

## SCR/SCR and SCR/Diode (MAGN-A-PAK Power Modules), 170 A, 250 A



MAGN-A-PAK

### FEATURES

- High voltage
- Electrically isolated base plate
- 3500 V<sub>RMS</sub> isolating voltage
- Industrial standard package
- Simplified mechanical designs, rapid assembly
- High surge capability
- Large creepage distances
- UL approved file E78996 
- Designed and qualified for industrial level
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**RoHS**  
COMPLIANT

### PRIMARY CHARACTERISTICS

|             |                               |
|-------------|-------------------------------|
| $I_{T(AV)}$ | 170 A, 250 A                  |
| Type        | Modules - thyristor, standard |
| Package     | MAGN-A-PAK                    |

### DESCRIPTION

This VSK series of MAGN-A-PAK modules uses high voltage power thyristor/thyristor and thyristor/diode in seven basic configurations. The semiconductors are electrically isolated from the metal base, allowing common heatsinks and compact assemblies to be built. They can be interconnected to form single phase or three phase bridges or as AC-switches when modules are connected in anti-parallel mode. These modules are intended for general purpose applications such as battery chargers, welders, motor drives, UPS, etc.

### MAJOR RATINGS AND CHARACTERISTICS

| SYMBOL            | CHARACTERISTICS | VSK.170..   | VSK.250..   | UNITS              |
|-------------------|-----------------|-------------|-------------|--------------------|
| $I_{T(AV)}$       | 85 °C           | 170         | 250         | A                  |
| $I_{T(RMS)}$      |                 | 377         | 555         |                    |
| $I_{TSM}$         | 50 Hz           | 5100        | 8500        |                    |
|                   | 60 Hz           | 5350        | 8900        |                    |
| $I^2t$            | 50 Hz           | 131         | 361         | kA <sup>2</sup> s  |
|                   | 60 Hz           | 119         | 330         |                    |
| $I^2\sqrt{t}$     |                 | 1310        | 3610        | kA <sup>2</sup> √s |
| $V_{DRM}/V_{RRM}$ |                 | 400 to 1600 | 400 to 2000 | V                  |
| $T_J$             | Range           | -40 to +130 |             | °C                 |



## ELECTRICAL SPECIFICATIONS

| VOLTAGE RATINGS |              |                                                                                         |                                                              |                                              |
|-----------------|--------------|-----------------------------------------------------------------------------------------|--------------------------------------------------------------|----------------------------------------------|
| TYPE NUMBER     | VOLTAGE CODE | $V_{RRM}/V_{DRM}$ , MAXIMUM REPETITIVE PEAK REVERSE AND OFF-STATE BLOCKING VOLTAGE<br>V | $V_{RSM}$ , MAXIMUM NON-REPETITIVE PEAK REVERSE VOLTAGE<br>V | $I_{RRM}/I_{DRM}$ AT 130 °C<br>MAXIMUM<br>mA |
| VS-VSK.170-     | 04           | 400                                                                                     | 500                                                          | 50                                           |
|                 | 08           | 800                                                                                     | 900                                                          |                                              |
|                 | 10           | 1000                                                                                    | 1100                                                         |                                              |
|                 | 12           | 1200                                                                                    | 1300                                                         |                                              |
|                 | 14           | 1400                                                                                    | 1500                                                         |                                              |
|                 | 16           | 1600                                                                                    | 1700                                                         |                                              |
| VS-VSK.250-     | 04           | 400                                                                                     | 500                                                          | 50                                           |
|                 | 08           | 800                                                                                     | 900                                                          |                                              |
|                 | 10           | 1000                                                                                    | 1100                                                         |                                              |
|                 | 12           | 1200                                                                                    | 1300                                                         |                                              |
|                 | 14           | 1400                                                                                    | 1500                                                         |                                              |
|                 | 16           | 1600                                                                                    | 1700                                                         |                                              |
|                 | 18           | 1800                                                                                    | 1900                                                         | 60                                           |
|                 | 20           | 2000                                                                                    | 2100                                                         |                                              |

