

## Phase Control Thyristors (Hockey PUK Version), 410 A


**TO-200AB (A-PUK)**

### FEATURES

- Center amplifying gate
- Metal case with ceramic insulator
- International standard case TO-200AB (A-PUK)
- 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)


**RoHS**  
COMPLIANT

### TYPICAL APPLICATIONS

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

### PRODUCT SUMMARY

|                   |                                                         |
|-------------------|---------------------------------------------------------|
| Package           | TO-200AB (A-PUK)                                        |
| Diode variation   | Single SCR                                              |
| $I_{T(AV)}$       | 410 A                                                   |
| $V_{DRM}/V_{RRM}$ | 400 V, 800 V, 1200 V, 1400 V,<br>1600 V, 1800 V, 2000 V |
| $V_{TM}$          | 1.69 V                                                  |
| $I_{GT}$          | 90 mA                                                   |
| $T_J$             | -40 °C to 125 °C                                        |

### MAJOR RATINGS AND CHARACTERISTICS

| PARAMETER         | TEST CONDITIONS | VALUES      | UNITS             |
|-------------------|-----------------|-------------|-------------------|
| $I_{T(AV)}$       |                 | 410         | A                 |
|                   | $T_{hs}$        | 55          | °C                |
| $I_{T(RMS)}$      |                 | 780         | A                 |
|                   | $T_{hs}$        | 25          | °C                |
| $I_{TSM}$         | 50 Hz           | 5700        | A                 |
|                   | 60 Hz           | 5970        |                   |
| $I^2t$            | 50 Hz           | 163         | kA <sup>2</sup> s |
|                   | 60 Hz           | 149         |                   |
| $V_{DRM}/V_{RRM}$ |                 | 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<br>REPETITIVE PEAK AND OFF-STATE<br>VOLTAGE<br>V | $V_{RSM}$ , MAXIMUM<br>NON-REPETITIVE PEAK VOLTAGE<br>V | $I_{DRM}/I_{RRM}$ , MAXIMUM<br>AT $T_J = T_J$ MAXIMUM<br>mA |
|--------------|--------------|------------------------------------------------------------------------------|---------------------------------------------------------|-------------------------------------------------------------|
| VS-ST230C..C | 04           | 400                                                                          | 500                                                     | 30                                                          |
|              | 08           | 800                                                                          | 900                                                     |                                                             |
|              | 12           | 1200                                                                         | 1300                                                    |                                                             |
|              | 14           | 1400                                                                         | 1500                                                    |                                                             |
|              | 16           | 1600                                                                         | 1700                                                    |                                                             |
|              | 18           | 1800                                                                         | 1900                                                    |                                                             |
|              | 20           | 2000                                                                         | 2100                                                    |                                                             |



