



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



INT-A-PAK

### FEATURES

- High voltage
- Electrically isolated by DBC ceramic ( $\text{Al}_2\text{O}_3$ )
- 3500  $V_{\text{RMS}}$  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    |                                                                                              |
|--------------------|----------------------------------------------------------------------------------------------|
| $I_{\text{F(AV)}}$ | 165 A to 230 A                                                                               |
| Type               | Modules - Diode, High Voltage                                                                |
| Package            | INT-A-PAK                                                                                    |
| Circuit            | Single diode, two diodes common anode, 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                        |
| $I_{\text{F(AV)}}$                |                 | 165         | 195       | 230       | A                            |
|                                   | $T_{\text{C}}$  | 100         | 100       | 100       | $^{\circ}\text{C}$           |
| $I_{\text{F(RMS)}}$               |                 | 260         | 305       | 360       | A                            |
| $I_{\text{FSM}}$                  | 50 Hz           | 4000        | 4750      | 5500      |                              |
|                                   | 60 Hz           | 4200        | 4980      | 5765      |                              |
| $I^2t$                            | 50 Hz           | 80          | 113       | 151       | $\text{kA}^2\text{s}$        |
|                                   | 60 Hz           | 73          | 103       | 138       |                              |
| $I^2\sqrt{t}$                     |                 | 798         | 1130      | 1516      | $\text{kA}^2\sqrt{\text{s}}$ |
| $V_{\text{RRM}}$                  |                 | 400 to 1600 |           |           | V                            |
| $T_{\text{J}}$                    | Range           | -40 to +150 |           |           | $^{\circ}\text{C}$           |

### ELECTRICAL SPECIFICATIONS

| VOLTAGE RATINGS                        |              |                                                                 |                                                                     |                                                  |
|----------------------------------------|--------------|-----------------------------------------------------------------|---------------------------------------------------------------------|--------------------------------------------------|
| TYPE NUMBER                            | VOLTAGE CODE | $V_{\text{RRM}}$ , MAXIMUM REPETITIVE PEAK REVERSE VOLTAGE<br>V | $V_{\text{RSM}}$ , MAXIMUM NON-REPETITIVE PEAK REVERSE VOLTAGE<br>V | $I_{\text{RRM}}$ AT 150 $^{\circ}\text{C}$<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                                                                                                                                                                                      |                                  |                                                                 | VALUES  |         |         | UNITS              |
|                                                                |                     |                                                                                                                                                                                                      |                                  |                                                                 | VSK.166 | VSK.196 | VSK.236 |                    |
| Maximum average on-state current at case temperature           | I <sub>F(AV)</sub>  | 180° conduction, half sine wave                                                                                                                                                                      |                                  |                                                                 | 165     | 195     | 230     | A                  |
|                                                                |                     |                                                                                                                                                                                                      |                                  |                                                                 | 100     | 100     | 100     | °C                 |
| Maximum RMS on-state current                                   | I <sub>F(RMS)</sub> |                                                                                                                                                                                                      |                                  |                                                                 | 260     | 305     | 360     |                    |
| Maximum peak, one-cycle on-state, non-repetitive surge current | I <sub>FSM</sub>    | t = 10 ms                                                                                                                                                                                            | No voltage reapplied             | Sine half wave, initial T <sub>J</sub> = T <sub>J</sub> maximum | 4000    | 4750    | 5500    | A                  |
|                                                                |                     | t = 8.3 ms                                                                                                                                                                                           |                                  |                                                                 | 4200    | 4980    | 5765    |                    |
|                                                                |                     | t = 10 ms                                                                                                                                                                                            | 100 % V <sub>RRM</sub> reapplied |                                                                 | 3350    | 4000    | 4630    |                    |
|                                                                |                     | t = 8.3 ms                                                                                                                                                                                           |                                  |                                                                 | 3500    | 4200    | 4850    |                    |
| Maximum I <sup>2</sup> t for fusing                            | I <sup>2</sup> t    | t = 10 ms                                                                                                                                                                                            | No voltage reapplied             |                                                                 | 80      | 113     | 151     | kA <sup>2</sup> s  |
|                                                                |                     | t = 8.3 ms                                                                                                                                                                                           |                                  |                                                                 | 73      | 103     | 138     |                    |
|                                                                |                     | t = 10 ms                                                                                                                                                                                            | 100 % V <sub>RRM</sub> reapplied |                                                                 | 56      | 80      | 107     |                    |
|                                                                |                     | t = 8.3 ms                                                                                                                                                                                           |                                  |                                                                 | 52      | 73      | 98      |                    |
| Maximum I <sup>2</sup> √t for fusing                           | I <sup>2</sup> √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 <sub>F(TO)1</sub> | (16.7 % × π × I <sub>F(AV)</sub> < I < π × I <sub>F(AV)</sub> ), T <sub>J</sub> maximum                                                                                                              |                                  |                                                                 | 0.73    | 0.69    | 0.7     | V                  |
| High level value of threshold voltage                          | V <sub>F(TO)2</sub> | (I > π × I <sub>F(AV)</sub> ), T <sub>J</sub> maximum                                                                                                                                                |                                  |                                                                 | 0.88    | 0.78    | 0.83    |                    |
| Low level value on-state slope resistance                      | r <sub>t1</sub>     | (16.7 % × π × I <sub>F(AV)</sub> < I < π × I <sub>F(AV)</sub> ), T <sub>J</sub> maximum                                                                                                              |                                  |                                                                 | 1.5     | 1.3     | 1.2     | mΩ                 |
| High level value on-state                                      | r <sub>t2</sub>     | (I > π × I <sub>F(AV)</sub> ), T <sub>J</sub> maximum                                                                                                                                                |                                  |                                                                 | 1.26    | 1.2     | 1.07    |                    |
| Maximum forward voltage drop                                   | V <sub>FM</sub>     | I <sub>FM</sub> = π × I <sub>F(AV)</sub> , T <sub>J</sub> = 25 °C, 180° conduction<br>Average power = V <sub>F(TO)</sub> × I <sub>F(AV)</sub> + r <sub>f</sub> × (I <sub>F(RMS)</sub> ) <sup>2</sup> |                                  |                                                                 | 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, $t = 1\text{ s}$ | 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 <sub>J</sub> , T <sub>Stg</sub> |                                                                                                                                                              | -40 to +150 |         |         | °C    |
| Maximum thermal resistance, junction to case per junction | R <sub>thJC</sub>                 | DC operation                                                                                                                                                 | 0.2         | 0.16    | 0.14    | K/W   |
| Maximum thermal resistance, case to heatsink per module   | R <sub>thCS</sub>                 | 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   |         |         |       |



