

## Phase Control Thyristors (Stud Version), 180 A



TO-93 (TO-209AB)

### FEATURES

- Hermetic glass-metal seal
- International standard case TO-93 (TO-209AB)
- 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

### TYPICAL APPLICATIONS

- DC motor controls
- Controlled DC power supplies
- AC controllers

### PRIMARY CHARACTERISTICS

|                       |                      |
|-----------------------|----------------------|
| $I_{T(AV)}$           | 180 A                |
| $V_{DRM}/V_{RRM}$     | 400 V, 800 V, 1000 V |
| $V_{TM}$              | 1.35 V               |
| $I_{GT}$              | 65 mA                |
| $T_J$                 | -40 °C to +125 °C    |
| Package               | TO-93 (TO-209AB)     |
| Circuit configuration | Single SCR           |

### MAJOR RATINGS AND CHARACTERISTICS

| PARAMETER         | TEST CONDITIONS | VALUES      | UNITS             |
|-------------------|-----------------|-------------|-------------------|
| $I_{T(AV)}$       |                 | 180         | A                 |
|                   | $T_C$           | 80          | °C                |
| $I_{T(RMS)}$      |                 | 285         | A                 |
| $I_{TSM}$         | 50 Hz           | 3800        |                   |
|                   | 60 Hz           | 4000        |                   |
| $I^2t$            | 50 Hz           | 72          | kA <sup>2</sup> s |
|                   | 60 Hz           | 66          |                   |
| $V_{DRM}/V_{RRM}$ |                 | 400 to 1000 | V                 |
| $t_q$             | Typical         | 100         | µs                |
| $T_J$             |                 | -40 to +125 | °C                |

### ELECTRICAL SPECIFICATIONS

#### VOLTAGE RATINGS

| PART NUMBER            | VOLTAGE CODE | $V_{DRM}/V_{RRM}$ , MAXIMUM REPETITIVE PEAK AND OFF-STATE VOLTAGE<br>V | $V_{RSM}$ , MAXIMUM NON-REPETITIVE PEAK VOLTAGE<br>V | $I_{DRM}/I_{RRM}$ MAXIMUM AT $T_J = T_J$ MAXIMUM<br>mA |
|------------------------|--------------|--|--|--|
| VS-180RKI<br>VS-181RKI | 40           | 400  | 500  | 30   |
|                        | 80           | 800  | 900  |  |
|                        | 100          | 1000   | 1100   |  |



