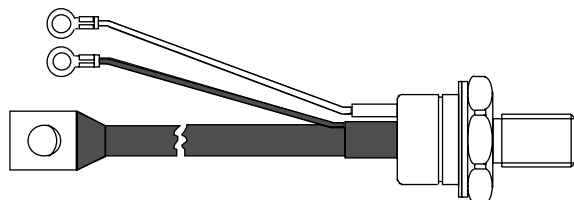


### Phase Control Thyristors (Stud Version), 110 A



TO-209AC (TO-94)

#### FEATURES

- High current and high surge ratings
- Hermetic ceramic housing
- RoHS compliant
- Designed and qualified for industrial level



#### TYPICAL APPLICATIONS

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

#### PRODUCT SUMMARY

|             |       |
|-------------|-------|
| $I_{T(AV)}$ | 110 A |
|-------------|-------|

#### MAJOR RATINGS AND CHARACTERISTICS

| PARAMETER         | TEST CONDITIONS | VALUES      | UNITS             |
|-------------------|-----------------|-------------|-------------------|
| $I_{T(AV)}$       |                 | 110         | A                 |
|                   | $T_C$           | 90          | °C                |
| $I_{T(RMS)}$      |                 | 172         | A                 |
| $I_{TSM}$         | 50 Hz           | 2080        | A                 |
|                   | 60 Hz           | 2180        |                   |
| $I^2t$            | 50 Hz           | 21.7        | kA <sup>2</sup> s |
|                   | 60 Hz           | 19.8        |                   |
| $V_{DRM}/V_{RRM}$ |                 | 400 to 1200 | V                 |
| $t_q$             | Typical         | 110         | μs                |
| $T_J$             |                 | - 40 to 140 | °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 |
|-------------|--------------|------------------------------------------------------------------------|------------------------------------------------------|--------------------------------------------------------|
| 110/111RKI  | 40           | 400                                                                    | 500                                                  | 20                                                     |
|             | 80           | 800                                                                    | 900                                                  |                                                        |
|             | 120          | 1200                                                                   | 1300                                                 |                                                        |

| ABSOLUTE MAXIMUM RATINGS                             |                     |                                                                                                          |                                  |                                                                       |        |                    |
|------------------------------------------------------|---------------------|----------------------------------------------------------------------------------------------------------|----------------------------------|-----------------------------------------------------------------------|--------|--------------------|
| PARAMETER                                            | SYMBOL              | TEST CONDITIONS                                                                                          |                                  |                                                                       | VALUES | UNITS              |
| Maximum average on-state current at case temperature | I <sub>T(AV)</sub>  | 180° conduction, half sine wave                                                                          |                                  |                                                                       | 110    | A                  |
|                                                      |                     |                                                                                                          |                                  |                                                                       | 90     | °C                 |
| Maximum RMS on-state current                         | I <sub>T(RMS)</sub> | DC at 83 °C case temperature                                                                             |                                  |                                                                       | 172    | 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 | 2080   | A                  |
|                                                      |                     | t = 8.3 ms                                                                                               |                                  |                                                                       | 2180   |                    |
|                                                      |                     | t = 10 ms                                                                                                | 100 % V <sub>RRM</sub> reapplied |                                                                       | 1750   |                    |
|                                                      |                     | t = 8.3 ms                                                                                               |                                  |                                                                       | 1830   |                    |
| Maximum I <sup>2</sup> t for fusing                  | I <sup>2</sup> t    | t = 10 ms                                                                                                | No voltage reapplied             |                                                                       | 21.7   | kA <sup>2</sup> s  |
|                                                      |                     | t = 8.3 ms                                                                                               |                                  |                                                                       | 19.8   |                    |
|                                                      |                     | t = 10 ms                                                                                                | 100 % V <sub>RRM</sub> reapplied |                                                                       | 15.3   |                    |
|                                                      |                     | t = 8.3 ms                                                                                               |                                  |                                                                       | 14.0   |                    |
| Maximum I <sup>2</sup> √t for fusing                 | I <sup>2</sup> √t   | t = 0.1 to 10 ms, no voltage reapplied                                                                   |                                  |                                                                       | 217    | 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 |                                  |                                                                       | 0.82   | 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                                   |                                  |                                                                       | 1.02   |                    |
| 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 |                                  |                                                                       | 2.16   | 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                                   |                                  |                                                                       | 1.70   |                    |
| Maximum on-state voltage                             | V <sub>TM</sub>     | I <sub>pk</sub> = 350 A, T <sub>J</sub> = T <sub>J</sub> maximum, t <sub>p</sub> = 10 ms sine pulse      |                                  |                                                                       | 1.57   | V                  |
| Maximum holding current                              | I <sub>H</sub>      | T <sub>J</sub> = 25 °C, anode supply 6 V resistive load                                                  |                                  |                                                                       | 200    | mA                 |
| Typical latching current                             | I <sub>L</sub>      |                                                                                                          |                                  |                                                                       | 400    |                    |