## ΔR CONDUCTION PER JUNCTION

| DEVICES | SINUSOIDAL CONDUCTION<br>AT T <sub>J</sub> MAXIMUM |       |       |       |       | RECTANGULAR CONDUCTION<br>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  $R_{thJC}$  when devices operate at different conduction angles than DC

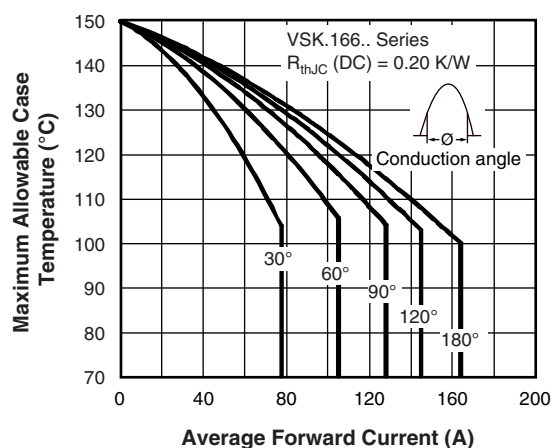


Fig. 1 - Current Ratings Characteristics

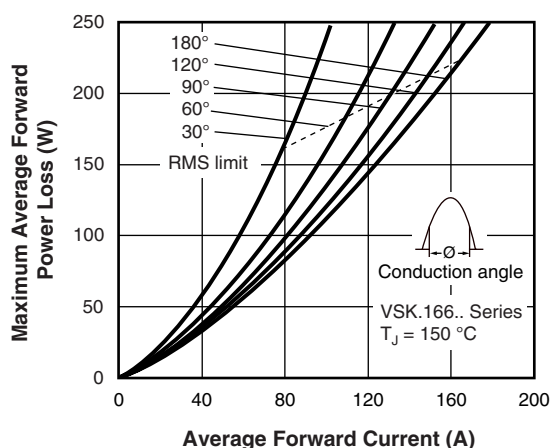


Fig. 3 - On-State Power Loss Characteristics

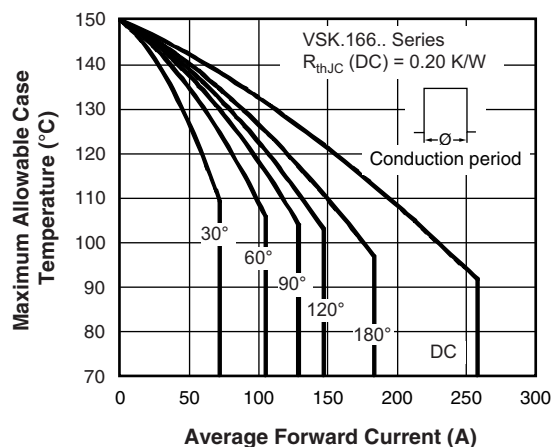


Fig. 2 - Current Ratings Characteristics

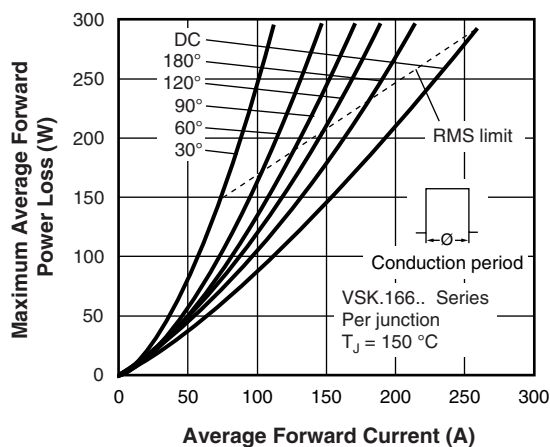


