

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


**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 ² 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 V | V_{RSM} , MAXIMUM NON-REPETITIVE PEAK VOLTAGE V | I_{DRM}/I_{RRM} MAXIMUM AT $T_J = T_J$ MAXIMUM mA |
| VS-ST230S | 14 | 1400 | 1500 | 30 |
| | 16 | 1600 | 1700 | |



| 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 | | 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 | | 5970 | |
| | | t = 10 ms | 100 % V_{RRM} reapplied | 4800 | |
| | | t = 8.3 ms | | 5000 | |
| Maximum I^2t for fusing | I^2t | t = 10 ms | No voltage reapplied | 163 | kA ² s |
| | | t = 8.3 ms | | 148 | |
| | | t = 10 ms | 100 % V_{RRM} reapplied | 115 | |
| | | t = 8.3 ms | | 105 | |
| Maximum $I^2\sqrt{t}$ for fusing | $I^2\sqrt{t}$ | t = 0.1 to 10 ms, no voltage reapplied | | 1630 | kA ² √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) | |

| 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 $T_J = T_J$ maximum, anode voltage ≤ 80 % V_{DRM} | | 1000 | A/μs |
| Typical delay time | t_d | Gate current 1 A, $di_g/dt = 1$ A/μs $V_d = 0.67$ % 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, $V_R = 50$ 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 |



| 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 | 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 |

| 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 | 0.04 | |
| Mounting torque, ± 10 % | | Non-lubricated threads | 31 (275) | N · m (lbf · in) |
| | | Lubricated threads | 24.5 (210) | |
| Approximate weight | | | 280 | g |
| Case style | | See dimensions - link at the end of datasheet | TO-93 (TO-209AB) | |

| ΔR_{thJC} CONDUCTION | | | | |
|--|-----------------------|------------------------|---------------------|-------|
| 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

