

## Phase Control Thyristors (Stud Version), 330 A



TO- 209AE (TO-118)

### FEATURES

- Center amplifying gate
- International standard case TO-209AE (TO-118)
- 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

| PRODUCT SUMMARY   |                   |
|-------------------|-------------------|
| $I_{T(AV)}$       | 330 A             |
| $V_{DRM}/V_{RRM}$ | 400 V, 2000 V     |
| $V_{TM}$          | 1.52 V            |
| $I_{GT}$          | 200 mA            |
| $T_J$             | -40 °C to 125 °C  |
| Package           | TO-209AE (TO-118) |
| Diode variation   | Single SCR        |

### TYPICAL APPLICATIONS

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

| MAJOR RATINGS AND CHARACTERISTICS |                 |             |                   |
|-----------------------------------|-----------------|-------------|-------------------|
| PARAMETER                         | TEST CONDITIONS | VALUES      | UNITS             |
| $I_{T(AV)}$                       |                 | 330         | A                 |
|                                   | $T_C$           | 75          | °C                |
| $I_{T(RMS)}$                      |                 | 520         | A                 |
| $I_{TSM}$                         | 50 Hz           | 9000        |                   |
|                                   | 60 Hz           | 9420        |                   |
| $I^2t$                            | 50 Hz           | 405         | kA <sup>2</sup> s |
|                                   | 60 Hz           | 370         |                   |
| $V_{DRM}/V_{RRM}$                 |                 | 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-ST330S       | 04           | 400                                                                    | 500                                                  | 50                                                     |
|                 | 08           | 800                                                                    | 900                                                  |                                                        |
|                 | 12           | 1200                                                                   | 1300                                                 |                                                        |
|                 | 16           | 1600                                                                   | 1700                                                 |                                                        |
|                 | 20           | 2000                                                                   | 2100                                                 |                                                        |



| ABSOLUTE MAXIMUM RATINGS                             |                     |                                                                                                           |                                  |                                                                       |        |                    |
|------------------------------------------------------|---------------------|-----------------------------------------------------------------------------------------------------------|----------------------------------|-----------------------------------------------------------------------|--------|--------------------|
| PARAMETER                                            | SYMBOL              | TEST CONDITIONS                                                                                           |                                  |                                                                       | VALUES | UNITS              |
| Maximum average on-state current at case temperature | I <sub>T(AV)</sub>  | 180° conduction, half sine wave                                                                           |                                  |                                                                       | 330    | A                  |
|                                                      |                     |                                                                                                           |                                  |                                                                       | 75     | °C                 |
| Maximum RMS on-state current                         | I <sub>T(RMS)</sub> | DC at 75 °C case temperature                                                                              |                                  |                                                                       | 520    | A                  |
| Maximum peak, one-cycle 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 | 9000   |                    |
|                                                      |                     | t = 8.3 ms                                                                                                |                                  |                                                                       | 9420   |                    |
|                                                      |                     | t = 10 ms                                                                                                 | 100 % V <sub>RRM</sub> reapplied |                                                                       | 7570   |                    |
|                                                      |                     | t = 8.3 ms                                                                                                |                                  |                                                                       | 7920   |                    |
| Maximum I <sup>2</sup> t for fusing                  | I <sup>2</sup> t    | t = 10 ms                                                                                                 | No voltage reapplied             |                                                                       | 405    | kA <sup>2</sup> s  |
|                                                      |                     | t = 8.3 ms                                                                                                |                                  |                                                                       | 370    |                    |
|                                                      |                     | t = 10 ms                                                                                                 | 100 % V <sub>RRM</sub> reapplied |                                                                       | 287    |                    |
|                                                      |                     | t = 8.3 ms                                                                                                |                                  |                                                                       | 262    |                    |
| Maximum I <sup>2</sup> √t for fusing                 | I <sup>2</sup> √t   | t = 0.1 to 10 ms, no voltage reapplied                                                                    |                                  |                                                                       | 4050   | kA <sup>2</sup> √s |
| Low level value of 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 |                                  |                                                                       | 0.834  | 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                                    |                                  |                                                                       | 0.898  |                    |
| Low level value of 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 |                                  |                                                                       | 0.687  | mΩ                 |
| High level value of on-state slope resistance        | r <sub>t2</sub>     | (I > π × I <sub>T(AV)</sub> ), T <sub>J</sub> = T <sub>J</sub> maximum                                    |                                  |                                                                       | 0.636  |                    |
| Maximum on-state voltage                             | V <sub>TM</sub>     | I <sub>pk</sub> = 1000 A, T <sub>J</sub> = T <sub>J</sub> maximum, t <sub>p</sub> = 10 ms sine pulse      |                                  |                                                                       | 1.52   | V                  |
| Maximum holding current                              | I <sub>H</sub>      | T <sub>J</sub> = 25 °C, anode supply 12 V resistive load                                                  |                                  |                                                                       | 600    | mA                 |
| Typical latching current                             | I <sub>L</sub>      |                                                                                                           |                                  |                                                                       | 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 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 | $I_{RRM}$ ,<br>$I_{DRM}$ | $T_J = T_J$ maximum, rated $V_{DRM}/V_{RRM}$ applied | 50     | 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         | 10.0   |      | 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                               | 200    | -    | mA    |
|                                     |             | $T_J = 25$ °C                                | 100    | 200  |       |
|                                     |             | $T_J = 125$ °C                               | 50     | -    |       |
| DC gate voltage required to trigger | $V_{GT}$    | $T_J = -40$ °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                          | 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                                 | 0.10              | K/W                 |
| Maximum thermal resistance, case to heatsink | $R_{thC-hs}$ | 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 dimension - link at the end of datasheet | TO-209AE (TO-118) |                     |

