

## Phase Control Thyristors (Stud Version), 230 A



TO-93 (TO-209AB)

### FEATURES

- Center amplifying gate
- International standard case TO-93 (TO-209AB)
- Hermetic metal case with ceramic insulator
- Compression bonded encapsulation for heavy duty operations such as severe thermal cycling
- 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 |                   |
|-------------------------|-------------------|
| $I_{T(AV)}$             | 230 A             |
| $V_{DRM}/V_{RRM}$       | 1400 V, 1600 V    |
| $V_{TM}$                | 1.55 V            |
| $I_{GT}$                | 150 mA            |
| $T_J$                   | -40 °C to +125 °C |
| Package                 | TO-93 (TO-209AB)  |
| Circuit configuration   | Single SCR        |

### TYPICAL APPLICATIONS

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

| MAJOR RATINGS AND CHARACTERISTICS |                 |              |                   |
|-----------------------------------|-----------------|--------------|-------------------|
| PARAMETER                         | TEST CONDITIONS | VALUES       | UNITS             |
| $I_{T(AV)}$                       |                 | 230          | A                 |
|                                   | $T_C$           | 85           | °C                |
| $I_{T(RMS)}$                      |                 | 360          | A                 |
| $I_{TSM}$                         | 50 Hz           | 5700         | A                 |
|                                   | 60 Hz           | 5970         |                   |
| $I^2t$                            | 50 Hz           | 163          | kA <sup>2</sup> s |
|                                   | 60 Hz           | 149          |                   |
| $V_{DRM}/V_{RRM}$                 |                 | 1400 to 1600 | V                 |
| $t_q$                             | Typical         | 100          | μs                |
| $T_J$                             |                 | -40 to +125  | °C                |

### ELECTRICAL SPECIFICATIONS

| VOLTAGE RATINGS |              |  |  |  |
|-----------------|--------------|--|--|--|
| TYPE 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-ST230S       | 14           | 1400   | 1500   | 30   |
|                 | 16           | 1600   | 1700   |  |



| <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   |                           | 230        | A                  |
|  |               |   |                           | 85         | °C                 |
| Maximum RMS on-state current                         | $I_{T(RMS)}$  | DC at 78 °C case temperature  |                           | 360        | A                  |
| Maximum peak, one-cycle non-repetitive surge current | $I_{TSM}$     | t = 10 ms   | No voltage reapplied      | 5700       |                    |
|  |               | t = 8.3 ms  | No voltage reapplied      | 5970       |                    |
|  |               | t = 10 ms   | 100 % $V_{RRM}$ reapplied | 4800       |                    |
|  |               | t = 8.3 ms  | 100 % $V_{RRM}$ reapplied | 5000       |                    |
| Maximum $I^2t$ for fusing                            | $I^2t$        | t = 10 ms   | No voltage reapplied      | 163        | kA <sup>2</sup> s  |
|  |               | t = 8.3 ms  | No voltage reapplied      | 148        |                    |
|  |               | t = 10 ms   | 100 % $V_{RRM}$ reapplied | 115        |                    |
|  |               | t = 8.3 ms  | 100 % $V_{RRM}$ reapplied | 105        |                    |
| Maximum $I^2\sqrt{t}$ for fusing                     | $I^2\sqrt{t}$ | t = 0.1 to 10 ms, no voltage reapplied  |                           | 1630       | 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 |                           | 0.92       | V                  |
| High level value of threshold voltage                | $V_{T(TO)2}$  | (I $> \pi \times I_{T(AV)}$ ), $T_J = T_J$ maximum                                      |                           | 0.98       |                    |
| 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 |                           | 0.88       | 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                             | $V_{TM}$      | $I_{pk} = 720$ A, $T_J = T_J$ maximum, $t_p = 10$ ms sine pulse                         |                           | 1.55       | V                  |
| Maximum holding current                              | $I_H$         | $T_J = 25$ °C, anode supply 12 V resistive load   |                           | 600        | mA                 |
| Maximum (typical) latching current                   | $I_L$         |   |                           | 1000 (300) |                    |

| <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 $\leq 80$ % $V_{DRM}$                             |  | 1000   | 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                                    | $t_q$  | $I_{TM} = 300$ A, $T_J = T_J$ maximum, $di_f/dt = 20$ A/μs,<br>$V_R = 50$ V, $dV/dt = 20$ V/μs, gate 0 V 100 Ω, $t_p = 500$ 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 | $I_{RRM}$ ,<br>$I_{DRM}$ | $T_J = T_J$ maximum, rated $V_{DRM}/V_{RRM}$ applied |  | 30     | mA    |



