



# Phase Control Thyristors (Stud Version), 300 A



TO-118 (TO- 209AE)

### FEATURES

- Center amplifying gate
- International standard case TO-118 (TO-209AE)
- Hermetic metal case with ceramic insulator
- Threaded studs UNF 3/4"-16UNF-2A or ISO M24 x 1.5
- 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

### TYPICAL APPLICATIONS

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

| PRIMARY CHARACTERISTICS |  |
|-------------------------|--|
| $I_{T(AV)}$             | 300 A  |
| $V_{DRM}/V_{RRM}$       | 400 V, 800 V, 1200 V, 1600 V, 1800 V, 2000 V |
| $V_{TM}$                | 1.28 V                                       |
| $I_{GT}$                | 200 mA                                       |
| $T_J$                   | -40 °C to +125 °C                            |
| Package                 | TO-118 (TO-209AE)                            |
| Circuit configuration   | Single SCR                                   |

| MAJOR RATINGS AND CHARACTERISTICS |                 |             |                   |
|-----------------------------------|-----------------|-------------|-------------------|
| PARAMETER                         | TEST CONDITIONS | VALUES      | UNITS             |
| $I_{T(AV)}$                       |                 | 300         | A                 |
|                                   | $T_C$           | 75          | °C                |
| $I_{T(RMS)}$                      |                 | 470         | A                 |
| $I_{TSM}$                         | 50 Hz           | 8000        |                   |
|                                   | 60 Hz           | 8380        |                   |
| $I^2t$                            | 50 Hz           | 320         | kA <sup>2</sup> s |
|                                   | 60 Hz           | 292         |                   |
| $V_{DRM}/V_{RRM}$                 |                 | 400 to 2000 | 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-ST300S       | 04           | 400  | 500  | 50   |
|                 | 08           | 800  | 900  |  |
|                 | 12           | 1200   | 1300   |  |
|                 | 16           | 1600   | 1700   |  |
|                 | 18           | 1800   | 1900   |  |
|                 | 20           | 2000   | 2100   |  |



| ABSOLUTE MAXIMUM RATINGS                             |               |   |                           |        |                    |
|--|---------------|---|---------------------------|--------|--------------------|
| PARAMETER  | SYMBOL        | TEST CONDITIONS   |                           | VALUES | UNITS              |
| Maximum average on-state current at case temperature | $I_{T(AV)}$   | 180° conduction, half sine wave   |                           | 300    | A                  |
|  |               |   |                           | 75     | °C                 |
| Maximum RMS on-state current                         | $I_{T(RMS)}$  | DC at 64 °C case temperature  |                           | 470    |                    |
| Maximum peak, one-cycle non-repetitive surge current | $I_{TSM}$     | t = 10 ms   | No voltage reapplied      | 8000   | A                  |
|  |               | t = 8.3 ms  |                           | 8380   |                    |
|  |               | t = 10 ms   | 100 % $V_{RRM}$ reapplied | 6730   |                    |
|  |               | t = 8.3 ms  |                           | 7040   |                    |
| Maximum $I^2t$ for fusing                            | $I^2t$        | t = 10 ms   | No voltage reapplied      | 320    | kA <sup>2</sup> s  |
|  |               | t = 8.3 ms  |                           | 292    |                    |
|  |               | t = 10 ms   | 100 % $V_{RRM}$ reapplied | 226    |                    |
|  |               | t = 8.3 ms  |                           | 207    |                    |
| Maximum $I^2\sqrt{t}$ for fusing                     | $I^2\sqrt{t}$ | t = 0.1 ms to 10 ms, no voltage reapplied   |                           | 3200   | 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) |                           | 0.97   | 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) |                           | 0.74   | mΩ                 |
| High level value of on-state slope resistance        | $r_{t2}$      | (I > $\pi \times I_{T(AV)}$ , $T_J = T_J$ maximum)                                      |                           | 0.73   |                    |
| Maximum on-state voltage                             | $V_{TM}$      | $I_{pk} = 940$ A, $T_J = T_J$ maximum, $t_p = 10$ ms sine pulse                         |                           | 1.66   | V                  |
| Maximum holding current                              | $I_H$         | $T_J = 25$ °C, anode supply 12 V resistive load   |                           | 600    | mA                 |
| Typical latching current                             | $I_L$         |   |                           | 1000   |                    |