Fig. 4 - On-State Power Loss Characteristics

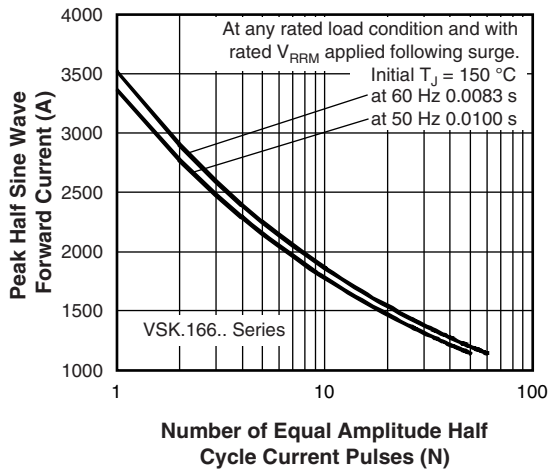


Fig. 5 - Maximum Non-Repetitive Surge Current

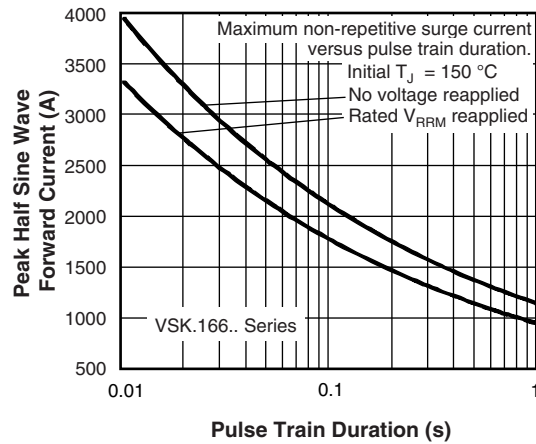


Fig. 6 - Maximum Non-Repetitive Surge Current

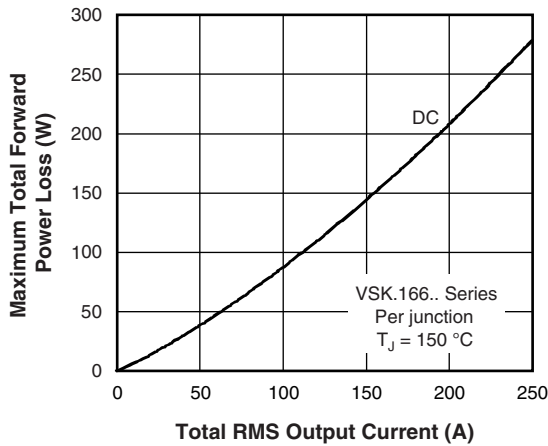


Fig. 7 - On-State Power Loss Characteristics

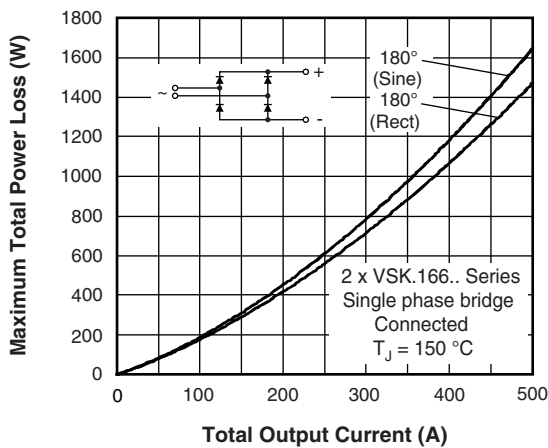
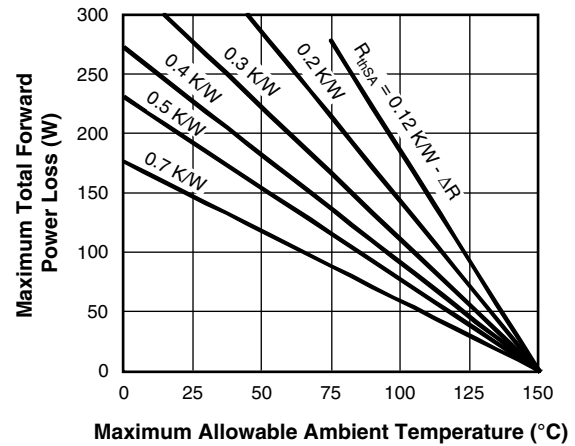
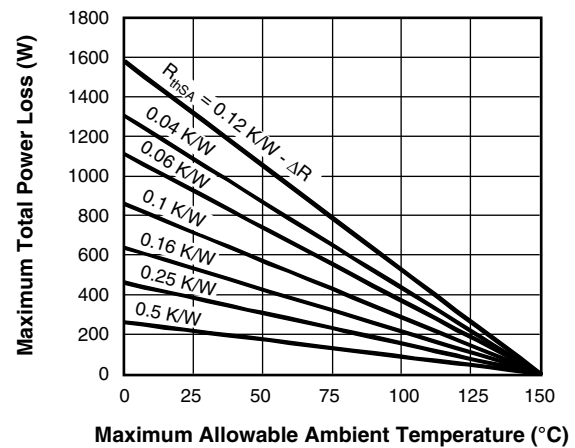


Fig. 8 - On-State Power Loss Characteristics



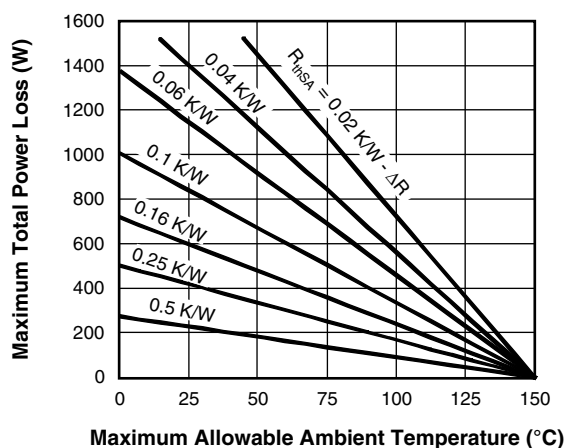
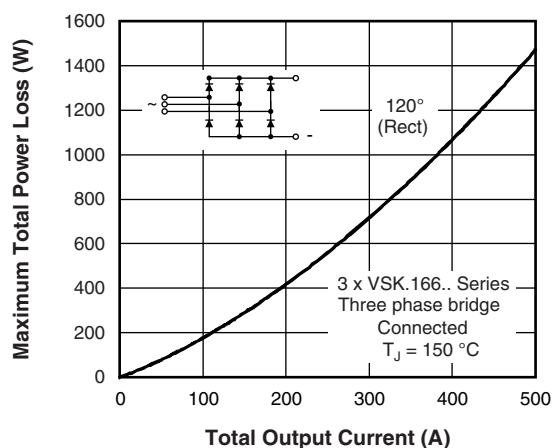


