

## Thyristor/Thyristor, 160 A (INT-A-PAK Power Modules)


**INT-A-PAK**

### PRIMARY CHARACTERISTICS

|             |                               |
|-------------|-------------------------------|
| $I_{T(AV)}$ | 160 A                         |
| Type        | Modules - thyristor, standard |
| Package     | 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 thyristor/diodes in three 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

### APPLICATIONS

- DC motor control and drives
- Battery charges
- Welders
- Power converters
- Lighting control
- Heat and temperature control

### MAJOR RATINGS AND CHARACTERISTICS

| SYMBOL        | CHARACTERISTICS | VALUES      | UNITS              |
|---------------|-----------------|-------------|--------------------|
| $I_{T(AV)}$   | 85 °C           | 160         | A                  |
| $I_{T(RMS)}$  |                 | 355         |                    |
| $I_{TSM}$     | 50 Hz           | 4870        |                    |
|               | 60 Hz           | 5100        |                    |
| $I^2t$        | 50 Hz           | 119         | kA <sup>2</sup> s  |
|               | 60 Hz           | 108         |                    |
| $I^2\sqrt{t}$ |                 | 1190        | kA <sup>2</sup> √s |
| $V_{RRM}$     | Range           | 1200, 1600  | V                  |
| $T_J$         | Range           | -40 to +125 | °C                 |

### ELECTRICAL SPECIFICATIONS

#### VOLTAGE RATINGS

| TYPE NUMBER | VOLTAGE CODE | $V_{RRM}/V_{DRM}$ , MAXIMUM REPETITIVE PEAK REVERSE VOLTAGE<br>V | $V_{RSM}/V_{DSM}$ , MAXIMUM NON-REPETITIVE PEAK REVERSE VOLTAGE<br>V | $I_{RRM}/I_{DRM}$ AT 125 °C<br>mA |
|-------------|--------------|------------------------------------------------------------------|----------------------------------------------------------------------|-----------------------------------|
| VS-VSK.162  | 12           | 1200                                                             | 1300                                                                 | 50                                |
|             | 16           | 1600                                                             | 1700                                                                 |                                   |



| ON-STATE CONDUCTION                                            |               |                                                                                                              |                            |        |
|----------------------------------------------------------------|---------------|--------------------------------------------------------------------------------------------------------------|----------------------------|--------|
| PARAMETER                                                      | SYMBOL        | TEST CONDITIONS                                                                                              |                            | VALUES |
| Maximum average on-state current at case temperature           | $I_{T(AV)}$   | 180° conduction, half sine wave                                                                              |                            | 160    |
|                                                                |               |                                                                                                              |                            | 85     |
| Maximum RMS on-state current                                   | $I_{T(RMS)}$  | As AC switch                                                                                                 |                            | 355    |
| Maximum peak, one-cycle on-state, non-repetitive surge current | $I_{TSM}$     | t = 10 ms                                                                                                    | No voltage reappplied      | 4870   |
|                                                                |               | t = 8.3 ms                                                                                                   | No voltage reappplied      | 5100   |
|                                                                |               | t = 10 ms                                                                                                    | 100 % $V_{RRM}$ reappplied | 4100   |
|                                                                |               | t = 8.3 ms                                                                                                   | 100 % $V_{RRM}$ reappplied | 4300   |
| Maximum $I^2t$ for fusing                                      | $I^2t$        | t = 10 ms                                                                                                    | No voltage reappplied      | 119    |
|                                                                |               | t = 8.3 ms                                                                                                   | No voltage reappplied      | 108    |
|                                                                |               | t = 10 ms                                                                                                    | 100 % $V_{RRM}$ reappplied | 84     |
|                                                                |               | t = 8.3 ms                                                                                                   | 100 % $V_{RRM}$ reappplied | 76.7   |
| Maximum $I^2\sqrt{t}$ for fusing                               | $I^2\sqrt{t}$ | t = 0.1 ms to 10 ms, no voltage reappplied                                                                   |                            | 1190   |
| Low level value of threshold voltage                           | $V_{T(TO)1}$  | $(16.7 \% \times \pi \times I_{T(AV)} < I < \pi \times I_{T(AV)})$ , $T_J$ maximum                           |                            | 0.8    |
| High level value of threshold voltage                          | $V_{T(TO)2}$  | $(I > \pi \times I_{T(AV)})$ , $T_J$ maximum                                                                 |                            | 0.98   |
| Low level value on-state slope resistance                      | $r_{t1}$      | $(16.7 \% \times \pi \times I_{T(AV)} < I < \pi \times I_{T(AV)})$ , $T_J$ maximum                           |                            | 1.67   |
| High level value on-state slope resistance                     | $r_{t2}$      | $(I > \pi \times I_{T(AV)})$ , $T_J$ maximum                                                                 |                            | 1.38   |
| Maximum on-state voltage drop                                  | $V_{TM}$      | $I_{TM} = \pi \times I_{T(AV)}$ , $T_J = 25\text{ °C}$ , 180° conduction                                     |                            | 1.54   |
| Maximum forward voltage drop                                   | $V_{FM}$      | $I_{TM} = \pi \times I_{T(AV)}$ , $T_J = 25\text{ °C}$ , 180° conduction                                     |                            | 1.54   |
| Maximum holding current                                        | $I_H$         | Anode supply = 6 V initial $I_T = 30\text{ A}$ , $T_J = 25\text{ °C}$                                        |                            | 200    |
| Maximum latching current                                       | $I_L$         | Anode supply = 6 V resistive load = 1 $\Omega$<br>Gate pulse: 10 V, 100 $\mu\text{s}$ , $T_J = 25\text{ °C}$ |                            | 400    |