| ABSOLUTE MAXIMUM RATINGS                                 |               |                                                                                        |            |                    |
|----------------------------------------------------------|---------------|----------------------------------------------------------------------------------------|------------|--------------------|
| PARAMETER                                                | SYMBOL        | TEST CONDITIONS                                                                        | VALUES     | UNITS              |
| Maximum average on-state current at heatsink temperature | $I_{T(AV)}$   | 180° conduction, half sine wave double side (single side) cooled                       | 410 (165)  | A                  |
|                                                          |               |                                                                                        | 55 (85)    | °C                 |
| Maximum RMS on-state current                             | $I_{T(RMS)}$  | DC at 25 °C heatsink temperature double side cooled                                    | 780        |                    |
| Maximum peak, one-cycle non-repetitive surge current     | $I_{TSM}$     | t = 10 ms                                                                              | 5700       | A                  |
|                                                          |               | t = 8.3 ms                                                                             | 5970       |                    |
|                                                          |               | t = 10 ms                                                                              | 4800       |                    |
|                                                          |               | t = 8.3 ms                                                                             | 5000       |                    |
| Maximum $I^2t$ for fusing                                | $I^2t$        | t = 10 ms                                                                              | 163        | kA <sup>2</sup> s  |
|                                                          |               | t = 8.3 ms                                                                             | 148        |                    |
|                                                          |               | t = 10 ms                                                                              | 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 <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 | 0.92       | 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                                 | $V_{TM}$      | $I_{pk} = 880$ A, $T_J = T_J$ maximum, $t_p = 10$ ms sine pulse                        | 1.69       | 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<br>$T_J = T_J$ maximum, anode voltage $\leq 80$ % $V_{DRM}$                           | 1000   | 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                                             | 1.0    | μs    |
| Typical turn-off time                                    | $t_q$   | $I_{TM} = 300$ A, $T_J = T_J$ maximum, $di/dt = 20$ 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 | 30     | 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 |                                                                                                                                                                   | 10.0   |      | W     |
| Maximum average gate power          | P <sub>G(AV)</sub> | T <sub>J</sub> = T <sub>J</sub> maximum, f = 50 Hz, d% = 50    |                                                                                                                                                                   | 2.0    |      |       |
| Maximum peak positive gate current  | I <sub>GM</sub>    | T <sub>J</sub> = T <sub>J</sub> maximum, t <sub>p</sub> ≤ 5 ms |                                                                                                                                                                   | 3.0    |      | A     |
| Maximum peak positive gate voltage  | + V <sub>GM</sub>  | T <sub>J</sub> = T <sub>J</sub> maximum, t <sub>p</sub> ≤ 5 ms |                                                                                                                                                                   | 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>12 V anode to cathode applied                           | 180    | -    |       |
|                                     |                    | T <sub>J</sub> = 25 °C                                         |                                                                                                                                                                   | 90     | 150  | mA    |
|                                     |                    | 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 temperature range              | T <sub>J</sub>      |                                               | - 40 to 125      | °C        |
| Maximum storage temperature range                | T <sub>Stg</sub>    |                                               | - 40 to 150      |           |
| Maximum thermal resistance, junction to heatsink | R <sub>thJ-hs</sub> | DC operation single side cooled               | 0.17             | K/W       |
|                                                  |                     | DC operation double side cooled               | 0.08             |           |
| Maximum thermal resistance, case to heatsink     | R <sub>thC-hs</sub> | DC operation single side cooled               | 0.033            |           |
|                                                  |                     | DC operation double side cooled               | 0.017            |           |
| Mounting force, ± 10 %                           |                     |                                               | 4900<br>(500)    | N<br>(kg) |
| Approximate weight                               |                     |                                               | 50               | g         |
| Case style                                       |                     | See dimensions - link at the end of datasheet | TO-200AB (A-PUK) |           |

| $\Delta R_{thJC}$ CONDUCTION |                       |             |                        |             |                     |       |
|------------------------------|-----------------------|-------------|------------------------|-------------|---------------------|-------|
| CONDUCTION ANGLE             | SINUSOIDAL CONDUCTION |             | RECTANGULAR CONDUCTION |             | TEST CONDITIONS     | UNITS |
|                              | SINGLE SIDE           | DOUBLE SIDE | SINGLE SIDE            | DOUBLE SIDE |                     |       |
| 180°                         | 0.015                 | 0.017       | 0.011                  | 0.011       | $T_J = T_J$ maximum | K/W   |
| 120°                         | 0.018                 | 0.019       | 0.019                  | 0.019       |                     |       |
| 90°                          | 0.024                 | 0.024       | 0.026                  | 0.026       |                     |       |
| 60°                          | 0.035                 | 0.035       | 0.036                  | 0.036       |                     |       |
| 30°                          | 0.060                 | 0.060       | 0.060                  | 0.061       |                     |       |

