# Phase Control Thyristors (Stud Version), 330 A

TO-118 (TO- 209AE)

## FEATURES

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

Pb-free

RoHS COMPLIANT

## TYPICAL APPLICATIONS

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

| PRIMARY CHARACTERISTICS | |
|---|---|
| $I_{T(AV)}$ | 330 A |
| $V_{DRM}/V_{RRM}$ | 400 V, 800 V, 1200 V, 1400 V, 1600 V, 2000 V |
| $V_{TM}$ | 1.52 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 |
| $I_{T(AV)}$ | | 330 | A |
| | $T_C$ | 75 | °C |
| $I_{T(RMS)}$ | | 520 | A |
| $I_{TSM}$ | 50 Hz | 9000 | |
| | 60 Hz | 9420 | |
| $I^2t$ | 50 Hz | 405 | $kA^2s$ |
| | 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 V | $V_{RSM}$, MAXIMUM NON-REPETITIVE PEAK VOLTAGE V | $I_{DRM}/I_{RRM}$ MAXIMUM AT $T_J = T_J$ MAXIMUM mA |
| VS-ST330S | 04 | 400 | 500 | 50 |
| | 08 | 800 | 900 | |
| | 12 | 1200 | 1300 | |
| | 14 | 1400 | 1500 | |
| | 16 | 1600 | 1700 | |
| | 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 | | | 330 | A |
| | | | | | 75 | °C |
| Maximum RMS on-state current | $I_{T(RMS)}$ | DC at 75 °C case temperature | | | 520 | A |
| Maximum peak, one-cycle non-repetitive surge current | $I_{TSM}$ | t = 10 ms | No voltage reapplied | Sinusoidal half wave, initial $T_J = T_J$ maximum | 9000 | |
| | | t = 8.3 ms | | | 9420 | |
| | | t = 10 ms | 100 % $V_{RRM}$ reapplied | | 7570 | |
| | | t = 8.3 ms | | | 7920 | |
| Maximum $I^2t$ for fusing | $I^2t$ | t = 10 ms | No voltage reapplied | | 405 | $kA^2s$ |
| | | t = 8.3 ms | | | 370 | |
| | | t = 10 ms | 100 % $V_{RRM}$ reapplied | | 287 | |
| | | t = 8.3 ms | | | 262 | |
| Maximum $I^2\sqrt{t}$ for fusing | $I^2\sqrt{t}$ | t = 0.1 to 10 ms, no voltage reapplied | | | 4050 | $kA^2\sqrt{s}$ |
| Low level value of threshold voltage | $V_{T(TO)1}$ | (16.7 % x π x $I_{T(AV)}$ < I < π x $I_{T(AV)}$), $T_J = T_J$ maximum | | | 0.834 | V |
| High level value of threshold voltage | $V_{T(TO)2}$ | (I > π x $I_{T(AV)}$), $T_J = T_J$ maximum | | | 0.898 | |
| Low level value of on-state slope resistance | $r_{t1}$ | (16.7 % x π x $I_{T(AV)}$ < I < π x $I_{T(AV)}$), $T_J = T_J$ maximum | | | 0.687 | mΩ |
| High level value of on-state slope resistance | $r_{t2}$ | (I > π x $I_{T(AV)}$), $T_J = T_J$ maximum | | | 0.636 | |
| Maximum on-state voltage | $V_{TM}$ | $I_{pk}$ = 1000 A, $T_J = T_J$ maximum, $t_p$ = 10 ms sine pulse | | | 1.52 | 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 ≤ 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 | $I_{RRM}$, $I_{DRM}$ | $T_J = T_J$ maximum, rated $V_{DRM}/V_{RRM}$ applied | 50 | mA |

