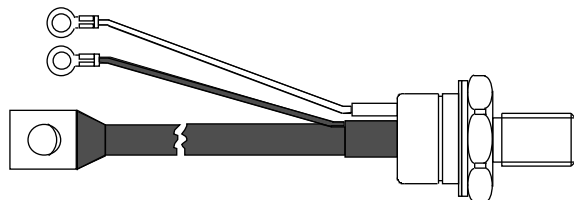


## Phase Control Thyristors (Stud Version), 110 A



TO-209AC (TO-94)

### FEATURES

- Center gate
- International standard case TO-209AC (TO-94)
- 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)
- Compliant to RoHS directive 2002/95/EC
- Designed and qualified for industrial level



**RoHS**  
COMPLIANT

### PRODUCT SUMMARY

|             |       |
|-------------|-------|
| $I_{T(AV)}$ | 110 A |
|-------------|-------|

### TYPICAL APPLICATIONS

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

### MAJOR RATINGS AND CHARACTERISTICS

| PARAMETER         | TEST CONDITIONS | VALUES      | UNITS             |
|-------------------|-----------------|-------------|-------------------|
| $I_{T(AV)}$       |                 | 110         | A                 |
|                   | $T_C$           | 90          | °C                |
| $I_{T(RMS)}$      |                 | 175         | A                 |
| $I_{TSM}$         | 50 Hz           | 2700        |                   |
|                   | 60 Hz           | 2830        |                   |
| $I^2t$            | 50 Hz           | 36.4        | kA <sup>2</sup> s |
|                   | 60 Hz           | 33.2        |                   |
| $V_{DRM}/V_{RRM}$ |                 | 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 |
|-------------|--------------|------------------------------------------------------------------------|------------------------------------------------------|--------------------------------------------------------|
| ST110S      | 04           | 400                                                                    | 500                                                  | 20                                                     |
|             | 08           | 800                                                                    | 900                                                  |                                                        |
|             | 12           | 1200                                                                   | 1300                                                 |                                                        |
|             | 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                                                          | 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 reappplied      | 2700           |
|                                                      |               | $t = 8.3$ ms                                                                             |                            | 2830           |
|                                                      |               | $t = 10$ ms                                                                              | 100 % $V_{RRM}$ reappplied | 2270           |
|                                                      |               | $t = 8.3$ ms                                                                             |                            | 2380           |
| Maximum $I^2t$ for fusing                            | $I^2t$        | $t = 10$ ms                                                                              | No voltage reappplied      | 36.4           |
|                                                      |               | $t = 8.3$ ms                                                                             |                            | 33.2           |
|                                                      |               | $t = 10$ ms                                                                              | 100 % $V_{RRM}$ reappplied | 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 reappplied                                                | 364                        | $kA^2\sqrt{s}$ |
| 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                       | $m\Omega$      |
| 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                       |                |

**SWITCHING**

| PARAMETER                                                | SYMBOL  | TEST CONDITIONS                                                                                                                                         | VALUES | UNITS      |
|----------------------------------------------------------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------------|
| Maximum non-repetitive rate of rise of turned-on current | $di/dt$ | Gate drive 20 V, 20 $\Omega$ , $t_r \leq 1$ $\mu s$<br>$T_J = T_J$ maximum, anode voltage $\leq 80$ % $V_{DRM}$                                         | 500    | A/ $\mu s$ |
| Typical delay time                                       | $t_d$   | Gate current 1 A, $di_g/dt = 1$ A/ $\mu s$<br>$V_d = 0.67$ % $V_{DRM}$ , $T_J = 25$ °C                                                                  | 2.0    | $\mu s$    |
| Typical turn-off time                                    | $t_q$   | $I_{TM} = 100$ A, $T_J = T_J$ maximum, $di/dt = 10$ A/ $\mu s$ ,<br>$V_R = 50$ V, $dV/dt = 20$ V/ $\mu s$ , gate 0 V 100 $\Omega$ , $t_p = 500$ $\mu s$ | 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/ $\mu s$ |
| 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         |



