

## Phase Control Thyristors (Hockey PUK Version), 650 A



E-PUK (TO-200AB)

### FEATURES

- Center amplifying gate
- Metal case with ceramic insulator
- International standard case E-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

|                       |                                              |
|-----------------------|----------------------------------------------|
| $I_{T(AV)}$           | 650 A                                        |
| $V_{DRM}/V_{RRM}$     | 400 V, 800 V, 1200 V, 1600 V, 1800 V, 2000 V |
| $V_{TM}$              | 2.18 V                                       |
| $I_{GT}$              | 100 mA                                       |
| $T_J$                 | -40 °C to +125 °C                            |
| Package               | E-PUK (TO-200AB)                             |
| Circuit configuration | Single SCR                                   |

### MAJOR RATINGS AND CHARACTERISTICS

| PARAMETER         | TEST CONDITIONS | VALUES      | UNITS             |
|-------------------|-----------------|-------------|-------------------|
| $I_{T(AV)}$       |                 | 650         | A                 |
|                   | $T_{hs}$        | 55          | °C                |
| $I_{T(RMS)}$      |                 | 1290        | A                 |
|                   | $T_{hs}$        | 25          | °C                |
| $I_{TSM}$         | 50 Hz           | 8000        | A                 |
|                   | 60 Hz           | 8380        |                   |
| $I^2t$            | 50 Hz           | 320         | kA <sup>2</sup> s |
|                   | 60 Hz           | 292         |                   |
| $V_{DRM}/V_{RRM}$ |                 | 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-ST300C..C | 04           | 400                                                                    | 500                                                  | 50                                                     |
|              | 08           | 800                                                                    | 900                                                  |                                                        |
|              | 12           | 1200                                                                   | 1300                                                 |                                                        |
|              | 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                        |                           | 650 (320) | A                  |
|                                                          |               |                                                                                         |                           | 55 (75)   | °C                 |
| Maximum RMS on-state current                             | $I_{T(RMS)}$  | DC at 25 °C heatsink temperature double side cooled                                     |                           | 1290      |                    |
| Maximum peak, one-cycle non-repetitive surge current     | $I_{TSM}$     | t = 10 ms                                                                               | No voltage reapplied      | 8000      | A                  |
|                                                          |               | t = 8.3 ms                                                                              | No voltage reapplied      | 8380      |                    |
|                                                          |               | t = 10 ms                                                                               | 100 % $V_{RRM}$ reapplied | 6730      |                    |
|                                                          |               | t = 8.3 ms                                                                              | 100 % $V_{RRM}$ reapplied | 7040      |                    |
| Maximum $I^2t$ for fusing                                | $I^2t$        | t = 10 ms                                                                               | No voltage reapplied      | 320       | kA <sup>2</sup> s  |
|                                                          |               | t = 8.3 ms                                                                              | No voltage reapplied      | 292       |                    |
|                                                          |               | t = 10 ms                                                                               | 100 % $V_{RRM}$ reapplied | 226       |                    |
|                                                          |               | t = 8.3 ms                                                                              | 100 % $V_{RRM}$ reapplied | 207       |                    |
| Maximum $I^2\sqrt{t}$ for fusing                         | $I^2\sqrt{t}$ | t = 0.1 to 10 ms, no voltage reapplied                                                  |                           | 3200      | 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 |                           | 0.97      | 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 |                           | 0.74      | mΩ                 |
| High level value of on-state slope resistance            | $r_{t2}$      | (I > $\pi \times I_{T(AV)}$ ), $T_J = T_J$ maximum                                      |                           | 0.73      |                    |
| Maximum on-state voltage                                 | $V_{TM}$      | $I_{pk} = 1635$ A, $T_J = T_J$ maximum, $t_p = 10$ ms sine pulse                        |                           | 2.18      | 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 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, $di/dt = 40$ 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 | $I_{RRM}, I_{DRM}$ | $T_J = T_J$ 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                          | 10.0   |      | 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 | E-PUK (TO-200AB) |           |

