

## Medium Power Phase Control Thyristors (Stud Version), 22 A



TO-208AA (TO-48)

### FEATURES

- Improved glass passivation for high reliability and exceptional stability at high temperature
- High  $di/dt$  and  $dV/dt$  capabilities
- Standard package
- Low thermal resistance
- Metric threads version available
- Types up to 1200 V  $V_{DRM}/V_{RRM}$
- Designed and qualified for industrial and consumer level
- Material categorization: For definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


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### TYPICAL APPLICATIONS

- Medium power switching
- Phase control applications
- Can be supplied to meet stringent military, aerospace and other high reliability requirements

### PRODUCT SUMMARY

|                   |                  |
|-------------------|------------------|
| Package           | TO-208AA (TO-48) |
| Diode variation   | Single SCR       |
| $I_{T(AV)}$       | 22 A             |
| $V_{DRM}/V_{RRM}$ | 100 V to 1200 V  |
| $V_{TM}$          | 1.70 V           |
| $I_{GT}$          | 60 mA            |
| $T_J$             | -65 °C to 125 °C |

### MAJOR RATINGS AND CHARACTERISTICS

| PARAMETER         | TEST CONDITIONS | VALUES      | UNITS            |
|-------------------|-----------------|-------------|------------------|
| $I_{T(AV)}$       |                 | 22          | A                |
|                   | $T_C$           | 85          | °C               |
| $I_{T(RMS)}$      |                 | 35          | A                |
| $I_{TSM}$         | 50 Hz           | 400         | A                |
|                   | 60 Hz           | 420         |                  |
| $I^2t$            | 50 Hz           | 793         | A <sup>2</sup> s |
|                   | 60 Hz           | 724         |                  |
| $V_{DRM}/V_{RRM}$ |                 | 100 to 1200 | V                |
| $t_q$             | Typical         | 110         | μs               |
| $T_J$             |                 | -65 to 125  | °C               |

### ELECTRICAL SPECIFICATIONS

#### VOLTAGE RATINGS

| TYPE NUMBER | VOLTAGE CODE | $V_{DRM}/V_{RRM}$ , MAXIMUM REPETITIVE PEAK AND OFF-STATE VOLTAGE <sup>(1)</sup><br>V | $V_{RSM}$ , MAXIMUM NON-REPETITIVE PEAK VOLTAGE <sup>(2)</sup><br>V | $I_{DRM}/I_{RRM}$ MAXIMUM AT $T_J = T_J$ MAXIMUM<br>mA |
|-------------|--------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------|--------------------------------------------------------|
| VS-22RIA    | 10           | 100                                                                                   | 150                                                                 | 20                                                     |
|             | 20           | 200                                                                                   | 300                                                                 | 10                                                     |
|             | 40           | 400                                                                                   | 500                                                                 |                                                        |
|             | 60           | 600                                                                                   | 700                                                                 |                                                        |
|             | 80           | 800                                                                                   | 900                                                                 |                                                        |
|             | 100          | 1000                                                                                  | 1100                                                                |                                                        |
|             | 120          | 1200                                                                                  | 1300                                                                |                                                        |

#### Notes

- <sup>(1)</sup> Units may be broken over non-repetitively in the off-state direction without damage, if  $di/dt$  does not exceed 20 A/μs
- <sup>(2)</sup> For voltage pulses with  $t_p \leq 5$  ms



