# Inverter Grade Thyristors (Stud Version), 85 A

TO-209AC (TO-94)

## FEATURES

- Center amplifying gate
- High surge current capability
- Low thermal impedance
- High speed performance
- Compression bonding
- 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

- Inverters
- Choppers
- Induction heating
- All types of force-commutated converters

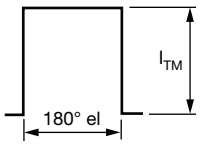
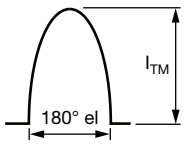
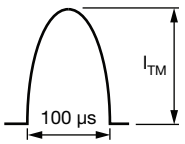
| PRODUCT SUMMARY | |
|---|---|
| Package | TO-209AC (TO-94) |
| Diode variation | Single SCR |
| $I_{T(AV)}$ | 85 A |
| $V_{DRM}/V_{RRM}$ | 400 V to 1200 V |
| $V_{TM}$ | 2.15 V |
| $I_{TSM}$ at 50 Hz | 2450 A |
| $I_{TSM}$ at 60 Hz | 2560 A |
| $I_{GT}$ | 200 mA |
| $T_C/T_{hs}$ | 85 °C |

| MAJOR RATINGS AND CHARACTERISTICS | | | |
|---|---|---|---|
| PARAMETER | TEST CONDITIONS | VALUES | UNITS |
| $I_{T(AV)}$ | | 85 | A |
| | $T_C$ | 85 | °C |
| $I_{T(RMS)}$ | | 135 | A |
| $I_{TSM}$ | 50 Hz | 2450 | A |
| | 60 Hz | 2560 | A |
| $I^2t$ | 50 Hz | 30 | $kA^2s$ |
| | 60 Hz | 27 | |
| $V_{DRM}/V_{RRM}$ | | 400 to 1200 | V |
| $t_q$ | Range | 10 to 20 | µs |
| $T_J$ | | -40 to 125 | °C |

## ELECTRICAL SPECIFICATIONS

| VOLTAGE RATINGS | | | | |
|---|---|---|---|---|
| TYPE NUMBER | VOLTAGE CODE | $V_{DRM}/V_{RRM}$, MAXIMUM REPETITIVE PEAK VOLTAGE V | $V_{RSM}$, MAXIMUM NON-REPETITIVE PEAK VOLTAGE V | $I_{DRM}/I_{RRM}$ MAX. AT $T_J = T_J$ MAX. mA |
| VS-ST083S | 04 | 400 | 500 | 30 |
| | 08 | 800 | 900 | |
| | 10 | 1000 | 1100 | |
| | 12 | 1200 | 1300 | |

## CURRENT CARRYING CAPABILITY

| FREQUENCY |  | |  | |  | | UNITS |
|---|---|---|---|---|---|---|---|
| 50 Hz | 210 | 120 | 330 | 270 | 2540 | 1930 | A |
| 400 Hz | 200 | 120 | 350 | 210 | 1190 | 810 | |
| 1000 Hz | 150 | 80 | 320 | 190 | 630 | 400 | |
| 2500 Hz | 70 | 25 | 220 | 85 | 250 | 100 | |
| Recovery voltage $V_r$ | 50 | 50 | 50 | 50 | 50 | 50 | V |
| Voltage before turn-on $V_d$ | $V_{DRM}$ | | $V_{DRM}$ | | $V_{DRM}$ | | |
| Rise of on-state current dI/dt | 50 | 50 | - | - | - | - | A/µs |
| Case temperature | 60 | 85 | 60 | 85 | 60 | 85 | °C |
| Equivalent values for RC circuit | 22/0.15 | | 22/0.15 | | 22/0.15 | | W/µF |