| TRIGGERING                          |                    |                                                                |                                                                                                                                                                   |        |      |       |
|-------------------------------------|--------------------|----------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|-------|
| PARAMETER                           | SYMBOL             | TEST CONDITIONS                                                |                                                                                                                                                                   | VALUES |      | UNITS |
|                                     |                    |                                                                |                                                                                                                                                                   | TYP.   | MAX. |       |
| Maximum peak gate power             | P <sub>GM</sub>    | T <sub>J</sub> = T <sub>J</sub> maximum, t <sub>p</sub> ≤ 5 ms |                                                                                                                                                                   | 5      |      | W     |
| Maximum average gate power          | P <sub>G(AV)</sub> | T <sub>J</sub> = T <sub>J</sub> maximum, f = 50 Hz, d% = 50    |                                                                                                                                                                   | 1      |      |       |
| Maximum peak positive gate current  | I <sub>GM</sub>    | T <sub>J</sub> = T <sub>J</sub> maximum, t <sub>p</sub> ≤ 5 ms |                                                                                                                                                                   | 2.0    |      | A     |
| Maximum peak positive gate voltage  | + V <sub>GM</sub>  |                                                                |                                                                                                                                                                   | 20     |      | V     |
| Maximum peak negative gate voltage  | - V <sub>GM</sub>  |                                                                |                                                                                                                                                                   | 5.0    |      |       |
| DC gate current required to trigger | I <sub>GT</sub>    | T <sub>J</sub> = - 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 <sub>J</sub> = 25 °C                                         |                                                                                                                                                                   | 90     | 150  |       |
|                                     |                    | T <sub>J</sub> = 125 °C                                        |                                                                                                                                                                   | 40     | -    |       |
| DC gate voltage required to trigger | V <sub>GT</sub>    | T <sub>J</sub> = - 40 °C                                       |                                                                                                                                                                   | 2.9    | -    | V     |
|                                     |                    | T <sub>J</sub> = 25 °C                                         |                                                                                                                                                                   | 1.8    | 3.0  |       |
|                                     |                    | T <sub>J</sub> = 125 °C                                        |                                                                                                                                                                   | 1.2    | -    |       |
| DC gate current not to trigger      | I <sub>GD</sub>    | T <sub>J</sub> = T <sub>J</sub> maximum                        | Maximum gate current/voltage<br>not to trigger is the maximum<br>value which will not trigger any<br>unit with rated V <sub>DRM</sub> anode to<br>cathode applied | 10     |      | mA    |
| DC gate voltage not to trigger      | V <sub>GD</sub>    |                                                                |                                                                                                                                                                   | 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                                  |  | 0.195            | 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-209AC (TO-94) |                  |

