

## 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  |  |



| <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       |                           | 960 (440) | A                  |
|  |               |  |                           | 55 (75)   | °C                 |
| Maximum RMS on-state current                             | $I_{T(RMS)}$  | DC at 25 °C heatsink temperature double side cooled                    |                           | 1900      |                    |
| Maximum peak, one-cycle non-repetitive surge current     | $I_{TSM}$     | t = 10 ms  | No voltage reapplied      | 15 000    | A                  |
|  |               | t = 8.3 ms   |                           | 15 700    |                    |
|  |               | t = 10 ms  | 100 % $V_{RRM}$ reapplied | 12 600    |                    |
|  |               | t = 8.3 ms   |                           | 13 200    |                    |
| Maximum $I^2t$ for fusing                                | $I^2t$        | t = 10 ms  | No voltage reapplied      | 1130      | kA <sup>2</sup> s  |
|  |               | t = 8.3 ms   |                           | 1030      |                    |
|  |               | t = 10 ms  | 100 % $V_{RRM}$ reapplied | 800       |                    |
|  |               | t = 8.3 ms   |                           | 725       |                    |
| Maximum $I^2\sqrt{t}$ for fusing                         | $I^2\sqrt{t}$ | t = 0.1 to 10 ms, no voltage reapplied                                 |                           | 11 300    | kA <sup>2</sup> √s |
| Low level value of threshold voltage                     | $V_{T(TO)1}$  | (16.7 % × π × $I_{T(AV)}$ < I < π × $I_{T(AV)}$ ), $T_J = T_J$ maximum |                           | 0.85      | V                  |
| High level value of threshold voltage                    | $V_{T(TO)2}$  | (I > π × $I_{T(AV)}$ ), $T_J = T_J$ maximum                            |                           | 0.88      |                    |
| Low level value of on-state slope resistance             | $r_{t1}$      | (16.7 % × π × $I_{T(AV)}$ < I < π × $I_{T(AV)}$ ), $T_J = T_J$ maximum |                           | 0.25      | mΩ                 |
| High level value of on-state slope resistance            | $r_{t2}$      | (I > π × $I_{T(AV)}$ ), $T_J = T_J$ maximum                            |                           | 0.24      |                    |
| Maximum on-state voltage                                 | $V_{TM}$      | $I_{pk} = 3000$ A, $T_J = T_J$ maximum, $t_p = 10$ ms sine pulse       |                           | 1.60      | 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 ≤ 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    |       |

| <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 |  | 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                               |  | Maximum required gate trigger/<br>current/voltage are the lowest<br>value which will trigger all units<br>12 V anode to cathode applied | 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       | $T_J = T_J$ 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