| TRIGGERING | | | | | | |
|---|---|---|---|---|---|---|
| PARAMETER | SYMBOL | TEST CONDITIONS | | VALUES TYP. | VALUES MAX. | UNITS |
| 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 | | W |
| 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 | | V |
| DC gate current required to trigger | $I_{GT}$ | $T_J$ = -40 °C | Maximum required gate trigger/ current/voltage are the lowest value which will trigger all units 12 V anode to cathode applied | 200 | - | mA |
| | | $T_J$ = 25 °C | | 100 | 200 | mA |
| | | $T_J$ = 125 °C | | 50 | - | mA |
| DC gate voltage required to trigger | $V_{GT}$ | $T_J$ = -40 °C | | 2.5 | - | V |
| | | $T_J$ = 25 °C | | 1.8 | 3 | V |
| | | $T_J$ = 125 °C | | 1.1 | - | V |
| DC gate current not to trigger | $I_{GD}$ | $T_J = T_J$ maximum | Maximum gate current/voltage not to trigger is the maximum value which will not trigger any unit with rated $V_{DRM}$ anode to cathode applied | 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 | °C |
| 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 | K/W |
| Mounting torque, ± 10 % | | Non-lubricated threads | 48.5 (425) | N · m (lbf · in) |
| Approximate weight | | | 535 | g |
| Case style | | See dimension - link at the end of datasheet | TO-118 (TO-209AE) | |