| ON-STATE CONDUCTION                                            |                     |                                                                                                                                                                                                                     |                                  |                                                                       |         |         |                    |  |
|----------------------------------------------------------------|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|-----------------------------------------------------------------------|---------|---------|--------------------|--|
| PARAMETER                                                      | SYMBOL              | TEST CONDITIONS                                                                                                                                                                                                     |                                  |                                                                       | VSK.170 | VSK.250 | UNITS              |  |
| Maximum average on-state current at case temperature           | I <sub>T(AV)</sub>  | 180° conduction, half sine wave                                                                                                                                                                                     |                                  |                                                                       | 170     | 250     | A                  |  |
|                                                                |                     |                                                                                                                                                                                                                     |                                  |                                                                       | 85      | 85      | °C                 |  |
| Maximum RMS on-state current                                   | I <sub>T(RMS)</sub> | As AC switch                                                                                                                                                                                                        |                                  |                                                                       | 377     | 555     | A                  |  |
| Maximum peak, one-cycle on-state non-repetitive, surge current | I <sub>TSM</sub>    | t = 10 ms                                                                                                                                                                                                           | No voltage reapplied             | Sinusoidal half wave, initial T <sub>J</sub> = T <sub>J</sub> maximum | 5100    | 8500    |                    |  |
|                                                                |                     | t = 8.3 ms                                                                                                                                                                                                          |                                  |                                                                       | 5350    | 8900    |                    |  |
|                                                                |                     | t = 10 ms                                                                                                                                                                                                           | 100 % V <sub>RRM</sub> reapplied |                                                                       | 4300    | 7150    |                    |  |
|                                                                |                     | t = 8.3 ms                                                                                                                                                                                                          |                                  |                                                                       | 4500    | 7500    |                    |  |
| Maximum I <sup>2</sup> t for fusing                            | I <sup>2</sup> t    | t = 10 ms                                                                                                                                                                                                           | No voltage reapplied             |                                                                       | 131     | 361     | kA <sup>2</sup> s  |  |
|                                                                |                     | t = 8.3 ms                                                                                                                                                                                                          |                                  |                                                                       | 119     | 330     |                    |  |
|                                                                |                     | t = 10 ms                                                                                                                                                                                                           | 100 % V <sub>RRM</sub> reapplied |                                                                       | 92.5    | 255     |                    |  |
|                                                                |                     | t = 8.3 ms                                                                                                                                                                                                          |                                  |                                                                       | 84.4    | 233     |                    |  |
| Maximum I <sup>2</sup> √t for fusing                           | I <sup>2</sup> √t   | t = 0.1 ms to 10 ms, no voltage reapplied                                                                                                                                                                           |                                  |                                                                       | 1310    | 3610    | kA <sup>2</sup> √s |  |
| Low level value or threshold voltage                           | V <sub>T(TO)1</sub> | (16.7 % × π × I <sub>T(AV)</sub> < I < π × I <sub>T(AV)</sub> ), T <sub>J</sub> = T <sub>J</sub> maximum                                                                                                            |                                  |                                                                       | 0.89    | 0.97    | V                  |  |
| High level value of threshold voltage                          | V <sub>T(TO)2</sub> | (I > π × I <sub>T(AV)</sub> ), T <sub>J</sub> = T <sub>J</sub> maximum                                                                                                                                              |                                  |                                                                       | 1.12    | 1.00    |                    |  |
| Low level value on-state slope resistance                      | r <sub>t1</sub>     | (16.7 % × π × I <sub>T(AV)</sub> < I < π × I <sub>T(AV)</sub> ), T <sub>J</sub> = T <sub>J</sub> maximum                                                                                                            |                                  |                                                                       | 1.34    | 0.60    | mΩ                 |  |
| High level value on-state slope resistance                     | r <sub>t2</sub>     | (I > π × I <sub>T(AV)</sub> ), T <sub>J</sub> = T <sub>J</sub> maximum                                                                                                                                              |                                  |                                                                       | 0.96    | 0.57    |                    |  |
| Maximum on-state voltage drop                                  | V <sub>TM</sub>     | I <sub>TM</sub> = π × I <sub>T(AV)</sub> , T <sub>J</sub> = T <sub>J</sub> maximum, 180° conduction, average power = V <sub>T(TO)</sub> × I <sub>T(AV)</sub> + r <sub>f</sub> × (I <sub>T(RMS)</sub> ) <sup>2</sup> |                                  |                                                                       | 1.60    | 1.44    | V                  |  |
| Maximum holding current                                        | I <sub>H</sub>      | Anode supply = 12 V, initial I <sub>T</sub> = 30 A, T <sub>J</sub> = 25 °C                                                                                                                                          |                                  |                                                                       | 500     | 500     | mA                 |  |
| Maximum latching current                                       | I <sub>L</sub>      | Anode supply = 12 V, resistive load = 1 Ω, gate pulse: 10 V, 100 μs, T <sub>J</sub> = 25 °C                                                                                                                         |                                  |                                                                       | 1000    | 1000    |                    |  |



| SWITCHING             |                |                                                                                                                                               |           |         |       |
|-----------------------|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------|-----------|---------|-------|
| PARAMETER             | SYMBOL         | TEST CONDITIONS                                                                                                                               | VSK.170   | VSK.250 | UNITS |
| Typical delay time    | t <sub>d</sub> | T <sub>J</sub> = 25 °C, gate current = 1 A dI <sub>g</sub> /dt = 1 A/μs<br>V <sub>d</sub> = 0.67 % V <sub>DRM</sub>                           | 1.0       |         | μs    |
| Typical rise time     | t <sub>r</sub> |                                                                                                                                               | 2.0       |         |       |
| Typical turn-off time | t <sub>q</sub> | I <sub>TM</sub> = 300 A; dI/dt = 15 A/μs; T <sub>J</sub> = T <sub>J</sub> maximum;<br>V <sub>R</sub> = 50 V; dV/dt = 20 V/μs; gate 0 V, 100 Ω | 50 to 150 |         |       |

