

## Phase Control Thyristors (Stud Version), 110 A



TO-94 (TO-209AC)


**RoHS  
COMPLIANT**
**FEATURES**

- Center gate
- International standard case TO-94 (TO-209AC)
- Compression bonded encapsulation for heavy duty operations such as severe thermal cycling
- Hermetic glass-metal case with ceramic insulator (Glass-metal seal over 1200 V)
- 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)

**TYPICAL APPLICATIONS**

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

**PRIMARY CHARACTERISTICS**

|                       |                              |
|-----------------------|------------------------------|
| $I_{T(AV)}$           | 110 A                        |
| $V_{DRM}/V_{RRM}$     | 400 V, 800 V, 1200 V, 1600 V |
| $V_{TM}$              | 1.52 V                       |
| $I_{GT}$              | 150 mA                       |
| $T_J$                 | -40 °C to +125 °C            |
| Package               | TO-94 (TO-209AC)             |
| Circuit configuration | Single SCR                   |

**MAJOR RATINGS AND CHARACTERISTICS**

| PARAMETER         | TEST CONDITIONS | VALUES      | UNITS             |
|-------------------|-----------------|-------------|-------------------|
| $I_{T(AV)}$       |                 | 110         | A                 |
|                   | $T_C$           | 90          | °C                |
| $I_{T(RMS)}$      |                 | 175         | A                 |
|                   | 50 Hz           | 2700        |                   |
| $I_{TSM}$         | 60 Hz           | 2830        | kA <sup>2</sup> s |
|                   | 50 Hz           | 36.4        |                   |
| $I^2t$            | 60 Hz           | 33.2        | kA <sup>2</sup> s |
|                   |                 | 400 to 1600 |                   |
| $V_{DRM}/V_{RRM}$ |                 | 400 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<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-ST110S   | 04           | 400  | 500  | 20   |
|             | 08           | 800  | 900  |  |
|             | 12           | 1200   | 1300   |  |
|             | 16           | 1600   | 1700   |  |



| <b>ABSOLUTE MAXIMUM RATINGS</b>                      |               |   |                           |        |                    |
|--|---------------|---|---------------------------|--------|--------------------|
| PARAMETER  | SYMBOL        | TEST CONDITIONS   |                           | VALUES | UNITS              |
| Maximum average on-state current at case temperature | $I_{T(AV)}$   | 180° conduction, half sine wave   |                           | 110    | A                  |
|  |               |   |                           | 90     | °C                 |
| Maximum RMS on-state current                         | $I_{T(RMS)}$  | DC at 85 °C case temperature  |                           | 175    |                    |
| Maximum peak, one-cycle non-repetitive surge current | $I_{TSM}$     | t = 10 ms   | No voltage reapplied      | 2700   | A                  |
|  |               | t = 8.3 ms  |                           | 2830   |                    |
|  |               | t = 10 ms   | 100 % $V_{RRM}$ reapplied | 2270   |                    |
|  |               | t = 8.3 ms  |                           | 2380   |                    |
| Maximum $I^2t$ for fusing                            | $I^2t$        | t = 10 ms   | No voltage reapplied      | 36.4   | kA <sup>2</sup> s  |
|  |               | t = 8.3 ms  |                           | 33.2   |                    |
|  |               | t = 10 ms   | 100 % $V_{RRM}$ reapplied | 25.8   |                    |
|  |               | t = 8.3 ms  |                           | 23.5   |                    |
| Maximum $I^2\sqrt{t}$ for fusing                     | $I^2\sqrt{t}$ | t = 0.1 to 10 ms, no voltage reapplied  |                           | 364    | 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) |                           | 0.90   | V                  |
| High level value of threshold voltage                | $V_{T(TO)2}$  | (I $> \pi \times I_{T(AV)}$ , $T_J = T_J$ maximum)                                      |                           | 0.92   |                    |
| 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) |                           | 1.79   | mΩ                 |
| High level value of on-state slope resistance        | $r_{t2}$      | (I $> \pi \times I_{T(AV)}$ , $T_J = T_J$ maximum)                                      |                           | 1.81   |                    |
| Maximum on-state voltage                             | $V_{TM}$      | $I_{pk} = 350$ 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   |                    |

