

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


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

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

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

| 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 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-ST230C..C    | 04           | 400  | 500  | 30   |
|                 | 08           | 800  | 900  |  |
|                 | 12           | 1200   | 1300   |  |
|                 | 14           | 1400   | 1500   |  |
|                 | 16           | 1600   | 1700   |  |
|                 | 18           | 1800   | 1900   |  |
|                 | 20           | 2000   | 2100   |  |



| <b>ABSOLUTE MAXIMUM RATINGS</b>                          |               |   |                           |            |                    |
|--|---------------|---|---------------------------|------------|--------------------|
| 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   | No voltage reapplied      | 5700       | A                  |
|  |               | t = 8.3 ms  |                           |            |                    |
|  |               | 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 <sup>2</sup> s  |
|  |               | t = 8.3 ms  |                           |            |                    |
|  |               | 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 <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) |                    |

| <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 $\leq 80$ % $V_{DRM}$                           |  | 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    |       |

| <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 |  | 30     | 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         | 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     |

| <b>THERMAL AND MECHANICAL SPECIFICATIONS</b>     |              |   |                  |           |
|--|--------------|---|------------------|-----------|
| PARAMETER  | SYMBOL       | TEST CONDITIONS                               | VALUES           | UNITS     |
| Maximum operating temperature range              | $T_J$        |   | -40 to 125       | °C        |
| Maximum storage temperature range                | $T_{Stg}$    |   | -40 to 150       |           |
| Maximum thermal resistance, junction to heatsink | $R_{thJ-hs}$ | DC operation single side cooled               | 0.17             | K/W       |
|  |              | DC operation double side cooled               | 0.08             |           |
| Maximum thermal resistance, case to heatsink     | $R_{thC-hs}$ | DC operation single side cooled               | 0.033            |           |
|  |              | DC operation double side cooled               | 0.017            |           |
| Mounting force, $\pm 10$ %                       |              |   | 4900<br>(500)    | N<br>(kg) |
| Approximate weight                               |              |   | 50               | g         |
| Case style                                       |              | See dimensions - link at the end of datasheet | A-PUK (TO-200AB) |           |

| <b><math>\Delta R_{thJC}</math> CONDUCTION</b> |                       |             |                        |             |                     |       |
|--|-----------------------|-------------|------------------------|-------------|---------------------|-------|
| 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