## ON-STATE CONDUCTION

| PARAMETER | SYMBOL | TEST CONDITIONS | | | VALUES | UNITS |
|---|---|---|---|---|---|---|
| Maximum average on-state current at case temperature | $I_{T(AV)}$ | 180° conduction, half sine wave | | | 85 | A |
| | | | | | 85 | °C |
| Maximum RMS on-state current | $I_{T(RMS)}$ | DC at 77 °C case temperature | | | 135 | A |
| Maximum peak, one half cycle, non-repetitive surge current | $I_{TSM}$ | t = 10 ms | No voltage reapplied | Sinusoidal half wave, initial $T_J = T_J$ maximum | 2450 | |
| | | t = 8.3 ms | | | 2560 | |
| | | t = 10 ms | 100 % $V_{RRM}$ reapplied | | 2060 | |
| | | t = 8.3 ms | | | 2160 | |
| Maximum $I^2t$ for fusing | $I^2t$ | t = 10 ms | No voltage reapplied | | 30 | $kA^2s$ |
| | | t = 8.3 ms | | | 27 | |
| | | t = 10 ms | 100 % $V_{RRM}$ reapplied | | 21 | |
| | | t = 8.3 ms | | | 19 | |
| Maximum $I^2\sqrt{t}$ for fusing | $I^2\sqrt{t}$ | t = 0.1 ms to 10 ms, no voltage reapplied | | | 300 | $kA^2\sqrt{s}$ |
| Maximum peak on-state voltage | $V_{TM}$ | $I_{TM}$ = 300 A, $T_J = T_J$ maximum, $t_p$ = 10 ms sine wave pulse | | | 2.15 | V |
| 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 | | | 1.46 | |
| High level value of threshold voltage | $V_{T(TO)2}$ | (I > π x $I_{T(AV)}$), $T_J = T_J$ maximum | | | 1.52 | |
| Low level value of forward slope resistance | $r_{t1}$ | (16.7 % x π x $I_{T(AV)}$ < I < π x $I_{T(AV)}$), $T_J = T_J$ maximum | | | 2.32 | mΩ |
| High level value of forward slope resistance | $r_{t2}$ | (I > π x $I_{T(AV)}$), $T_J = T_J$ maximum | | | 2.34 | |
| Maximum holding current | $I_H$ | $T_J$ = 25 °C, $I_T$ > 30 A | | | 600 | mA |
| Typical latching current | $I_L$ | $T_J$ = 25 °C, $V_A$ = 12 V, $R_a$ = 6 Ω, $I_G$ = 1 A | | | 1000 | |

## SWITCHING

| PARAMETER | SYMBOL | TEST CONDITIONS | VALUES | | UNITS |
|---|---|---|---|---|---|
| | | | MIN. | MAX. | |
| Maximum non-repetitive rate of rise of turned on current | dI/dt | $T_J = T_J$ max., $V_{DRM}$ = Rated $V_{DRM}$, $I_{TM}$ = 2 x dI/dt | 1000 | | A/µs |
| Typical delay time | $t_d$ | $T_J$ = 25 °C, $V_{DM}$ = Rated $V_{DM}$, $I_{TM}$ = 50 A DC, $t_p$ = 1 µs Resistive load, gate pulse: 10 V, 5 Ω source | 0.80 | | µs |
| Maximum turn-off time | $t_q$ | $T_J = T_J$ maximum, $I_{TM}$ = 100 A, commutating dI/dt = 10 A/µs $V_R$ = 50 V, $t_p$ = 200 µs, dV/dt = 200 V/µs | 10 | 20 | |

| 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 % $V_{DRM}$, higher value available on request | 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** |
| Maximum peak gate power | $P_{GM}$ | $T_J = T_J$ maximum, f = 50 Hz, d% = 50 | 40 | W |
| Maximum average gate power | $P_{G(AV)}$ | | 5 | |
| Maximum peak positive gate current | $I_{GM}$ | $T_J = T_J$ maximum, $t_p \leq 5$ ms | 5 | A |
| Maximum peak positive gate voltage | $+V_{GM}$ | | 20 | V |
| Maximum peak negative gate voltage | $-V_{GM}$ | | 5 | |
| Maximum DC gate current required to trigger | $I_{GT}$ | $T_J$ = 25 °C, $V_A$ = 12 V, $R_a$ = 6 Ω | 200 | mA |
| Maximum DC gate voltage required to trigger | $V_{GT}$ | | 3 | V |
| Maximum DC gate current not to trigger | $I_{GD}$ | $T_J = T_J$ maximum, rated $V_{DRM}/V_{RRM}$ applied | 20 | mA |
| Maximum DC gate voltage not to trigger | $V_{GD}$ | | 0.25 | V |

| THERMAL AND MECHANICAL SPECIFICATIONS | | | | |
|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **VALUES** | **UNITS** |
| Maximum junction operating 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 | 0.195 | K/W |
| Maximum thermal resistance, case to heatsink | $R_{thCS}$ | Mounting surface, smooth, flat and greased | 0.08 | |
| Mounting torque, ± 10 % | | Non-lubricated threads | 15.5 (137) | N · m (lbf · in) |
| | | Lubricated threads | 14 (120) | |
| Approximate weight | | | 130 | g |
| Case style | | See dimensions - link at the end of datasheet | TO-209AC (TO-94) | |