| SWITCHING             |          |                                                                                                                                                                                      |                                                                                                 |           |               |
|-----------------------|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-----------|---------------|
| PARAMETER             | SYMBOL   | TEST CONDITIONS                                                                                                                                                                      |                                                                                                 | VALUES    | UNITS         |
| Typical delay time    | $t_{gd}$ | $T_J = 25\text{ }^{\circ}\text{C}$                                                                                                                                                   | Gate current = 1 A, $dI_g/dt = 1\text{ A}/\mu\text{s}$<br>$V_d = 0.67\text{ \% }V_{\text{DRM}}$ | 1         | $\mu\text{s}$ |
| Typical rise time     | $t_{gr}$ |                                                                                                                                                                                      |                                                                                                 | 2         |               |
| Typical turn-off time | $t_q$    | $I_{\text{TM}} = 300\text{ A}$ , $-dI/dt = 15\text{ A}/\mu\text{s}$ ; $T_J = T_J$ maximum<br>$V_R = 50\text{ V}$ ; $dV/dt = 20\text{ V}/\mu\text{s}$ ; gate 0 V, $100\text{ }\Omega$ |                                                                                                 | 50 to 200 |               |

| BLOCKING                                           |                          |                                                          |  |        |
|----------------------------------------------------|--------------------------|----------------------------------------------------------|--|--------|
| PARAMETER                                          | SYMBOL                   | TEST CONDITIONS                                          |  | VALUES |
| Maximum peak reverse and off-state leakage current | $I_{RRM}$ ,<br>$I_{DRM}$ | $T_J = 125\text{ °C}$                                    |  | 50     |
| RMS insulation voltage                             | $V_{INS}$                | 50 Hz, circuit to base, all terminals shorted, t = 1 s   |  | 3500   |
| Critical rate of rise of off-state voltage         | $dV/dt$                  | $T_J = T_J$ maximum, exponential to 67 % rated $V_{DRM}$ |  | 1000   |