| <b>ABSOLUTE MAXIMUM RATINGS</b>                      |               |   |                            |        |                    |
|--|---------------|---|----------------------------|--------|--------------------|
| PARAMETER  | SYMBOL        | TEST CONDITIONS   |                            | VALUES | UNITS              |
| Maximum average on-state current at case temperature | $I_{T(AV)}$   | 180° conduction, half sine wave   |                            | 180    | A                  |
|  |               |   |                            | 80     | °C                 |
| Maximum RMS on-state current                         | $I_{RMS}$     | DC at 79 °C case temperature  |                            | 285    |                    |
| Maximum peak, one-cycle non-repetitive surge current | $I_{TSM}$     | t = 10 ms   | No voltage reappplied      | 3800   | A                  |
|  |               | t = 8.3 ms  |                            | 4000   |                    |
|  |               | t = 10 ms   | 100 % $V_{RRM}$ reappplied | 3500   |                    |
|  |               | t = 8.3 ms  |                            | 3660   |                    |
| Maximum $I^2t$ for fusing                            | $I^2t$        | t = 10 ms   | No voltage reappplied      | 72     | kA <sup>2</sup> s  |
|  |               | t = 8.3 ms  |                            | 66     |                    |
|  |               | t = 10 ms   | 100 % $V_{RRM}$ reappplied | 61     |                    |
|  |               | t = 8.3 ms  |                            | 56     |                    |
| Maximum $I^2\sqrt{t}$ for fusing                     | $I^2\sqrt{t}$ | t = 0.1 ms to 10 ms, no voltage reappplied  |                            | 720    | kA <sup>2</sup> √s |
| Low level value of threshold voltage                 | $V_{T(TO)1}$  | (16.7 % $\times \pi \times I_{T(AV)} < I < \pi \times I_{T(AV)}$ ), $T_J = T_J$ maximum |                            | 0.83   | V                  |
| High level value of threshold voltage                | $V_{T(TO)2}$  | (I > $\pi \times I_{T(AV)}$ ), $T_J = T_J$ maximum                                      |                            | 0.89   |                    |
| Low level value of on-state slope resistance         | $r_{t1}$      | (16.7 % $\times \pi \times I_{T(AV)} < I < \pi \times I_{T(AV)}$ ), $T_J = T_J$ maximum |                            | 0.92   | mΩ                 |
| High level value of on-state slope resistance        | $r_{t2}$      | (I > $\pi \times I_{T(AV)}$ ), $T_J = T_J$ maximum                                      |                            | 0.81   |                    |
| Maximum on-state voltage                             | $V_{TM}$      | $I_{pk} = 570$ A, $T_J = T_J$ maximum, $t_p = 10$ ms sine pulse                         |                            | 1.35   | V                  |
| Maximum holding current                              | $I_H$         | $T_J = 25$ °C, anode supply 12 V resistive load   |                            | 600    | mA                 |
| Typical latching current                             | $I_L$         |   |                            | 1000   |                    |

| <b>SWITCHING</b>   |         |  |  |        |       |
|--|---------|--|--|--------|-------|
| PARAMETER  | SYMBOL  | TEST CONDITIONS  |  | VALUES | UNITS |
| Maximum non-repetitive rate of rise of turned-on current | $di/dt$ | Gate drive 20 V, 20 Ω, $t_r \leq 1$ μs<br>$T_J = T_J$ maximum, anode voltage $\leq 80$ % $V_{DRM}$ |  | 300    | A/μs  |
| Typical delay time                                       | $t_d$   | Gate current 1 A, $di_g/dt = 1$ A/μs<br>$V_d = 0.67$ % $V_{DRM}$ , $T_J = 25$ °C                   |  | 1.0    | μs    |
| Typical turn-off time                                    | $t_q$   | $I_{TM} = 50$ A, $T_J = T_J$ maximum, $di/dt = 10$ A/μs,<br>$V_R = 100$ V, $dV/dt = 20$ V/μs       |  | 100    |       |

| <b>BLOCKING</b>                                    |                    |   |  |        |       |
|--|--------------------|---|--|--------|-------|
| PARAMETER  | SYMBOL             | TEST CONDITIONS                                     |  | VALUES | UNITS |
| Maximum critical rate of rise of off-state voltage | $dV/dt$            | $T_J = T_J$ maximum linear to 80 % rated $V_{DRM}$  |  | 500    | V/μs  |
| Maximum peak reverse and off-state leakage current | $I_{RRM}, I_{DRM}$ | $T_J = T_J$ maximum rated $V_{DRM}/V_{RRM}$ applied |  | 30     | mA    |