| $\Delta R_{thJC}$ CONDUCTION | | | | |
|---|---|---|---|---|
| **CONDUCTION ANGLE** | **SINUSOIDAL CONDUCTION** | **RECTANGULAR CONDUCTION** | **TEST CONDITIONS** | **UNITS** |
| 180° | 0.034 | 0.025 | $T_J = T_J$ maximum | K/W |
| 120° | 0.041 | 0.042 | | |
| 90° | 0.052 | 0.056 | | |
| 60° | 0.076 | 0.079 | | |
| 30° | 0.126 | 0.127 | | |

**Note**

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

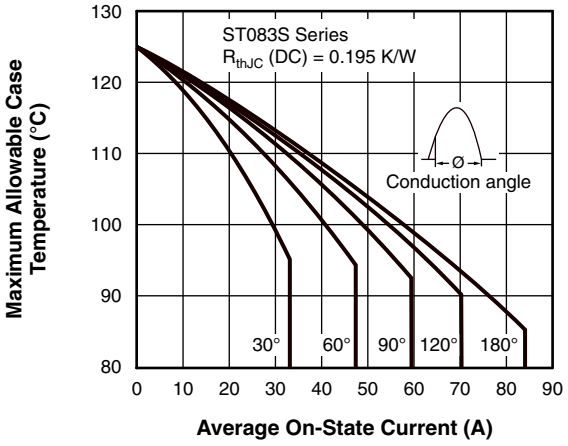



Fig. 1 - Current Ratings Characteristics

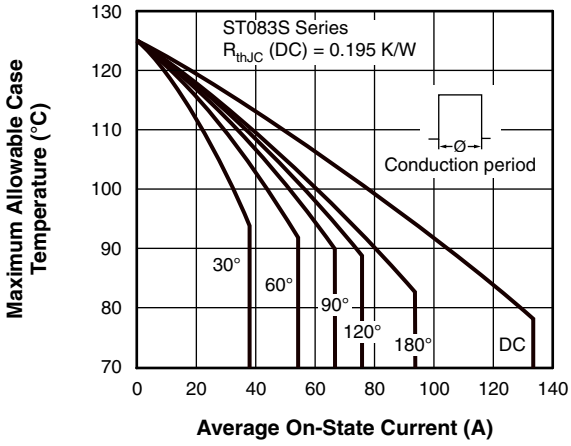
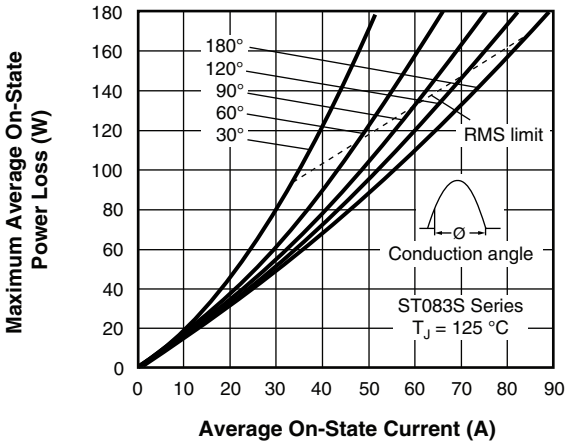



Fig. 2 - Current Ratings Characteristics



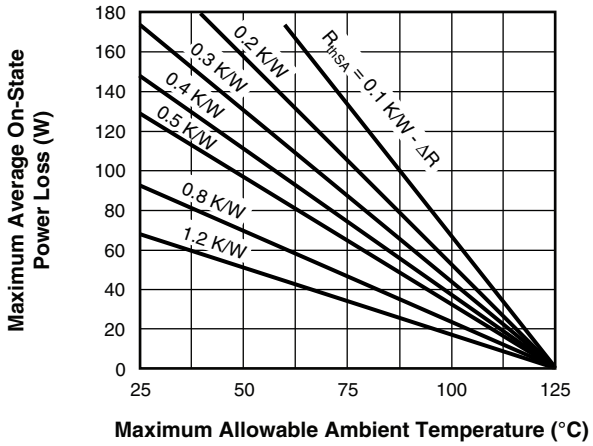
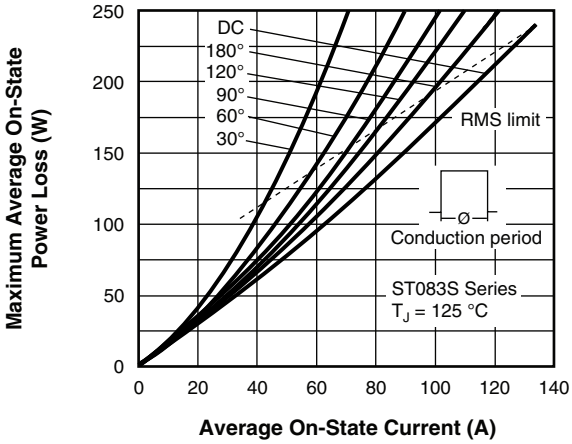