| <b>SWITCHING</b>   |        |  |  |        |       |
|--|--------|--|--|--------|-------|
| 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 $\leq 80$ % $V_{DRM}$                           |  | 500    | 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   |  | 2.0    | μs    |
| Typical turn-off time                                    | $t_q$  | $I_{TM} = 100$ A, $T_J = T_J$ maximum, $dI/dt = 10$ A/μs,<br>$V_R = 50$ V, $dV/dt = 20$ V/μs, gate 0 V 100 Ω, $t_p = 500$ μs |  | 100    |       |

| <b>BLOCKING</b>                                    |                          |  |  |        |       |
|--|--------------------------|--|--|--------|-------|
| 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 |  | 20     | 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         |  | 5      |      | W     |
| Maximum average gate power          | $P_{G(AV)}$ | $T_J = T_J$ maximum, $f = 50$ Hz, $d\% = 50$ |  | 1      |      |       |
| Maximum peak positive gate current  | $I_{GM}$    | $T_J = T_J$ maximum, $t_p \leq 5$ ms         |  | 2.0    |      | A     |
| Maximum peak positive gate voltage  | $+V_{GM}$   |  |  | 20     |      |       |
| Maximum peak negative gate voltage  | $-V_{GM}$   |  |  | 5.0    |      |       |
| DC gate current required to trigger | $I_{GT}$    | $T_J = -40$ °C                               | Maximum required gate trigger/<br>current/voltage are the lowest<br>value which will trigger all units<br>6 V anode to cathode applied | 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     |

| <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                                  | 0.195            | K/W              |
| Maximum thermal resistance, case to heatsink | $R_{thCS}$ | Mounting surface, smooth, flat and greased    | 0.08             |                  |
| Mounting torque, $\pm 10$ %                  |            | Non-lubricated threads                        | 15.5 (137)       | Nm<br>(lbf · in) |
|  |            | Lubricated threads                            | 14 (120)         |                  |
| Approximate weight                           |            |   | 130              | g                |
| Case style                                   |            | See dimensions - link at the end of datasheet | TO-94 (TO-209AC) |                  |

| <b><math>\Delta R_{thJC}</math> CONDUCTION</b> |                       |                        |                     |       |
|--|-----------------------|------------------------|---------------------|-------|
| CONDUCTION ANGLE                               | SINUSOIDAL CONDUCTION | RECTANGULAR CONDUCTION | TEST CONDITIONS     | UNITS |
| 180°   | 0.035                 | 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