| <b>TRIGGERING</b>                   |             |  |        |      |       |
|-------------------------------------|-------------|--|--------|------|-------|
| PARAMETER                           | SYMBOL      | TEST CONDITIONS                              | VALUES |      | UNITS |
|                                     |             |  | TYP.   | MAX. |       |
| Maximum peak gate power             | $P_{GM}$    | $T_J = T_J$ maximum, $t_p \leq 5$ ms         | 10.0   |      | 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  | $+V_{GM}$   | $T_J = T_J$ maximum, $t_p \leq 5$ ms         | 20     |      | V     |
| Maximum peak negative gate voltage  | $-V_{GM}$   |  | 5.0    |      |       |
| DC gate current required to trigger | $I_{GT}$    | $T_J = -40$ °C                               | 180    | -    | mA    |
|                                     |             | $T_J = 25$ °C                                | 90     | 150  |       |
|                                     |             | $T_J = 125$ °C                               | 40     | -    |       |
| DC gate voltage required to trigger | $V_{GT}$    | $T_J = -40$ °C                               | 2.9    | -    | V     |
|                                     |             | $T_J = 25$ °C                                | 1.8    | 3.0  |       |
|                                     |             | $T_J = 125$ °C                               | 1.2    | -    |       |
| 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     |

| <b>THERMAL AND MECHANICAL SPECIFICATIONS</b> |              |   |                  |                     |
|--|--------------|---|------------------|---------------------|
| 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                                  | 0.10             | K/W                 |
| Maximum thermal resistance, case to heatsink | $R_{thC-hs}$ | Mounting surface, smooth, flat and greased    | 0.04             |                     |
| Mounting torque, $\pm 10$ %                  |              | 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) |                     |

| <b><math>\Delta R_{thJC}</math> CONDUCTION</b> |                       |                        |                     |       |
|--|-----------------------|------------------------|---------------------|-------|
| CONDUCTION ANGLE                               | SINUSOIDAL CONDUCTION | RECTANGULAR CONDUCTION | TEST CONDITIONS     | UNITS |
| 180°   | 0.016                 | 0.012                  | $T_J = T_J$ maximum | K/W   |
| 120°   | 0.019                 | 0.020                  |                     |       |
| 90°  | 0.025                 | 0.027                  |                     |       |
| 60°  | 0.036                 | 0.037                  |                     |       |
| 30°  | 0.060                 | 0.060                  |                     |       |