| TRIGGERING                                  |                    |                                                                                                 |                                                          |        |       |  |
|---------------------------------------------|--------------------|-------------------------------------------------------------------------------------------------|----------------------------------------------------------|--------|-------|--|
| PARAMETER                                   | SYMBOL             | TEST CONDITIONS                                                                                 |                                                          | VALUES | UNITS |  |
| Maximum peak gate power                     | P <sub>GM</sub>    | t <sub>p</sub> ≤ 5 ms, T <sub>J</sub> = T <sub>J</sub> maximum                                  |                                                          | 12     | W     |  |
| Maximum average gate power                  | P <sub>G(AV)</sub> | f = 50 Hz, T <sub>J</sub> = T <sub>J</sub> maximum                                              |                                                          | 3      |       |  |
| Maximum peak gate current                   | I <sub>GM</sub>    | t <sub>p</sub> ≤ 5 ms, T <sub>J</sub> = T <sub>J</sub> maximum                                  |                                                          | 3      | A     |  |
| Maximum peak negative gate voltage          | - V <sub>GT</sub>  |                                                                                                 |                                                          | 10     | V     |  |
| Maximum required DC gate voltage to trigger | V <sub>GT</sub>    | T <sub>J</sub> = - 40 °C                                                                        | Anode supply = 6 V, resistive load; R <sub>a</sub> = 1 Ω | 4      |       |  |
|                                             |                    | T <sub>J</sub> = 25 °C                                                                          |                                                          | 2.5    |       |  |
|                                             |                    | T <sub>J</sub> = T <sub>J</sub> maximum                                                         |                                                          | 1.7    |       |  |
| Maximum required DC gate current to trigger | I <sub>GT</sub>    | T <sub>J</sub> = - 40 °C                                                                        |                                                          | 270    | mA    |  |
|                                             |                    | T <sub>J</sub> = 25 °C                                                                          |                                                          | 150    |       |  |
|                                             |                    | T <sub>J</sub> = T <sub>J</sub> maximum                                                         |                                                          | 80     |       |  |
| Maximum gate voltage that will not trigger  | V <sub>GD</sub>    | T <sub>J</sub> = T <sub>J</sub> maximum, rated V <sub>DRM</sub> applied                         |                                                          | 0.3    | V     |  |
| Maximum gate current that will not trigger  | I <sub>GD</sub>    |                                                                                                 |                                                          | 10     | mA    |  |
| Maximum rate of rise of turned-on current   | dI/dt              | T <sub>J</sub> = T <sub>J</sub> maximum, I <sub>TM</sub> = 400 A rated V <sub>DRM</sub> applied |                                                          | 300    | A/μs  |  |

| THERMAL AND MECHANICAL SPECIFICATIONS                     |                                   |                                                                                                                                                              |             |                  |
|-----------------------------------------------------------|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|------------------|
| PARAMETER                                                 | SYMBOL                            | TEST CONDITIONS                                                                                                                                              | VALUES      | UNITS            |
| Maximum junction operating temperature range              | $T_J$                             |                                                                                                                                                              | -40 to +125 | $^\circ\text{C}$ |
| Maximum storage temperature range                         | $T_{Stg}$                         |                                                                                                                                                              | -40 to +150 |                  |
| Maximum thermal resistance, junction to case per junction | $R_{thJC}$                        | DC operation                                                                                                                                                 | 0.16        | K/W              |
| Maximum thermal resistance, case to heat sink per module  | $R_{thCS}$                        | Mounting surface, smooth, flat and greased                                                                                                                   | 0.05        |                  |
| Mounting torque $\pm 10\%$                                | IAP to heat sink<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°    |       |
| VS-VSK.162                 | 0.0030                                             | 0.0031 | 0.0032 | 0.0033 | 0.0034 | 0.0029                                              | 0.0036 | 0.0039 | 0.0041 | 0.0040 | K/W   |

**Note**

- Table shows the increment of thermal resistance  $R_{thJC}$  when devices operate at different conduction angles than DC