Fig. 3 - On-State Power Loss Characteristics



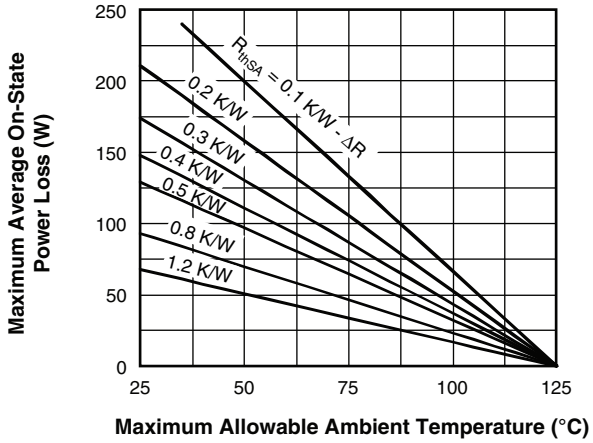




Fig. 4 - On-State Power Loss Characteristics

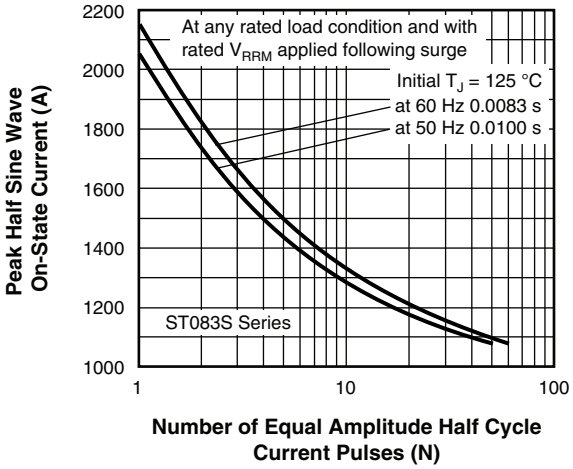



Fig. 5 - Maximum Non-Repetitive Surge Current

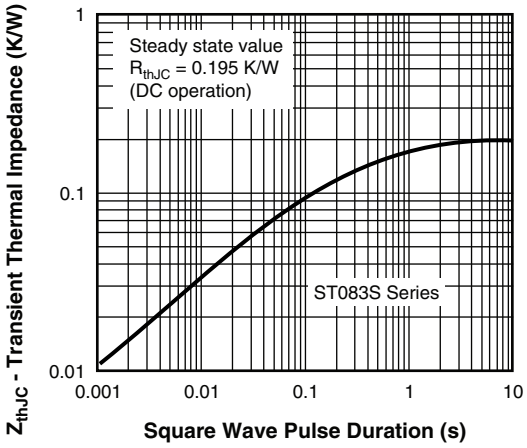



Fig. 8 - Thermal Impedance $Z_{thJC}$ Characteristic

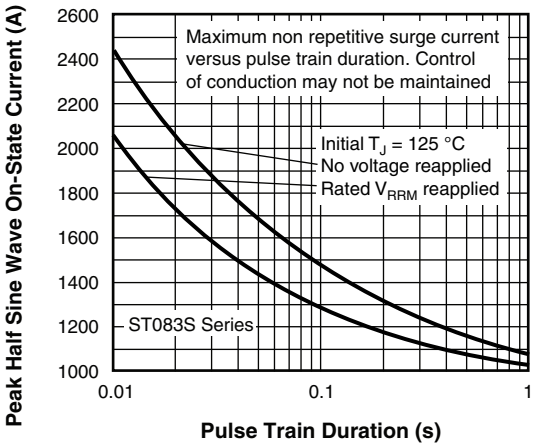



Fig. 6 - Maximum Non-Repetitive Surge Current