| $\Delta R_{thJC}$ CONDUCTION |                       |                        |                     |       |
|------------------------------|-----------------------|------------------------|---------------------|-------|
| 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

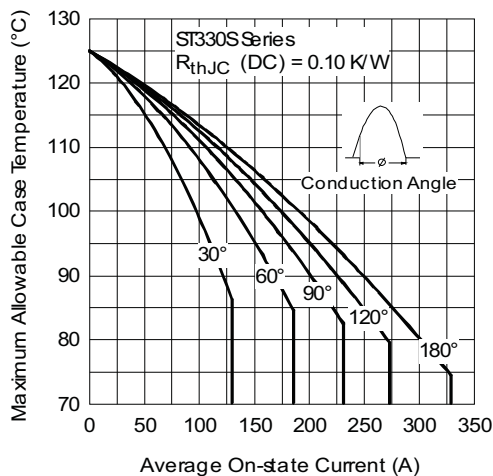


Fig. 1 - Current Ratings Characteristics

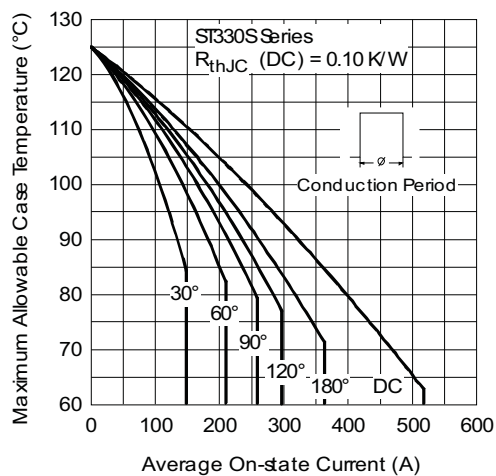


Fig. 2 - Current Ratings Characteristics

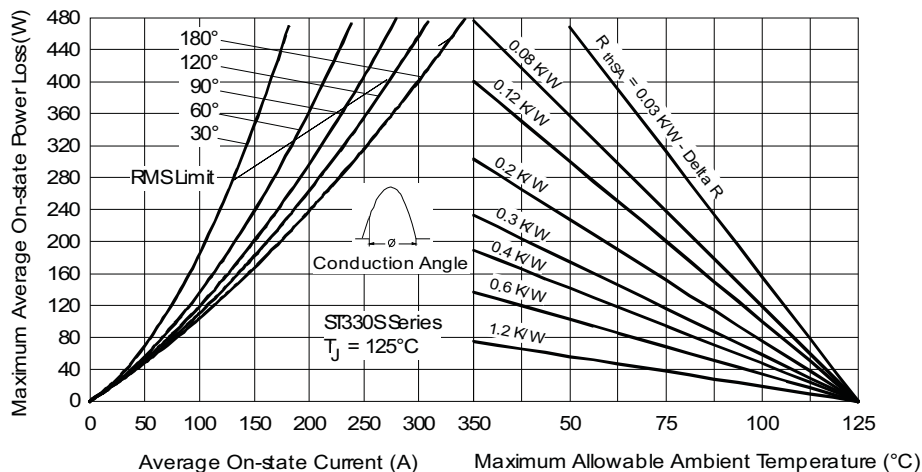


Fig. 3 - On-State Power Loss Characteristics

