

## Phase Control Thyristors (Hockey PUK Version), 960 A


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

### FEATURES

- Center amplifying gate
- Metal case with ceramic insulator
- International standard case TO-200AB (E-PUK)
- Low profile hockey PUK to increase current-carrying capability
- 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**

### PRODUCT SUMMARY

|                   |                  |
|-------------------|------------------|
| Package           | TO-200AB (E-PUK) |
| Diode variation   | Single SCR       |
| $I_{T(AV)}$       | 960 A            |
| $V_{DRM}/V_{RRM}$ | 400 V, 600 V     |
| $V_{TM}$          | 1.60 V           |
| $I_{GT}$          | 100 mA           |
| $T_J$             | -40 °C to 125 °C |

### TYPICAL APPLICATIONS

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

### MAJOR RATINGS AND CHARACTERISTICS

| PARAMETER         | TEST CONDITIONS | VALUES     | UNITS             |
|-------------------|-----------------|------------|-------------------|
| $I_{T(AV)}$       |                 | 960        | A                 |
|                   | $T_{hs}$        | 55         | °C                |
| $I_{T(RMS)}$      |                 | 1900       | A                 |
|                   | $T_{hs}$        | 25         | °C                |
| $I_{TSM}$         | 50 Hz           | 15 000     | A                 |
|                   | 60 Hz           | 15 700     |                   |
| $I^2t$            | 50 Hz           | 1130       | kA <sup>2</sup> s |
|                   | 60 Hz           | 1030       |                   |
| $V_{DRM}/V_{RRM}$ |                 | 400 to 600 | 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 $T_J = T_J$<br>MAXIMUM mA |
|--------------|--------------|------------------------------------------------------------------------|------------------------------------------------------|--------------------------------------------------------|
| VS-ST380C..C | 04           | 400                                                                    | 500                                                  | 50                                                     |
|              | 06           | 600                                                                    | 700                                                  |                                                        |



| ABSOLUTE MAXIMUM RATINGS                                 |                     |                                                                                                          |                                  |                                                                       |           |                    |
|----------------------------------------------------------|---------------------|----------------------------------------------------------------------------------------------------------|----------------------------------|-----------------------------------------------------------------------|-----------|--------------------|
| PARAMETER                                                | SYMBOL              | TEST CONDITIONS                                                                                          |                                  |                                                                       | VALUES    | UNITS              |
| Maximum average on-state current at heatsink temperature | I <sub>T(AV)</sub>  | 180° conduction, half sine wave double side (single side) cooled                                         |                                  |                                                                       | 960 (440) | A                  |
|                                                          |                     |                                                                                                          |                                  |                                                                       | 55 (75)   | °C                 |
| Maximum RMS on-state current                             | I <sub>T(RMS)</sub> | DC at 25 °C heatsink temperature double side cooled                                                      |                                  |                                                                       | 1900      | A                  |
| Maximum peak, one-cycle non-repetitive surge current     | I <sub>TSM</sub>    | t = 10 ms                                                                                                | No voltage reapplied             | Sinusoidal half wave, initial T <sub>J</sub> = T <sub>J</sub> maximum | 15 000    |                    |
|                                                          |                     | t = 8.3 ms                                                                                               |                                  |                                                                       | 15 700    |                    |
|                                                          |                     | t = 10 ms                                                                                                | 100 % V <sub>RRM</sub> reapplied |                                                                       | 12 600    |                    |
|                                                          |                     | t = 8.3 ms                                                                                               |                                  |                                                                       | 13 200    |                    |
| Maximum I <sup>2</sup> t for fusing                      | I <sup>2</sup> t    | t = 10 ms                                                                                                | No voltage reapplied             |                                                                       | 1130      | kA <sup>2</sup> s  |
|                                                          |                     | t = 8.3 ms                                                                                               |                                  | 1030                                                                  |           |                    |
|                                                          |                     | t = 10 ms                                                                                                | 100 % V <sub>RRM</sub> reapplied | 800                                                                   |           |                    |
|                                                          |                     | t = 8.3 ms                                                                                               |                                  | 725                                                                   |           |                    |
| Maximum I <sup>2</sup> √t for fusing                     | I <sup>2</sup> √t   | t = 0.1 to 10 ms, no voltage reapplied                                                                   |                                  |                                                                       | 11 300    | kA <sup>2</sup> √s |
| Low level value of threshold voltage                     | V <sub>T(TO)1</sub> | (16.7 % × π × I <sub>T(AV)</sub> < I < π × I <sub>T(AV)</sub> ), T <sub>J</sub> = T <sub>J</sub> maximum |                                  |                                                                       | 0.85      | V                  |
| High level value of threshold voltage                    | V <sub>T(TO)2</sub> | (I > π × I <sub>T(AV)</sub> ), T <sub>J</sub> = T <sub>J</sub> maximum                                   |                                  |                                                                       | 0.88      |                    |
| Low level value of on-state slope resistance             | r <sub>t1</sub>     | (16.7 % × π × I <sub>T(AV)</sub> < I < π × I <sub>T(AV)</sub> ), T <sub>J</sub> = T <sub>J</sub> maximum |                                  |                                                                       | 0.25      | mΩ                 |
| High level value of on-state slope resistance            | r <sub>t2</sub>     | (I > π × I <sub>T(AV)</sub> ), T <sub>J</sub> = T <sub>J</sub> maximum                                   |                                  |                                                                       | 0.24      |                    |
| Maximum on-state voltage                                 | V <sub>TM</sub>     | I <sub>pk</sub> = 3000 A, T <sub>J</sub> = T <sub>J</sub> maximum, t <sub>p</sub> = 10 ms sine pulse     |                                  |                                                                       | 1.60      | V                  |
| Maximum holding current                                  | I <sub>H</sub>      | T <sub>J</sub> = 25 °C, anode supply 12 V resistive load                                                 |                                  |                                                                       | 600       | mA                 |
| Typical latching current                                 | I <sub>L</sub>      |                                                                                                          |                                  |                                                                       | 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 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                                    | $t_q$   | $I_{TM} = 550$ A, $T_J = T_J$ maximum, $di/dt = 40$ 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 | $I_{RRM}$ ,<br>$I_{DRM}$ | $T_J = T_J$ maximum, rated $V_{DRM}/V_{RRM}$ applied | 50     | mA    |