Fig. 9 - On-State Power Loss Characteristics

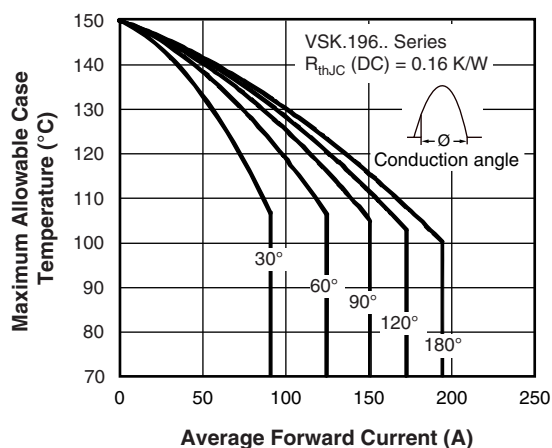


Fig. 10 - Current Ratings Characteristics

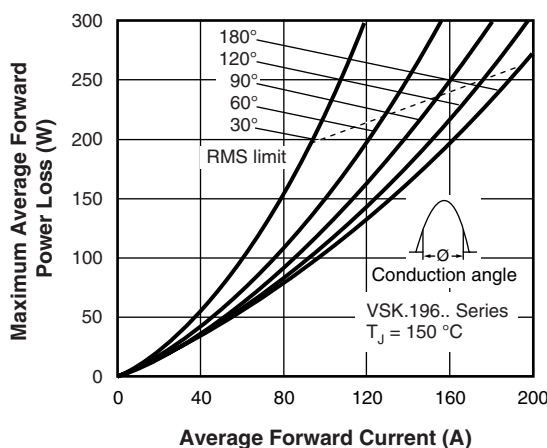


Fig. 12 - On-State Power Loss Characteristics

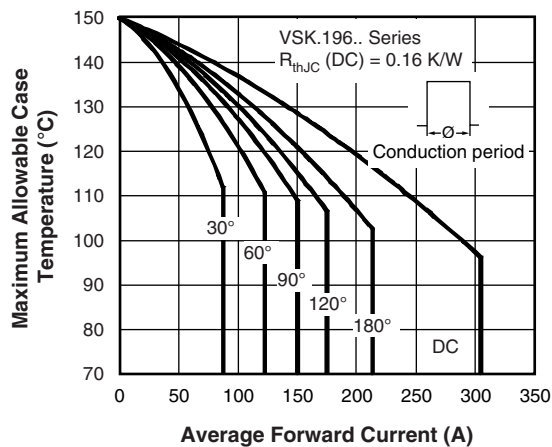


Fig. 11 - Current Ratings Characteristics

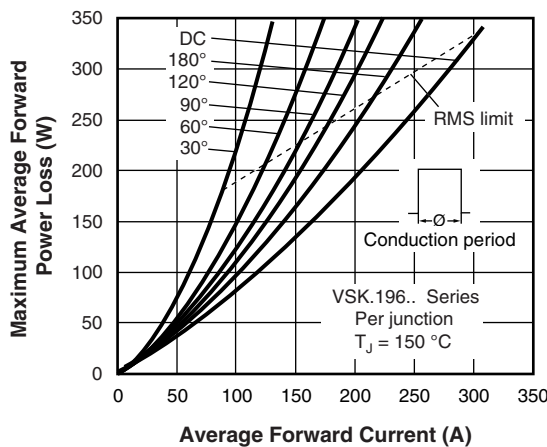


Fig. 13 - On-State Power Loss Characteristics

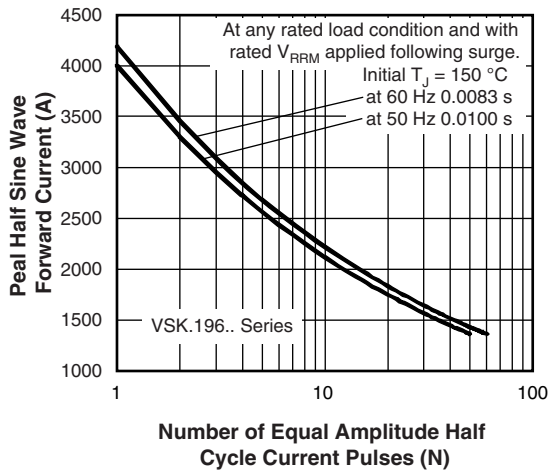


