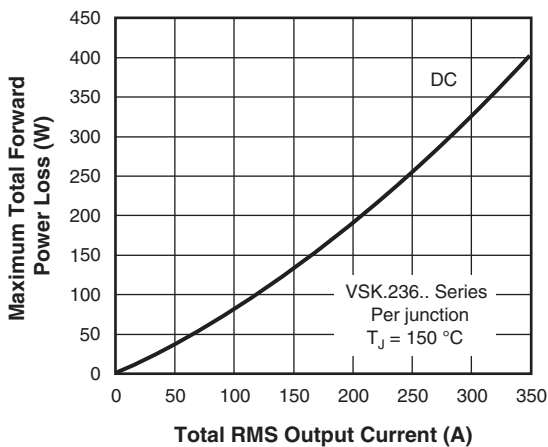


Fig. 25 - On-State Power Loss Characteristics

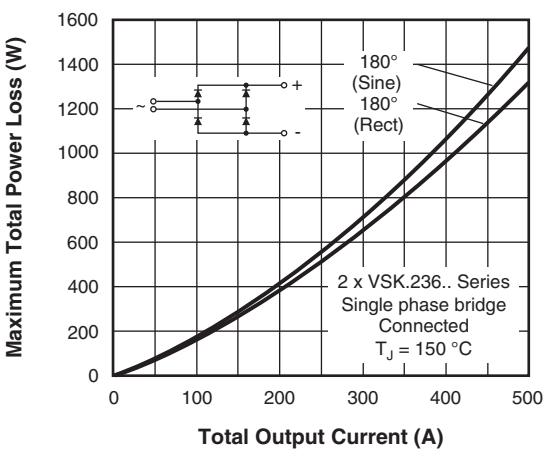
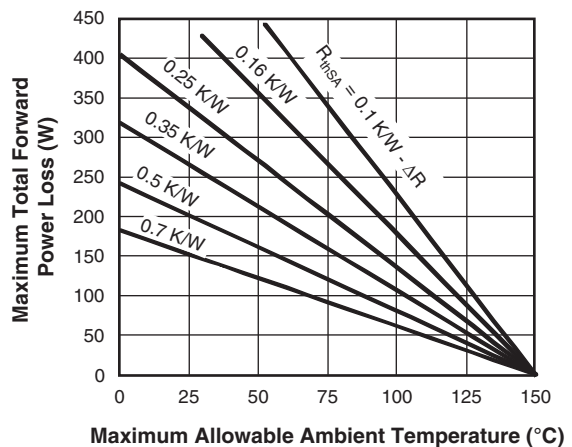


Fig. 26 - On-State Power Loss Characteristics

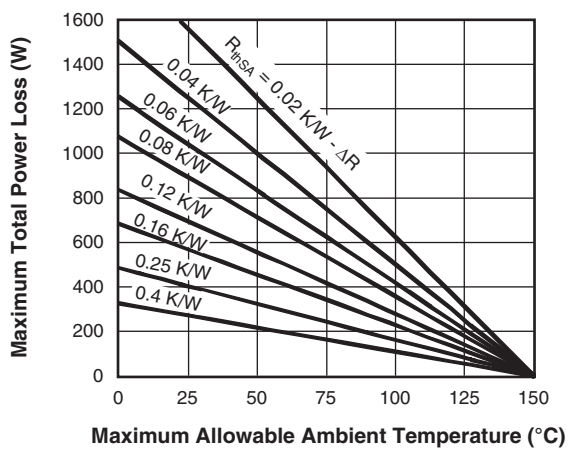






Fig. 27 - On-State Power Loss Characteristics



Fig. 28 - On-State Voltage Drop Characteristics



Fig. 30 - On-State Voltage Drop Characteristics



Fig. 29 - On-State Voltage Drop Characteristics



Fig. 31 - Thermal Impedance  $Z_{thJC}$  Characteristics



Fig. 32 - Thermal Impedance  $Z_{thJC}$  Characteristics

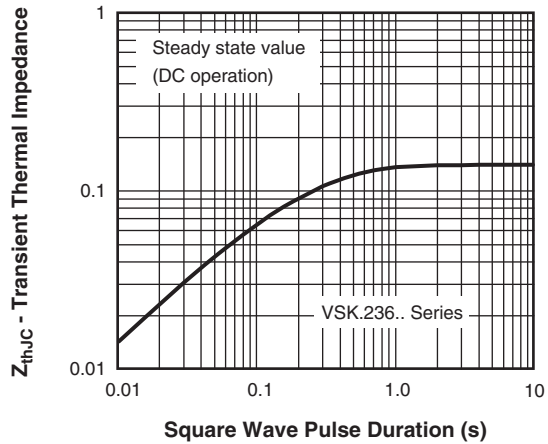


Fig. 33 - Thermal Impedance  $Z_{thJC}$  Characteristics

ORDERING INFORMATION TABLE

|             |              |           |                                |           |            |
|-------------|--------------|-----------|--------------------------------|-----------|------------|
| Device code | <b>VS-VS</b> | <b>KD</b> | <b>236</b>                     | <b>16</b> | <b>PbF</b> |
|             | ①            | ②         | ③                              | ④         | ⑤          |
|             | <b>1</b>     | -         | Vishay Semiconductors product  |           |            |
|             | <b>2</b>     | -         | Circuit configuration          |           |            |
|             | <b>3</b>     | -         | Current rating: $I_{F(AV)}$    |           |            |
|             | <b>4</b>     | -         | Voltage code x 100 = $V_{RRM}$ |           |            |
|             | <b>5</b>     | -         | PbF = Lead (Pb)-free           |           |            |

Note

- To order the optional hardware go to [www.vishay.com/doc?95172](http://www.vishay.com/doc?95172)



| CIRCUIT CONFIGURATION      |                            |                       |
|----------------------------|----------------------------|-----------------------|
| CIRCUIT DESCRIPTION        | CIRCUIT CONFIGURATION CODE | CIRCUIT DRAWING       |
| Two diodes doubler circuit | D                          | <p><b>VSKD...</b></p> |
| Two diodes common cathodes | C                          | <p><b>VSKC...</b></p> |
| Two diodes common anodes   | J                          | <p><b>VSKJ...</b></p> |
| Single diode               | E                          | <p><b>VSKE...</b></p> |

| LINKS TO RELATED DOCUMENTS |  |
|----------------------------|--|
| Dimensions                 | <a href="http://www.vishay.com/doc?95254">www.vishay.com/doc?95254</a> |

## INT-A-PAK DBC

**DIMENSIONS** in millimeters (inches)





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