| SWITCHING  |         |  |  |        |       |
|--|---------|--|--|--------|-------|
| 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                                    | $t_q$   | $I_{TM} = 550$ A, $T_J = T_J$ maximum, $di/dt = 40$ A/μs,<br>$V_R = 50$ V, $dV/dt = 20$ V/μs, gate 0 V 100 Ω, $t_p = 500$ μs |  | 100    |       |

| BLOCKING   |                    |  |  |        |       |
|--|--------------------|--|--|--------|-------|
| 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    |



| <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 | $I_{GT}$    | Maximum required gate trigger/<br>current/voltage are the lowest<br>value which will trigger all units<br>12 V anode to cathode applied | $T_J = -40$ °C   | 200  | -     | mA |
|                                     |             |   | $T_J = 25$ °C  | 100  | 200   |    |
|                                     |             |   | $T_J = 125$ °C   | 50   | -     |    |
| DC gate voltage required to trigger | $V_{GT}$    | Maximum required gate trigger/<br>current/voltage are the lowest<br>value which will trigger all units<br>12 V anode to cathode applied | $T_J = -40$ °C   | 2.5  | -     | V  |
|                                     |             |   | $T_J = 25$ °C  | 1.8  | 3     |    |
|                                     |             |   | $T_J = 125$ °C   | 1.1  | -     |    |
| DC gate current not to trigger      | $I_{GD}$    | $T_J = T_J$ maximum   | Maximum gate current/voltage<br>not to trigger is the maximum<br>value which will not trigger any<br>unit with rated $V_{DRM}$ anode to<br>cathode applied |      | 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 | $R_{thCS}$ | Mounting surface, smooth, flat and greased    | 0.03              |                     |
| Mounting torque, $\pm 10$ %                  |            | Non-lubricated threads                        | 48.5<br>(425)     | N · m<br>(lbf · in) |
| Approximate weight                           |            |   | 535               | g                   |
| Case style                                   |            | See dimensions - link at the end of datasheet | TO-118 (TO-209AE) |                     |

| <b><math>\Delta R_{thJC}</math> CONDUCTION</b> |                       |                        |                     |       |
|--|-----------------------|------------------------|---------------------|-------|
| CONDUCTION ANGLE                               | SINUSOIDAL CONDUCTION | RECTANGULAR CONDUCTION | TEST CONDITIONS     | UNITS |
| 180°   | 0.011                 | 0.008                  | $T_J = T_J$ maximum | K/W   |
| 120°   | 0.013                 | 0.014                  |                     |       |
| 90°  | 0.017                 | 0.018                  |                     |       |
| 60°  | 0.025                 | 0.026                  |                     |       |
| 30°  | 0.041                 | 0.042                  |                     |       |