| TRIGGERING                          |             |  |        |      |       |
|-------------------------------------|-------------|--|--------|------|-------|
| PARAMETER                           | SYMBOL      | TEST CONDITIONS                              | VALUES |      | UNITS |
|                                     |             |  | TYP.   | MAX. |       |
| Maximum peak gate power             | $P_{GM}$    | $T_J = T_J$ maximum, $t_p \leq 5$ ms         | 10     |      | W     |
| Maximum average gate power          | $P_{G(AV)}$ | $T_J = T_J$ maximum, $f = 50$ Hz, $d\% = 50$ | 2.0    |      |       |
| Maximum peak positive gate current  | $I_{GM}$    | $T_J = T_J$ maximum, $t_p \leq 5$ ms         | 3.0    |      | A     |
| Maximum peak positive gate voltage  | $+V_{GM}$   |  | 20     |      | V     |
| Maximum peak negative gate voltage  | $-V_{GM}$   |  | 5.0    |      |       |
| DC gate current required to trigger | $I_{GT}$    | $T_J = -40$ °C                               | 130    | -    | mA    |
|                                     |             | $T_J = 25$ °C                                | 65     | 150  |       |
|                                     |             | $T_J = 125$ °C                               | 35     | -    |       |
| DC gate voltage required to trigger | $V_{GT}$    | $T_J = -40$ °C                               | 2.0    | -    | V     |
|                                     |             | $T_J = 25$ °C                                | 1.2    | 2.5  |       |
|                                     |             | $T_J = 125$ °C                               | 0.9    | -    |       |
| DC gate current not to trigger      | $I_{GD}$    | $T_J = T_J$ maximum                          | 10     |      | mA    |
| DC gate voltage not to trigger      | $V_{GD}$    |  | 0.25   |      | V     |

| THERMAL AND MECHANICAL SPECIFICATIONS           |            |   |                  |                     |
|---|------------|---|------------------|---------------------|
| PARAMETER                                       | SYMBOL     | TEST CONDITIONS                               | VALUES           | UNITS               |
| Maximum operating junction temperature range    | $T_J$      |   | -40 to 125       | °C                  |
| Maximum storage temperature range               | $T_{Stg}$  |   | -40 to 150       |                     |
| Maximum thermal resistance, junction to case    | $R_{thJC}$ | DC operation                                  | 0.15             | K/W                 |
| Maximum thermal resistance, junction to ambient | $R_{thCS}$ | Mounting surface, smooth, flat and greased    | 0.04             |                     |
| Mounting force, $\pm 10$ %                      |            | Non-lubricated threads                        | 31<br>(275)      | N · m<br>(lbf · in) |
|   |            | Lubricated threads                            | 24.5<br>(210)    |                     |
| Approximate weight                              |            |   | 280              | g                   |
| Case style                                      |            | See dimensions - link at the end of datasheet | TO-93 (TO-209AB) |                     |

| $\Delta R_{thJC}$ CONDUCTION |                       |                        |                     |       |
|------------------------------|-----------------------|------------------------|---------------------|-------|
| CONDUCTION ANGLE             | SINUSOIDAL CONDUCTION | RECTANGULAR CONDUCTION | TEST CONDITIONS     | UNITS |
| 180°                         | 0.050                 | 0.032                  | $T_J = T_J$ maximum | K/W   |
| 120°                         | 0.063                 | 0.059                  |                     |       |
| 90°                          | 0.080                 | 0.082                  |                     |       |
| 60°                          | 0.118                 | 0.124                  |                     |       |
| 30°                          | 0.225                 | 0.228                  |                     |       |