| ABSOLUTE MAXIMUM RATINGS                             |                     |                                                                                                           |                                  |                                                                       |        |                   |
|------------------------------------------------------|---------------------|-----------------------------------------------------------------------------------------------------------|----------------------------------|-----------------------------------------------------------------------|--------|-------------------|
| PARAMETER                                            | SYMBOL              | TEST CONDITIONS                                                                                           |                                  |                                                                       | VALUES | UNITS             |
| Maximum average on-state current at case temperature | I <sub>T(AV)</sub>  | 180° sinusoidal conduction                                                                                |                                  |                                                                       | 22     | A                 |
|                                                      |                     |                                                                                                           |                                  |                                                                       | 85     | °C                |
| Maximum RMS on-state current                         | I <sub>T(RMS)</sub> |                                                                                                           |                                  |                                                                       | 35     | 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 | 400    | A                 |
|                                                      |                     | t = 8.3 ms                                                                                                |                                  |                                                                       | 420    |                   |
|                                                      |                     | t = 10 ms                                                                                                 | 100 % V <sub>RRM</sub> reapplied |                                                                       | 335    |                   |
|                                                      |                     | t = 8.3 ms                                                                                                |                                  |                                                                       | 355    |                   |
| Maximum I <sup>2</sup> t for fusing                  | I <sup>2</sup> t    | t = 10 ms                                                                                                 | No voltage reapplied             |                                                                       | 793    | A <sup>2</sup> s  |
|                                                      |                     | t = 8.3 ms                                                                                                |                                  |                                                                       | 724    |                   |
|                                                      |                     | t = 10 ms                                                                                                 | 100 % V <sub>RRM</sub> reapplied |                                                                       | 560    |                   |
|                                                      |                     | t = 8.3 ms                                                                                                |                                  |                                                                       | 515    |                   |
| Maximum I <sup>2</sup> √t for fusing                 | I <sup>2</sup> √t   | t = 0.1 to 10 ms, no voltage reapplied, T <sub>J</sub> = T <sub>J</sub> maximum                           |                                  |                                                                       | 7930   | A <sup>2</sup> √s |
| Low level value of threshold voltage                 | V <sub>T(TO)1</sub> | (16.7 % x π x I <sub>T(AV)</sub> ) < I < π x I <sub>T(AV)</sub> , T <sub>J</sub> = T <sub>J</sub> maximum |                                  |                                                                       | 0.83   | V                 |
| High level value of threshold voltage                | V <sub>T(TO)2</sub> | (I > π x I <sub>T(AV)</sub> ), T <sub>J</sub> = T <sub>J</sub> maximum                                    |                                  |                                                                       | 0.95   |                   |
| Low level value of on-state slope resistance         | r <sub>t1</sub>     | (16.7 % x π x I <sub>T(AV)</sub> ) < I < π x I <sub>T(AV)</sub> , T <sub>J</sub> = T <sub>J</sub> maximum |                                  |                                                                       | 14.9   | mΩ                |
| High level value of on-state slope resistance        | r <sub>t2</sub>     | (I > π x I <sub>T(AV)</sub> ), T <sub>J</sub> = T <sub>J</sub> maximum                                    |                                  |                                                                       | 13.4   |                   |
| Maximum on-state voltage                             | V <sub>TM</sub>     | I <sub>pk</sub> = 70 A, T <sub>J</sub> = 25 °C                                                            |                                  |                                                                       | 1.70   | V                 |
| Maximum holding current                              | I <sub>H</sub>      | T <sub>J</sub> = 25 °C, anode supply 6 V, resistive load                                                  |                                  |                                                                       | 130    | mA                |
| Latching current                                     | I <sub>L</sub>      |                                                                                                           |                                  |                                                                       | 200    |                   |

| SWITCHING                                 |                              |          |                                                                                                                                                                                                                         |        |                  |
|-------------------------------------------|------------------------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------------------|
| PARAMETER                                 |                              | SYMBOL   | TEST CONDITIONS                                                                                                                                                                                                         | VALUES | UNITS            |
| Maximum rate of rise of turned-on current | $V_{DRM} \leq 600\text{ V}$  | di/dt    | $T_J = T_J$ maximum, $V_{DM} = \text{Rated } V_{DRM}$<br>Gate pulse = 20 V, 15 $\Omega$ , $t_p = 6\text{ }\mu\text{s}$ , $t_r = 0.1\text{ }\mu\text{s}$ maximum<br>$I_{TM} = (2 \times \text{rated di/dt})\text{ A}$    | 200    | A/ $\mu\text{s}$ |
|                                           | $V_{DRM} \leq 800\text{ V}$  |          |                                                                                                                                                                                                                         | 180    |                  |
|                                           | $V_{DRM} \leq 1000\text{ V}$ |          |                                                                                                                                                                                                                         | 160    |                  |
|                                           | $V_{DRM} \leq 1600\text{ V}$ |          |                                                                                                                                                                                                                         | 150    |                  |
| Typical turn-on time                      |                              | $t_{gt}$ | $T_J = 25\text{ }^\circ\text{C}$ , at rated $V_{DRM}/V_{RRM}$ , $T_J = 125\text{ }^\circ\text{C}$                                                                                                                       | 0.9    | $\mu\text{s}$    |
| Typical reverse recovery time             |                              | $t_{rr}$ | $T_J = T_J$ maximum, $I_{TM} = I_{T(AV)}$ , $t_p > 200\text{ }\mu\text{s}$ ,<br>di/dt = - 10 A/ $\mu\text{s}$                                                                                                           | 4      |                  |
| Typical turn-off time                     |                              | $t_q$    | $T_J = T_J$ maximum, $I_{TM} = I_{T(AV)}$ , $t_p > 200\text{ }\mu\text{s}$ , $V_R = 100\text{ V}$ ,<br>di/dt = - 10 A/ $\mu\text{s}$ , dV/dt = 20 V/ $\mu\text{s}$ linear to 67 % $V_{DRM}$ ,<br>gate bias 0 V to 100 W | 110    |                  |