**Note**

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

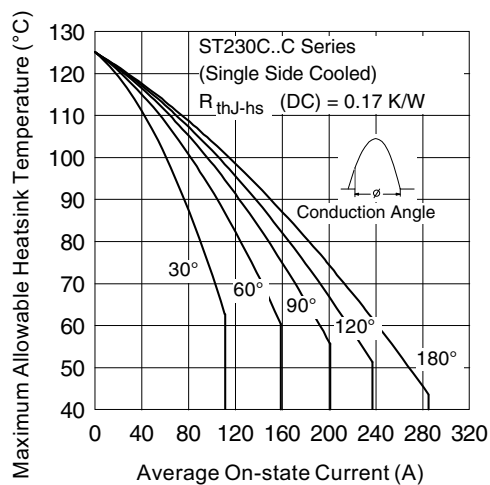


Fig. 1 - Current Ratings Characteristics

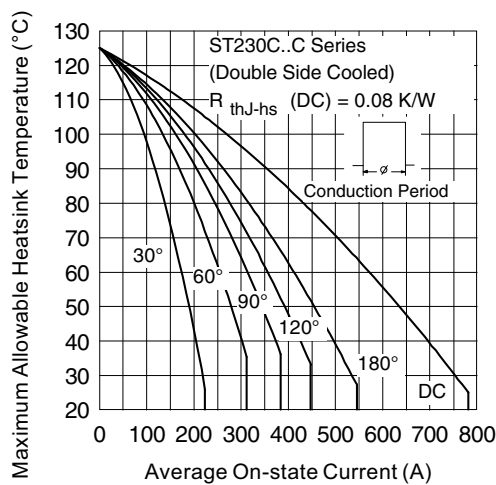


Fig. 4 - Current Ratings Characteristics

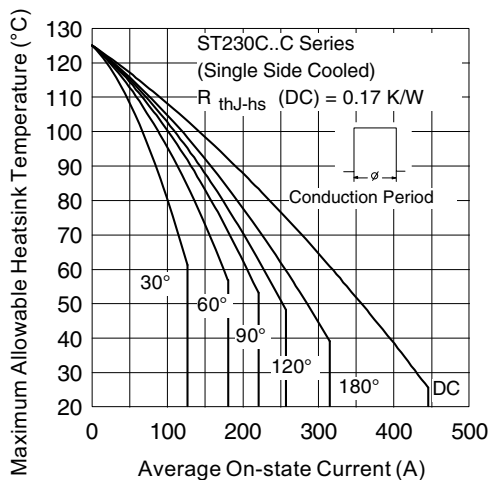


Fig. 2 - Current Ratings Characteristics

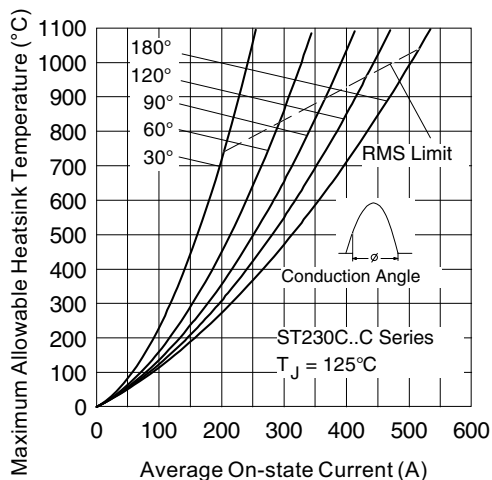


Fig. 5 - On-State Power Loss Characteristics

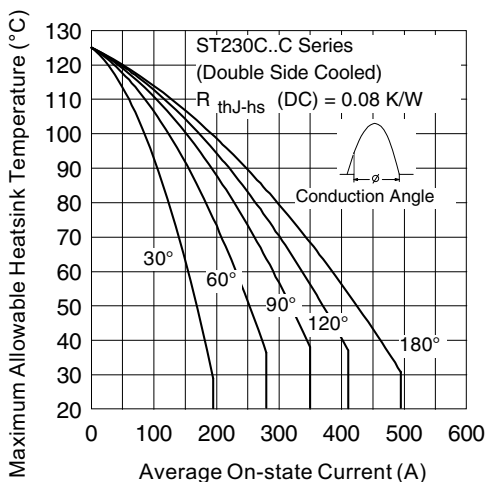


Fig. 3 - Current Ratings Characteristics

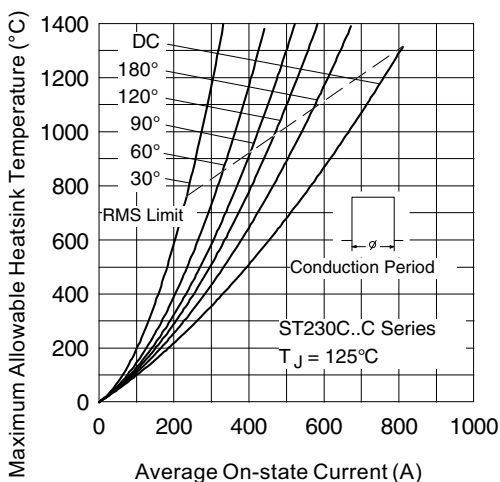


Fig. 6 - On-State Power Loss Characteristics

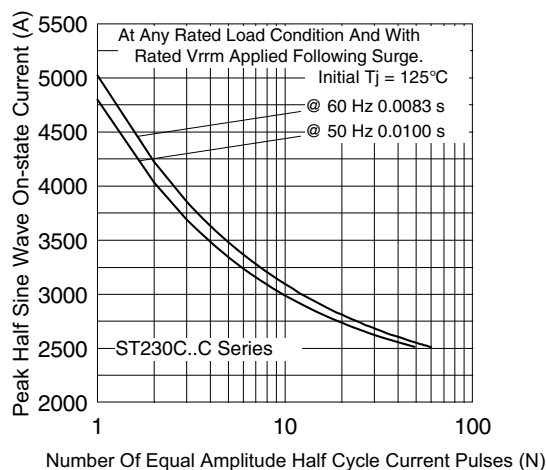


Fig. 7 - Maximum Non-Repetitive Surge Current Single and Double Side Cooled

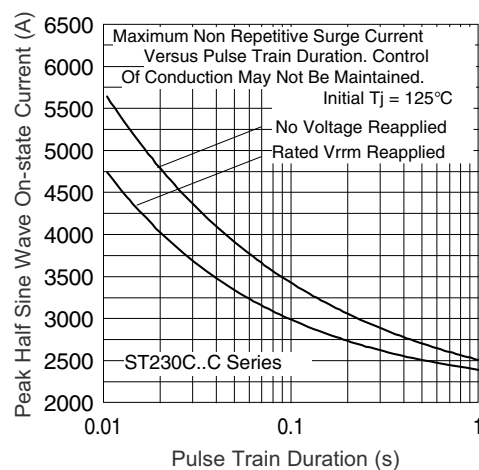


Fig. 8 - Maximum Non-Repetitive Surge Current Single and Double Side Cooled

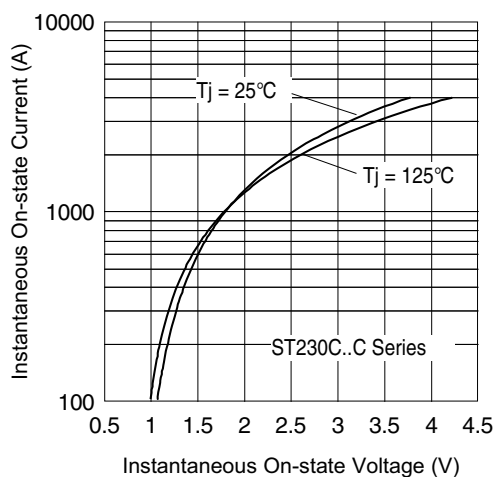


Fig. 9 - On-State Voltage Drop Characteristics