**Note**

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

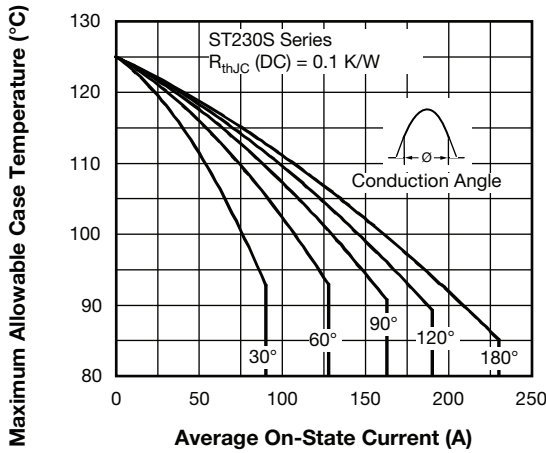


Fig. 1 - Current Ratings Characteristics



Fig. 2 - Current Ratings Characteristics

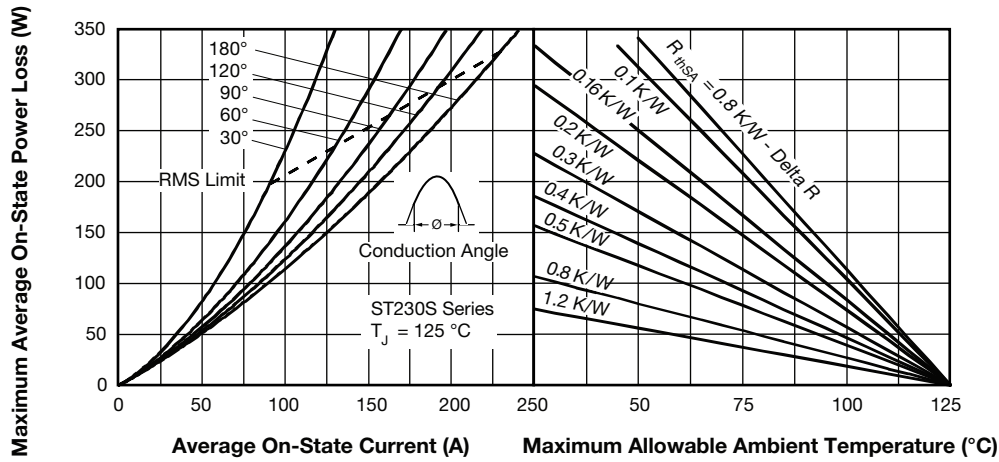


Fig. 3 - On-State Power Loss Characteristics



Fig. 4 - On-State Power Loss Characteristics



Fig. 5 - Maximum Non-Repetitive Surge Current

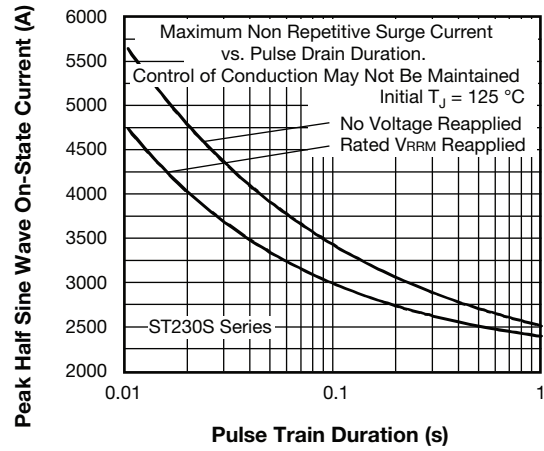


Fig. 6 - Maximum Non-Repetitive Surge Current



Fig. 7 - On-State Voltage Drop Characteristics

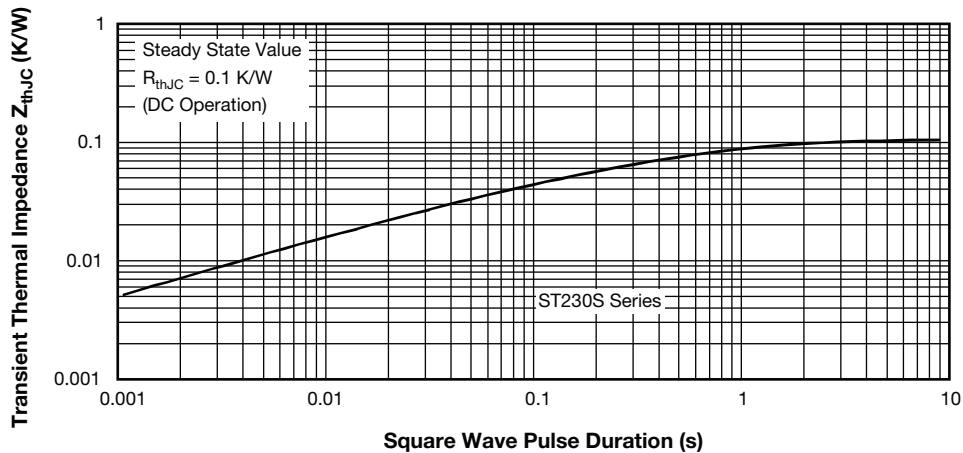


Fig. 8 - Thermal Impedance  $Z_{thJC}$  Characteristics

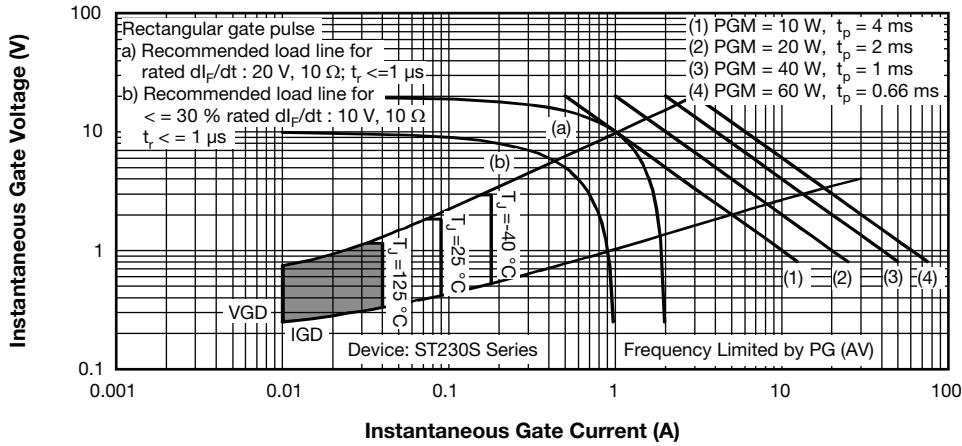


Fig. 9 - Gate Characteristics

## ORDERING INFORMATION TABLE

|             |            |           |           |          |          |           |          |          |            |
|-------------|------------|-----------|-----------|----------|----------|-----------|----------|----------|------------|
| Device code | <b>VS-</b> | <b>ST</b> | <b>23</b> | <b>0</b> | <b>S</b> | <b>16</b> | <b>P</b> | <b>0</b> | <b>PbF</b> |