| 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 $\leq 80$ % $V_{DRM}$         | 300    | 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                                    | $t_q$   | $I_{TM} = 50$ A, $T_J = T_J$ maximum, $di/dt = -5$ A/μs,<br>$V_R = 50$ V, $dV/dt = 20$ V/μs; gate 0 V 25 Ω | 110    |       |

| 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 | 20     | mA    |



| TRIGGERING                          |                    |                                                                |                                                                                                                                                                   |        |      |       |
|-------------------------------------|--------------------|----------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|-------|
| PARAMETER                           | SYMBOL             | TEST CONDITIONS                                                |                                                                                                                                                                   | VALUES |      | UNITS |
|                                     |                    |                                                                |                                                                                                                                                                   | TYP.   | MAX. |       |
| Maximum peak gate power             | P <sub>GM</sub>    | T <sub>J</sub> = T <sub>J</sub> maximum, t <sub>p</sub> ≤ 5 ms |                                                                                                                                                                   | 12     |      | W     |
| Maximum average gate power          | P <sub>G(AV)</sub> | T <sub>J</sub> = T <sub>J</sub> maximum, f = 50 Hz, d% = 50    |                                                                                                                                                                   | 3.0    |      |       |
| Maximum peak positive gate current  | I <sub>GM</sub>    | T <sub>J</sub> = T <sub>J</sub> maximum, t <sub>p</sub> ≤ 5 ms |                                                                                                                                                                   | 3.0    |      | A     |
| Maximum peak positive gate voltage  | +V <sub>GM</sub>   | T <sub>J</sub> = T <sub>J</sub> maximum, t <sub>p</sub> ≤ 5 ms |                                                                                                                                                                   | 20     |      | V     |
| Maximum peak negative gate voltage  | -V <sub>GM</sub>   |                                                                |                                                                                                                                                                   | 10     |      |       |
| DC gate current required to trigger | I <sub>GT</sub>    | T <sub>J</sub> = - 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                           | 180    | -    | mA    |
|                                     |                    | T <sub>J</sub> = 25 °C                                         |                                                                                                                                                                   | 80     | 120  |       |
|                                     |                    | T <sub>J</sub> = 140 °C                                        |                                                                                                                                                                   | 40     | -    |       |
| DC gate voltage required to trigger | V <sub>GT</sub>    | T <sub>J</sub> = - 40 °C                                       |                                                                                                                                                                   | 2.5    | -    | V     |
|                                     |                    | T <sub>J</sub> = 25 °C                                         |                                                                                                                                                                   | 1.6    | 2    |       |
|                                     |                    | T <sub>J</sub> = 140 °C                                        |                                                                                                                                                                   | 1      | -    |       |
| DC gate current not to trigger      | I <sub>GD</sub>    | T <sub>J</sub> = T <sub>J</sub> maximum                        | Maximum gate current/voltage<br>not to trigger is the maximum<br>value which will not trigger any<br>unit with rated V <sub>DRM</sub> anode to<br>cathode applied | 6.0    |      | mA    |
| DC gate voltage not to trigger      | V <sub>GD</sub>    |                                                                |                                                                                                                                                                   | 0.25   |      | V     |