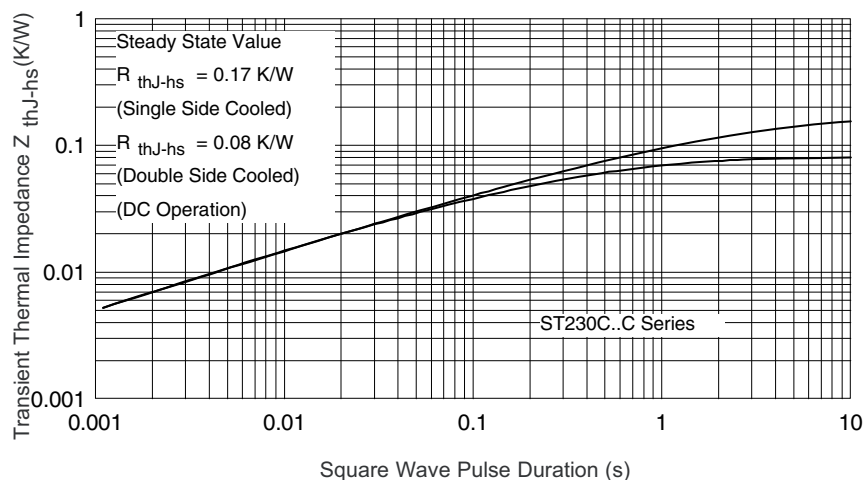


Fig. 10 - Thermal Impedance  $Z_{thJ-hs}$  Characteristics

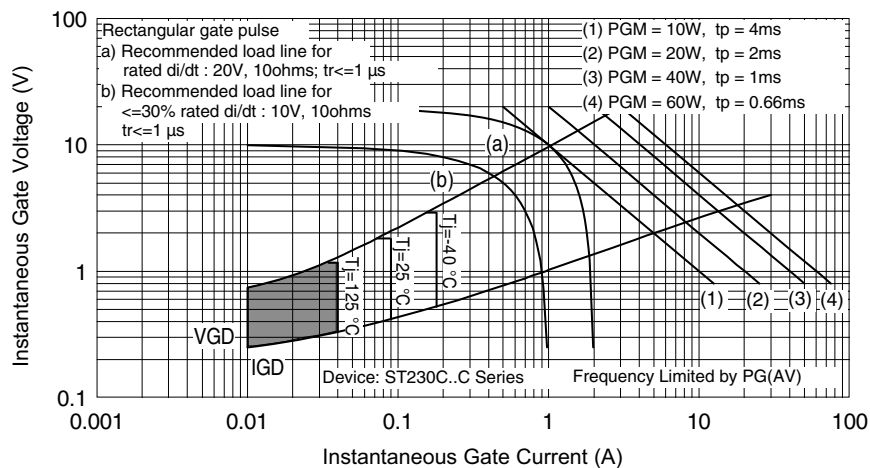


Fig. 11 - Gate Characteristics

## ORDERING INFORMATION TABLE

| Device code | VS-                                                                  | ST  | 23  | 0   | C   | 20  | C   | 1   | -   |
|-------------|----------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|
|             | (1)                                                                  | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| <b>1</b>    | - Vishay Semiconductors product                                      |     |     |     |     |     |     |     |     |
| <b>2</b>    | - Thyristor                                                          |     |     |     |     |     |     |     |     |
| <b>3</b>    | - Essential part number                                              |     |     |     |     |     |     |     |     |