Fig. 14 - Maximum Non-Repetitive Surge Current

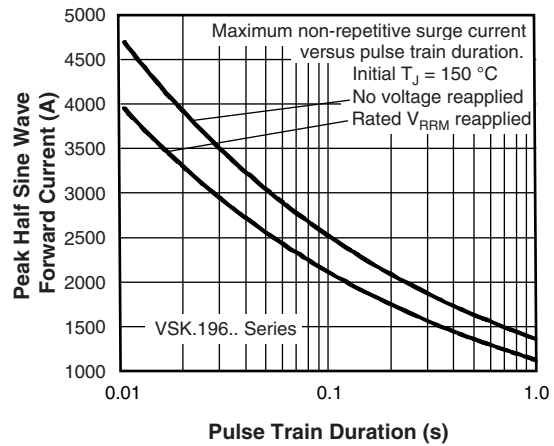


Fig. 15 - Maximum Non-Repetitive Surge Current

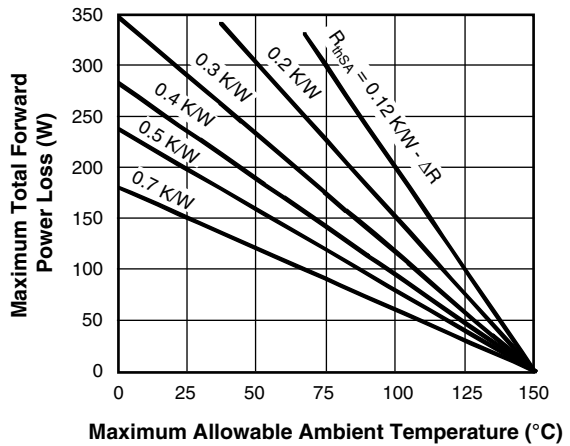
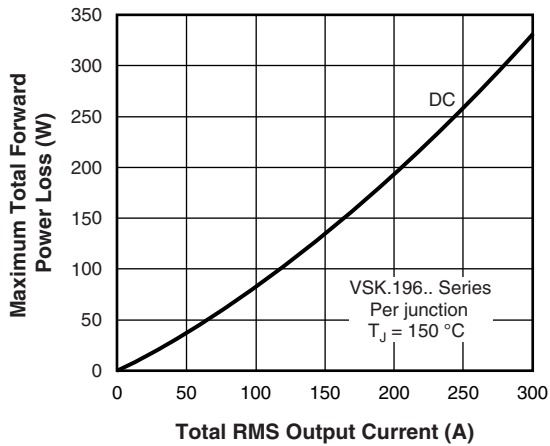


Fig. 16 - On-State Power Loss Characteristics

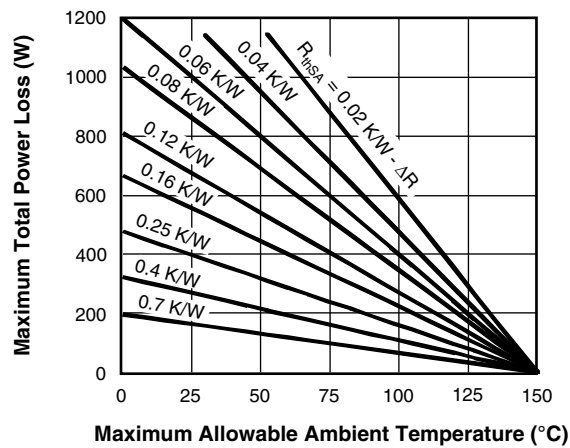
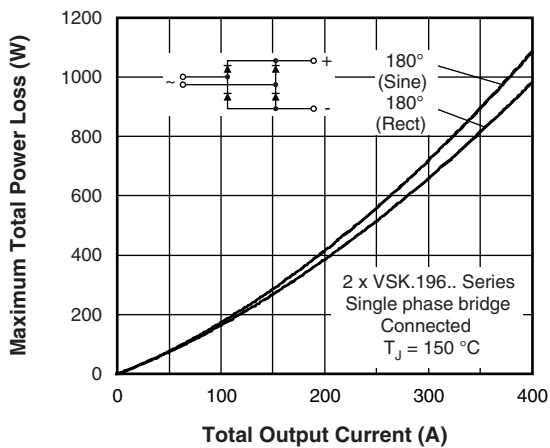


Fig. 17 - On-State Power Loss Characteristics

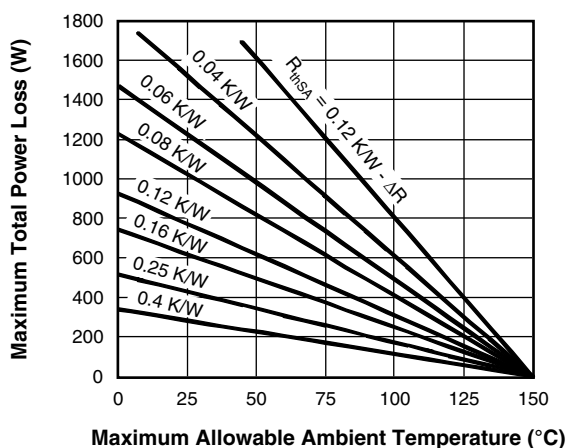
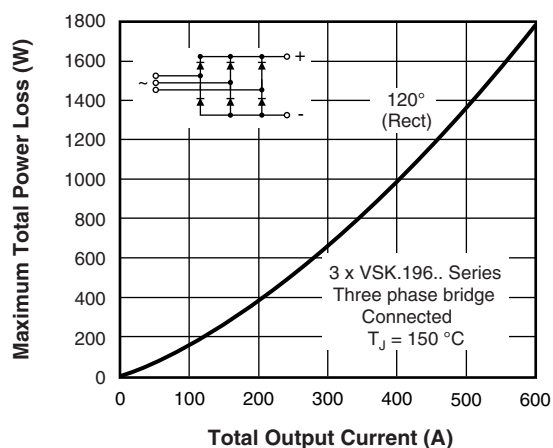