| THERMAL AND MECHANICAL SPECIFICATIONS        |            |                                               |                  |                     |
|----------------------------------------------|------------|-----------------------------------------------|------------------|---------------------|
| PARAMETER                                    | SYMBOL     | TEST CONDITIONS                               | VALUES           | UNITS               |
| Maximum operating junction temperature range | $T_J$      |                                               | - 40 to 140      | °C                  |
| Maximum storage temperature range            | $T_{Stg}$  |                                               | - 40 to 150      |                     |
| Maximum thermal resistance, junction to case | $R_{thJC}$ | DC operation                                  | 0.27             | K/W                 |
| Maximum thermal resistance, case to heatsink | $R_{thCS}$ | Mounting surface, smooth, flat and greased    | 0.1              |                     |
| Mounting torque, $\pm 10$ %                  |            | Non-lubricated threads                        | 15.5<br>(137)    | N · m<br>(lbf · in) |
|                                              |            | Lubricated threads                            | 14<br>(120)      |                     |
| Approximate weight                           |            |                                               | 130              | g                   |
| Case style                                   |            | See dimensions - link at the end of datasheet | TO-209AC (TO-94) |                     |

| $\Delta R_{thJC}$ CONDUCTION |                       |                        |                     |       |
|------------------------------|-----------------------|------------------------|---------------------|-------|
| CONDUCTION ANGLE             | SINUSOIDAL CONDUCTION | RECTANGULAR CONDUCTION | TEST CONDITIONS     | UNITS |
| 180°                         | 0.043                 | 0.031                  | $T_J = T_J$ maximum | K/W   |
| 120°                         | 0.052                 | 0.053                  |                     |       |
| 90°                          | 0.066                 | 0.071                  |                     |       |
| 60°                          | 0.096                 | 0.101                  |                     |       |
| 30°                          | 0.167                 | 0.169                  |                     |       |