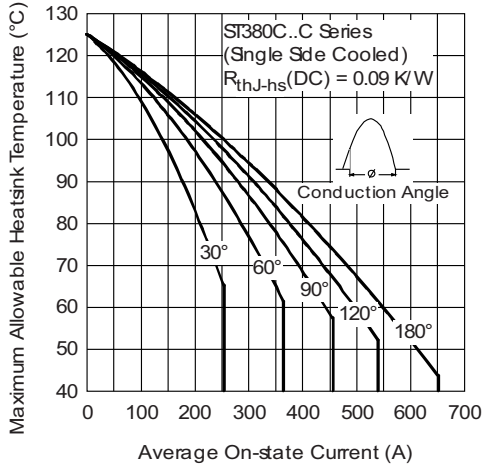


Fig. 1 - Current Ratings Characteristics

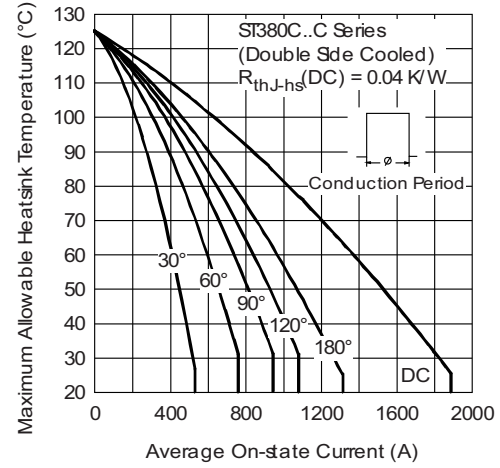


Fig. 4 - Current Ratings Characteristics

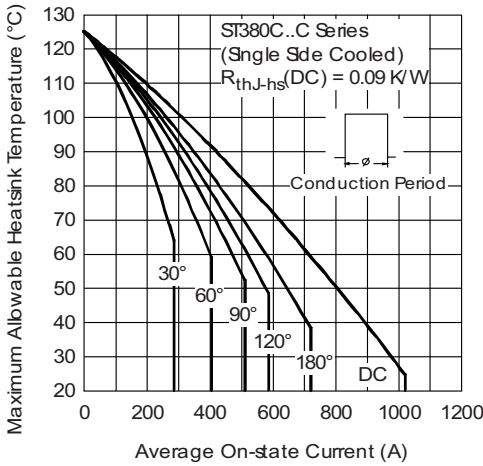


Fig. 2 - Current Ratings Characteristics

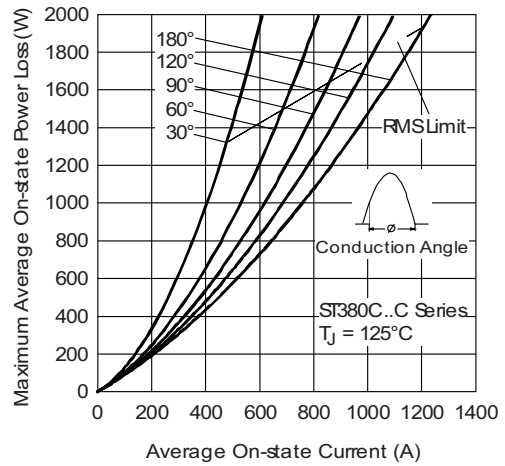


Fig. 5 - On-State Power Loss Characteristics

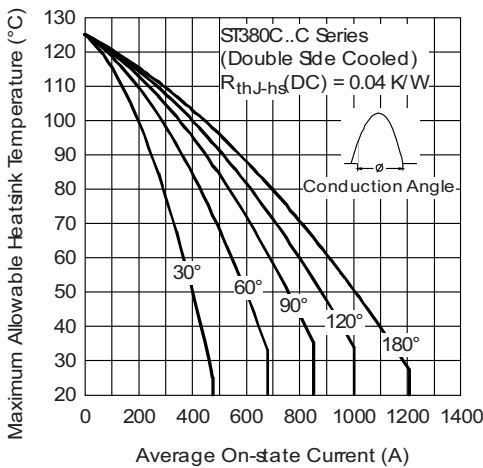


Fig. 3 - Current Ratings Characteristics

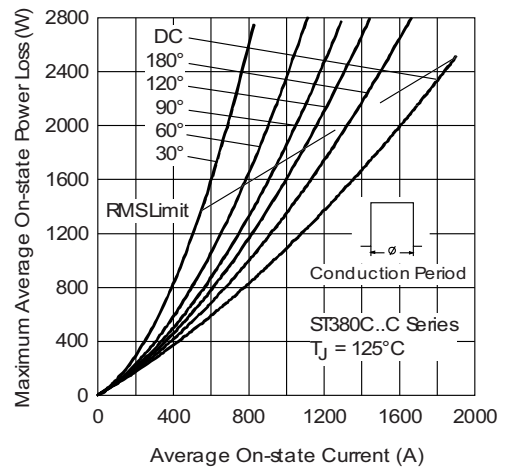


Fig. 6 - On-State Power Loss Characteristics

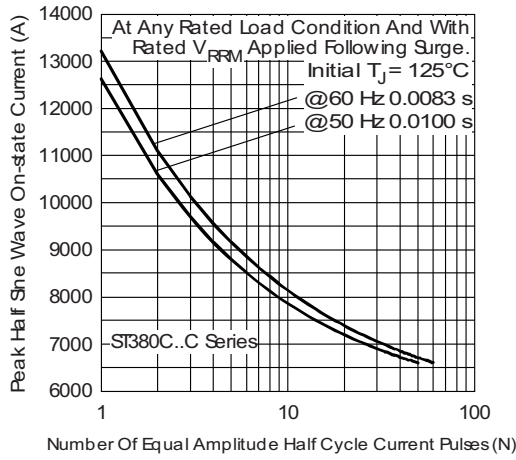


Fig. 7 - Maximum Non-Repetitive Surge Current Single and Double Side Cooled

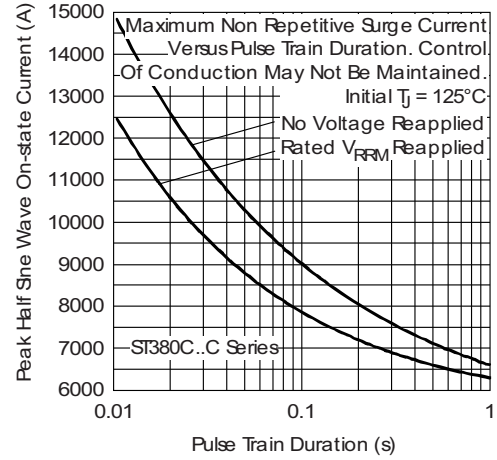