| $\Delta R_{thJ-hs}$ 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

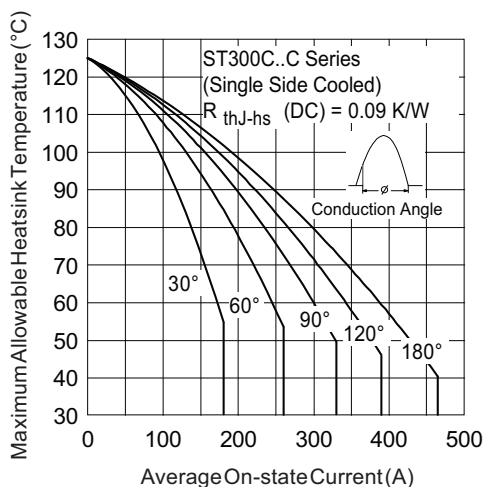


Fig. 1 - Current Ratings Characteristics

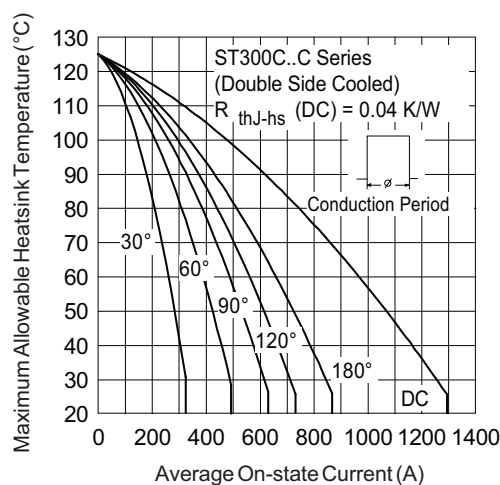


Fig. 4 - Current Ratings Characteristics

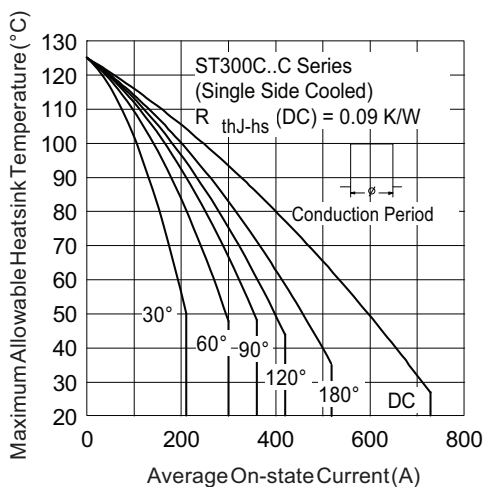


Fig. 2 - Current Ratings Characteristics

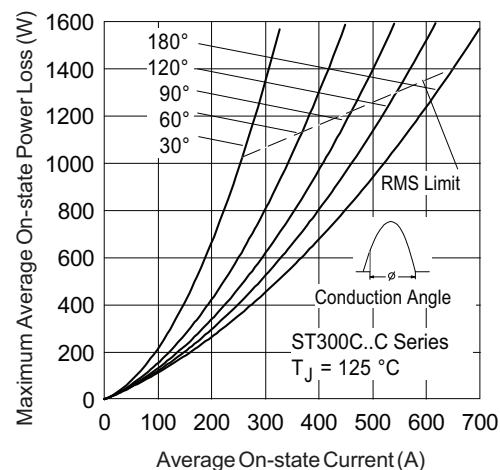


Fig. 5 - On-State Power Loss Characteristics

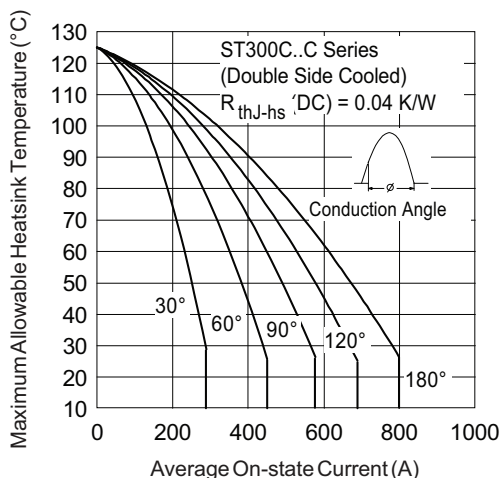


Fig. 3 - Current Ratings Characteristics

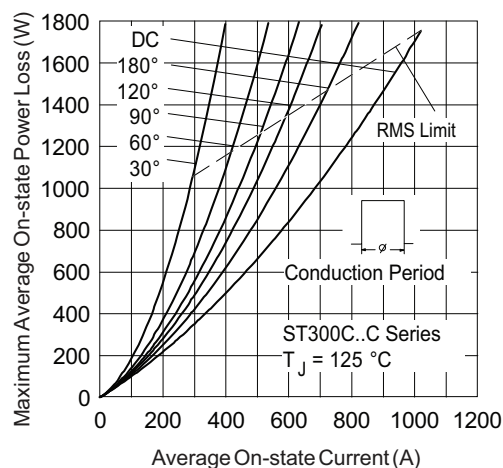


Fig. 6 - On-State Power Loss Characteristics

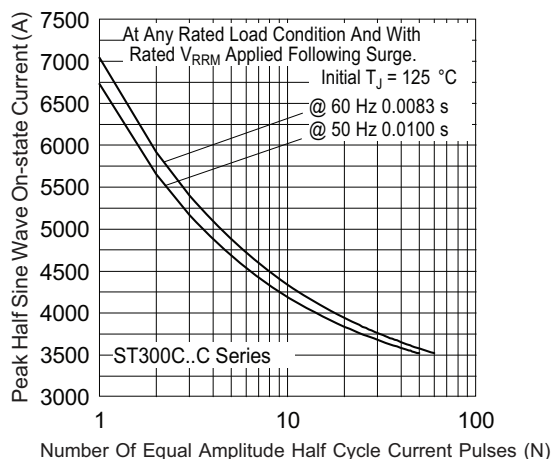


Fig. 7 - Maximum Non-Repetitive Surge Current Single and Double Side Cooled