| <b>4</b>    | - 0 = Converter grade                                                |     |     |     |     |     |     |     |     |
| <b>5</b>    | - C = Ceramic PUK                                                    |     |     |     |     |     |     |     |     |
| <b>6</b>    | - Voltage code x 100 = $V_{RRM}$ (see Voltage Ratings table)         |     |     |     |     |     |     |     |     |
| <b>7</b>    | - C = PUK case TO-200AB (A-PUK)                                      |     |     |     |     |     |     |     |     |
| <b>8</b>    | - 0 = Eyelet terminals (gate and auxiliary cathode unsoldered leads) |     |     |     |     |     |     |     |     |
|             | 1 = Fast-on terminals (gate and auxiliary cathode unsoldered leads)  |     |     |     |     |     |     |     |     |
|             | 2 = Eyelet terminals (gate and auxiliary cathode soldered leads)     |     |     |     |     |     |     |     |     |
|             | 3 = Fast-on terminals (gate and auxiliary cathode soldered leads)    |     |     |     |     |     |     |     |     |
| <b>9</b>    | - Critical $dV/dt$ : • None = 500 V/ $\mu s$ (Standard selection)    |     |     |     |     |     |     |     |     |
|             | • L = 1000 V/ $\mu s$ (Special selection)                            |     |     |     |     |     |     |     |     |

### LINKS TO RELATED DOCUMENTS

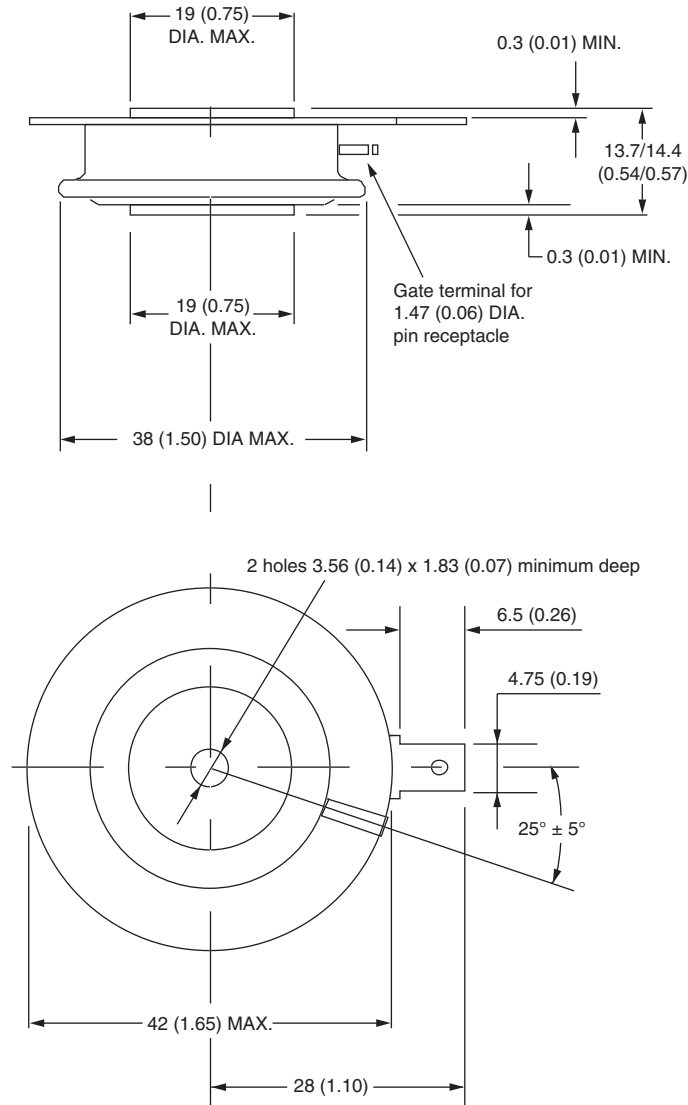
Dimensions

[www.vishay.com/doc?95074](http://www.vishay.com/doc?95074)

## TO-200AB (A-PUK)

### DIMENSIONS in millimeters (inches)

Anode to gate  
Creepage distance: 7.62 (0.30) minimum  
Strike distance: 7.12 (0.28) minimum



Quote between upper and lower pole pieces has to be considered after application of mounting force (see thermal and mechanical specification)



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