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

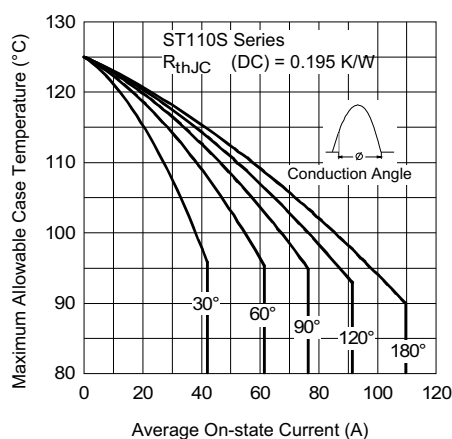


Fig. 1 - Current Ratings Characteristics

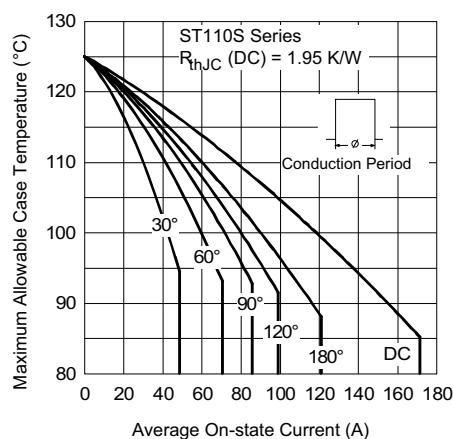


Fig. 2 - Current Ratings Characteristics

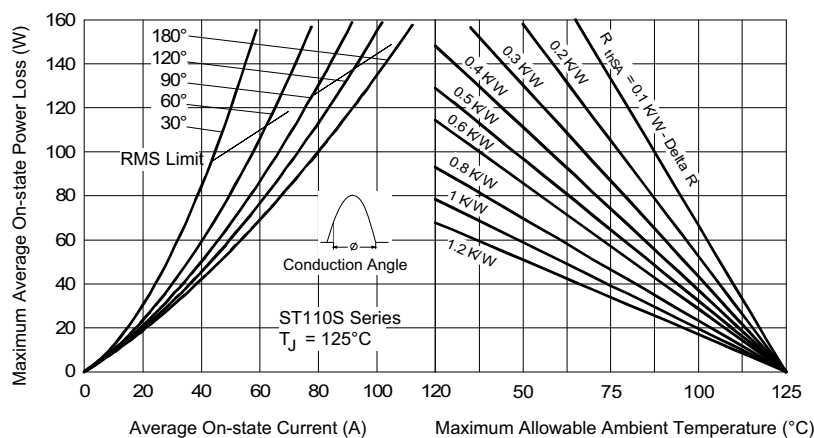


Fig. 3 - On-State Power Loss Characteristics

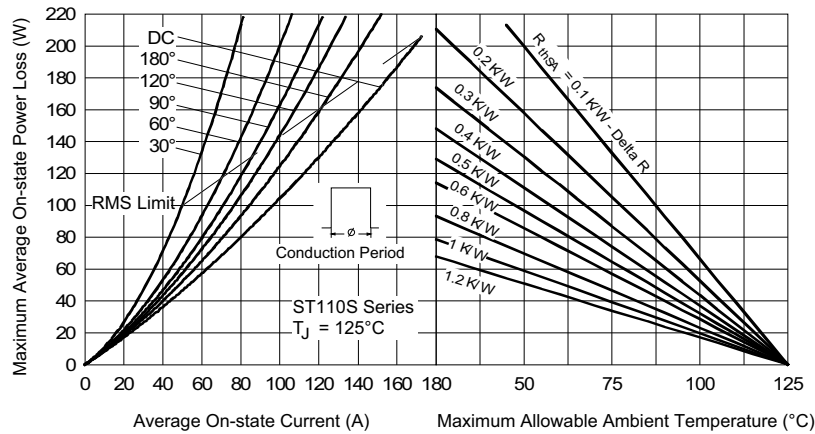


Fig. 4 - On-State Power Loss Characteristics

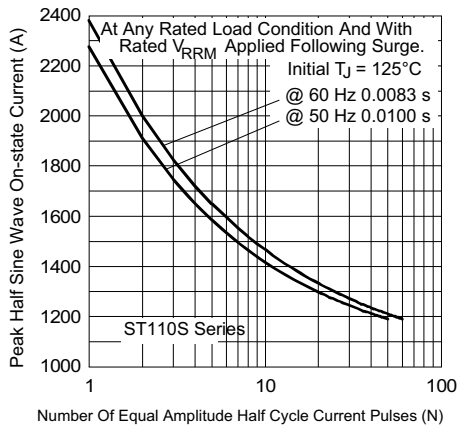


Fig. 5 - Maximum Non-Repetitive Surge Current

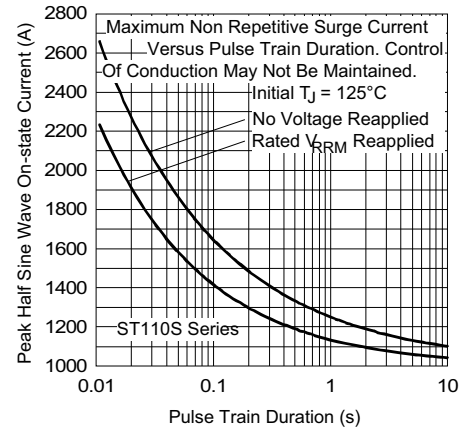


Fig. 6 - Maximum Non-Repetitive Surge Current

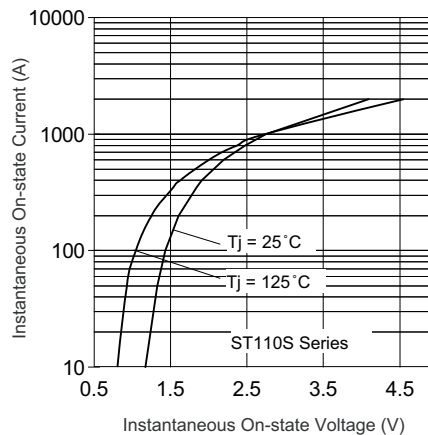


Fig. 7 - On-State Voltage Drop Characteristics

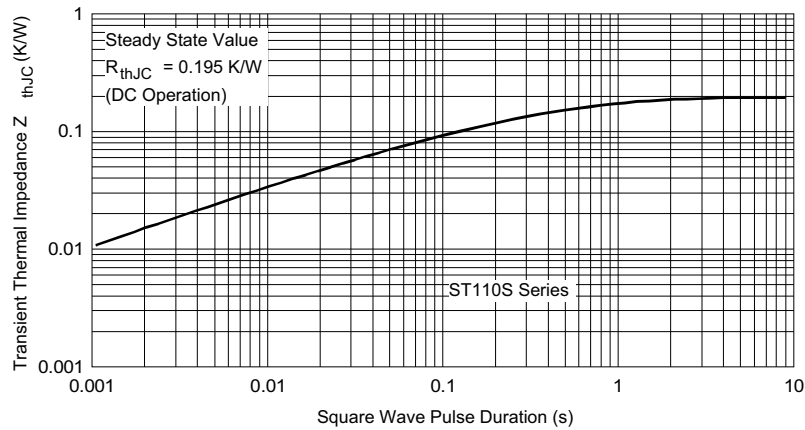


Fig. 8 - Thermal Impedance  $Z_{thJC}$  Characteristic

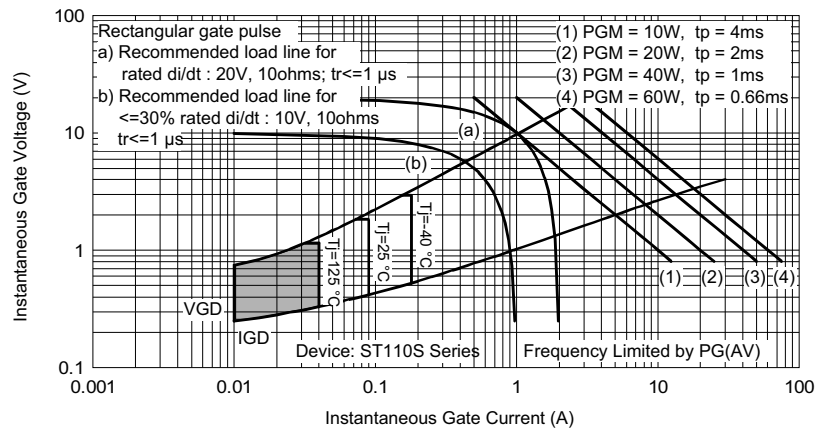


Fig. 9 - Gate Characteristics



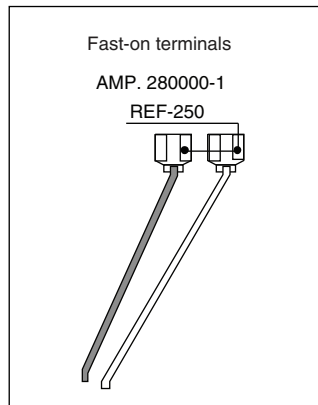
## ORDERING INFORMATION TABLE

|             |    |    |   |   |    |   |   |   |   |     |
|-------------|----|----|---|---|----|---|---|---|---|-----|
| Device code | ST | 11 | 0 | S | 16 | P | 0 | V | L | PbF |
|             | 1  | 2  | 3 | 4 | 5  | 6 | 7 | 8 | 9 | 10  |

- |           |   |                                                                                                                                                                            |
|-----------|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1</b>  | - | Thyristor                                                                                                                                                                  |
| <b>2</b>  | - | Essential part marking                                                                                                                                                     |
| <b>3</b>  | - | 0 = Converter grade                                                                                                                                                        |
| <b>4</b>  | - | S = Compression bonding stud                                                                                                                                               |
| <b>5</b>  | - | Voltage code x 100 = $V_{RRM}$ (see Voltage Ratings table)                                                                                                                 |
| <b>6</b>  | - | P = Stud base 20UNF threads                                                                                                                                                |
| <b>7</b>  | - | 0 = Eyelet terminals (gate and auxiliary cathode leads)<br>1 = Fast-on terminals (gate and auxiliary cathode leads)<br>2 = Flag terminals (for cathode and gate terminals) |
| <b>8</b>  | - | • V = Glass-metal seal (only up to 1200 V)<br>• None = Ceramic housing (over 1200 V)                                                                                       |
| <b>9</b>  | - | Critical dV/dt:<br>• None = 500 V/ $\mu$ s (standard value)<br>• L = 1000 V/ $\mu$ s (special selection)                                                                   |
| <b>10</b> | - | Lead (Pb)-free                                                                                                                                                             |