**Note**

- $t_q = 10\text{ }\mu s$  up to 600 V,  $t_q = 30\text{ }\mu s$  up to 1600 V available on special request

| BLOCKING                                           |        |                                                                                |                    |       |
|----------------------------------------------------|--------|--------------------------------------------------------------------------------|--------------------|-------|
| PARAMETER                                          | SYMBOL | TEST CONDITIONS                                                                | VALUES             | UNITS |
| Maximum critical rate of rise of off-state voltage | dV/dt  | T <sub>J</sub> = T <sub>J</sub> maximum linear to 100 % rated V <sub>DRM</sub> | 100                | V/μs  |
|                                                    |        | T <sub>J</sub> = T <sub>J</sub> maximum linear to 67 % rated V <sub>DRM</sub>  | 300 <sup>(1)</sup> |       |

**Note**

<sup>(1)</sup> Available with:  $dV/dt = 1000\text{ V}/\mu s$ , to complete code add S90 i.e. 22RIA120S90



| TRIGGERING                          |                    |                                                                         |                                                                                                                                                       |        |       |
|-------------------------------------|--------------------|-------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|--------|-------|
| PARAMETER                           | SYMBOL             | TEST CONDITIONS                                                         |                                                                                                                                                       | VALUES | UNITS |
| Maximum peak gate power             | P <sub>GM</sub>    | T <sub>J</sub> = T <sub>J</sub> maximum                                 |                                                                                                                                                       | 8.0    | W     |
| Maximum average gate power          | P <sub>G(AV)</sub> |                                                                         |                                                                                                                                                       | 2.0    |       |
| Maximum peak positive gate current  | I <sub>GM</sub>    | T <sub>J</sub> = T <sub>J</sub> maximum                                 |                                                                                                                                                       | 1.5    | A     |
| Maximum peak negative gate voltage  | -V <sub>GM</sub>   | T <sub>J</sub> = T <sub>J</sub> maximum                                 |                                                                                                                                                       | 10     | V     |
| DC gate current required to trigger | I <sub>GT</sub>    | T <sub>J</sub> = - 65 °C                                                | Maximum required gate trigger current/voltage are the lowest value which will trigger all units 6 V anode to cathode applied                          | 90     | mA    |
|                                     |                    | T <sub>J</sub> = 25 °C                                                  |                                                                                                                                                       | 60     |       |
|                                     |                    | T <sub>J</sub> = 125 °C                                                 |                                                                                                                                                       | 35     |       |
| DC gate voltage required to trigger | V <sub>GT</sub>    | T <sub>J</sub> = - 65 °C                                                |                                                                                                                                                       | 3.0    | V     |
|                                     |                    | T <sub>J</sub> = 25 °C                                                  |                                                                                                                                                       | 2.0    |       |
|                                     |                    | T <sub>J</sub> = 125 °C                                                 |                                                                                                                                                       | 1.0    |       |
| DC gate current not to trigger      | I <sub>GD</sub>    | T <sub>J</sub> = T <sub>J</sub> maximum, V <sub>DRM</sub> = Rated value |                                                                                                                                                       | 2.0    | mA    |
| DC gate voltage not to trigger      | V <sub>GD</sub>    | T <sub>J</sub> = T <sub>J</sub> maximum, V <sub>DRM</sub> = Rated value | Maximum gate current/voltage not to trigger is the maximum value which will not trigger any unit with rated V <sub>DRM</sub> anode to cathode applied | 0.2    | V     |