| BLOCKING                                           |                          |                                                                          |         |         |                  |
|----------------------------------------------------|--------------------------|--------------------------------------------------------------------------|---------|---------|------------------|
| PARAMETER                                          | SYMBOL                   | TEST CONDITIONS                                                          | VSK.170 | VSK.250 | UNITS            |
| Maximum peak reverse and off-state leakage current | $I_{RRM}$ ,<br>$I_{DRM}$ | $T_J = T_J$ maximum                                                      | 50      | 60      | mA               |
| RMS insulation voltage                             | $V_{INS}$                | 50 Hz, circuit to base, all terminals shorted, 25 $^\circ\text{C}$ , 1 s | 3000    |         | V                |
| Critical rate of rise of off-state voltage         | $dV/dt$                  | $T_J = T_J$ maximum, exponential to 67 % rated $V_{DRM}$                 | 1000    |         | V/ $\mu\text{s}$ |

| TRIGGERING                                  |             |                                                                        |         |         |                  |
|---------------------------------------------|-------------|------------------------------------------------------------------------|---------|---------|------------------|
| PARAMETER                                   | SYMBOL      | TEST CONDITIONS                                                        | VSK.170 | VSK.250 | UNITS            |
| Maximum peak gate power                     | $P_{GM}$    | $t_p \leq 5\text{ ms}$ , $T_J = T_J$ maximum                           | 10.0    |         | W                |
| Maximum average gate power                  | $P_{G(AV)}$ | $f = 50\text{ Hz}$ , $T_J = T_J$ maximum                               | 2.0     |         |                  |
| Maximum peak gate current                   | + $I_{GM}$  | $t_p \leq 5\text{ ms}$ , $T_J = T_J$ maximum                           | 3.0     |         | A                |
| Maximum peak negative gate voltage          | - $V_{GT}$  | $t_p \leq 5\text{ ms}$ , $T_J = T_J$ maximum                           | 5.0     |         | V                |
| Maximum required DC gate voltage to trigger | $V_{GT}$    | $T_J = -40\text{ }^\circ\text{C}$                                      | 4.0     |         |                  |
|                                             |             | $T_J = 25\text{ }^\circ\text{C}$                                       | 3.0     |         |                  |
|                                             |             | $T_J = T_J$ maximum                                                    | 2.0     |         |                  |
| Maximum required DC gate current to trigger | $I_{GT}$    | $T_J = -40\text{ }^\circ\text{C}$                                      | 350     |         | mA               |
|                                             |             | $T_J = 25\text{ }^\circ\text{C}$                                       | 200     |         |                  |
|                                             |             | $T_J = T_J$ maximum                                                    | 100     |         |                  |
| Maximum gate voltage that will not trigger  | $V_{GD}$    | $T_J = T_J$ maximum, rated $V_{DRM}$ applied                           | 0.25    |         | V                |
| Maximum gate current that will not trigger  | $I_{GD}$    | $T_J = T_J$ maximum, rated $V_{DRM}$ applied                           | 10.0    |         | mA               |
| Maximum rate of rise of turned-on current   | $dI/dt$     | $T_J = T_J$ maximum, $I_{TM} = 400\text{ A}$ , rated $V_{DRM}$ applied | 500     |         | A/ $\mu\text{s}$ |

| THERMAL AND MECHANICAL SPECIFICATIONS                     |                                                |                                                                                                                                                |             |         |                  |
|-----------------------------------------------------------|------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|-------------|---------|------------------|
| PARAMETER                                                 | SYMBOL                                         | TEST CONDITIONS                                                                                                                                | VSK.170     | VSK.250 | UNITS            |
| Junction operating and storage temperature range          | $T_J$ , $T_{Stg}$                              |                                                                                                                                                | -40 to +130 |         | $^\circ\text{C}$ |
| Maximum thermal resistance, junction to case per junction | $R_{thJC}$                                     | DC operation                                                                                                                                   | 0.17        | 0.125   | K/W              |
| Typical thermal resistance, case to heatsink per module   | $R_{thCS}$                                     | Mounting surface flat, smooth and greased                                                                                                      | 0.02        | 0.02    |                  |
| Mounting torque $\pm 10\%$                                | MAGN-A-PAK to heatsink<br>busbar to MAGN-A-PAK | A mounting compound is recommended and the torque should be rechecked after a period of about 3 hours to allow for the spread of the compound. | 4 to 6      |         | Nm               |
| Approximate weight                                        |                                                |                                                                                                                                                | 500         |         | g                |
|                                                           |                                                |                                                                                                                                                | 17.8        |         | oz.              |
| Case style                                                |                                                |                                                                                                                                                | MAGN-A-PAK  |         |                  |



## ΔR CONDUCTION PER JUNCTION

| 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.170- | 0.009                                           | 0.010 | 0.010 | 0.020 | 0.032 | 0.007                                            | 0.011 | 0.015 | 0.020 | 0.033 | K/W   |
| VSK.250- | 0.009                                           | 0.010 | 0.014 | 0.020 | 0.032 | 0.007                                            | 0.011 | 0.015 | 0.020 | 0.033 |       |