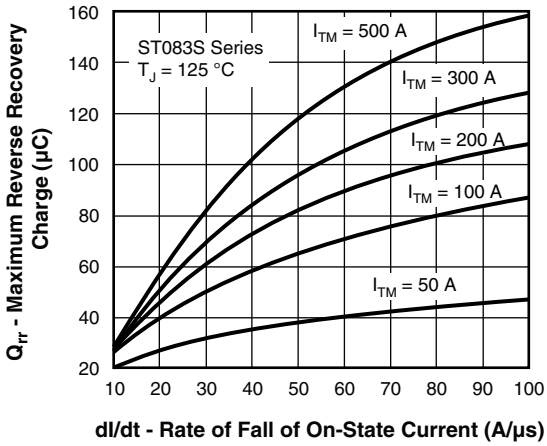



Fig. 9 - Reverse Recovered Charge Characteristics

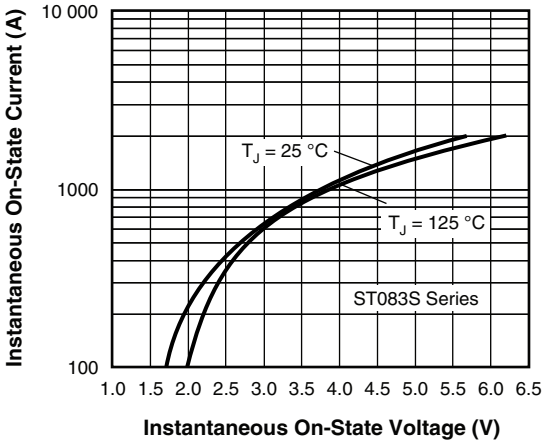



Fig. 7 - On-State Voltage Drop Characteristics

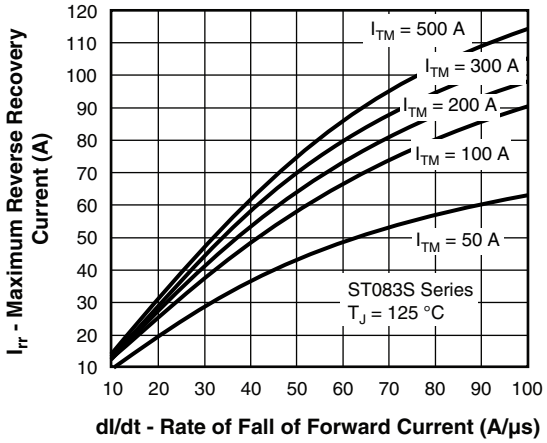



Fig. 10 - Reverse Recovery Current Characteristics

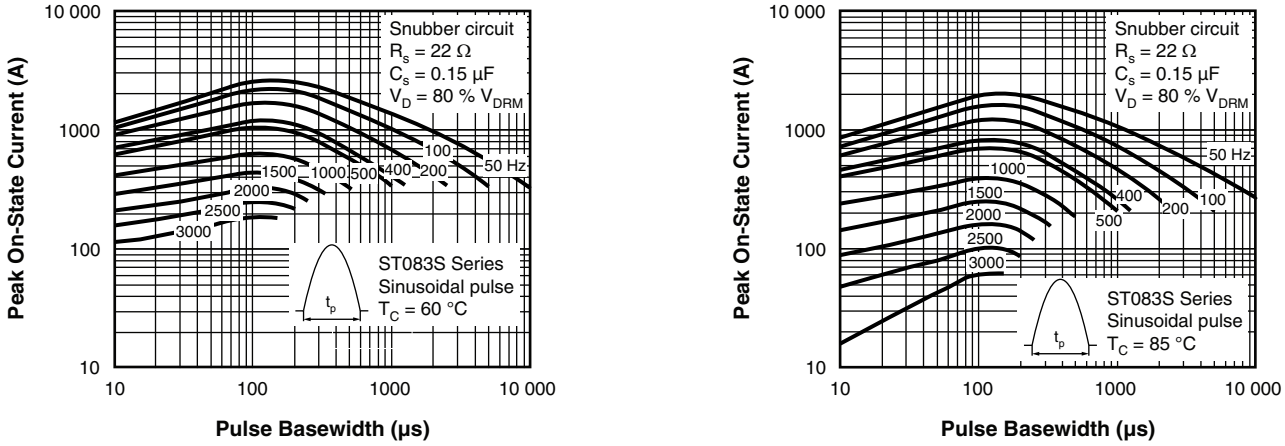



Fig. 11 - Frequency Characteristics

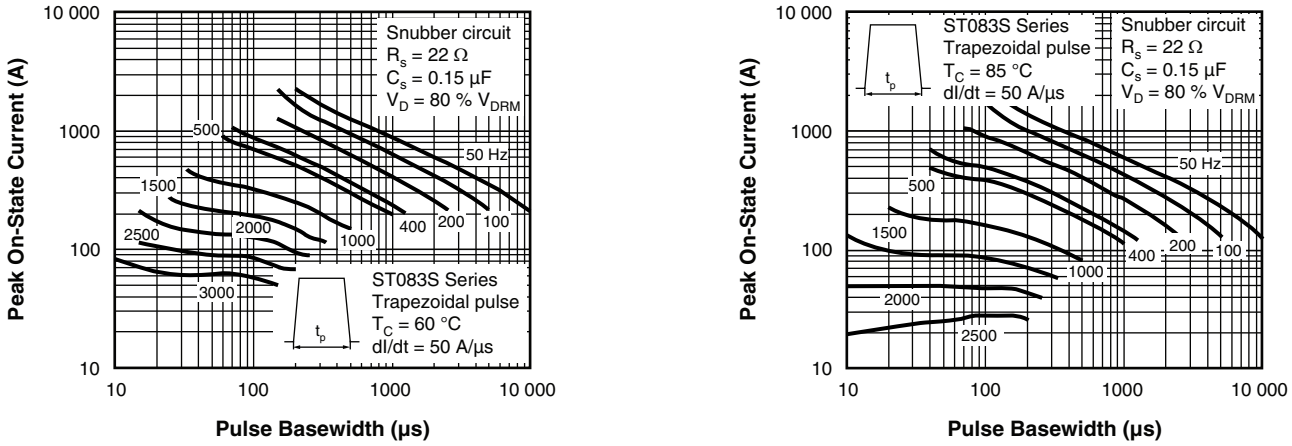



Fig. 12 - Frequency Characteristics