**Note**

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

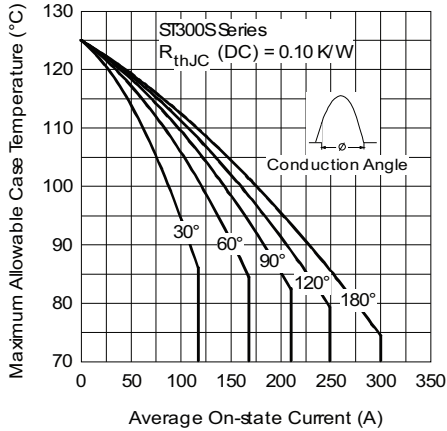


Fig. 1 - Current Ratings Characteristics

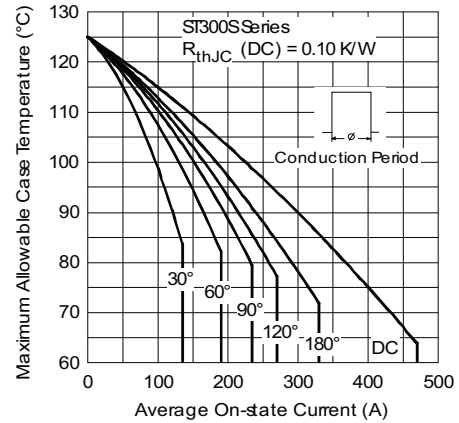


Fig. 2 - Current Ratings Characteristics

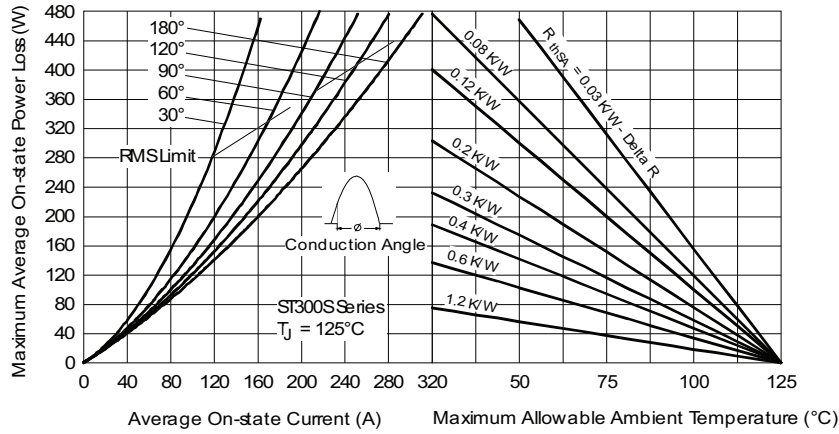


Fig. 3 - On-State Power Loss Characteristics

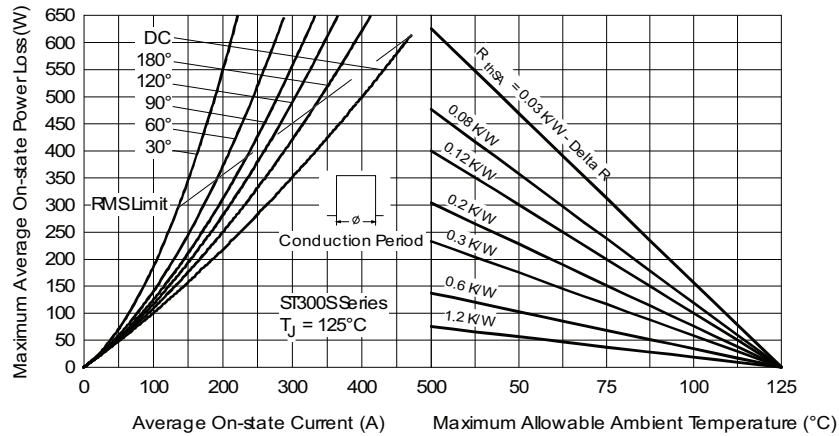


Fig. 4 - On-State Power Loss Characteristics

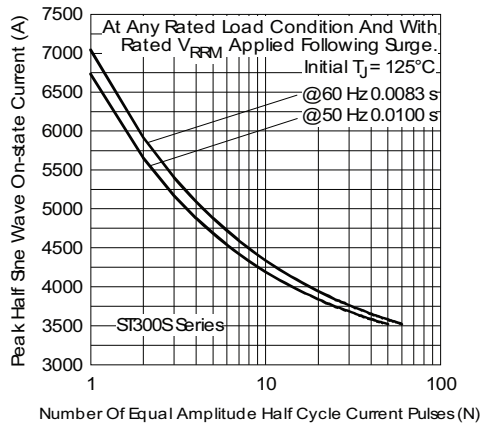


Fig. 5 - Maximum Non-Repetitive Surge Current

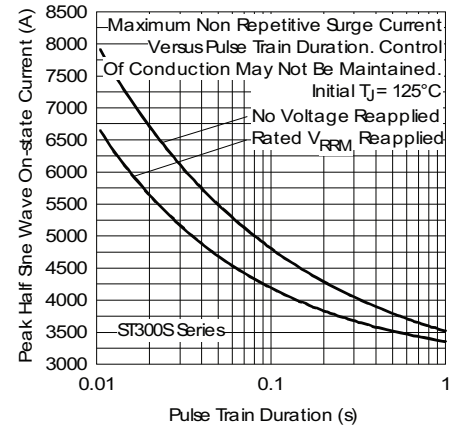


Fig. 6 - Maximum Non-Repetitive Surge Current

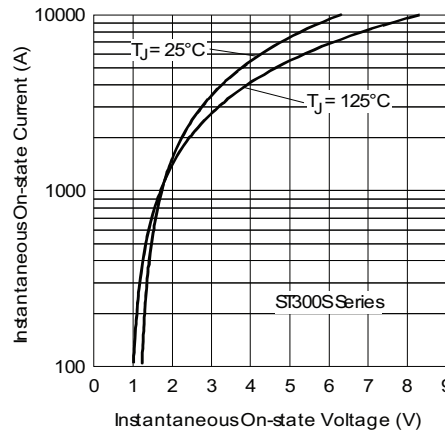


Fig. 7 - On-State Voltage Drop Characteristics

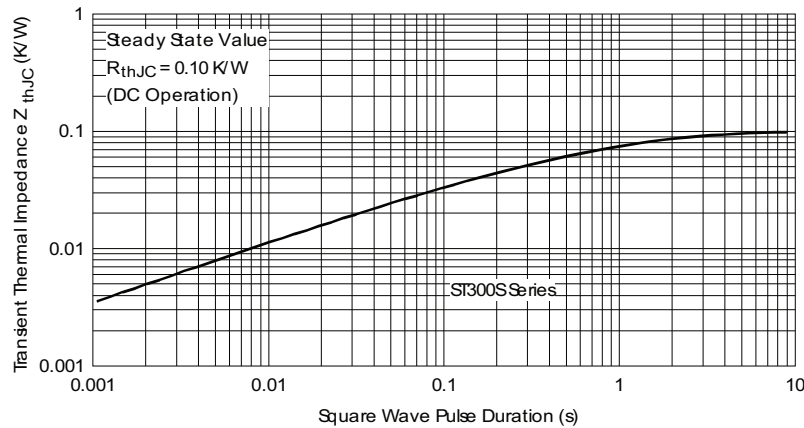