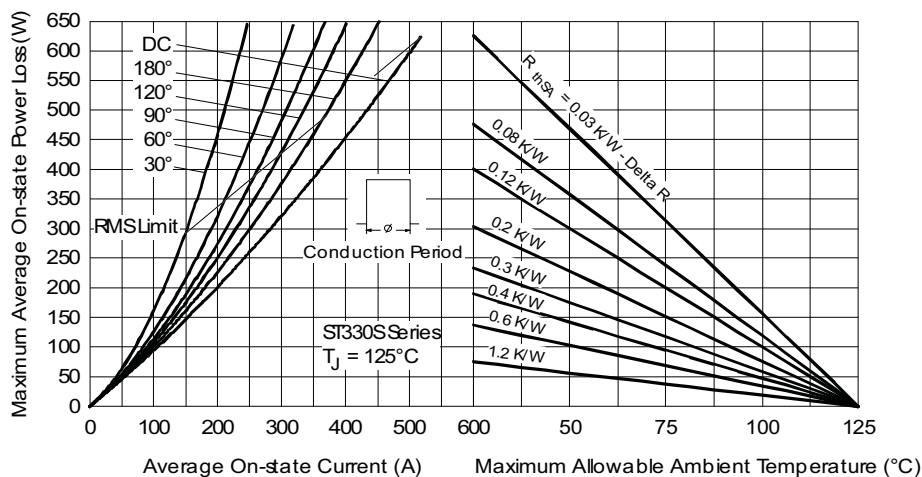


Fig. 4 - On-State Power Loss Characteristics

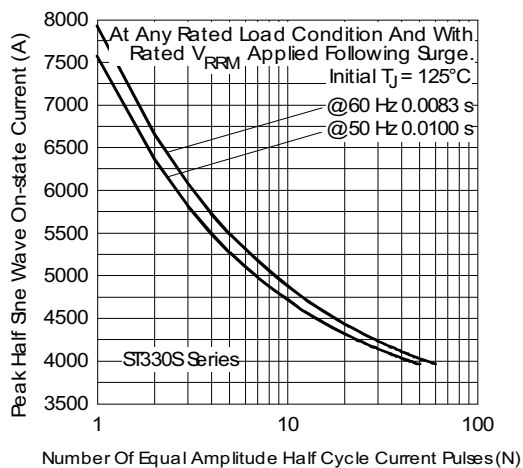


Fig. 5 - Maximum Non-Repetitive Surge Current

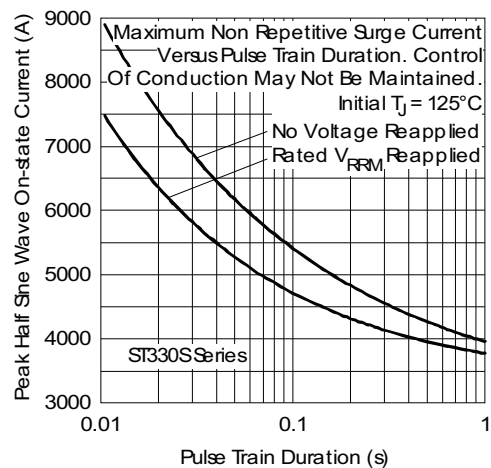


Fig. 6 - Maximum Non-Repetitive Surge Current

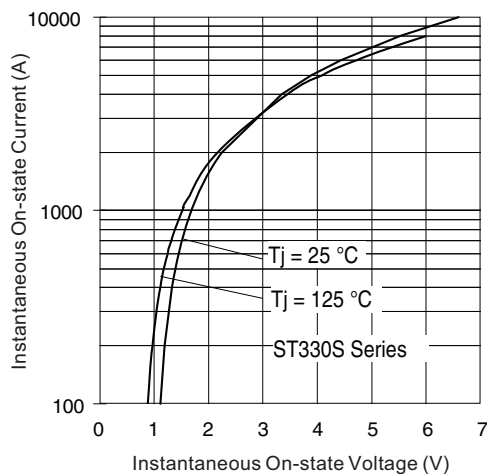
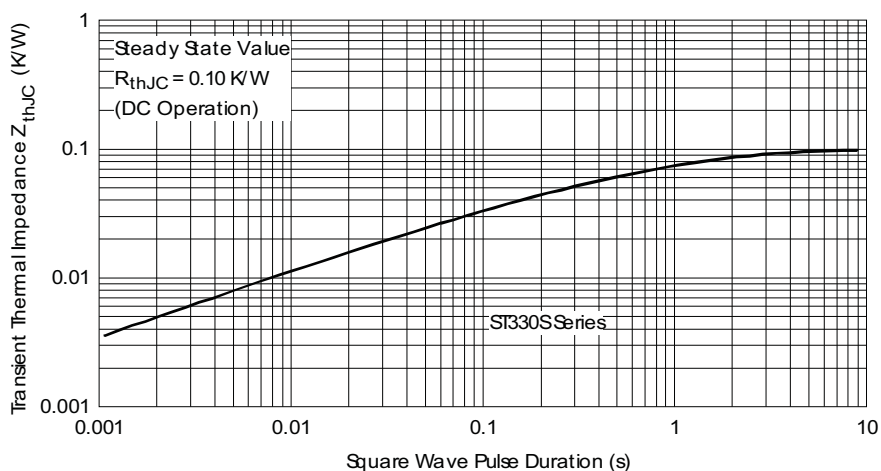


Fig. 7 - On-State Voltage Drop Characteristics


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

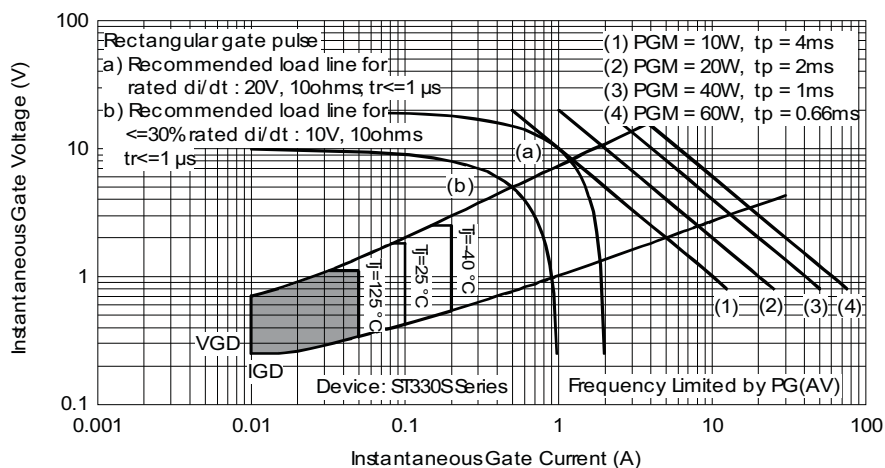


Fig. 9 - Gate Characteristics

## ORDERING INFORMATION TABLE

| Device code | VS- | ST  | 33  | 0   | S   | 16  | P   | 0   | PbF |
|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|             | (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"-16UNF-2A threads                                                                                 |
| 8 | - 0 = Eyelet terminals (gate and auxiliary cathode leads)<br>1 = Fast-on terminals (gate and auxiliary cathode leads) |
| 9 | - None = Standard production<br>- PbF = Lead (Pb)-free                                                                |