| TRIGGERING                          |             |                                              |        |      |       |
|-------------------------------------|-------------|----------------------------------------------|--------|------|-------|
| 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                               | 200    | -    | mA    |
|                                     |             | $T_J = 25$ °C                                | 100    | 200  |       |
|                                     |             | $T_J = 125$ °C                               | 50     | -    |       |
| DC gate voltage required to trigger | $V_{GT}$    | $T_J = -40$ °C                               | 2.5    | -    | V     |
|                                     |             | $T_J = 25$ °C                                | 1.8    | 3.0  |       |
|                                     |             | $T_J = 125$ °C                               | 1.1    | -    |       |
| 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     |

| 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 heatsink | $R_{thJ-hs}$ | DC operation single side cooled               | 0.09             | K/W       |
|                                                  |              | DC operation double side cooled               | 0.04             |           |
| Maximum thermal resistance, case to heatsink     | $R_{thC-hs}$ | DC operation single side cooled               | 0.02             |           |
|                                                  |              | DC operation double side cooled               | 0.01             |           |
| Mounting force, $\pm 10$ %                       |              |                                               | 9800<br>(1000)   | N<br>(kg) |
| Approximate weight                               |              |                                               | 83               | g         |
| Case style                                       |              | See dimensions - link at the end of datasheet | TO-200AB (E-PUK) |           |

| $\Delta R_{thJ-hs}$ CONDUCTION |                       |             |                        |             |                                         |       |
|--------------------------------|-----------------------|-------------|------------------------|-------------|-----------------------------------------|-------|
| CONDUCTION ANGLE               | SINUSOIDAL CONDUCTION |             | RECTANGULAR CONDUCTION |             | TEST CONDITIONS                         | UNITS |
|                                | SINGLE SIDE           | DOUBLE SIDE | SINGLE SIDE            | DOUBLE SIDE |                                         |       |
| 180°                           | 0.010                 | 0.011       | 0.007                  | 0.007       | T <sub>J</sub> = T <sub>J</sub> maximum | K/W   |
| 120°                           | 0.012                 | 0.012       | 0.012                  | 0.013       |                                         |       |
| 90°                            | 0.015                 | 0.015       | 0.016                  | 0.017       |                                         |       |
| 60°                            | 0.022                 | 0.022       | 0.023                  | 0.023       |                                         |       |
| 30°                            | 0.036                 | 0.036       | 0.036                  | 0.037       |                                         |       |