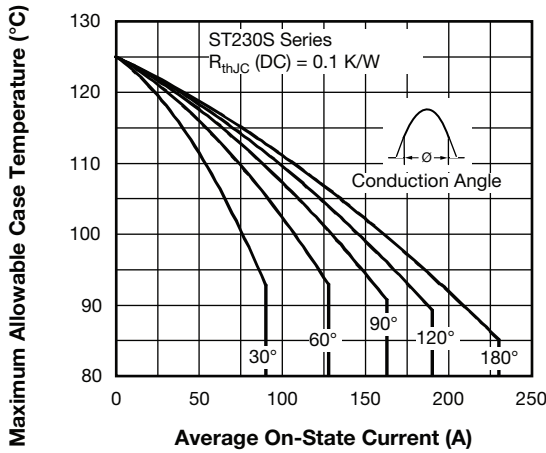


Fig. 1 - Current Ratings Characteristics

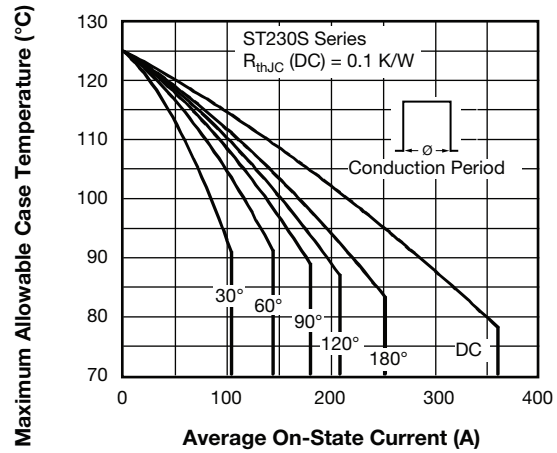


Fig. 2 - Current Ratings Characteristics

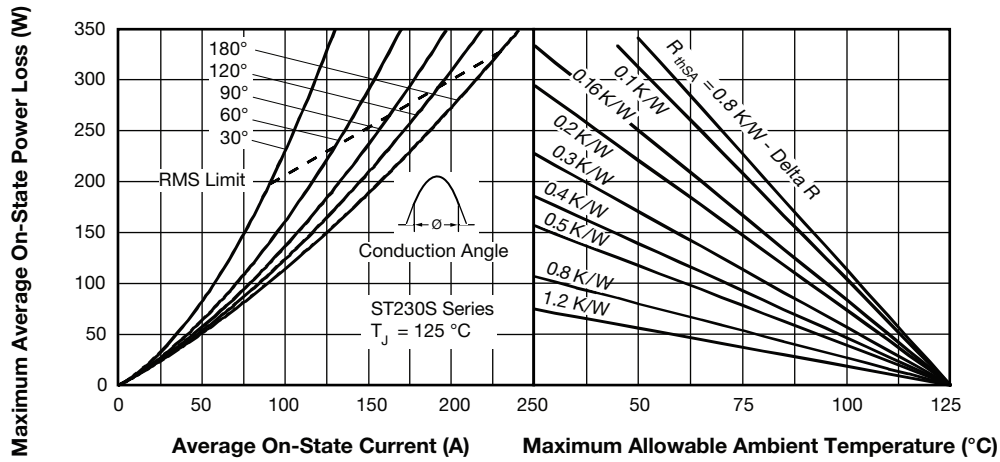


Fig. 3 - On-State Power Loss Characteristics

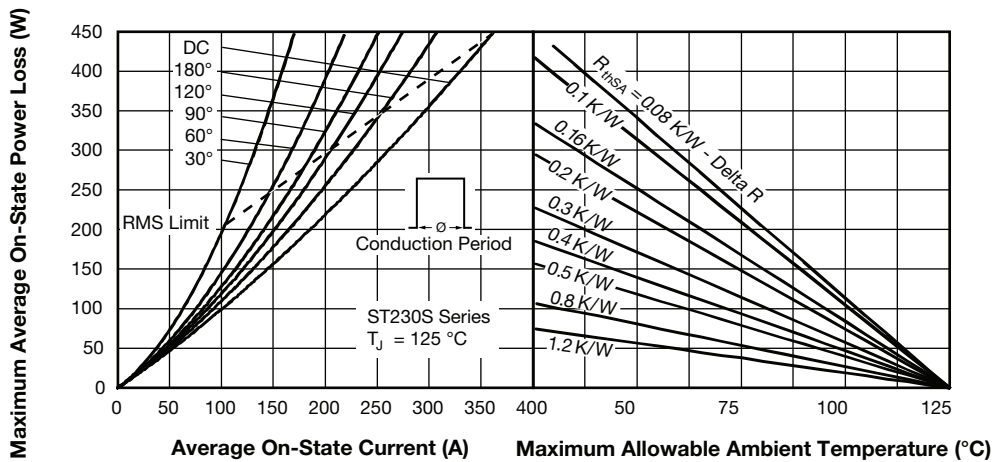


Fig. 4 - On-State Power Loss Characteristics

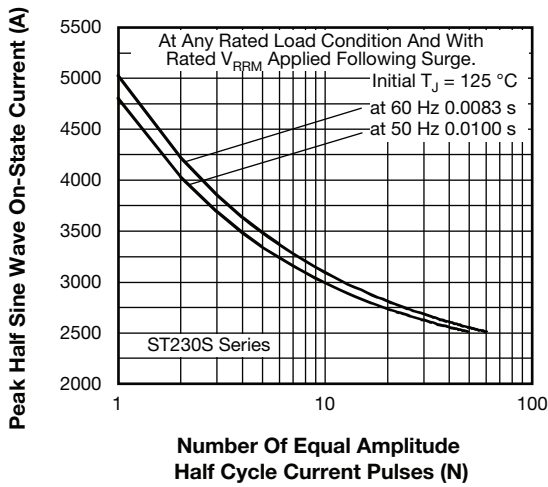


Fig. 5 - Maximum Non-Repetitive Surge Current

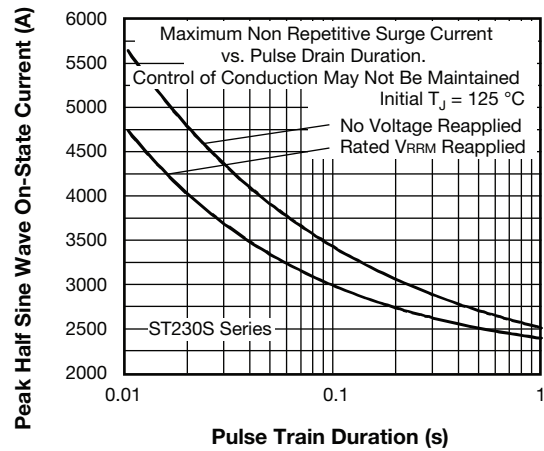


Fig. 6 - Maximum Non-Repetitive Surge Current

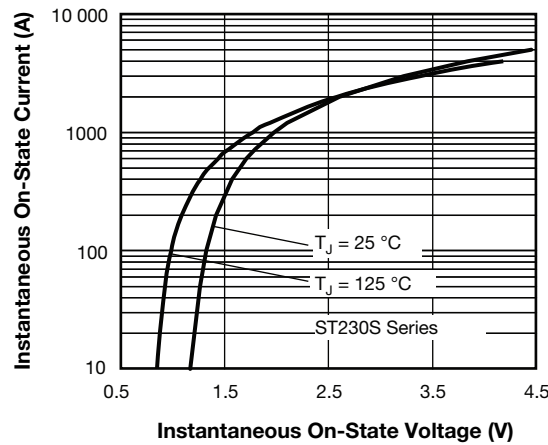