Fig. 18 - On-State Power Loss Characteristics

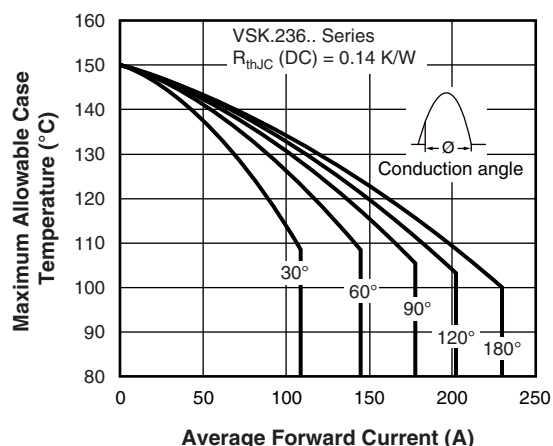


Fig. 19 - Current Ratings Characteristics

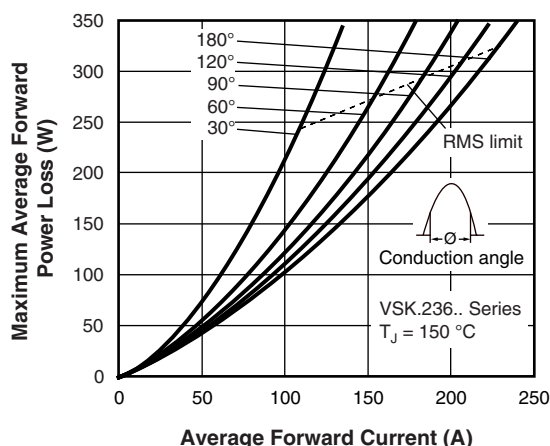


Fig. 21 - On-State Power Loss Characteristics

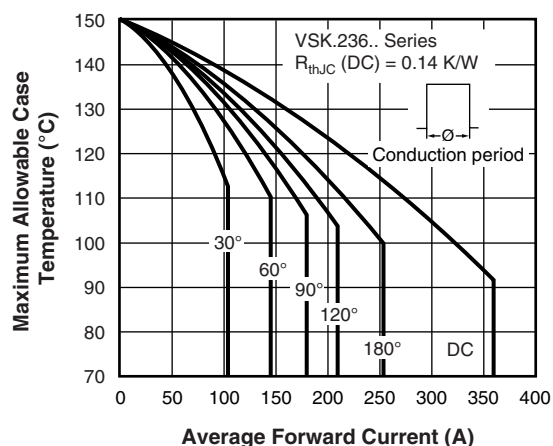


Fig. 20 - Current Ratings Characteristics

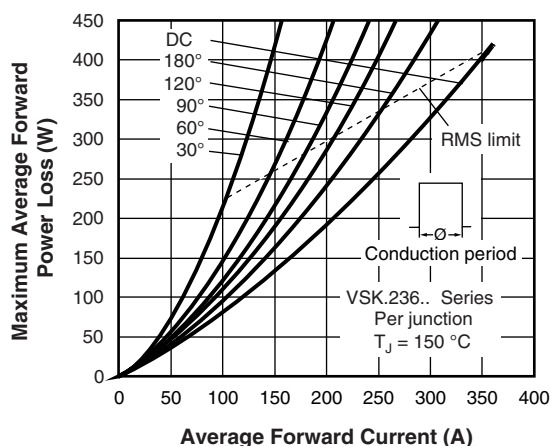


Fig. 22 - On-State Power Loss Characteristics



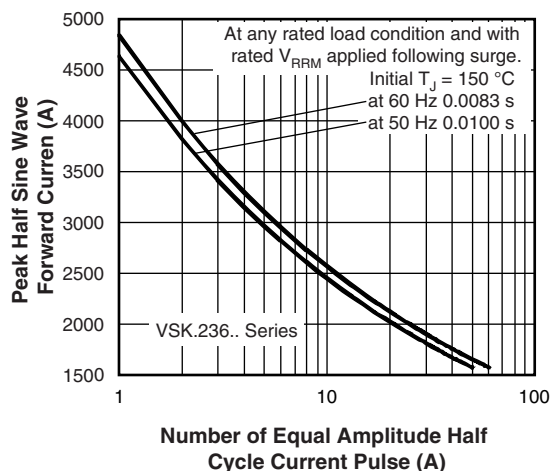