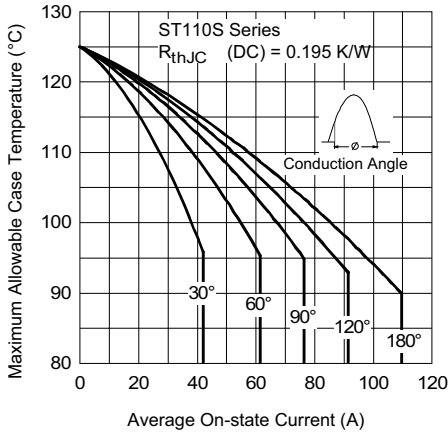


Fig. 1 - Current Ratings Characteristics

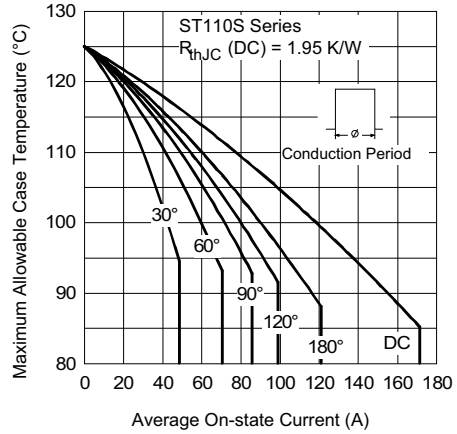


Fig. 2 - Current Ratings Characteristics

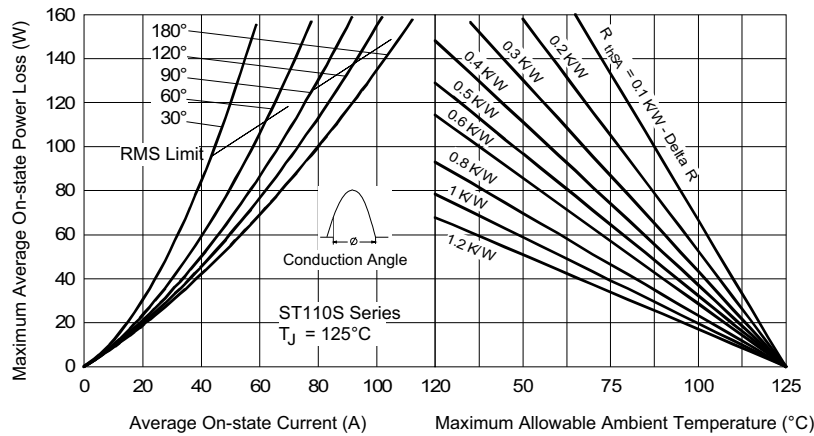


Fig. 3 - On-State Power Loss Characteristics

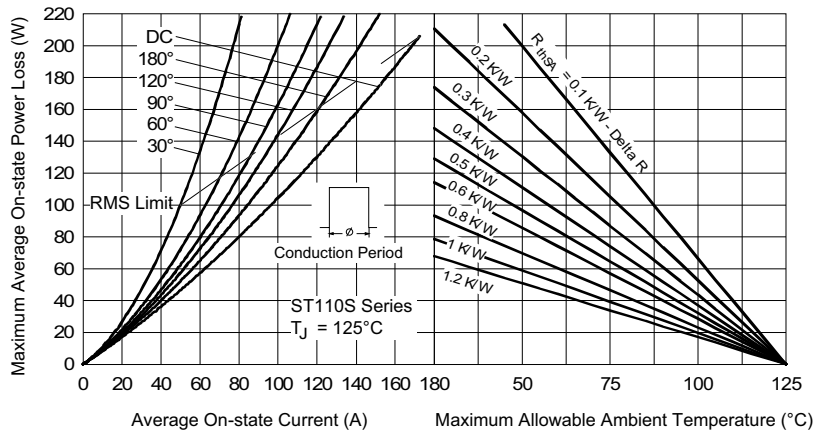


Fig. 4 - On-State Power Loss Characteristics

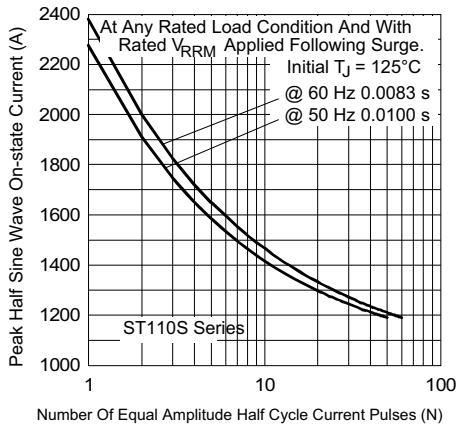


Fig. 5 - Maximum Non-Repetitive Surge Current

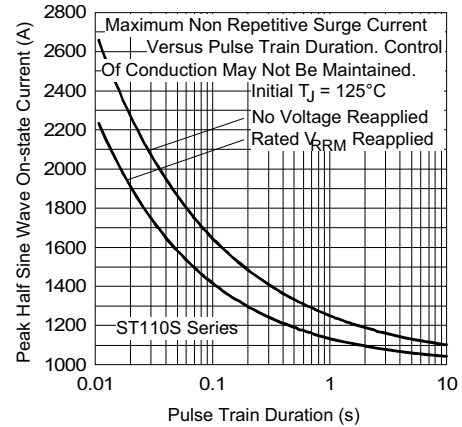


Fig. 6 - Maximum Non-Repetitive Surge Current

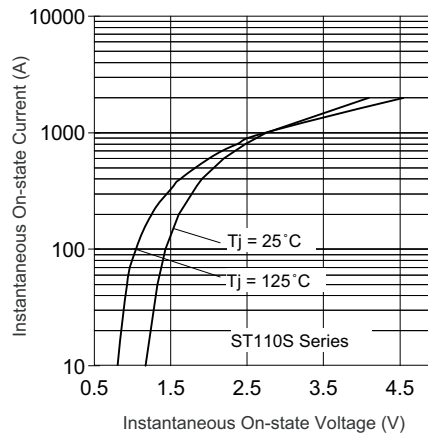


Fig. 7 - On-State Voltage Drop Characteristics

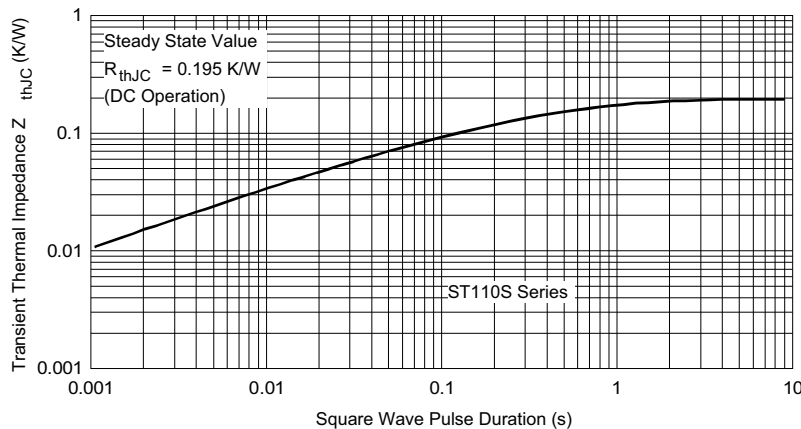


Fig. 8 - Thermal Impedance  $Z_{thJC}$  Characteristic

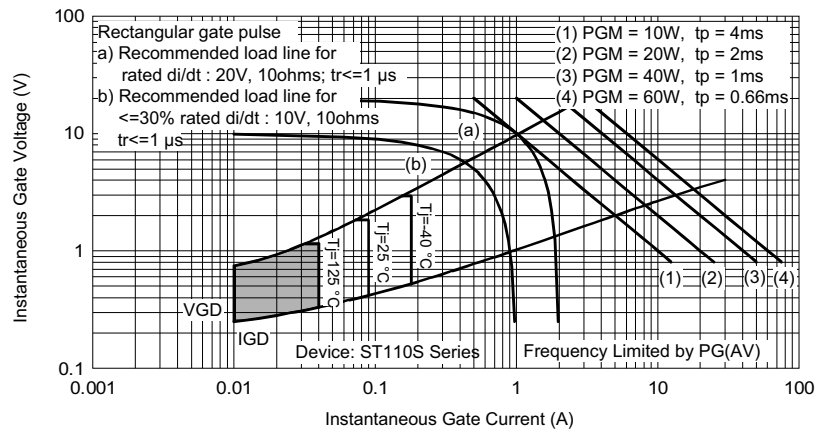