| $\Delta R_{thJC}$ 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

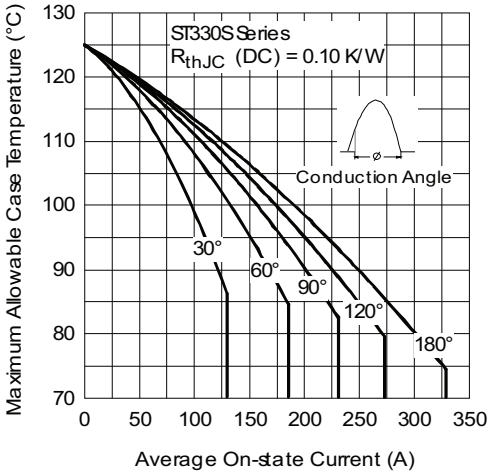



Fig. 1 - Current Ratings Characteristics

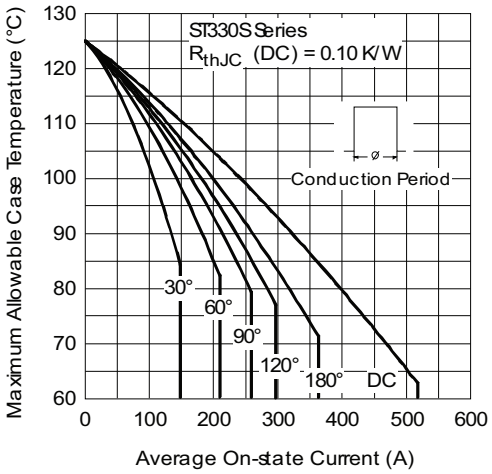



Fig. 2 - Current Ratings Characteristics

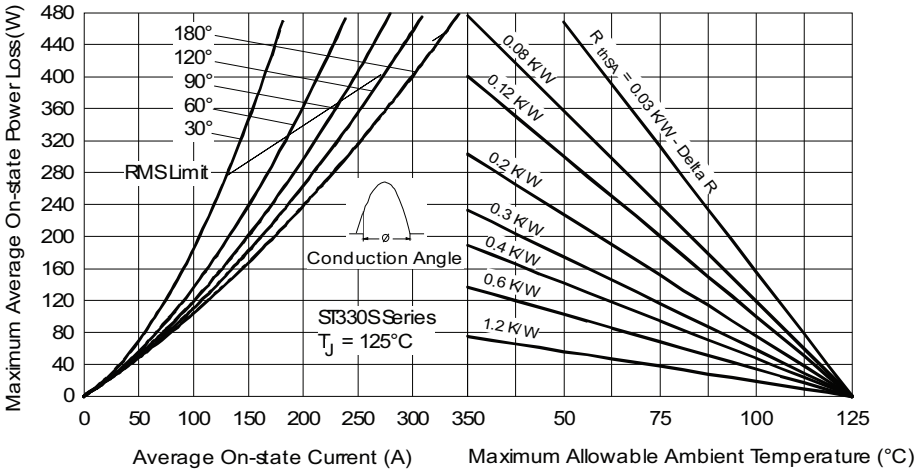



Fig. 3 - On-State Power Loss Characteristics

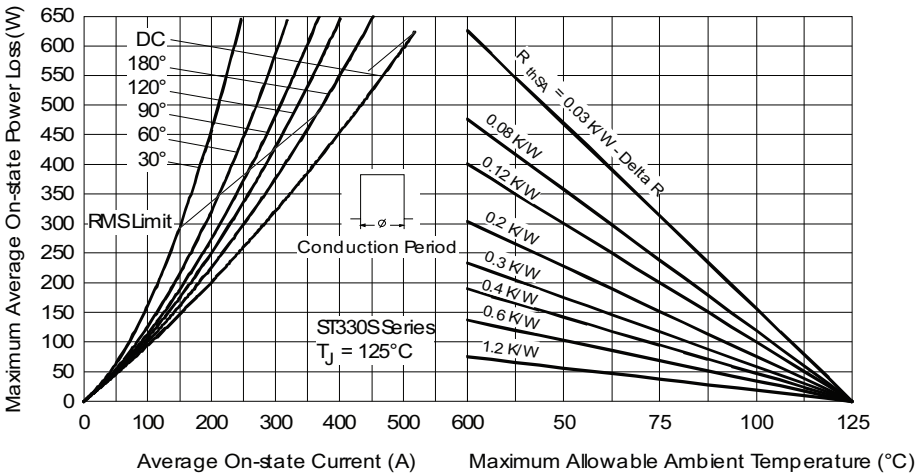



Fig. 4 - On-State Power Loss Characteristics

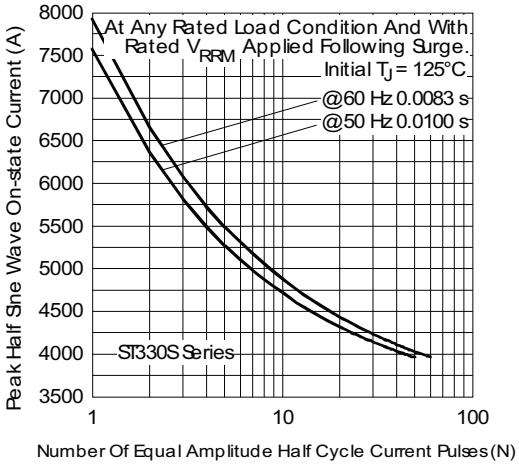



Fig. 5 - Maximum Non-Repetitive Surge Current