### Note

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

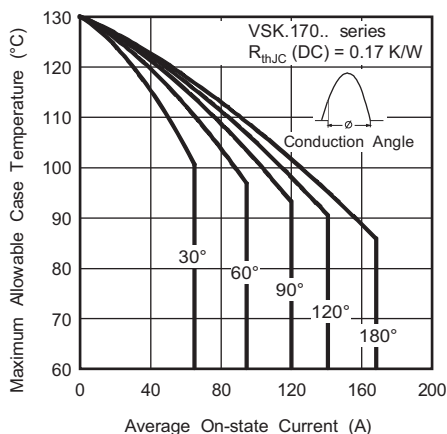


Fig. 1 - Current Ratings Characteristics

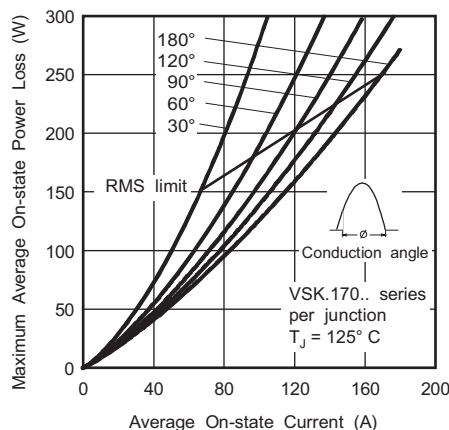


Fig. 3 - On-State Power Loss Characteristics

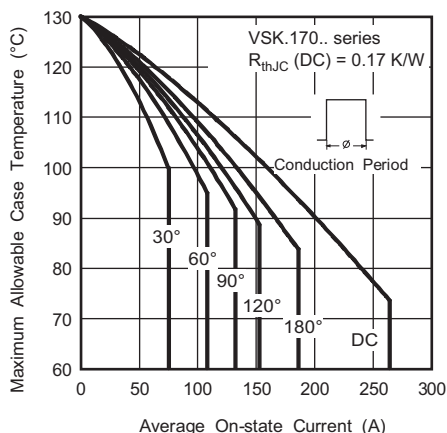


Fig. 2 - Current Ratings Characteristics

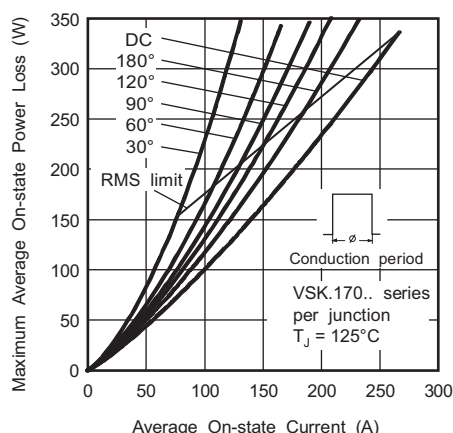


Fig. 4 - On-State Power Loss Characteristics

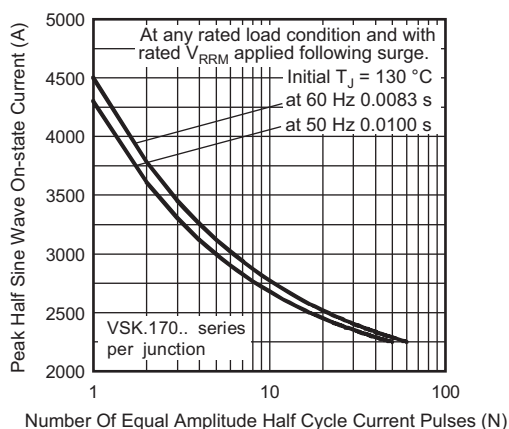


Fig. 5 - Maximum Non-Repetitive Surge Current

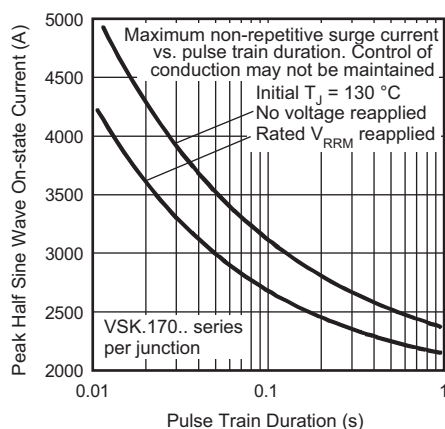