**Note**

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

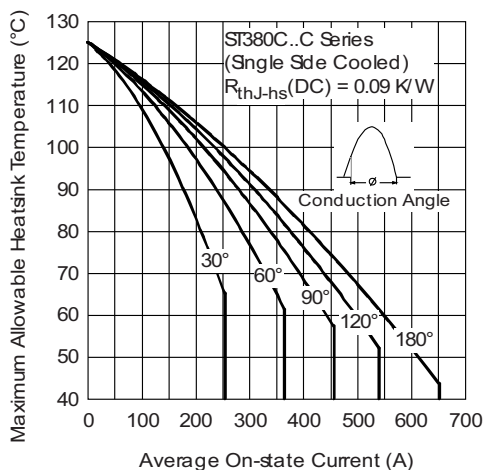


Fig. 1 - Current Ratings Characteristics

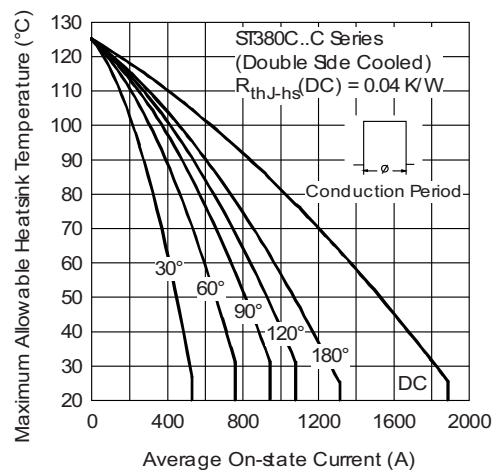


Fig. 4 - Current Ratings Characteristics

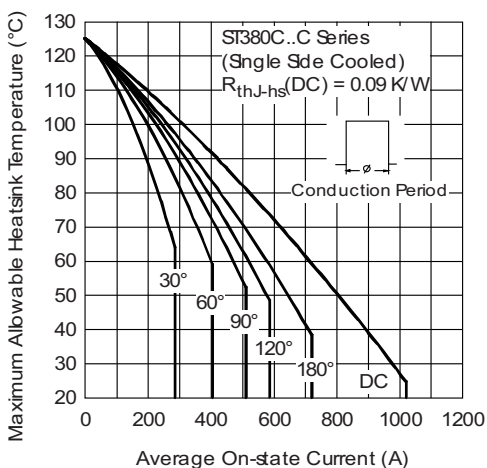


Fig. 2 - Current Ratings Characteristics

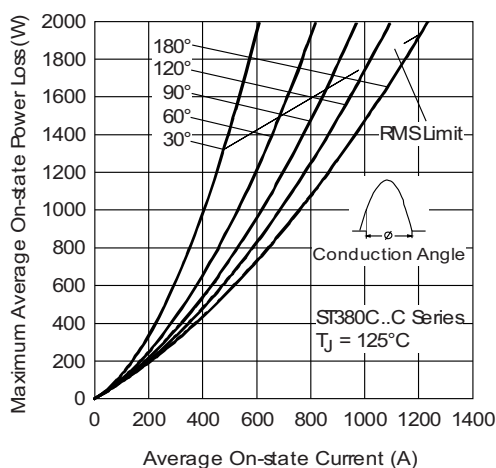


Fig. 5 - On-State Power Loss Characteristics

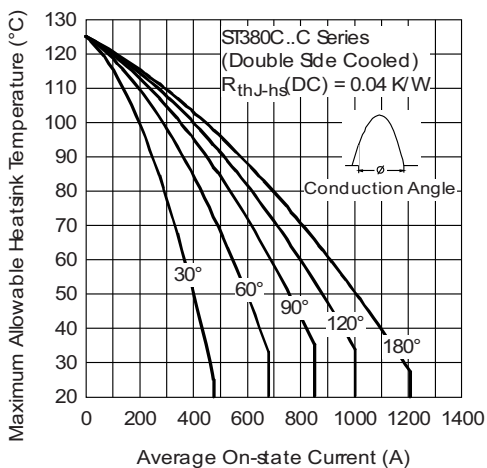


Fig. 3 - Current Ratings Characteristics

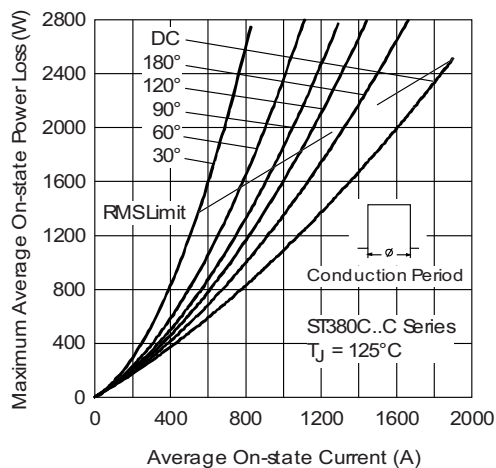


Fig. 6 - On-State Power Loss Characteristics

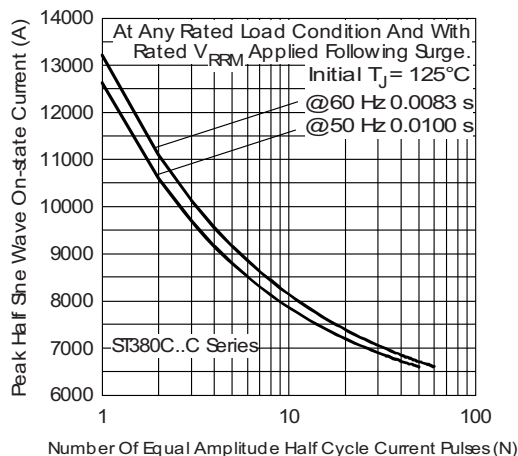


Fig. 7 - Maximum Non-Repetitive Surge Current Single and Double Side Cooled