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

**DIMENSIONS** in millimeters (inches)

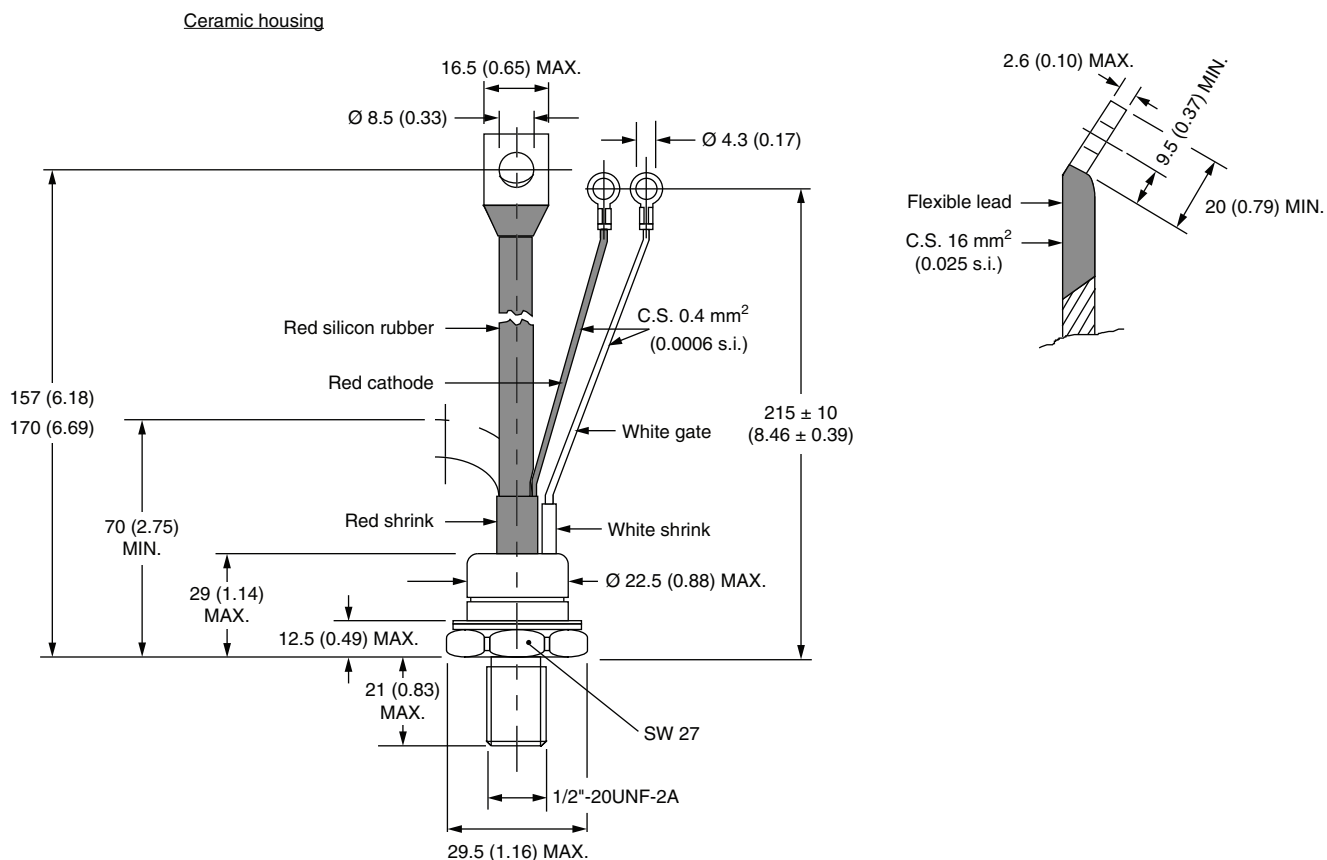


# Outline Dimensions

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



**DIMENSIONS** in millimeters (inches)





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