Fig. 6 - Maximum Non-Repetitive Surge Current

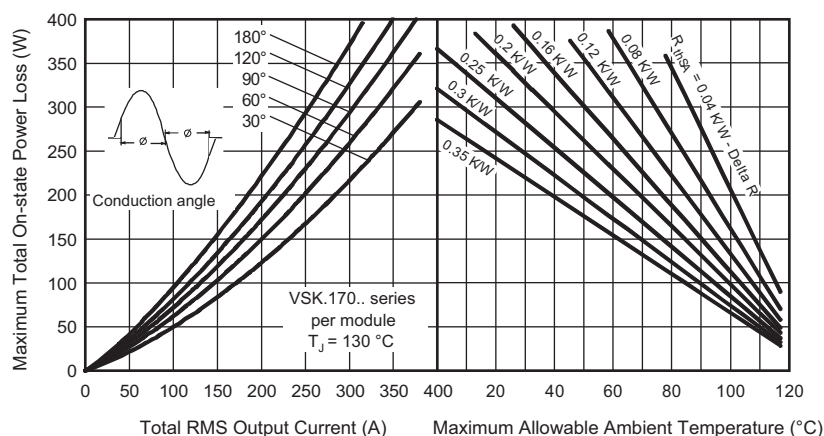


Fig. 7 - On-State Power Loss Characteristics

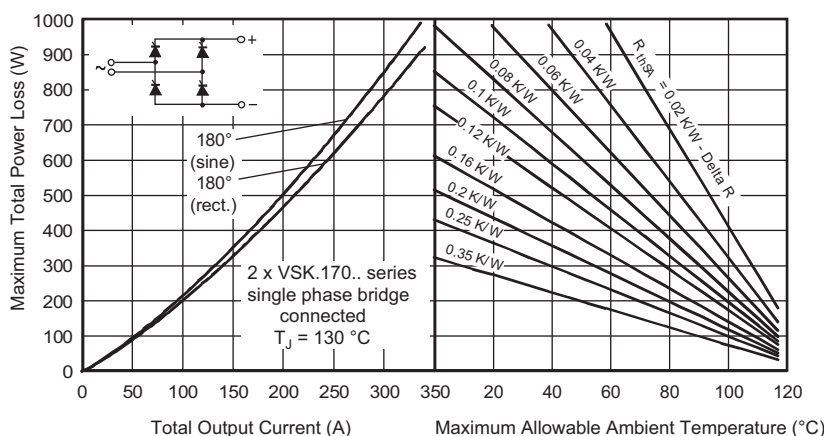


Fig. 8 - On-State Power Loss Characteristics

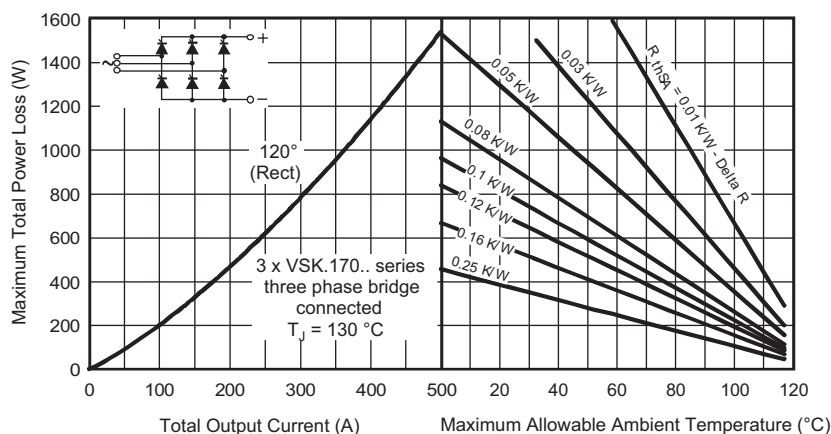


Fig. 9 - On-State Power Loss Characteristics

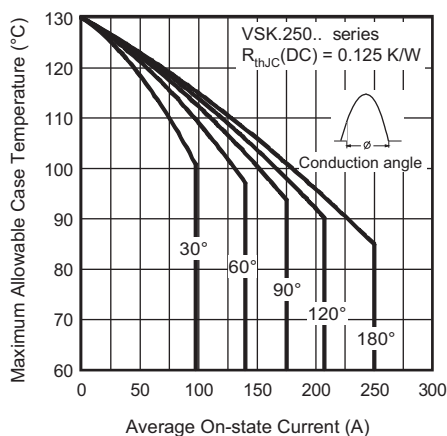


Fig. 10 - Current Ratings Characteristics

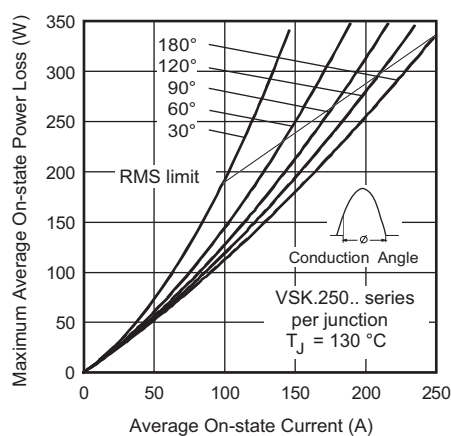


Fig. 12 - On-State Power Loss Characteristics

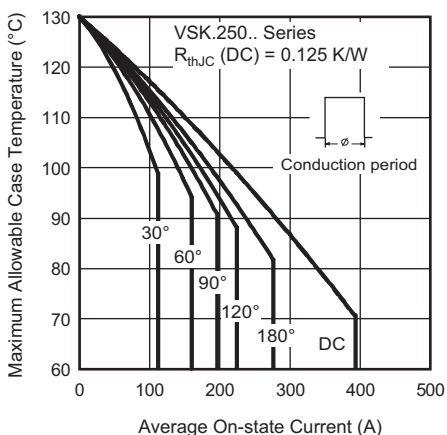