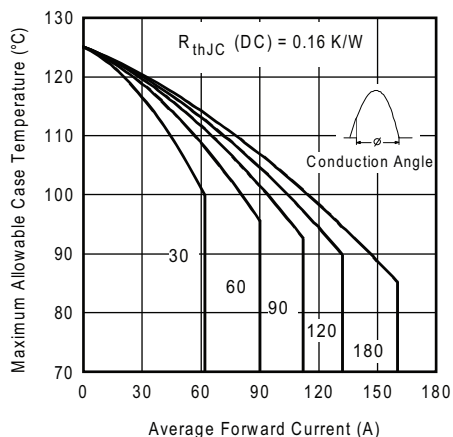


Fig. 1 - Current Ratings Characteristics

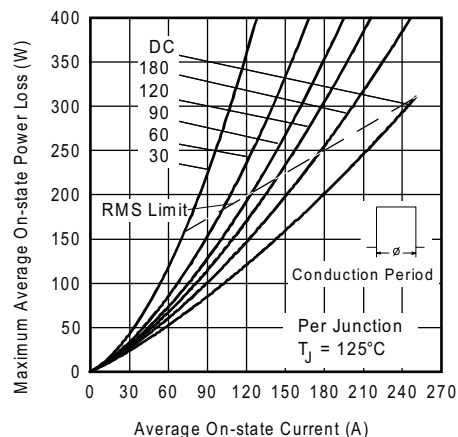


Fig. 4 - On-State Power Loss Characteristics

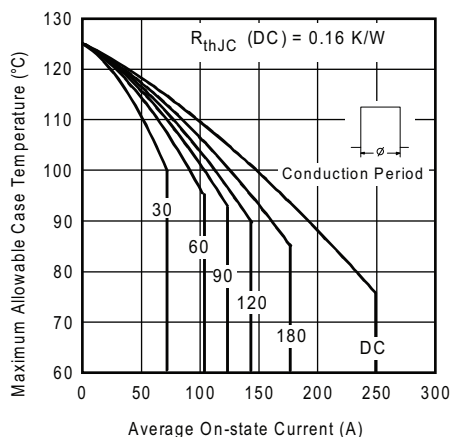


Fig. 2 - Current Ratings Characteristics

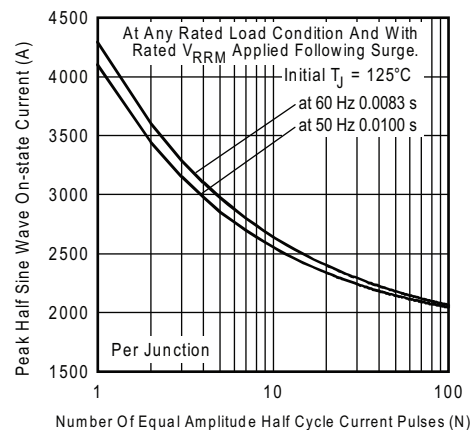


Fig. 5 - Maximum Non-Repetitive Surge Current

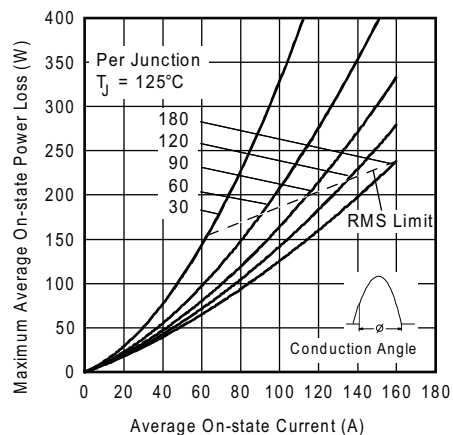


Fig. 3 - On-State Power Loss Characteristics

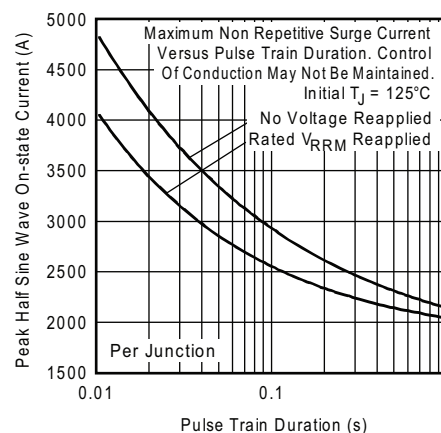


Fig. 6 - Maximum Non-Repetitive Surge Current

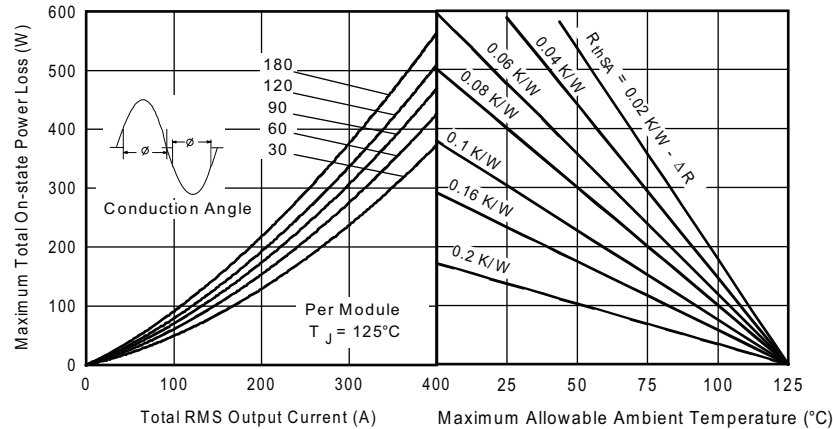


Fig. 7 - On-State Power Loss Characteristics

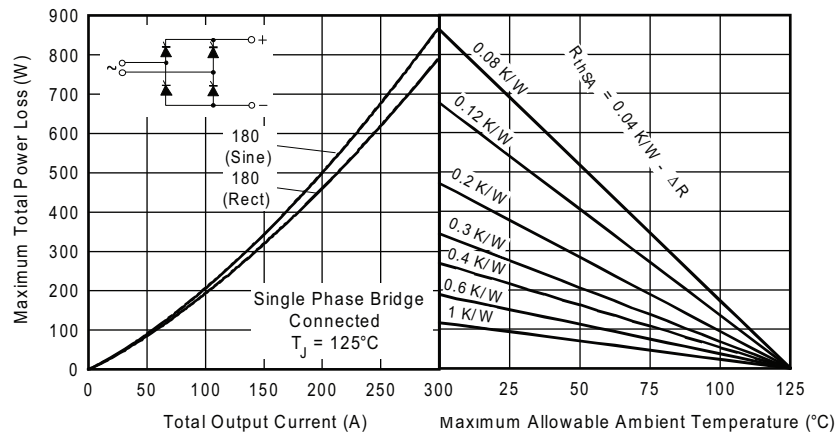


Fig. 8 - On-State Power Loss Characteristics

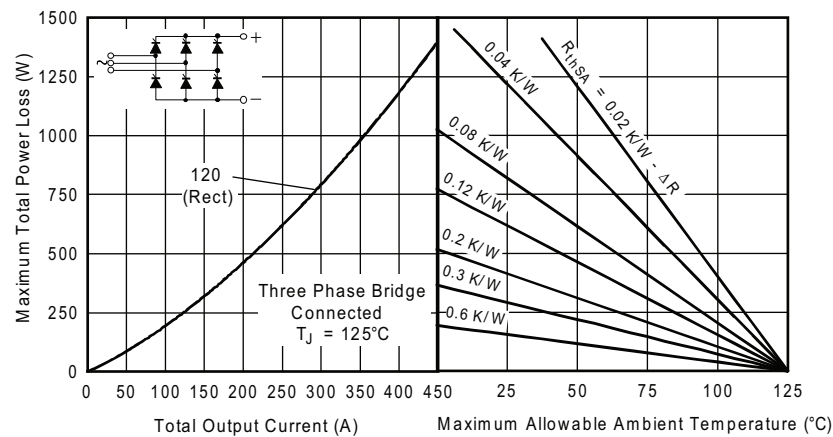