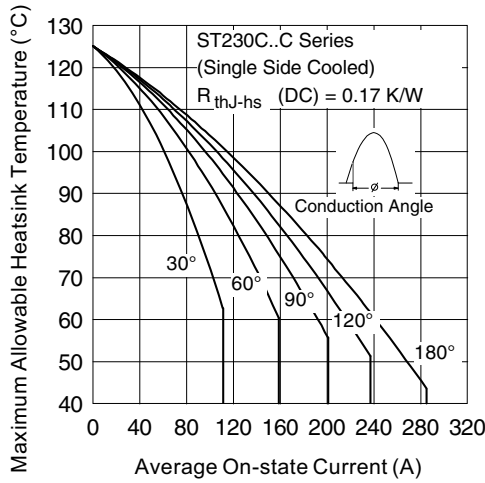


Fig. 1 - Current Ratings Characteristics

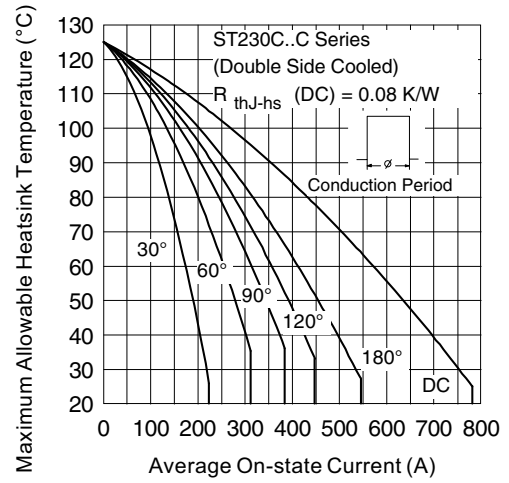


Fig. 4 - Current Ratings Characteristics

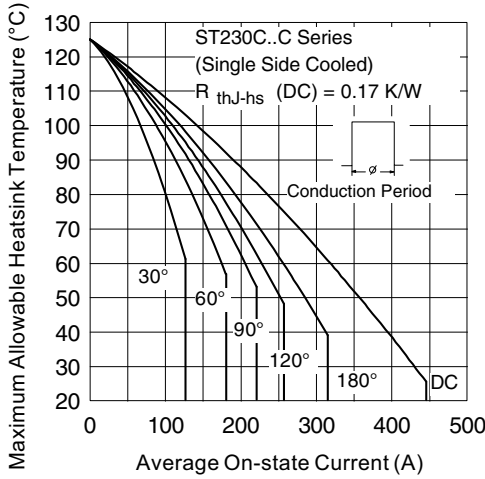


Fig. 2 - Current Ratings Characteristics

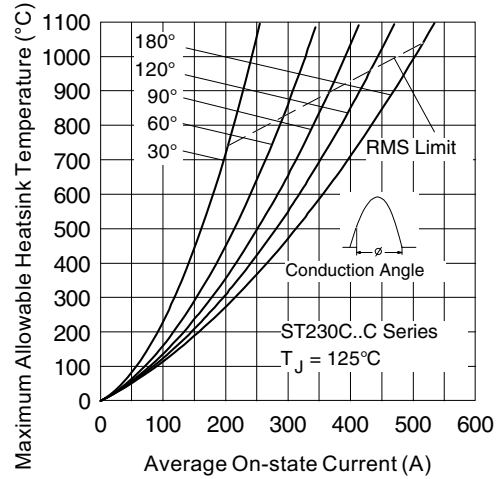


Fig. 5 - On-State Power Loss Characteristics

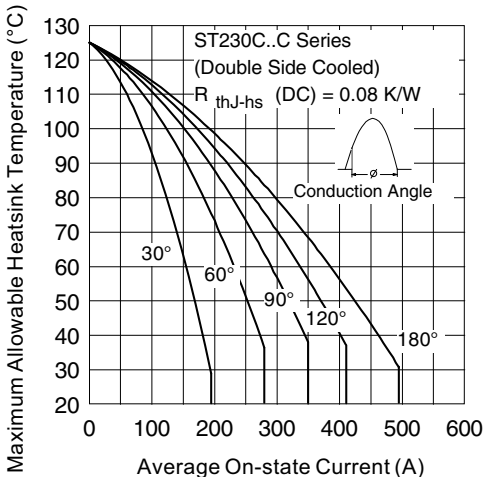


Fig. 3 - Current Ratings Characteristics

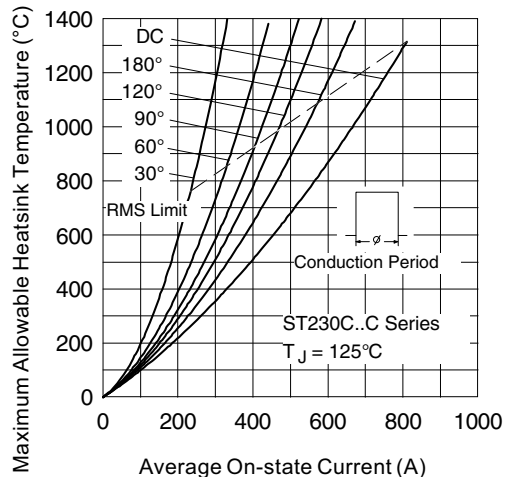


Fig. 6 - On-State Power Loss Characteristics

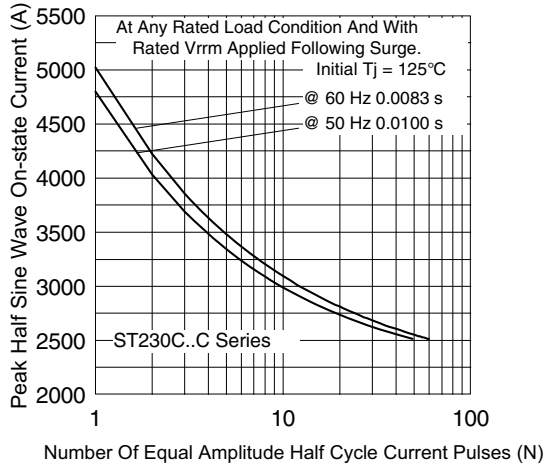


Fig. 7 - Maximum Non-Repetitive Surge Current Single and Double Side Cooled

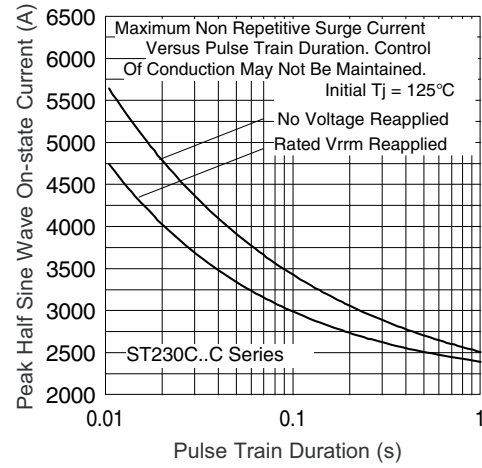


Fig. 8 - Maximum Non-Repetitive Surge Current Single and Double Side Cooled

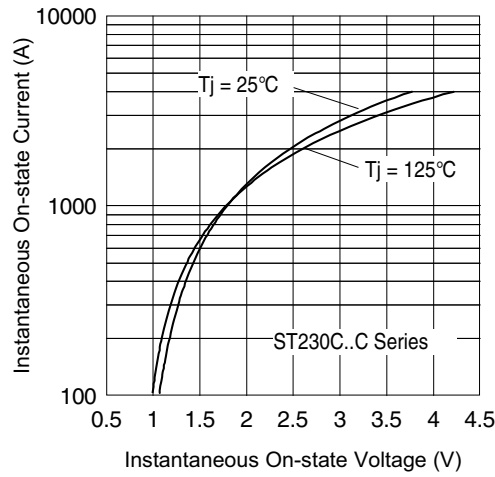


Fig. 9 - On-State Voltage Drop Characteristics