**Note**

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

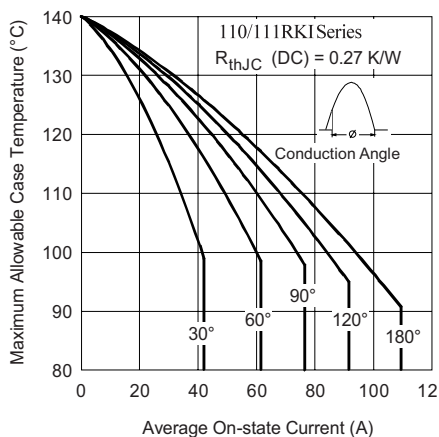


Fig. 1 - Current Ratings Characteristics

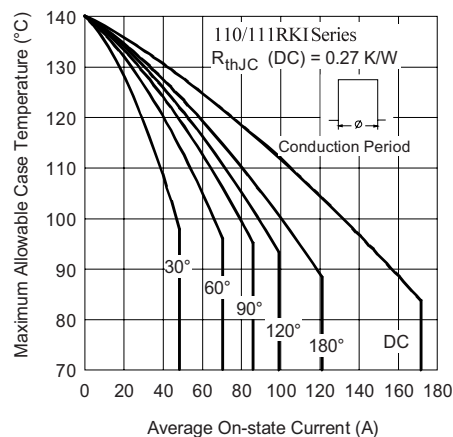


Fig. 2 - Current Ratings Characteristics

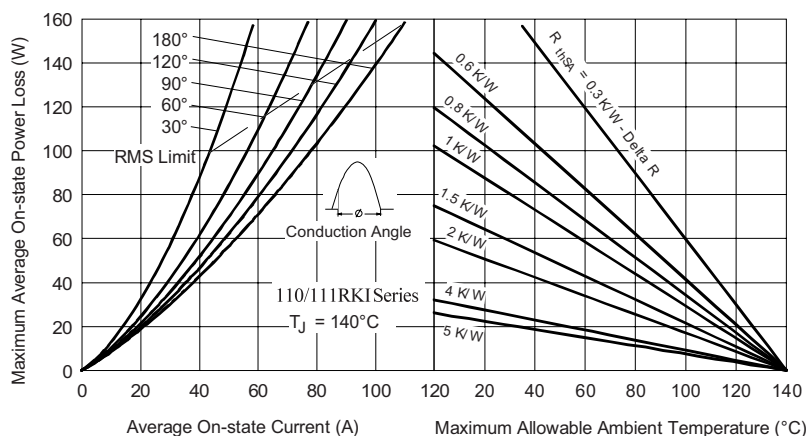


Fig. 3 - On-State Power Loss Characteristics

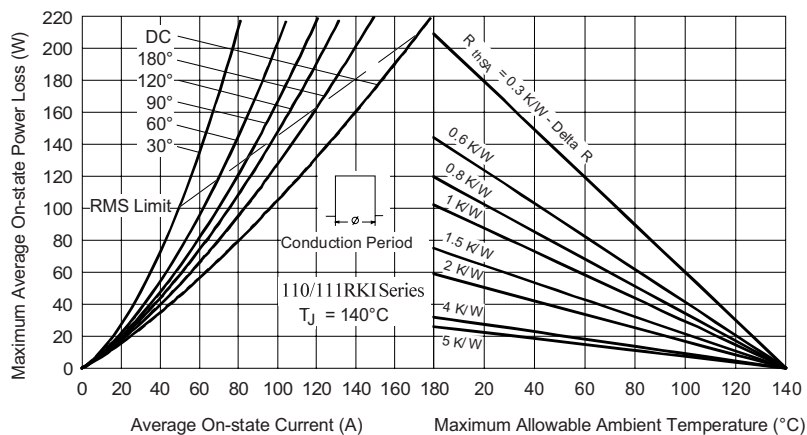


Fig. 4 - On-State Power Loss Characteristics

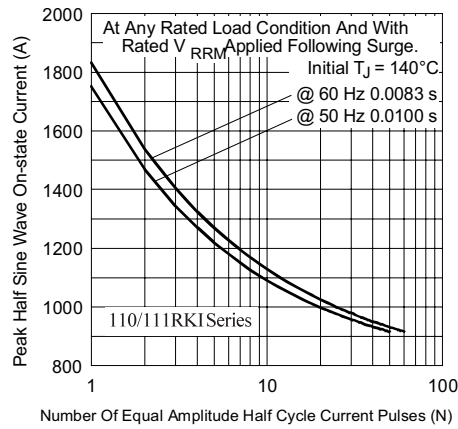


Fig. 5 - Maximum Non-Repetitive Surge Current

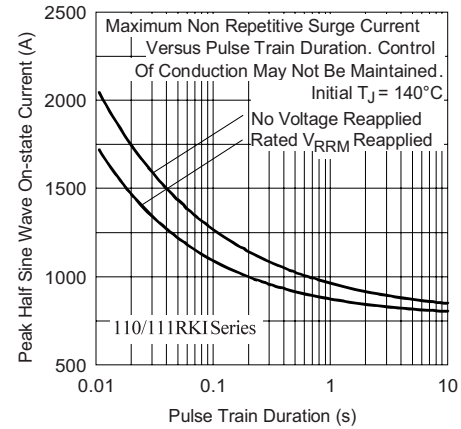