Fig. 9 - On-State Power Loss Characteristics

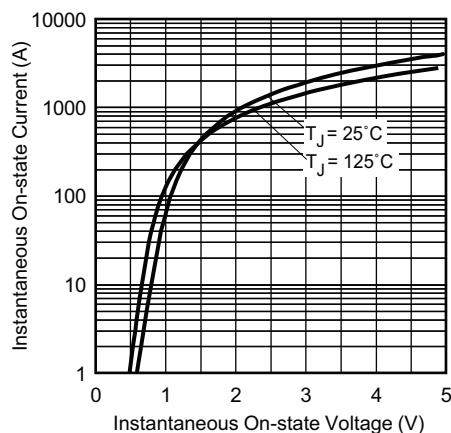


Fig. 10 - On-State Voltage Drop Characteristics

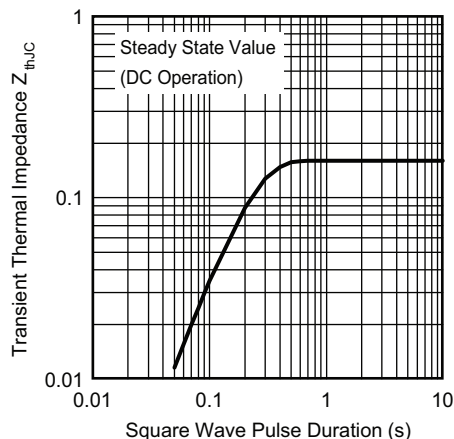
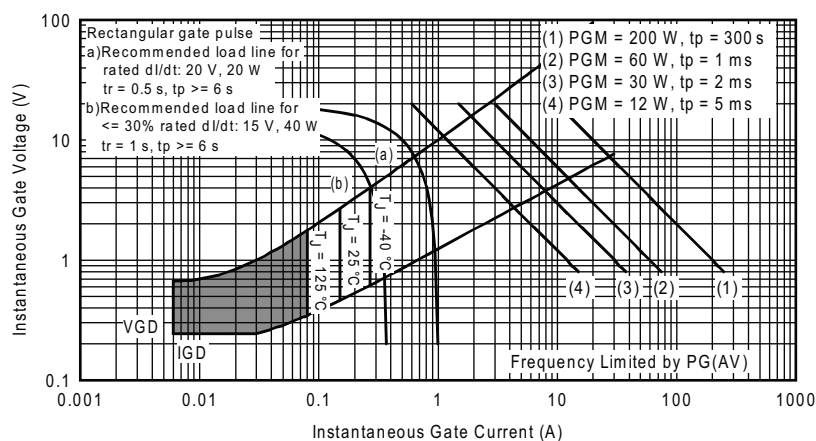
Fig. 11 - Thermal Impedance  $Z_{thJC}$  Characteristics

Fig. 12 - Gate Characteristics

**ORDERING INFORMATION TABLE**

| Device code | VS-VS | KU                             | 162 | 16 | PbF |
|-------------|-------|--------------------------------|-----|----|-----|
|             | ①     | ②                              | ③   | ④  | ⑤   |
| ①           | -     | Vishay Semiconductors product  |     |    |     |
| ②           | -     | Circuit configuration          |     |    |     |
| ③           | -     | Current rating: $I_{T(AV)}$    |     |    |     |
| 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 SCRs common cathodes | U                          | <p><b>VSKU</b></p> <p>1<br/>2<br/>3<br/>K1 G1 K2 G2</p> |
| Two SCRs common anodes   | V                          | <p><b>VSKV</b></p> <p>1<br/>2<br/>3<br/>K1 G1 K2 G2</p> |

| LINKS TO RELATED DOCUMENTS |                                                                        |
|----------------------------|------------------------------------------------------------------------|
| Dimensions                 | <a href="http://www.vishay.com/doc?95067">www.vishay.com/doc?95067</a> |

**DIMENSIONS** in millimeters (inches)





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