Fig. 7 - On-State Voltage Drop Characteristics

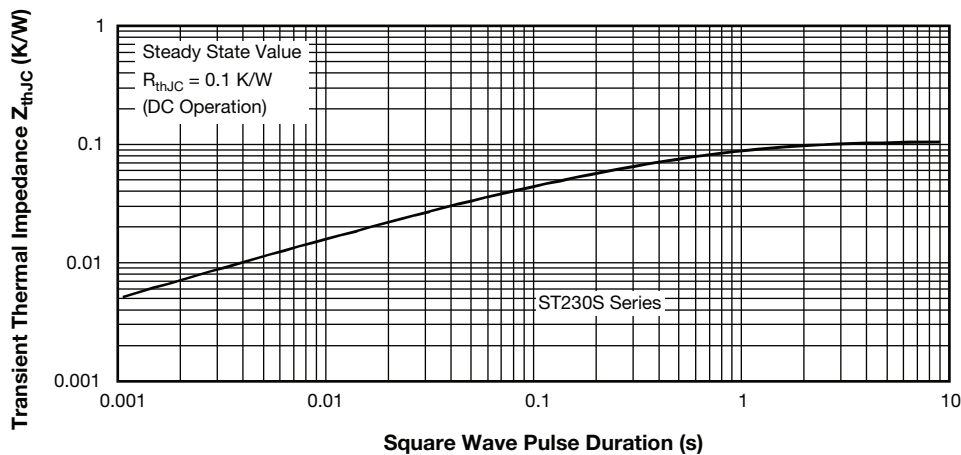


Fig. 8 - Thermal Impedance Z_{thJC} Characteristics

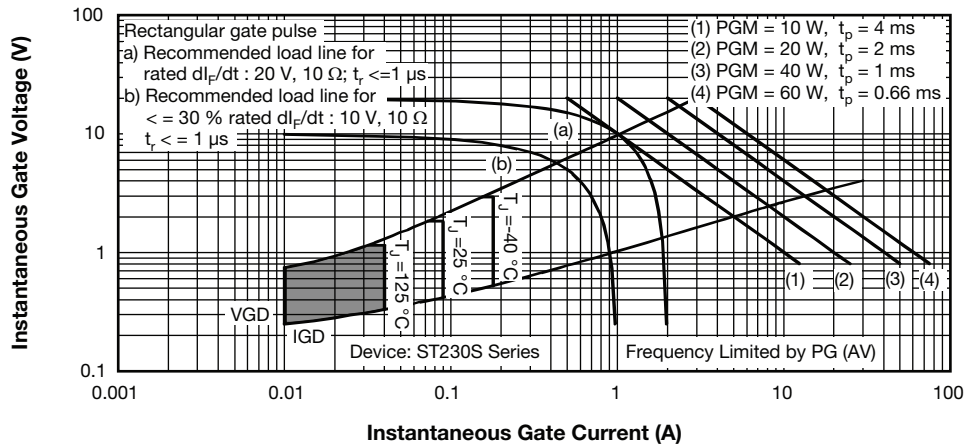


Fig. 9 - Gate Characteristics

ORDERING INFORMATION TABLE

| | | | | | | | | | |
|-------------|------------|-----------|-----------|----------|----------|-----------|----------|----------|------------|
| Device code | VS- | ST | 23 | 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"-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