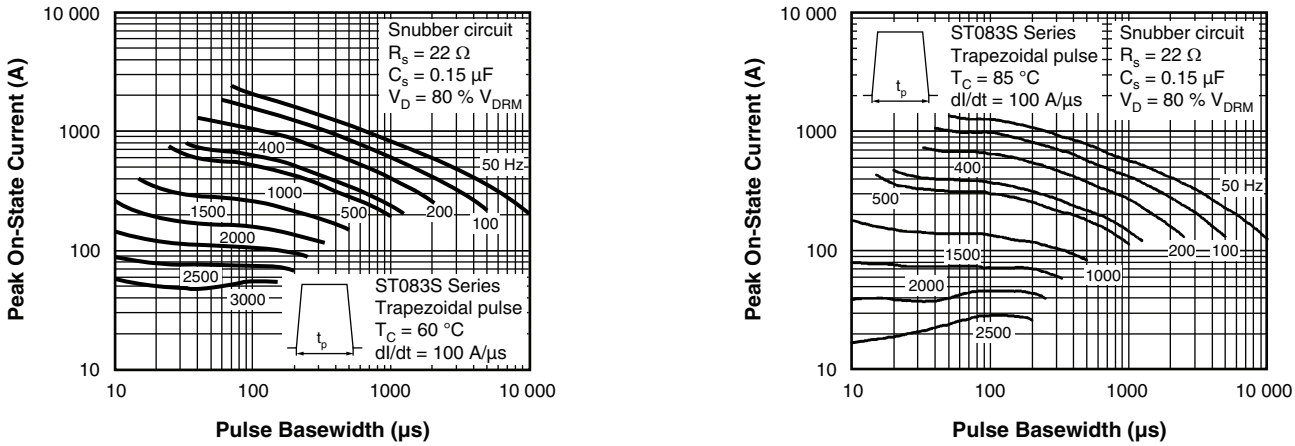



Fig. 13 - Frequency Characteristics

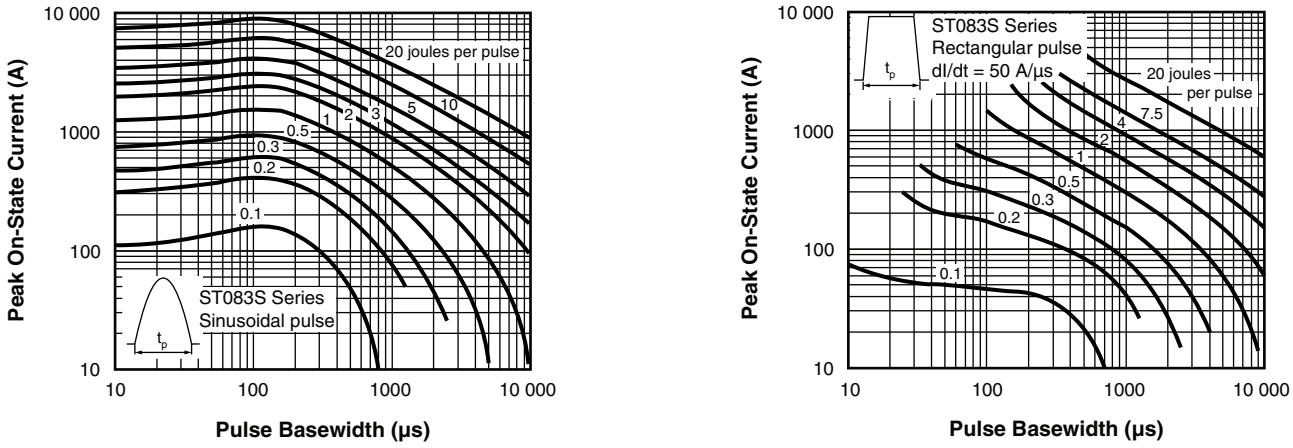



Fig. 14 - Maximum On-State Energy Power Loss Characteristics

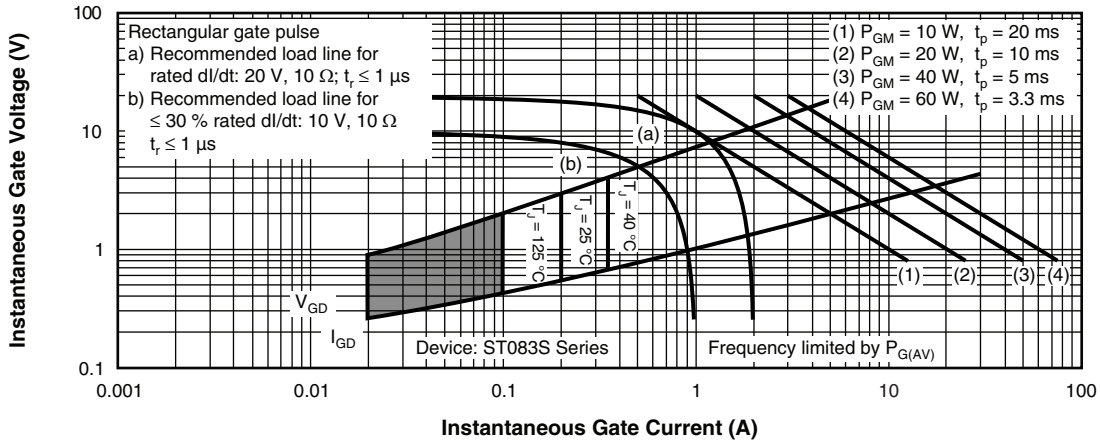
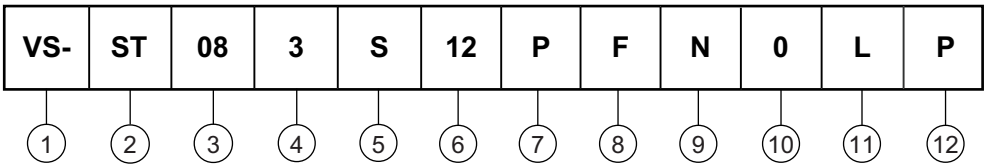



Fig. 15 - Gate Characteristics

## ORDERING INFORMATION TABLE

**Device code**




1 - Vishay Semiconductors product

2 - Thyristor

3 - Essential part number

4 - 3 = Fast turn-off

5 - S = Compression bonding stud

6 - Voltage code x 100 = $V_{RRM}$ (see Voltage Ratings table)

7 - • P = Stud base 1/2"-20UNF-2A threads
• M = Metric M12, contact factory for availability

8 - Reapplied dV/dt code (for $t_q$ test condition)

9 - $t_q$ code

10 - • 0 = Eyelet terminals (gate and aux. cathode leads)
• 1 = Fast-on terminals (gate and aux. cathode leads)
• 2 = Flag terminals (gate and aux. cathode leads)