Fig. 9 - Gate Characteristics

**ORDERING INFORMATION TABLE**

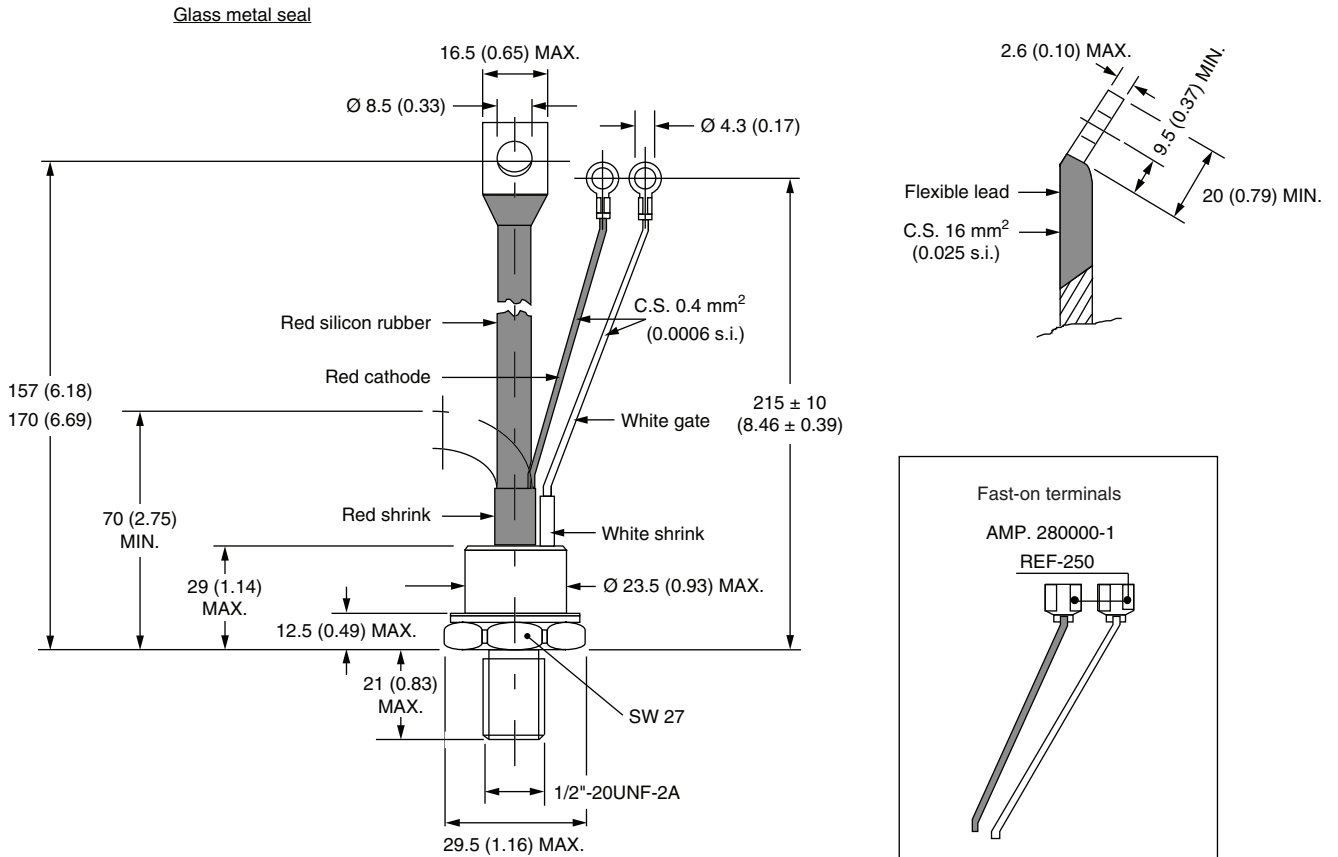
|             |            |           |           |          |          |           |          |          |          |          |            |
|-------------|------------|-----------|-----------|----------|----------|-----------|----------|----------|----------|----------|------------|
| Device code | <b>VS-</b> | <b>ST</b> | <b>11</b> | <b>0</b> | <b>S</b> | <b>16</b> | <b>P</b> | <b>0</b> | <b>V</b> | <b>L</b> | <b>PbF</b> |
|             | (1)        | (2)       | (3)       | (4)      | (5)      | (6)       | (7)      | (8)      | (9)      | (10)     | (11)       |

- 1** - Vishay Semiconductors product
- 2** - Thyristor
- 3** - Essential part marking
- 4** - 0 = converter grade
- 5** - S = compression bonding stud
- 6** - Voltage code x 100 =  $V_{RRM}$  (see Voltage Ratings table)
- 7** - P = stud base 20UNF threads
- 8** - 0 = eyelet terminals (gate and auxiliary cathode leads)  
1 = fast-on terminals (gate and auxiliary cathode leads)  
2 = flag terminals (for cathode and gate terminals)
- 9** - • V = glass-metal seal (only up to 1200 V)  
• None = ceramic housing (over 1200 V)
- 10** - Critical dV/dt:  
• None = 500 V/ $\mu$ s (standard value)  
• L = 1000 V/ $\mu$ s (special selection)
- 11** - None = standard production  
- PbF = lead (Pb)-free

| LINKS TO RELATED DOCUMENTS |  |
|----------------------------|--|
| Dimensions                 | <a href="http://www.vishay.com/doc?95078">www.vishay.com/doc?95078</a> |