Fig. 8 - Maximum Non-Repetitive Surge Current Single and Double Side Cooled

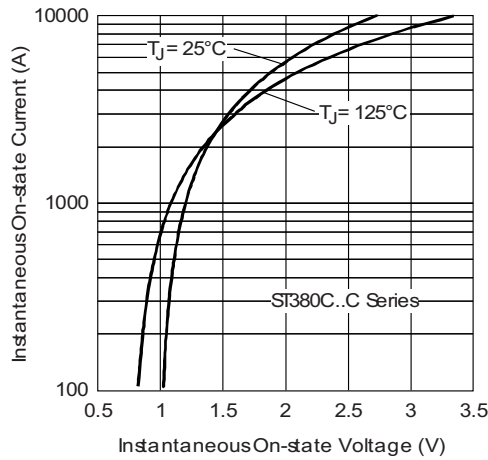


Fig. 9 - On-State Voltage Drop Characteristics

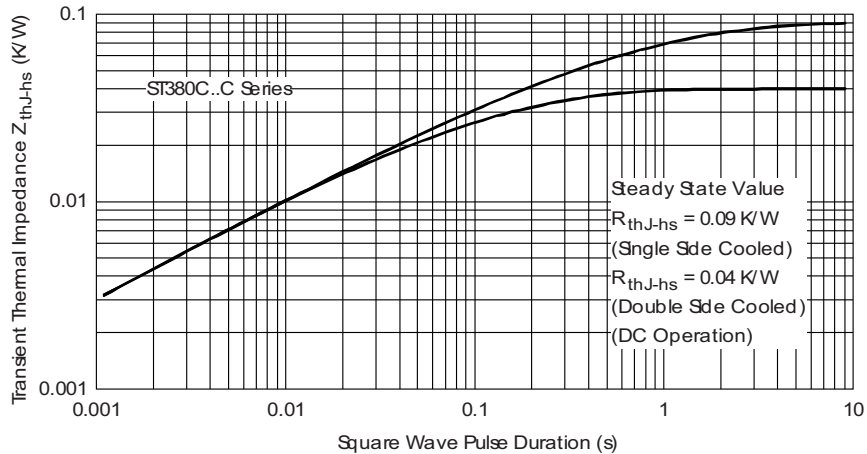


Fig. 10 - Thermal Impedance  $Z_{thJ-hs}$  Characteristics

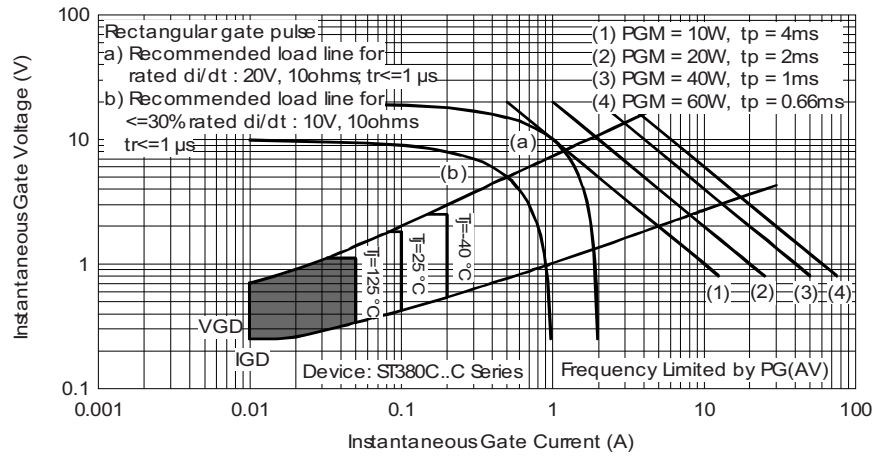


Fig. 11 - Gate Characteristics

## ORDERING INFORMATION TABLE

|             |            |           |           |          |          |           |          |          |          |
|-------------|------------|-----------|-----------|----------|----------|-----------|----------|----------|----------|
| Device code | <b>VS-</b> | <b>ST</b> | <b>38</b> | <b>0</b> | <b>C</b> | <b>06</b> | <b>C</b> | <b>1</b> | <b>-</b> |