Fig. 23 - Maximum Non-Repetitive Surge Current

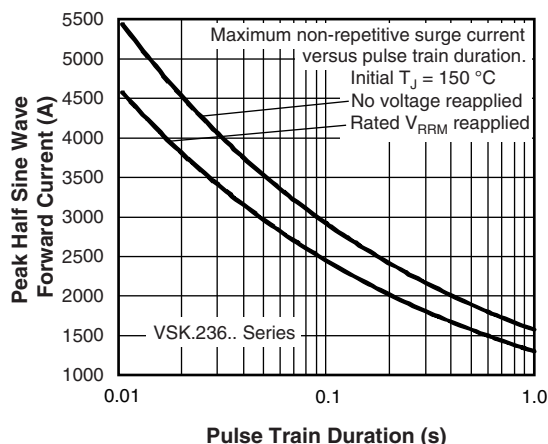


Fig. 24 - Maximum Non-Repetitive Surge Current

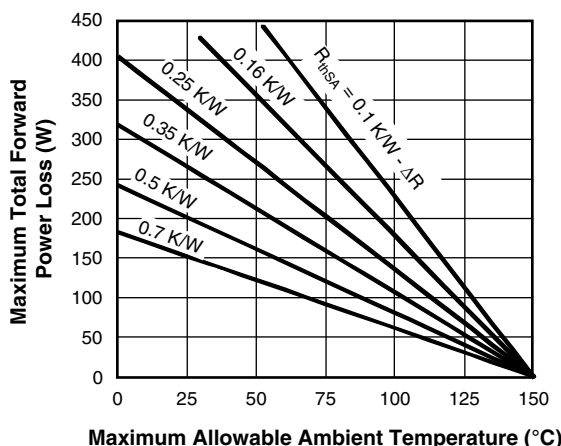
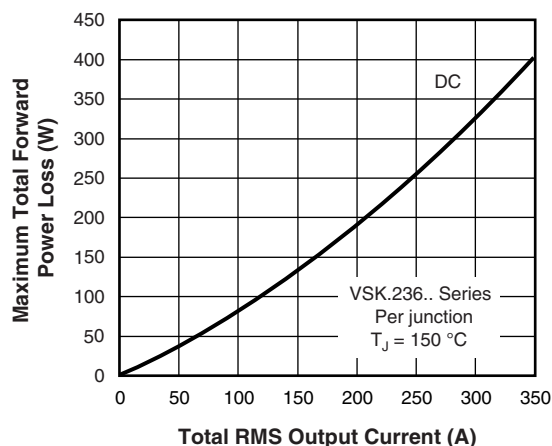


Fig. 25 - On-State Power Loss Characteristics

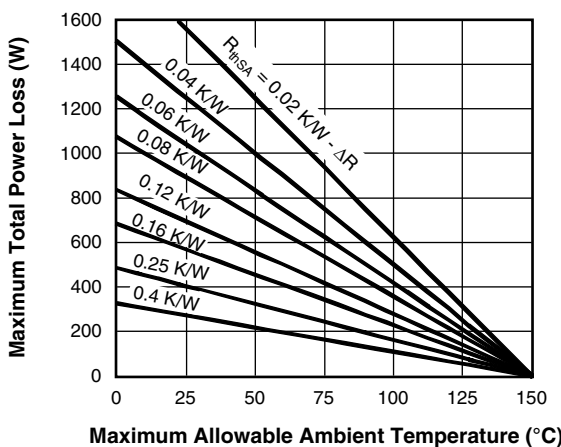
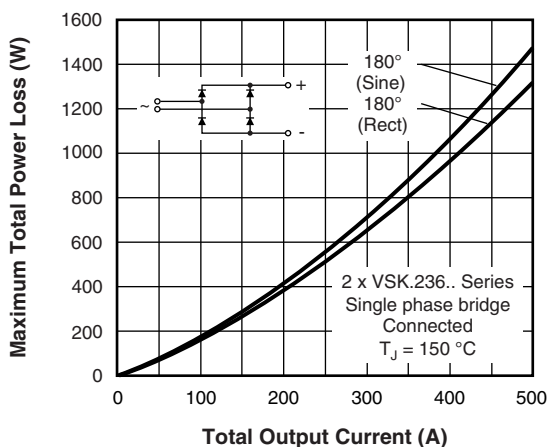


Fig. 26 - On-State Power Loss Characteristics



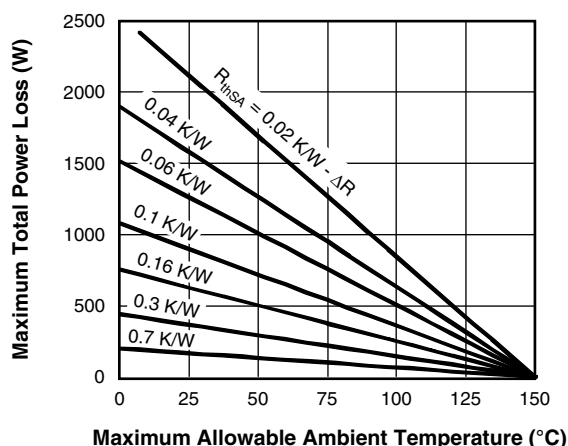
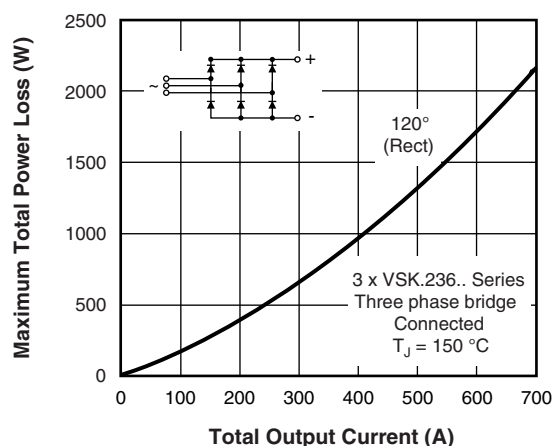