|             | (1)        | (2)       | (3)       | (4)      | (5)      | (6)       | (7)      | (8)      | (9)        |

- 1** - Vishay Semiconductors product
- 2** - Thyristor
- 3** - Essential part number
- 4** - 0 = converter grade
- 5** - S = compression bonding stud
- 6** - Voltage code x 100 =  $V_{RRM}$  (see Voltage Ratings table)
- 7** - P = stud base 3/4"-16UNF2A threads
- 8** - 0 = eyelet terminals (gate and auxiliary cathode leads)  
1 = fast-on terminals (gate and auxiliary cathode leads)
- 9** - None = standard production  
- PbF = lead (Pb)-free

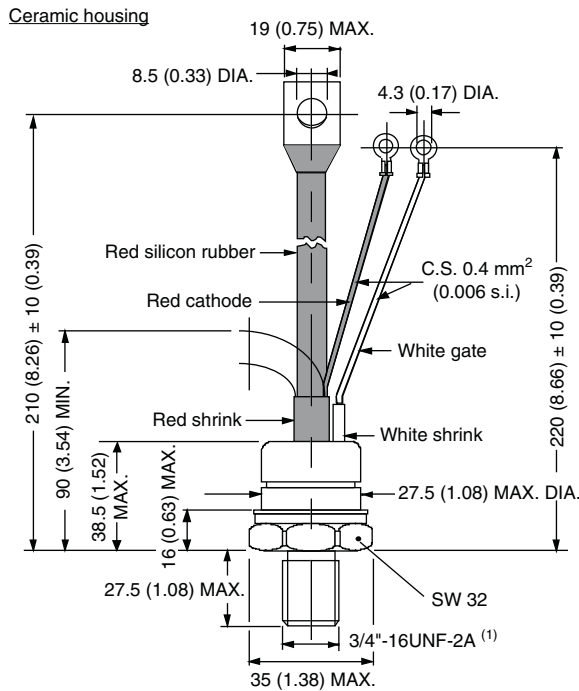
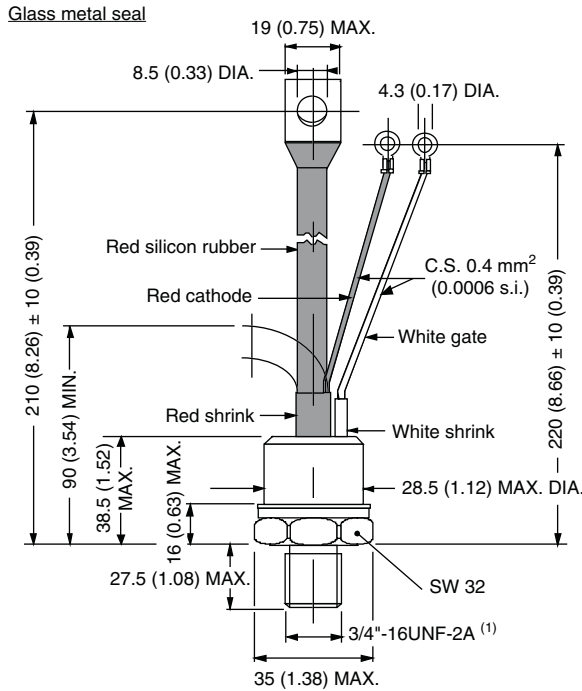
Note: For metric device M16 x 1.5 contact factory

| LINKS TO RELATED DOCUMENTS |  |
|----------------------------|--|
| Dimensions                 | <a href="http://www.vishay.com/doc?95082">www.vishay.com/doc?95082</a> |



### TO-209AB (TO-93)

**DIMENSIONS** in millimeters (inches)



**Note**

(1) For metric device: M16 x 1.5 - length 21 (0.83) maximum



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