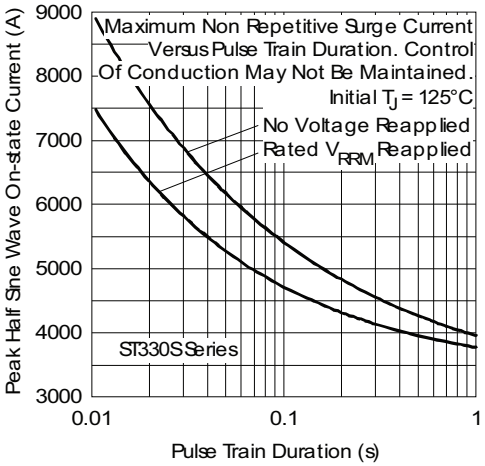



Fig. 6 - Maximum Non-Repetitive Surge Current

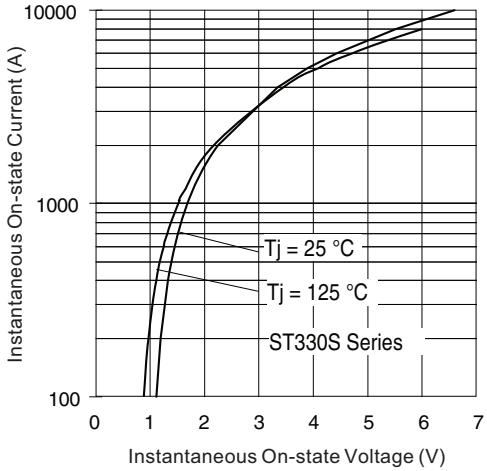



Fig. 7 - On-State Voltage Drop Characteristics

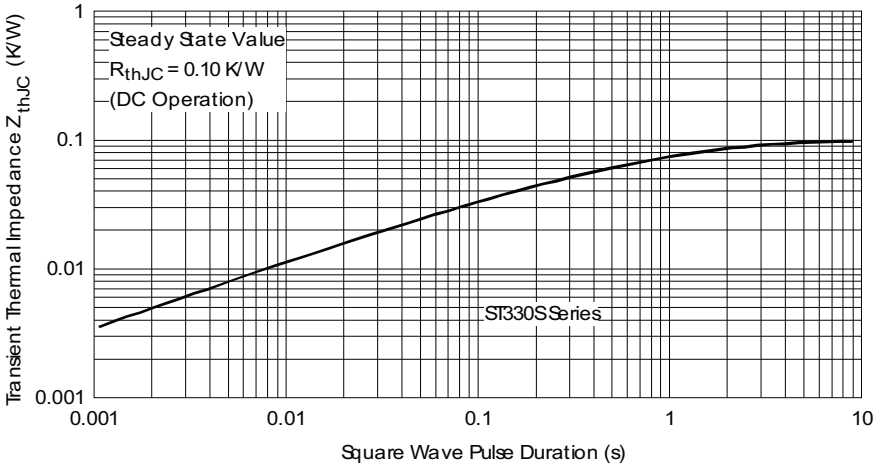



Fig. 8 - Thermal Impedance $Z_{thJC}$ Characteristics

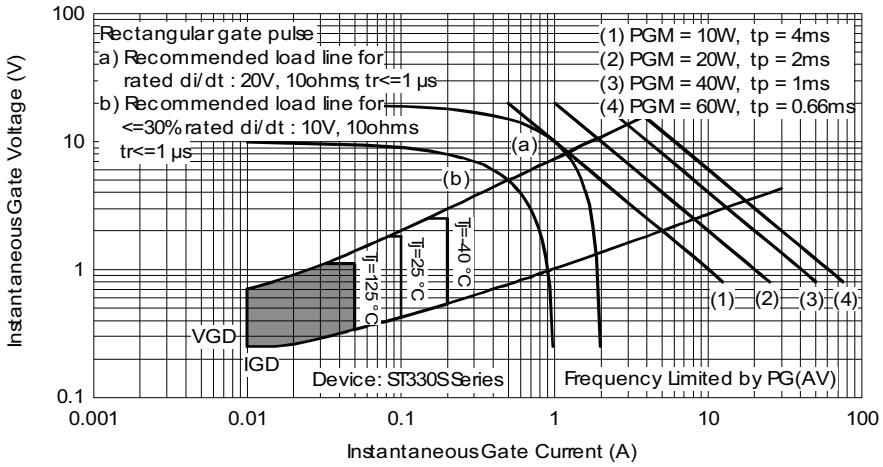



Fig. 9 - Gate Characteristics

## ORDERING INFORMATION TABLE

**Device code**

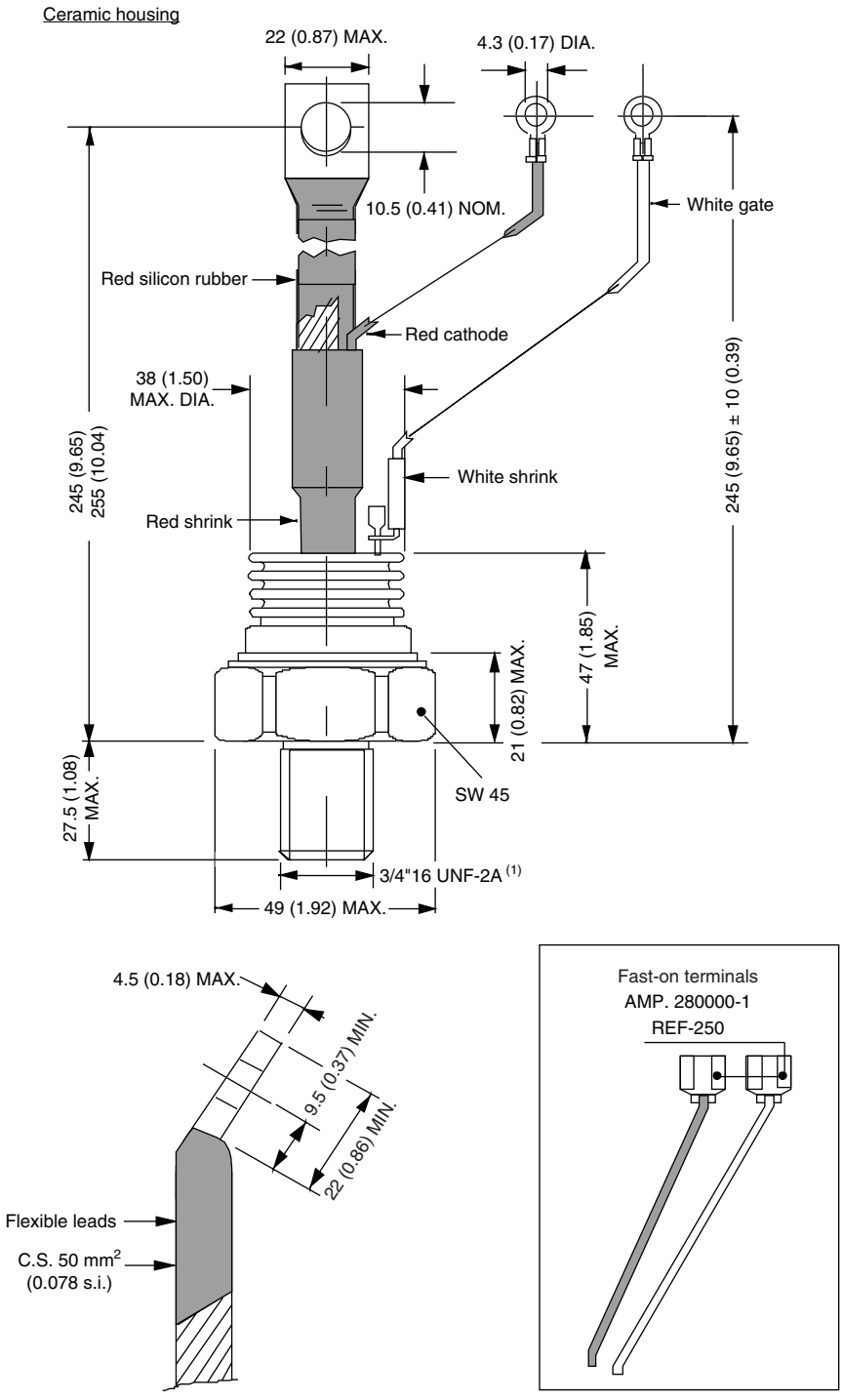
| VS- | ST | 33 | 0 | S | 16 | P | 0 | PbF |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

- **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
  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)
- **9** - None = standard production
  - PbF = lead (Pb)-free

| LINKS TO RELATED DOCUMENTS | |
|---|---|
| Dimensions | www.vishay.com/doc?95080 |

# TO-209AE (TO-118)

**DIMENSIONS** in millimeters (inches)




**Note**

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

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