Fig. 27 - On-State Power Loss Characteristics

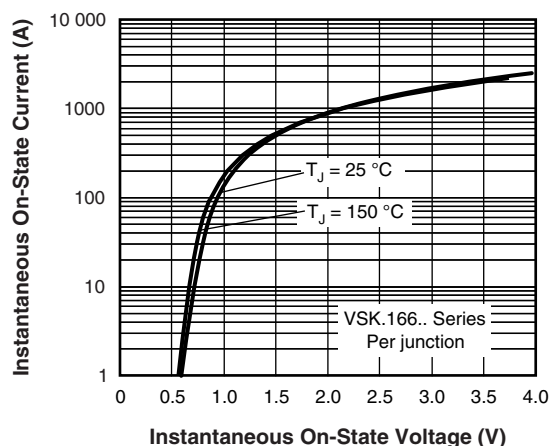


Fig. 28 - On-State Voltage Drop Characteristics

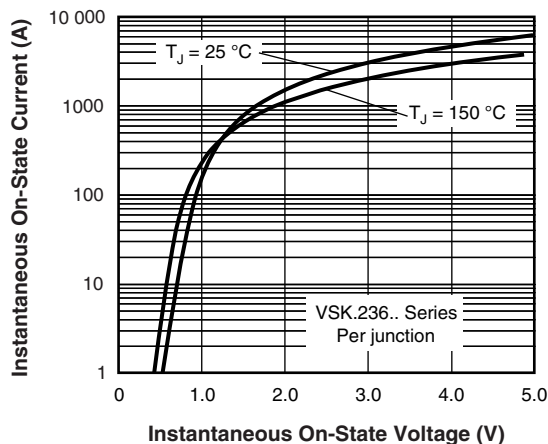


Fig. 30 - On-State Voltage Drop Characteristics

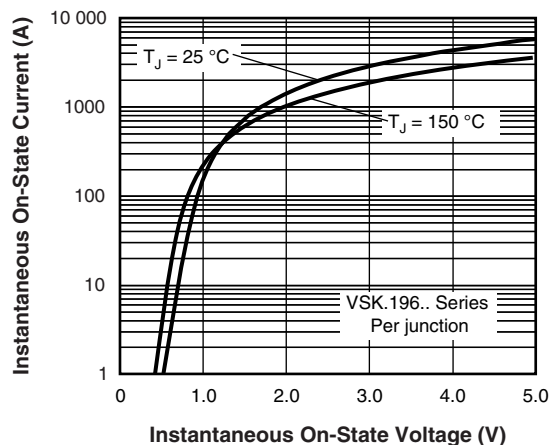


Fig. 29 - On-State Voltage Drop Characteristics

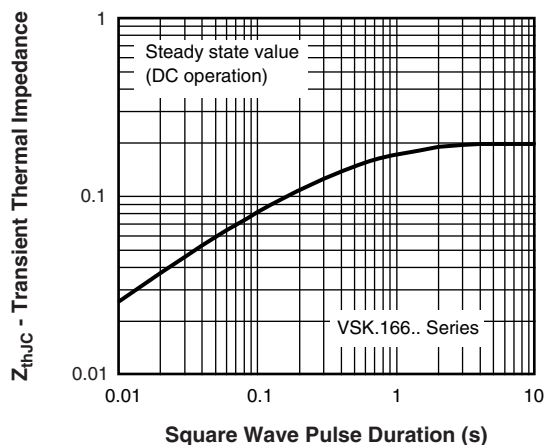


Fig. 31 - Thermal Impedance  $Z_{\theta JC}$  Characteristics

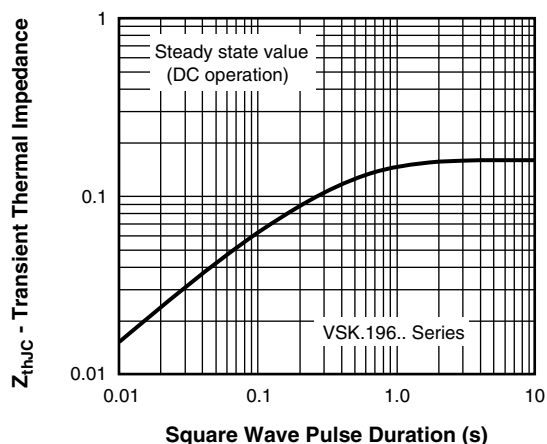


Fig. 32 - Thermal Impedance  $Z_{thJC}$  Characteristics

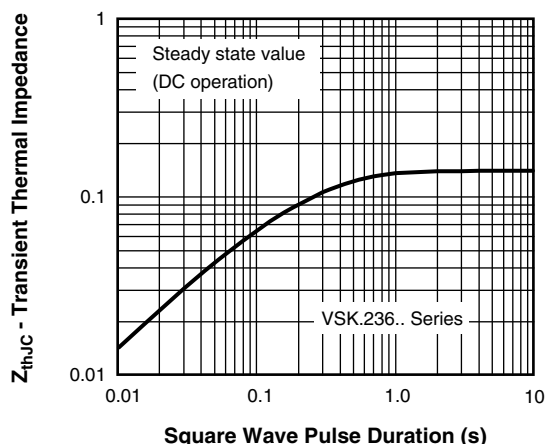


Fig. 33 - Thermal Impedance  $Z_{thJC}$  Characteristics

## ORDERING INFORMATION TABLE

Device code

| VS-VS | KD | 236 | 16 | PbF |
|-------|----|-----|----|-----|
|-------|----|-----|----|-----|

1

2

3

4

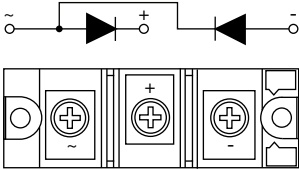
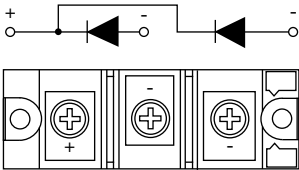
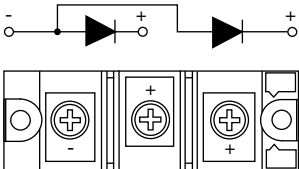
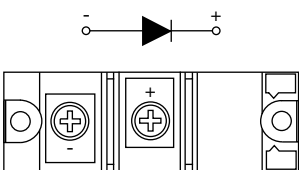
5

- |   |   |                                |
|---|---|--------------------------------|
| 1 | - | Vishay Semiconductors product  |
| 2 | - | Circuit configuration          |
| 3 | - | Current rating: $I_{F(AV)}$    |
| 4 | - | Voltage code x 100 = $V_{RRM}$ |
| 5 | - | 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 cathode  | C                          | <p><b>VSKC...</b></p>    |
| Two diodes common anode    | 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> |

**DIMENSIONS** in millimeters (inches)





## Disclaimer

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