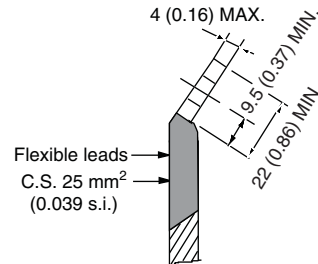
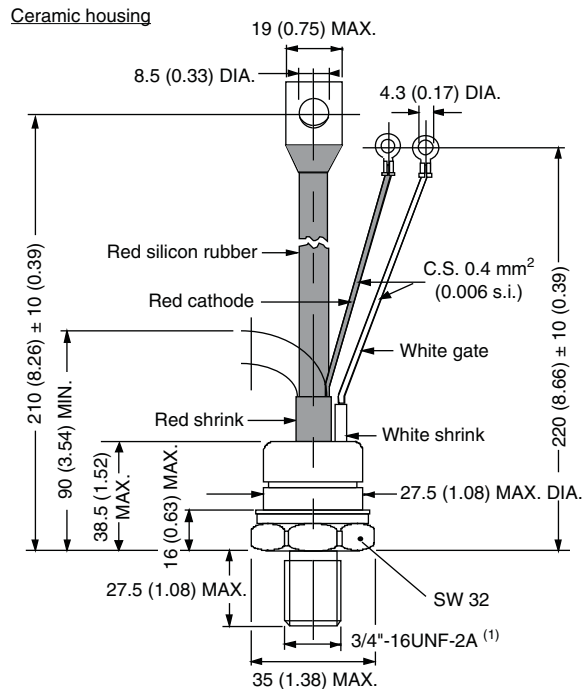
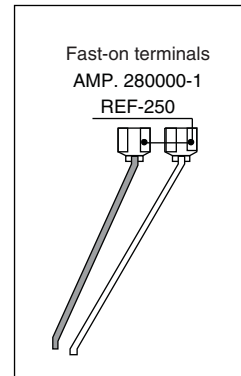
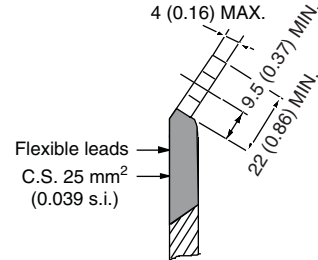
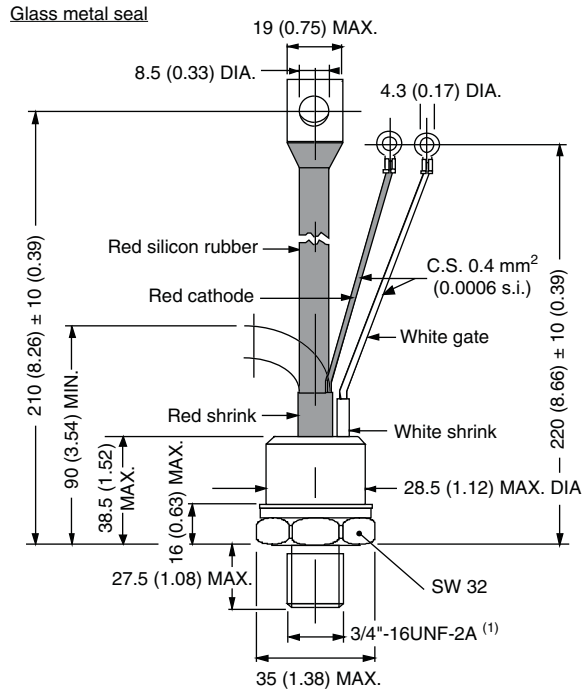
Note: For metric device M16 x 1.5 contact factory

| LINKS TO RELATED DOCUMENTS | |
|----------------------------|--|
| Dimensions | www.vishay.com/doc?95082 |



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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