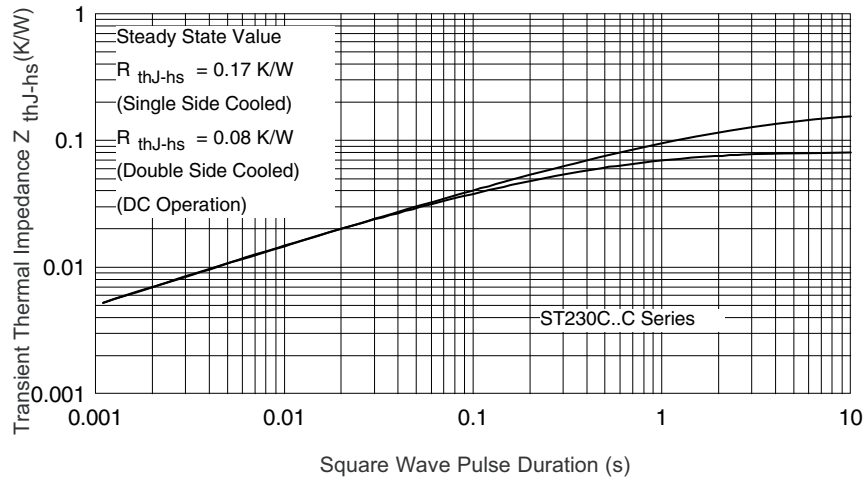


Fig. 10 - Thermal Impedance  $Z_{thJ-hs}$  Characteristics

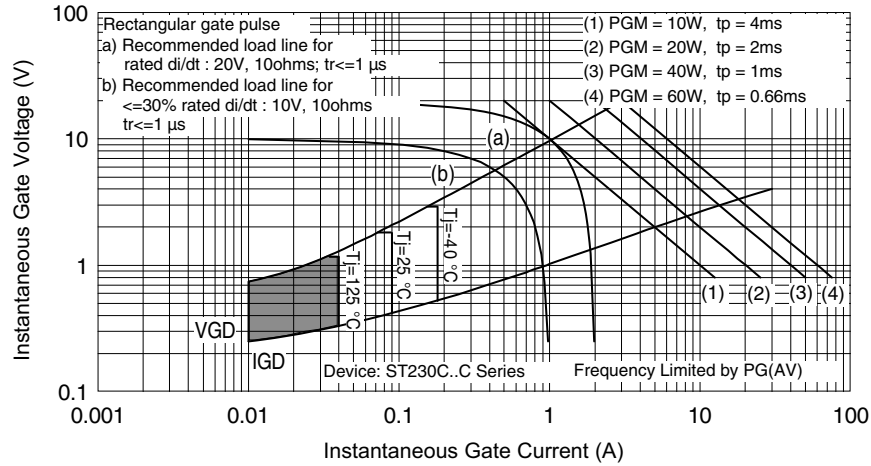


Fig. 11 - Gate Characteristics

## ORDERING INFORMATION TABLE

|             |            |           |           |          |          |           |          |          |          |
|-------------|------------|-----------|-----------|----------|----------|-----------|----------|----------|----------|
| Device code | <b>VS-</b> | <b>ST</b> | <b>23</b> | <b>0</b> | <b>C</b> | <b>20</b> | <b>C</b> | <b>1</b> | <b>-</b> |
|             | (1)        | (2)       | (3)       | (4)      | (5)      | (6)       | (7)      | (8)      | (9)      |

- 1** - Vishay Semiconductors product
- 2** - Thyristor
- 3** - Essential part number
- 4** - 0 = converter grade