Fig. 11 - Current Ratings Characteristics

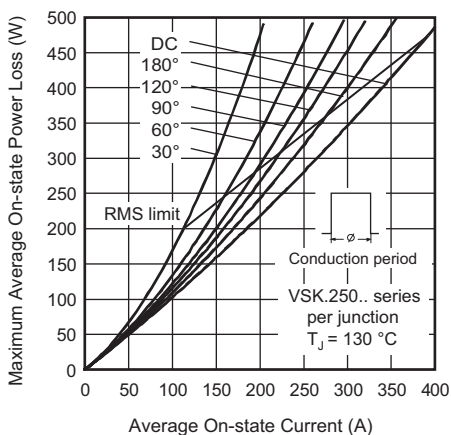


Fig. 13 - On-State Power Loss Characteristics

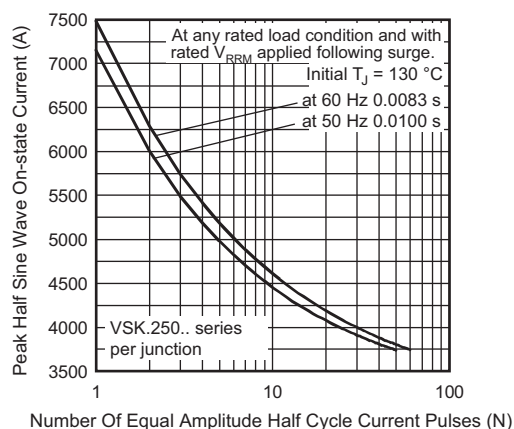


Fig. 14 - Maximum Non-Repetitive Surge Current

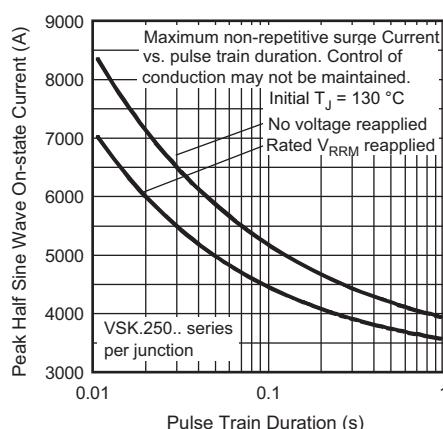


Fig. 15 - Maximum Non-Repetitive Surge Current

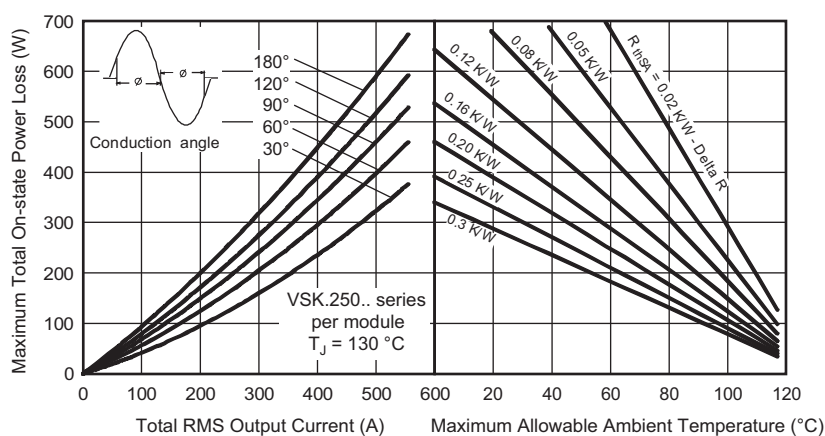


Fig. 16 - On-State Power Loss Characteristics

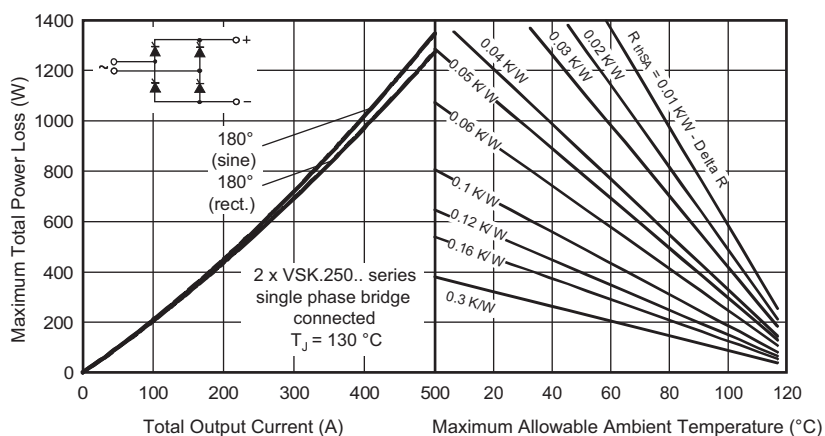


Fig. 17 - On-State Power Loss Characteristics