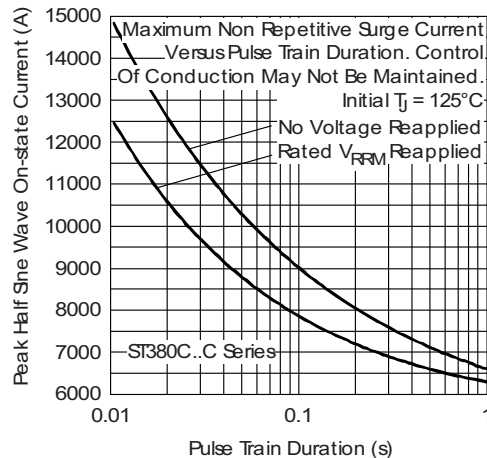


Fig. 8 - Maximum Non-Repetitive Surge Current Single and Double Side Cooled

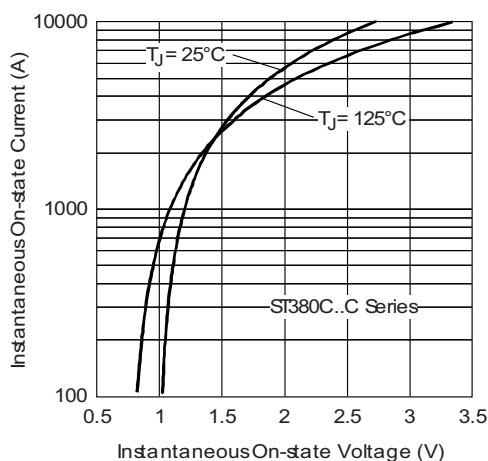


Fig. 9 - On-State Voltage Drop Characteristics

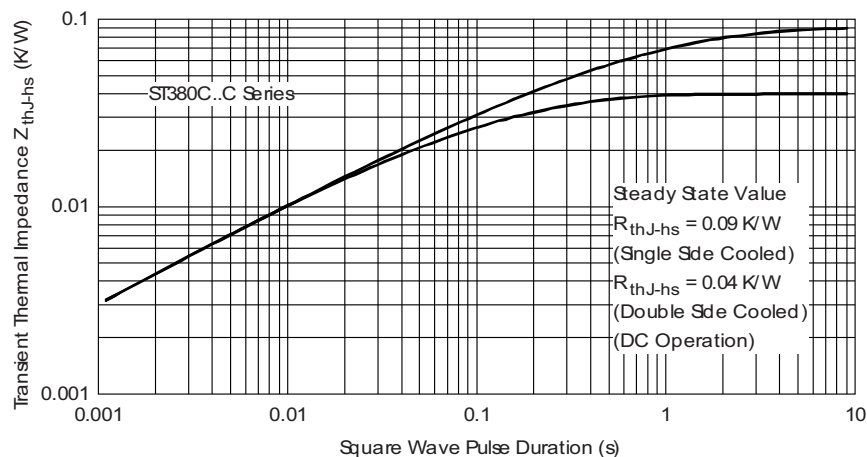


Fig. 10 - Thermal Impedance  $Z_{thJ-hs}$  Characteristics

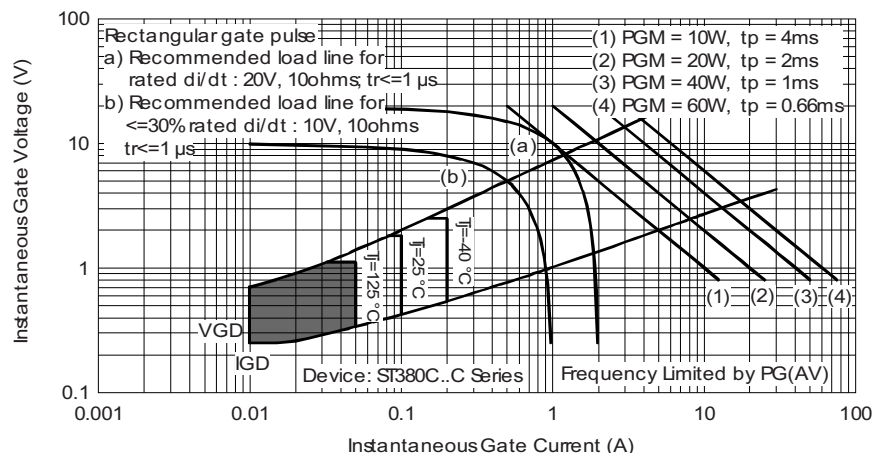


Fig. 11 - Gate Characteristics

## ORDERING INFORMATION TABLE

| Device code | VS-                                                                  | ST  | 38  | 0   | C   | 06  | 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 (E-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)                            |     |     |     |     |     |     |     |     |