11 - Critical dV/dt:
• None = 500 V/µs (standard value)
• L = 1000 V/µs (special selection)

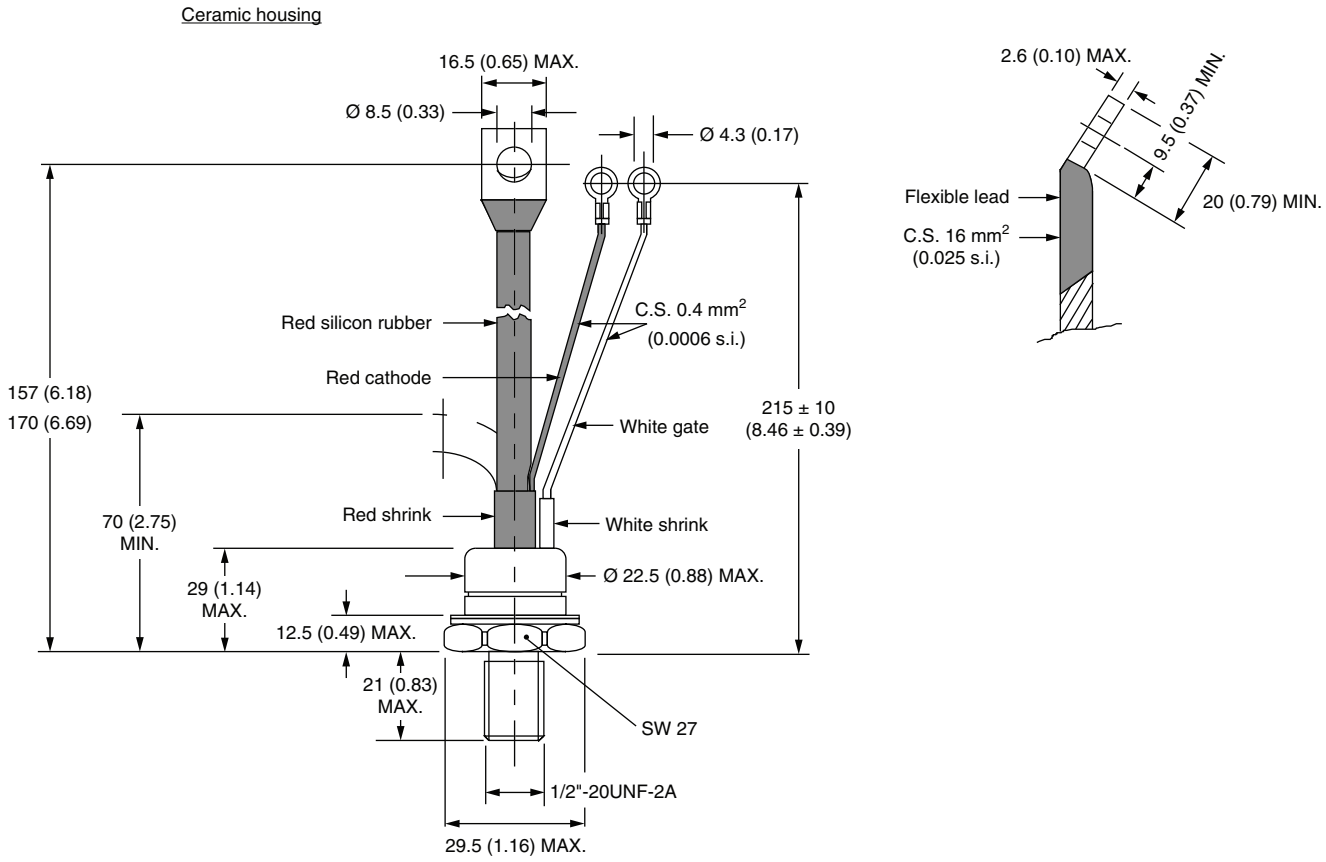
12 - None = Standard production; P = Lead (Pb)-free

| dV/dt - $t_q$ combinations available | | |
|---|---|---|
| | **dV/dt (V/µs)** | **200** |
| **$t_q$ (µs)** up to 800V | 10 | FN |
| | 20 | FK |
| **$t_q$ (µs)** only for 1000/1200 V | 20 | FK |

| LINKS TO RELATED DOCUMENTS | |
|---|---|
| Dimensions | www.vishay.com/doc?95003 |

# TO-209AC (TO-94) for ST083S and ST103S Series

**DIMENSIONS** in millimeters (inches)



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