| THERMAL AND MECHANICAL SPECIFICATIONS                    |                                   |                                                |                  |           |          |
|----------------------------------------------------------|-----------------------------------|------------------------------------------------|------------------|-----------|----------|
| PARAMETER                                                | SYMBOL                            | TEST CONDITIONS                                | VALUES           |           | UNITS    |
| Maximum operating junction and storage temperature range | T <sub>J</sub> , T <sub>Stg</sub> |                                                | -65 to 125       |           | °C       |
| Maximum thermal resistance, junction to case             | R <sub>thJC</sub>                 | DC operation                                   | 0.86             |           | K/W      |
| Maximum thermal resistance, case to heatsink             | R <sub>thCS</sub>                 | Mounting surface, smooth, flat and greased     | 0.35             |           |          |
|                                                          |                                   |                                                | TO NUT           | TO DEVICE |          |
| Mounting torque                                          |                                   | Lubricated threads<br>(Non-lubricated threads) | 20 (27.5)        | 25        | lbf · in |
|                                                          |                                   |                                                | 0.23 (0.32)      | 0.29      | kgf · m  |
|                                                          |                                   |                                                | 2.3 (3.1)        | 2.8       | N · m    |
| Approximate weight                                       |                                   |                                                | 14               |           | g        |
|                                                          |                                   |                                                | 0.49             |           | oz.      |
| Case style                                               |                                   | See dimensions - link at the end of datasheet  | TO-208AA (TO-48) |           |          |

| $\Delta R_{thJC}$ CONDUCTION |                       |                        |                     |       |
|------------------------------|-----------------------|------------------------|---------------------|-------|
| CONDUCTION ANGLE             | SINUSOIDAL CONDUCTION | RECTANGULAR CONDUCTION | TEST CONDITIONS     | UNITS |
| 180°                         | 0.21                  | 0.15                   | $T_J = T_J$ maximum | K/W   |
| 120°                         | 0.25                  | 0.25                   |                     |       |
| 90°                          | 0.31                  | 0.34                   |                     |       |
| 60°                          | 0.45                  | 0.47                   |                     |       |
| 30°                          | 0.76                  | 0.76                   |                     |       |