Fig. 8 - Thermal Impedance  $Z_{thJC}$  Characteristics

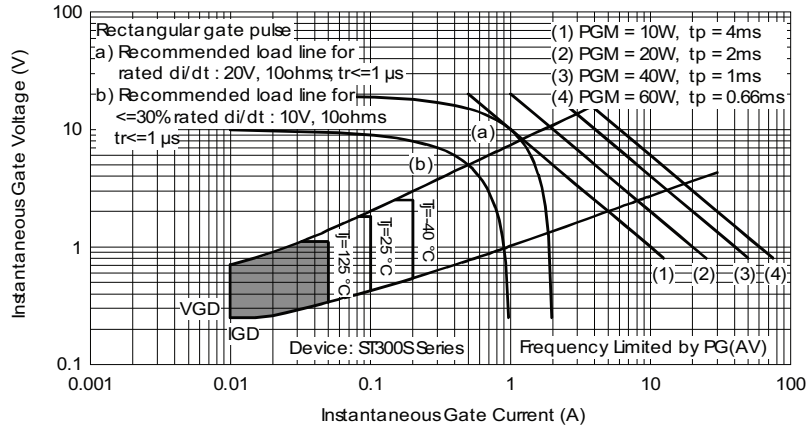


Fig. 9 - Gate Characteristics

### ORDERING INFORMATION TABLE

|             |            |           |           |          |          |           |          |          |          |            |
|-------------|------------|-----------|-----------|----------|----------|-----------|----------|----------|----------|------------|
| Device code | <b>VS-</b> | <b>ST</b> | <b>30</b> | <b>0</b> | <b>S</b> | <b>20</b> | <b>P</b> | <b>0</b> | <b>-</b> | <b>PbF</b> |
|             | ①          | ②         | ③         | ④        | ⑤        | ⑥         | ⑦        | ⑧        | ⑨        | ⑩          |