|             | ①          | ②         | ③         | ④        | ⑤        | ⑥         | ⑦        | ⑧        | ⑨        |

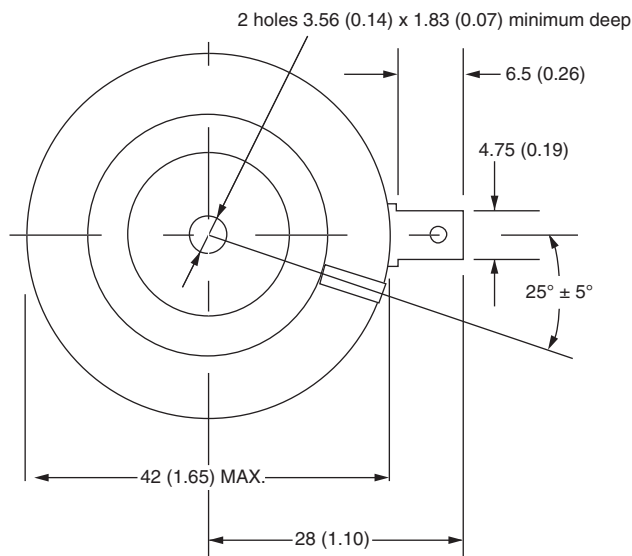
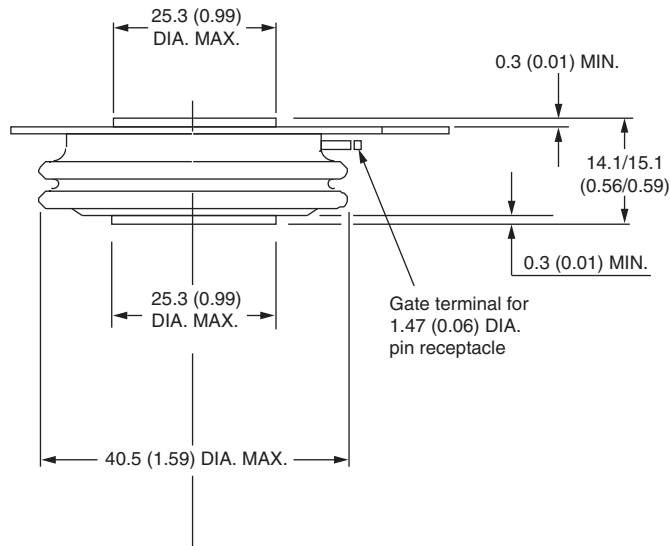
- 1** - Vishay Semiconductors product
- 2** - Thyristor
- 3** - Essential part number
- 4** - 0 = Converter grade
- 5** - C = Ceramic PUK
- 6** - Voltage code x 100 =  $V_{RRM}$  (see Voltage Ratings table)
- 7** - C = PUK case TO-200AB (E-PUK)
- 8** - 0 = Eyelet terminals (gate and auxiliary cathode 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/ $\mu$ 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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