Fig. 6 - Maximum Non-Repetitive Surge Current

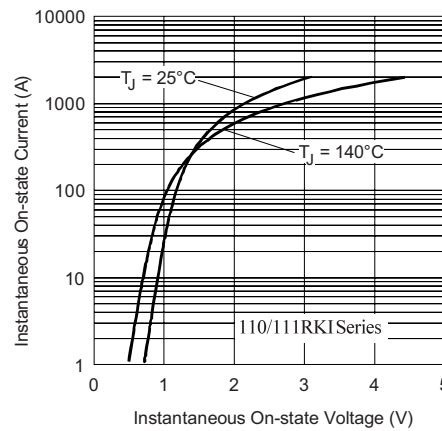


Fig. 7 - On-State Voltage Drop Characteristics

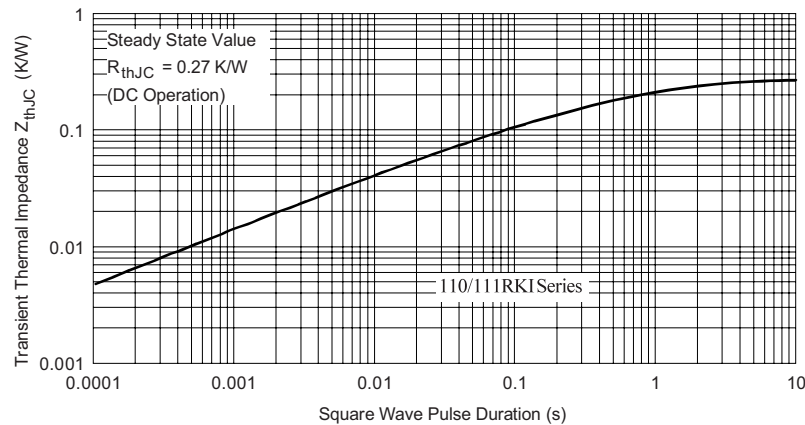


Fig. 8 - Thermal Impedance  $Z_{thJC}$  Characteristics

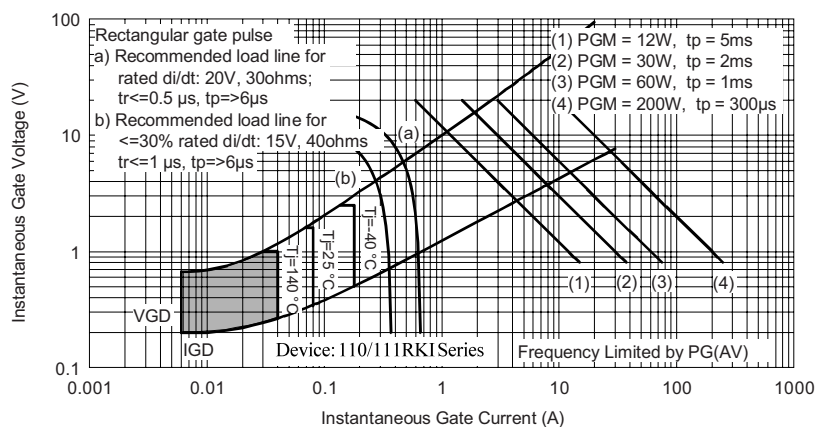


Fig. 9 - Gate Characteristics

## ORDERING INFORMATION TABLE

**Device code**

|           |          |            |            |
|-----------|----------|------------|------------|
| <b>11</b> | <b>1</b> | <b>RKI</b> | <b>120</b> |
|-----------|----------|------------|------------|