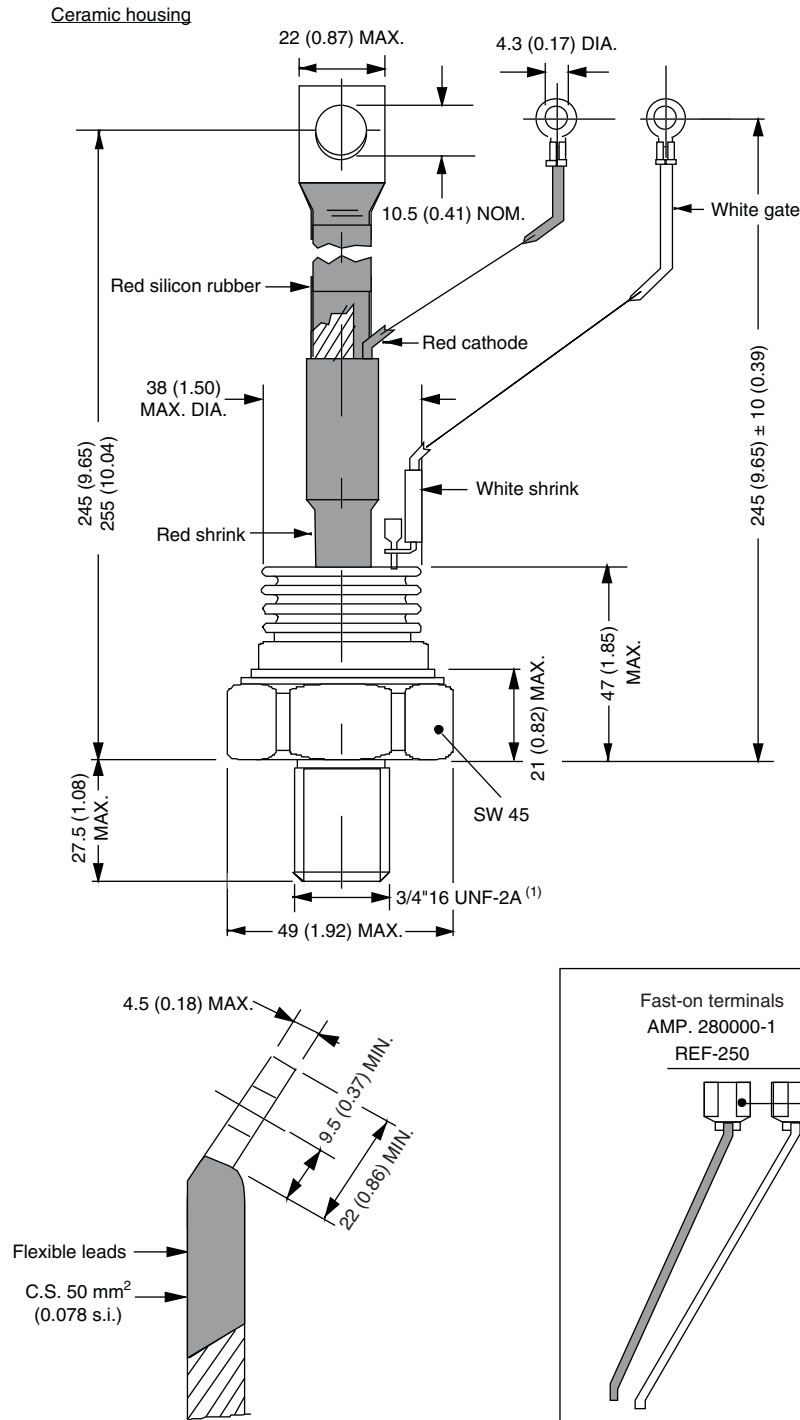
### LINKS TO RELATED DOCUMENTS

Dimensions

[www.vishay.com/doc?95080](http://www.vishay.com/doc?95080)

## TO-209AE (TO-118)

**DIMENSIONS** in millimeters (inches)



**Note**

<sup>(1)</sup> For metric device: M24 x 1.5 - length 21 (0.83) maximum



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