**Note**

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

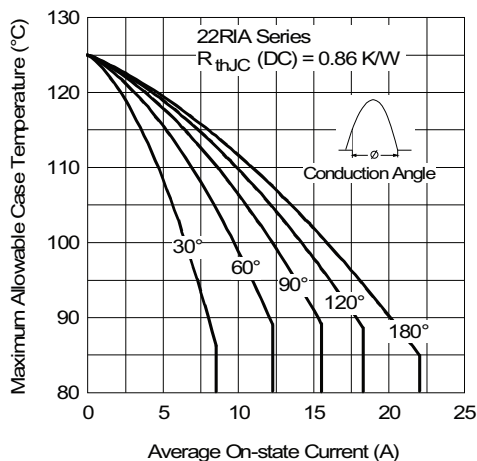


Fig. 1 - Current Ratings Characteristics

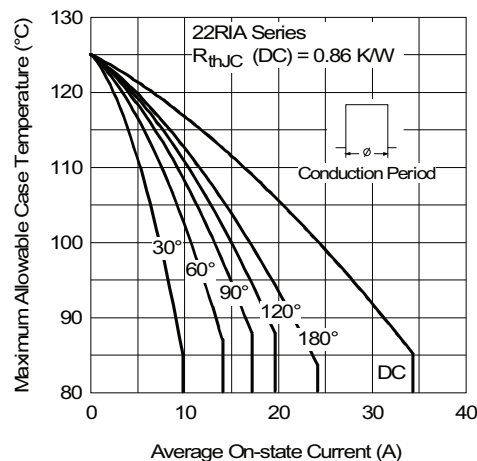


Fig. 1 - Current Ratings Characteristics

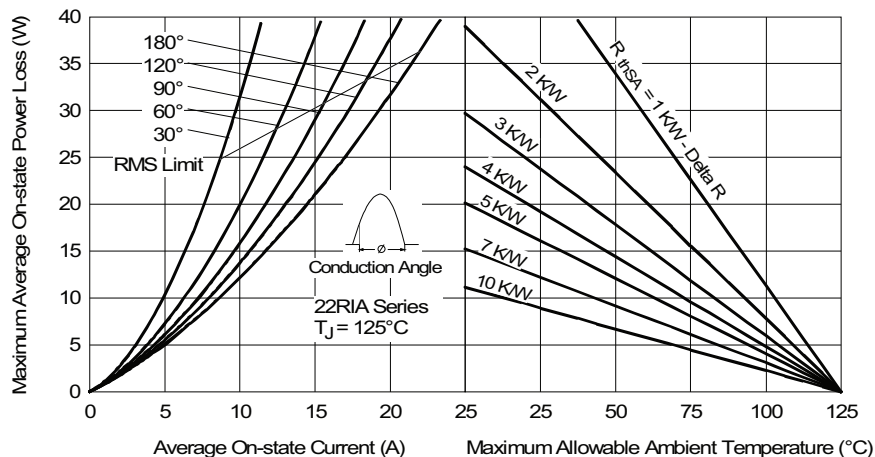


Fig. 2 - On-State Power Loss Characteristics

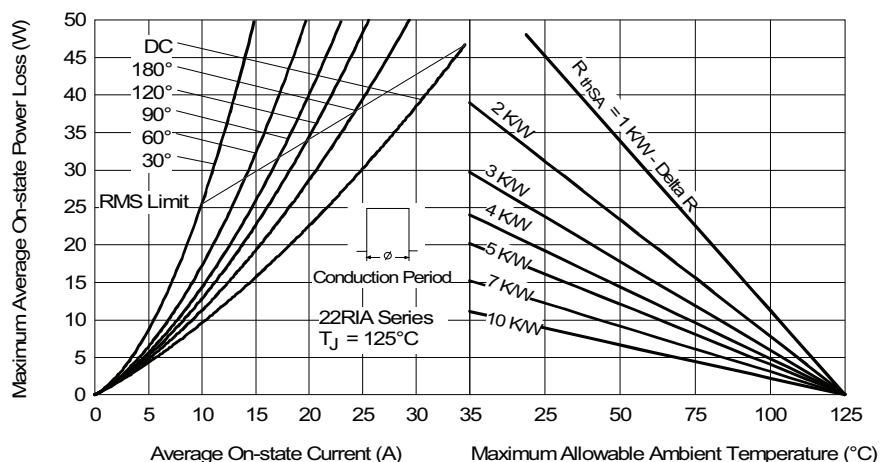


Fig. 3 - On-State Power Loss Characteristics

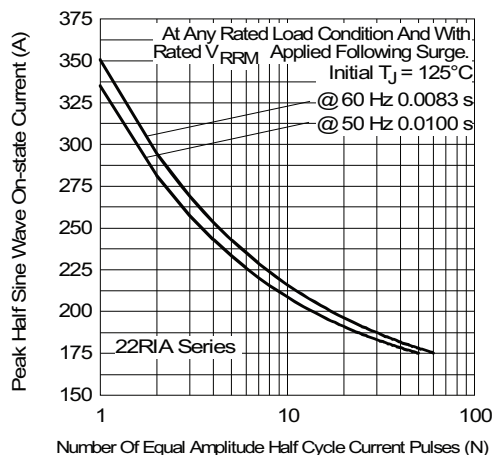


Fig. 4 - Maximum Non-Repetitive Surge Current

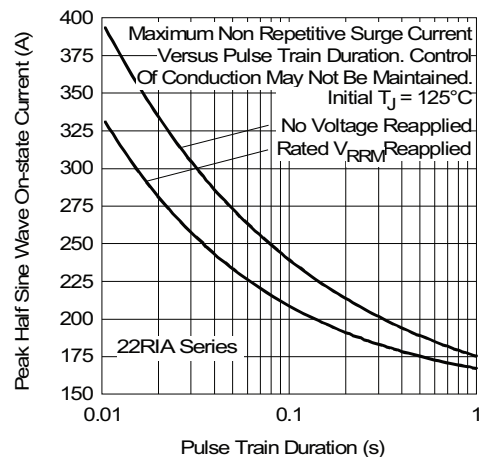


Fig. 5 - Maximum Non-Repetitive Surge Current

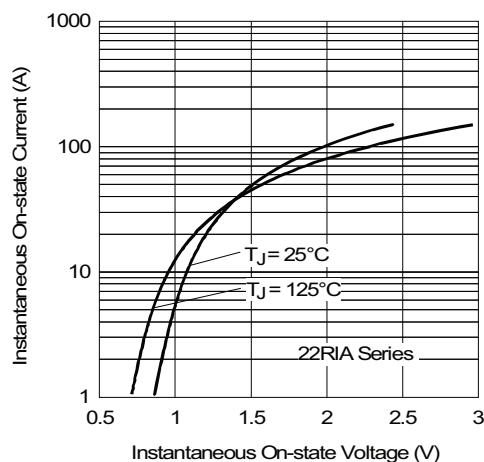


Fig. 6 - Forward Voltage Drop Characteristics

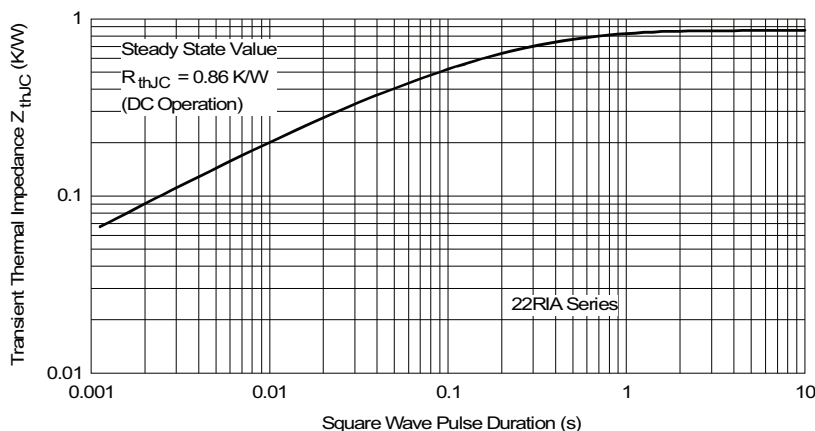


Fig. 7 - Thermal Impedance  $Z_{thJC}$  Characteristics

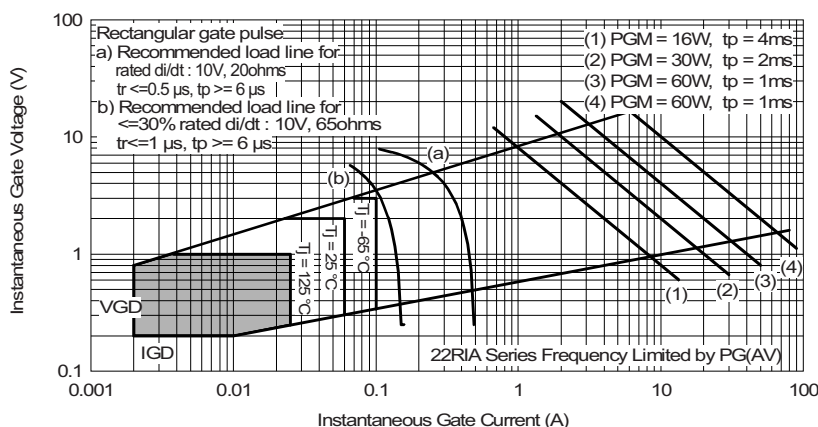


Fig. 8 - Gate Characteristics

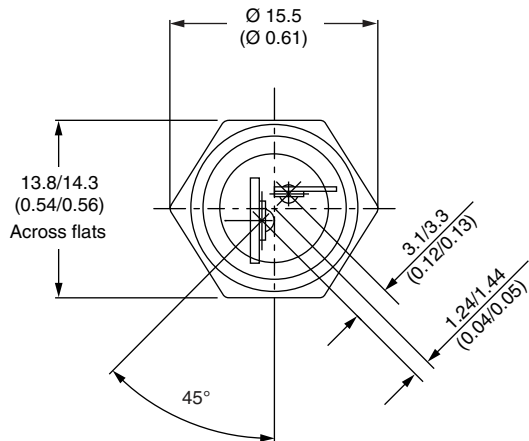
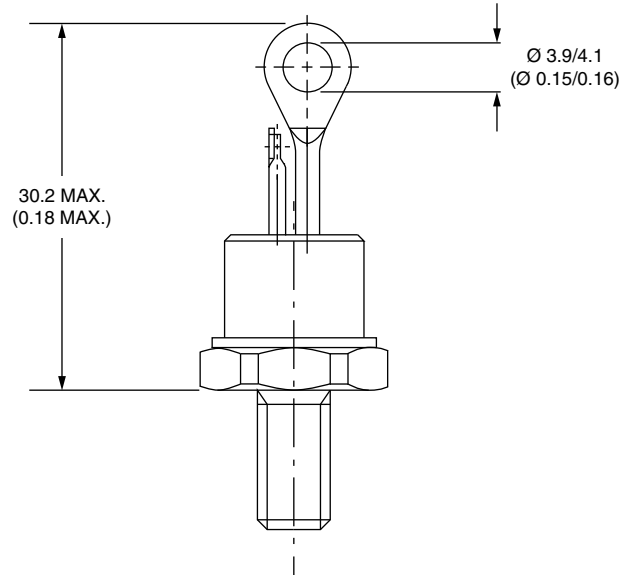