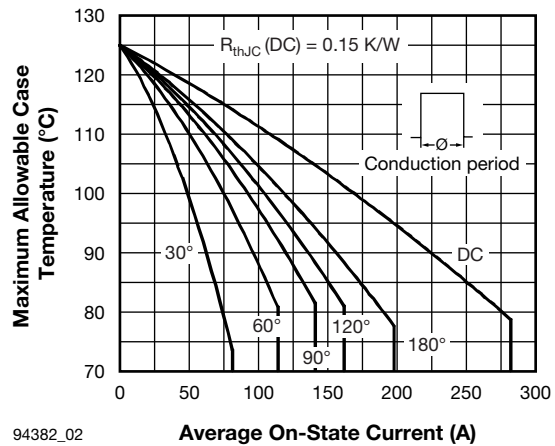
**Note**

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



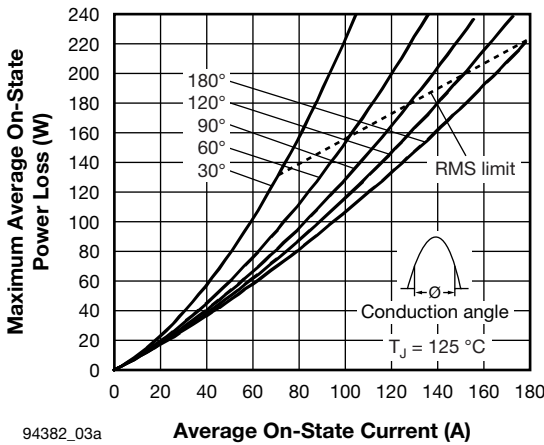
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Fig. 1 - Current Ratings Characteristics

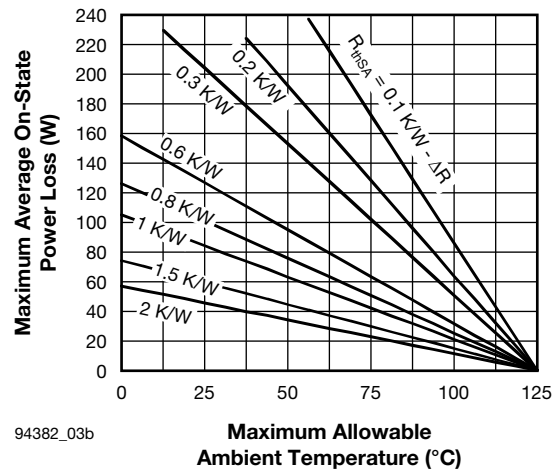


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Fig. 2 - Current Ratings Characteristics

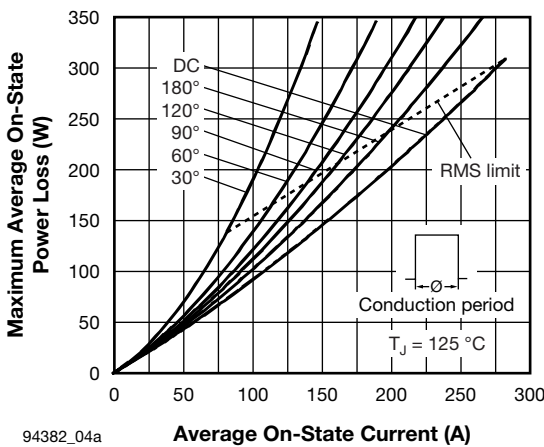


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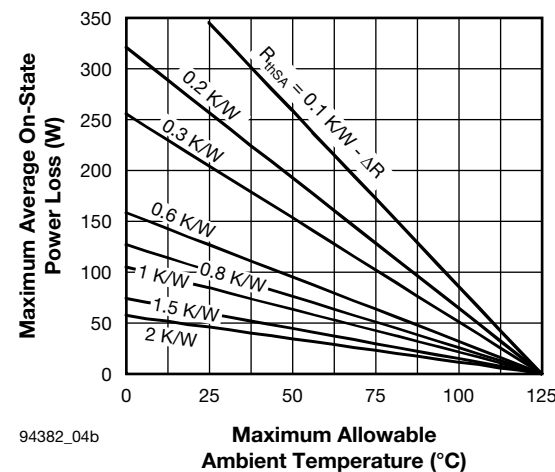


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Fig. 3 - On-State Power Loss Characteristics



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Fig. 4 - On-State Power Loss Characteristics