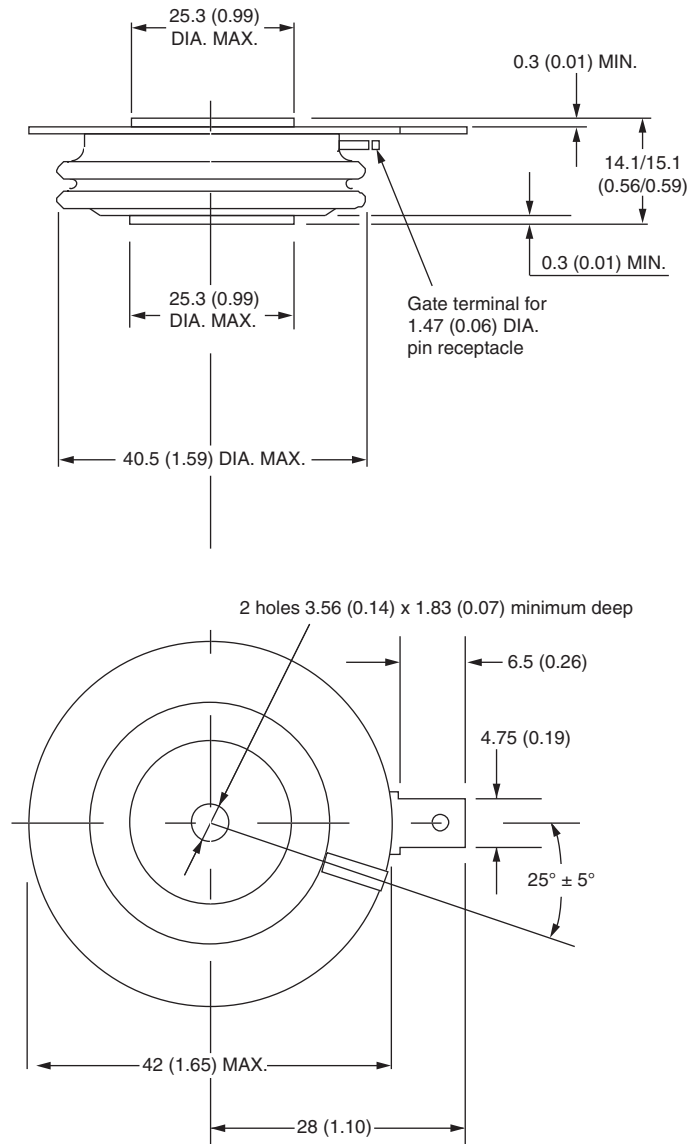
### LINKS TO RELATED DOCUMENTS

|            |                                                                               |
|------------|-------------------------------------------------------------------------------|
| Dimensions | <a href="http://www.vishay.com/doc?95075">http://www.vishay.com/doc?95075</a> |
|------------|-------------------------------------------------------------------------------|

## TO-200AB (E-PUK)

### DIMENSIONS in millimeters (inches)

Anode to gate  
Creepage distance: 11.18 (0.44) minimum  
Strike distance: 7.62 (0.30) 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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