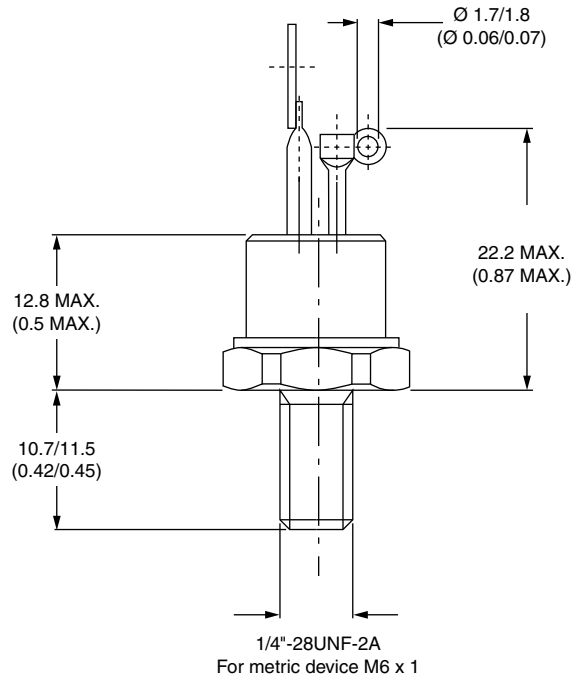
## ORDERING INFORMATION TABLE

| Device code | VS-                                                                                                       | 22 | RIA | 120 | M | S90 |
|-------------|-----------------------------------------------------------------------------------------------------------|----|-----|-----|---|-----|
|             | 1                                                                                                         | 2  | 3   | 4   | 5 | 6   |
| 1           | Vishay Semiconductors product                                                                             |    |     |     |   |     |
| 2           | Current code                                                                                              |    |     |     |   |     |
| 3           | Essential part number                                                                                     |    |     |     |   |     |
| 4           | Voltage code x 10 = $V_{RRM}$ (see Voltage Ratings table)                                                 |    |     |     |   |     |
| 5           | None = Stud base TO-208AA (TO-48) 1/4" 28UNF-2A<br>M = Stud base TO-208AA (TO-48) M6 x 1                  |    |     |     |   |     |
| 6           | Critical $dV/dt$ :<br>None = 300 V/ $\mu s$ (standard value)<br>S90 = 1000 V/ $\mu s$ (special selection) |    |     |     |   |     |

| LINKS TO RELATED DOCUMENTS |                                                                        |
|----------------------------|------------------------------------------------------------------------|
| Dimensions                 | <a href="http://www.vishay.com/doc?95333">www.vishay.com/doc?95333</a> |

## TO-208AA (TO-48)

**DIMENSIONS** in millimeters (inches)





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