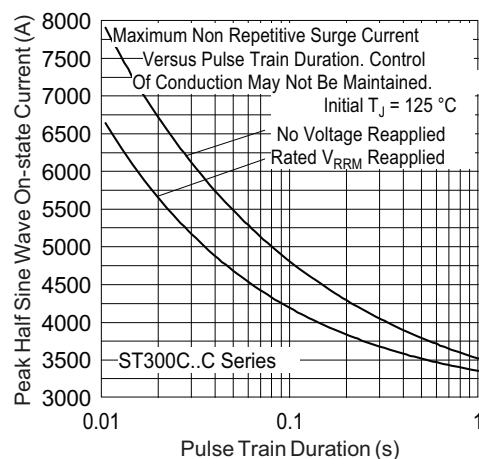


Fig. 8 - Maximum Non-Repetitive Surge Current Single and Double Side Cooled

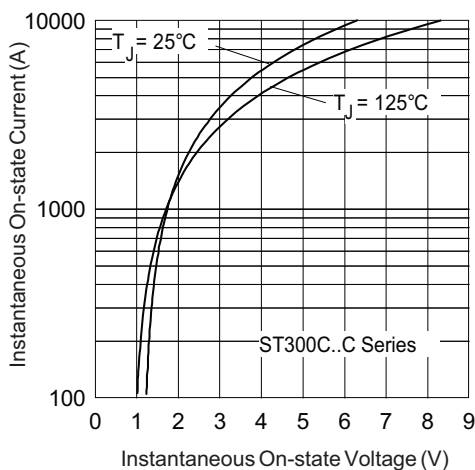


Fig. 9 - On-State Voltage Drop Characteristics

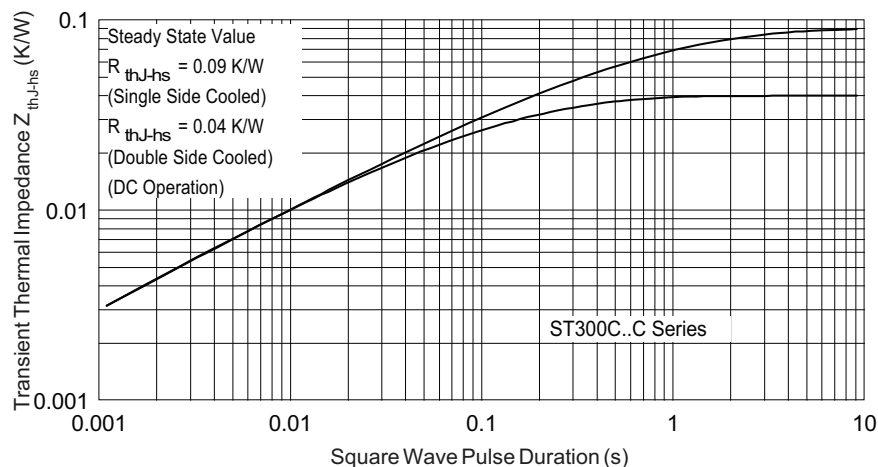


Fig. 10 - Thermal Impedance  $Z_{thJ-hs}$  Characteristics

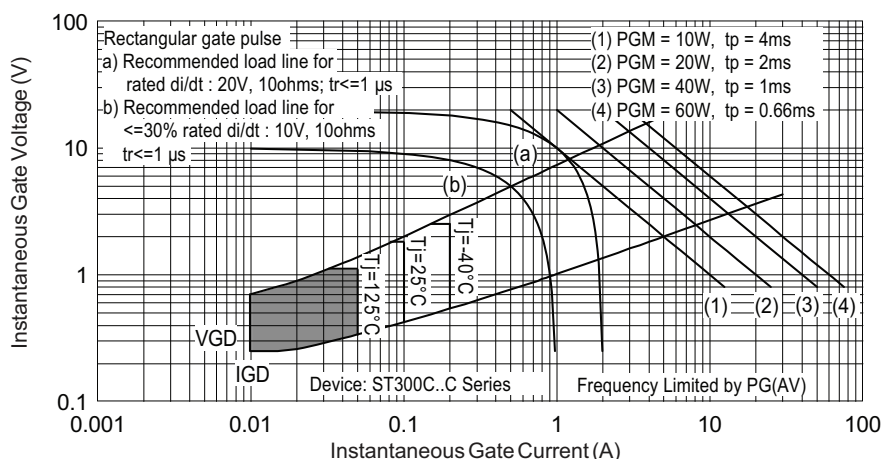


Fig. 11 - Gate Characteristics

## ORDERING INFORMATION TABLE

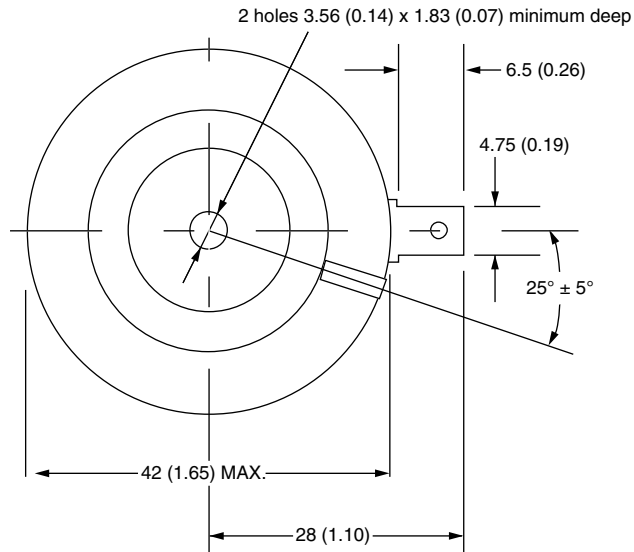
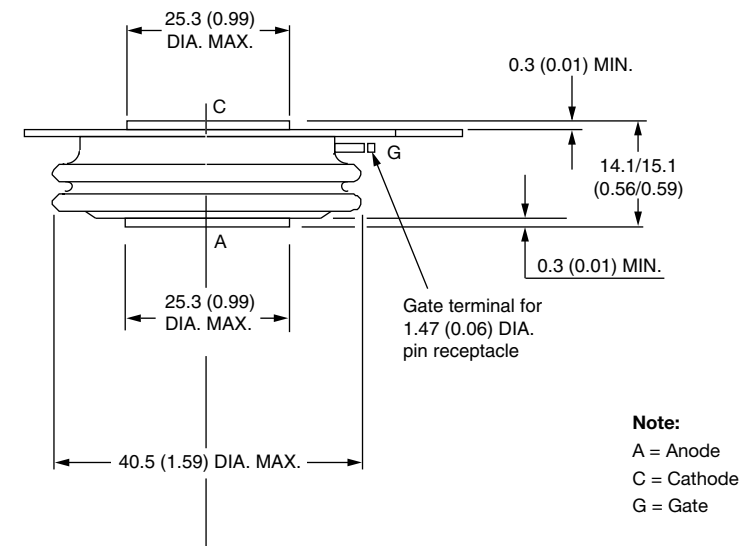
| Device code | VS-                                                                 | ST | 30 | 0 | C | 20 | C | 1 | - |
|-------------|---------------------------------------------------------------------|----|----|---|---|----|---|---|---|
|             | 1                                                                   | 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 E-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/ $\mu s$ (standard value)         |    |    |   |   |    |   |   |   |
|             | • L = 1000 V/ $\mu s$ (special selection)                           |    |    |   |   |    |   |   |   |

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

## E-PUK (TO-200AB)

### 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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