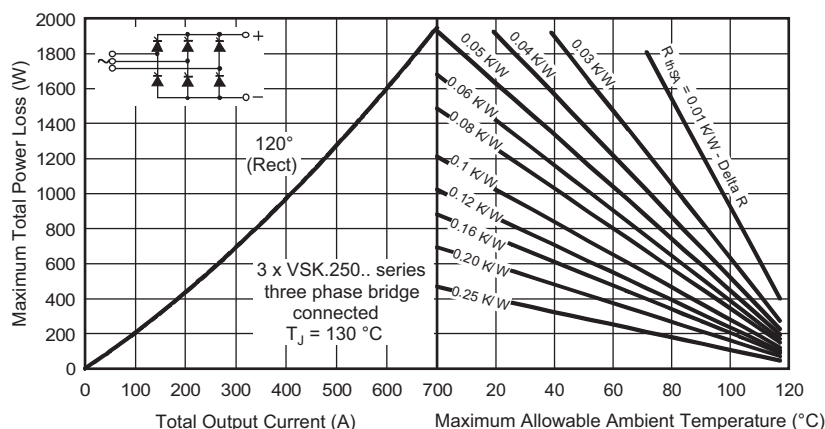


Fig. 18 - On-State Power Loss Characteristics

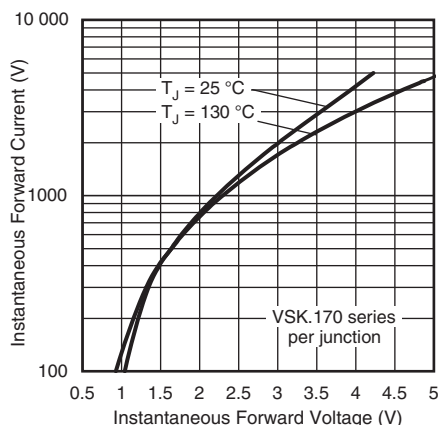


Fig. 19 - On-State Voltage Drop Characteristics

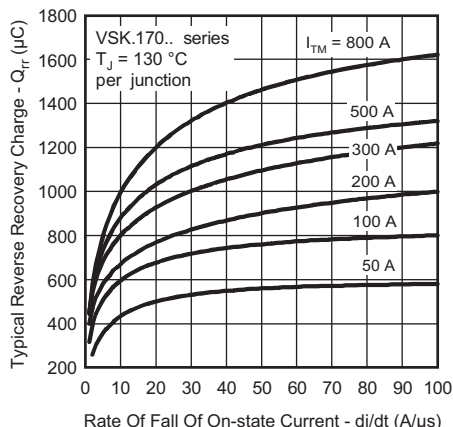


Fig. 21 - Reverse Recovery Charge Characteristics

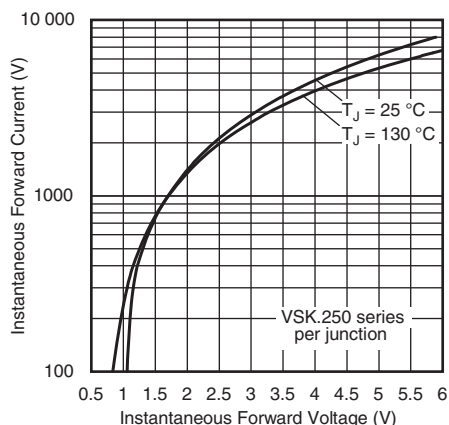


Fig. 20 - On-State Voltage Drop Characteristics

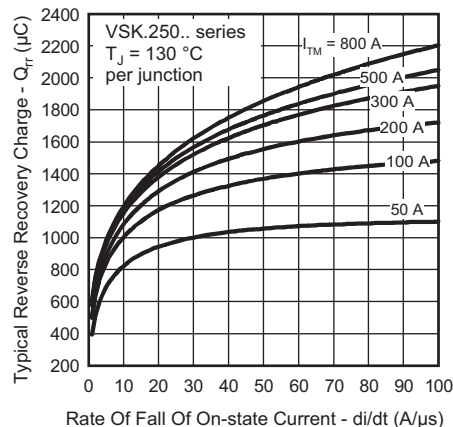


Fig. 22 - Reverse Recovery Charge Characteristics

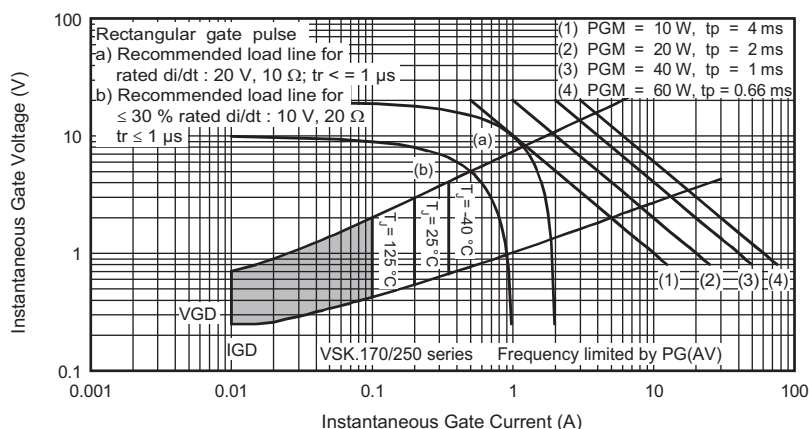
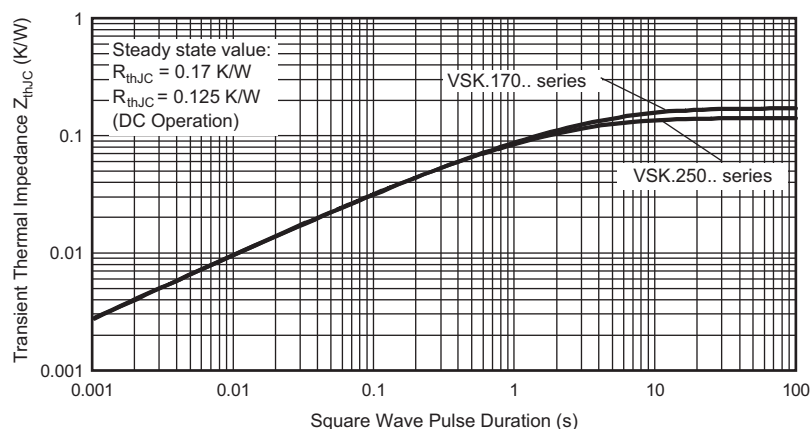