- 5** - C = ceramic PUK
- 6** - Voltage code x 100 =  $V_{RRM}$  (see Voltage Ratings table)
- 7** - C = PUK case A-PUK (TO-200AB)
- 8** - 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)
- 9** - Critical dV/dt: • None = 500 V/μs (standard selection)  
 • L = 1000 V/μs (special selection)

### LINKS TO RELATED DOCUMENTS

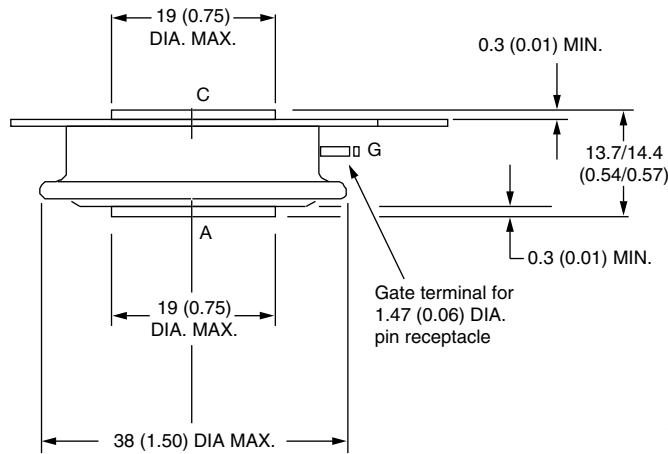
|            |  |
|------------|--|
| Dimensions | <a href="http://www.vishay.com/doc?95074">www.vishay.com/doc?95074</a> |
|------------|--|



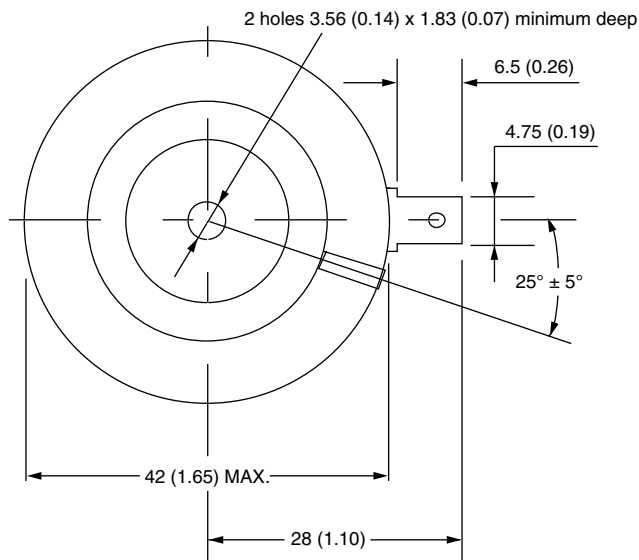
## A-PUK (TO-200AB)

### DIMENSIONS in millimeters (inches)

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



**Note:**  
 A = Anode  
 C = Cathode  
 G = Gate



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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