## TO-209AC (TO-94) for ST110S Series

**DIMENSIONS** in millimeters (inches)

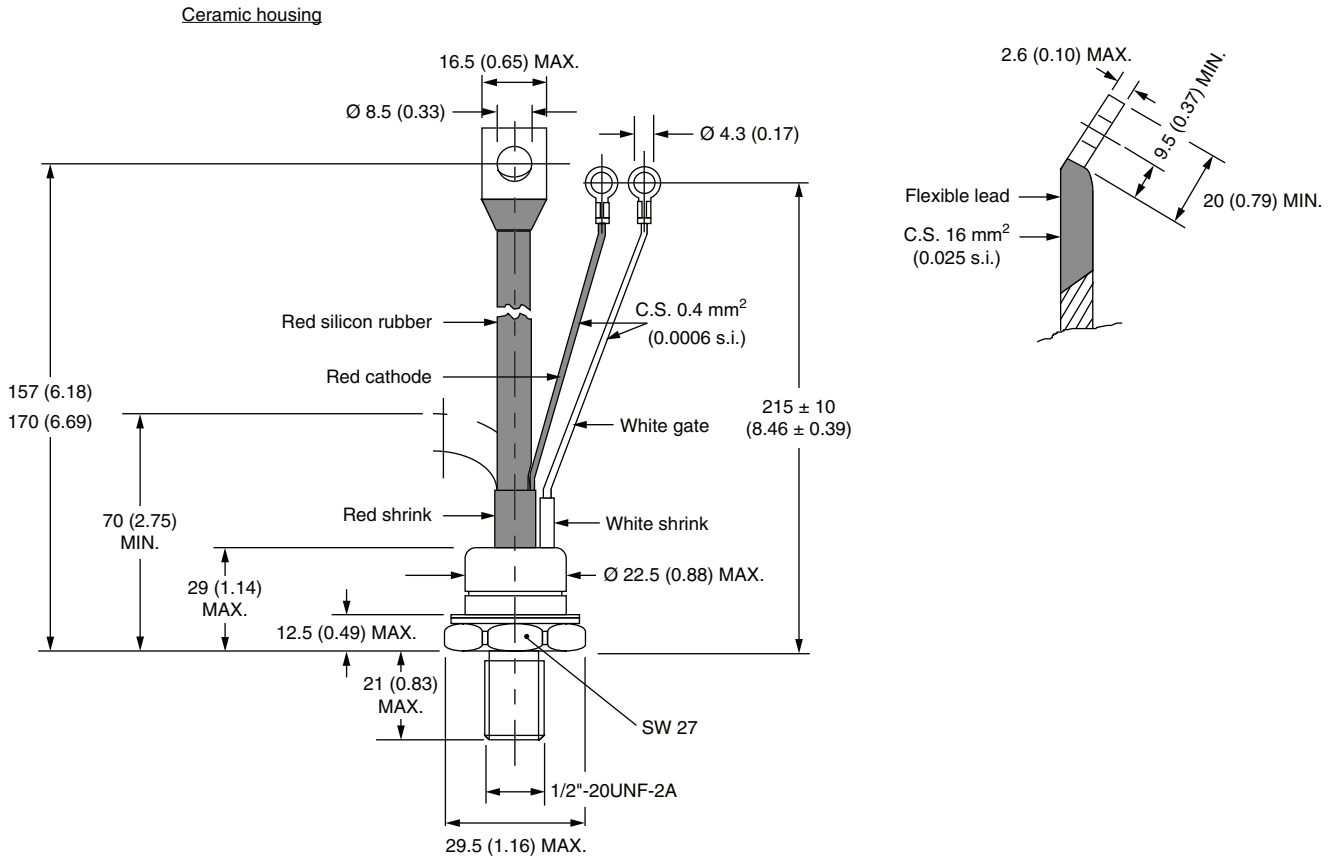


# Outline Dimensions

Vishay Semiconductors TO-209AC (TO-94) for ST110S Series



**DIMENSIONS** in millimeters (inches)







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