Fig. 23 - Gate Characteristics


Fig. 24 - Thermal Impedance  $Z_{thJC}$  Characteristics

## ORDERING INFORMATION TABLE

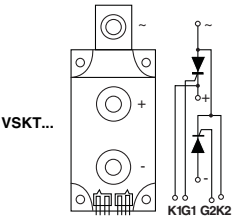
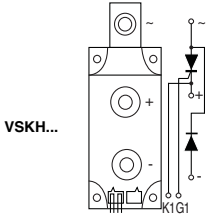
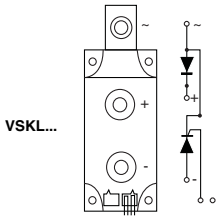
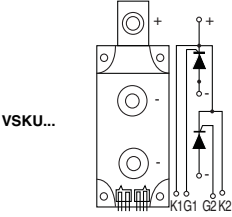
| Device code | VS-VS | KT | 250 | - | 20 | PbF |
|-------------|-------|----|-----|---|----|-----|
|-------------|-------|----|-----|---|----|-----|

① ② ③ ④ ⑤

- ① - Vishay Semiconductors product
- ② - Circuit configuration (see dimensions - link at the end of datasheet)
- ③ - Current rating
- ④ - Voltage code x 100 =  $V_{RRM}$  (see Voltage Ratings table)
- ⑤ -
  - None = standard production
  - PbF = lead (Pb)-free

### Note

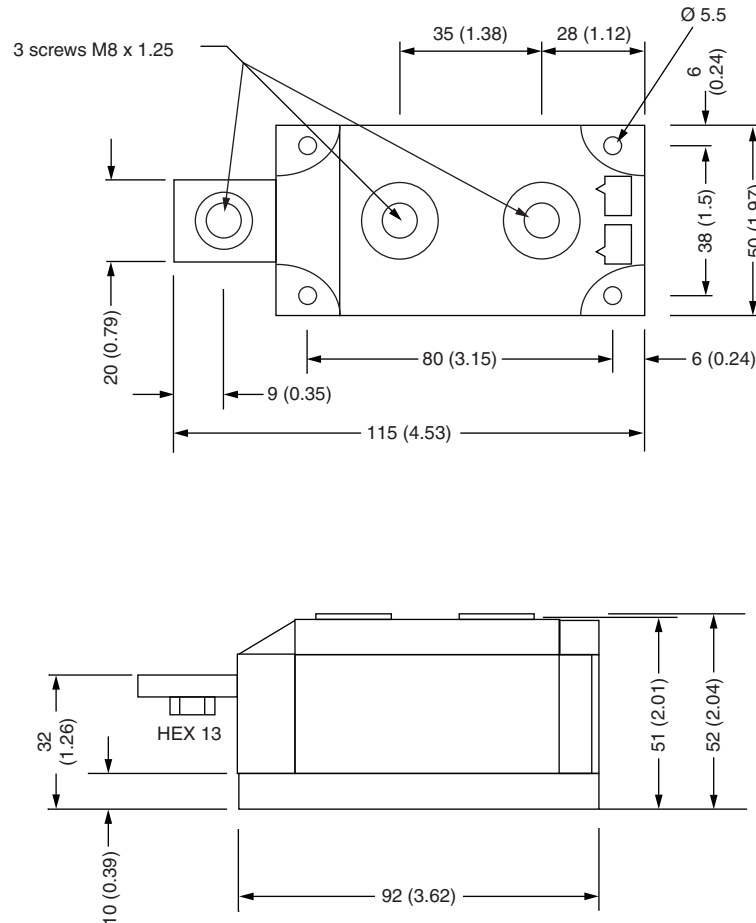
- To order the optional hardware go to [www.vishay.com/doc?95172](http://www.vishay.com/doc?95172)

| CIRCUIT CONFIGURATION                       |                            |                                                                                                                                                                |
|---------------------------------------------|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CIRCUIT DESCRIPTION                         | CIRCUIT CONFIGURATION CODE | CIRCUIT DRAWING                                                                                                                                                |
| Two SCRs doubler circuit                    | KT                         |  <p>Available up to 2000 V, contact factory for different requirement</p>   |
| SCR/diode doubler circuit, positive control | KH                         |  <p>Available up to 2000 V, contact factory for different requirement</p>   |
| SCR/diode doubler circuit, negative control | KL                         |  <p>Available up to 2000 V, contact factory for different requirement</p>  |
| Two SCRs common cathodes                    | KU                         |  <p>Available up to 1200 V, contact factory for different requirement</p> |

| LINKS TO RELATED DOCUMENTS |                                                                        |
|----------------------------|------------------------------------------------------------------------|
| Dimensions                 | <a href="http://www.vishay.com/doc?95086">www.vishay.com/doc?95086</a> |

## MAGN-A-PAK

**DIMENSIONS** in millimeters (inches)



### Notes

- Dimensions are nominal
- Full engineering drawings are available on request
- UL identification number for gate and cathode wire: UL 1385
- UL identification number for package: UL 94 V-0



## Disclaimer

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