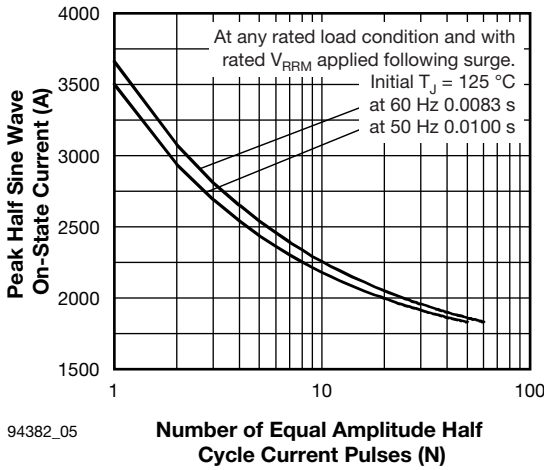


Fig. 5 - Maximum Non-Repetitive Surge Current



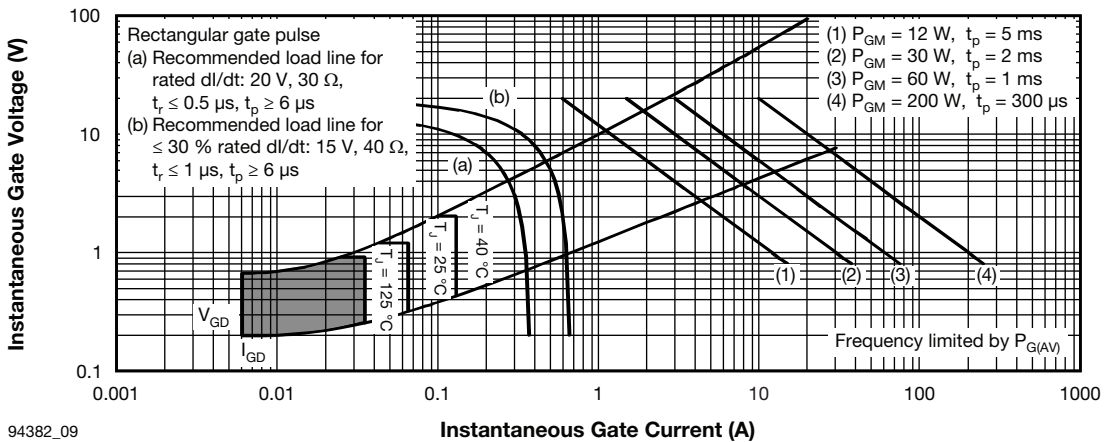
Fig. 6 - Maximum Non-Repetitive Surge Current



Fig. 7 - On-State Voltage Drop Characteristics



Fig. 8 - Thermal impedance  $Z_{thJC}$  Characteristics



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Fig. 9 - Gate Characteristics

## ORDERING INFORMATION TABLE

|             |            |           |   |            |            |            |
|-------------|------------|-----------|---|------------|------------|------------|
| Device code | <b>VS-</b> | <b>18</b> | <b>1</b>  | <b>RKI</b> | <b>100</b> | <b>PbF</b> |
|             | (1)        | (2)       | (3)   | (4)        | (5)        | (6)        |
|             | <b>1</b>   | -         | Vishay Semiconductors product   |            |            |            |
|             | <b>2</b>   | -         | $I_{T(AV)}$ rated average output current (rounded/10)   |            |            |            |
|             | <b>3</b>   | -         | <ul style="list-style-type: none"> <li>0 = eyelet terminals (gate and auxiliary cathode leads)</li> <li>1 = fast-on terminals (gate and auxiliary cathode leads)</li> </ul> |            |            |            |
|             | <b>4</b>   | -         | Thyristor   |            |            |            |
|             | <b>5</b>   | -         | Voltage code x 10 = $V_{RRM}$ (see Voltage Ratings table)   |            |            |            |
|             | <b>6</b>   | -         | <ul style="list-style-type: none"> <li>None = standard production</li> <li>PbF = lead (Pb)-free</li> </ul>  |            |            |            |

### LINKS TO RELATED DOCUMENTS

|            |  |
|------------|--|
| Dimensions | <a href="http://www.vishay.com/doc?95077">www.vishay.com/doc?95077</a> |
|------------|--|

## TO-209AB (TO-93)

**DIMENSIONS** in millimeters (inches)





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