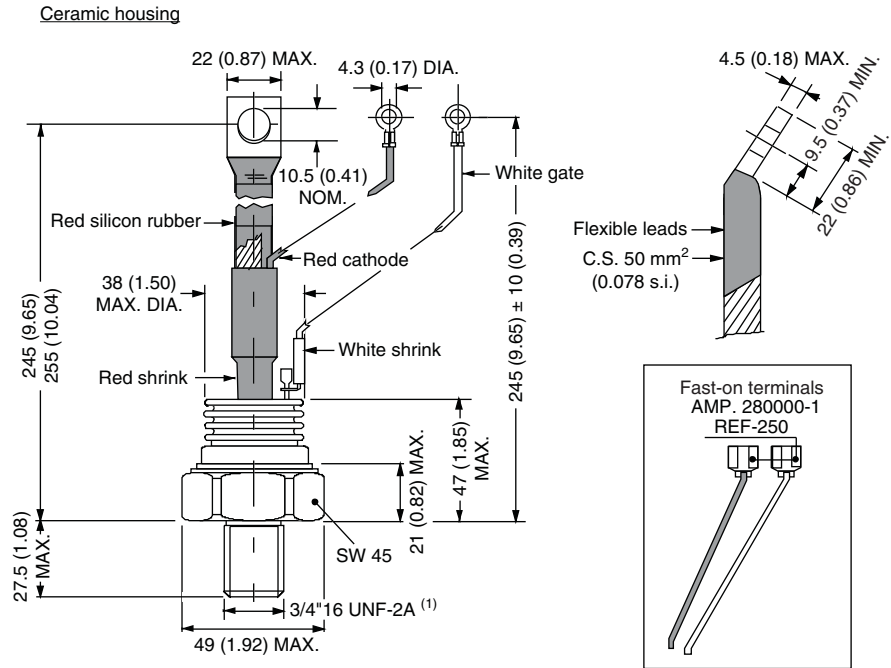
- ① - Vishay Semiconductors product
- ② - Thyristor
- ③ - Essential part number
- ④ - 0 = Converter grade
- ⑤ - S = Compression bonding stud
- ⑥ - Voltage code x 100 =  $V_{RRM}$  (see Voltage Ratings table)
- ⑦ - P = stud base 3/4" 16UNF-2A threads  
M = stud base metric threads (M24 x 1.5)
- ⑧ - 0 = Eyelet terminals (gate and auxiliary cathode leads)  
1 = Fast-on terminals (gate and auxiliary cathode leads)  
3 = Threaded top terminal 3/8" 24UNF-2A
- ⑨ - Critical  $dV/dt$ : • None = 500 V/ $\mu$ s (standard value)  
• L = 1000 V/ $\mu$ s (special selection)
- ⑩ - None = Standard production  
PbF = Lead (Pb)-free

#### LINKS TO RELATED DOCUMENTS

|            |  |
|------------|--|
| Dimensions | <a href="http://www.vishay.com/doc?95084">www.vishay.com/doc?95084</a> |
|------------|--|

## TO-209AE (TO-118)

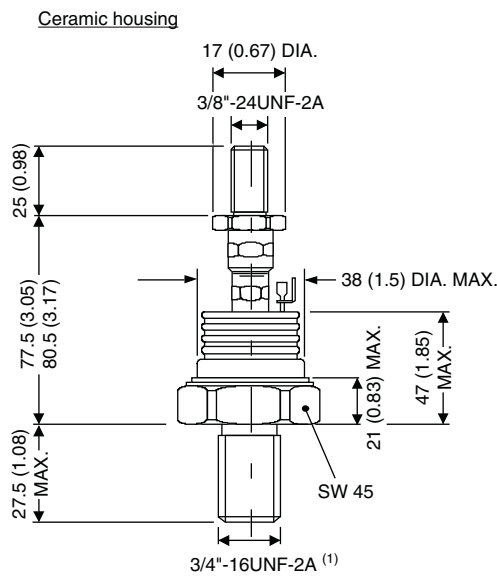
### DIMENSIONS - TO-209AE (TO-118) in millimeters (inches)



**Note**

(1) For metric device: M24 x 1.5 - length screw 21 (0.83) maximum

### DIMENSIONS - TO-209AE (TO-118) WITH TOP THREAD TERMINAL 3/8" in millimeters (inches)



**Note**

(1) For metric device: M24 x 1.5 - length screw 21 (0.83) maximum



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