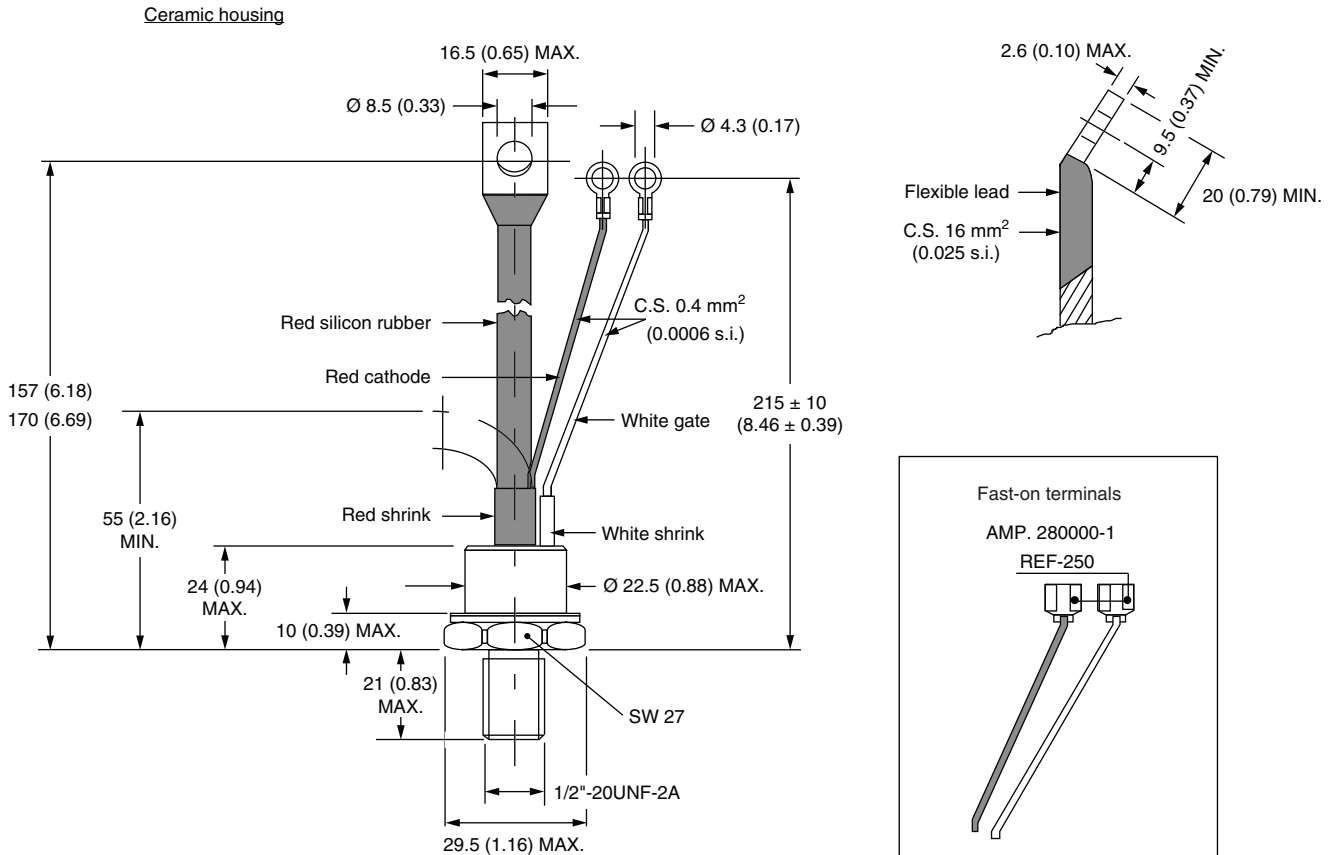
Diagram illustrating the Device code structure (11 1 RKI 120) with corresponding pin numbers (1, 2, 3, 4) below each digit.

- 1** -  $I_{T(AV)}$  rated average output current (rounded/10)
- 2** - 0 = Eyelet terminals (gate and auxiliary cathode leads)  
1 = Fast-on terminals (gate and auxiliary cathode leads)
- 3** - Thyristor
- 4** - Voltage code x 10 =  $V_{RRM}$  (see Voltage Ratings table)

| LINKS TO RELATED DOCUMENTS |                                                                               |
|----------------------------|-------------------------------------------------------------------------------|
| Dimensions                 | <a href="http://www.vishay.com/doc?95003">http://www.vishay.com/doc?95003</a> |

## TO-209AC (TO-94) for 110RKI and 111RKI Series

### DIMENSIONS in millimeters (inches)



### Note

- For metric device: M12 x 1.75 contact factory



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### Офис по работе с юридическими лицами:

105318, г.Москва, ул.Щербаковская д.3, офис 1107, 1118, ДЦ «Щербаковский»

Телефон: +7 495 668-12-70 (многоканальный)

Факс: +7 495 668-12-70 (доб.304)

E-mail: [info@moschip.ru](mailto:info@moschip.ru)

Skype отдела продаж:

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